

The diversity of wild orchids in the southern slope of Mount Merapi, Yogyakarta, Indonesia eight years after the 2010 eruption

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Abstract. Kurniawan FY, Putri F, Suyoko A, Masyhuri H, Sulistianingrum MP, Semiarti E. 2020. The diversity of wild orchids in the southern slope of Mount Merapi, Yogyakarta, Indonesia eight years after the 2010 eruption. *Biodiversitas* 21: 4457-4465. The ecosystem of the slopes of Mount Merapi is mountain tropical forest which is frequently affected by volcanic activities. The dynamics of the volcano affect the diversity and abundance of orchids in the ecosystem. Tritis is an area included in the Turgo Hill of the southern slope of Mount Merapi and is under the management of Mount Merapi National Park. The ecosystem in Tritis area classified as lower mountain forest and it has been affected by Mount Merapi eruption. This study aimed to do an inventory of orchid species in Tritis to know the diversity and abundance of orchids that exist in this area. In particular, we were interested to investigate the diversity after the 2010 eruption. The sampling was done using plot method by establishing four observation plots with size of each plot was 500 m x 20 m. The orchids found were identified using literature and we calculated the density, frequency, relative density, relative frequency and important value index. This study found 24 species of orchids, consisting of 15 species of epiphytic orchids, 6 terrestrial species, 2 holomycotrophic species and 1 semiterrestrial species. There were 6 species of orchids with the highest density and 2 species with the highest frequency value. *Thrixspermum* sp. and *Mycaranthes oblitterata* were the most dominant species in Tritis based on important value index. Overall, the diversity of orchids in Tritis can be categorized as high, likely because Tritis environment supports the growth of epiphytic orchids, but it is less favorable for the growth of terrestrial, holomycotrophic and semiterrestrial orchids. The results of this study can serve as baseline information to monitor the dynamics of orchid diversity and abundance in relation to the highly volcanic activities of Mount Merapi.

Keywords: Diversity, inventory, Mount Merapi, Orchidaceae, Tritis

INTRODUCTION

Orchidaceae is a family of flowering plants (spermatophyte) with a large number of species and varieties. Around 25,000-35,000 orchid species have been described and a fifth of them have original distribution in Indonesia (Schuttleworth et al. 1970; Sutyoso and Sarwono 2006). Indonesia is a tropical country with a great diversity of orchids, reaching 5000 species, but only around 1500 species have been identified (Semiarti 2012). There are 731 species of orchids distributed in Java Island in which 295 species are in Central Java, 390 are in East Java, and the most numerous are in West Java. From 731 species of total orchid species in Java are spread evenly in various regions, and some of them are endemic (Comber 1990).

Orchid diversity in Java Island is affected by altitude as it causes differences in environmental factors. Java Island consists of 92% areas with altitude of less than 1000 m asl (above sea level), 7% between 1000-2000 m asl and 0.7% more than 2000 m asl (Comber 1990). There are less than 10% of the areas in Java which have altitude of more than

1000 m asl and they are located in mountainous or hilly regions.

One of the mounts in Java is Mount Merapi. Mount Merapi is an active volcano with its summit has an altitude of 2986 m asl. Mount Merapi is located at 7°32'30" S and 110°26'30" E and administratively located in four districts and two provinces, namely Yogyakarta (Sleman District) and Central Java Province (Magelang, Boyolali, and Klaten Districts) (Kiswiranti and Kirbani 2013). The ecosystem type in Mount Merapi can be divided into lower mountain forests (1200-1800 m asl), upper mountain forests (1800-3000 m asl), and grassland (Rakhmawati 2008).

The ecosystems in Mount Merapi are mostly natural forests that are often affected by volcanic activities. Based on historical records, there have been approximately 61 eruptions of Mount Merapi in the mid-1500s to 2000, with 32 eruptions causing lava floods. In 1872 and 2010 there were the most severe explosive eruptions with the highest Volcano Explosivity Index (VEI) in the history of Mount Merapi eruption. Primary hazards due to eruption of Mount Merapi generally consist of gaseous elements, rock, and volcanic ash preceded by lava flows. This volcanic

eruption is always followed by pyroclastic flows activity which is destructive to buildings and forests around the slopes (Marfai et al. 2012). The destructive eruption affects vegetation succession on the mountain slopes. This succession process will result in the process of adaptation of vegetation to conditions of resistance to high temperatures or fire (Sodhi and Ehrlich 2010).

To conserve the diversity of ecosystems, plants, and animals in Mount Merapi, a national park has been established in the area and named as Mount Merapi National Park (MMNP). It was formed through Minister of Forestry Decree number 134/Menhut-II/2004 in May 4, 2004 with the aim of protecting water sources, rivers, and supporting life systems of districts/cities in the areas of Sleman, Yogyakarta, Klaten, Boyolali, and Magelang. The park is located at altitude of 600-2,968 m asl with total area is 6,410 ha (Rakhmawati 2008). There are Turgo and Plawangan Hills in Mount Merapi slopes which are the part of Kaliurang tourist area.

There are approximately 54 orchid species found in Mount Merapi National Park (Susantyo 2011). *Vanda tricolor* was recorded as a native orchid species from Mount Merapi, especially for species *Vanda tricolor* Lindl. var. *suavis* forma Merapi (Dwiyani et al. 2012; Kusumastianto et al. 2015; Semiarti and Rozikin 2015). There are also orchid species from *Dendrobium* genera found in this area. *Dendrobium mutabile* is an endemic species found in this area (Rakhmawati 2008). The dynamic of volcanic activities in Mount Merapi affects orchid diversity in this region, especially the epiphytic orchids which are more resistant. In 2010 there was a huge eruption of Mount Merapi which affected the condition of vegetation and habitat on the southern slope. Before the eruption in 2010, there were 90 species of orchids identified in this area. After the eruption, a decline in the number of species can be found in this area, which was

only about 51 species found (Sulistiyono 2011). Another study in Cangkringan area showed that before the 2010 eruption, there were 23 species of orchids found in the area with 19 species of epiphytic orchids and 4 terrestrial orchid species (Susila et al. 2011).

Tritis is an area included in Turgo Hill and Mount Merapi National Park. The ecosystem type in Tritis is classified as lower mountain forest that has also been affected by Mount Merapi eruption. Based on literature studies that have been conducted, there is no literature that reveals the diversity of wild orchids specifically only in Tritis after 2010 eruption. This study aimed to do an inventory of orchid species in Tritis to know the diversity and abundance of orchids that exist in this area. We expected the results of this study can serve as baseline information to monitor the dynamics of orchid diversity and abundance in relation to the highly volcanic activities of Mount Merapi so that it can be developed appropriate management efforts for the conservation and preservation of natural orchid species in Tritis as part of Mount Merapi National Park.

MATERIALS AND METHODS

Study area and period

This study was conducted in forest around Tritis area which is located in the Turgo Hill, Southern Slope of Mount Merapi, Purwobinangun, Pakem Sub-district, Sleman District, Special Region of Yogyakarta, Indonesia at the coordinates of 7°35'11.0 "S, 110°24'59.0" E (Figure 1). The research area was estimated to be 40,000 m². The sampling was carried out in March 2018 until October 2019. The density of trees canopy in the research site was between 60-95%.

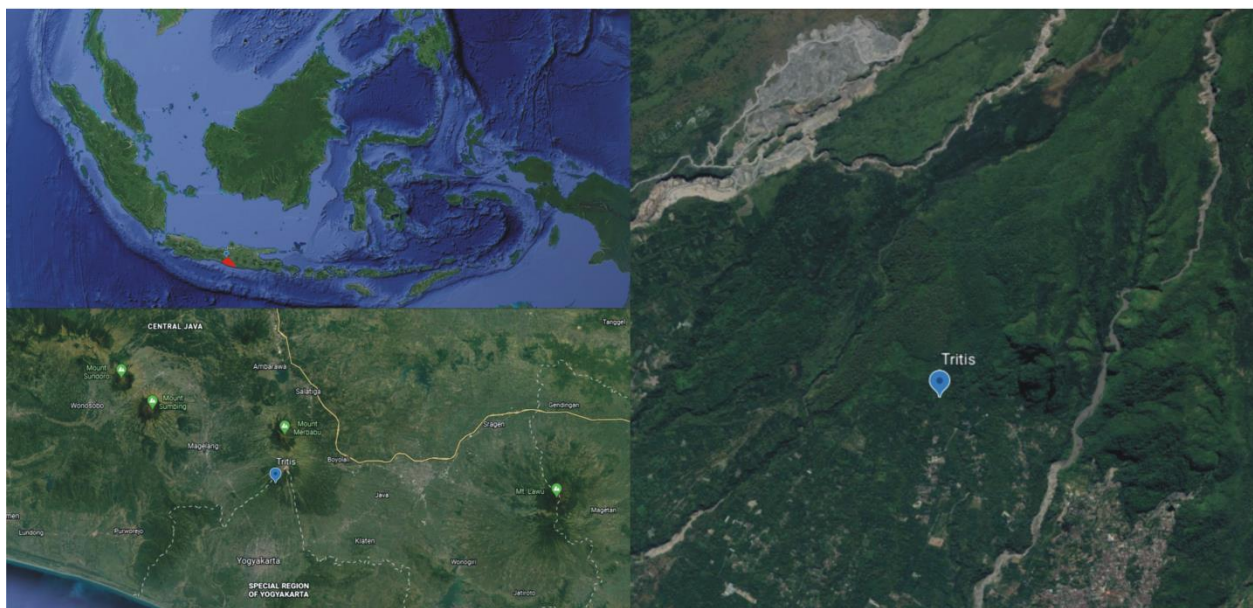


Figure 1. Map of research location in Tritis, Turgo Hill, Purwobinangun, Sleman, Yogyakarta, Indonesia (<https://earth.google.com>)

Table 1. The environmental variables at four plots in research site in Tritis, Sleman District, Yogyakarta

| Variable | Plot | | | |
|-----------------------|----------|-----------|-----------|-----------|
| | 1 | 2 | 3 | 4 |
| Altitude (m asl) | 983-1004 | 1025-1064 | 1067-1111 | 1043-1116 |
| Relative humidity (%) | 87 | 65-89 | 71-79 | 71 |
| Air temperature (°C) | 24.4 | 22-23.6 | 22.3-24.3 | 24.3-24.8 |
| Light intensity (lux) | 107-204 | 135-148 | 303-567 | 374-1576 |

Procedures

Survey and data sampling

The sampling was done using plot method. Four imaginary plots of 500 m x 20 m each was established randomly by selecting points along the exploration tracks in the location. Data was collected in the form of number and species name of wild orchids that exist in each predetermined plot. In addition, orchid photo was taken for documentation and environmental variables were measured at each plot. The environmental variables measured included altitude, relative humidity, air temperature, and light intensity (Table 1).

Species identification

Orchid samples found in the four plots were identified by matching the collection sample with orchid flora literature, such as Orchids of Java (Comber 1990), Orchids of Sumatra (Comber 2001), Merapi Orchid Identification Handbook (Sulistiyono 2011), and a paper from previous study (Susila et al. 2011). Subfamily determination referred to subfamily according to Chase et al. (2015). Observations on the flower morphology or specific vegetative organs in several orchids were carried out to identify the species levels. Samples with the flowering were absent can only be identified to genus level. Valid names were given based on the current updates in Plant List 1.1 (2020) (www.theplantlist.org).

Data analysis

Data were analyzed descriptively. The following parameters were calculated and analyzed for each species: density (D); frequency (F); relative density (RD); relative frequency (RF) and importance value index (IVI). The formula for those parameters followed Musavi (2015) as below:

$$IVI = RD + RF$$

$$D = \frac{\text{Number of individuals in each species}}{\text{Area of the sampling}}$$

$$F = \frac{\text{Number of sampling units in which the species was found}}{\text{Total number of sampling units}}$$

$$RD = \frac{\text{Density of species X}}{\text{Total density of all species found in the study}} \times 100\%$$

$$RF = \frac{\text{Frequency of species X}}{\text{Total frequency of all species found in the study}} \times 100\%$$

RESULTS AND DISCUSSION

This study recorded 24 species of natural orchid species in Tritis, the southern slope of Mount Merapi, Yogyakarta (Table 2). Following Chase et al. (2015), 22 species or 91.67% belong to the subfamily Epidendroideae, one species belong to the Vanilloideae subfamily, and one species from the Orchidoideae subfamily. Based on the type of life form, 15 species (62.5%) were epiphytic, 6 species (25%) were terrestrial; 2 species (8.3%) were holomycotropic and 1 species (4.2%) was semiterrestrial. These results are consistent with Merckx (2013) which states that the Orchidaceae family consists of 80% Epidendroideae subfamily, with most of its members being the type of epiphytic orchids. *Bulbophyllum flavescens* and *Dendrobium mutabile* were species that can be found at all four plots.

Epiphytic orchid is orchid that grows attached to a substrate, which is generally in the form of tree stem, tree branch, and other. The advantage of this life form is the availability of optimal light intensity compared to terrestrial orchid, which grows on the forest floor which only gets 1-2% of the light from canopy. The disadvantage is limited contact to soil, sometime causing problems with water supply and anchorage (Gegenbauer et al. 2013). The result of the inventory in this study shows that there were 15 species of epiphytic orchids, namely *Acriopsis liliifolia* which is characterized by ovoid pseudobulb, so it is often referred to as onion orchids like and it has purplish-red flowers (Figure 2.A). *Appendicula* sp. is characterized by slender cylindrical pseudobulb and lanceolate leaves with split ends. *Bulbophyllum flavescens* is characterized by pseudobulbs which are round and have stolons (Figure 2.B). *Bryobium retusum* is characterized by its very small size compared to other orchids, oval-shaped pseudobulb, and yellow flowers (Figure 2.C). *Coelogyne speciosa* is characterized by yellowish-green sepals and petals, and the labellum is predominantly brown with a white tip (Figure 2.D). *Dendrobium crumenatum* is called a pigeon orchid because the flower has shape like a white pigeon with a yellow callus on the labellum (Figure 2.E). *Dendrobium mutabile* is characterized by long, curved pseudobulb (zig-zag), white-pink flowers (Figure 2.F). *Dendrobium sagittatum* is characterized by flat pseudobulb and white-pink flowers (Figure 2.G). *Dendrobium* sp. has a brown pseudobulb with node and internode. *Mycaranthes latifolia* is characterized by lanceolate leaves with pointed tips. *Mycaranthes oblitterata* is characterized by cylindrical pseudobulb with green-brown oval-shaped fruit (Figure 2.H). *Oberonia similis* is characterized by flat pseudobulb

and yellow flowers (Figure 2.I). *Pholidota carnea* is characterized by oval-shaped pseudobulbs and pale brown-orange flowers. *Schoenorchis juncifolia* is characterized by cylindrical pseudobulb, teret (pencil-like) leaves, and white-purple flowers (Figure 2.J). *Thrixspermum* sp. is characterized by green cylindrical pseudobulb, lanceolate leaves with split ends.

Epiphytic orchids usually grow on branches along with ferns (Pteridophyte), such as *Asplenium nidus*, and also species of moss (Bryophyte) (Setiaji et al. 2018). The same thing was also found in our study in Tritis in which epiphytic orchids found were associated with mosses (Bryophyte), such as *Fissidens* sp., *Thuidium* sp., *Bryum* sp., *Campylopus* sp., etc.. In addition, *Nephrolepis* sp. which is classified as Pteridophyte was also found. Bryophyte has the ability to save or maintain water supply and humidity (Goetz and Price 2015; Oishi 2018). Epiphytic orchids, which have limitations in water supply, can grow well and have a high diversity in Tritis is likely because of its association with moss plants that provide water supply and maintain micro humidity of orchid habitat. The abundance of mosses can also be used as an indicator of air humidity of a habitat (Karger et al. 2012) and air quality (Smith 1982).

Apart from associations with other plants to help maintain water availability, epiphytic orchids are also characterized by pseudobulb stems and succulent leaves to store water (Zhang et al. 2018). Epiphytic orchids in Tritis grew up in groups on each tree because all epiphytic orchids found have a sympodial stem growth type. Sympodial means the growth is dominated by axillary buds into horizontally or sideways, so that clumps or units are seen (Gegenbauer et al. 2013). In addition, orchids have millions of seeds, so orchid seedling can be found in very large numbers on branches of the tree. This phenomenon

was found in very large numbers in one tree, but sometimes not found in other trees. The epiphytic orchid distribution pattern is classified as a clumped distribution pattern (Odum 1998).

Terrestrial orchids are orchids that grow on soil substrates and generally have special structures, such as rhizomes or tubers that are found below the soil (Gegenbauer et al. 2013). Terrestrial orchids mainly get nutrients from soil, while epiphytic orchids get from air, solid substrate, wet or dry deposition, and nitrogen from microorganisms (Zhang et al. 2018). There were six species of terrestrial orchids found in the study site in Tritis, namely *Anoectochilus reinwardtii* which is often referred to as jewel orchids because of the beauty on their leaves. The leaves are dark green-black with a venation pattern characteristic that is orange-red bright (Figure 3.A). *Crepidium kobi* is characterized by raceme flower inflorescence type, purple in color and not undergoing resupination (Figure 3.B-C). *Dienia ophrydis* is characterized by raceme flower inflorescence type, green-purple flower (3.D-E). If it is only seen from vegetative organs, it is difficult to distinguish between *Crepidium kobi* and *Dienia ophrydis* because of the similarity of the vegetative organs characteristics such as leaves and stems. *Phaius* sp. is characterized by the presence of bulbs and lanceolate type leaves with pointed tips. *Tainia paucifolia* has a unique character in the form of pseudobulb which is generally owned by epiphytic orchids, but in this orchid, we can find stem that is classified as oval-shaped pseudobulb. A pseudobulb will support a leaf stalk and lanceolate leaf (Figure 3.H). *Zeuxine odorata* is characterized by cylindrical stems and elliptical leaves with a white pattern on the center of the leaf and green on the edge (Figure 3.J).

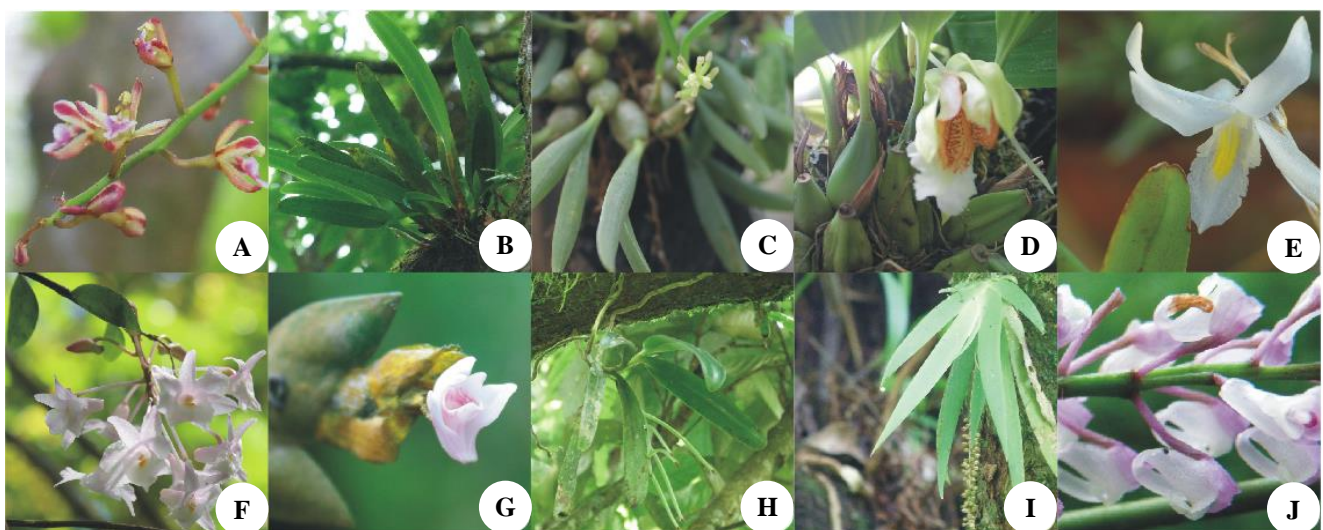


Figure 2. Epiphytic wild orchids species found in the study site in Tritis, Sleman, Yogyakarta, Indonesia. A. *Acriopsis liliifolia*, B. *Bulbophyllum flavescens*, C. *Bryobrium retusum*, D. *Coelogyne speciosa*, E. *Dendrobium crumenatum*, F. *Dendrobium mutabile*, G. *Dendrobium sagittatum*, H. *Myrcanthes oblitterata*, I. *Oberonia similis*, and J. *Schoenorchis juncifolia*

Table 2. Natural orchid species at four plots in research site in Tritis, Sleman District, Yogyakarta, Indonesia

| Subfamily | Species | Life form | Locations (Plot) | | | |
|----------------|--|-----------|------------------|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| Epidendroideae | <i>Acriopsis liliifolia</i> (J.Koenig) Seidenf. | Ep | + | - | - | - |
| Epidendroideae | <i>Anoectochilus reinwardtii</i> Blume | Tr | - | - | + | - |
| Epidendroideae | <i>Appendicula</i> sp. | Ep | - | - | + | - |
| Epidendroideae | <i>Bryobrium retusum</i> (Blume) Y.P.Ng & P.J.Cribb | Ep | + | + | - | - |
| Epidendroideae | <i>Bulbophyllum flavescens</i> (Blume) Lindl. | Ep | + | + | + | + |
| Epidendroideae | <i>Coelogyne speciosa</i> (Blume) Lindl. | Ep | - | - | + | + |
| Epidendroideae | <i>Crepidium kobei</i> (J.J.Sm.) M.A.Clem. & D.L.Jones | Tr | - | + | - | - |
| Epidendroideae | <i>Dendrobium crumenatum</i> Sw. | Ep | + | + | + | - |
| Epidendroideae | <i>Dendrobium mutabile</i> (Blume) Lindl. | Ep | + | + | + | + |
| Epidendroideae | <i>Dendrobium sagittatum</i> J.J.Sm. | Ep | + | + | + | - |
| Epidendroideae | <i>Dendrobium</i> sp. | Ep | + | + | + | - |
| Epidendroideae | <i>Dienia ophrydis</i> (J.Koenig) Seidenf. | Tr | + | - | - | + |
| Epidendroideae | <i>Epipogium roseum</i> (D.Don) Lindl. | Hm | - | + | - | - |
| Epidendroideae | <i>Gastrodia</i> sp. | Hm | - | - | - | + |
| Epidendroideae | <i>Mycaranthes latifolia</i> Blume | Ep | - | + | - | - |
| Epidendroideae | <i>Mycaranthes oblitterata</i> Blume | Ep | + | + | + | - |
| Epidendroideae | <i>Oberonia similis</i> (Blume) Lindl. | Ep | - | - | - | + |
| Epidendroideae | <i>Phaius</i> sp. | Tr | - | - | - | + |
| Epidendroideae | <i>Pholidota carnea</i> (Blume) Lindl. | Ep | + | + | - | - |
| Epidendroideae | <i>Schoenorchis juncifolia</i> Reinw. ex Blume | Ep | - | - | - | + |
| Epidendroideae | <i>Tainia paucifolia</i> (Breda) J.J.Sm. | Tr | - | + | + | - |
| Epidendroideae | <i>Thrixspermum</i> sp. | Ep | - | + | + | - |
| Vanilloideae | <i>Vanilla planifolia</i> Jacks. ex Andrews | St | + | - | - | - |
| Orchidoideae | <i>Zeuxine odorata</i> Fukuy. | Tr | - | + | - | - |

Note: Ep: Epiphytic; Tr: Terrestrial; Hm: Holomycotropic; St: Semiterrestrial; +: present; and -: absent

Table 3. The density, frequency, relative density, relative frequency and important value index of natural orchid's species in Tritis, Sleman District, Yogyakarta, Indonesia

| Species | D | F | RD | RF | IVI |
|----------------------------------|-----|------|--------|-------|--------|
| <i>Acriopsis liliifolia</i> | 3 | 0.25 | 0.216 | 2.273 | 2.489 |
| <i>Anoectochilus reinwardtii</i> | 1 | 0.25 | 0.072 | 2.273 | 2.345 |
| <i>Appendicula</i> sp. | 20 | 0.25 | 1.443 | 2.273 | 3.716 |
| <i>Bryobrium retusum</i> | 28 | 0.5 | 2.020 | 4.546 | 6.566 |
| <i>Bulbophyllum flavescens</i> | 150 | 1 | 10.823 | 9.091 | 19.913 |
| <i>Coelogyne speciosa</i> | 214 | 0.5 | 15.440 | 4.546 | 19.986 |
| <i>Crepidium kobei</i> | 2 | 0.25 | 0.144 | 2.273 | 2.417 |
| <i>Dendrobium crumenatum</i> | 4 | 0.75 | 0.289 | 6.818 | 7.107 |
| <i>Dendrobium mutabile</i> | 125 | 1 | 9.019 | 9.091 | 18.110 |
| <i>Dendrobium sagittatum</i> | 155 | 0.75 | 11.183 | 6.818 | 18.001 |
| <i>Dendrobium</i> sp. | 14 | 0.75 | 1.010 | 6.818 | 7.828 |
| <i>Dienia ophrydis</i> | 5 | 0.5 | 0.361 | 4.546 | 4.906 |
| <i>Epipogium roseum</i> | 2 | 0.25 | 0.144 | 2.273 | 2.417 |
| <i>Gastrodia</i> sp. | 4 | 0.25 | 0.289 | 2.273 | 2.561 |
| <i>Mycaranthes latifolia</i> | 6 | 0.25 | 0.433 | 2.273 | 2.706 |
| <i>Mycaranthes oblitterata</i> | 262 | 0.75 | 18.903 | 6.818 | 25.722 |
| <i>Oberonia similis</i> | 3 | 0.25 | 0.217 | 2.273 | 2.489 |
| <i>Phaius</i> sp. | 1 | 0.25 | 0.072 | 2.273 | 2.345 |
| <i>Pholidota carnea</i> | 63 | 0.5 | 4.545 | 4.546 | 9.091 |
| <i>Schoenorchis juncifolia</i> | 2 | 0.25 | 0.144 | 2.273 | 2.417 |
| <i>Tainia paucifolia</i> | 19 | 0.5 | 1.371 | 4.546 | 5.916 |
| <i>Thrixspermum</i> sp. | 290 | 0.5 | 20.924 | 4.546 | 25.469 |
| <i>Vanilla planifolia</i> | 2 | 0.25 | 0.144 | 2.273 | 2.417 |
| <i>Zeuxine odorata</i> | 11 | 0.25 | 0.794 | 2.273 | 3.066 |

Note: D: Density; F: Frequency; RD: Relative density; RF: Relative frequency; and IVI: Important value index

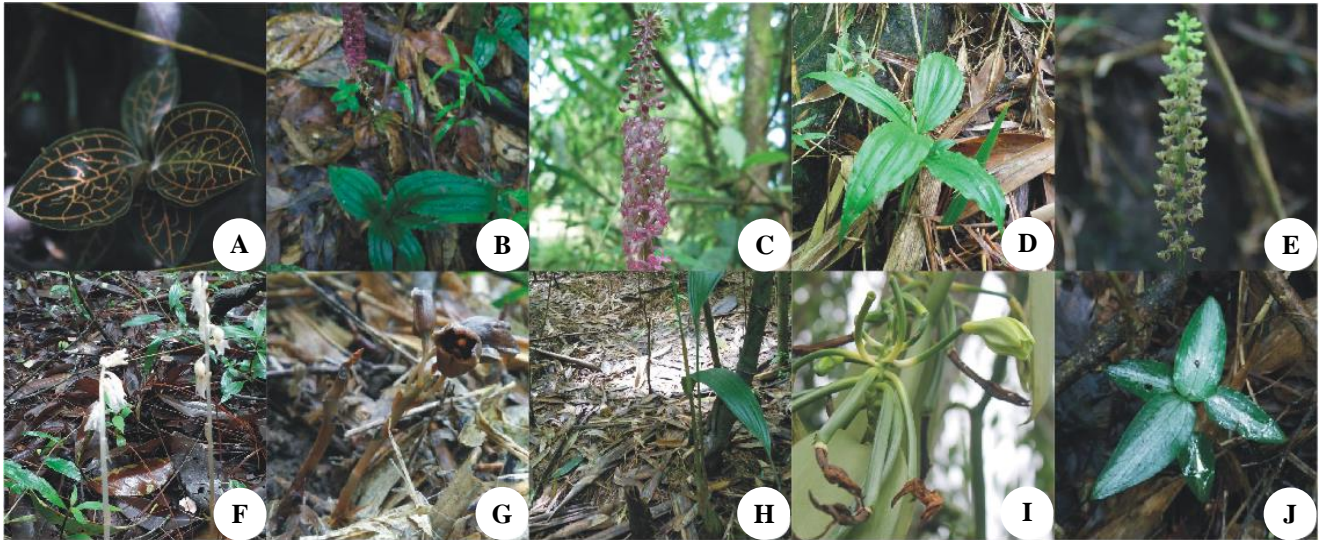


Figure 3. Terrestrial, holomycotrophic, and semiterrestrial natural orchids species in the study site in Tritis, Sleman District, Yogyakarta, Indonesia. A. *Anoectochilus reinwardtii*, B-C. *Crepidium kobei*, D-E. *Dienia ophrydis*, F. *Epipogium roseum*, G. *Gastrodia* sp., H *Tainia paucifolia*, I. *Vanilla planifolia*, and J. *Zeuxine odorata*

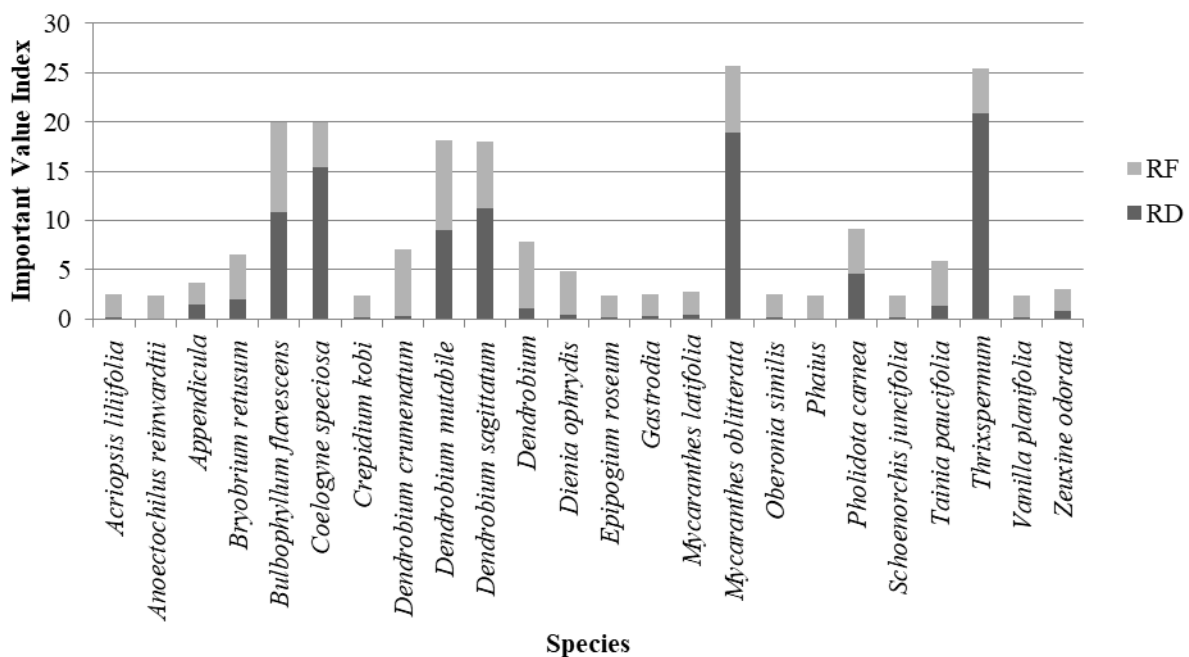


Figure 4. Important value index (IVI) of wild orchid species in Tritis, Sleman District, Yogyakarta, Indonesia

Holomycotrophic orchids are orchids that can be classified as terrestrial orchids, but these orchids have pale yellow leaves or brown scales along the stem. As such, the ability of photosynthesis in this orchid is reduced. To obtain nutrients, Holomycotrophic orchids associate with fungus. These orchids will use the fungus mycelium to take nutrients from the host tree or litter, so these orchids are sometimes referred to as parasite orchids (Gegenbauer et al. 2013). It is also included in saprophyte plants due to loss of function to absorb CO₂ and organic substances from

the substrate (Suryowinoto 1987). There were two species of holomycotrophic orchids found in Tritis namely *Epipogium roseum* which is often referred to *pocong* orchid, because of its white flower character (Figure 3F). This orchid has a rhizome stem with scales. Second is *Gastrodia* sp. which is referred to ghost orchids or also referred to as bamboo orchids (Figure 3G). *Gastrodia* sp. from Mount Merapi was once proposed as a novel species by Metusala and Supriatna (2017), because based on morphological characters it has similarities with *Gastrodia*

abscondita J.J.Sm, but there are some differences between them. Flowers in *Gastrodia* sp. from Mount Merapi is larger and dark brown in color, longer perianth tubes, ovate-shaped petals, longer oblong-lanceolate labellum shaped, differences in the shape of the keels on lip, and difference in the shape of column. Based on these differences Metusala and Supriatna (2017) gave the name *Gastrodia bambu*, because the substrate grows specifically on bamboo leaf litter and is often found growing in bamboo forest habitats. Both of these holomycotrophic orchids have local names that are related to the name of the ghost, because holomycotrophic orchids are rarely or never encountered in the dry season because they are in dormancy. When the rainy season arrives, these orchids will suddenly be seen on the ground. This sudden process of emergence and departure, due to orchids is only seen when the flowering phase, while when the vegetative phase is only rhizome in the soil, or referred to one of the geophyte plant characters. Geophyte plants also have bulbous, tuberous, or rhizomes (Proches et al. 2006; Korkmaz and Ilhan 2015; Howard et al. 2019).

Semiterrestrial orchids are orchids that have two types of roots, namely terrestrial roots that anchoring stems into the soil and have function like common roots to absorb water and minerals from the soil. In addition, there are dorsiventral roots that serve to attach stem to the tree, so that this orchid can maximize sunlight gain. There is one species found in Tritis, namely *Vanilla planifolia*. This orchid is characterized by cylindrical stems, yellowish-green flowers, oval-shaped fruit (Figure 3I). This fruit is commonly used as an ingredient to add vanilla scents for food.

According to a study by Susila et al. (2011) which was conducted before the 2010 eruption, there were 19 species of epiphytic orchids found in Turgo, but in this research, we can only found 15 species of epiphytic orchids in Tritis. Epiphytic orchid species that recorded by Susila et al. (2011) but not found in this study were *Acriopsis javanica*, *Appendicula reflexa*, *Cymbidium bicolor*, *Flickingeria* sp., *Eria* sp., *Gastrochillus sororius*, *Liparis condylobulbon*, *Liparis latifolia*, and *Thrixspermum anceps*. Epiphytic orchids recorded by this study but not found by Susila et al. (2011) namely *Acriopsis liliifolia*, *Appendicula* sp., *Oberonia similis*, *Mycarantes latifolia*, *Mycarantes oblitterata*, *Schoenorchis juncifolia*, and *Thrixspermum* sp. Three terrestrial orchid species found by Susila et al. (2011) but not recorded in this study namely *Arundina graminifolia*, *Malaxis* sp. and *Habenaria* sp. One holomycotrophic orchid, *Epipogium roseum* was found by Susila et al. (2011) and was also found in this study in Tritis. In addition to the wild orchid species found in Tritis, several surveys of orchid species were deliberately planted as an in situ conservation effort in the National Park of Mount Merapi. Some orchid species were planted not only from the Yogyakarta area, but some are from outside Yogyakarta. Some orchids planted were *Vanda tricolor* var. *suavis*, *Coelogyne* sp., and others. Apart from aiming at in situ conservation of natural orchids, natural orchids from the genera of *Dendrobium* and *Vanda* actually contain

secondary metabolites that have potential as drugs in the field of pharmacology (Semiarti et al. 2020).

Based on the calculation, there are seven species of orchids in Tritis that have high-density values, namely *Thrixspermum* sp., *Mycarantes oblitterata*, *Coelogyne speciosa*, *Dendrobium sagittatum*, *Bulbophyllum flavescens*, *Dendrobium mutabile*, and *Pholidota carnea* (Table 3). Based on the density value, all epiphytic orchids are classified as having higher density values than terrestrial, holomycotrophic and semiterrestrial orchids. Based on the frequency values, *Bulbophyllum flavescens* and *Dendrobium mutabile* have the highest values, because they were found in all plots (Table 3). Based on the calculation of the importance value index, there are two species of orchids that have the highest importance value, *Thrixspermum* sp. and *M. oblitterata* (Figure 4). Both have the highest important value index because of their high relative density values. Nonetheless, *Thrixspermum* sp. has a higher relative density than *M. oblitterata*, while *M. oblitterata* has a higher relative frequency compared to *Thrixspermum* sp.. Both *Thrixspermum* sp. and *M. oblitterata* have the highest abundance of orchid species in Tritis area.

One of the environmental factors that influence the growth of orchids in Tritis is altitude. The altitude from the plot one to plot four is increasing, ranging from 983-1116 m asl. Altitude factor affects other environmental variables, such as temperature, light intensity, and humidity. Environmental parameters associated with altitude will affect orchid composition in a region and distribution of orchid breeding system (Jacquemyn et al. 2005). One of the factors that influence photosynthesis is temperature, in which the rate of photosynthesis will increase as the temperature rises to a certain limit (Ribeiro et al. 2006). Temperature between 20-37°C is the optimal temperature for photosynthesis in orchids (Pratiwi 2010). According to Soetopo and Saputra (2019), 22-29°C is the optimal range temperature for epiphytic orchid growth. The temperature range at the four plots in Tritis was around 22-24.8°C, which is still relatively optimal, but at a lower limit. Besides temperature, light is also a major factor influencing photosynthesis and process of growth and metabolism in orchids (Omon et al. 2007). Low light intensity can be caused by the presence of tree canopy (Thery 2001; Ardie 2006). The canopy cover in Tritis was quite high at 60-95%, so the light intensity measured at the four plots was relatively low at 107-1576 lux. Humidity is one of the main factors that affect growth. According to Fitch et al. (1997), the optimal relative humidity for orchid growth is in the range of 40-70%. Based on the measurement results at the four plots, relative humidity ranged between 65-89%, which is classified as very high.

Based on these results, the habitat and trees in Tritis are suitable environments for epiphytic orchid to grow, indicated by the presence of mosses associated with orchids to create optimal microclimates for epiphytic orchids. In addition, the position of epiphytic orchids on the tree makes epiphytic orchids have several advantages, namely the acquisition of optimal light intensity which results in higher air temperatures compared to orchids on the forest

floor. Water does not settle on the tree, so the humidity is not classified as very high. In terrestrial, holomycotropic and semiterrestrial orchids have a small density, because Tritis forest floor environment is less supportive for the growth of these orchids. The main factor that influences is the shade of the canopy which is very unfavorable for these orchids. Due to the large shade, the intensity of the light received is less than optimal. Shading affects temperature and humidity also. It can cause stress in plant, because it blocks a high amount of light and affects understory vegetation to grow (Valladares et al. 2016). The forest floor in Tritis captures a lot of water when it rains which causes humidity to increase and air temperature to decrease. Based on the unique location in Tritis, the diversity of orchids in its area is relatively high, but it is less advantageous for the growth of terrestrial, holomycotropic, and semiterrestrial orchids.

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