Orchids of Mount Ungaran (Indonesia) compiled from a decade of data collections between 2010 and 2021

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Abstract. Kurniawan FH, Nazar I, Anjarwati R, Sasono HD, Rahayuningsih M. 2021. Orchids of Mount Ungaran (Indonesia) compiled from a decade of data collections between 2010 and 2021. Nusantara Bioscience 13: 238-252. Orchid is well known as a plant group widely used as ornamental plants because of their uniqueness. But, high exploitation, deforestation, and land-use changes have threatened orchid species and triggered extinction. It also happened in Mount Ungaran, Central Java, Indonesia, despite designation as an essential ecosystem area. This research was conducted to add an updated list of wild orchid species that can serve as biodiversity baseline data for conservation management in Mount Ungaran. The study was carried out through exploration activities from 2010 to 2021. The study area covered eleven sites namely Gentong Hills, Kalisidi, Pasigitan, Banyuwindu, Gajahmungkur, Watuondo, Mawar Camp, Indrakila, Gondang and Puncak which were all included in the buffer zone of Mount Ungaran. A total of 115 species from 54 genera of orchids were successfully identified, including 78 species of epiphyte and 37 species of terrestrial orchids. Among the species recorded, at least 27 species were known to be endemic to Indonesia, and 8 species were endemic to the island of Java, which four species were listed in the IUCN Red List. In addition, all the species found were listed in Appendix II of the CITES, except one species, Paphiopedilum javanicum which was listed in Appendix I. This study recorded the new distribution records of several species of orchids that were previously only found in West Java or East Java, i.e., Ania penangiana, Pholidota convallariae, and Crepidium jungshinii. This study has also documented a species from genus Crepidium, which morphological characters have not been described in any identification guides. The Gentong area has potential as a priority for in-situ orchid protection area by the highest number of species were reached 54% of all orchids found on Mount Ungaran.

Key words: Diversity, Mount Ungaran, Orchidaceae, wild orchid

INTRODUCTION

The Orchidaceae (orchid group) is one of the largest families in the plant kingdom, consisting of about 28,000 currently accepted species and some 800 subspecies distributed in about 763 genera (Biswas and Singh 2019). The Orchidaceae family can be divided into five sub-families: Apostasioideae, Cypripedioideae, Epidendroideae, Orchidoideae, and Vanilloideae (Chase et al. 2015; Dong et al. 2018). Indonesia, as a mega-biodiversity country in the tropical equator, consists of at least 5000 species of orchids (Hariyanto et al. 2020). The presence of mountains in Java had contributed to the high value of wild orchids. It is recognized that Java has at least 731 species within 130 genera (Comber 1990). For example, Mount Ungaran in Central Java with an extent of 5500 ha comprised forested areas and mixed plantations serve as habitat of various species, including wild orchids.

Because of the richness of their members, orchids have a variety of diverse growth forms such as lithophytes, terrestrials, epiphytes, to saprophytes. It's the same with leaf shapes ranging from pencil form, elongated, rounded, peltate, etc. Like most monocotyledonous plants, the orchid lamina exhibits the type of parallel leaf veins with thicknesses that vary from thin to fleshy. Whereas, orchids species may be recognized by the unique flower structures which show three sepals, one of which is located on the back called the dorsal sepals, while the other two are called lateral sepals. In addition, orchids also have two lateral petals, and one differentiation petal (Artaka 2019; De 2020). This differentiation petal is modified as labellum and column, the modification to self-pollination and even attract their pollinators (Attri and Kant 2011).

Orchids have ecological, economic, and even health benefits. In ecology, orchids are bio-indicators of environmental health due to their sensitivity to environmental changes, play a role in the nitrogen cycle, and support soil composition due to their association with mycorrhizae (Seaton et al. 2013; Nurfadillah et al. 2016). Economically, orchids are popular as ornamental plants, thus wild orchids have the potential as a parental lineage in a breeding program to produce beautiful desired varieties (Sadili and Sundari 2017). In terms of health benefits, some orchid species are herbal medicines such as pain relievers, anti-inflammatory, anti-rheumatic, digestive, and even used as toners and beauty soaps (Asseleih et al. 2015). Unfortunately, such uses often result in reducing the natural population of some orchid species and even local extinction.
Despite being designated as an important bird and biodiversity area (Birdlife International 2021), some forested areas in Mount Ungaran have been deforested (up to 31.5-40.1%) during the 2000-2005 periods due to agricultural expansion and settlement development (Rahayuningsih et al. 2015; Rahayuningsih et al. 2020). Furthermore, another data showed that in 1991-2009, about 75% of the forest of Mount Ungaran was converted to other land uses (Rahayuningsih et al. 2017). In addition, the existence of orchids in Mount Ungaran is also threatened by illegal collection by orchids hunters. Altogether, these threats put pressure on various types of orchids to endangerment moreover for species that have not been recorded (Agustini et al. 2016; Besi et al. 2019).

Several studies on the theme of the conservation of Mount Ungaran have been carried out including data collection on birds and other biodiversity (Rahayuningsih et al. 2015; Rahayuningsih et al. 2017; Rahayuningsih et al. 2020). However, the study on orchids of Mount Ungaran has not been fully revealed, while the threats to the plant as mentioned above continue unabated. Over many years, wild orchids’ botanical collections have been focused on ex-situ species conservation to save them from extinction (Besi et al. 2019). Although a book of orchids in Ungaran has been published for conservation purpose (Utami et al. 2018), some anecdotal information about undocumented species have not yet been published scientifically.

Therefore, this study aimed to inventory orchids in a broader scope of Mount Ungaran to provide an updated list of orchid species in the area. The documented species will be accompanied with data of species composition based on the area studied, life types, current global distribution, and their conservation status. The result of this study can be used as baseline information to support the ongoing conservation and management program including the plan for establishing Mount Ungaran as an Essential Ecosystem Area (Kawasan Ekosistem Esensial/KEE).

MATERIALS AND METHODS

Study sites

Mount Ungaran is located in Central Java Province, Indonesia (S 7°12’ E 110°20’), is one of the remaining forest area in Java Island which Perhutani manages. Mount Ungaran has 5500 ha which is covered by two regencies, i.e., Kendal and Semarang province of Central Java, Indonesia. Mount Ungaran has an average temperature range from 22-27°C and the range of altitude is between 900-2050 masl. Mount Ungaran has several habitat types, i.e., primary dry forest and secondary dry forest with coffee plantation under the canopy. The study took place in 11 sites, i.e., Gentong, Kalisidi, Pasigitan, Banyuwindu, Watuondo, Indrakila, Gonoharjo, Gajahmungkur, Camp Mawar, Gondang, and Puncak (Figure 1).
Gentong, Kalisidi, Pasigitan, Banyuwindu, Watuondo, Gonoharjo, and Indrakila are included as sub-montane forests with altitudes between 900-1500 m asl, represent the secondary forest with the domination of Syzigium sp., Weinmannia fraxinea and some of Lauracea and Euphorbiaceae families. Under the canopy in these areas are commonly used by localities as coffee plantations. Then, Gajahmungkur, Gondang, and Puncak are included as a montane forest with ranges of altitudes 1500-2050 masl, represent the primary forest, and relatively dominated by members of Fagaceae family (Lithocarpus sp., and Castanopsis sp.) (Figure 1). In addition, we explored Mawar Camp (1000-1800 masl), a unique area with three vegetation types such as homogenous pine plantation, primary forest, and intensive coffee plantation. Mawar Camp is used by localities as a legal tracking route to submit the mountain. We explored all of these areas from 2010 to 2021, divided into 3 periods: the first in 2010-2014, the second in 2014-2018, and the last third in 2018-2021.

Data collection procedures

Data were collected using opportunistic sampling method by searching for species in habitats along defined pathways in each 11 sites. We used the photographic approach to minimize the collection of both living specimen and herbarium. The picture of each orchid organ in each species was as detailed as possible, including the habitus, leaves, stem, inflorescence and flower. In addition, clear flower photographs must be showed the petals, sepals, labellum and column were conducted as important orchid characters to conduct identification. GPS tagged each orchid species found in the pathways as a base for weekly monitoring to check the flowering periods.

Data analyze

The taxonomical identification used several sources, including Orchids of Java (Comber 1990), Die Orchideen von Java Figuren atlas (Smith 1908) and the online data from Swiss Orchids Foundation (https://orchid.unibas.ch/index.php/en/) The valid names and the current distribution data were retrieved based on the current data of The World Checklist of Selected Plant Families (Govaerts et al. 2021). Expert consultations were also sought to make an accurate identification. The protection status of each species was based on IUCN (http://www.iucnredlist.org), Index of CITES species (https://checklist.cites.org/#/en), and Indonesian Regulation of Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia No. P.106/MenLHK/Setjen/Kum.1/12/2018 for validation (KLHK 2018).

RESULTS AND DISCUSSION

Species composition

Across the 11 sites surveyed in Mount Ungaran, a total of 115 orchids species were found, including 78 species that were epiphyte and the remaining 37 species were terrestrial on their life type (Table 1). All of the species found were successfully identified, except one species from genus Crepidium. Among the 11 areas surveyed, Gentong had the highest number of species with 61 species, while Indrakila had the lowest number with only six species (Figure 2A). The second survey period found the most significant number of orchids with a record of 93 identified species, followed by the first period with 82 species and the third period with 52 species (Figure 2B). We found 27 species to be endemic to Indonesia, and eight species were endemic to the island of Java. The protection status of CITES includes 114 species in Appendix II and only a species is in Appendix I. All species were not protected by national regulation. On the other hand, four species are protected by the IUCN Redlist, including Paphiopedilum javanicum (Reinw. ex Lindl.) Pfitzer which is categorized as Endangered and Appendix I.
| Taxa | Growth habit | Protection status | Global current distribution | Specific distribution in the areas studied |
|------|--------------|-------------------|----------------------------|----------------------------------------|
| Acriopsis liliifolia var. liliifolia (J.Koenig) Ormerod | E - II - | | | Ban, Maw, Gond |
| Aerides odorata Lour. | E - II - | | Andaman Is., Assam, Bangladesh, Borneo, Cambodia, China South-Central, China Southeast, East Himalaya, Hainan, India, Jawa, Laos, Lesser Sunda Is., Malaysia, Maluku, Myanmar, Nepal, Nicobar Is., Philippines, Sulawesi, Sumatera, Thailand, Vietnam | Gen, Ban, Gond |
| Agrostophyllum cyathiforme J.J.Sm. | E LC - II - | | Borneo, Jawa, Malaysia, Sumatera | Maw, Gond |
| Agrostophyllum stipulatum subsp. bicapsidatum (J.J.Sm.) Schuit. | E - II - | | Borneo, Jawa, Malaysia, Sulawesi, Sumatera | Gen, Kal, Pas, Gaj, Ban, Gaj, Wat, Gond |
| Anla penangiana (Hook.f.) Summerh. | T - II - | | Assam, Borneo, East Himalaya, Hainan, India, Jawa, Malaysia, Maluku, Nepal, New Guinea, Sumatera, Taiwan, Thailand, Vietnam | Gen, Pas |
| Anoectochilus reinwardtii Blume | T - II - | | Borneo, Jawa, Malaysia, Maluku, Sumatera, Thailand | Gen, Wat |
| Appendicula alba Blume | T - II - | | Borneo, Jawa, Lesser Sunda Is., Malaysia, Philippines, Sulawesi, Sumatera, Thailand | Gen, Gaj, Gond |
| Appendicula angustifolia Blume** | E - II - | | Jawa, Sumatera | Gen, Kal, Pas, Gaj, Ban, Gaj, Wat, Gond |
| Appendicula ramosa Blume** | E - II - | | Jawa, Lesser Sunda Is., Sulawesi, Sumatera | Ban |
| Appendicula reflexa Blume | E - II - | | Bismarck Archipelago, Borneo, Cambodia, Caroline Is., Fiji, Jawa, Lesser Sunda Is., Malaysia, Maluku, New Caledonia, New Guinea, Nicobar Is., Philippines, Santa Cruz Is., Solomon Is., Sulawesi, Sumatera, Taiwan, Thailand, Tonga, Vanuatu, Vietnam, Wallis-Futuna Is. | Gen, Pun |
| Arundina graminifolia (D.Don) Hochr. | T - II - | | Assam, Bangladesh, Borneo, Cambodia, China South-Central, China Southeast, East Himalaya, Hainan, India, Jawa, Laos, Lesser Sunda Is., Malaysia, Maluku, Myanmar, Nansei-shoto, Nepal, Philippines, Sri Lanka, Sulawesi, Sumatera, Taiwan, Thailand, Tibet, Vietnam | Pun |
| Bogoria raciborskii J.J.Sm.** | E - II - | | Borneo, Jawa | Ind |
| Bryobium retusum (Blume) Y.P.Ng & P.J.Cribb | E - II - | | Borneo, Christmas I., Jawa, Lesser Sunda Is., New Caledonia, Solomon Is., Sulawesi | Wat |
| Bulbophyllum angustifolium (Blume) Lindl. | E - II - | | Jawa, Lesser Sunda Is., Malaysia, Sumatera | Gen, Gaj |
| Bulbophyllum biflorum Teijsm. & Binn. | E - II - | | Borneo, Jawa, Lesser Sunda Is., Malaysia, Sumatera, Thailand | Gen, Kal, Pas, Gaj, Ban, Wat |
| Bulbophyllum capitatum (Blume) Lindl.** | E - II - | | Borneo, Jawa | Gaj, Gaj, Gond |
| Bulbophyllum depressum King & Pantl | E - II - | | Assam, Borneo, China South-Central, China Southeast, East Himalaya, Hainan, India, Jawa, Laos, Lesser Sunda Is., Malaysia, Myanmar, Sumatera, Thailand, Vietnam | Gen, Pas, Wat |
| Bulbophyllum ecorumatum subsp. ecorumatum (J.J.Sm.) J.J.Sm. | E - II - | | Borneo, Jawa, Lesser Sunda Is. | Wat |
| Bulbophyllum flavidiflorum Carr** | E - II - | | Jawa, Lesser Sunda Is., Sumatera | Gaj, Gaj, Pun |
| Scientific Name                                                                 | Range                                                                                               | Author(s)                  | Notes                  |
|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|---------------------------|------------------------|
| Bulbophyllum gibbosum (Blume)                                                   | E - II - Borneo, Jawa, Lesser Sunda Is., Malaysia, Sumatera, Pun, Gond                              |                           |                        |
| Bulbophyllum laxiflorum (Blume)                                                | E - II - Borneo, Cambodia, Jawa, Laos, Malaysia, Myanmar, Philippines, Sulawesi, Sumatera, Thailand, Vietnam | Gen                       |                        |
| Bulbophyllum lobbii Lindl. subsp. lobbii                                        | E - II - Assam, Bangladesh, Borneo, Cambodia, East Himalaya, Jawa, Lesser Sunda Is., Myanmar, Philippines, Sumatera, Thailand, Vietnam | Gen, Kal, Ind             |                        |
| Bulbophyllum stelis J.J.Sm.**                                                   | E - II - Jawa, Sumatera                                                                             | Pun                       |                        |
| Bulbophyllum sulcatum (Blume)                                                  | E - II - Jawa, Lesser Sunda Is., Malaysia, Sumatera, Thailand, Vietnam                              | Gaj, Gaj                  |                        |
| Calanthe triplicata (Willemet) Ames                                             | T - II - Andaman Is., Assam, Bismarck Archipelago, Borneo, Cambodia, Caroline Is., China South-Central, China Southeast, East Himalaya, Fiji, Hainan, India, Jawa, Kazan-retto, Laos, Lesser Sunda Is., Malaysia, Maluku, Maritans, Myanmar, Nansei-shoto, New Caledonia, New Guinea, New South Wales, Norfolk Is., Ogasawara-shoto, Philippines, Queensland, Samo, Society Is., Solomon Is., Sri Lanka, Sulawesi, Sumatera, Taiwan, Thailand, Tonga, Tubuai Is., Vanuatu, Vietnam, Wallis-Futuna Is. | Gen, Kal, Pas, Gon, Ban, Gaj, Wat, Ind |                        |
| Ceratostylis backeri J.J.Sm.*                                                   | E - II - Jawa, Sumatera                                                                             | Gaj, Pun                  |                        |
| Ceratostylis graminea Blume**                                                  | E - II - Jawa, Sumatera                                                                             | Gen, Pas                  |                        |
| Ceratostylis radiata J.J.Sm.                                                    | E - II - Assam, Borneo, Jawa, Malaysia, Myanmar, Sumatera, Thailand, Tibet, Vietnam                 | Gen                       |                        |
| Ceratostylis subulata Blume                                                    | E - II - Assam, Borneo, Cambodia, East Himalaya, Hainan, Jawa, Laos, Malaysia, Maluku, Myanmar, New Guinea, Nicobar Is., Philippines, Santa Cruz Is., Solomon Is., Sumatera, Thailand, Vanuatu, Vietnam | Gen, Ban                  |                        |
| Chrysoglossum ornatum Blume                                                    | T - II - Assam, Borneo, Cambodia, China South-Central, China Southeast, East Himalaya, Fiji, Hainan, India, Jawa, Laos, Malaysia, Myanmar, Nepal, New Caledonia, New Guinea, Philippines, Samo, Sri Lanka, Sulawesi, Sumatera, Taiwan, Thailand, Tibet, Vanuatu, Vietnam | Gen, Pas, Gon             |                        |
| Cleisostoma discolor Lindl.                                                    | E - II - Assam, Borneo, Cambodia, East Himalaya, India, Jawa, Laos, Lesser Sunda Is., Malaysia, Sumatera, Thailand, Vietnam | Ban                      |                        |
| Coelogyne miniata (Blume) Lindl.**                                             | E - II - Jawa, Lesser Sunda Is., Sumatera                                                           | Gaj, Maw, Pun             |                        |
| Coelogyne speciosa (Blume) Lindl.**                                            | E - II - Jawa, Lesser Sunda Is., Sumatera                                                           | Gen, Kal, Pas, Gom, Ban, Gaj, Wat, Maw, Ind |                        |
| Corymborkis veratrifolia (Reinw.) Blume                                        | T - II - Andaman Is., Assam, Bangladesh, Bismarck Archipelago, Borneo, Cambodia, Caroline Is., China South-Central, China Southeast, Christmas I., East Himalaya, Fiji, India, Jawa, Laos, Lesser Sunda Is., Malaysia, Maluku, Maritans, Myanmar, Nansei-shoto, New Caledonia, New Guinea, Nicobar Is., Ogasawara-shoto, Philippines, Queensland, Samo, Santa Cruz Is., Society Is., Solomon Is., Sri Lanka, Sulawesi, Sumatera, Taiwan, Thailand, Tonga, Vanuatu, Vietnam, Wallis-Futuna Is. | Gen, Ban, Gond            |                        |
| Crepidium acuminatum (D.Don) Szlach.                                          | T - II - Andaman Is., Assam, Bangladesh, Cambodia, China South-Central, China Southeast, East Himalaya, India, Jawa, Laos, Myanmar, Nepal, Nicobar Is., Northern Territory, Philippines, Sumatera, Thailand, Tibet, Vietnam, West Himalaya | Gen                       |                        |
| Crepidium junghuhni (J.J.Sm.) Szlach.                                          | E - II - Jawa                                                                                        | Gen, Gaj                  |                        |
| Crepidium kobi (J.J.Sm.) M.A.Clem. & D.L.Jones*                               | T - II - Jawa                                                                                        | Gen, Maw                  |                        |
| Crepidium perakensis (Ridl.) Szlach.                                           | T - II - Borneo, Jawa, Malaysia, Thailand                                                           | Ban                      |                        |
| Crepidium sp.                                                                  | T - II - N/A                                                                                        | Gaj, Maw                  |                        |
| Species                        | Distribution                                                                 | Genbank Accession Numbers |
|-------------------------------|------------------------------------------------------------------------------|---------------------------|
| **Cymbidium bicolor** subsp.  | pubescens (Lindl.) Du Puy & P.J.Cribb                                        |                           |
|                               | Andaman Is., Borneo, Cambodia, Jawa, Lesser Sunda Is., Malaysia, Nicobar Is.,| Gen                        |
|                               | Sulawesi, Sumatera                                                           |                           |
| Cymbidium lanceifolium Hook.  | Assam, Bangladesh, Borneo, Cambodia, China South-Central, China Southeast,   | Gen, Ban                  |
|                               | East Himalaya, Hainan, Japan, Jawa, Korea, Laos, Malaysia, Maluku, Myanmar,   |                           |
|                               | Nansei-shoto, Nepal, New Guinea, Sulawesi, Sumatera, Taiwan, Thailand, Tibet, |                           |
|                               | Vietnam, West Himalaya                                                       |                           |
| Dendrobium atavus J.J.Sm.*    | Jawa                                                                          | Ban                       |
| Dendrobium aureotubum J.J.Sm. | Jawa, Malaysia, Sumatera                                                     | Ban, Wat                  |
| Dendrobium barbatum Breda      | Bangladesh, Jawa, Sumatera                                                   | Gen, Kal, Pas, Gon, Ban,   |
|                               | Wat                                                                           |                           |
| Dendrobium connatum (Blume)   | Andaman Is., Borneo, Jawa, Lesser Sunda Is., Malaysia, Maluku, Sumatera,     | Gen, Kal, Pas, Gon, Ban,   |
| Lindl.                        | Thailand                                                                      | Wat                       |
| Dendrobium conspicuum Banh.f. | China South-Central, Jawa, Lesser Sunda Is., Sumatera, Vietnam                | Gen, Kal, Pas, Gen, Ban,   |
| Dendrobium crumenatum Sw.     | Andaman Is., Borneo, Cambodia, Christmas I., India, Jawa, Laos, Lesser Sunda | Gon, Wat                  |
|                               | Is., Malaysia, Maluku, Myanmar, New Guinea, Nicobar Is., Philippines, Sri    |                           |
|                               | Lanka, Sulawesi, Sumatera, Taiwan, Thailand, Vietnam                          |                           |
| Dendrobium lobulatum Rolfe ex | Andaman Is., Borneo, Jawa, Maluku, Sumatera                                  | Gen, Kal, Pas, Gon, Ban,   |
| J.J.Sm.**                     |                                                                               | Wat, Gond                 |
| Dendrobium macrostachyum Lindl.| Andaman Is., Bangladesh, Borneo, India, Jawa, Lesser Sunda Is., Malaysia,    | Ban                       |
|                               | Maldives, Myanmar, Nepal, Nicobar Is., Philippines, Sri Lanka, Sulawesi,     |
|                               | Sumatera, Thailand, Vietnam                                                   |                           |
| Dendrobium mutabile (Blume)   | Jawa, Lesser Sunda Is., Sumatera                                             | Gen, Kal, Pas, Gon, Ban,   |
| Lindl.**                      |                                                                               | Wat, Gaj                  |
| Dendrobium nudum (Blume)      | Andaman Is., Borneo, Jawa, Sumatera                                          | Gen, Kal, Pas, Gon, Ban,   |
| Lindl.**                      |                                                                               | Wat, Maw, Ind Gaj         |
| Dendrobium sagittatum J.J.Sm.**| Andaman Is., Borneo, Jawa, Lesser Sunda Is., Sumatera                         | Gen, Kal, Pas, Gon, Ban,   |
|                               |                                                                               | Wat, Gond                 |
| Dendrobium salacense (Blume)  | Andaman Is., Assam, Borneo, China South-Central, East Himalaya, Hainan,     | Gaj                       |
| Lindl.                        | India, Jawa, Laos, Lesser Sunda Is., Malaysia, Myanmar, Sri Lanka, Sumatera,|                           |
|                               | Thailand, Tibet, Vietnam                                                     |                           |
| Dendrochilum aurantiacum Blume**| Andaman Is., Borneo, Jawa, Sumatera                                          | Gaj                       |
| Dendrochilum pallidiflavens Blume var. pallidiflavens | Andaman Is., Borneo, Jawa, Lesser Sunda Is., Malaysia, Myanmar, Philippines, Sumatera, Thailand | Pas, Gond |
| Epipogium roseum (D.Don) Lindl.| Angola, Assam, Borneo, Cameroon, Central African Repu, China South-Central,   | Gen, Pas                   |
|                               | China Southeast, Congo, East Himalaya, Fiji, Ghana, Guinea, Gulf of Guinea    |                           |
|                               | Is., Hainan, India, Japan, Jawa, Kenya, Laos, Lesser Sunda Is., Liberia,     |                           |
|                               | Malawi, Malaysia, Maluku, Myanmar, Nansei-shoto, Nepal, New Caledonia, New   |                           |
|                               | Guinea, New South Wales, Nigeria, Pakistan, Philippines, Queensland,         |                           |
|                               | Solomon Is., Sri Lanka, Sudan, Sulawesi, Sumatera, Taiwan, Thailand, Tibet,  |                           |
|                               | Uganda, Vanuatu, Vietnam, West Himalaya, Zaïre                                |                           |
| Eria bogoriensis J.J.Sm.      | Andaman Is., Borneo, Cambodia, Jawa, Lesser Sunda Is., New Guinea            | Ban                       |
| Scientific Name | Country/Region                          | Culture/Region                           | Notes   |
|-----------------|-----------------------------------------|------------------------------------------|---------|
| *Eria javanica* (Sw.) Blume | E - II | Assam, Bismarck Archipelago, Borneo, China South-Central, East Himalaya, Jawa, Laos, Lesser Sunda Is., Malaysia, Maluku, Myanmar, New Guinea, Philippines, Sulawesi, Sumatera, Taiwan, Thailand, Vietnam | Kal     |

**Additional Species:**
- *Erythodes blumei* (Lindl.) Schltr.
- *Eulophia zollingeri* (Rchb.f.) J.J.Sm.
- *Gastrochilus sororius* Schltr.
- *Goodyera bifida* (Blume) Blume*
- *Goodyera novembrilis* (Rchb.f.) Ormerod**
- *Goodyera reticulata* (Blume) Blume*
- *Habenaria loerzingii* J.J.Sm.*
- *Habenaria undulatifolia* Frapp. ex Cordem.*
- *Hetaeria lamellata* Blume*
- *Liparis caespitosa* (Lam.) Lindl.
- *Liparis condylobulbon* Rchb.f.
- *Liparis elliptica* Wight
- *Liparis latifolia* Lindl.
- *Liparis paillida* (Blume) Lindl.
- *Liparis wightiana* Thwaites
- *Luisia javanica* J.J.Sm.**
- *Luisia taurina* J.J.Sm.**
- *Macodes petola* (Blume) Lindl.
- *Mycaranthes latifolia* Blume
- *Mycaranthes oblitterata* Blume
- *Nepenthes pulchrum* Blume
| Species/Genus | Author | Areana | Habitat/Range |
|--------------|--------|--------|---------------|
| Nervilia concolor (Blume) Schlr. | T - | II - | Andaman Is., Assam, Bangladesh, Bismarck Archipelago, Cambodia, Caroline Is., China South-Central, Cook Is., Fiji, India, Jawa, Laos, Lesser Sunda Is., Malaysia, Maluku, Marianas, Myanmar, Nansei-shoto, Nepal, New Caledonia, New Guinea, Niue, Northern Territory, Pakistan, Philippines, Queensland, Samoa, Society Is., Solomon Is., Sulawesi, Sumatera, Taiwan, Thailand, Tibet, Tonga, Vanuatu, Vietnam, Wallis-Futuna Is., West Himalaya |
| Nervilia punctata (Blume) Makino | T - | II - | Borneo, Cambodia, Fiji, India, Jawa, Laos, Malaysia, New Guinea, Nicobar Is., Sumatera, Thailand, Vietnam |
| Oberonia similis (Blume) Lindl.* | E - | II - | Jawa, Lesser Sunda Is. |
| Paphiopedilum javanicum (Reinw. ex Lindl.) Pfitzer** | T EN I - | | Borneo, Jawa, Lesser Sunda Is., Sumatera |
| Phaius flavus (Blume) Lindl. | T - | II - | Assam, Borneo, Cambodia, China South-Central, China Southeast, East Himalaya, Hainan, Japan, Jawa, Laos, Malaysia, Maluku, Myanmar, Nansei-shoto, Nepal, New Guinea, Philippines, Sulawesi, Sumatera, Taiwan, Thailand, Tibet, Vietnam |
| Phaius pauciflorus (Blume) Blume | T - | II - | Borneo, Jawa, Lesser Sunda Is., Malaysia, Sumatera |
| Phalaenopsis amabilis (L.) Blume | E - | II - | Bismarck Archipelago, Borneo, Jawa, Lesser Sunda Is., Maluku, New Guinea, Philippines, Queensland, Sulawesi, Sumatera |
| Phalaeonopsis imperialis Lindl. | E - | II - | Assam, Borneo, Cambodia, China South-Central, East Himalaya, Jawa, Laos, Malaysia, Myanmar, Nepal, Sulawesi, Sumatera, Thailand, Tibet, Vietnam, West Himalaya |
| Pholidota articulata Lindl. | E - | II - | Borneo, Jawa, Lesser Sunda Is., Malaysia, Maluku, New Guinea, Philippines, Sulawesi, Sumatera, Thailand |
| Pholidota carnea (Blume) Lindl. | E - | II - | Borneo, Jawa, Lesser Sunda Is., Malaysia, Maluku, New Guinea, Philippines, Sulawesi, Sumatera, Thailand |
| Pholidota convallariar (E.C.Parish & Rchb.f.) Hook.f. | E - | II - | Assam, China South-Central, East Himalaya, Jawa, Myanmar, Sumatera, Thailand, Tibet, Vietnam |
| Pholidota globosa (Blume) Lindl.** | E LC II - | | Jawa, Lesser Sunda Is., Sumatera |
| Pholidota imbricata Lindl. | E - | II - | Andaman Is., Assam, Bangladesh, Bismarck Archipelago, Borneo, Cambodia, China South-Central, East Himalaya, Fiji, India, Jawa, Laos, Lesser Sunda Is., Malaysia, Maluku, Myanmar, Nepal, New Caledonia, New Guinea, Nicobar Is., Philippines, Queensland, Santa Cruz Is., Solomon Is., Sri Lanka, Sulawesi, Sumatera, Thailand, Tibet, Tonga, Vanuatu, Vietnam, West Himalaya |
| Phreatia plantaginifolia (J.Koenig) Ormerod | E - | II - | Andaman Is., Borneo, Cambodia, Jawa, Lesser Sunda Is., Malaysia, Maluku, Philippines, Sulawesi, Sumatera, Thailand, Vietnam |
| Phreatia tibodasana J.J.Sm.** | E - | II - | Jawa, Sumatera |
| Pinaulata djaratensis Schlr.** | E - | II - | Jawa, Sumatera |
| Pinaulata multiflora (Blume) | E - | II - | Jawa, Lesser Sunda Is., Sumatera |
| Kuntze** | E - | II - | Andaman Is., Angola, Argentina Northwest, Bahamas, Bolivia, Borneo, Brazil North, Brazil Northeast, Brazil South, Brazil Southeast, Brazil West-Central, Burundi, Cambodia, Cameroon, Cape Provinces, Cayman Is., Central African Repu, China South-Central, Colombia, Comoros, Congo, Cuba, Dominican Republic, Ecuador, Equatorial Guinea, Ethiopia, Florida, French Guiana, Gabon, Ghana, Guatemala, Guinea, Gulf of Guinea Is., Guyana, Haiti, India, Ivory Coast, Jamaica, Java, Kenya, KwaZulu-Natal, Laos, Leeeward Is., Lesser Sunda Is., Liberia, Madagascar, Malawi, Malaysia, Maluku, Mauritius, Mexico Southeast, Mozambique, Nicobar Is., Nigeria, Northern Provinces, Panamá, Peru, Philippines, Puerto Rico, Rwanda, Réunion, Seychelles, Sierra Leone, Sri Lanka, Sudan, Sulawesi, Sumatera, Suriname, Swaziland, Tanzania, Thailand, Togo, Trinidad-Tobago, Uganda, Venezuela, Venezuelan Antilles, Vietnam, Windward Is., Zambia, Zaire, Zimbabwe |
| Scientific Name                          | Category | Subcategory | Endemic Area                                                                 |
|----------------------------------------|----------|-------------|------------------------------------------------------------------------------|
| *Pteroceras compressum* (Blume)        | E        | II          | Jawa, Malaysia, Sumatera, Thailand                                           |
| Holttum**                              |          |             |                                                                               |
| *Rhomboda cristata* (Blume) Ormerod    | T        | II          | Jawa, Lesser Sunda Is., Philippines                                          |
| *Rhomboda velutina* (J.J.Sm.) Ormerod  | T        | II          | Jawa, Lesser Sunda Is.                                                       |
| Ormerod**                              |          |             |                                                                               |
| *Rhyynchostylis retusa* (L.) Blume     | E        | II          | Andaman Is., Assam, Bangladesh, Cambodia, China South-Central, East Himalaya, India, Jawa, Laos, Malaysia, Myanmar, Nepal, Nicobar Is., Philippines, Sri Lanka, Sumatera, Thailand, Vietnam, West Himalaya |
| Schoenorchis juncefolia Reinw. ex Blume| E        | II          | Borneo, Jawa, Lesser Sunda Is., Malaysia, Sumatera, Thailand                  |
| Spathoglottis aurea* Lindl.            | T        | II          | Borneo, Jawa, Lesser Sunda Is., Malaysia, New Guinea, Sulawesi, Sumatera, Thailand, Vietnam |
| Spathoglottis plicata Blume            | T        | II          | Andaman Is., Assam, Bangladesh, Bismarck Archipelago, Borneo, Cambodia, Caroline Is., Cook Is., East Himalaya, Fiji, India, Jawa, Laos, Lesser Sunda Is., Malaysia, Maluku, Marianas, Myanmar, Nansei-shoto, New Caledonia, New Guinea, Nicobar Is., Niue, Philippines, Queensland, Samoa, Santa Cruz Is., Solomon Is., Sri Lanka, Sulawesi, Sumatera, Taiwan, Thailand, Tonga, Vanuatu, Vietnam, Wallis-Futuna Is. |
| Spathoglottis velutina* Blume          |          |             |                                                                               |
| Stereosandra javanica Blume            | T        | II          | Borneo, China South-Central, East Himalaya, Jawa, Malaysia a, Myanmar, Nansei-shoto, New Guinea, Philippines, Samoa, Solomon Is., Sumatera, Taiwan, Thailand, Vietnam |
| *Taeniophyllum hasseltii* Rchb.f.       | E        | II          | Borneo, Jawa, Lesser Sunda Is., Malaysia, Sumatera, Thailand                  |
| Tainia speciosa Blume                  | T        | II          | Borneo, Jawa, Malaysia, Sumatera, Thailand                                   |
| *Thelymitra javanica* Blume            | T        | II          | Jawa, Philippines                                                            |
| *Thrixpermum obtusum* (Blume) Rchb.f.* | E        | II          | Jawa                                                                         |
| *Trichotosia pauciflora* Blume         | E        | II          | Borneo, Jawa, Lesser Sunda Is., Malaysia, Sumatera, Thailand                  |
| Tropidia angulosa* (Lindl.) Blume      | T        | II          | Andaman Is., Assam, Bangladesh, China South-Central, China Southeast, East Himalaya, India, Kal |
| Tropidia curculigoides* Lindl.         | T        | II          | Andaman Is., Assam, Bangladesh, China South-Central, China Southeast, East Himalaya, Hainan, India, Jawa, Laos, Lesser Sunda Is., Malaysia, Myanmar, Sulawesi, Sumatera, Taiwan, Thailand, Vietnam |
| *Tuberolabium zollingeri* (Rchb.f.) Ormerod & Juwara** | E | II | Jawa, Lesser Sunda Is.                                                      |
| Vanda tricolor* Lindl.**               | E        | II          | Jawa, Lesser Sunda Is.                                                       |
| Zeuxine gracilis* (Breda) Blume        | T        | II          | Assam, Borneo, East Himalaya, India, Jawa, Malaysia, Sumatera                 |

Notes: (*) Javan endemic; (**) Indonesian endemic; T: Terrestrial, E: Epiphyte; (-): Not evaluated. LC: Least concern, EN: Endangered; II: Appendix II; Gen: Gentong, Kal: Kalisidi, Pas: Pasigitan, Gon: Gonojarho, Ban: Banyuwindo, Gaj: Gajah Mungkur, Wat: Watuondo, Gond: Gondang, Ind: Indrakila, Pun: Puncak, Maw: Mawar Camp
Discussion

Of the five sub-families of Orchidaceae, only three sub-families occurred in Mount Ungaran, namely Cypripedioideae, Orchidoideae, and the rich one, Epidendroideae. Each sub-family had specific characteristics that can be used as a discriminator for grouping some genera with other genera related. The members of Cypripedioideae sub-family are spectacular orchids with terrestrial on their life type and have distinct slipper-shaped pouches as the shape of their labellum. In this study, the sub-family was represented by only a single genus *Paphiopedilum* with a single species, namely *P. javanicum*. This endangered orchid has a green herbaceous leaf with many dark spots on the abaxial side. The main feature of *Paphiopedilum* is its pouch-like lip on the flower (Romadlon et al. 2021). While the diagnostic characters of *P. javanicum* are the presence of mottled leaves, with darker green spots superimposed over a light green background; the dorsal sepal is ovate, acute, green with white margins, longitudinally striped dark brown; petals long-oblong, held nearly horizontal but sometimes dropping, greenish finely spotted reddish-brown in the lower two-thirds, white or pink in the apical third; and the dull lip brownish-green (Comber 1990; Hendriyani et al. 2019).

The second sub-family in this study is Orchidoideae, a group of orchids that grow as terrestrial with erect inflorescences. Sub-family Orchidoideae shows several diagnostic characters such as their life form as terrestrial, the growing from tubers or a horizontal fleshy rhizome; anther basifixed or not; pollinia segmented, comprising massulae, or mealy (Chase et al. 2015). The Orchidoideae sub-family found in this study was represented by 9 genera grouped in 3 tribes: Cranichideae, Diurideae, and Orchideae. The Cranichideae was represented by seven genera including *Anoectochilus*, *Erythrodes*, *Goodyera*, *Hetaeria*, *Rhomboda*, *Macodes*, and *Zeuxine*. While tribe Diurideae was represented by the genus *Thelymitra*, equal to Tribe Orchideae which was only represented by the genus *Habenaria*.

As the largest sub-family in Orchidaceae family (80% out of all orchid species), Epidendroideae has diverse characteristics (Dong et al. 2018). There are known 26 tribes as members of this sub-family (Freudenstein and Chase 2015). Although Epidendroideae has a diverse member with various variations, the members can be compiled into this group due to synthentic features such as a single anther that is entirely incumbent to sub-erect. The anther form arises from column elongation or, as in the vandoids, from early anther bending. Most of these family members are epiphytes, but some tribes contain only
terrestrial orchids. We found 45 genera in this sub-family which can be grouped into 11 tribes as follows: Tribe Arethuseae was represented by genera Arundina, Nephelaphyllum, Calanthe, Phaius, Spathoglottis, Tainia, and Ania; Tribe Collabieae was represented by genus Chrysoglossum; Tribe Coelogyneae was represented by genera Coelogyne, Pholidota, and Dendrochilum; Tribe Epidendraeae was represented by genus Agrostophyllum; Tribe Epipogieae was represented by genera Epipogium and Stereoandra; Tribe Gastrodieae was represented by genus Nervilia; Tribe Malaxideae was represented by genera Crepidium and Liparis, Tribe Podochileae Bulbophyllum, Dendrobium, Erig, Bryobium, Mycarnanthes, Pinaila, Trichotosia, Appendicula, Ceratostylis, and Phreatica; Tribe Tropidieae was represented by genera Tropidia and Corymborkis; Tribe Cymbidieae was represented by genera Acropis, Cymbidium, and Eulophia; Tribe Vandeae was represented by genera Aerides, Rhynchosytilis, Phalaenopsis, Luisia, Bogoria, Cleisostoma, Thrixpermum, Vanda, Polystachya, Taeniophyllum, Schoenorchis, Gastrochilus, and Tuberalabium. Some studies showed that the average temperature on Mount Ungaran ranges from 22-27°C and the range of altitude is between 900-2050 masl (Rahayuningsih et al. 2017). Such characters will support mosses as well as mycorrhizal fungus to life (Nurfadi et al. 2020). Mosses and mycorrhizal fungus are important successors as natural orchids microhabitat (Kurniawati et al. 2020). The presence of these moss provides the moisture needed for orchid roots to grow and develop (Sathiyadash et al. 2012). In addition, the availability of large and old trees with many branches is also a factor in the number of orchid species, especially those with epiphytic life forms. Trees with these characters can store substrates that, of course, keep nutrients and water (Garcia et al. 2020; Kusumastuti et al. 2021). This condition was observed in Gentong (Rahayuningsih et al. 2015) so it was not surprising that the area had the most orchid species and 50% were epiphytic species. This is also the reason that the Epidendroideae sub-family whose members are mostly epiphytic species had the most abundant wealth compared to other sub-families in Ungaran.

The species richness of Ungaran orchids is less than some conservation areas in West Java. For example, in Gede-Pangrango National Park (NP) with 201 species. This is not surprising due to intensive care and more organized area by their zonation. However, the number of Mount Ungaran orchid species will not be much different compared to Java's eastern part conservation area with equal forestry management such as Bromo Tengger Semeru NP with 135 species (Artaka 2019). Nevertheless, it means that Mount Ungaran has potential for natural orchids habitat.

Our previous study of orchids in Mount Ungaran only found 68 species (Utami et al. 2018). Another previous study of orchids in Ngesrepbalong village (Gentong site) showed 12 species orchids (Dewi et al. 2018). The total number of orchids species found in this study provides evidence that Mount Ungaran has a high richness of orchid and might still have an opportunity to record additional species. Interestingly, we also got field information from residents that other species from the type list compiled can still be found on the other side of Mount Ungaran.

The observation period of 2014-2018 recorded the highest number of orchid species with 93 species, while the last observation period (2018-2021) found the lowest number of orchid species with 53 species. It is likely due to the forest fires in Mount Ungaran and the spread of COVID-19 which resulted in a decrease in the intensity and range of exploration during that period.

This study recorded the new distribution records of several species of orchids that were previously only found in West Java or East Java by Comber (1990). These species are Ania penangiana, Pholidota convallariae, and Crepidium junguhiuntii. Whereas, some of species are losing their endemic statuses such as Goodyera reticulata, Bogoria raciborski, and Taeniophyllum hasseltii (Averyanov et al. 2018; Ong et al. 2019; Hsu et al. 2020). In this study, we encountered several confusable and sympatric Crepidium species displaying the complex structure of the flowers. Based on the consultation with several experts, this species is a variation of C. koordersii. The description of the holotype that refers to C. koordersii is a diamond-shaped labellum, a tapered auricle in the shape of a triangle that narrows towards the base (Smith 1905; Comber 1990). However, the type we encountered was different, with the labellum tending to be rounded and the auricle kidney-shaped with rounded ends, as well as a pulpinth on both its tepals and sepals. The other discussion said that this species is a natural hybrid between C. koordersii and C. Acuminatum. The genus Crepidium has plenty diverse members; at least 365 species have been known as members of this genus (Govaerts et al. 2021). Based on these reasons mentioned and the various member of the genus (Besi et al. 2020), it is essential to conduct a deeper study of the characteristics in more detail in live specimens and their herbarium so that we are in the process of waiting for the inflorescences for a more detailed study as a follow-up to the findings of this species and continue to designate this species as Crepidium sp.

Overexploitation of orchids to fulfill the orchid species market needs conservation action as soon as possible. Especially orchids with large and unique flowers, such as Bulbophyllum lobbii, Vanda tricolor, Aerides odorata, Rhynchosytilis retusa, and P. javanicum. These orchids were rarely found in this study, and even the endangered P. javanicum found only in one individual. In addition, Macodes petala, Anoectochilus reinwardtii, which have unique leaves with glowing leaf veins, are the main attraction for orchid lovers. From the 11 observation locations, Gentong has the potential to be designated as in-situ conservation area to conserve the remaining orchids of Mount Ungaran. Not only has a high level of species diversity, but forest cover on Gentong is also relatively good with dense tree crowns that provide ideal habitat and microclimate to support orchid growth. Large trees and coffee plantations left without intensive care also become a suitable habitat for epiphytic orchids.
Figure 3. The representation of Mount Ungaran (Indonesia) Orchids based on the sub-family: The representation of Ungaran Orchids in each sub-family. A. sub-family Cypripedioideae: Paphiopedilum javanicum. B-H. subfamily Orchidoideae: B. Goodyera, C. Hetaeria lamellata, D. Rhomboda cristata, E. Macodes petola, F. Erythrodes blumei, G. Habenaria loerzingii, H. H. undulata. I-T. Sub-family Epidendroideae: I. Arundina gramminifolia, J. Nephelaphyllum pulchrum, K. Calanthe triplicata, L. Phaius callosus, M. Spathoglottis plicata, N. Anta penangiana, O. Chrysoglossum ornatum, P. Coelogyne miniata, Q. Pholidota globosa, R. Dendrobium pallideflavens; S. Agrostophyllum stipulatum subsp. bicuspidatum; T. Epipogium roseum
Figure 4. The representation sub-family Epidendroideae in Ungaran (continuation of figure 3): A. Nervilia punctata, B. Crepidium acuminatum, C. Liparis caespitosa, D. Bulbophyllum ecoratum subsp. ecoratum, E. Eria javanica, F. Mycaranthes latifolia, G. Pinalia multiflora, H. Trichotosia pauciflora, I. Appendicula ramosa, J. Phreatia plantaginifolia, K. Corymborkis veratrifolia, L. Acriopsis liliifolia var. liliifolia, M. Cymbidium bicolor subsp. pubescens, N. Rhynchostylis retusa, O. Luisia taurina, P. Bogoria raciborskii, Q. Cleisostoma discolor, R. Vanda tricolor, S. Taeniophyllum hasseltii, T. Schoenorchis juncifolia
In conclusion, a total of 115 orchids species were found in Mount Ungaran, highlighting that this area serves as critical habitat for wild orchids. Among all species recorded, at least 27 species were known to be endemic to Indonesia, and 8 species were endemic to the island of Java, which four species were listed in the IUCN Red List. Besides that, all of the documented species were listed in Appendix II category of the CITES, except one species, *P. javanicum* which is listed in Appendix I. Gentong is recommended as a priority for in-situ orchid protection area due to the highest number of species recorded which contributed to 54% of all orchids found. Yet, future exploration efforts are still needed in the other area of Mount Ungaran to obtain complete information on orchid diversity to support its conservation and enrich the knowledge of orchids in the region.

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Figure 5. *Crepidium* sp found in this research (A), compared with *C.koordersii* from other side in west Java (B), and digitized sketch from Smith (1908) (C). Photo of *C.koordersii* by Yuda Rehata Yudistira
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