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RESEARCH ARTICLE

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Diversity and habitat preference of orchirds in R. Soerjo Forest Park, East Java, Indonesia

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Abstract

The diversity and habitat preferences of orchids in the natural tourist attraction area of R. Soerjo Forest Park (TAHURA) are not yet completely known. Lack of information and the activities of tourist visitors increase the risk of natural orchid habitat degradation. The aim of this research is to determine the diversity and habitat preferences of orchids in R. Soerjo Forest Park. The research design used a line transect method for orchid diversity data and a purposive sampling method with a plot measuring 10 × 10m for habitat preference analysis or environmental data. The research results show that there are 37 species of orchids in the natural tourist attraction area of R. Soerjo Forest Park, which is divided into 25 epiphytic orchids and 12 terrestrial orchids. The results of the Shannon-Wienner analysis show that the orchid diversity index value is 2.46, which is show a medium level of diversity. Dominant orchids grow at an altitude of 1,400–1,600 m.a.s.l. The most dominant orchid species are *Nervilia punctata* (558), *Appendicula angustifolia* (296), and *A. elegans* (130), with an evenness value of 0,32, 0,17, and 0,07. The dominance of *N. punctata* is influenced by the root shape, which is modified as a tuberous type. The results of redundancy analysis (RDA) show that the environmental variables that most influence the distribution of orchids are air temperature, soil pH levels, light intensity, and elevation.

Keywords: Diversity, Habitat Preferences, Orchids, R. Soerjo Forest Park

Introduction

Orchids are unique flowering plants, and their flowers are more modern compared to other members of the monocot family[1]. Orchid flowers have very diverse color variations; the petals and corolla are difficult to distinguish due to modified morphology; the male and female reproductive organs are fused in one part called the column; and one of the middle corollas is modified into a labellum, which is considered the most unique and aesthetic part of the orchid[2]. The unique morphology

and color variations make orchids widely used as ornamental plants with high economic value. Currently, orchids are widely traded in the form of cut flowers or potted plants[3,4].

Orchids, as an ornamental plant commodity, led plant breeders to continuously create new varieties through the breeding process. This process can be carried out conventionally by crossing parent plants from wildtype species or using modern techniques such as plant tissue culture and molecular breeding[5]. Several wild-type orchid genera that are widely harvested for the breeding process are *Calanthe*, *Cattleya*, *Dendrobium*, *Oncidium*, and *Phalaenopsis*[6,7]. Orchids as breeding stock objects cause their population to be threatened with decline due to exploitation. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) even categorized 36 types of Indonesian orchids into Appendix I, which means contain an endangered species that cannot be traded in any form; and also 2,252 species in Appendix II, which means contain a species that is not threatened with extinction but, if traded, is at risk of becoming endangered[8]. A total of 27 species of Indonesian orchids are also protected in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 106 of 2018, which includes the genera *Cymbidium*, *Paphiopedilum*, *Paraphalaenopsis*, *Phalaenopsis*, and *Vanda*[9].

R. Soerjo Forest Park (TAHURA) is one of the conservation areas in East Java, Indonesia, with a total area of 27,868.30 ha. The R. Soerjo Forest Park area stretches across the districts of Malang, Jombang, Mojokerto, Pasuruan, and Batu City. Several types of ecosystems in the R. Soerjo Forest Park include primary and secondary mountain rainforests, production forests, savannas, and rivers. R. Soerjo Forest Park has several natural tourist attractions (*Objek Wisata Alam*/*OWA*), especially waterfall tourism, which is located in the utilization block with a total area of 291.80 ha. The OWA area is directly adjacent to the protection block as a zone for conservation purposes[10,11]. The proximity of the OWA to the conservation zone poses a threat to ecosystem change. Visitor activities in the OWA zone should not have a negative impact on the ecosystem, but they must be educated to contribute to mutually protecting the ecosystem and biodiversity[12,13].

The diversity of orchids in R. Soerjo Forest Park is estimated to be quite high because there are primary and secondary mountain rainforest ecosystems that support orchid's growth[14]. Unfortunately, there is lack information about the diversity and habitat preferences of orchids in R. Soerjo Forest Park. This research aims to determine the number of species and patterns of orchid habitat preferences in R. Soerjo Forest Park.

Materials and methods

Study area and species

The research was carried out in R. Soerjo Forest Park (Malang Regency and Batu City) in 2018–2020 (**Figure 1**). The research area focuses on the utilization zone, which consists of three natural tourism objects (OWA), i.e., Cangar, Watu Ondo, and Sendi. The research area is located between latitude and longitude -7.742320°, 112.534246°, and -7.702006°, 112.530123°. The elevation of the research area is between 800 and 1.800 m.a.s.l., with an average air temperature of 18-220°C during the day. Based on their life form, orchids can be divided into terrestrial and epiphytic orchids. Epiphytic orchids generally have pseudostems (bulbs) and succulent leaves. The leaf veins are parallel or form a net structure. Orchid flowers consist of 2 lateral petals, 2 lateral sepals, 1 dorsal sepal, 1 petal that is modified as a

labellum, and a column (stigma and pollinia). The fruit is in a capsule that is usually divided into six loci.

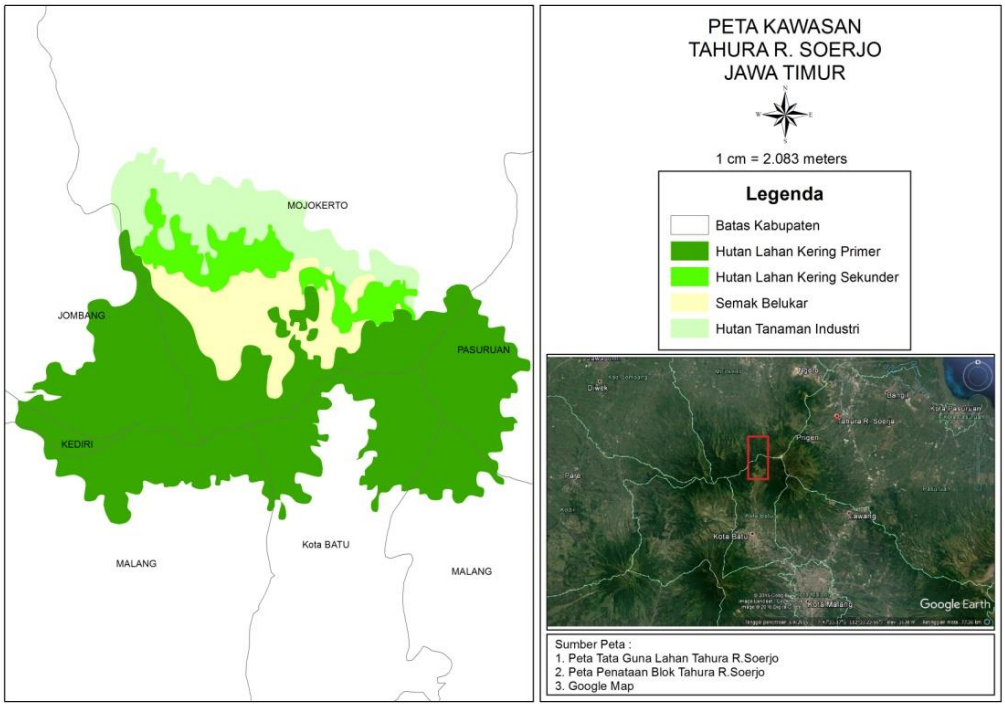

Figure 1. Map of R. Soerjo Forest Park Division Zones.

Procedures

Data on orchid diversity was obtained using the line transect method or exploring the OWA footpath/track. The orchids that have been discovered were identified, and the number of individuals was recorded. Orchid habitat preference data was obtained using a purposive sampling method, where measurements were taken at the place where orchids were found by forming a 10x10m2 plot[15]. The types of environmental variables measured are air temperature (SU), air humidity (KU), light intensity (IC), soil pH (pH), and altitude (EL). Identification of orchid species refers to the books Orchid of Java, Orchid of Indonesia, and Natural Orchids in Java Island Conservation Areas[16–18]. Non-flowering orchids were identified at the genus level.

Data analysis

Orchid species diversity was determined using the Shannon-Wiener Diversity Index[19,20]. The influence of environmental parameters on orchid distribution was analyzed using the Canoco for Windows 4.5 application and depicted using the CanoDraw application.

H= - ∑_(i=1)^s⁡〖pi ×ln⁡pi 〗

Where pi = proportion of individuals of species i, and ln is the natural logarithm, and S = species richness. The value of H ranges from 0 to Hmax.

Results

In three areas of OWA R. Soerjo Forest Park, 37 species orchids were found and belonging to 21 genera. Based on their life form, there are 25 types of epiphytic orchids and 12 types of terrestrial orchids

(**Figure 2 and 4**). Among the types of terrestrial orchids, there is 1 type of saprophytic orchid, *Cystorchis aphylla*, and 1 type of amoebophytic orchid, *Nervilia punctata*. The orchid species with the highest number of individuals are *N. punctata* (558), *Appendicula angustifolia* (296), and *A. elegans* (130).

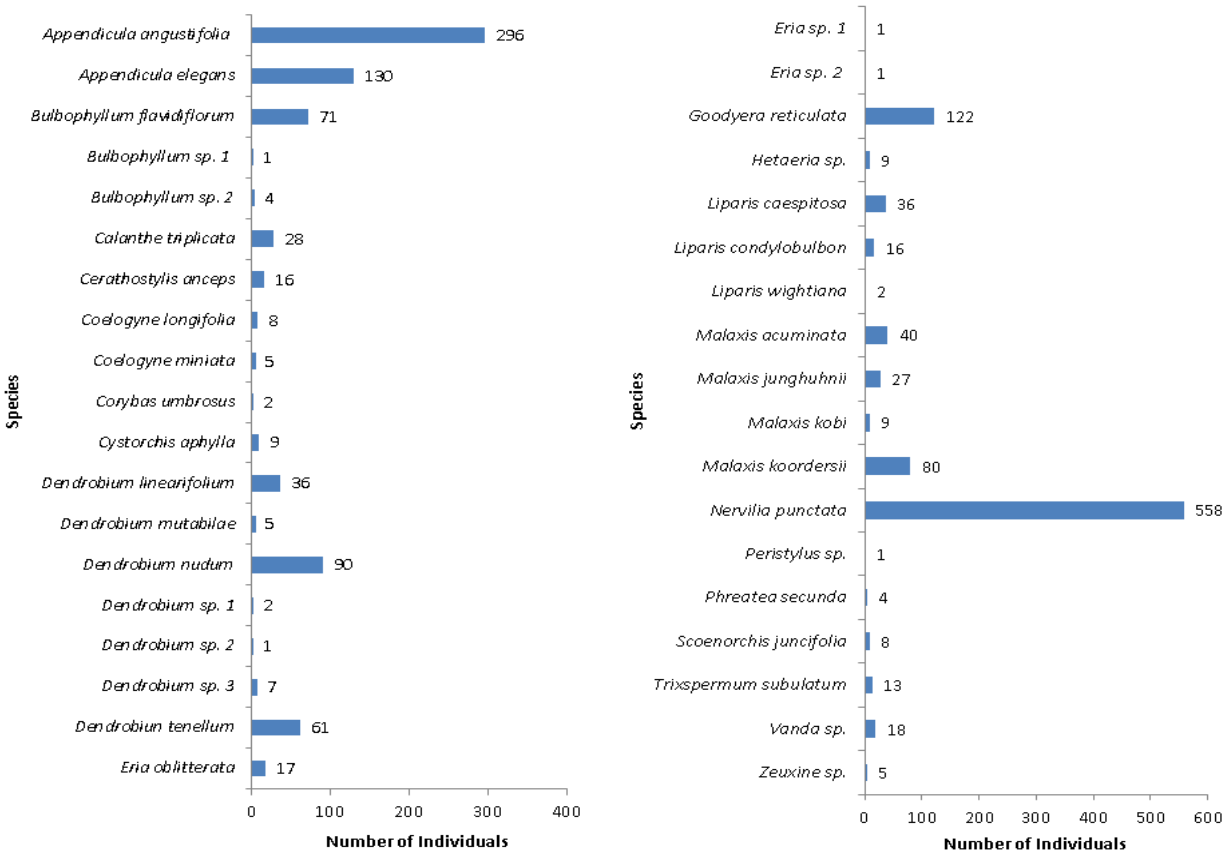

Figure 2. Graph of species and number of orchid individuals in OWA of R. Soerjo Park.

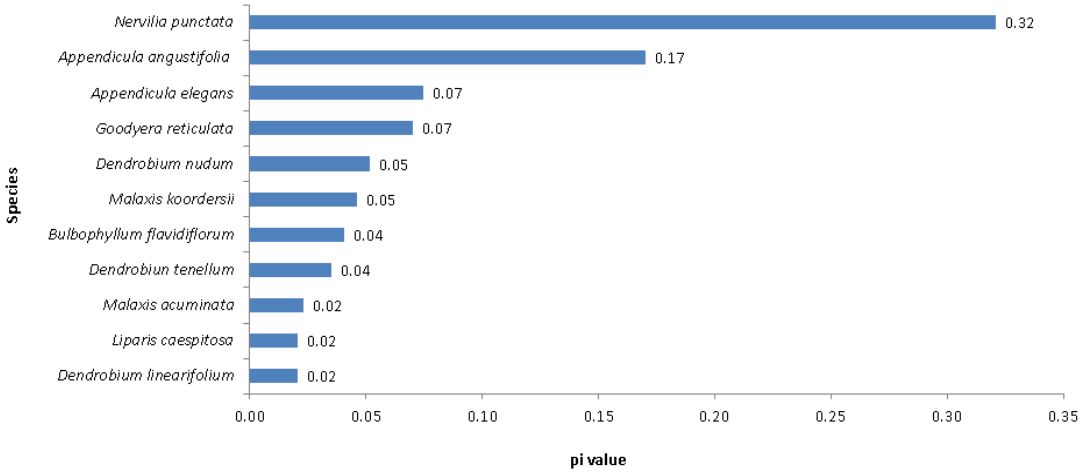

Figure 3. Graph of the highest pi-value of orchids in the OWA of R. Soerjo Forest Park.

The results of redundancy analysis (RDA) show four groups of orchids whose existence is influenced by different environmental factors. The first group is influenced by elevation (EL) and light intensity (IC), such as *Cerathostylis anceps* (7), *Liparis caespitosa* (24), and *L. condylobulbon* (25). The second group is influenced by the variables air temperature (SU) and soil pH levels (pH), such as *Coelogyne*

longifolia (8), *Cystorchis aphylla* (11) and *Scoenorchis juncifolia* (34). The third group is influenced by the variables air humidity (KU) and soil moisture (KT), such as *Hetaeria sp*. (23) and *Malaxis kobi* (29). The fourth group is a group of orchids whose distribution is not influenced by the environmental variables measured in this study (**Figure 6**). The longest arrow in **Figure 6** shows the environmental variables that most influence to the presence of orchids in R. Soerjo Forest Park are air temperature, soil pH levels, light intensity, and elevation.

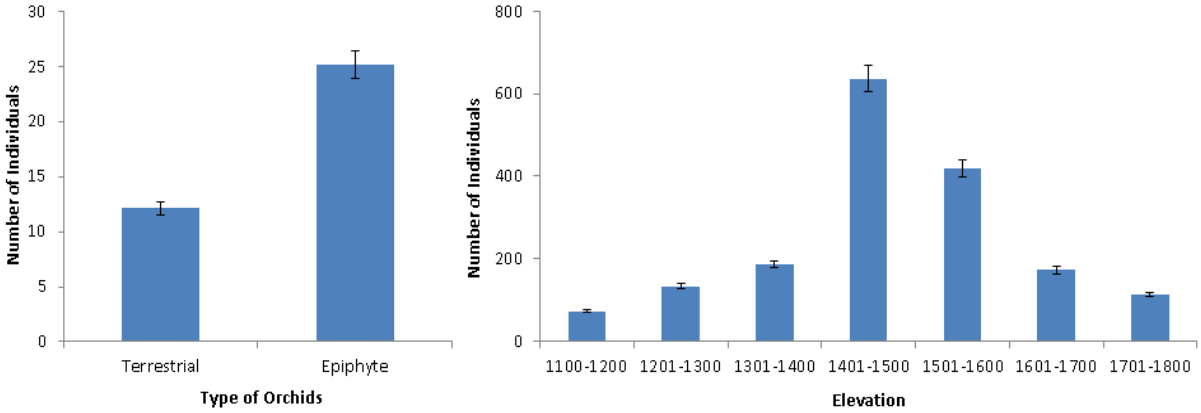

Figure 4. Graph of life form (left) and elevation of orchid habitat (right) in the OWA of R. Soerjo Forest Park.

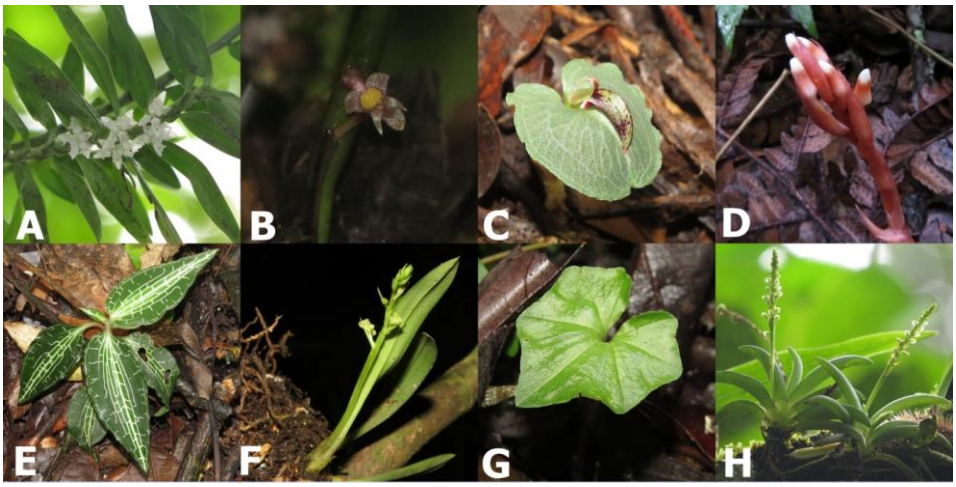

Figure 5. **A:** ***Appendicula angustifolia*****;** **B:** *Ceratostylis anceps***;** **C:** *Corybas umbrosus***;** **D:** *Cystorchis aphylla***;** **E:** *Goodyera* ***reticulate*****:** **F:** *Liparis caespitosa***;** **G:** *Nervilia* ***punctate*****;** **H:** *Phreatia secunda***.**

Table 1. Result of environmental variables analysis of orchid habitats.

Environmental Variables	Min	Max	Mean	Standard Error	Standard Deviation
Air Temperature (⁰C)	17	23	20.33	11.53	1.76
Air Humidity (%)	55	85	66.28	9.09	7.29
ph Soil Level	5.2	7	39.68	18.55	0.35
Light Intensity (lx)	222	14,100	2,198.5	0.9	2,477.3
Air Humidity (%)	25	95	72.94	4.36	16.73
Elevation (m.a.s.l.)	1,158	1,746	1,411	8.35	169.05

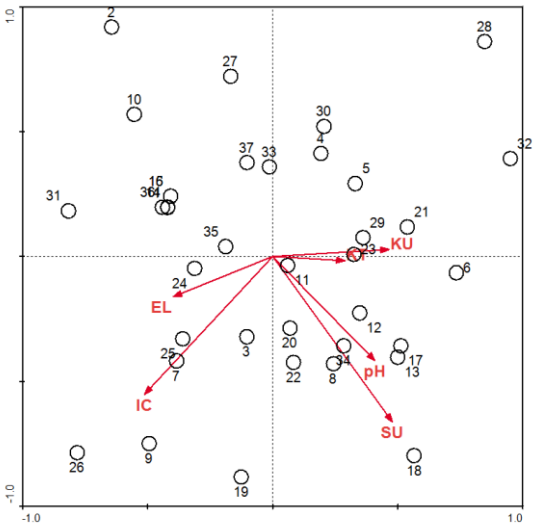

Figure 6. Result of redundancy analysis (RDA) between environmental parameters and the presence of orchids. Note: SU = air temperature; KU = air humidity; pH = soil pH; IC = light intensity; KT: soil moisture; and EL = elevation.

Discussion

The orchid diversity index value in the three OWAs of R. Soerjo Forest Park is 2.46, which means it has moderate diversity. Even though the number of orchid species (richness value) is quite diverse (37 species), there are several dominant species, which are indicated by high evenness values. Species with high evenness or pi values include *N. punctata* (0.32) and *A. angustifolia* (0.17) (**Figure 3**). The dominance of a species can increase the evenness value and reduce the diversity value[20]. The dominance of *N. punctata* compared to other types is highest due to the morphological form of the roots that are modified into tubers. *N. punctata* tubers form stolon that can spread widely and initiate new individuals; therefore, *N. punctata* population are found in clustered form. With the same tuber, *N. punctata* can also initiate flower development. If environmental conditions are not supportive, *N. punctata* tubers will activate the dormant phase; this is the reason why *N. punctata* is called an amoebophytic orchid[21–23].

The saprophytic orchid *Cystorchis aphylla*, the most unique orchid species, was found in the OWA R. Soerjo Forest Park (**Figure 5**). *C. aphylla* is often known as the ghost orchid; this orchid is not capable of photosynthesis; therefore, *C. aphylla* is very dependent on simple organic material from the remains of decomposers around it or is in symbiosis with certain fungi; hence, it is called mycoheterotrophic plants[24]. If a habitat does not have optimal mineral nutrients and humidity, then saprophytic orchid species will be difficult to find. *C. aphylla* in R. Soerjo Forest Park was found in habitat with an air temperature of 20°C, air humidity of 72%, soil moisture of 70%, soil pH of 6.4, and at 1,729 m.a.s.l. This data supports the previous research, where *C. aphylla* was found growing in groups on the forest floor with the characteristics of low light intensity, high humidity, and thick humus[20,25].

Table 1 show that the distribution of orchids in the OWA R. Soerjo Forest Park area is at an average elevation of 1,411 m.a.s.l. Meanwhile, the data in **Figure 4** shows that an altitude of 1,400-1,600 m.a.s.l. is where the highest number of orchid individuals was found. This data confirmed that elevation also influences the distribution of orchid in the OWA R. Soerjo Forest Park (**Figure 6**). The results of this

study support the previous research, which show that the richness and density of orchids in highland forests are generally higher than in lowland forests[21]. Elevation is positively correlated with soil and air humidity. Vegetation cover in the highlands forests can also reduce light intensity values; this causes a decrease in air temperature; also increasing soil and air humidity[26].

According to previous research, the distribution of orchids in various elevation ranges is caused by adaptive behaviour that related to morphological form such as root modification[27]. Roots act as a nutrient and water reserve for orchids. Based on root modifications, orchids can be categorized into three groups, i.e. rhizomatous, intermediate (palmate, fusiform, or stoloniferous tubers) orchids, and tuberous orchids. Orchids with rhizomatous root types tend to grow in the highlands because they do not undergo modification to store nutrient reserves that resemble tubers, such as the intermediate and tuberous types. In this study, orchids with rhizomatous root types such as *Corybas umbrosus*, *Goodyera reticulata*, and *Cystorchis aphylla* were found growing at an altitude of 1,680-1,743 m.a.s.l. Meanwhile, types of orchids whose roots are modified into intermediate and tuberous forms are often found at altitudes below 1,400 m.a.s.l., such as *N. punctata* and *Calanthe triplicata*. The effect of root modification on the distribution of orchids based on elevation gradients in this study is supported by previous research, which show that orchids with intermediate and tuberous root types are often found at an altitude of 600 m.a.s.l, and continuosly increases in line with elevation[28].

Conclusions

Number of orchid species was found in three OWAs of R. Soerjo Forest Park were 37 species. Based on their habitat or life form, the orchids that were found consisted of 25 epiphytic orchids and 12 terrestrial orchids. The most dominant orchid species were *Nervilia punctata* with 558 individuals, *Appendicula angustifolia* with 296 individuals, and *A. elegans* with 130 individuals. These three species have an evenness value of 0.32, 0.17, and 0.07. The dominance of *N. punctata* is influenced by the root shape, which is modified as tuberous; hence its ability to carry out the dormancy process and produce new individuals is likely to be greater than that of other species. In general, the results of redundant analysis show that the environmental variables that most influence the distribution of orchids are air temperature, soil, pH levels, light intensity, and elevation. There are four groups of orchids whose existence is influenced by different environmental factors.

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Conflicts of Interest

There are not potential conflicts of interest.

References

1. Dirks-Mulder A. Evolution and development of orchid flowers and fruits. *Doctoral Thesis*. Leiden University; 2020.
2. Gerry Y, Permatasari F, Dewi RK. *Keanekaragam Anggrek Di Taman Anggerk Badak LNG*. ITS Press; 2020.
3. Hinsley A, Boer H De, Fay M, et al. A review of the trade in orchids and its implications for conservation. *Bot J Linn Soc*. 2018;186(4):435-455. doi:https://doi.org/10.1093/botlinnean/box083
4. Tiwari P, Sharma A, Bose S, Park K. Advances in orchid biology: Biotechnological achievements, translational success, and commercial outcomes. *Horticulturae*. 2024;10(2):152. doi:https://doi.org/10.3390/horticulturae10020152
5. Li C, Dong N, Zhao Y, Wu S, Liu Z, Zha J. A review for the breeding of orchids: Current achievements and prospects. *Hortic Plant J*. 2021;7(5):380-392. doi:https://doi.org/10.1016/j.hpj.2021.02.006
6. De L, Pathak P, Rao A, Rajeevan P. 5 breeding approaches for improved genotypes. In: *Commercial Orchids*. De Gruyter Open; 2019:103-117.
7. De L. Good agricultural practices of commercial orchids. *Vigyan Varta*. 2020;1(5):53-64.
8. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Species+. The Convention on International Trade in Endangered Species. Published 2024. Accessed March 20, 2024. https://speciesplus.net/species#/taxon_concepts?taxonomy=cites_eu&taxon_concept_query=orchid&geo_entities_ids=16&geo_entity_scope=cites&page=1
9. Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia (KLHKRI). Jaringan Dokumentasi dan Informasi Hukum Kementerian LHK. Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia (KLHKRI). Published 2018. Accessed March 12, 2024. https://jdih.menlhk.go.id/new2/index.php/permenlhk/page/28/0
10. Dinas Kehutanan Jawa Timur. Peraturan Daerah Provinsi Jawa Timur Nomor 2 Tahun 2013 tentang Pengelolaan Taman Hutan Raya R. Soerjo. Dinas Kehutanan Jawa Timur. Published 2013. Accessed March 3, 2024. https://jdih.jatimprov.go.id/uploads/topics/PERDA.NOMOR_2_.TAHUN_2013_.TENTANG_PENGELOLAAN_TAMAN_HUTAN_RAYA_R_._SOERJO_.pdf
11. Purwadi. Sejarah terbentuknya Taman Hutan Raya R. Soerjo. In: *Bakti Rimba*. Dinas Kehutanan Provinsi Jawa Timur; 2017:9-12.
12. Miller AB, Blahna D, Morse W, Leung Y, Rowland M. From recreation ecology to a recreation ecosystem: A framework accounting for social-ecological systems. *J Outdoor Recreat Tour*. 2022;38:100455. doi:https://doi.org/10.1016/j.jort.2021.100455
13. Baloch Q, Syah S, Iqbal N, et al. Impact of tourism development upon environmental sustainability: a suggested framework for sustainable ecotourism. *Env Sci Pollut Res Int*. 2023;30(3):5917–5930. doi:https://doi.org/10.1007%2Fs11356-022-22496-w
14. Prapitasari B, Kurniawan A, Muharram D. Keanekaragaman dan kemelimpahan jenis anggrek (Orchidaceae) di resort selabintana Taman Nasional Gunung Gede Pangrango (TNGGP) Jawa

Barat. *Biosf J Bio Pend Bio*. 2020;5(1):24-30. doi:10.23969/biosfer.v5i1.2569

15. Zulkarnaen R, Nisyawati, Witono J. Population study and habitat preferences of Pinang Jawa (*Pinanga javana*) in Mt. Slamet, Central Java, Indonesia. *Biodiversitas*. 2020;20(3):712-718. doi:10.13057/biodiv/d200314
16. JB Comber. *Orchid of Java*. Royal Botanical Garden; 1990.
17. Lembaga Ilmu Pengetahuan Indonesia. *Anggrek Alam Di Kawasan Konservasi Pulau Jawa*. LIPI Press; 2003.
18. Handoyo F. *Orchid of Indonesia*. Indonesian Orchid Society; 2010.
19. Prawito H, Pratamaningtyas S, Nugroho Y, Artaka A. Keanekaragaman jenis anggrek hutan (epifit) di Resort PTN Ranu Darungan Seksi PTN Wilayah VI Bidang PTN Wilayah II Taman Nasional Bromo Tengger Semeru. *Agrika*. 2023;17(2):208. doi:10.31328/ja.v17i2.5161
20. Pielou E. The measurement of diversity in different types of biological collections. *J Theor Biol*. 1966;13:131–144. doi:10.1016/0022-5193(66)90013-0
21. Nisa R, Wisanti, Putri E, Kuntjoro S, Artaka T. Keanekaragaman spesies anggrek di Ranu Darungan Taman Nasional Bromo Tengger Semeru. *LenteraBio*. 2021;10(1):1-9. doi:https://doi.org/10.26740/lenterabio.v13n2
22. Djordjevic V, Tsiftsis S, Kindlmann P, Stevanovis V. Orchid diversity along an altitudinal gradient in the central Balkans. *Front Ecol Evol*. 2022;10:929266. doi:10.3389/fevo.2022.929266
23. Sharma S, Kumar R, Singh S, Jalal J. Nervilia puncatata (Orchidaceae) – A new record for Northeast India. *Richardiana*. 2013;14:32-38.
24. Rohmah L. Studi habitat dan pengaruh naungan tumbuhan asing invasif terhadap populasi anggrek terestrial di Tahura R. Soerjo Jawa Timur. *Undergraduate Thesis*. UIN Sunan Kalijaga; 2018.
25. Zulkarnaen R, Garvita R, Wawangningrum H, Tyas K. Population ecology size and habitat preference of the ghost orchid didymoplexis pallens in Bogor Botanic Gardens, Indonesia. *Biodiversitas*. 2020;21(5):2056-2061. doi:10.13057/biodiv/d210531
26. Velez-Abarca L, Jimanez M, Ramirez-Iglesias E, Parra-Suarez S, Torrochi-Carrasco E, Benitez E. Orchid diversity at three elevations in the mountain sandstone plateaus of the Cordillera del Cóndor Ecuador. *Diversity*. 2023;15(9):979. doi:https://doi.org/10.3390/d15090979
27. Tsiftsis S, Stipkova Z, Kindlmann P. Role of way of life, latitude, elevation and climate on the richness and distribution of orchid species. *Biodivers Conserv*. 2019;28(1):75-96. doi:10.1007/s10531-018-1637-4
28. Stipkova Z, Tsiftsis S, Kindlmann P. Distribution of orchids with different rooting systems in the Czech Republic. *Plants*. 2022;10(4):632. doi:10.3390/plants10040632