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DISTRIBUTION PATTERN AND DIVERSITY OF EPIPHYTIC ORCHIDS IN THE CURUG CIBEREUM PATH, MOUNT GEDE PANGRANGO, INDONESIA

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ABSTRACT

The Curug Cibereum path as a tourist attraction in the Mount Gede Pangrango area is dominated by a lush tree, making it a suitable place to find a diversity of epiphytic orchids. This study aimed to determine the distribution pattern and diversity of epiphytic orchids along the Curug Cibereum path which is influenced by environtmental parameters. The research method was carried out by plotting ten plots on the right and left sides of the path, with each plot measuring 500 x 5 m and the distance between plots was 100 m. The results showed that there were 31 species of epiphytic orchids from 12 genera. The distribution pattern of epiphytic orchids was mostly clustered except for *Oberonia lotsyana,* which had a uniform pattern. The epiphytic orchid species with the highest INP were *Bulbophyllum gibbosum* with an INP value of 35% and *Coelogyne speciosa* with an INP value of 20%. Species diversity (H ') was moderate (H '=2.54), the evenness index (E) was high (E=0.73), the dominance index (D) was low (D=0.13). The measurements of environmental parameters showed optimal conditions for the growth of epiphytic orchids, namely with a temperature of 24.5 ^{o}C, soil moisture of 76.5%, air humidity of 70%, pH 5.1, the light intensity of 6351 lux and wind speed of 0.03 m/s.

Keywords: Curug Cibereum, distribution, diversity, dominance, epiphytic orchid

INTRODUCTION

Orchids are unique plants because they have several benefits both economically and ecologically. The many uses of orchids for decoration, traditional medicinal ingredients and cosmetics make orchids have a high selling value in the world of trade and many fans because they have high aesthetics value. The number of orchids in the world is estimated at around 20,000-30,000 species consisting of 700 genera (Shutleworth *et al.* 1970). Orchids in Indonesia are estimated at 5,000 species from 40 genera scattered in Sumatra, Kalimantan, Papua, Sulawesi and Java. In Java, there are about 731 species of orchids with the 231 species are endemic. In terms of orchid distribution, West Java has 642 species, East Java has 390 species, and Central Java has 295 species (Chomber 1990).

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An epiphytic orchid is one type of natural orchid that has the characteristic of sticking to the host tree. Ecologically, epiphytic orchids function as habitats for certain animals such as ants and termites. Research activities on epiphytic orchids are currently considered very important because of the many damaged habitats caused by felling trees to clear forests used for repairs, animal husbandry and visitor attractions. According to the World Conservation Monitoring Center (1995), orchids are plants with a high threat of extinction, around 39% (203 species) compared to native Indonesian plants, which are also threatened. Based on these conditions, many orchids may have become extinct, but no data has been collected (Puspitaningtyas 2005).

Mount Gede Pangrango, West Java, is a national park used as a conservation area, climbing or tourist attraction. One of the attractions in the area is Curug Cibereum which is located at Resort Selabintana, Sukabumi. The

area consists of a natural forest where many orchids are found, both epiphytic and terrestrial. The types of orchids in the area have been recorded. Namely, 46 species were found, consisting of 25 species of epiphytic orchids and 21 species of terrestrial orchids (Prapitasari *et al.* 2020). The existence of tourist activities on the Curug Cibereum path, of course, can affect the reduction in the types of orchids in the area. Based on the above explanation, this study was conducted to determine the distribution pattern and diversity of epiphytic orchids in the Curug Cibereum path which is influenced by environmental parameters. This research is also expected to provide data updates from previous studies.

MATERIALS AND METHODS

Study Site

The research was conducted in March 2021 in the Selabintana Resort Area, Sukabumi, which is on the route to Curug Cibereum Mount Gede Pangrango, West Java. Geographically, Selabintana Resort is located at 106°57'41"E and 06°50'50"S with an area of 2,547.93 ha (Fig. 1). This area has a topography of hills and mountains with slightly sloping areas, altitudes ranging from 1,130 to 3,019 masl. In general, Selabintana Resort is an area with a wet climate with an average rainfall of 3,000-4,200 mm/year. The rainy season lasts from October to May, and from December to March the rainfall can be more than 400 mm/month. The average temperature at Resort Selabintana is 18 °C with relatively high humidity throughout the year, which is around 80-90% (Dendang 2009). Based on these environmental parameters, it can be seen that the environment in the Selabintana area is a suitable habitat for the growth of epiphytic orchids. It can be seen that the types of epiphytic orchids in the Selabintana area are very plentiful, especially along the curug path. Curug Cibereum is the highest waterfall in the Gunung Gede Pangrango National Park area and is located at an altitude of 1,200 masl. The Curug Cibereum path is perfect for a leisurely walk or hiking. The waterfall can be reached with a distance of 3.1 km using GPS or 1.5 h from the entrance to Resort Selabintana or Pondok Halimun.

Material and Data Collection

The tools used in this research are tally sheet, camera, environmental parameter tools (lux meter, thermometer, hygrometer, anemometer, soil tester), *Global Positioning System* (GPS), and orchid identification book, namely Orchid of Java book (Chomber 1990), Native Orchids of Indonesia (Handoyo & Ramadhani 2006) and Orchids of Indonesia (Handoyo 2019). Data collection is done by plotting along the right and left sides of the waterfall path. There were ten plots with each plot size of 500 m long and 5 m wide (Fig. 2). The distance between plots was 100 m. The data were collected in the form of epiphytic orchids found (types of orchids, number of species of orchids, the number of individuals of each type of orchid, and data on environmental parameters).

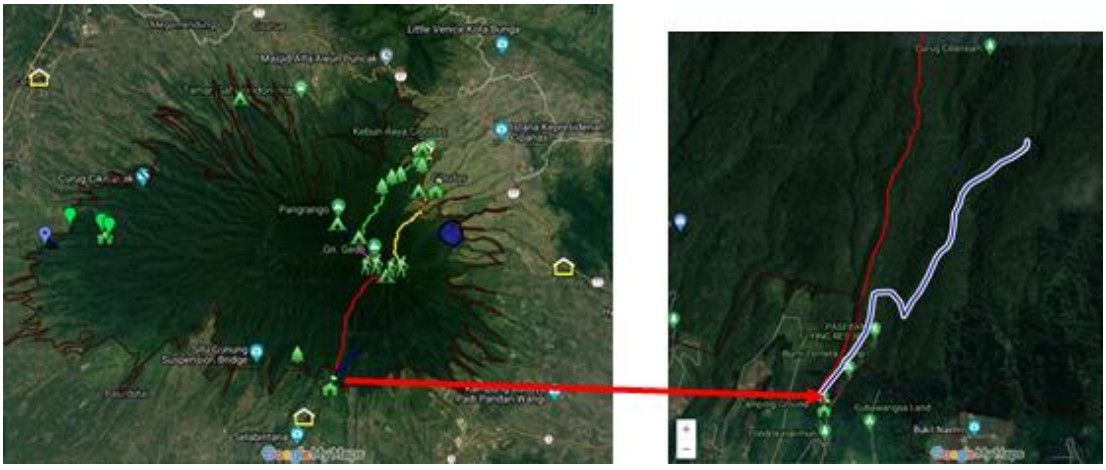

Figure 1 Research sites (The blue and white line is the Curug Cibereum path)

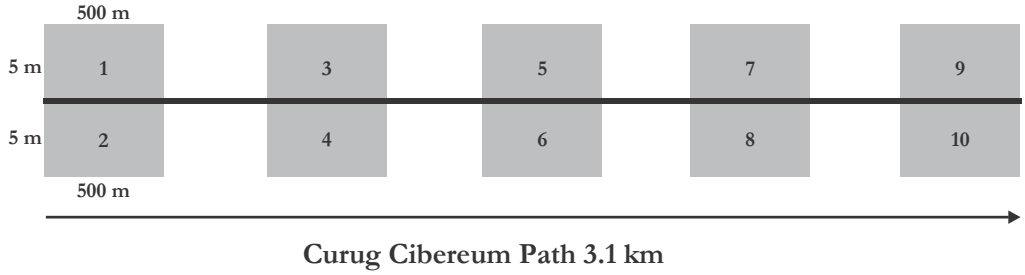

Figure 2 The research sampling design of epiphytic orchids in the Curug Cibereum path

Data Analysis

Data analysis was carried out qualitatively and quantitatively. Qualitative analysis was done by describing the data that have been collected and processed from the research results. Quantitative analysis was used to determine species composition and level of species diversity. Determination of species composition was used to determine Density (D), Relative Density (RD), Frequency (F), Relative Frequency (RF) and Important Value Index (IVI) (Indriyanto 2006). The level of species diversity was determined by the Shannon-Wiener Index (H'), Evenness Index (E), Morishita Index (Id) and Dominance Index (D) (Ernst *et al.* 2002).

1. Species composition

a. $\text{Density (D)} = \frac{\text{Number of individuals of species}}{\text{Total area}}$

b. $\text{Relative Density (RD)} = \frac{\text{Density each species}}{\text{Density all species}} \times 100\%$

c. $\text{Frequency Density (F)} = \frac{\text{Number of individuals}}{\text{Total number of plots}} \times 100\%$

d. $\text{Relative Frequency (RF)} = \frac{\text{Number of frequency of each species}}{\text{Frequency all species}} \times 100\%$

e. Important Value Index= RD+RF

2. Species diversity

a. Shannon-Wiener Diversity Index (H')

$H' = -\Sigma [pi \ln (pi)]$; $pi: \frac{ni}{N}$

Description:
H': Shannon-Wiener Diversity Index
ni: Number of individuals of each species
N: Number of all species

Shannon-Wiener Diversity Index (H') determination criteria:
H' >3: The diversity is high
H' 1-3: The diversity is moderate
H' <3: The diversity is low

b. Evenness Index (E)

$E = \frac{H'}{\text{Ln } S}$

Description:
E : Evenness Index
H' : Shannon-Wiener Diversity Index
S : Number of species

Evenness index (E) determination criteria: Evenness index values ranged from 0-1. If the value is 0, it indicates the level of evenness of species is very uneven, whereas if the value is close to 1, almost all species have the same abundance (Maguran 1988).

c. Morishita Index (Id)

$Id = q \frac{(Xi(Xi - 1)}{N(N - 1)}$

Description:
Id : Morishita Index
q : Number of sample plots
Xi : Number of individuals on the plots
N : Total number of species

The criteria for determining the Morishita Index:
Id>1 : The pattern of distribution of individual types is clumped
Id=1 : The distribution pattern of individual types is random
Id<1 : The distribution pattern of individual species is uniform

d. Dominance Index (C)

$C = \Sigma[ni/N]^2$

Description:
C: The dominance index of a species
ni: the number of individuals of a species
N: Number of individuals of all types

Dominance Index determination criteria (C): When the value of C is close to 0, then no individual dominates so that there is excellent uniformity. The value of C is close to 1, indicates that several species dominate at specific locations so that the value of the uniformity index is getting smaller (Odum 1993).

RESULTS AND DISCUSSION

Distribution Pattern of Epiphytic Orchids

The study results found as many as 31 species of epiphytic orchids consisting of 12 genera. Comparing our results with the research of Prapitasari *et al.* (2020) regarding the types of orchids found in the Selabintana area (both on the Curug Cibereum path and the hiking trail), there was an increase in the number of epiphytic orchid species in the Curug Cibereum path from this study, which was 13 species. The epiphytic orchid species found were *Adenoncos virens*, *Appendicula cornuta*, *Bulbophyllum capitatum*, *Bulbophyllum multiflora*, *Bulbophyllum gibbosum*, *Bulbophyllum* sp. 1, *Bulbophyllum* sp. 2, *Cerastostylis anceps*, *Cerastostylis graminea*, *Dendrochilum* sp., *Oberonia lotsyana, Oberonia similis*, and *Phreatia* sp. (Table 1).

Table 1 Comparison of the types of epiphytic orchids found in the Curug Cibereum path in 2020 and 2021

No	Types of epiphytic orchid	2020	2021	Distribution index (Id)
1	*Adenoncos virens*	-	√	Clumped
2	*Agrostophyllum bicuspidatum*	√	√	Clumped
3	*Agrostophyllum laxum*	√	√	Clumped
4	*Appendicula angustifolia*	√	√	Clumped
5	*Appendicula cornuta*	-	√	Clumped
6	*Bulbophyllum capitatum*	-	√	Clumped
7	*Bulbophyllum multiflora*	-	√	Clumped
8	*Bulbophyllum gibbosum*	-	√	Clumped
9	*Bulbophyllum* sp. 1	-	√	Clumped
10	*Bulbophyllum* sp. 2	-	√	Clumped
11	*Bulbophyllum* sp. 3	√	√	Clumped
12	*Cerastostylis anceps*	-	√	Clumped
13	*Cerastostylis graminea*	-	√	Clumped
14	*Cerastostylis* sp.	√	√	Clumped
15	*Coelogyne speciosa*	√	√	Clumped
16	*Dendrobium mutabile*	√	-	Clumped
17	*Dendrobium rugosum*	√	√	Clumped
18	*Dendrobium* sp. 1	√	√	Clumped
19	*Dendrobium* sp. 2	√	√	Clumped
20	*Dendrobium* sp. 3	√	√	Clumped
21	*Dendrobium* sp. 4	√	√	Clumped
22	*Dendrochilum* sp.	-	√	Clumped
23	*Eria iridifolia*	√	√	Clumped
24	*Eria monostachya*	√	√	Clumped
25	*Eria multiflora*	√	√	Clumped
26	*Eria* sp.	√	√	Clumped
27	*Liparis eliptica*	√	√	Clumped
28	*Liparis pallida*	√	√	Clumped
29	*Oberonia similis*	√	√	Unifrom
30	*Oberonia lotsyana*	-	√	Clumped
31	*Phreatia* sp.	-	√	Clumped
32	*Schoenorcis juncifolia*	√	√	Clumped
	Amount	20	31	

Based on the analysis of the Morishita Index (Id), most of the epiphytic orchids in the Curug Cibereum path showed a clumped distribution pattern (Id>1), and there were only one species with uniform distribution, namely *Oberonia similis* (Id<1) (Table 1). The distribution of clumped is influenced by several factors, such as the breeding process. Epiphytic orchids reproduce by producing vast numbers of seeds and usually fall near their mother. Besides that, they also reproduce by rhizomes that produce many vegetative tillers (Barbour *et al.* 1987). Environmental factors also affect the distribution pattern of epiphytic orchids due to non-uniform environmental conditions (Wahyuni *et al.* 2017). The uniform pattern is caused by the intense competition for survival between epiphytic orchid species, resulting in the distribution of the same living space in an environment. The uniform distribution pattern is a non-random pattern indirectly caused by a limiting factor to the existence of a population. Uniform dispersion comes from negative intuition between individual species, such as competition for nourishment or other specialties (Onrizal *et al.* 2005). In addition, not all of the host trees in the Curug Cibereum patth area are suitable for epiphytic orchids to live. There are also epiphytic spikes that can inhibit the growth of epiphytic orchids because there are too many of them (Paramitha *et al.* 2010).

Types and Composition of Epiphytic Orchids

The most dominant epiphytic orchid species found in the Curug Cibereum path were *Appendicula angustifolia* (171 individual pieces/ 2.5 ha), *Bulbophyllum multiflora* (142 individuals/ 2.5 ha), *Bulbophyllum gibbosum* (670 individuals/ 2.5 ha), *Coelogyne speciosa* (323 individual pieces/ 2.5 ha), *Eria iridifolia* (119 individuals/2.5 ha), and *Eria multiflora* (272 individuals/2.5 ha). While the few epiphytic orchids found were *Dendrobium* sp. 1 (2 individuals/2.5 ha), *Dendrobium rugosum* (2 individuals/2.5 ha), *Liparis elliptica* (3 individuals/2.5 ha), *Oberonia similis* (1 individual/2.5 ha), and *Oberonia lotsyana* (2 individuals count/2.5 ha) (Fig. 3).

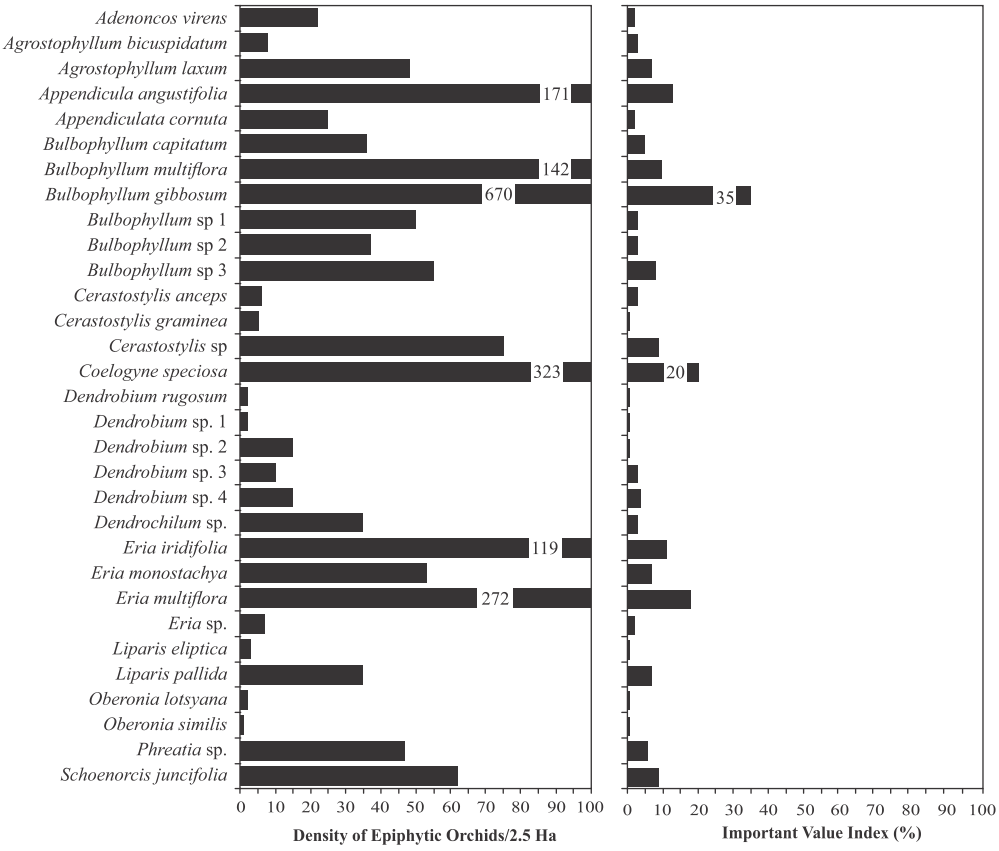

Figure 3 The density of epiphytic orchids and important value index (IVI) in the Curug Cibereum path

The presence of several dominant species of epiphytic orchids will affect the value of the Important Value Index (IVI). The IVI value is obtained from Relative Density (DR) and Relative Frequency (FR) results by adding the two parameters. The greater the level of dominance of the species in a community, the greater the Important Value Index of that species (Tahier *et al.* 2018). Based on the graph above, it is known that the highest IVI value of epiphytic orchids is also found in the orchids which are the most abundant or dominant in the research location. Epiphytic orchid species with high IVI were *Bulbophyllum gibbosum* with an IVI value of 35% and *Coelogyne speciosa* with IVI 20% (Fig. 3). Species with a high IVI dominate and have an influential role in an area, namely, play a role in ecosystem stability. Meanwhile, epiphytic orchids with low IVI indicate that the species have a narrow distribution and a specific environment to grow (Wulanesa *et al.* 2017).

Diversity of Epiphytic Orchids

Species diversity is a community-level characteristic based on its biology that can express community structure. At the same time, the diversity index is a value that can indicate the high and low population diversity of the species in the community. This value is obtained by comparing the number of species and individuals in a community or habitat (Yuanda 2007). The Species Diversity Index (H') of epiphytic orchids in the Curug Cibereum path is in the medium category with an H' value of 2.54 (Fig. 4). The moderate diversity index indicates that the ecosystem is relatively balanced, with sufficient productivity and moderate ecological pressure (Fitriana 2006). The medium category is also caused by the area having almost the same abundance of epiphytic orchid species. According to Odum (1996), the greater the number of species found, the greater the diversity, whereas if the number of species found is small, the diversity will be low, and it is suspected that a few species only dominate the area.

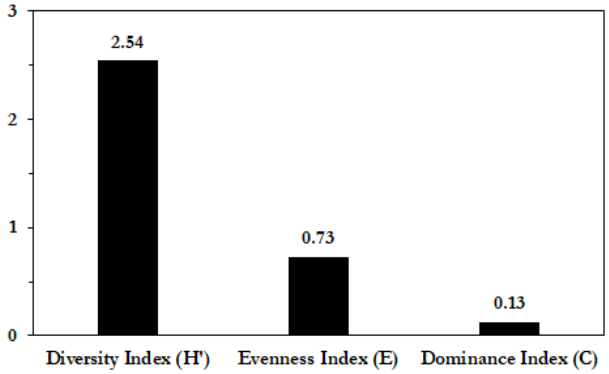

Figure 4 Diversity Index (H'), Evenness Index (E), and Dominance Index (C) of epiphytic orchids in the Curug Cibereum path

The evenness index, also known as the species abundance index, is used to determine the level of species abundance influenced by diversity. The evenness index value of epiphytic orchids in the Curug Cibereum path was E = 0.73, indicating the evenness of epiphytic orchids in the Curug Cibereum path was relatively high (because the value is close to 1). A reasonably high evenness index indicates that epiphytic orchids are evenly distributed with a stable number in a habitat (Zulkhaidah *et al.* 2018). The high evenness index of epiphytic orchid species is also influenced by the reasonably stable value of the species diversity index (H'). Species diversity (H') of epiphytic orchids in the Curug Cibereum path is moderate with abundant epiphytic orchid species so that the distribution of orchid species in the location is evenly distributed with the stable numbers of individual orchids. A species with a high level of stability has a more significant opportunity to maintain the sustainability of its species in an environment (Odum 1993).

The dominance index of a species illustrates that the species is very influential on the environment. The dominance index value of epiphytic orchids in the Curug Cibereum path was C = 0.13, which means that the epiphytic orchid Dominance Index in the Curug Cibereum path had a low-level dominating category. Having a dominant species in the study location, it is suspected that the species is the most able species to adapt and survive in an environment. Dominant species will affect the value of the uniformity index, which will decrease. The dominance index (C) value is related to the value of species diversity, in which

the higher the species diversity, the lower the dominance index or vice versa (Rikardus *et al.* 2017). Thus, moderate diversity index (H') of epiphytic orchids in the Curug Cibereum path means lower dominance index.

Environmental Parameter Factors

The high level of diversity of epiphytic orchids in the Curug Cibereum path is strongly influenced by environmental parameters. Environmental parameters are an essential factor in determining the existence of a plant. Environmental parameters in the Curug Cibereum path showed normal conditions for the growth of epiphytic orchids (Table 2).

Table 2 Environmental parameters in the Cibereum Curug

No	Environtmental parameters	Measurement results
1	Soil pH	5.1 ± 0.96
2	Soil moisture (%)	76.5 ± 15.11
3	Air temperature (°C)	24.5 ±2.44
4	Humidity (%)	70 ± 11.73
5	Light intensity (Lux)	6,321 ± 16,482.52
6	Wind velocity (m/s)	0.03 ± 0.19

The optimal temperature for the growth of epiphytic orchids is 24.5 °C. The magnitude of the temperature is very suitable for the growth of orchids. The coldest temperature for orchid growth is 12.7 °C, and the average temperature for orchids is in the range of 15-28 °C (Indarto 2011). Furthermore, soil pH measurements were carried out under the epiphytic orchid host tree and not in the area around the epiphytic orchid growth because the location was difficult to reach. The result of soil pH measurement was 5.1, indicating that the pH is suitable for the growth of epiphytic orchid host trees. The normal pH for orchid growth is 5-6.5 (Purbadi *et al.* 2005). Soil pH condition at the study site tend to be acidic (pH = 5.1) due to high soil moisture, which was 76.5%. Wet soil due to high humidity will cause a low pH value, and vice versa (Yulia 2008).

Air humidity at the research site was 70%. The high humidity condition is very suitable for the growth of epiphytic orchids. The humidity required for optimal orchid growth is 50 - 80%. Humidity that is too low causes the air around the orchid to dry out and cause a disturbance. Conversely, if the humidity is too high, it will increase disease attacks, especially diseases caused by fungi and bacteria. Air humidity on the Curug Cibereum path is high, also influenced by low wind speeds so that it tends to get wet. If the humidity is low, the wind speed is high, causing an area to experience dry condition. At the study site, there was almost no wind blowing. It was only encountered several times with very low speeds so that the results of the average wind speed at the study site were only 0.03 m/s. The wind speed is very suitable for orchid growth, where orchids like soft air circulation. (Purwanto 2016).

Light intensity is one of the environmental parameter affecting the growth of epiphytic orchids. The living nature of epiphytic orchids attached to the host tree is one form of adaptation to get sunlight. Therefore, epiphytic orchids require more light than terrestrial orchids (Tirta & Sutomo 2014). Usually, epiphytic orchids require different light intensities depending on the type of epiphytic orchid itself. For example, the type of *Dendrobium* requires a light intensity of 2,000-3,000 lux. The light intensity for orchid growth is 1,000-2,000 footcandle or 10,000-20,000 lux (Darmono 2007). The results of the light intensity measurement in the Curug Cibereum path were 6,321 lux. The amount of light intensity is still suitable for the growth of epiphytic orchids because it does not interfere with the growth of epiphytic orchids in the Curug Cibereum path. In addition, the light intensity at the study site is also influenced by the canopy density. Several locations do not have a dense canopy causing relatively high light intensity. However, epiphytic orchids are more commonly found in low light intensity.

CONCLUSION

There were 31 species of epiphytic orchids from 12 genera found in the Curug Cibereum path. Curug Cibereum has environment parameters suitable for epiphytic orchids.

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