Comparing the Javanese Edelweiss (*Anaphalis javanica*)
density in Tegal Alun, Tegal Bungbrun and Pondok Saladah of Mount Papandayan

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Abstract. Javanese Edelweiss (*Anaphalis javanica*) is a natural plant possessing enormous ecological benefits. It is commonly found in volcanic ash deposits and soils as in Mount Papandayan. However, it is considered as an endangered species. This study was intended to: (1) compare the density of Javanese Edelweiss in Mount Papandayan especially in Tegal Alun, Tegal Bungbrun and Pondok Saladah; (2) find out the abiotic factor effects (temperature, light intensity and soil pH) on the Javanese Edelweiss density. To this end, this study employed quantitative descriptive method. The data were collected through belt transect technique covering 100-meter-in-length and 5-meter-in-length tracks in the three different locations; Tegal Alun (28 transects), Tegal Bungbrun (3 transects) and Pondok Saladah (10 transects). The result found that the density of the Javanese Edelweiss in Tegal Alun, Tegal Bungbrun and Pondok Saladah was different. The density values are 2275.7 trees per hectare in Tegal Alun, 946.7 trees per hectare in Tegal Bungbrun and 366 trees per hectare in Pondok Saladah. For the abiotic factors, the statistical analysis revealed that air temperature, light intensity and soil pH simultaneously influence the density of Javanese Edelweiss with $R = 0.85$ and effect size of 70%.

1. Introduction
The most dominant vegetation in active volcano areas is pioneer plants as a result of volcanic activities. One of the example of the pioneer plants is Javanese Edelweiss (*Anaphalis javanica*). It is recognized as a unique long-living pioneer plant in volcanic ash deposits and soils especially in active volcanic craters as in Mount Papandayan [1]. Edelweiss is a distinctive plant commonly found in alpine zone or in mounts with an altitude of 1600-3600 m above sea level and with a temperature of 5°C - 25°C. Edelweiss can be found in the form of many-branching shrubs reaching 4 meters high. Edelweiss is a pioneer plant on volcanic soil in mountain forests. It is able to maintain its survival on barren and nutrient-poor land because it has the ability to form Michoriza with certain soil fungi that effectively expand the area reached by its roots which in turns increase its efficiency in finding nutrients. Its flowers are immensely favored by insects. More than 300 types of insects such as fleas, butterflies, flies and bees are constantly visiting them. If the branches grow firmly enough, they can be a nesting place for Javan whistling thrush (*Myophonus glaucinus*) and wet Edelweiss branches can be a place for certain types of mold and lichens. The flowers are generally seen between April and August in sunny weather. Cross pollination is sure to occur yet self-pollination can also take place in hazy weather [1]. To date, the existence of Edelweiss is endangered [2]. To illustrate, along the official Mount Semeru hiking trail, there is extremely high damage, especially at point 62 with an altitude of 2,708 m above sea level, the
damage reaches 100% [3]. Another study on Mount Lawu recorded an Edelweiss density of 710 trees per hectare [4]. While in Mount Buni Telong Bener Meriah Aceh, the density of Edelweiss is 1435 trees per hectare [5]. Thus far, there have been no studies that compared the density of Javanese Edelweiss (*Anaphalis javanica*) on Mount Papandayan, particularly in Tegal Alun, Tegal Bungbrun and Pondok Saladah. It is, therefore, imperative to fill the gap by posing the following questions: (1) what is the density of Javanese Edelweiss (*Anaphalis javanica*) in Tegal Alun, Tegal Bungbrun and Pondok Saladah? (2) What are the effects of abiotic factors (temperature, light intensity and soil pH) on the Edelweiss density in Tegal Alun, Tegal Bungbrun and Pondok Saladah?

2. Methods

The primary sample used in this study was Javanese Edelweiss (*Anaphalis javanica*) fenced by the belt transect. The decision for choosing the sampling and location was carried out purposively. It was due to the fact that Javanese Edelweiss (*Anaphalis javanica*) dispersion pattern is uniformly grouped [6].

The observation was done from April to August 2018. Based on the secondary data and field observation, the Javanese Edelweiss in Mount Papandayan was dispersed in several areas. As a result, the locations of the research were in the following sites:

a. Tegal Alun (± 12 Ha) from the total area of ± 24 Ha.
b. Tegal Bungbrun (± 1,2 Ha).
c. Pondok Saladah (± 5 Ha).

The following equation was used to identify the density [7]:

\[
Pi = \frac{\sum_{\text{Edelweiss}}}{\text{Area}}
\]

\(Pi\) : Density  
\(\sum_{\text{Edelweiss}}\) : the total number of observed Edelweiss  
Area : Sampling Area

The data collected were Edelweiss density and the Environmental factors (temperature, light intensity, Soil pH and moisture). The normal distribution and homogeneity tests were initially applied to ensure that the data were normally distributed and homogenous. Afterward, the ANOVA test with 0.05 (\(\alpha = 0.05\)) significance level was carried out [8]. The abiotic factor data were analyzed using multiple regression analysis [8]. The statistical analysis was done in MS. Excel 2016.

3. Results and discussion

3.1. Javanese Edelweiss density

The observed density value of the Javanese Edelweiss was presented in Table 1. Based on the statistical analysis, there are significant differences of Javanese Edelweiss density in Tegal Alun, Tegal Bungbrun and Pondok Saladah.

**Table 1.** The Density of Edelweiss in the three observation locations.

| No. | Observation Location | Density (Edelweiss/hectare) |
|-----|----------------------|-----------------------------|
| 1   | Tegal Alun           | 2275,7                      |
| 2   | Tegal Bungbrun       | 946,7                       |
| 3   | Pondok Saladah       | 366                         |
Figure 1. Javanese Edelweiss in Mount Papandayan.

The differences occur due to several influencing factors, such as: stand/moor area, abiotic factors and human influence.

3.1.1. Stand/moor area: Tegal Alun is the largest area which is around 24 hectares compared to Tegal Bungbrun, which is only about 1.2 hectares and Pondok Saladah which is around 5 hectares. It allows the Javanese Edelweiss to fully grow and thrive. According to van Steenis, the existence of Javanese Edelweiss (Anaphalis javanica) is often concentrated on open, flat and large moor as in a square [1].

3.1.2. Abiotic factors: Light intensity and air temperature are very important factors for the Javanese Edelweiss (Anaphalis javanica) to grow [9]. From the multiple regression test, it can be predicted that the lower the air temperature is, the higher the density becomes. Since the average temperatures observed are 15.9 ºC in Tegal Alun, 17.7ºC in Tegal Bungbrun and 17.9ºC in Pondok Saladah, the density in Tegal Alun is higher than the density in Tegal Bungbrun and Pondok Saladah. In terms of light intensity, the higher the light intensity is, the higher the density of Edelweiss becomes. The light intensity in the locations was 150921.4 Lux in Tegal Alun, 142600 Lux in Tegal Bungbrun and 118000 Lux in Pondok Saladah. The density in Tegal Alun is higher than Tegal Bungbrun and Pondok Saladah. Whereas for soil pH, the average pH value of soil in Tegal Alun is 6.2, the density is the highest compared to the other locations.

3.1.3. Human factors: Mount Papandayan is an eco-tourism park that is regularly visited by many campers. Of the three observation location, Tegal Alun is not accessible for campers so that the negative effect of negligent visitors is minor. Contrasting to what has happened along the official Mount Semeru hiking trail, there is extremely high damage, especially at point 62 with an altitude of 2,708 m a.s.l., the damage has reached 100% [3].

3.2. Abiotic factors

Based on the multiple regression analysis, it was found that air temperature, light intensity and soil pH simultaneously contribute to the Edelweiss density. The correlation coefficient is 0.85 or 85%; with 0.70 or 70% effect size. In addition, the statistical analysis has also resulted in the following multiple regression equation:

\[
Y = 369,170 + (-29,065X_1) + 0,002X_2 + (-4,221X_3)
\]

The air temperature and light intensity to some extent have a significant effect on density, while the soil pH partially has no effect on density.
3.2.1. Temperature: The result of multiple regression test can predict that for each addition of one variable unit in air temperature, there will be a reduction in the number of Edelweiss by 29,065 assuming that the other variables remain unchanged. Considering the average temperature of the three sample locations; Tegal Alun = 15.9°C, Tegal Bungbrun = 17.7°C and Pondok Saladah = 17.9°C, low air temperature is suitable for optimal Edelweiss growth. Figure 1 A shows that the lower the air temperature is, the higher the density of Javanese Edelweiss will grow. Air temperature is an important influencing factor for the Javanese Edelweiss (Anaphalis javanica) to grow [9]. As a matter of fact, air temperature is the most influencing factor on the Javanese Edelweiss density [6]. It is due to the fact that air temperature is an environmental factor that has both direct and indirect impact to living organisms. The direct impact means that it affects all of the plant function by controlling chemical processes in the plant. Additionally, the indirect impact means that it affects other factors especially water supply. Moreover, air temperature contributes to evaporation rate and causes not only rain effectiveness but also water loss rate from living organisms [10].

3.2.2. Light intensity: The results of multiple regression test can predict that for each increase of one variable unit in light intensity (Lux), there will be an increase in the number of Edelweiss by 0.002 assuming that the other variables remain unchanged. Given the average light intensity results from the three locations; Tegal Alun = 150921.4 Lux, Tegal Bungbrun = 142600 Lux and Pondok Saladah = 118000 Lux, it can be concluded that high light intensity is suitable for optimal Edelweiss growth. Figure 1 B shows that the higher the intensity of light is, the higher the density of Edelweiss will become. As an adaptation to high light intensity, Javanese Edelweiss has lance-shaped, wooly and scattered leaves [1]. Light intensity is an important factor for the Javanese Edelweiss (Anaphalis javanica) growth [9].
3.2.3. Soil pH: Based on the multiple regression analysis, the significant value of soil pH is $0.92 > (\alpha = 0.05)$. It implies that the soil pH partially does not affect the density of Edelweiss so that it cannot be used as a good predictor. The average soil pHs in the three location are: Tegal Alun 6.2, Tegal Bungbrun 6.2 and Pondok Saladah 6.08. Figure 1 C shows that the highest density of Javanese Edelweiss is at 6.2 soil pH. This is due to the fact that nutrients are easily absorbed by plant roots at neutral soil pH of 6-7. It is because at that pH level most nutrients dissolve easily. Furthermore, macro elements such as N, P, K, Mg, Ca and S are more widely available in soil solutions with pH of 6 to 7.5. At lower or higher pH, the availability of these macro elements tends to decrease. Meanwhile, the number of micro elements available at neutral pH tends to be smaller compared to lower or higher pH, but this amount has fulfilled what a plant needs [10].

4. Conclusion

Based on the results and data analysis, it can be concluded that there are differences in the density of Javanese Edelweiss (*Anaphalis javanica*) in the three observation locations. The highest density of Javanese Edelweiss is in Tegal Alun. Air temperature, light intensity and soil pH simultaneously influence the density of Javanese Edelweiss.

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