Population status of *Saurauia* spp. in Slamet Mountain, Central Java

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Abstract. *Saurauia* is belong to Actinidiaceae family. *Saurauia* spreading naturally in several highlands in Indonesia including Slamet Mountain. Some species of *Saurauia* had been used as traditional medicines for diabetes, cancer, and cholesterol. The population of *Saurauia* in Indonesia has been greatly reduced. This study aims to determine its distribution, population size and population structure of *Saurauia* in Slamet Mountain forest area. It was conducted in 4 locations forest which are on different slopes on Slamet Mountain. Retrieval of population data following existing track using a purposive sampling method. A measuring plot of 20x20 m² was made at the location in which *Saurauia* spp. discovered. The result of this research found 636 individuals in 103 measuring plots. Which consists of 4 species of *Saurauia* i.e. *S. nudiflora* DC. (90 individuals), *S. pendula* Blume (382), *S. microphylla* de Vriese (145) and *S. bracteosa* DC. (19). *S. microphylla* and *S. bracteosa* are species included in IUCN red list with vulnerable status. Both species require more conservation efforts. The population structure of *Saurauia* found was dominated by the seedling phase around 45.91%, mature phase 36.01% and juvenile phase 18.08% with varying height and diameter.

1. Introduction

*Saurauia* is a genus of members of the family Actinidiaceae family. *Saurauia* spreading naturally in the highlands of the world including Slamet Mountain. The population of *Saurauia* in Indonesia is currently declining and is in danger of extinction. Some *Saurauia* species distributed in Indonesia are listed on the International Union for Conservation of Nature (IUCN Red List). According to IUCN data in 2019 [1], there are 4 species of *Saurauia* in Indonesia that fall into the susceptible (Vulnerable) category namely *S. microphylla*, *S. bracteosa*, *S. cauliflora*, and *S. lanceolata*. One species in the critical (Critically Endangered) category is *S. bogoriensis*. The decrease in population in nature is due to habitat destruction, loss of land function [2] and other causal factors such as forest fires.

*Saurauia* is a plant that has the potential for traditional medicine and fruit consumption. Some *Saurauia* species are known to have useful compound content. *Saurauia bracteosa* leaves are known to contain phenolic compounds, flavonoids, and tannins that have anticancer properties [3] and antioxidants [4]. *S. bracteosa* leaves are believed to cure diabetes, tumors and lower cholesterol [5]. Sitorus [6] and Hutapea *et al.* [7] report that the leaf extract of *Saurauia vulcani* has anti-diabetes activity. The plant is known as traditional medicine by the Karonese and Tobanese communities of North Sumatra [7]. *Saurauia* fruit can also be consumed as a daily fruit source. Sidiasa [8] mentioned
the fruit of *Sauraria* spp. consumed by the community of Setulang Village, Regency of Malinau (Kalimantan) and called *lempede* fruit.

Mount Slamet is the second-highest mountain on Java Island. The summit of Mount Slamet is at 3,432 m. The slopes of Mount Slamet are still guarded and covered with forest. The forest has a very high plant diversity. Several distribution zones of plant species are vertically located on the slopes of the mountain such as the plateau ecosystem to the sub-alpine [9]. Mount Slamet is one of the natural areas of *Sauraria* distribution in Indonesia. The results of the herbarium and literature study provide information on the dispersal of the plant in the forest area of Mount Slamet. *Sauraria microphylla* has been found in the area of Mount Slamet [10], the eastern ascending path (Bambangan-Purbalingga). *Sauraria microphylla*, *S. pendula* and *S. nudiflora* grow in natural forests at an altitude of 1,000-2,500 m above sea level [2]. *Sauraria bracteosa* and *S. cauliflora* were found at a height of 700-1,100 m above sea level on the western slopes, the south-east slopes and the northern slopes of Mount Slamet [11].

Information on population size and structure of *Sauraria* spp. in the area of Mount Slamet is unknown. This study aimed to assess the population status of *Sauraria* spp. growing up in Mount Slamet. The specific objectives were to determine its distribution, population size and population structure. This information is important as a basis for the conservation efforts of *Sauraria* spp. in Mount Slamet. This is useful in preventing the local extinction of *Sauraria* spp. in the area of Mount Slamet.

2. **Method**

2.1. **Research site and materials**

The research was conducted in the Mount Slamet forest area. The study site is located in the forest along the northern, eastern, southern and western slopes of Mount Slamet with a height of 600-2,400 m. Research conducted in July-August 2019 includes data collection and identification of herbarium specimens. The material that is the object of this research is all genus *Sauraria* spp. which grows naturally in Mount Slamet forests area. Data collection methods use purposive sampling methods by following existing hiking thrill around the area [12][13][14]. Research path starts from the beginning of a hiking trail located on the border of the forest area with settlements at different heights on each slope. In locations with a high abundance *Sauraria* spp. new lines are made around the right and left of the existing lane to find the presence of other individuals. Track study end at an altitude where there was found no *Sauraria* spp. Measuring plot made at where the location of *Sauraria* spp. was found. The size of each measuring plot is 20x20 m² for all phase [12].

Plots were made based on the existence of *Sauraria* spp. with a total of 103 plots. Data taken included the location of *Sauraria* spp. founded which is recorded with GPS (Garmin 78S). Each *Sauraria* individual in saplings, poles and tree phases found in the plot is recorded and identified. Each individual measured height and diameter at breast height (dbh) using a compact laser distance meter (Leica geosystem) and tape diameter. While for the seedling phase, individuals found in the plot are identified by their species and counted. Determination of plants based on height and diameter. The seedlings phase has a height of <1.5 m. The saplings are > 1.5 m height and <10 cm dbh. The poles phase has a height of > 1.5 m and dbh between 10-20 cm. The tree phase has a height of > 1.5 m and dbh > 20 cm [15].

Plant generative phase data is also recorded by identifying the presence of flowers and fruit in each individual. This is to determine the stage of the plant breeding stage. The seedling phase is the phase where the plants have not flowered and have a height of <1.5 m. Juvenile phase is the phase of the plant that has not flowered and has a height of > 1.5 m. Mature phase is the phase of plants that have flowered or fruited. Analyze the data in this study using Microsoft Excel Ver. 2013.
3. Result and discussion

3.1. Species Distribution

In this study, 636 Saurauia individuals were found of which there were 4 species of Saurauia namely S. nudiflora DC, S. pendula Blume, S. microphylla de Vriese and S. bracteosa DC. Table 1. shows the Saurauia distribution was founded in each slope of Mount Slamet. The southern slope is the most common location of Saurauia spp. with the number of individuals as many as 351. The eastern slope is the slope of the least found in the genus Saurauia 31 individuals. Table 1. shows that the southern slope was found 3 species (S. nudiflora, S. pendula and S. microphylla). Western slope is also found 3 species (S. pendula, S. microphylla and S. bracteosa). The northern slope found 2 species (S. pendula and S. microphylla). The eastern slope is only 1 species namely S. microphylla.

| Species      | Number of individual | Total |
|--------------|----------------------|-------|
|              | Northern  | Eastern | Southern | Western |       |
| S. nudiflora | 0         | 0       | 90       | 0       | 90    |
| S. pendula   | 163       | 0       | 209      | 10      | 382   |
| S. microphylla| 54       | 31      | 52       | 8       | 145   |
| S. bracteosa | 0         | 0       | 0        | 19      | 19    |
| Total        | 217       | 31      | *351     | 37      | 636   |

Note: *southern slope is the most common location of the genus Saurauia with a total of 351 individuals.
The southern slope is the slope which has the highest number of individuals. This is probably caused by the forest on a southern slope that is relatively better than other slopes. From the results GPS point record, forest on the southern slopes starting from a height of ± 900 m above sea level. Other forest slopes situated at an altitude > 1000 m above sea level. This shows that the forest intervention on northern, eastern and western slopes is greater so that it affects the number of *Saurauia*.

The results we found were closely different from those reported by Soemarno and Girmansyah [2] previously. They found *S. microphylla*, *S. pendula* and *S. nudiflora* in the eastern slope of Mount Slamet while we only found *S. microphylla*. We have not found *S. pendula* and *S. nudiflora* in the same research location on hiking trail from Bambangan village. This may be due to changes in land use from natural forests to other uses. Management of forests area that did not focus on the conservation aspect presents a potential threat to the existing population in a regional ecosystem. Pirard *et al.*, [16] mentioned that there are negative environmental impacts of production forests. That is because a single species is planted in a very large area, often even planted in areas that were previously forested. The results of this study are also slightly different from what was delivered by Purnomo *et al.*, [11] that report *S. bracteosa* and *S. cauliflora* were found on several slopes on Mount Slamet. In the present study, *S. bracteosa* was only found on the western slope and not yet found on other slopes. Meanwhile, *S. cauliflora* has not been found at the research location in this study. This might be because the current research location is different from the research location reported by Purnomo *et al.* [11]. Further research needs to be done to find out the factors that cause the decrease of several species on Mount Slamet slope.

*Saurauia* lives in highland forests generally it grows in low-lying areas in forests, along small rivers and basins [17]. *Saurauia* found in Mount Slamet has distribution in other mountains on Java island. *Saurauia bracteosa* was discovered by Wihermanto [18] in the Gunung Gede Pangrango National Park in West Java. Marsusi *et al.* [19] found *Saurauia* in the Central Java Jobolarangan forest area. *Saurauia bracteosa* also found in Merratus Forest, southern Borneo [20]. Gunawan [21] also reports on several species of *Saurauia* in Kemojang Nature Reserve, West Java. *Saurauia lanceolata* and *S. bogoriensis* are the only known traces of its existence.

### 3.2. Population and structure

*Saurauia pendula* are the most abundant of the total *Saurauia* population found. This was demonstrated by the discovery of 382 individuals consisting of 223 seedling, 53 juvenile, and 106 mature trees. Figure 2. shows the data then the *S. pendula* population composition is quite good because the amount of seedling available in nature exceeds its phases. Therefore, if there is a disturbance in the forest area in juvenile and mature phases it will be replaced immediately by the seedling phase. The juvenile is a phase with the least number of individuals in this population. It may be due to a disturbance in the juvenile phase. We found there were several cases of disturbance in *S. pendula* individuals including natural fractures and human destruction like logging.
Figure 2 Population of *Saurauia* spp. found at 4 slopes of Slamet Mountain research location (seedling = had never been flowering and height < 1.5 m; juvenile = had never been flowering & height > 1.5 m; mature = have been flowering)

*Saurauia microphylla* had the second-largest number of *Saurauia* population. This population is dominated by a mature phase (92 individuals). The number of juvenile phases was found in less than 50 individuals. The seedling phase is the smallest phase found with only 3 individuals. The population structure of *S. microphylla* is shaped like a reverse pyramid, which is a poor state. The condition is worrying because the population regeneration rate is too small. If there is no condition change better it will cause the rarity of *S. microphylla* species future. A small amount of seedling can be caused by the interruption. We recorded some interference by humans in the form of felling and cutting rod for timber. We found this in several locations on the southern and western slopes. In addition, there are many *S. microphylla* individuals who break naturally due to natural factors.

*Saurauia nudiflora* has the third-highest number with a total number are 90 individuals. The number of individuals in each phase was 58 (seedling), 12 (juvenile) and 20 (mature). In this study, *S. nudiflora* population structure was favorable because it had a large seedling inventory and had a high number of productive individuals. *Saurauia bracteosa* is a species that has the least number of populations. This species is very difficult to find in the Mount Slamet forest area. In this research, *S. bracteosa* was found only on western slopes by 19 individuals. The total is comprised of 11 mature and 8 seedling individuals. *Saurauia bracteosa* in the juvenile phase was not found. These conditions reflect the presence or gap in *S. bracteosa* population structure. This species grows on heavy slopes and open area enough. This species founded in the location between the cliffs and hills. Difficult location requirements and land changes are likely to be the cause of the decreasing population of *S. bracteosa*. Majority locations where this species discovered have been turned into a plantation. The population status needs great concern in terms of sustainability.

Figure 2. shown the total population of *Saurauia* found dominated by the seedling phase approximately 45.91%, mature phase 36.01% and juvenile phase 18.08%. This indicates a slight susceptibility to the juvenile phase of *Saurauia*. The juvenile phase is one of the important phases for the plant. Further observations are required on threats and growth inhibitory factors of *Saurauia* spp. in Mount Slamet.
Table 2 Number of individual each species base on 4 phases of trees

| Species       | Number of individual | Total |
|---------------|----------------------|-------|
|               | Seedlings | Saplings | Poles | Trees |
| S. nudiflora  | 58        | 11       | 11    | 10    | 90    |
| S. pendula    | 223       | 129      | 19    | 11    | 382   |
| S. microphylla| 3         | 89       | 39    | 14    | 145   |
| S. bracteosa  | 8         | 0        | 0     | 11    | 19    |
| Total         | *292      | 229      | 69    | 46    | 636   |

Note: *the seedling phase has the highest number of individuals of all genera of Saurauia found with the number 292 seedling. (seedlings = height <1.5 m; saplings = height > 1.5 m & dbh <10 cm; polish = height >1.5 m & dbh 10-20 cm; Trees = height > 1.5 m & dbh > 20 cm).

Table 2 shows that the seedling phase is a phase most of the individuals were found that 292 individuals. Followed by 229 individual sapling phase, 69 individual polishes phase, and 46 individual trees. Saurauia nudiflora, S. pendula and S. microphylla were found in all four phases. Meanwhile, Saurauia bracteosa was not found in the sampling and polishing phase. This condition is not good for the survival of the species population. Poor population structure conditions are also found in S. microphylla. Saurauia microphylla that is found has a very small amount of seedling which is 3 individuals. Saurauia microphylla and S. bracteosa are species which include in IUCN red list with vulnerable status. This is in good agreement with the results of this study. The population number and composition of both species fall into vulnerable categories. Structure and population composition data indicate that S. microphylla has very limited seedling phases. In the meantime, S. bracteosa has problems finding individuals in the juvenile phase. Both of S. microphylla and S. bracteosa require high conservation efforts.

Figure 3 Distribution of Saurauia diameter (cm) each species in Slamet Mountain forest area

Saurauia populations in the Slamet Mountain forests area have various diameter distribution. Figure 3 shown the individuals number from each Saurauia species at several diameter levels. Saurauia nudiflora, S. pendula and S. microphylla have good diameter distribution. The number of smaller diameter plants is more numerous than the above diameter level. These species are dominated by plants with stem diameters <10 cm. Figure 3 also shows the dominance of dbh <10 cm stem in the Mount
Slamet forest area. *S. bracteosa* population has a different structure because the number of individuals is dominated by stands with diameters >10 cm.

![Figure 4](image_url)

**Figure 4** Distribution of *Saurauia* plant height (m) each species in Mount Slamet forest area

*Saurauia* found in the various distribution of plant height. Figure 4 shows the variation in plant height *Saurauia* population. *Saurauia nudiflora* and *S. pendula* are dominated by individuals which have a height of <1.5 meters. This showed a good form of height distribution where substitute individuals have more numbers. There is a decrease in the number of individuals at the top height level but not to form the letter "J" is reversed. Curve-shaped communities forming inverted "J" letters reflect relatively disturbed communities [22]. *S. bracteosa* population has a problem because plants with a height of 1.5-5 m were not found. This will have an impact if there is damage to the population, the substitute individual needs more long time. *S. microphylla* has the number of individuals with height >10 m at least 1 individual. That cause the tendency of *S. microphylla* to have smaller shape compared to other species.

4. Conclusion
This study concludes that there were 4 *Saurauia* species distributed in the Slamet Mountain forest area. *Saurauia nudiflora* was found on the southern slope. *S. pendula* were found on the south, west and north slopes. *Saurauia microphylla* on all slopes and *S. bracteosa* only on the western slope. Further research and identification are needed to determine the definite number of species that grow naturally in the Slamet Mountain forest area currently. A total of 636 individuals *Saurauia* were found. *Saurauia pendula* are the most commonly found species with 382 individuals, followed by *S. microphylla* with 145 individuals, *S. nudiflora* with 90 individuals, and *S. bracteosa* with 19 individuals (lowest). Base on the plant generative phase, the population structure of *Saurauia* was dominated by the seedling phase around 45.91%, mature phase 36.01% and juvenile phase 18.08%. Based on the distribution of height and diameter, the seedling phase is the most common (292 individuals) followed by the sapling phase (229 individuals), the pole phase (69 individuals) and trees (46 individuals). *Saurauia* population structure and composition are generally quite good, but some species require more treatment. The number of individuals in the seedling and sapling phase of *S. bracteosa* and *S. microphylla* are measly. This shown the deficient population structure and composition. Therefore, *S. bracteosa* and *S. microphylla* require higher conservation efforts.
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