



Original Research Article

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## Mapping and Early Transplantations of Threatened *Lobaria* Species in Conservation Center, Cibodas Botanical Garden

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### Abstract

The objective of this research was to investigate the population of *Lobaria* in Cibodas Botanical Garden, Indonesia. The mapping of *Lobaria* was conducted on 3724 trees through exploration method and the samples were collected from whole tree trunk surface area with the height of 0-2 m. The transplantations used 20 thalli of 1 cm x 1 cm with 10 thalli for each species. Only two species of *Lobaria* were found i.e., *Lobaria retigera* and *L. pulmonaria* with 16 total thalli and 0.14% of frequency (5 of 3724 trees). The thallus number and frequency of *L. retigera* were higher (11 thalli; 0.11%) than *L. pulmonaria* (5 thalli; 0.03%) but smaller total coverage (79.74 cm<sup>2</sup> per m<sup>2</sup> of tree trunk surface area) than *L. pulmonaria* (117.67 cm<sup>2</sup> per m<sup>2</sup> of tree trunk surface area). Only 11 thalli of transplants (55%) were established successfully and growth with 4 thalli (20%) of *L. retigera* and 7 thalli (35%) of *L. pulmonaria*. *Lobaria* transplantation was successfully. Increasing of lobule coverage in *L. pulmonaria* was 445.89% over 12 months transplantation, but *L. retigera* was only 33.93%. Increasing of thallus coverage in *L. pulmonaria* was 104.03% during 12 months transplantation, but *L. retigera* was only 0.81%.

### Article Info

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Population  
Transplantation

### Introduction

Researches lichens in Indonesia are still limited. Based on visual observations in Cibodas Botanical Garden (CBG) from 2001 to 2011 by Sudirman (unpublished) found that the occurrence of *Lobaria* was very critical. Even *Lobaria* specimens were not found in Herbarium Bogoriense, Indonesian Institute of Sciences (LIPI). Due to this condition the mapping, identification and transplantation of *Lobaria* was suggested to investigate in detail.

Cibodas Botanical Garden (CBG) was chosen for sampling site because many foliose lichens were found

in CBG and surrounded by Mount Gede Pangrango National Park. CBG is located in a range of 1300-1425 meters above sea level, therefore, CBG have fresh and good air quality. This condition makes *Lobaria* to grow and develop healthy and survive with the abundant thallus.

*Lobaria* is a type of foliose and often used as a medicine (Sharnoff, 2002). *Lobaria* also can be used as an indicator of forest sustainability. Ellis and Coppins (2007) stated that *Lobaria* is very sensitive to environmental changes. Walser et al. (2002) also reported that *Lobaria* is sensitive to acid pollutants in the atmosphere. Even in France, the trees overgrown by

*Lobaria* is protected (van Haluwyn, 1993). Based on this information, *Lobaria* as rare lichens and as bioindicator environment, it must be conserved with vegetative propagated through transplantation.

Thallus (Garty and Weissman, 2001; Kon et al., 2010; Fadila et al., 2012), soredia (Werth, 2005; Kon and Yoshihito, 2010) and fragmen or thallus containing soredia can be used for transplantation. Soredia in the form of flour and mixture with water can be used transplantation and it was distributed easily. During lichen transplantation, there are several factors that must be considered for succesful transplantation, they are kind of substrate, climate, abiotic factors (temperature, humidity, light intensity, wind direction and speed, precipitation, etc.) (Armstrong and Bradwell, 2000), techniques of transplantation, and control of transplant (Coppins and Coppins, 2005).

This research project were conducted from June 2013 until June 2014 with the aims to map, to identify and to transplant of *Lobaria*. The purpose of mapping lichens were to get information the population and divercity of *Lobaria* at CBG. The purpose of the transplantation is to determine whether *Lobaria* could be reproduced at the same place and conditions.

## Materials and methods

### Study period and location

Mapping and transplantation of lichens were carried out from June 2013 up to June 2014 in CBG. Macroscopic and microscopic observations were performed at Common Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University (IPB). The preparation for permanent slides using paraffin method was performed at Laboratory of Morphology, Anatomy and Cytology, LIPI, Cibinong.

### Mapping *Lobaria*

CBG has an area of ±125 ha and consists of 22 blocks. *Lobaria* mapping was performed at all the blocks consisting of 3724 trees using exploration method. *Lobaria* spp. were obtained from the whole tree trunk surface of 0-2m height, they were then prepared for herbarium collection.

### Identification of *Lobaria*

Identification of *Lobaria* was conducted until species

level using identification keys by Ren et al. (2012). Identification of lichens consisted of macroscopic and microscopic observations and chemical reaction test. Observation of macroscopic morphology included were thallus colour, thallus surface structure, vegetative and reproductive organ structures. Microscopic characters were observed including photobiont and medulla color. Chemicals 10% potassium hydroxide (KOH), Na-hypochlorite 5.25% and other reagents were used (Brodo et al., 2001).

## Data analysis

### Determination surface area of tree trunk

The surface area (SA) of tree trunk was calculated using the following formula:

$$SA = 2\pi rh$$

Where,

$$r \text{ (radius) } = C/2\pi$$

$$H = \text{height of tree}$$

$$C = \text{circumference of tree trunk}$$

### Determination of total thallus number and the thallus coverage

Population of lichens consisted of total thallus number, thallus coverage and frequency of thallus. Lichens were observed on all of trees using transparant plastic (30 × 20 cm). Lichen covers were obtained by drawing the whole thalli on a piece of transparent plastic sheet. To measure the coverage, each thallus that had been drawn was cut off and then weighed using analytic balance. The weight was converted into centimeter squares. The weight of thallus was converted into a transparent plastic 1 cm<sup>2</sup> (0.0149 g). The coverage of thallus was calculated using formula below :

$$\text{Thallus coverage} = \frac{\text{Weight of thallus} \times \text{Surface area of plastic (1 cm}^2\text{)}}{\text{Weight of plastic sheet (0.0149 g)}}$$

### Frequency of *Lobaria*

Frequency is the thallus number *Lobaria* presence on each tree. *Lobaria* frequency was determined using the following formulawith modifications (Dietrich and Scheidegger 1997; Rugayah et al., 2004; Smith and Smith 2007):

$$\text{Frequency} = \frac{\text{The number of trees overgrown by } Lobaria}{\text{Total number of trees}} \times 100\%$$

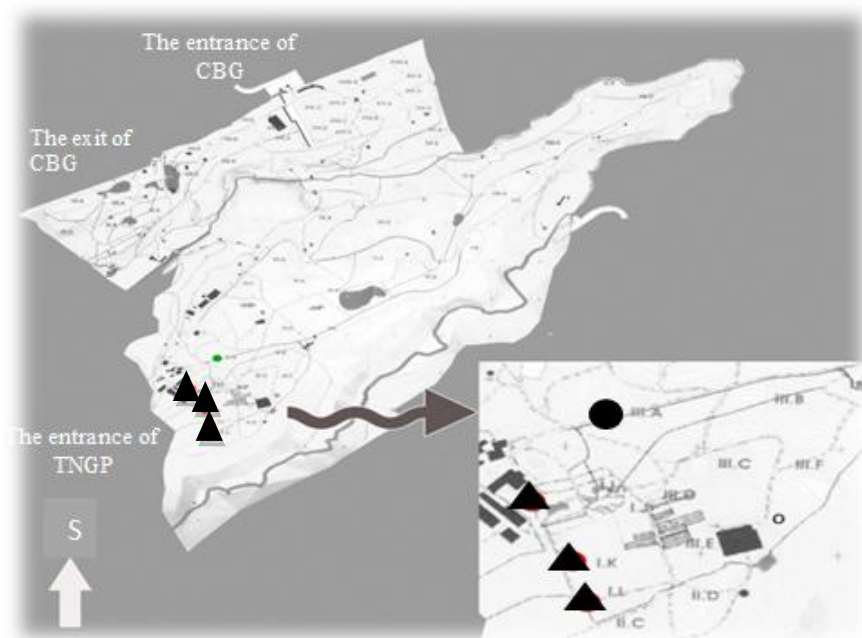
### Transplantations

The transplantation of *Lobaria* was carried out using thallus containing *isidium* and *lobule* at 0-1 m (*L. pulmonaria*) and 1-2 m (*L. retigera*). The transplantations were started by making quadrant from fine yarn, then were divided up into 10 quadrants. The tree trunk in the quadrant was spread with aquades. The ten transplants were placed in each provided quadrant, held in position by fine yarn, screwed then, and covered using paranet. Maintaining and measurement the transplants were conducted every month during the whole year.

Measurement of transplant was conducted by measuring the *lobule* coverage using a transparent plastic sheet attached to a *lobule* then traced. *Lobule* coverage was calculated using the formula of thallus coverage.

### Results

*Lobaria* found consisted of *L. pulmonaria* and *L. retigera* in four blocks namely block IA, II, IK and IIIA (164 trees) from 22 observed blocks on bark of *Araucaria bidwilli*, *Prunus cerasoides* and *Yucca elephantipes* (3724 trees) (Fig. 1). The characteristics of *Araucaria bidwilli*, *Prunus cerasoides* and *Yucca elephantipes* barks is woody, the surface is rough, humid, wet and having a *gemma*.



**Fig. 1:** Location of *Lobaria retigera* and *L. pulmonaria* in block IA, II, IK and IIIA in Cibodas Botanical Garden (▲ *L. retigera* and ● *L. pulmonaria*).



**Fig. 2:** Morphology of *L. retigera* (a) and *L. pulmonaria* (b).

The differences between 2 *Lobaria* species were as follows: thallus of *L. retigera* was greenish brown, loosely attached to the substrate, sorediate, rhizine squarrose, black tomentum, cyanobacterial photobiont, and yellowish white medulla. Thallus of *L. pulmonaria* was green, firmly attached to the substrate, the soredium was not visible, unbranched rhizine, dark brown tomentum, greenalgael photobiont, and white medulla.

The total number of thallus was 16, they were 11 thallus

of *L. retigera* (68.75%) and 5 thallus of *L. pulmonaria* (31.25%) with total frequency 0.14% (5 trees out of 3724 trees) (Table 1). *Lobaria retigera* was found in three blocks, namely block IA, II and IK (109 trees) with total thallus average of 176.32 cm<sup>2</sup> or average thallus coverage per surface area of tree trunk of 19.94 cm<sup>2</sup>/m<sup>2</sup> and frequency 0.11%. *Lobaria pulmonaria* was found in one block, namely block IIIA (55 trees) with total thallus coverage of 202.40 cm<sup>2</sup> or average thallus coverage per surface area of tree trunk of 117.67 cm<sup>2</sup>/m<sup>2</sup> and frequency 0.03% (Tables 1 and 2).

**Table 1.** Number of thallus and thallus coverage surface of *Lobaria* on each surface area on tree trunk of *Araucaria bidwilli*, *Prunus cerasoides* and *Yucca elephantipes*.

Block	Trees	Lichen	Surface area tree of trunk (m <sup>2</sup> )	Number of thallus (%)	Thallus coverage (cm <sup>2</sup> )
IA	<i>Prunus cerasoides</i>	<i>Lobaria retigera</i>	4.22*	2(12.5)	23.99**
	<i>P. cerasoides</i>	<i>L. retigera</i>	1.76	1(6.25)	41.53
II	<i>P. cerasoides</i>	<i>L. retigera</i>	1.66	5(31.25)	73.78
IK	<i>Yucca elephantipes</i>	<i>L. retigera</i>	6.16	3(18.75)	37.02
	<b>Subtotal</b>		<b>13.8</b>	<b>11(68.75)</b>	<b>176.32</b>
IIIA	<i>Araucaria bidwilli</i>	<i>L. pulmonaria</i>	1.72	5(31.25)	202.40
	<b>Subtotal</b>		<b>1.72</b>	<b>5(31.25)</b>	<b>202.40</b>
	<b>Total</b>		<b>15.52</b>	<b>16(100)</b>	<b>378.72</b>

**Note:** \* Surface area of tree trunk =  $2\pi r t$ . Radius (r) = circumference/ $2\pi$ .

\*\* Coverage surface = [weight of thallus/weight of plastic (0.0149 g)] × surface area of plastic sheet (1cm<sup>2</sup>)

**Table 2.** Frequency of *Lobaria* based on 3724 trees.

Block	Lichen	The number of trees overgrown of <i>Lobaria</i>	Frequency of <i>Lobaria</i> (%)
IA	<i>Lobaria retigera</i>	2	0.11
II	<i>L. retigera</i>	1	
IK	<i>L. retigera</i>	1	
	<b>Subtotal</b>	<b>4</b>	
IIIA	<i>L. pulmonaria</i>	1	0.03
	<b>Subtotal</b>	<b>1</b>	
	<b>Total</b>	<b>5</b>	<b>0.14</b>

A total of 11 transplants (55%) was able to grow, they were 4 transplants (20%) of *L. retigera* and 7 transplants (35%) of *L. pulmonaria*. The growth of transplants increased from January up to June 2014 (Fig. 2). Increasing of lobule coverage in *L. pulmonaria* was 445.89% (0.0852 cm<sup>2</sup> to 0.4651 cm<sup>2</sup>) during 12 months transplantation, but *L. retigera* was only 33.93% (0.3658 cm<sup>2</sup> to 0.4899 cm<sup>2</sup>) (Fig. 4). Increasing of thallus coverage in *L. pulmonaria* was 104.03% (1 cm<sup>2</sup> to 2.0403 cm<sup>2</sup>) during 12 months transplantation, but *L. retigera* was only 0.81% (1 cm<sup>2</sup> to 1.0081 cm<sup>2</sup>) (Fig. 5).

The growth of transplants was affected by climate. Average climate in CBG had temperature of 19.8°–19.7°C and humidity of 85%–91.1% from January 2013

up to February 2014 (Fig. 6). The transplantation was conducted in June 2013 during dry season in temperature of 11.9°–20°C and humidity of 85%–90.9% for 6 months. At the time the the lobules and thallus did not grow rapidly. Nevertheless, they grew rapidly in January up to June 2014 (Fig. 4). However, the data of temperature and humidity on those months were not recorded. For instance the range of temperatures from January up to May of 2013 was 19.7°–20°C and the range of humidity was 90.8–92.6%. Therefore, the humidity was a very important factor compared to the temperature. It is suggested that transplantation should be performed in January up to May because at that time the condition is more humid so that it will be a lot of chance for the transplants to grow rapidly (Fig. 6).

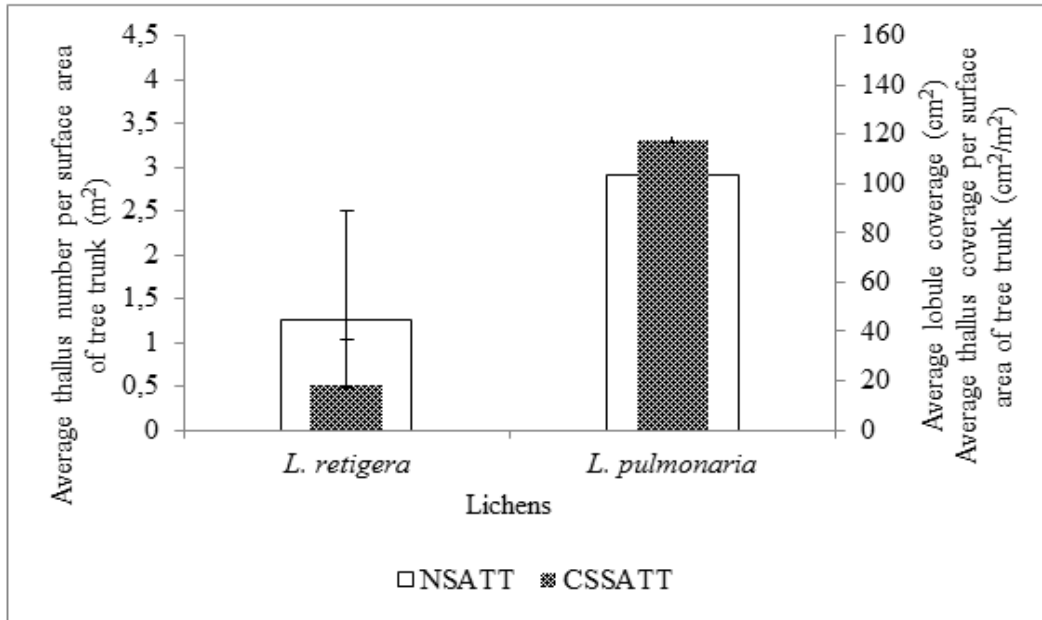


Fig. 3: Thallus number thallus and thallus coverage of tree trunk.

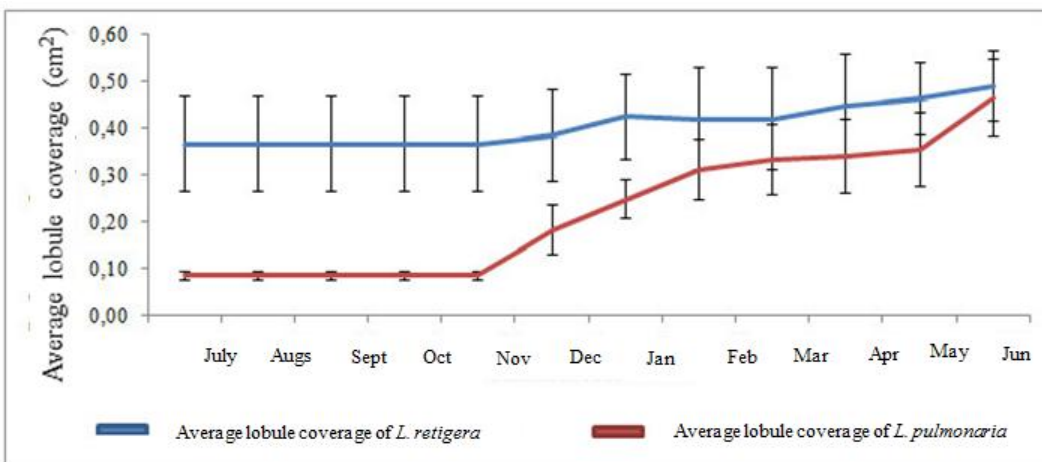


Fig. 4: Growth of lobule coverage.

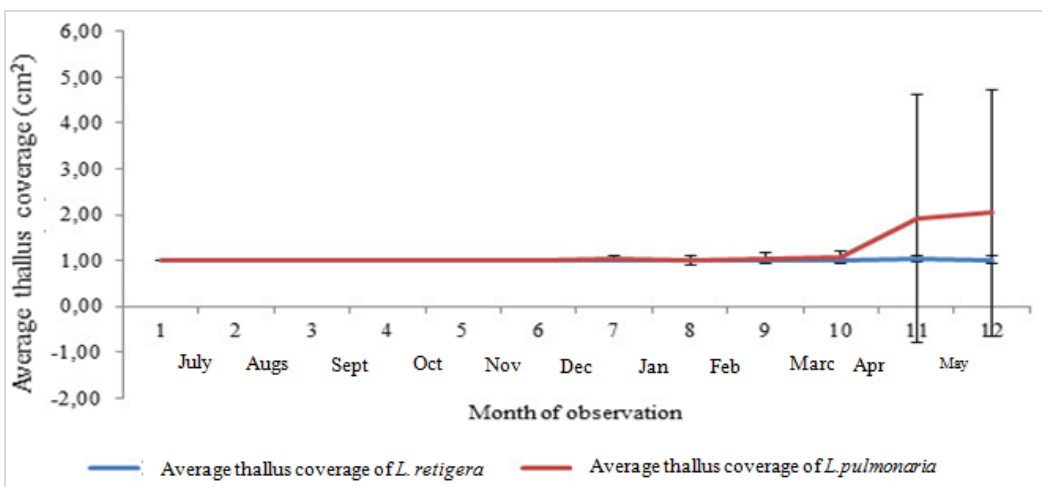


Fig. 5: Growth of thallus coverage.

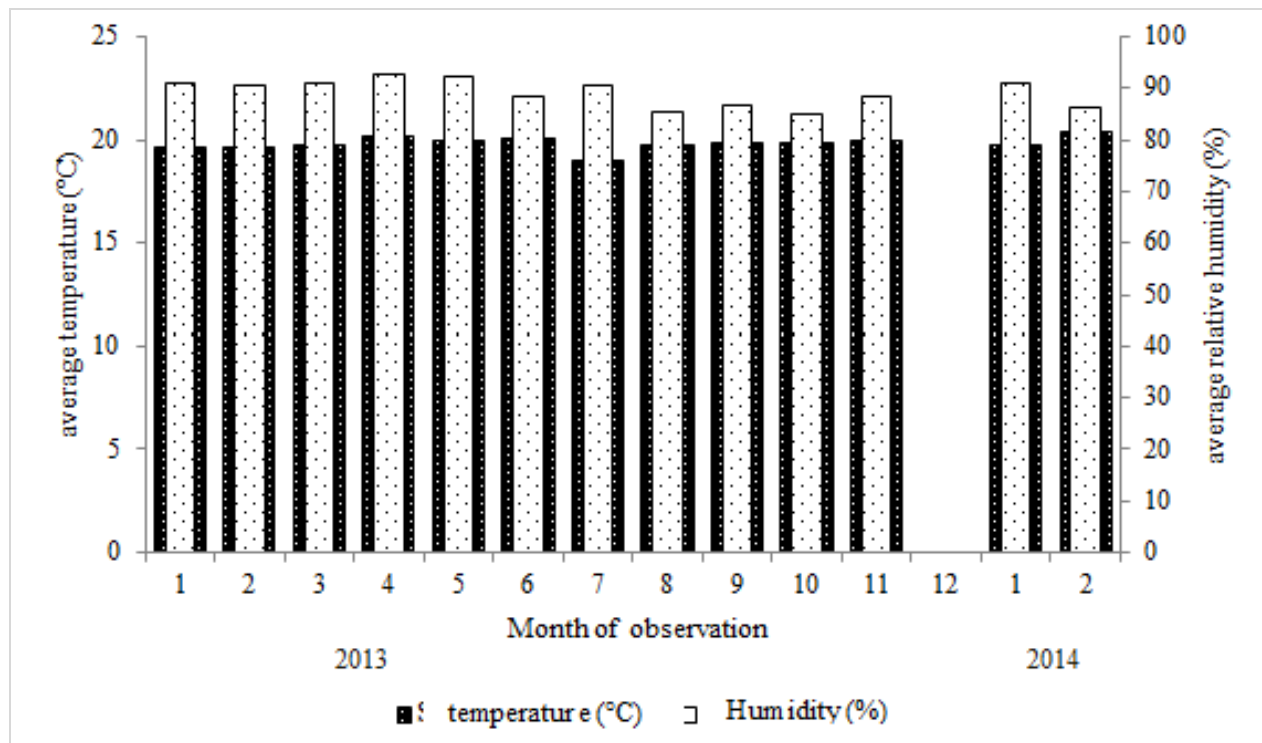


Fig. 6: Average temperature and average humidity of the months in Cibodas Botanical Garden.

## Discussion

The mapping results showed that of *Lobaria* population is very critical, indicated with the fact that on out of 3724 trees *L. pulmonaria* was only found on one tree, i.e. *Araucaria bidwili* which was induced from Queensland (Australia) (Database of CBG, unpublished). In addition, *L. retigera* was found on *Prunus cerasoides* and *Yucca elephantipes* induced from Himalaya and Mexico (Database of CBG, unpublished). The bark characteristics of those species are allegedly suitable for *Lobaria* to grow. Other factors influencing *L. pulmonaria* growth, in addition to bark physicochemical characteristics, are substrate texture (Moxham 1981, Armstrong 1993) and thallus position on the substrate (Armstrong, 1987).

The bark of *Prunus cerasoides*, *Yucca elephantipes*, and *Araucaria bidwili* is woody, rough surfaced, moist, wet, and with gemma, indicating that *Lobaria* grows on the bark of various species. Every species has different ability in saving water, highly depending on trunk's porosity and texture (Hale 1983). Rough bark surface is used by thallus to firmly attach. Brodo et al. (2001) stated that every tree is capable of naturally producing chemical compound which can help lichens survival. In addition, barks characteristics and conditions influence

thallus shape and growth (Brodo et al., 2001). The fact that *L. pulmonaria* and *L. retigera* were only found in block I and III indicated that the lichens can serve as air quality bio-indicator because the blocks were located far from vehicular traffic, in addition to having fewer visitors. This is in accordance with Purvis (2000) who stated that *Lobaria* is sensitive to air pollution.

*Lobaria retigera* are commonly found on the trunk of *Prunus cerasoides*. Therefore, the transplantations were carried out on the trunk of the species (as transplant natural substrate) in order to make the transplant grow and develop well. Coppins and Coppins (2005) stated that the transplantation of foliose thallus is more suitable to be carried out on trunk rather than on stone. Transplant materials used were *isidiate* thallus with *lobule*. Selecting thallus as transplant material should take into following consideration, e.g. wide lobes grows faster than the narrow one; thallus with young, intact lobes grows faster than *sorediate* and mature thallus. The variance in lobes growth depends on lobes properties rather than on the overall thallus (Scheidegger et al., 1995). Variance in lobes growth is due to allocation, metabolism and different carbohydrate production (Armstrong and Smith, 1994).

A total of 11 transplants were successfully transplanted

(55%) while the other 45% did not well grow due to several reasons, e.g. thallus dried and color changed; thallus did not well attached on the substrate; thallus size reduced; and thallus contained no young lobes. This result was in accordance with Philips (1969) where the study resulted in well grew transplants but the other lobes did not manage to grow at all. Mature thallus is capable of growing in various conditions, while isidia growth is influenced by light intensity and wind direction (Scheidegger et al., 1995).

Based on the transplant results, it is recommended that transplantation is carried out from January to May because the humidity during the period is higher, making the transplants have higher possibility to rapidly grow. Climatic condition suitable for thallus growth is the key factor for the successful transplant attachment on natural substrate. Accordingly, less favorable climatic condition hinders the degeneration process of diaspore transplanted (Scheidegger et al., 1995).

## Conclusion

Two lichen species were found, i.e., *Lobaria retigera* and *Lobaria pulmonaria*. *Lobaria* grows on bark of *Araucaria bidwilli*, *Prunus cerasoides* and *Yucca elephantipes*. *Lobaria* population is very critical. Transplantations were established successfully. The growing transplant result of *L. pulmonaria* was higher than *L. retigera*.

## Conflict of interest statement

Authors declare that they have no conflict of interest.

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