

Factors affecting the growth of lichens

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(1) Introduction

What are lichens?

Lichen is composite organisms consisting of fungus and the photosynthetic partner, which is usually either a green algae or cyanobacteria, growing together in a stable symbiotic relationship. The portion of fungus in lichen is dominated in the relationship, called the mycobiont, and in contrast, the alga in smaller portion in lichen is called photobiont. However, whether the relationship between them is mutualism or extremely evolved parasitism is controversial (Ahmadjian, 1993). In fact, the fungi can benefit from the organic matter produced in the photosynthesis carried out by the algae, while the algae gain protection provided by the fungi, which gives the ability for the algae to live in dry substrates (Nimis & Skert, 1999). Most of the lichens belong to three main types: crustose type, which are tightly packed and strongly attached to the surface on which they grow, foliose type, which are loosely attached to the surface on which they grow and fruticose type, which grow upright. Lichens are usually used to detect the air quality in a particularly area, as their growth rate will be affected by the air quality, i.e. lichens cannot be found in urban areas due to poor air quality, and lichens are usually found in the areas with good air quality.

(2) Aims of the study

Based on the experiments done in Tai Tong and Hung Shui Kiu, this report examine how the light intensity, temperature, relative humidity, pH value in that place, circumference and direction of the tree, and the difference between the road and the tree these factors affect the growth rate and the number of types of lichens other than the air quality.

(3) Investigation method

We did several experiments at 2 places. We did one experiment in Yuen Long Tai Tong and the other one in a road from Hung Shui Kiu to Lam Tei.

We first find a tree with lichens on it. Then we start to measure the light intensity, humidity, pH value of that place, temperature of that place by using pH paper and data log meter. We also used a compass to find out the direction of the road from the tree and measure the distance between the road and the tree. We can find the effects of human activities (cars or other human activities) on lichens.

After that, we use a transparent plastic sheet to record the amount of the lichens present in 10cmx10cm square.

The controlled variables of the experiment are the size of the marked square (10cm x 10cm), the distilled water used for measuring the pH value and the tools used for measurements. The lichens recorded are also controlled to be higher than 1m. The things we are measuring are the light intensity, humidity, pH value of the tree, temperature, distance between the tree and the road and the direction of the road from the tree.

(4) Data collected

a) Tai Tong (Site 1)

Environmental Factors Collected In Tai Tong									
Location of the tree	Environmental Factors	Circumference of tree (cm)	Temperature (°C)	Relative humidity (%)	pH value	Light intensity (lux)	Area covered (cm ²)	Distance from road(cm)	Direction to road
Near the main road		64	24.7	75	9	646	49	311.5	N60°W
Near the second road		63	23.2	84	9	197	53.5	100	N45°E
Near the barbeque site		63	22.6	84	9	225.5	32	150	N
Near the woodland		48.5	23.3	82	9	154	56	605	N60°W
Deep in Tai Mo Shan (facing the sidewalk 1)						217.5	59	400	S20°E
Deep in Tai Mo Shan (facing the sidewalk 2)		62.5	23.5	80	9	189	53	700	N50°E

(b) Hung Shui Kiu to Lam Tei (Site 2)

Environmental Factors From Hung Shi Kiu to Lam Tei			
	Near the main road	Near the second road	Near the country park
Circumference of the tree (cm)	43	42	75
Temperature (°C)	31.6	31.4	32
relative humidity (%)	67	64	67
pH value	9.3	8.3	9.3
light intensity (Lux)	941.5	618.5	617.5
area covered (cm ²)	31	42	48
distance from road (cm)	90	148	188
direction to road	E	N40W	S80E

(5) Discussion

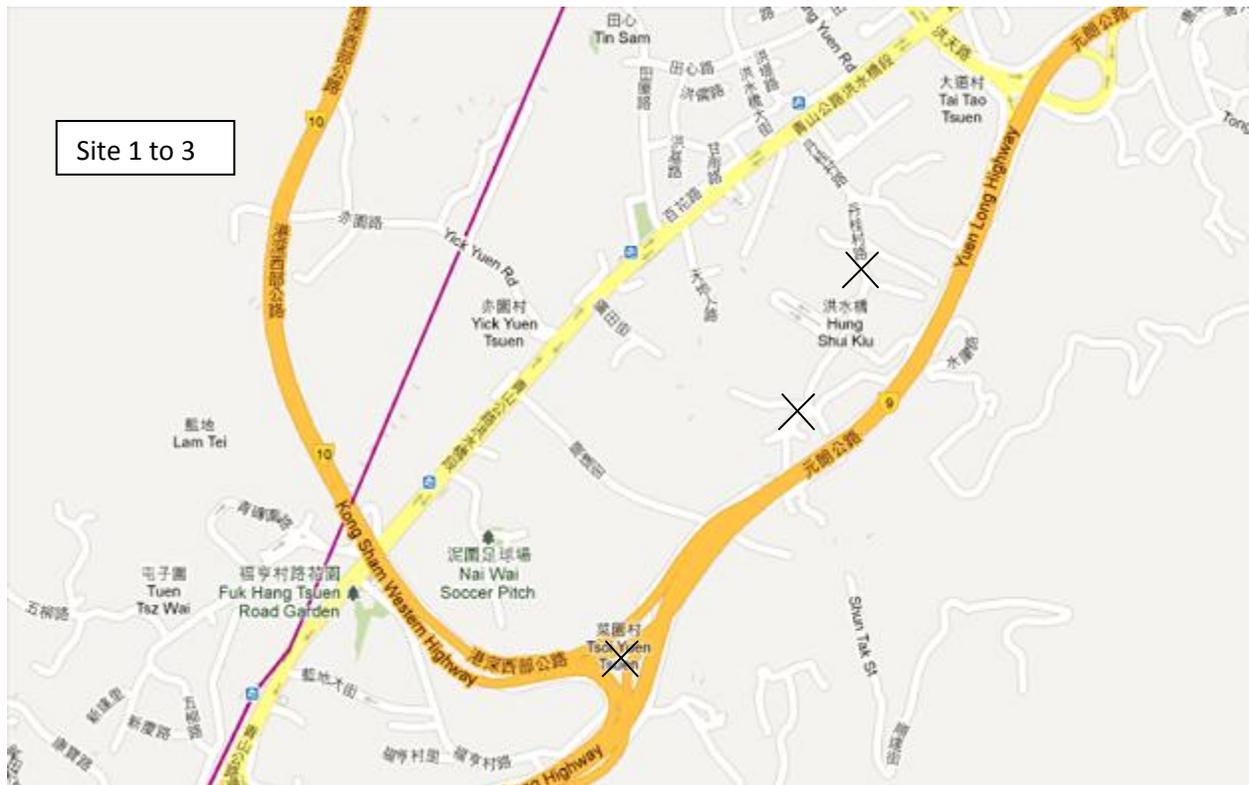
- a) The environment of the site
 - i) Tai Tong





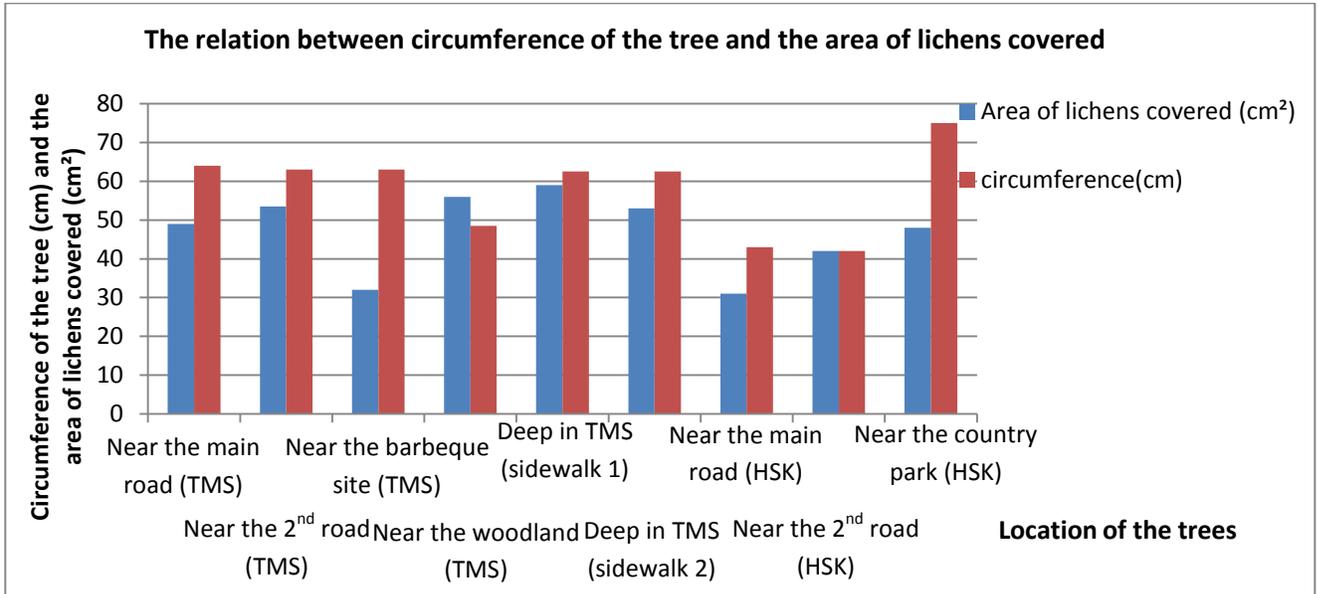
Tai Tong is surrounded by trees. Our site of observation is inside a country park. It is less affected by human activities.

ii) Hung Shui Kiu



The site we did our investigation in Hung Shui Kiu is near to the roads. There are a lot of human activities happening around.

b) how the hosting tree affect the growth rate of lichens



From our investigation, we can see that the circumferences of the trees are mainly around 60-70cm. But the circumference has small effects on the growth of lichens. They were mostly rapped with lichens. We can find 3 types of lichens on different trees namely Dirinaria, Script Lichen and Orange Lichen. These different types of lichens may appear together and can be found all over the tree. We could also see that the host trees have rough surfaces. These rough surfaces can help trap water and let the lichens to absorb. The photosynthetic partner in the lichen can then use the water and carbon dioxide and undergo photosynthesis. The oxygen produced can help clean the air. So lichens can help regulate the components in air. As we could not find trees which have both smooth surface and lichens grow on it. We assume that the trees which have smooth did not have lichens to grow on it.

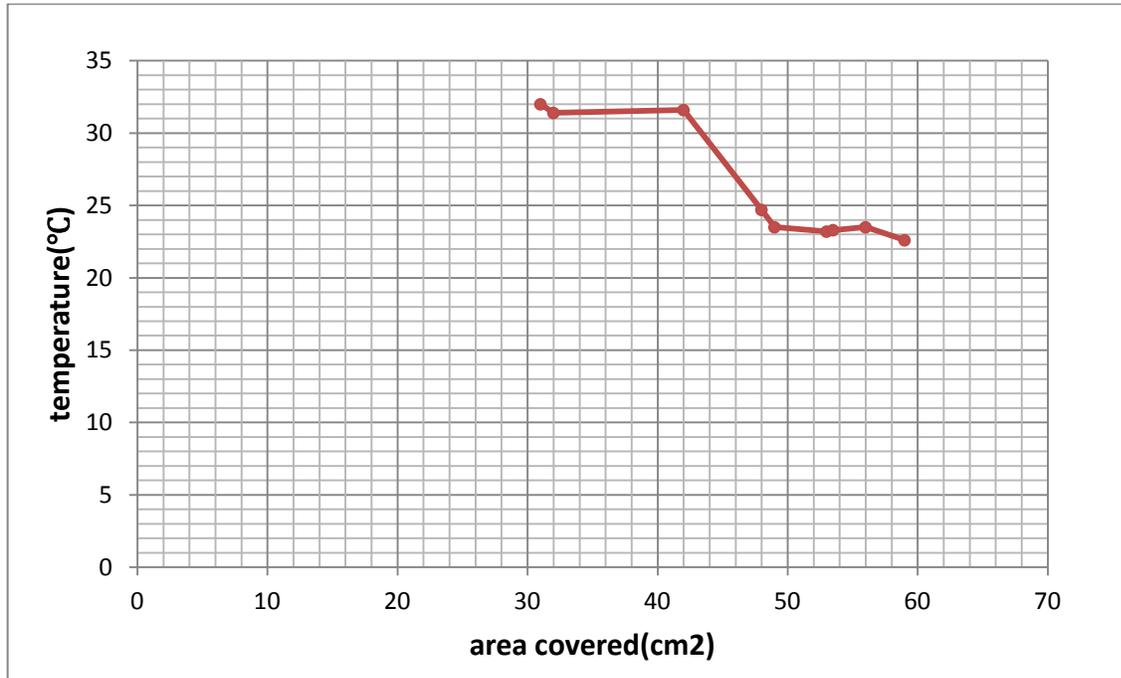
3 types of lichen appear together



Rough surface of the hosting tree

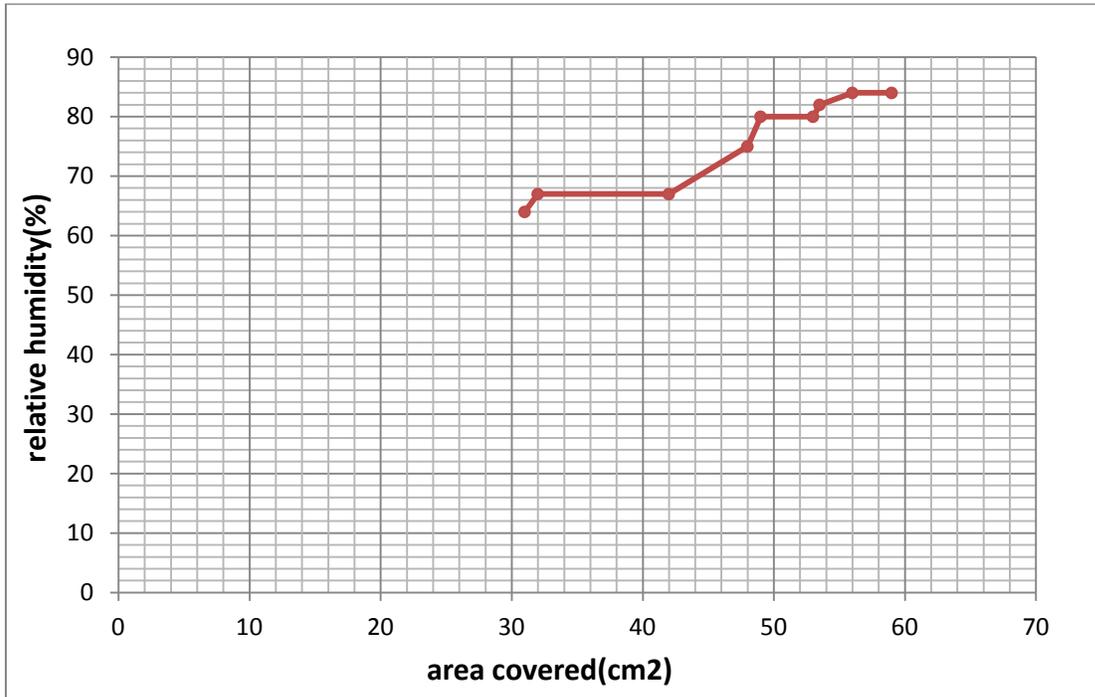


c) how temperature affect the growth rate of lichens



From the results of the experiments, temperatures are different on the days of experiments. In the 1st experiment in Tai Tung, the temperature in there is around 22°C to 24°C. However, the area of lichens covered in 100cm² varies between 32cm² and 59cm². In the 2nd experiment in Hung Shui Kiu and Tuen Mun, the temperature in there is around 31.4°C and 32°C. Nevertheless, the area of lichens covered in 100cm² is between 31cm² and 48cm² (Fig.1). In each of the experiment, different positions of the lichens are observed, such as nearly the barbeque site and deep in the mountain. But the temperatures are almost the same in each site. This shows that temperature and the growth of lichens are not really related, which is a match with other report (Macfarlane & Kershaw, 1978).

d) how relative humidity affect the growth rate of lichens



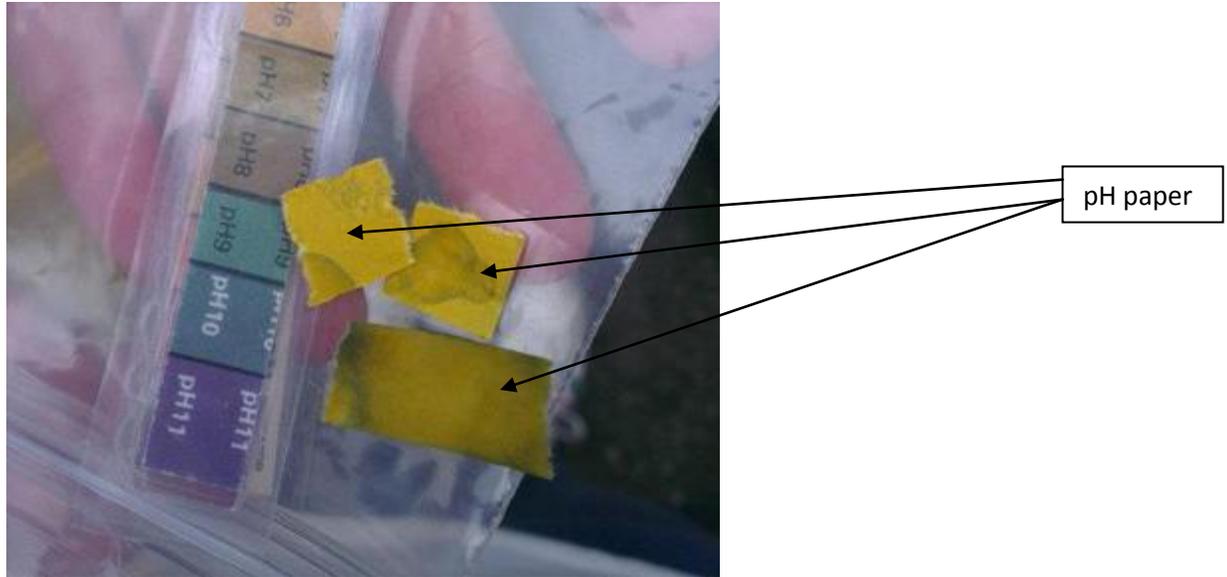
Relative humidity is one of the factors that affect the distribution of lichen. About the relative humidity of trees with lichen, the relative humidity of trees are similar with other trees that at same site. At site 1, the relative humidity of tree1 is 75%; at tree2, there are two result as the tree facing the road at two directions. Relative humidity of tree2a is 80%, and at tree2b is also 80%; at tree 3, the relative humidity is 82%; at tree 4 and tree 5, both of them the relative humidity is 84%. From the results of site 1, we can conclude that the relative humidity of the trees at site1 is around 80%. At site 2, the relative humidity of tree 1 is 67%; at tree 2, the relative humidity is 64%; at tree 3, the relative humidity is 67%. The relative humidity of the trees at site 2 is around 65.5%. The relative humidity at tree 3 is 67%. The relative humidity of the trees at site 2 is around 65.5%. where light intensity was higher and average relative humidity lower than in the neighboring woods, lichen cover on the bark of trees was significantly higher (over 50° of bark covered) than in the woods.

Like all lichens very dependent on high relative humidity, they obtain their required nutrients and water directly from the atmosphere. Relative high humidity habitat is rich in lichen biodiversity. The majority of lichens that

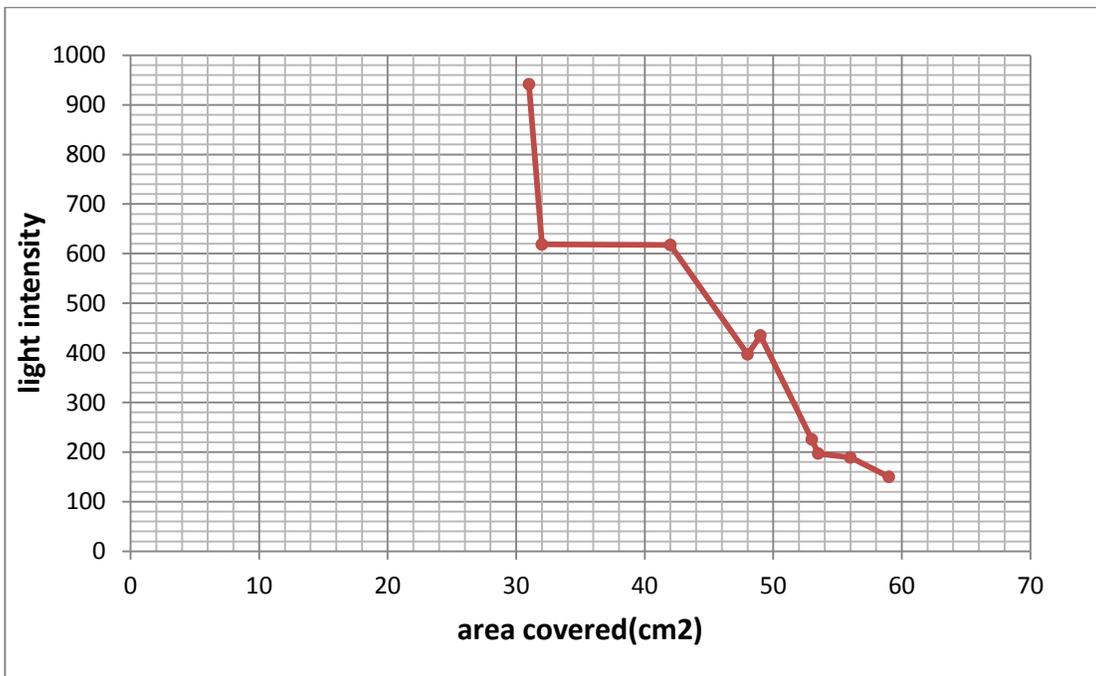
occurs in this habitat, although often colorful, are very common. Lichens absorb the water from air. The more water it gets the more nutrition it gets because it gets spread around easier because of the water. Thus when trees contain higher relative humidity, it encourages the growth of lichens. Just like the result at site 2, the tree with highest relative humidity contains the largest area of lichens. Lichens may dry completely when moisture is unavailable. This is not simply dehydration as it occurs in plants and animals we are familiar with, but a complete loss of body water such that the lichen becomes quite brittle. When moisture is again available, they quickly absorb water, becoming soft and fleshy again. Not only can lichens undergo this drying, but while they are dry and brittle, pieces may flake off and later grow into new lichens. Therefore, we can observe that environment with high humidity is more suitable for lichen. If the tree contains low relative humidity, lichen will become brittle or even die. To conclude, the high relative humidity facilitates the growth of lichens.

e) how acidity and alkalinity affect the grow rate of lichens

From the results of the observations, all the pH value was measured in both site are around 8-9, which means the concentration of hydrogen ions is larger than the concentration of hydroxide ion. This shows that lichens live in the alkali environment rather than in acidic. From the reference (<http://accuvin.com/pHSO2Links.pdf>), we can see that lichens are sensitive to SO₂, when the pH value is relatively higher, the concentration of SO₂ is relatively lower, and there are less SO₂. Therefore, it is found that a pH value around 8-9 is more favorable for lichens to growth.

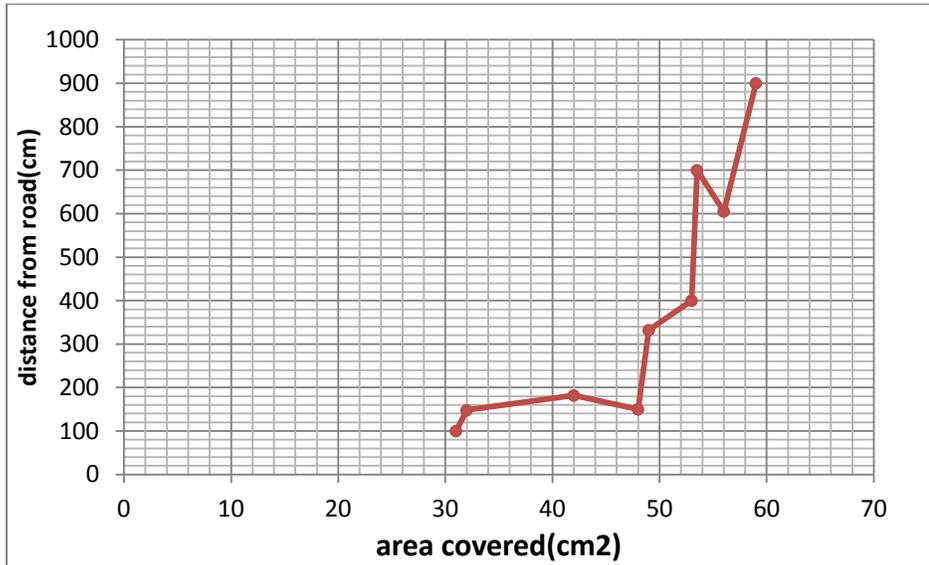


f) how light intensity affect the growth rate of lichens



The light intensity has a reverse proportion to the light intensity. The most favorable light intensity is 150 Lux with the area covered of lichen is 59cm². From this we can see that lichens do not like strong sunlight. This can explain why we usually find the lichens in the shaded areas. The light intensity is low.

g) how the distance from the road affect the growth rate of lichens



Distance from road also affects the growth of lichen. At site 1, the distance between road and tree1 is 331.7 cm; at tree 2, the distance of tree2a from the road is 400 cm and the distance of tree2b from the road is 700cm;the distance between tree 3 and the road is 605cm;the distance of tree 4 from the road is 150 cm; the distance of tree 5 from the road is 100 cm. At site 2, the distance of tree 1 from the road is 90 cm; the distance between tree 2 and the road is 148cm; the distance of tree 3 from the road is 188 cm.

The major pollutants that kill the lichens are nitrogen compounds from road traffic and the sulphur dioxide from automobiles. When vehicles pass through the road, they release some air pollutants such as nitrogen compound and sulphur dioxide, which are the air pollutant that killing lichen. Lichens are very sensitive to air pollution. If lichens are exposed to air pollutants at all times, without any deciduous parts, they are unable to avoid the accumulation of pollutants. Sulphur dioxide can also inhibit lichen reproduction, both sexual and asexual. It is the most intensively air pollutant that is a gas that dissolves readily in water to produce highly reactive acidic ions, which are readily absorbed through lichen thalli. And when lichen absorbs it, it will disrupt photosynthesis of lichen. Thus the closer from the road, the larger amount of air pollutant. If the level of nitrogen is high or the air pollution is serious, the surface area of lichen will be smaller or even no lichen can grow in this condition. On the other hand, if the trees are far away from the road, the

influence of air pollutant on lichen will be smaller. So the distortion of lichen will be larger. From our data, the farthest trees from the road at site 2 contain the largest area of lichen. Thus lichen can be an air quality indicator as it grows only when there is no air pollution. As a result, the longer the distance from the road, the less influence of air pollutants on lichen and then the more suitable environment for the growth of lichens.



h) direction which lichens tends to grow to

From the result of observations, it is found that the direction of lichens facing, is mostly NE or NW, which is tend to north. As these directions would have more sunlight than in the other direction. This shows that lichens do need sunlight for photosynthesis.



(6) Conclusion

To conclude, the circumference of the trees with lichen is 63 cm. If the circumference of the trees is too small, there will be no lichen. About the temperature of condition of trees with lichen, the temperature is similar in the same site. The relative humidity of the environment around the trees is also similar in the same site. Higher relative humidity facilitates the growth of lichen. The pH value of lichen is around 9, which are alkaline. For light intensity, it is variable. Most lichens covered over 50cm² within a 100cm² square. And for the distance from the road, mostly of them are more than 100cm as there will be no lichen if trees are near the road. Also if trees grow at pollution source such as barbecue site, hiking trail, there will be no lichen. About the direction of the tree, mostly of them grow in NW and NE direction and according to reference, lichen mostly grows in north direction. These are the factors affecting the growth of lichen.

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(8) Acknowledgements

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(9) Reflections

June: After this investigation, I know more about lichens. They are not as simple as I think. I can experience how the true scientists do their investigation. It is a wonderful experience.

Jenny: I realize that lichens are really interesting after this investigation. Many factors can affect the growth of lichens. It was really funny to know about this.

Vicki: After going this trip, I had found that there are lots of organisms are living in different kinds of environment. For example, lichens, most of them are growing on the trees. I have learnt a lot from this trip, like using the apparatuses such as light intensity meter. It is a valuable and unforgettable experience for me; I hope I can join this kind of program again.

Cindy: This project is really interesting and meaningful. I know how to cooperate with my teammates. When we were measuring the condition of the trees, each of us needed to response for different things. For example, I need to calculate the surface area of lichen. If we cannot communicate and cooperate with each other, we cannot make this project. Thus I learn the communication skill and cooperation with your teammate. Also, it is unusual for me going hiking. This project gives me the opportunity of hiking. During hiking, I know the beauty of nature. It is a very unforgettable experience.