EFFECT OF SUBSTRATE AND LIGHT INTENSITY ON LICHEN DISTRIBUTION IN KINABALU PARK

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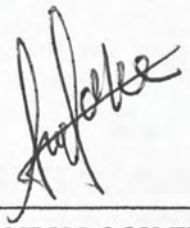

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ABSTRACT

This study was carried out to determine the influence of types of substrate (trees, rocks, soil and dead wood) and the effect of light intensity on lichen distribution in Kinabalu Park, Sabah. Two study sites were selected: the first site is located at an elevation of 2900 meters while the second site is located at an elevation of 3300 meters above sea level. Quadrats were used to sample lichen specimen from these sites. Ten 1 m X 1 m quadrats were used for the first sampling site while thirty 10cm X 20cm quadrats (10 quadrats each for each light intensity) were set at second sampling site. The surface area of lichen found in each quadrat was taken to represent the abundance of lichen in the quadrat. A total of 32 species of lichen from 19 genera and five unidentified specimens were collected from both sites. The types of substrate which influence the distribution of lichen were tested. The results show that 65% of total surface area of lichen was found on trees, while only 4% of lichen was found on soil. The distribution of saxicolous lichens was not affected by light intensity. The result of One-way ANOVA ($p>0.05$) shows that there was no significant difference between lichen growing at high, medium and low light intensity.

ABSTRAK

Kajian ini dijalankan untuk mengetahui pengaruh substrat (pokok, batu, tanah dan kayu reput) dan kesan keamatan cahaya terhadap taburan liken di Taman Kinabalu, Sabah. Dua tapak kajian dipilih: tapak pertama terletak di altitut 2900 meter dan tapak kedua terletak di altitut 3300 meter dari paras laut. Kaedah kuadrat telah digunakan untuk menyampel liken dari kedua-dua tapak ini. Sepuluh kuadrat 1 m X 1 m digunakan untuk tapak pertama dan 30 kuadrat 10cm X 20cm untuk tapak kedua (10 kuadrat untuk setiap tahap keamatan cahaya). Luas permukaan liken yang dijumpai dalam setiap kuadrat mewakili kelimpahan liken dalam kuadrat. Sejumlah 32 spesies liken dari 19 genera dan lima specimen yang tidak dapat dikenalpasti telah disampel dari kedua-dua tapak kajian. Substrat didapati mempengaruhi taburan liken. Keputusan menunjukkan 65% daripada jumlah luas permukaan liken yang disampel adalah besubstratkan pokok, manakala hanya 4% liken yang dijumpai terdapat pada substrat tanah. Taburan "saxicolous" liken (liken yang tumbuh pada batu) tidak dipengaruhi oleh keamatan cahaya. Keputusan dari analisis ANOVA sehala ($p>0.05$) menunjukkan tiada perbezaan yang signifikan di antara data yang dikumpul dari keamatan cahaya yang tinggi, sederhana dan rendah.

TABLE OF CONTENTS

		Page
DECLARATION		ii
APPROVAL		iii
ACKNOWLEDGEMENT		iv
ABSTRACT		v
ABSTRAK		vi
TABLE OF CONTENTS		vii
LIST OF TABLES		x
LIST OF FIGURES		xi
LIST OF PHOTOS		xiii
LIST OF SYMBOLS		xiv
LIST OF APPENDIXES		xv
CHAPTER 1	**INTRODUCTION**	**1**
1.1	THE BIOLOGY OF LICHEN	1
1.2	JUSTIFICATION OF PROJECT	7
1.3	OBJECTIVES	8
1.4	HYPOTHESIS OF THE STUDY	8
CHAPTER 2	**LITERATURE REVIEW**	**9**
2.1	DISTRIBUTION OF LICHEN	9
2.2	GROWTH AND REPRODUCTION OF LICHEN	10
2.3	FACTORS AFFECTING LICHEN DISTRIBUTION	14
2.4	ECOLOGICAL ROLE OF LICHEN	15

2.4.1 Lichen as primary colonizers of substrate (such as rock) 15

2.4.2 Lichen as food for animals 16

2.5 OTHER IMPORTANCE OF LICHEN 17

2.5.1 Lichen as bioindicator for air pollution 17

2.5.2 Lichenometry 18

2.5.3 Uses of Lichens 18

2.6 ISOLATION AND CULTURE OF LICHEN SYMBIONT 19

CHAPTER 3 METHODOLOGY 21

3.1 STUDY SITE 21

3.2 SAMPLING 24

3.2.1 Lichen samples 24

3.2.2 Parameter 26

3.2.3 Identification of lichen specimen 26

3.3 DATA ANALYSIS 27

CHAPTER 4 RESULTS AND DISCUSSION 28

4.1 LICHEN SPECIMENS 28

4.1.1 Identification of lichen 29

4.1.2 Effect of type of substrate on lichen distribution 34

4.1.3 Effect of light intensity on lichen distribution 41

4.2 IDENTIFICATION KEY TO THE LICHEN GENERA OF KINABALU PARK 49

4.3 DIFFICULTIES FACED DURING STUDY 52

4.4 RECOMMENDATION 53

CHAPTER 5 CONCLUSION 54

REFERENCES 56

APPENDIXES 59 - 68

LIST OF TABLES

Table		Page
4.1	Total lichens collected according to growth form and genera.	29
4.2	List of lichen species identified from two sampling stations at Mount Kinabalu.	31
4.3	Parameter of first study site.	34
4.4	Lichens collected from Station 1 according to growth form and genera.	35
4.5	Lichens collected from first sampling site according to substrate and genera.	35
4.6	Parameter of Station 2.	41
4.7	Lichens collected from Station 2 according to growth form and genera.	42

LIST OF FIGURES

Figure		Page
1.1	Cross section of crustose lichen thalli.	4
1.2	Cross section of foliose lichen thalli.	5
1.3	Cross section of fruticose lichen thalli.	6
2.1	*Isidia* formed at the surface of lichen thallus.	12
2.2	The form of *soredia* and how it released from the thallus.	12
2.3	Section through apothecium of lichen.	13
2.4	Section through perithecium of lichen.	13
3.1	Map of Kinabalu Park and its area.	22
3.2	Summit trial of Mount Kinabalu and the 2 sampling station selected.	23
4.1	Percentage of lichen found in this study according to their growth form.	32
4.2	Abundance of lichen (expressed as growing surface area in cm^2) from both station.	33
4.3	Total abundance of lichens (cm^2) in each quadrat.	36
4.4	Total abundance of lichens (cm^2) in each quadrat according to their substrate.	37
4.5	The overall percentage of lichens found on different substrates at elevation of 2900meters.	37
4.6	Abundance of lichen species (expressed as growing surface area in cm^2).	39

4.7 Percentage of lichen found in Station 2 growing at the three levels of light intensity. 43

4.8 Total surface area of lichen found at each level of light intensity according to their growth form. 44

4.9 Abundance of lichen species (expressed as growing surface area in cm^2). 46

LIST OF PHOTOS

Photo		Page
1.1	Crustose lichen found in Kinabalu Park.	4
1.2	Foliose lichen found in Kinabalu Park.	5
1.3	Fruticose lichen found in Kinabalu Park.	6
3.1	Plastic sheet with 10cm X 20 cm quadrat frame were used to trace lichens distribution at Station 2.	26
4.1	Trees are the most preferred substrate for lichen at an elevation 2900 m.	40
4.2	Rocks as one of the substrate for lichen.	40
4.3	*Usnea* sp., dominant species, at an elevation of 2500 m to 3000 m.	41
4.4	Photograph shows one of the unidentified lichen (Non-ID 5). This crustose lichen does not have a fruiting body.	47
4.5	An example of exposed rock for sampling lichens grown on high light high light intensity.	48
4.6	Quadrat placed on a partly shaded rock. Sampling for lichens grows on medium light intensity.	48
4.7	Quadrat set at the side of a large boulder. Light intensity here is less than 10,000 lux. Quadrat used to sample lichens grows on low light intensity.	49

LIST OF SYMBOLS

m	meter
cm	centimeter
cm^2	square centimeter
km^2	square kilometer
ft	foot
^oC	degree Celsius
%	percent / percentage

LIST OF APPENDIXES

		Page
APPENDIX A	Data from sampling day on 1 February 2006	59
APPENDIX B	Data from sampling day on 23 October 2005	60
APPENDIX C	Result of Statistical Analysis	62
APPENDIX D	Photograph of Lichen	63
APPENDIX E	Glossary of technical terms.	67

CHAPTER 1

INTRODUCTION

1.1 THE BIOLOGY OF LICHENS

Lichens are not a single organism, but consist of two or three organisms that form a mutualistic interaction. It was not realized that lichens were symbionts until 1867. Before that time, lichens were regarded as a class of plants distinct from either fungi or algae (Smith and Douglas, 1987). At first, lichen was defined as 'a symbiotic association between fungus and algae' but later the definition was changed to 'lichen is an association of fungus and a photosynthetic symbiont'. The latter description was then found unsatisfactory as certain brown seaweeds (*Ascophyllum nodosum* and *Pelvetia canaliculata*) invariably support fungi that do them no harm, but these associations are not considered lichen. The current definition of lichen as given in '*Dictionary of the Fungi'* is 'Lichen is a stable self supporting association of a fungus (mycobiont) and an algae or cyanobacterium (photobiont)' as cited in Gilbert (2000).

The organisms that form lichens are fungi (mycobiont), which provide protection, and algae (photobiont or phycobiont – either a green alga or a cyanobacterium), the latter undergo photosynthesis and provide food (Hawksworth & Hill, 1984; Alexopoulos, 1962). Lichens which result from these symbiotic unions are

completely different from those of either the alga or the fungus growing alone in nature. A mushroom covered with or growing among green algae should not be termed as lichen even though its hyphae may be associated intimately with the algae cells and a mutualistic relationship can be demonstrated (Ahmadjian, 1967).

In many cases, the alga which forms lichen may be found living without its partner in nature but not all of the mycobiont that form lichen can survive on its own (Holmes, 1986) as it becomes dependent on its algal partner for survival. In a few lichen species, both types of algae are present; the paler green algal cells are scattered throughout the lichen thallus, whereas the darker blue-green algal cells are localized in tiny colonies called cephalodia (Hale, 1970). The photobionts obtain protection, moisture and minerals from the mycobionts; whereas the mycobionts gain growth substances and products of photosynthesis from the algae and fixed atmospheric nitrogen by cyanobacterium, also known as blue-green algae.

The lichen body is called the "thallus" (Bland, 1971). A lichen thallus usually consists of layers such as an upper and lower cortex, algal layer, and medulla. The layers differ in thickness and are better developed in some species than in other (Paracer and Ahmadjian, 2000). The algae are suspended in a compact layer below the upper cortex or dispersed throughout the thallus (Hale, 1970). Lichens come in many different shapes, sizes and colors. According to Hawksworth & Rose (1976), lichen growth forms are artificially grouped into four major forms, (a) crustose (crust-like), (b) foliose (leaf-like), (c) fruticose (hair-like or twig-like), and (d) squamulose (tightly clustered and slightly flattened pebble-like units). Some references only

categorize lichens into three major groups, namely (a) crustose, (b) foliose and (c) fructicose (Paracer and Ahmadjian, 2000).

Crustose lichens are flat and crustlike (Photo 1.1), with the whole thallus adhering firmly to the substrate. This type of lichens is often the dominant form on rocks in extreme environment (Moore-Landecker, 1996). Crustose lichen lacks a lower cortex (Figure 1.1) and is generally considered to be the most primitive type. Some species grow inside rock cervices and bark and still manage to produce separate layers (Paracer and Ahmadjian, 2000).

A foliose thallus has an upper and lower cortex, an algal layer, and medulla (Figure 1.2). They usually attach loosely to the substrate by rhizines, hair-like structures which function like a root in vascular plant (Photo 1.2). The thallus has many different sizes and shapes and is often divided into lobes (Paracer and Ahmadjian, 2000).

Fruticose lichens (Figure 1.3 and Photo 1.3) form an upright strap-shaped or cylindrical branched thalline which are usually attached to its substratum by a holdfast, or a pendulous thallus that hangs downward from the aerial support such as a tree (Bland, 1971; Moore-Landecker, 1996).

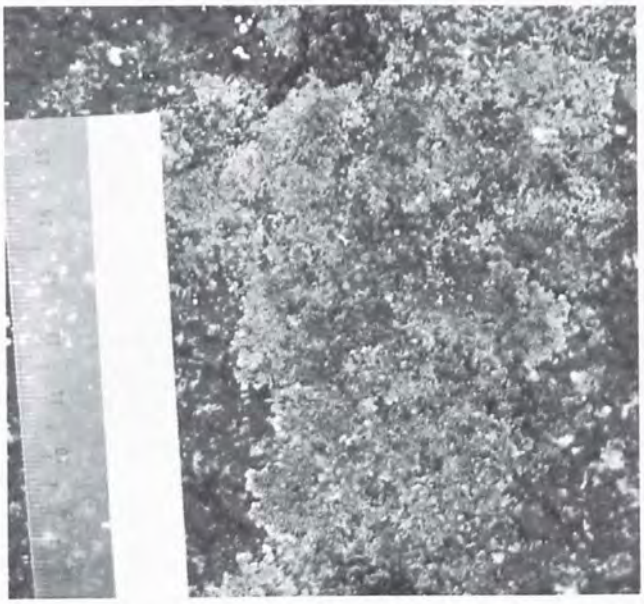
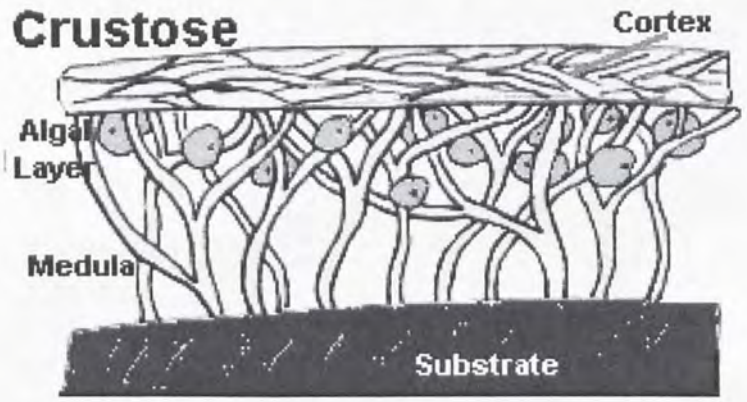


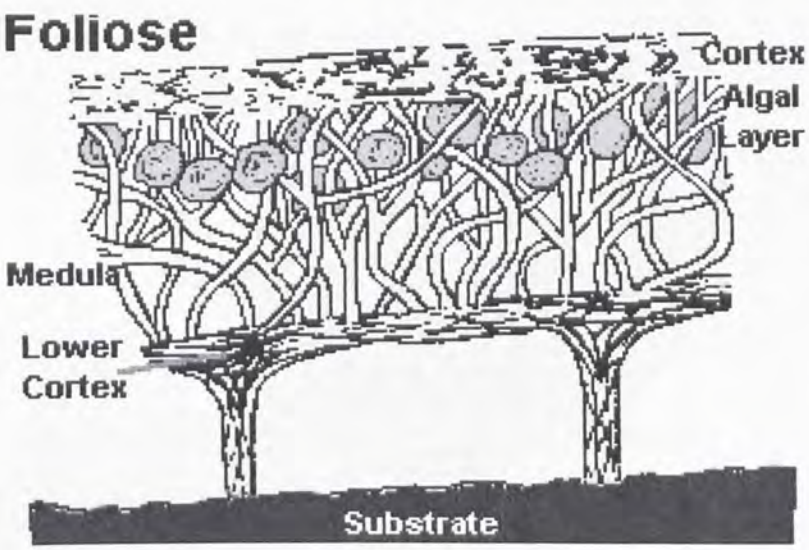
Photo 1.1 Crustose lichen found in Kinabalu Park.



(Source: http://www.earthlife.net/lichens/lichen.html)

Figure 1.1 Cross section of crustose lichen thalli.

Photo 1.2 Foliose lichen found in Kinabalu Park.



(Source: http://www.earthlife.net/lichens/lichen.html)

Figure 1.2 Cross section of foliose lichen thalli.

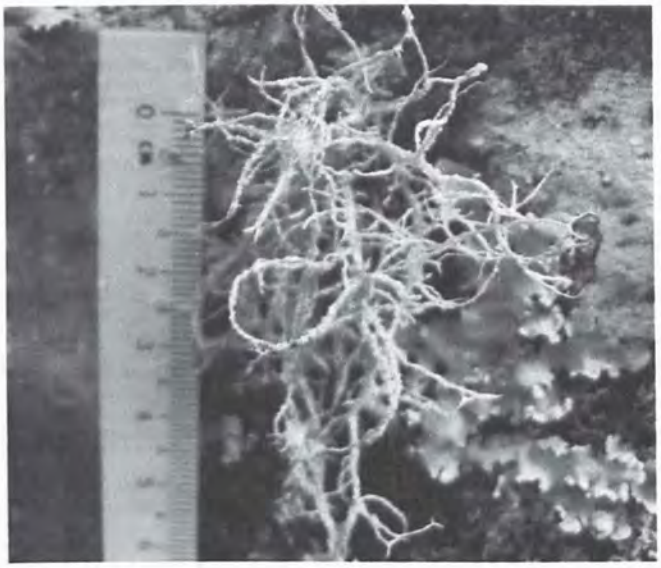
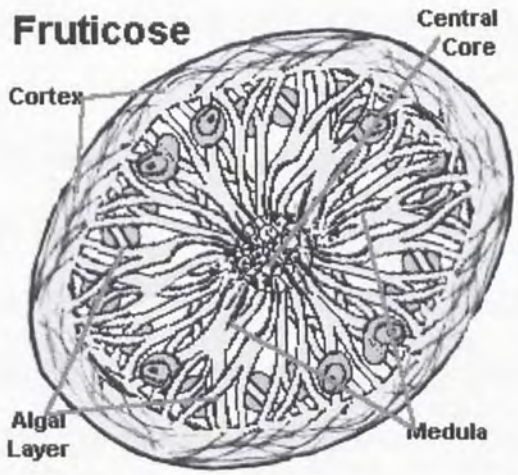


Photo 1.3 Fruticose lichen found in Kinabalu Park.



(Source: http://www.earthlife.net/lichens/lichen.html)

Figure 1.3 Cross section of fruticose lichen thalli.

1.2 JUSTIFICATION OF PROJECT

Lichenology is the study of lichen. They are often given the passing reference in textbooks, claimed by neither mycologist nor algologists (Hale, 1970). Ahmadjian (1967) claimed that lichens have been studied for over two hundred years but the basic nature of this organism still remains a mystery. Research about lichen has been carried out recently to look deeper into this unique organism. However, lichen research in Malaysia is very limited.

Lichens play an important role in the ecosystem. They act as food source for animals and are important for nutrient cycling. Besides, lichens have been widely used as bioindicator for air pollution and environmental changes. However, in order for these applications to be successful, the knowledge about lichen distribution and ecological factors affecting lichen distribution should be understood.

Light intensity is said to be one of factors that affects lichen distribution (Hale, 1970; Smith and Douglas, 1987). The effect of light intensity on lichen distribution will be tested in this study. Lichen is a combination of a mycobiont and photobiont. The photobiont needs light and moisture to undergo photosynthesis to provide food (carbohydrate) for growth of the thallus. The distribution of lichen depends on the growth. As a result, light intensity is assumed to affect the distribution of lichen.

Kinabalu Park ranges over 4-climate zones, from the rich lowland dipterocarp forest through the montane oak, rhododendron, and coniferous forests, to the alpine meadows plants, and stunted bushes of the summit zone. Kinabalu Park has probably

one of the richest flora collections in the world (Wong and Chan, 1997). Kinabalu Park was chosen to be the study site for this dissertation.

1.3 OBJECTIVES

The following are objectives of this study:

i. To identify some lichens from Kinabalu Park

ii. To study the distribution of these lichens on various substrates

iii. To determine the effect of light intensity on the distribution of lichens growing on rock in Kinabalu Park

1.4 HYPOTHESES OF THE STUDY

There are two hypotheses to be tested in this dissertation:

Hypothesis 1: Type of substrate will influence distribution of lichens.

Hypothesis 2: Lichen distribution is affected by light intensity.

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