Preliminary observations on the growth of transplanted lichens *Parmotrema tinctorum* in four ecosystems at Khao Yai National Park.

การศึกษาการเติบโตเบื้องต้นของไลเคน *Parmotrema tinctorum* ที่ย้ายปลูกในสี่ระบบนิเวศ ณ อุทยานแห่งชาติเขาใหญ่

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บทคัดย่อ: สารชีวภาพในไลเคนมีศักยภาพในการนำมาใช้ประโยชน์ได้หลากหลาย โดยมีการวิจัยอยู่มากในปัจจุบัน แต่ไลเคนเติบโตช้าและอยู่ในภาวะเสี่ยงต่อการสูญพันธุ์ จึงควรมีวิธีการอนุรักษ์ไลเคนให้สามารถใช้ประโยชน์ได้อย่างยั่งยืน การทดลองนี้มีวัตถุประสงค์ 1) สังเกตการเติบโตของไลเคนที่ย้ายปลูกไปในสภาพแวดล้อมที่แตกต่าง 2) สังเกตอิทธิพลของภูมิอากาศต่ออัตราการเติบโต และ 3) ประเมินสภาพแวดล้อมที่ไลเคนเติบโตได้ดีที่สุด โดยมีสมมุติฐานว่าอัตราการเติบโตของไลเคนแตกต่างกันเนื่องจากอิทธิพลของแสง การทดลองย้ายปลูก *Parmotrema tinctorum* ที่พบได้ทั่วไปในทุกระบบนิเวศ จากป่ารุ่นสอง ไปยังป่าดิบเขา ป่าดิบชื้น ป่าดิบแล้ง และ ป่ารุ่นสอง จำนวน 560 แทลลัสบนต้นไม้ 3 ชนิดในแต่ละนิเวศในเดือนตุลาคม 2546 ซึ่งพบว่าไลเคน 237 ตัวอย่างตายเนื่องจากที่อยู่อาศัยบริเวณระดับต่ำสุดของลำต้นไม่เหมาะสม ประมาณ 200 ตัวอย่างไม่มีการเติบโต การวัดอัตราการเติบโตของแทลลัสที่เติบโตได้ 116 ตัวอย่างเริ่มในเดือนมกราคม-มิถุนายน 2547 โดยพบว่าไลเคนมีอัตราการเติบโตสูงสุดเฉลี่ยคือ 0.37 มม./เดือน ในป่าดิบเขา รองลงมาคือ 0.24 มม./เดือนในป่ารุ่นสอง 0.17มม./เดือนในป่าดิบชื้น และ 0.12 มม./เดือนในป่าดิบแล้ง อัตราการเติบโตสูงสุดวัดได้ที่ป่าดิบเขาคือ 0.95 มม./เดือน อัตราต่ำสุด 0.02 มม./เดือน วัดได้ที่ป่าดิบชื้น ดิบแล้ง และ รุ่นสอง อุณหภูมิต่ำและปริมาณความชื้นสูงเป็นปัจจัยที่ทำให้ไลเคนเติบโตได้ดีที่สุดในป่าดิบเขา สภาพแวดล้อมชื้น แสงสลัว และอบอุ่น ในป่าดิบชื้นและป่าดิบแล้งชะลอการเติบโตของไลเคนลงมากกว่าครึ่งในป่าดิบชื้น และเหลือเพียงหนึ่งในสามในป่าดิบแล้งเมื่อเปรียบเทียบกับป่าดิบเขา ดังนั้นป่าดิบเขาจึงเป็นนิเวศที่เหมาะสมที่สุดในการย้ายปลูกไลเคนให้ได้ผลผลิตสูง

Abstract: Lichens have high prospects for bioactive compounds and are under investigations in present researches. However, lichens are threatened to extinction, in addition to their slow growth rates. These are the major constraints for sustainable use of lichens. The objectives of the study are: 1) to observe growth of transplant lichens in various ecosystems 2) to observe the influence of climate on growth rates of transplant lichens and 3) to assess the most favorable ecosystem for lichen growth. The hypothesis of the study is growth rate of lichens differ because of light environment. The study was performed by transplanting *Parmotrema tinctorum*, which usually grow in every ecosystem, from the Secondary forest to the Lower montain forest, the tropical rain forest, the Dry evergreen forest and with in the Secondary forest. Five hundred forty thalli were transplantation to three host trees at each ecosystem in October 2003. Two hundred and thirty seven thalli were unable to survive because of unsustainable habitat at the lowest level of the tree trunks. About two hundred thalli had no growth. Growth rates of 116 transplanted thalli were measured from January 2004 to June 2004. The highest in average growth rate of 0.37 mm/month was observed in the LMF, and subsequently lower in the SF, TRF and DEF with rates of 0.24, 0.17 and 0.12 mm/month respectively. The maximum growth rate as high as 0.95 mm/month was observed in the LMF and the minimum as low as 0.02 mm/month was observed in the TRF, DEF and SF. Low temperature with high atmospheric moisture is the most favorable factor for lichen growth in the LMF. Wet, dim and warm environment of the TRF and DEF

retarded growths of lichen to less than half and one-third of growth in the LMF. Therefore, LMF is the most appropriate ecosystem for growing lichens to achieve maximum yield.

Introduction: Lichen is important biological resource. They have natural products that are different from other higher plants, and having high potential to be used in pharmaceutical, industrial and other purposes. Thailand is rich in biological diversity of lichens. Previous study at Khao Yai National Park found more than 520 species inhabited the park (Boonpragob et al, 1998). However, lichens are extremely sensitive to air pollution, and can be efficiently used as bioindicator of air pollution. Only eight species of lichens were recorded in Bangkok (Boonpragob et al, 2003). In addition, lichens have very slow growth rates, which vary depends on climate of the habitats (Nash, 1996). Sustainable uses of lichens involve conservation of species, as well as increase productivity of lichens in natural habitats. This study was designed to compare growth rates of lichens in four ecosystems, which have different climate, in order to grow lichens for maximum yield in the future.

Methodology: The foliose lichen *Parmotrema tinctorum* (Despr. ex Nyl.) Hale was collected from the secondary forest at Khao Yai National Park. Thalli near the edges, which comprise of active growing zones, were cut into pieces of about 2-3 cm^2 for transplantation. A total of twelve host trees were selected from the Tropical rain forest (TRF), the Dry evergreen forest (DEF), the Lower Mountain forest (LMF) and the Secondary forest (SF). A total of about 560 thalli were transplanted on four aspects, North, South, East and West, of trunks at 1.5 m intervals from the bases to the canopies. Observation of lichen growth was carried on during January 2004 to June 2004 by drawing out lines of thallus on overlying transparency sheets. Photographs were also taken. Areas of individual thallus were calculated by copying the transparent sheets that have thallus boundary. Each thallus area was label around the edge in AxioVision AC Rel. 4.1, then determined the thallus areas. Averages of the areas were taken from at least three readings. Relative growth rates were calculated from

$$X = \frac{D2 - D_1}{T}$$

X = Growth rates of individual lichens (mm/month)
D_2 = Thallus diameter at the end of each observation
D_1 = Thallus diameter at the beginning of each observation
T = Number of month during observation

Result, Discussion and Conclusion: Figure 1 shows differences in the average growth rate of *Parmotrema tinctorum* transplanted in four ecosystems. The maximum and highest average growth rate were noted from the LMF. The transplanted lichen grew best in the LMF. The minimum growth rate found in the DEF TRF and SF. Relative growth rates ranged between 0.05-0.12 mm/mm/month which means that transplanted lichens grew only very slowly. In addition, the relative growth rate of lichen showed no correlation with thallus size. This is because the measurement were performed on small thalli of almost equal in size.

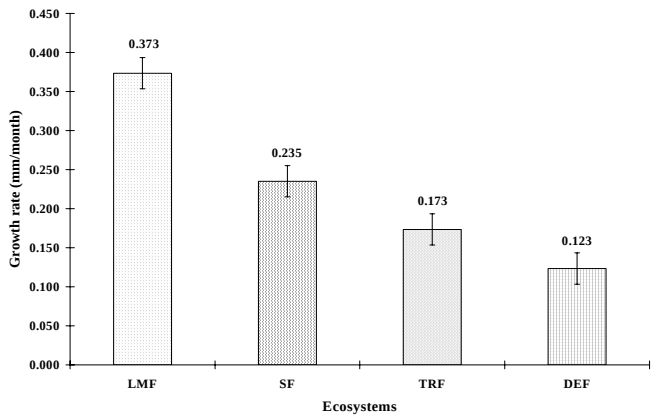

Figure.1 shows different of average growth rate of *P. tinctorum* in each ecosystem.
(LMF n=49, SF n= 26, TRF n= 17, DEF n= 9)

P. tinctorum in nature is classified as fast growing lichens, having the average growth rate at as high as 1.5 mm/month in SF (Osathanon, 2002). That relative growth rate was averaged from thalli of various sizes, which included those that were during the logarithmatic phase of growth. The thalli in this study were all small, in establishment phase, which generally has slow growth. More over, transferring may retard lichen growth rate as lichens had to adapt to new environmental conditions in the first period of transplantation. Nevertheless,

microclimate has strong influence on lichen establishment. The microclimates in four ecosystems, LMF, TRF, DEF and SF, were relatively different. Microclimates at lichen habitats revealed that average day-time temperature of the LMF was lower, which relative humidity lower then the other ecosystems. Low temperature at approximately 25 °C has positive effect on net photosynthesis of lichens (Nash, 1996). Higher temperature at about 30 °C in the TRF, DEF, and SF causes greater rate of respiration which leaves less organic matters necessary for growth. The SF which had higher average temperature higher and relative humidity lower then the other ecosystem should result in low growth rate of lichens. Nevertheless, growth rate of lichens in this ecosystem was second to the LMF. This is probably due to light environment of the tree trunk at every level were high throughout the day. Thus, temperature and moisture has the highest influence on the growth rate of lichens transplanted into various ecosystems.

Ecosystems	Growth rate (mm/month)			Relative growth rate(mm/mm/month)
	Maximum	Minimum	Mean ± SD	
LMF	0.95	0.03	0.373 ± 0.02	0.123
SF	0.6	0.02	0.235 ± 0.02	0.080
TRF	0.57	0.02	0.173 ± 0.02	0.057
DEF	0.38	0.02	0.123 ± 0.02	0.040

Table 1. Maximum, minimum and mean ± SD of growth rates, and average relative growth rates of *P. tinctorum* during January 2004 to June 2004 at Khao Yai National Park.

Temperature (°C)					
Ecosystems	Maximum	Minimum	Average		
			Day-time (6:00-18:00)	Night (18:00-5:00)	
TRF	29.7	16.9	24	20.5	
DEF	30	16	22.6	20	
LMF	29	15.7	21.6	19.4	
SF	32	19.5	26	22	
Relative humidity (%)					
	Maximum	Minimum	Morning (5:00-9:00)	Day-time (6:00-18:00)	Night (18:00-5:00)
TRF	97	65	87	78	92
DEF	99	69	93	82	94
LMF	97	69	92	84	90
SF	94	56	86	70	89
Light Intensity (μmol m^{-2} s^{-1})					
	Morning (5:00-9:00)			Day (6:00-18:00)	
	Canopy	Mid-trunk	Base	Canopy	Mid-trunk	Base
TRF	147	99	4	124	71	4
DEF	38	45	1	19	50	3
LMF	173	185	6	114	129	7
SF	39	66	62	44	76	86

Table 2 Temperature, Relative humidity and Light Intensity on microhabitats of lichens at four ecosystems during January 2004 to June 2004 at Khao Yai National Park.

Acknowledgement: We are grateful to Mr. Wetchasart Polyiam, Miss Nongyao Chaikom, Mr. Nimitr Osathanon and Mr. Prathom Ruatreaw for their assistance in fieldwork. A number of colleagues at Lichen Research Unit, Ramkhamhaeng University. We are grateful to the officers and staff at Khao Yai National Park for their kind cooperation.

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Keyword: Lichen transplantation, Microclimate, Growth rate, Ecosystem**,** Microhabitat