

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
ABSTRACT IN ENGLISH	iv
ABSTRACT IN THAI	vi
LIST OF TABLE	ix
LIST OF FIGURES	x
ABBREVIATION AND SYMBOLS	xii
CHAPTER 1 INTRODUCTION	1
CHAPTER 2 LITERATURE REVIEWS	5
CHAPTER 3 METERIALS AND METHOD	25
CHAPTER 4 RESULTS	55
CHAPTER 5 DISCUSSIONS	103
CHAPTER 6 CONCLUSION	114
REFERENCES	117
APPENDICES	127
APPENDIX A Statistical table between Mango and Bullet wood trees	128
APPENDIX B Statistical table	129
APPENDIX C Sum of lichen frequencies on 6 mango or bullet wood trees in sampling site, standard deviation (SD) and sum of all squared deviation	131
APPENDIX D Preparation of solutions for NO ₂ sampling and analysis	135
APPENDIX E Location of passive sampling sites	139
APPENDIX F Some pictures of lichens	143
APPENDIX G Recording form	144
CURRICULUM VITAE	146

LIST OF TABLES

Table		Page
3.1	The convention for classification of the air quality classes	43
4.1	List of lichen species and sum of frequencies in study areas	56
4.2	List of Diversity Index, Evenness and Richness in study areas	58
4.3	Air quality indices (AQI) and standard deviation (SD)	62
4.4	Air Quality Classes (AQC) in this study	66
4.5	Air Quality Classes (AQC) of each grid square and interpretation In Chiang Mai	66
4.6	Confine of study areas with different air quality	71
4.7	Average frequency of <i>Phyllopeltula cf. corticola</i> , <i>Hyperphyscia adglutinata</i> , <i>Pyxine cocoes</i> , <i>Lecanora</i> spp. and <i>Dirinaria picta</i> for study areas in 2011	75
4.8	Comparison of bark pH and air quality classes	84
4.9	The location of sampling sites in Chiang Mai Province	88
4.10	Linear dynamic ranges of nitrite standard	90
4.11	Absorbance of nitrite standard solution	91
4.12	Limit of detection and limit of quantification of spectrophotometer for nitrite measurement	93
4.13	Repeatability and reproducibility of spectrophotometer	94
4.14	The concentration of NO ₂ (ppbv) in each month 2012 in Chiang Mai City	95
4.15	Comparison of average concentration of NO ₂ (ppbv) in ambient air with lichen air quality class	98
4.16	The average frequency of lichen, average NO ₂ in each class and AQI values	99

LIST OF FIGURES

Figure		Page
2.1	Thallus section of foliose lichen	6
2.2	Lichen groups	
	(a) Crustose lichen	7
	(b) Foliose lichen	7
	(c) Fruticose lichen	7
3.1	Chiang Mai map	30
3.2	The study area in Chiang Mai	31
3.3	Land use type within Chiang Mai	32
3.4	Annual temperature of Chiang Mai in 2011	33
3.5	Annual relative humidity of Chiang Mai in 2011	34
3.6	Annual rain fall of Chiang Mai in 2011	34
3.7	Wind direction of Chiang Mai in 2011	35
3.8	Investigated grid square in Chiang Mai	38
3.9	The point of selected trees in each grid square in Chiang Mai	39
3.10	Grid frame on the tree trunk	40
3.11	The standard exposure scale	44
3.12	Daily temperatures during the exposure period	47
3.13	Relative humidity during the exposure period	47
3.14	Rain fall during the exposure period	48
3.15	Wind directions during the exposure period	48
3.15	(a-d) Wind directions in each month during the exposure period	49
3.16	The configuration of passive sampler	52
3.17	The protective shelter	52
4.1	Dendrogram of lichen species and average frequency	61
4.2	Exposure scale of the study area	65
4.3	Air quality map presents each grid square colored according to the AQC	70

LIST OF FIGURES (CONTINUED)

Figure	Page
4.4 Air quality map of isoline	72
4.5 Lichen species for produce lichen distribution mapping	
(a) <i>Lecanora</i> spp.	73
(b) <i>Phyllopeltula</i> cf. <i>corticola</i>	73
(c) <i>Hyperphyscia</i> <i>adglutinata</i>	73
(d) <i>Pyxine</i> <i>cocoes</i>	73
(e) <i>Dirinaria</i> <i>picta</i>	73
4.6 Distribution and average frequency of <i>Phyllopeltula</i> cf. <i>corticola</i>	78
4.7 Distribution and average frequency of <i>Hyperphyscia</i> <i>adglutinata</i>	79
4.8 Distribution and average frequency of <i>Pyxine</i> <i>cocoes</i>	80
4.9 Distribution and average frequency of <i>Lecanora</i> spp.	81
4.10 Distribution and average frequency of <i>Dirinaria</i> <i>picta</i>	82
4.11 Average of bark pH in each air quality classes	83
4.12 The direction which found the lichens in the study sites	85
4.13 The direction which found the lichens in the A and B site	85
4.14 Passive sampling positions in the study areas	87
4.15 Linear dynamic range of nitrite standard	90
4.16 Calibration curve of nitrite standard solution	92
4.17 The average of NO ₂ (ppbv) in each month with study site by direction	96
4.18 The average of NO ₂ (ppbv) each month in each Air Quality Class	97
4.19 The average frequency of lichen, average NO ₂ in each class and AQI values	100
4.20 The correlation between NO ₂ and AQI	102
4.21 The correlation between NO ₂ and pH value	102

ABBREVIATION AND SYMBOLS

Abbreviation	Meaning
NO ₂	Nitrogen dioxide
TEA	Triethanolamine
DI	De- ionized water
N	North Direction
NE	Northeast Direction
E	East Direction
SE	Southeast Direction
S	South Direction
SW	Southwest Direction
W	West Direction
NW	Northwest Direction
ANOVA	Analysis of Variance
SD	standard deviation
sp.	species (one sp.)
spp.	species (more than one sp.)
cf.	confer
<i>et al.</i>	et alii
m	meter
m ²	squaremeter
cm	centimeter
mm	millimeter
s	second
i.e.	id est (that is)
PP	Polypropylene
ppbv	part per billion volume