ECOLOGY AND CONSERVATION OF THE WHITE-HANDED GIBBON (*Hylobates lar* L.) IN A TROPICAL SEASONAL DECIDUOUS FOREST IN MAE HONG SON PROVINCE, NORTHERN THAILAND

PATHOM YIMKAO

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE
(ENVIRONMENTAL BIOLOGY)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2005

ISBN 974-04-6897-5

ECOLOGY AND CONSERVATION OF THE WHITE-HANDED GIBBON (*Hylobates lar* L.) IN A TROPICAL SEASONAL DECIDUOUS FOREST IN MAE HONG SON PROVINCE, NORTHERN THAILAND

PATHOM YIMKAO

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE
(ENVIRONMENTAL BIOLOGY)
FACULTY OF GRADUATE STUDIES
2005

ISBN 974-04-6397-5

Thesis
Entitled

ECOLOGY AND CONSERVATION OF THE WHITE-HANDED GIBBON (*Hylobates lar* L.) IN A TROPICAL SEASONAL DECIDUOUS FOREST IN MAE HONG SON PROVINCE, NORTHERN THAILAND

.....
Mr. Pathom Yimkao
Candidate

.....
Assoc.Prof. Sompoad Srikosamatara,
Ph.D.(Zoology)
Major-Advisor

.....
Prof. Warren Y. Brockelman,
Ph.D.(Zoology)
Co-Advisor

.....
Asst.Prof. John R. Milne,
Ph.D.(Entomology)
Co-Advisor

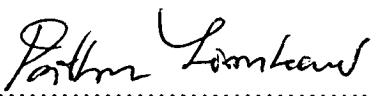
.....
Assoc.Prof. Rassmidara Hoonsawat,
Ph.D.
Dean
Faculty of Graduate Studies

.....
Assoc.Prof. Prayad Pokethitiyook,
Ph.D.(Engineering)
Chair
Master of Science Programme
in Environmental Biology
Faculty of Science

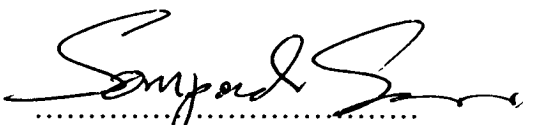
Thesis
Entitled

ECOLOGY AND CONSERVATION OF THE WHITE-HANDED GIBBON (*Hylobates lar* L.) IN A TROPICAL SEASONAL DECIDUOUS FOREST IN MAE HONG SON PROVINCE, NORTHERN THAILAND

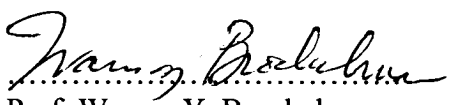
was submitted to the Faculty of Graduate Studies, Mahidol University
for the degree of Master of Science (Environmental Biology)
on
16 May, 2005



Mr. Pathom Yimkao
Candidate

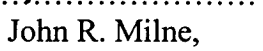


Assoc.Prof. Sompoad Srikosamatara,
Ph.D.(Zoology)
Chair

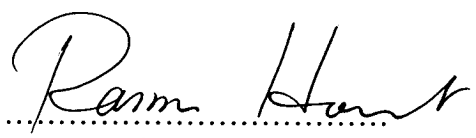


Prof. Warren Y. Brockelman,
Ph.D.(Zoology)
Member

Mr. Surapon Duangkhae,
M. Sc. (Environmental Biology)
Member



Asst.Prof. John R. Milne,
Ph.D.(Entomology)
Member



Assoc.Prof. Rassmidara Hoonsawat,
Ph.D.
Dean
Faculty of Graduate Studies
Mahidol University

Prof. Amaret Bhumiratana,
Ph.D.
Dean
Faculty of Science
Mahidol University

ACKNOWLEDGEMENTS

I acknowledge first to Assoc. Prof. Dr. Sompoad Srikosamatara, my advisor for his great teaching, guidance, and various helping throughout this study. My respect to Ajan Prof. Dr. Warren Y. Brockelman my co-advisor for his invaluable advice, and light me for my gibbon study and many subjects. My grateful respect to Asst. Prof. Dr. John R. Milne, my co-advisor, for his kindly advice and improving on my writing. Special thank to Ajan Surapon Duangkhae for his worthy advice in modern wildlife conservation in the complicated world.

- Thank Ajan J.F. Maxwell, Ajan Chirayupin Chandraprasong, Ajan Thaya Jenjittikul, P Pranee, Khun Aim, Khun Thamarat for their helping for plant identification. Grateful impression goes to Ajan Vacharobon Thirakhupt for insect identification. I must thank Ajan Seri Banpavichit giving me Ajan Sompoad's thesis.

I must thank people of Ban Muang Phaem in helping me through my field work especially my best friend and helper in the field, Arun and his wife Wanna, for their various contribution and daily climatic recording during my absence. Great thank to their parents in helping me a lot for my field work and providing me various type of special food and safe places for my long staying. I also thank my young friends in Room 505 Tao, Aon, Ton, Tae, for being as my friend for half a decade in this great institute. I am very grateful to all people in the Department of Biology in their various help. I would like to acknowledge to Chief Suwit Naosawad and Chief Suwit Kawpiyarat and all staffs of San Pan Daen and Lum Nam Pai WS for their help in my staying in the field. Special thank to Jaree, the most important in the beginning, for her help in vegetation study, and spiritual discussion on human education. Thank Paul and Piyarat Martins for their help and encouraging.

Most of the good thing I did I proudly dedicated this study to my father who always stay in my soul. Beyond every thing I thank my mother for my life and all her unconditional supports. Lastly, I please and acknowledge invaluable the nature providing me every need on the planet. This work was supported by the TRF/BIOTEC Special Program for Biodiversity Research and Training grant T_347005.

Pathom Yimkao

ECOLOGY AND CONSERVATION OF THE WHITE-HANDED GIBBON (*Hylobates lar* L.) IN A TROPICAL SEASONAL DECIDUOUS FOREST IN MAE HONG SON PROVINCE, NORTHERN THAILAND

PATHOM YIMKAO 4336690 SCEB/M

M.Sc. (ENVIRONMENTAL BIOLOGY)

THESIS ADVISOR: SOMPOAD SRIKOSAMATARA, Ph.D. (ZOOLOGY), WARREN Y. BROCKELMAN, Ph.D. (ZOOLOGY), JOHN R. MILNE, Ph.D. (ENTOMOLOGY), SURAPON DUANGKHAE, M.Sc. (ENVIRONMENTAL BIOLOGY)

ABSTRACT

This field study focused on the 1) distribution, 2) ranging, feeding and singing behaviour, and 3) habitat structure, of the white-handed gibbon (*H. lar*) in a tropical seasonal deciduous forest in Muang Phaem Forest, and 4) human impacts on gibbons and 5) the role of villagers and park staff in gibbon conservation. The study was conducted from 26 February, 2004 to 26 February, 2005. About 87 individuals in six separate populations of gibbons in Nam Lang basin were confirmed. Most gibbons inhabited preserved and community forest nearby Karen villages. At least 3 gibbons died during the study due to hunting. The main study group (G1) ranged within about 40-61 ha of deciduous and bamboo forest with an average height of 23.50 m, ranging from 2-42 m (SD= ±9.99) (n=264) and average dbh of 34.5 cm, ranging from 10-165.5 cm (SD= ±23.55) (n=381).

Group G1 spent most time around forest cliff sites, for rest, play, sleep and shelter. Sometimes they visited pine-deciduous dipterocarp forest searching for food and singing. Bamboo was frequently used by the group as a food source, sleeping place and travelling route. Annual rainfall of 1,598 mm was recorded during the study. Minimum and maximum temperature in the main study site ranged from 6-42 degrees Celsius. Group G1 was observed to feed on 29 species of plants. Eight other species have strong evidence of being eaten by the gibbons. Thirteen species also recorded as being eaten by the gibbon in other studies were present in the G1 home range. Nine species are classified as potential food using local knowledge. Starting times of the first call (duet) of group G1 ranged from 06:47-10:45 h, but mostly from 07:45-08:15 h (13 times), 08:45-09:15 h (11 times) and 10:00-10:45 h (12 time) (n=61) during the whole study period. All groups started calling later in winter. Among 3 ethnics groups including Karen, Lahu and Thai Yai (Shan), Karen showed that their culture and tradition play a significant role in the survival of the gibbons, and it is hoped to initiate gibbon conservation work in Muang Phaem Forest and surrounding areas with Karen people. The role of wildlife sanctuaries in continuous wildlife protection during the study period was unfortunately interrupted due mainly to the transfer of the chief. Co-management between stakeholders and networking as site-based actions are suggested and considered necessary for gibbon conservation.

KEY WORDS: WHITE-HANDED GIBBON/ MAE HONG SON/ CONSERVATION/ TROPICAL DECIDUOUS FOREST/ KAREN.

149 P. ISBN 974-04-6397-5

นิเวศวิทยาและการอนุรักษ์ชะนีมือขาว (*Hylobates lar* L.) ในป่าผลัดใบเขตร้อน จังหวัดแม่ฮ่องสอน

(ECOLOGY AND CONSERVATION OF THE WHITE-HANDED GIBBON (*Hylobates lar* L.) IN A TROPICAL SEASONAL DECIDUOUS FOREST, IN MAE HONG SON PROVINCE, NORTERN THAILAND)

ปฐม ยิ้มขาว 4336690 SCEB/M

วท.ม. (ชีววิทยาสภาวะแวดล้อม)

คณะกรรมการควบคุมวิทยานิพนธ์ : สมโภชน์ ศรีโกสามาตร, Ph.D., วรเรณ บรอคเคลแมน, Ph.D., จอห์น มิลน์, Ph.D.

บทคัดย่อ

การศึกษานี้ครอบคลุมเรื่อง 1) การกระจายและขนาดประชากรของชะนีมือขาว (*H. lar*) 2) พฤติกรรมการใช้พื้นที่ การกิน และการร้อง ในป่าผลัดใบและป่าไผ่บ้านเมืองแพม 3) พืชอาหารและโครงสร้างถิ่นอาศัย 4) กิจกรรมของมนุษย์ที่ส่งผลกระทบต่อชะนีและ 5) การมีส่วนร่วมของชาวบ้านและเจ้าหน้าที่เขตรักษาพันธุ์สัตว์ป่าในการอนุรักษ์ชะนี โดยได้ทำการศึกษาในระหว่างเดือนกุมภาพันธ์ 2547 - กุมภาพันธ์ 2548 ในเบื้องต้นสามารถยืนยันได้ว่ามีชะนีอย่างน้อย 87 ตัว จาก 6 ประชากร กระจายอยู่ตามหย่อมป่าในบริเวณลุ่มน้ำลาง ซึ่งส่วนใหญ่อาศัยอยู่ในเขตป่าอนุรักษ์และป่าชุมชนใกล้หมู่บ้านชาวกะเหรี่ยง ระหว่างทำการศึกษามีชะนี 3 ตัวถูกล่า กลุ่มศึกษาหลัก (G1) ใช้พื้นที่ป่าใช้สอยกึ่งอนุรักษ์ขนาด 40-61 เฮกแตร์ ซึ่งมีความสูงเฉลี่ยของเรือนยอด 23.50 เมตร (2-42) (SD=23.55, n=264) และมีเส้นผ่าศูนย์กลางเฉลี่ยของต้นไม้ที่ระดับอก 34.5 เซนติเมตร (10-165.5) (SD=23.55, n=381)

กลุ่ม G1 ใช้พื้นที่บริเวณเชิงผาค่อนข้างบ่อยเพื่อการพักผ่อน เล่น นอน และหลบภัย บางครั้งจะเข้าไปใช้พื้นที่บริเวณชายขอบป่าเต็งรังผสมสนเพื่อหาอาหารและร้องประกาศอาณาเขต ตลอดช่วงเวลาการศึกษา วัดปริมาณน้ำฝนได้ 1,598 มิลลิเมตร อุณหภูมิต่ำสุดสูงสุดอยู่ระหว่าง 6-42 องศาเซลเซียส พบพืชอาหารชะนี ในอาณาเขตของกลุ่ม G1 อย่างน้อย 57 ชนิด จาก 25 วงศ์ พบเห็นขณะกิน 29 ชนิด (ไทร 10 ชนิด) วิเคราะห์จากร่องรอยบ่งบอกการกิน 8 ชนิด อ้างถึงพืชอาหารของชะนีในการศึกษาอื่นๆ 13 ชนิด และ จากประสบการณ์ความรู้ของชาวบ้าน 9 ชนิด ชะนีกลุ่ม G1 เริ่มส่งเสียงร้องตั้งแต่ 06:47-10:45 น. โดยเริ่มร้องบ่อยที่สุดในระหว่าง 07:45-08.15 น. (13 ครั้ง) 08:45-09:15 น. (11 ครั้ง) 10:00-10:45 น. (12 ครั้ง) (n=61) ในฤดูหนาวชะนีแต่ละกลุ่มจะเริ่มร้องช้ากว่าในฤดูร้อนและฤดูฝน จากการศึกษากิจกรรมการใช้ประโยชน์จากป่าของ 3 ชาติพันธุ์ คือกะเหรี่ยง มูเซอ และไทยใหญ่ (ฉาน) พบว่ากะเหรี่ยงมีบทบาทสำคัญต่อการอยู่รอดของชะนีเป็นอันดับแรกและเด่นชัดและมีความเป็นไปได้ในการฟื้นฟูและการอนุรักษ์ชะนีในพื้นที่ป่าเมืองแพมและป่ารอบๆ การโยกย้ายหัวหน้าเขตรักษาพันธุ์ฯส่งผลกระทบอย่างมากต่อความต่อเนื่องของบทบาทในการอนุรักษ์ถิ่นอาศัยของสัตว์ป่าเมื่อเทียบกับในระยะแรกของการจัดตั้งเขตรักษาพันธุ์ฯ ปฏิบัติการณ์ในพื้นที่เพื่อให้เกิดข้อตกลงและการจัดการในการใช้ทรัพยากรธรรมชาติร่วมกันระหว่างชาติพันธุ์ต่างๆในลักษณะของเครือข่ายโดยมีเจ้าหน้าที่เขตรักษาพันธุ์ฯและเจ้าหน้าที่ฝ่ายปกครองส่วนท้องถิ่นให้ความร่วมมือและสนับสนุนจำเป็นอย่างยิ่งต่อการอนุรักษ์ชะนี

149 หน้า. ISBN 974-04-6397-5

CONTENTS

CONTENTS (Continuous)

CONTENTS (Continuous)

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

LIST OF MAPS

Maps **Page**

LIST OF PLATES

"At that moment, his eyes latched on to the mother with clinging young, trying to stop her blood flowing incessantly out from her slim body. Stretching out her white hand to the nearest leaves, she applied them to the tiny wound, it was the only thing she could do at the time. Seeing this, the man, the self witness, had wider eyes while the innocent little ape showed greater wonder. At the last moment, the mother decided to put her baby on the branch a second before her body fell from view of both baby and hunter. From that day, he never hunted the gibbons any more" said the people.

A story from Mae Hong Son

CHAPTER I
INTRODUCTION

Globally, although white-handed gibbon (*Hylobates lar*) is not categorized as one of critical endangered or endangered species, but, locally, especially in fragmented habitats throughout Thailand (which is the largest white-handed gibbon distribution areas), many populations are now facing extinction. Only the survey of Srikosamatara et al., (1999) documented a fragmented populations of white-handed gibbons distributed in Nam Lang and Nam Khong river (upper Pai river basin) which feed the land it run through including some area of Lum Nam Pai, San Pan Daen Wildlife Sanctuaries (LNPWS, SPDWS) and vast area of cultivated fields of about 60 villages of 9 ethnic minorities who have occupied and distributed within the area for more than 3 centuries (Srikosamatara et al., 1999). Till now few populations of gibbon in the area have been confirmed while their number are decreasing moderately by hunting (mostly by opportunistic hunting) and habitat loss through illegal logging and land clearing for cropping performed by diverse hill tribes, especially Lahu Nyi, Lisu, Thai Yai, Shan people and Karen. Among those highland people, Karen are known to have less impact on gibbon since they still obey prohibition or taboos against hunting and eating of gibbon while the other hill people seem to have lose those kinds of traditions and beliefs. In the beginning, Karen communities have a strong influence on the existing of gibbons both in protected areas and community reserved forest, but since the past decade those protections have shown weak. During my preliminary survey in May 2002 and April-June 2003, the occurrence of 2 isolated populations of 3 and 4 groups in Muang Phaem Forest (Karen) and only 1 population of 2 groups (vocalization survey) in Ban Huai Nam Pong Forest (Lua) have been confirmed. Both populations inhabit small patch of forest which at first it seems difficult for them to survive. Up to now, just a few studies had been conducted in the area and no conservation activities had been initiated before.

Ban Muang Phaem community, although it has long been exposed and in contact with the outside world for more than 40 years (has moved from Pai district), still relies mostly on natural resources for subsistence. However, at present, the methods, the directions, and rate of natural resources exploitation of Karen and the others hill tribes have been changed in high degree in opposite way. Most ethnic groups in the area have changed their own ways inherited from the ancestors. Their wisdom to living harmony with the nature and exploitation of natural resources have been abandoned and gradually losted. Only a little part of their traditional knowledge and beliefs adopted from ancestors have influenced in preserving the ecosystem, which they ever and always used. Karen people, once considered as the greatest conservationists in this region, are now not the same. There are many signals that show the weakness of their ability to maintain their traditional practice in sustainable ways. Note that, only a few wildlife species are still prohibited for hunting and eating, including gibbons and great hornbills. Lahu Nyi especially Bala Lahu (Christ Lahu) who were formerly hunter-gatherers in this area, now practice unlimited slash and burn cultivation in the area around their villages without any rules of conservation. This has resulted in fragmentation of gibbon habitats. Moreover, in the past and even now, some government polices concerning national poverty reduction and rural development programs and nature-tour (such as elephant riding) leading to great degradation of the remaining forests of the gibbon in many villages in Mae Hong Son.

Although the white-handed gibbon is considered as the most well-studied species among the 12 species of the Hylobatidae, in many details, especially in different habitats, there are some aspects still poorly known. Even in long-term and intensive study areas of gibbon, in Khao Yai National Park (KYNP), theoretically, there are some aspects still unclear both in their ecology and social system (Brockelman, in press). In Mae Hong Son, where the gibbon inhabited a dry forest which is home to 9 ethnic minorities of about 60 villages (Srikosamatara et al., 1999), there has been no study conducted while the population is decreasing every year. This is the main justification for this study. However, there are many differences between Mae Hong Son and KYNP and other well protected study areas, especially in terms of human impact and conservation.

At the present time, in Thailand's protected forests, there are gibbons living, but very little research documentation and conservation actions have been done. Their recent status and distribution data are still unknown and waiting to be investigated. There was no any formal management plan in the country for all species of gibbons occurred in Thailand both in the Zoo and wild populations (Tilson et al., 1993). Then in April 1994, a special workshop on the topic of "Thai gibbon population and habitat viability analysis" (PHVA) was conducted in order to define the gibbons conservation status and to produce conservation strategy for this lesser ape both in the wild and in captivity. However, the workshop although considered as one of the good effort with a lot of expertise participation, but many topics concerning natural populations, need deeper analysis (Brockelman, 1994). Except for the PHVA workshops, there have been scattered efforts made for future gibbon conservation plans in the country. Therefore, intensive study and dedicated work on gibbons both in the wild and in captivity (especially in the natural habitat) are needed in order to encourage more conservation efforts. Necessarily, dedicated staffs team-work and networking for monitoring the gibbons are priority needs.

At the international level, there have been a number of conservation discussion such as the symposium on "Gibbon Diversity and Conservation" held at the 19th Congress of the International Primatological Society on September 2002, some resolutions for the gibbons from participants were proposed (Geissmann, 2003). For IUCN, species survival had played a role worldwide but lack of field monitoring and investigation has been carried out especially in their endemic habitat in South East Asia.

From the reasons above, intensive study of White-handed gibbon in Muang Phaem forest has been started during late April to end of June, 2003 in order to provide basic information. Study of distribution, group density, habitat structure, threats to the gibbons with strong emphasis on food plants and ranging in that area of Muang Phaem forest was initiated. Local participation was designed to enhance integration of local knowledge and modern knowledge of ecology in conservation. Hopefully, after this study, better protection and monitoring of this population of the gibbons and perhaps others wildlife species, can be carried out by local people

themselves in order to involve in wildlife management program which once use to exist among Karen (in terms of their spiritual and traditional way).

This study scopes mainly on the conservation status of the gibbons and risk factors influencing their survival in the area. Habitat structure and its qualities, conservation status of gibbon population in Nam Lang basin was the main target. For behavioral data had also been concerned. Analyzing how local activities influencing gibbon survival and the quality of their habitat are basic topics of investigation.

Ecologically, although the gibbons have a significant meaning to sustain the forest they live as critical seed disperser, possibly for some rare species that need feeding strategy of the gibbon (Brockelman, in press), but the lack of knowledge of this kind of ecological services of the gibbon are of little concern among the villagers and the rest of the people. So, community-based ecological study for rural education and conservation programs are needed. I do not hope that my study could be only an attempt to understand more about the extinction process caused by us, but I hope knowledge-based development programs of sustainable use in these areas can be established using the results of this study. Furthermore, if necessary, reintroduction of captive populations in to some place that we have habitat information may be one of the potential future projects for this area.

Beside consumerism and globalization trend, wildlife extinction is on the way. So people's awareness these trend is needed. Education, especially on ecological science, is important because it may shape hill tribe's knowledge which now cannot function to sustain the local ecosystem any longer. Finally I hope that, gibbon and wildlife conservation based on field ecological information combined with local wisdoms, will be achieved as fast as possible and provide us some tools to save human society (as one) from the effect of ecological failure in the future. Lastly, under the umbrella of the gibbon, the rest of wildlife can be protected too.

Objectives

1. To estimate population and define the conservation status and distribution of white-handed gibbon in a selected area of Nam Lang basin, San Pan Daen and Lum Nam Pai Wildlife Sanctuaries.
2. To study ranging, feeding, singing and human defensive behavior of selected groups of white-handed gibbons (*H. lar*) in a Tropical Seasonal Deciduous Forest of Ban Muang Phaem village.
3. To study subsistence activities of Karen and its impacts on white-handed gibbon populations.
4. To study the vegetation of gibbon habitat including forest structure, food plants and their phenology in the home ranges of the main study group in Muang Phaem Forest.
5. To promote participation of sanctuary staff and villagers in some parts of the study.

CHAPTER II
LITERATURE REVIEW

2.1 Populations of white-handed gibbon in Thailand

Brockelman (1975) reported the range of white-handed gibbon (*Hylobes lar*) in the South, West and most of the Northern region of Thailand. One of the largest intact forest in Thailand for the gibbons was in Ranong, Phang-nga and Surat Thani provinces which covered as area about 5,000 sq km. After that documentation, there have no clear data on population of white-handed gibbon in their distribution areas in the country except in Khao Yai National Park (KYNP), which is home to an estimated 3,000 individuals, most of them inhabiting the well protected forest of the park close to the park headquarters and adjacent area with pileated gibbon (*H. pileatus*), the neighboring related species (Brockelman personal communication).

One family group of *H. lar* normally consists of 2-6 individuals (Carpenter, 1940). In well protected part of KYNP such as the Mo Singto long term study site, group density reach to 5 group/1km^2 (Brockelman et al., 1998). Some areas protected and remote from human settlement core area may contain as much as 4 groups/km^2, but in the area that hunting has occurred it contain 1 group or less/km^2 (Brockelman & Srikosamatara, 1993). The density of gibbon population in Thung Yai Naresuan (TYNWS) is 2.1/km^2 over all and 4.1/km^2 in Dry Evergreen Forest (Steinmetz & Mather, 1996). The healthy populations of the gibbon in the country clearly known are in KYNP. Considering from intact and area size of the forest, Kaeng Kra Chan Wildlife Sanctuary (KKCWS) and Huai Kha Khaeng Wildlife Sanctuary (HKKWS) probably a potential habitat for large gibbon population at the present, but, however, there have poor information on these areas. Tilson et al., (1993), Brockelman (1994), (PHVA workshop) summarized that the population of *H. lar* in Thailand was about 110,000 individuals in the total area of about 17,000 km^2. Most populations were small and only few large viable populations remain.

2.2 Distribution and habitats

H. lar is commonly found in Evergreen and Mixed Deciduous Forests throughout Thailand except for the southeast, and sometimes on the edges of Deciduous Forest (Marshall et al., 1972). Brockelman (1975) reported that gibbons occur in 75,000 km^2 of remaining forest habitat in geographical range in Thailand where forest regeneration does not happen except on slopes or isolated or other unsuitable site for permanent settlement.

The wildlife survey done by Srikosamatara and team (1999) showed the existence of *H. lar* in forest around 50 villages out of 60 villages in Lum Nam Pai and San Pan Daen Wildlife Sanctuaries, which cover an area of 1,181 and 277 km^2, respectively. Gibbons are found mostly in Karen settlement area in widely scattered and isolated populations. The forests of both sanctuaries seem to have some limiting factors for gibbon to maintain and sustain their populations, especially, ecological factors such as, drought (annual rainfall less than 1,500 mm.), dry forest with annual forest fires, food limitation, and fragmentation of the habitats. Both sanctuaries covered mainly by Tropical Mixed Deciduous Forest, Deciduous Dipterocarp Forest and Pine-Deciduous Dipterocarp Forest. (Suntisuk, 1988). There was no detailed study on ecology and conservation status in such dry habitats. The study of Suwannakerd (2001) explain that the study group of *H. lar* at Tham Nam Lod Wildlife Conservation Development and Extension Center live in as area which covered by Mixed Deciduous Forest, Dry Evergreen Forest and Dry Dipterocarp Forest.

White-handed gibbon distributed widely in Thailand, mostly in less disturbed Tropical Evergreen and less seasonal part of Semi-evergreen Forest (Brockelman, 1975). Chivers (1977) summarized that this species can be found over most of Thailand, Peninsula Malaysia, on the west and northern Sumatra. In peninsular Malaysia the gibbons inhabit Lowland rainforest, Submontane Rain forest and Montane forest and most of them inhabit lowland rain forest (Ellefson, 1974). In Thailand, most of the gibbons inhabit protected forests in which are free from human encroachment. In KYNP, a nearly thousand of them living in the evergreen forest in the core area of the park (Brockelman personal communication). In HKKWS gibbons live in Dry Evergreen, Mixed Deciduous and Dry Dipterocarp Forest (Chivers, 1985).

Bhumpakphan, (1988). reported that gibbons inhabit mostly the Dry Evergreen Forest, which has about 70-85% canopy cover. However, some newly formed groups were found in Deciduous Forest, especially in the rainy season. Except for the pioneer study of gibbon by Carpenter (1940) in Doi Chiang Dao where the very first study of gibbons has been done, only few groups calls were reported in April 1998 in that area by P. D. Round (Round personal communication). For southern forest complex, for example, Khlong Saeng Wildlife Sanctuary (KSWS) (1,156 km^2), existence of white-handed gibbon has been reported (my preliminary survey, 2001), but there have been no recent intensive study in the area. The eastern forest complex, in the range of the pileated gibbon of Khao Soi Dao Wildlife Sanctuary (KSDWS) (745 km^2), Khao Khitchakut National Park (59 km^2) and Khao Ang Ru Nai Wildlife Sanctuary (1,030 km^2), have not been recently surveyed.

2.3 Home range

In Doi Chiang Dao, Chiang Mai, home range of the white-handed gibbon possibly range from 30-50 ha (Carpenter, 1940). The well studied group in KYNP, travel within an area of about 15-50 ha which they prevent from another group (Brockelman et al., 1998). In HKKWS they spent a year within the 30-50 ha of undisturbed Mixed Deciduous Forest. Area used by the gibbons in a dry and wet season is different (Bhumpakphan, 1988). The study of Muangkhum (2001) at HKKWS concluded that the study group used 11-15 ha depend on season. Suwannakerd (2001) reported the single study group which structured by released male and widows with her young at Tam Nam Lod Wildlife Conservation development and Extension Center, ranged in an area of about 8-10 ha during summer.

2.4 Reproduction

Both sex of gibbon reach their reproductive age when they are about 8 years or more (Brockelman et al., 1998). Female cycle is about few months (Ellefson, 1974) Gestation period of *H. lar* is 7 months (Leighton, 1987), and one female can give only one offspring on average every 3-4 years, and has to care for her young till they grow enough to travel, forage and escape from all the dangers by themselves. One female

gibbon (Andromeda) in KYNP is about 30 years after giving 5 young (2 of them survived till reach to reproducing adult) (Brockelman personal communication).

2.5 Maturation

Most of the gibbon in KYNP became adult when they are about 8 years and spend longer time with the parent group. This age is older than commonly assumed for both wild population and in captive (Brockelman et al., 1998). When the male become adult they will be excluded from the group by adult male while the subadult female will be forced out by adult female (Ellefson 1974). Suwanvecho (1997) concluded that subadult males and females are not excluded by their parents because they still have important function for the group such as to play with the baby or for territory defense. The delaying of exclusion of the premature male by adult male is probably the need of territory defense more effective and to reduce the chance to be replaced by adult male from other groups (Brockelman et al., 1998). Chivers, (2000) summary that, adult male may help his maturing offspring establishing neighboring territory. Death may allow inheritance of the natal territory.

2.6 Status and conservation of wild gibbons in Thailand

Although *H. lar* are considered as the most widespread and abundant among the family of Hylobatidae in South East Asia, and are not currently included in those of 96 critically endanger primate species (Chapman & Peres, 2001) but in local population they may face extinction within a short future.

Only vigorous protection of large area of forest from longing and hunting for saving adequate population (Brockelman, 1975).

Since Brockelman (1975) reported that the greatest threat to their future survival in the kingdom is deforestation, this makes most populations fragmented into small isolated remnants of habitat. To keep significant numbers of gibbons in Thailand we have to make many more people who have conservational-minded and achieve a spectacular reversal of the forces which cause gibbon population decrease rapidly. From that time, there has been no effort following Brockelman (1975) information in term of conservation. The rate of populations decline varied among forest areas, according to local practices and needs (Brockelman & Chivers, 1984).

After that there has been no any other systematic study and estimation of population stats.

A study of primate community in Phu Khieo Wildlife Sanctuary, Northeast, Thailand, documented a high frequency of white-handed gibbon seen in a Dry Evergreen Forest, but detailed study has not yet been done (Borries et al., 2002).

2.7 Behavior

Traveling and ranging

Gibbon may travel 1,600-1,800 m a day within the territory that covers about 35-40 acres (Carpenter, 1940). Chivers (1984) summarized that most of small size rain forest gibbons ranged between 1,300-1,700 m in a day, except *H. pileatus* travel only about 850 m daily. The study of Reichard (1991) and Nettelbeck (1993) in KYNP found that gibbons travel about 850-1200 m depend on group and seasons. Day ranging behavior should be studied in all months because food source and range use change month by month (Brockelman, unpublished data). Home range of the gibbon has been recorded as 16-32 ha for *H. lar* in evergreen forest (Carpenter, 1940), 40 ha for *H. lar* in low land rain forest (Ellefson, 1974), 29 ha for agile gibbon (*H. agilis*) in low land Tropical Rainforest (Gittins, 1982), 10 ha for one isolated group of white-handed gibbon in a Mixed Deciduous and Dry Evergreen Forest (Suwannakerd, 2001). Gibbon travels in 11.48 ha in evergreen part and 15.88 in deciduous part of the study site in HKKWS (Muangkhum, 2001). In the wild habitat, *H. lar* occupied home range of about 60 ha, and the size of the home range can increase or decrease depending on hunting and on clearing of the surrounding forest (Raemaekers, 1984).

Gibbons are sensational acrobats, moving mostly by swinging with their arms (Brockelman, 1975). The gibbon can move very fast if necessary and impossible to be followed (Carpenter, 1940). Ellefson (1974) concluded that, they seem to use the most facility route, especially when alternative route seem more difficult.

Feeding and diet

H. lar at Doi Intanon have feeding peak two times a day during 06:15-07:00 and 13:30-14:00 (Carpenter, 1940). Their feeding bouts last 30 min on average and

contain 5 bouts per day. Proportion of feeding to all daily activities is slightly more than 25 % (Ellefson, 1974). From the study of *H. lar* in HKKWS, the first feeding bout start at 06:15-07:00, but in some situation they start their first feeding bout later and stop around 09:30 (Carpenter, 1940, Bhumpakphan, 1988). They usually spent lesser time for a second bout (Bhumpakphan, 1988). Like *H. agilis* and other small apes, *H. lar* can feed on the terminal branch or twigs of the food trees (Gittins, 1983). *H. lar* feed mainly on fruits, leaves and sometimes on insect and bird eggs (Brockelman, 1975) but mostly on fruit (Carpenter, 1940, Ellefson 1974, Bhumpakphan, 1988, Kanwatanakid, 2000 Suwannakerd, 2001). Palombit (1997) reported that both *H. lar* and *H. syndactylus* siamang were intensively frugivorous, but siamang was more folivorous than the *H. lar*. The study group in Doi Chiang Dao usually choose the ripe fruit (Carpenter, 1940, Ellefson, 1974, Bhumpakphan, 1988, Kanwatanakid, 2000), but in Mo Singto study site KYNP, the gibbons choose unripe fruits also (Whitington & Treesucon, 1991). Sometimes they eat a new shoots of fern (Ellefson, 1974). From stomach contents it was found that the gibbons sometimes eat nestling (Carpenter, 1940). Carpenter rated relative important of 12 fruits eaten by gibbon. The main food plants according to Carpenter (4 months study) consist of for example, *Ficus* spp, *Polyalthia cunonaceae*, *Knema corticosa*. . Experiments on food size selection in captive animal at Doi Chiang Dao showed that gibbon selected the largest fruit (Carpenter, 1940). From the study of Bhumpakphan (1988) in HKKWS, 53 species of food plants were recorded and most of them (79%) were tree fruits. In Mo Singto study site in KYNP, the main food for white-handed gibbon is also fruit (73.5 % of plant diet) (Kanwatanakid, 2000), and figs are the most significant food plant of their diet (Whitington & Treesucon, 1991). Suwanvecho (2003) concluded that in Klong Sai study site, KYNP, both *H. pileatus* and *H. lar* dependent highly of fig and non fig. *H. lar* in Tham Nam Lod, Pang Ma Pa, Mae Hong Son, consumed at least 40 species of food plants of 23 families. More species of fruits were eaten during the rainy season compared to a dry season (Suwannakerd, 2001). The reason explained preference to fig are a larger food source and fast energy source. As *H. syndactylus*, *H. lar* feed on fig first in early morning and at last in the evening before go to sleeping tree, possibly because they avoid competition with another fruit-eating animals (Raemaekers, 1978). Unquestionably, the main and basic fruit for wild gibbons are

Ficus spp. In all of their habitats of the country, diverse of *Ficus* spp were found as a major food for gibbon through out a year, but the proportion in gibbon diet of various types of habitats requires more investigation.

Vocalization

- Some basic note shapes (see Raemaekers et al., 1984)

1 A *wa* is the simplest and commonest note which short, steeply rising note of straight or slightly concave of 0.1-0.8 kHz produced by both sex.

2. A sharp *wow* is the note that rises steeply to high pitch before inflects sharply to fall in an equally steep concavely. This note is produced by adult male and sub adult male.

3. An *oo* is mainly a female note produced in an introductory sequence of duet. The male produce also it any time.

4. An *ooaa* is J-shaped note produced by single animal and by all the members of the group. *Ooaa* duet is highly infectious and stimulate other groups to respond by this call (Raemaekers & Raemaekers, 1984).

- Definitions of some structured phrases

1. Great call: Great call equal to Carpenter's type 1 call and restricted to female. This call last about 12-22 seconds and contain 6-13 notes with invariable two humped shape that rises from 0.4-0.6 kHz to first peak of 0.8-1.2 kHz then falls to 0.4-0.6 kHz before rises to a second peak of 1.3-1.6 kHz (climax) and falls again to 0.4 kHz.

2. Male solo: Male solo is given earlier than other calls. (begin at first light or before dawn). Male solo are given from night tree in territory. Starting time peak is 05.30-06.00. Solo are give by both adult and subadult male but most by subadult male. Subadult call bouts last on average about 45 min while about 25 min in adult.

3. Male quaver: This phase is sex- and species -specific (produced by male) and it is quite variable and was divided in to 4 types.

4. Duet: Duet comprised of 3 types of sequences.

- Introductory; last an average 2 min consist of unbroken rhythmical delivery of *oos*, *wa-oos*, leaning *was*, and *was* produced by either sex.

- Great call; of female with or without answering the last phrase of the end of male song (male coda). It start by low *was* forming a *lead-in* to warn her mate not to make a call.

- Interlude; Ellefson's refractory period or whatever occurs between great calls and after last great call sequence. Haimoff (1981) described it as organizing sequence (preparation for the next great call). This sequence is the most variable.

- Calling time

Gibbon have been known for about 60 years to produce calls once or twice a day in the morning (05:30-09:00) and sometime but rarely in the afternoon (Carpenter, 1940). At Doi Intanon, morning calls reach to the peak at 08:30-09:00 h while it was around 07:30-08.00 h at Doi Chiang Dao, in summer time. Gibbons at Doi Chiang Dao produced 5-24 calls per day, showing a great variation in each day (Carpenter, 1940). The result from my preliminary study in Ban Muang Phaem forest, SPWS, during April-June 2003, showed that the gibbon started calling (mostly group duets by adult male and female) at about 08:00 h (05:57-12:02) (n=34) and end about 08:13 h (07:35-12:10) (n=25). For densely-populated gibbon areas with many gibbon groups, gibbon duets and loud calls are more likely to response to neighboring groups than non-neighboring group (Raemaekers & Raemaekers, 1985), but in small and low density populations in various habitats, it is interesting to know if frequencies of duets or loud calls between groups are different. Temperature, light and weather influence to morning call and they will call late when it cold and foggy (Carpenter, 1940). Although gibbon vocalization has been studied for many years by many people throughout Southeast Asia and knowledge on these has been accumulated, but, however, pattern and the significant meaning of same type of calls in a given time of different condition need more studies.

2.8 Social system

Gibbons are generally considered to be monogamous lesser ape and live in family group of relatively few individuals. *H. lar* maintain their monogamy group of 2-6 individuals (Carpenter 1940, Ellefson 1974, Bhumpakphan, 1988). The theories of baby raising and territory defense are the two main reasons given for the maintaining

of monogamy. For male gibbon, monogamy increase the chance of transmission of his gene to the offspring. However, it was found that one group of pileated gibbon *(H. pileatus)* are not restricted to pair-bonding of monogamous family as we accepted before (Srikosamatara, 1980, Srikosamatara & Brockelman 1987). Palombit (1994) reported that gibbon pair bonds are not life-long but adult may leave their mates sometimes for new reproductive opportunity. In addition, the study of mated-pair system in white-handed gibbon in KYNP by Reichard, (1995) found that the gibbon social system is more flexible than previously thought, the gibbon are not real monogamous. The social pattern among them has been found to be different from that in earlier studies (Brockelman et al., 1998). Fuentes (2000) concluded that inter-group influence intra-group relation. So, to understand gibbon intra-group inter-relation, we have to study inter-relation between groups. However, social system of gibbons has not been completely explained (Brockelman, in press).

2.9 Gibbon studies

From the first study of gibbon (*H. lar*) in 1937 by Carpenter, and many other studies of different species of gibbons, such as the study of *H. lar* by Ellefson (1974) in peninsular Malaysia, first study of *H. syndactylus* during 1966-1970 in Malaysian by Chivers and his colleagues, the view of knowledge about gibbon behavior and social organization had been changed. Most of the studies have been conducted in KYNP. Long-term study in KYNP has been conducted to explain gibbon ecology and behavior and their interaction with plants. However, unknown data about gibbon remain, especially in various habitats and climate particularly in Thailand had rarely been studied. The study of the ecology and behavior of black-crested gibbon (*Hylobates concolor*) in Yunnan, China by Chen (1995) showed a new specific data for this species which inhabiting in the habitats that different from another species. The result from his study provided us new ecological and behavioral knowledge in extreme climate of black-crested gibbon. For the study of white-handed gibbon in HKKWS by Bhumpakphan (1988) and Muangkhum (2001) also provide us the more information on food and social behavior of the isolated study group of white-handed gibbon in some area of Dry Deciduous Forest. For LNPWS and SPDWS are considered as the different habitats for white-handed gibbon compared to others study

area in the country. Therefore, research on gibbon in these areas can provide important data that can be used for comparison with other studies that conducted in other habitats such as KYNP (1980-present), KSDWS (1981) and HKKWS (1988 and 2001). The study in Tham Lod conducted by Suwannakerd (2001) had earned some information on isolated new form group of captive male and the group with widow in the small fragmented habitat. Studies of gibbons in Thailand were presented in Table 2.1.

In the past we use a large number of primate species including the gibbons for medical research and anthropology studies. More than 48 species had been used by many US medical research institutes 30 years ago (Goodwin & Augustine, 1975). At present, some of them had been extincted, while most of them are rare and threatened and close to extinction from their natural habitats. In KSDWS, Srikosamatara (1980, 1984) had studied the ecology of *H. pileatus*. During that time he considered that the study area was one of the most abundant population (4-5 groups/1km^2), but at the present, their population status are poorly known, there has been no recent study and monitoring. Srikosamatara, (1980, 1984) also reported that there were a lot of hunting at the study site and proposed that conservation effort should be established in order to protect them from extinction, but there has been no response from authorities. For other areas it has no any information on their population and conservation status. Brockelman & Chivers (1984) proposed two strategies to promote long term survival of them: (1) we need to promote gibbon in pubic concern and (2) positive management known. There has been no recent study and monitoring.

Table 2.1: Gibbon studies in the Kingdom of Thailand.

Study sites	Authors	Topic	species
DCDWS	Carpenter, 1940	Ecology	*H. lar*
Northern	Kawamura, 1961	Pilot study	*H. lar*
KYNP	Marshall et al., 1972	Distribution of each species.	*H. lar* and *H. pileatus*
KYNP*	Brockelman, 1980-at the present	Pop+conser.+ many gibbon related studies	*H. lar* and *H. pileated*
KSDWS	Srikosamatara, 1980, 1984	Ecology	*H. pileatus*
KYNP	Raemaekers & Raemaekers, 1984	Vocalization	*H. lar*
KYNP	Raemaekers, Raemaekers and Haimoff, 1984	Vocalization	*H. lar*
KYNP	Raemaekers & Raemaekers, 1985	Vocalization	*H. lar*
KSDWS	Srikosamatara and Brockelman, 1987	Eco + conser.	*H. pileatus*
HKKWS	Bhumpakphan, N. 1988	Ecology	*H. lar*
KYNP	Whithington & Treesucon, 1991	Food selection	*H. lar*
KYNP	Brockelman & Srikosamatara, 1993	Density estimation	*H. pileatus*
KYNP	Suwanvecho, 1997, 2003	Maturation, species interspecific relations	*H. lar and H. pileatus*
KYNP	Brockelman et al., 1998	Social structure	*H. lar*
KYNP	Reichard, 1998	Sleeping behavior	*H. lar*
KYNP	Kanwatanakid, 2000	Food selection	*H. lar*
HKKWS	Muangkhum, 2001	Home range, diet	*H. lar*
LNPWS	Suwannakerd, 2001	Ecology, Social behavior	*H. lar*
PKWS	Borries et al., 2002	Primate community	*H. lar*
KYNP	Brockelman, in press	Ecology and Social structure	*H. lar* and *H. pileatus*
TNCWS	Ratanama, 2004	Fruit tree-frugivores interaction	*H. lar*
SPDWS, LNPWS	**This study, 2005**	Ecology and conservation	*H. lar*

* Long term study in Khao Yai National Park, Thailand.

Note: DCDWS=Doi Chiang Dao Wildlife Sanctuary, KSDWS=Khao Soi Dao Wildlife Sanctuary, KYNP= Khao Yai National Park, HKKWS = Huai Kha Khaeng Wildlife Sanctuary, LNPWS=Lum Nam Pai Wildlife Sanctuary, PKWS=Phu Khieo Wildlife Sanctuary, SPDWS=San Pan Daen wildlife Sanctuary, TNCWS=Ton Nga Chang Wildlife Sanctuary.

2.10 Hill tribes and gibbons

Karen and Hmong in the past liked to have a large number of gibbons in the forest because they believed that the gibbon calls would increase their crops yield (Carpenter, 1940, Lekagul & McNeely, 1977). However, because of cash economic and increase of cash value of the gibbon, new generation ignore their own belief, so the gibbon in forest near by hill tribe villages have become few (Lekagul & McNeely, 1977). Karen live very close to wildlife especially hornbill and gibbon. There were many evidences for this could be found in the story through many tales of the older people who have experience of listening from their ancestors such as "One gibbon died 7 layers of the forest sad and lonely". Karen believe that eating gibbon causes people who eat them have to stay apart from each other. Nevertheless, some of the villagers caught them for a pet, but they did not shoot the mother, they just chased away the adults and other gibbons and caught the baby.

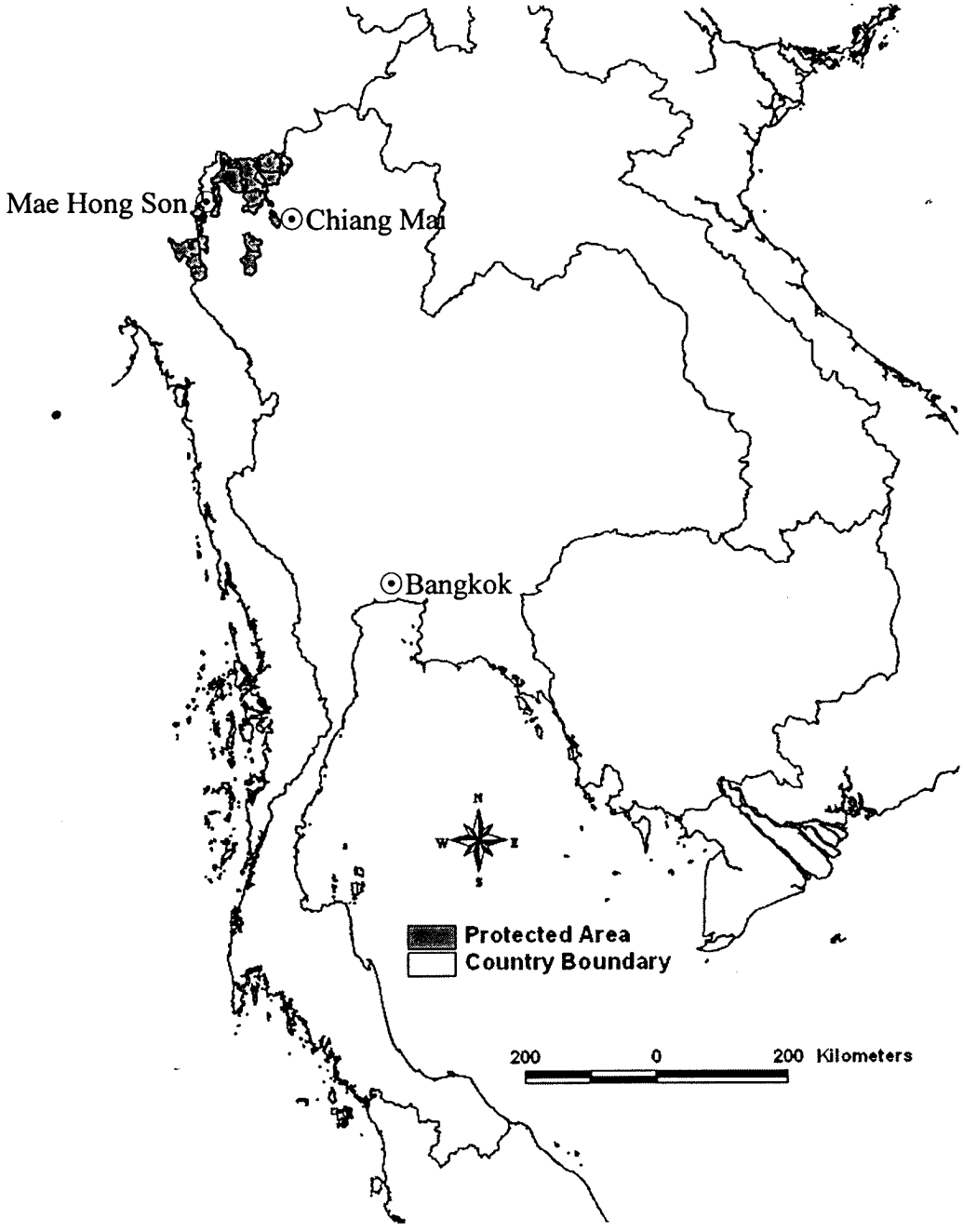
There are no documentation which directly point out the role of Karen and other minorities to gibbon conservation. From my preliminary study in Ban Muang Phaem, it is quite clear that none of them used the gibbons as a food. However, primitive hill tribe (including Karen) who lived around Doi Intanon occasionally hunted them for food (Carpenter, 1940).

CHAPTER III
METHODOLOGY

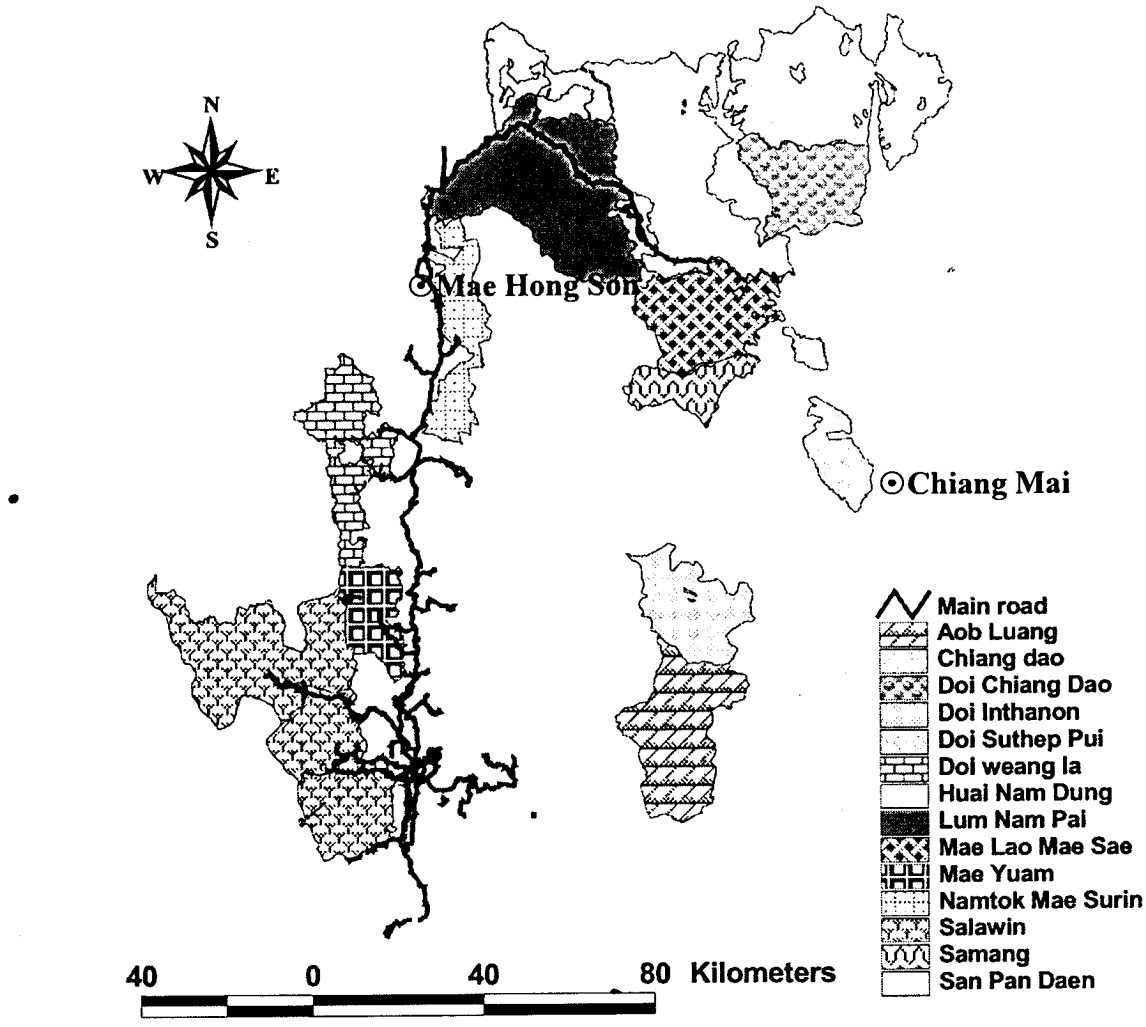
3.1 Study site

The study was conducted in Lum Nam Pai Wildlife Sanctuary (LNPWS) (1,181 km^2, 19°13′-19° 37′ N, 97° 57′-99° 26′ E) and San Pan Daen Wildlife Sanctuary (SPDWS) (277 km^2, 19°33′- 19° 45′N, 98° 5′- 98° 22′ E) which located in protected area complex in Mae Hong Son Province (about 800 km from Bangkok) (Maps 3.1 and 3.2). Both sanctuaries consist of "Karst Topography" (limestone cave and mountain) at an elevation ranging from 300 to1,500 m from average sea level and it receives 1,200-1,300 mm annual rainfall (1,598 in the time of the study in Ban Muang Pam forest). Temperature recorded during the study rank 5.5 to 41 degree Celsius. In the area lower than 1,000 m from average sea level covered by Tropical Mixed Deciduous Forest Deciduous Dipterocarp Forest, Pine-Deciduous Dipterocarp Forest. Lower (Santisuk, 1988). *Pinus merkusii* and *Pinus kesiya* can be found in Pine-Deciduous Dipterocarp Forest at 800-1,000 m from average sea level, *P. merkusii* has much higher density. Secondary growth and grass fields are diffusely found in the area. In both sanctuaries, there are different size of communities of ethnic minority distributed in low density, and clump for some area. Some of them, such as Lahu Nyi still practice traditional cultivation such as "Swidden cultivation".

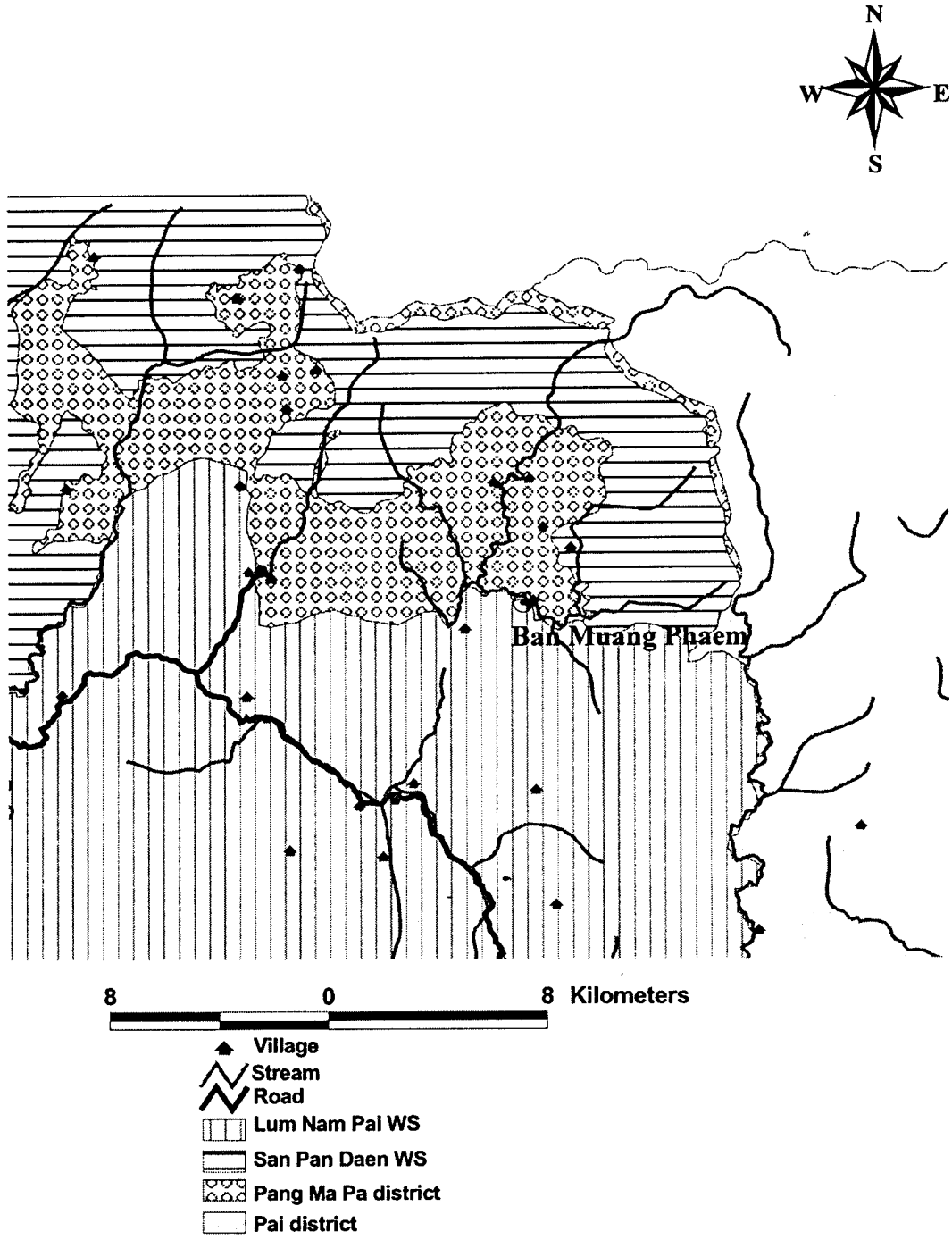
My intensive study site (Ban Muang Phaem Forest) is located in community reserved forest adjacent to SPWS and LNPWS part of Pang Ma Pha district (Map 3.3). The site consisted of Seasonal Deciduous Hardwood and Bamboo, Fire-damaged, continuously degraded forest in rugged limestone terrain surrounded by Dipterocarp and Pine forest (followed Maxwell & Elliott, 2001). Pang Ma Pha area structured by limestone, granite and sandstone topography resulting in diversity of forest and plant community (Khamyong et al., 2003). In dry season in every year plants on forest floor



Map 3.1. Location of protected areas in Mae Hong Son and Chiang Mai.



Map 3.2. The location of San Pan Daen WS and Lum Num Pai WS and the distribution of protected areas in Mae Hong Son and Chiang Mai provinces, Northern Thailand.



Map 3.3. Location of Ban Muang Phaem in Pang Ma Pa district surrounded by San Pan Daen WS and Lum Nam Pai WS.

has seriously been destroyed by domestic cows, buffalos and annual forest fire.

Ban Muang Phaem village is home to more than 400 people of 96 families of Sgaw Karen in Mae Hong Son (2004). Most of them are Buddhists but 3 families are Christian. Most families have their own lands for agriculture (rice and crop field) and they use forest products as supplementary food sources and they still hunt wildlife for their need of protein. In reserved forest around the village, grazing of domestic livestock such as buffalos and cows were exceptionally allowed. Moreover, the surrounding forest has been used for nature tourism for many years.

At least 12 mammal species were found in the home range of the main study group including Assamese macaque (*Macaca assamensis* Mec.) (one male), Phayre's langur *(Presbytis phayrei* Bly.*)* (1 individual), Asiatic jackal (*Canis aureus* Lin.) (I saw 1 time and heard their voice many time at night), barking deer (*Muntiacus muntjak* Zim.) (5 time sighting, at least 4 animals), Burmese striped squirrel (*Tamiops mcclellandi* Hor.), bay bamboo rat (*Cannomys badius* Hod.) and squirrel (*Callosciurus* sp), small Indian civet (*Viverra indica* Des.), pangolin (*Manis pentadactyla* L. or *Manis javanica* Des.), large bamboo rat (*Rhizomys sumatrensis* Raf.), northern tree shrew (*Tupaia belangeri*), and rats (*Rattus* spp). Large bird species consist of great hornbill (*Buceros rhinoceros*), jungle fowl (*Callus gallus*), etc. Small and medium size birds that share the fig with the gibbons include hill myna, dove, red-whiskered bulbul, black-crested bulbul, sooty-headed bulbul, 3 species of barbet, etc. Snakes included king cobra (*Ophiophagus Hannah*), cobra (*Naja* sp.), one species of pit viper (*Trimeresurus* sp).

Gibbon habitat in Muang Phaem forest covered mostly by Tropical Mixed Deciduous forest and Deciduous Pine-Dipterocarp Forest (Santisuk, 1988) and small proportion of Mixed Evergreen and Seasonal Deciduous and bamboo Forest (Maxwell & Elliott, 2001). Some part of their home range is difficult or impossible to access due to steep slope cliffs. In summer time, most area of the forest floor is completely burned by annual forest fires that brought by their cultivation processes (slash and burn cultivation) and for other purposes such as to facilitate hunting and facilitate trekking tour.

In late 2003, a vast area of the forest was cleared because misunderstanding of the villagers to the government land use policy. Moreover, this even affects directly to

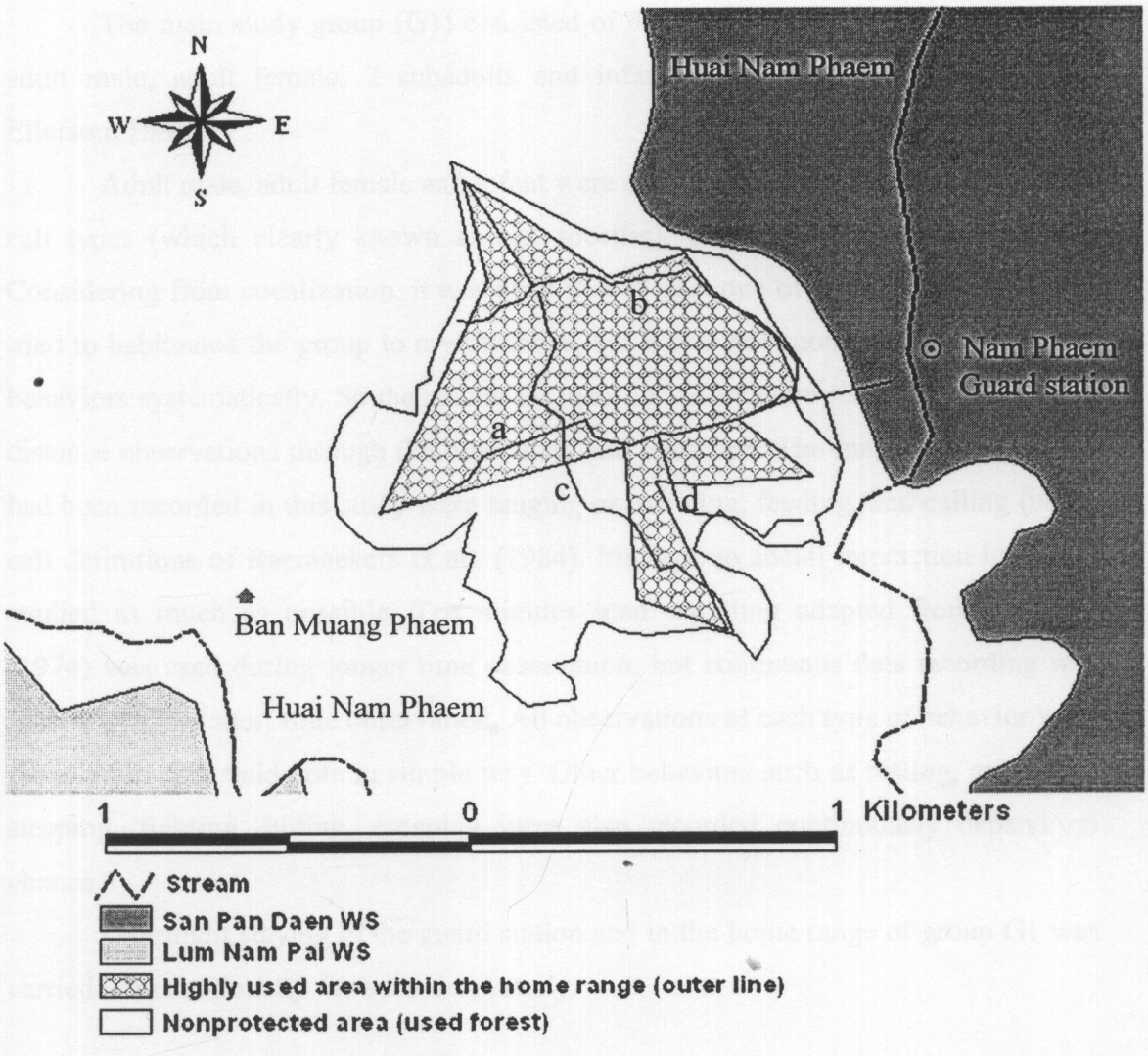
rotational cultivation system of Karen with the rotation cycle now being relatively short compare to the past (every 5-10 year depend on their need). This cause gibbon habitats to be more limited.

3.2 Gibbon distribution survey

A previous presence/absence data of white-handed gibbon in the San Pan Daen and Lum Nam Pai Wildlife Sanctuaries from an interview survey conducted by Srikosamatara and his team (1999) was used as a guideline for rapid surveys in 7 selected villages in Nam Lang basin. Communicate with the villagers who lived near by the gibbon forest and listened to the gibbons loud calls was a major method. The results of preliminary studies conducted during May, 2002 and April-June, 2003 were included in the study and were used in data analysis also. The main study was carried out from 25 February, 2004 to 26 February, 2005 in Muang Phaem forest, the main study site (cover an area about 12 km^2), and some other areas where gibbon lived. Hand compass was used to locate the group directions, and the distance from the calling group was estimated from listening.

3.3 Behavioral study

At least 636 hrs of 131 observation days (mostly 06.00-12.00) were spent searching and observing the main study group (G1). Four major study trails (a, b, c, d) **(Map 3.4)** were made along the main traveling route of the main study group (Muang Phaem community used forest) during the last preliminary study (in year 2003) and during the study period across the gibbon home range for observation study and phenological study of food plants. GPS (Garmin GPS 12 XL (12 Channel), and compass were used for indication and recording all positions visited by all groups of population L1, L2 and other groups. Universal Transverse Mercator grid system (UTM) was used to indicate all the locations in topographic map (1:50,000). Pens, field note books, digital



Map 3.4. The main study trails in the home range (61 ha) by GPS survey and the highly used area (41 ha) of the main study group (a-d).

watch were used most for the study. Time spent in feeding, traveling, singing and other behaviors by each member of the study group was recorded in field notebooks.

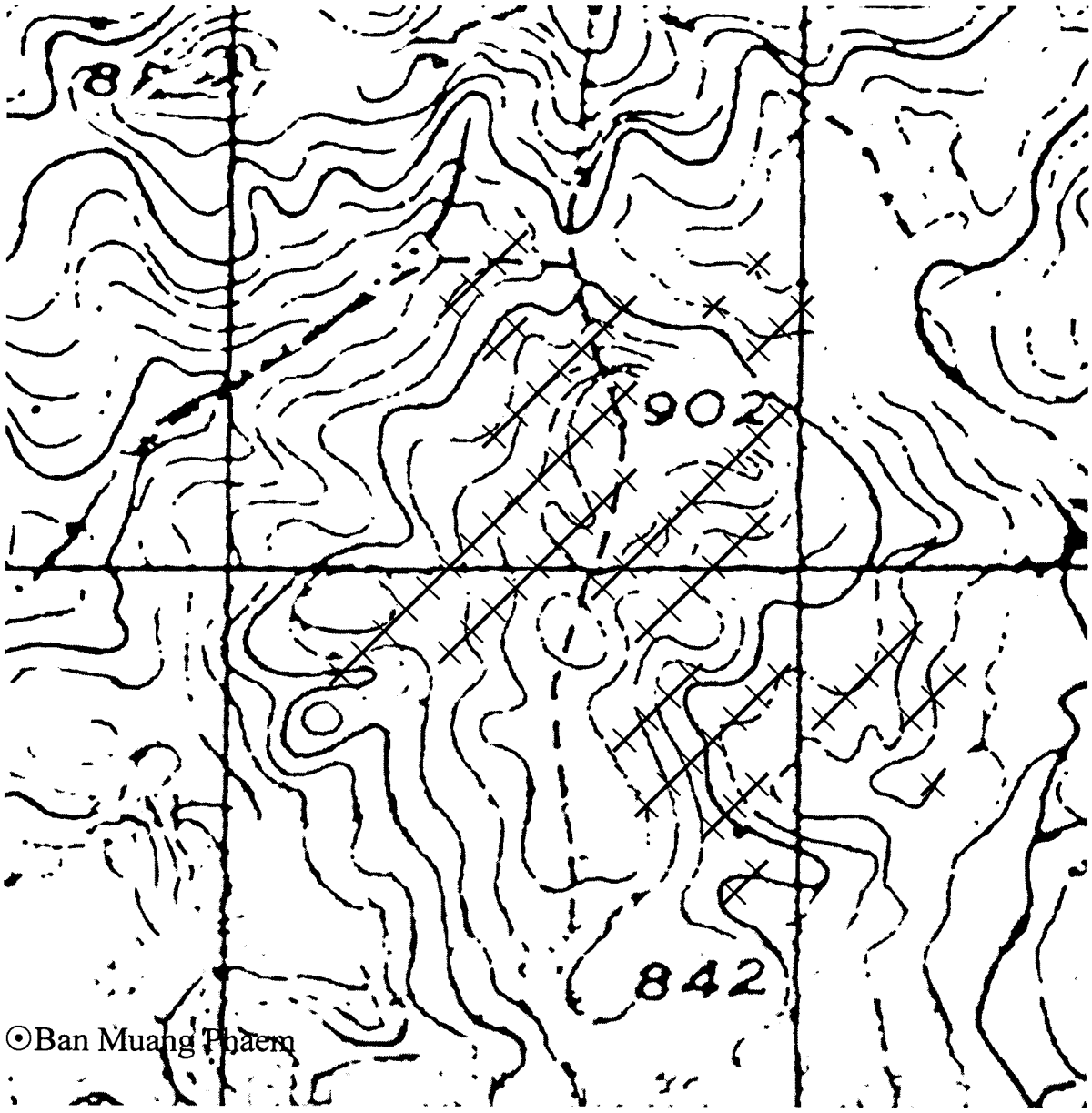
The main study group (G1) consisted of 5 members which were identified as adult male, adult female, 2 subadults and infant (weaning) (using definition of Ellefson, 1984).

Adult male, adult female and infant were distinguished by considering size and call types (which clearly known as sex specific), but not for the two subadults. Considering from vocalization, it was clear that at least one of them is female. I have tried to habituated the group to my presence, but it was not enough to observed their behaviors systematically. So the results for their behaviors were received mostly from distance observations through the binoculars and telescope. The major behaviors that had been recorded in this study were ranging or traveling, feeding, and calling (using call definitions of Raemaekers et al., (1984). Intra-group social interaction had been studied as much as possible. Ten minutes scan sampling adapted from Altmann (1974) was used during longer time observation, but continuous data recording was mostly used for short time observation. All observations of each type of behavior were recorded in data field note in simple way. Other behaviors such as resting, grooming, sleeping, fighting, hiding, escaping were also recorded continuously depend on chance.

Overnight staying in the guard station and in the home range of group G1 was carried out occasionally for behavioral study.

3.4 Habitat study

Seventy-eight strait sampling plots at 50 m intervals along straight line were established within the home range of the main study group. Standard compass was used to make the straight lines at a 45 degree bearing (Map 3.5). Plots of 11.30 m radius (400 m^2) were set up, and all trees with more than 10 cm diameter at breast height (DBH) were recorded (adopted from Brockelman, 1998). Some part of the area which consisted of limestone rock and which could not be accessed or used by the gibbon was skipped. Optical rangefinder (model TLR 75 working range 10-75 m, Forestry Suppliers, Inc™, USA) was used to measure the overhead highest point of



Map 3.5. The study plots in the home range of group G1 in Muang Phaem used forest. Seventy eight sampling plots of 400 m^2 at 50 m intervals were established.

canopy covered at 4 points from the center of each direction (North, East, South and West) were recorded into data sheets (Appendix). Field species identification of trees more than 10 cm DBH was done by plant taxonomist expert, J.F. Maxwell CMU herbaria, within each plot. The densities of some gibbon food tree grow in each plot were calculated. Feces dropped by the gibbon of the study group were also collected whenever possible for more additional information for their role in plant dispersal and for additional diet composition by eyes estimation.

3.5 Phenological study

All species of gibbon food plants in the home range was observed at least every 2 weeks using 8x40 binoculars and 20-60 power Nikon telescope for their phenology (fruiting, flowering, shooting, young leave, mature leave).

Fruits, flowers, and leaves of all food plants species both eaten and reported eaten by gibbon were photographed and collected through out the study in all year round. Plant samples were preserved and sent to Chiang Mai University herbaria for species identification. "Trees of the Northern of Thailand" by Gardner et al. (2000) and "Thai Plant Names" by Samitinand, (2001) were used as guides for plant species identification in the study site.

3.6 Climatic study

Muang Phaem study site climatic information was measured. Rainfall was recorded daily at 18:00 by using 50 ml rain gauge. Temperature was recorded two times a day at 06:00 and 18:00 using min-max mercury thermometer. Ten minutes sampling interval was applied for daily climatic change (windy, cloudy, and sunny) recording.

For daily climatic changing such as rainy, sunny, cloudy, and windy was recorded every 10-20 minutes in order to study relation of the climate and their singing behavior.

3.7 Human activities and its impact on the gibbons

Most of the night time was spent staying in the village with Karen (mostly in Ban Muang Phaem) and one week with Lahu Nyi (Ban Aela) collecting detailed

information on their activities in the forest which possibly affect gibbons. I had observed also daily activities in the village and in the forest. Some activities in the home range of the main study group such as wood cutting, searching for non timber and timber products and cropping, for example, was recorded in the field notebook. Home stay interview was carried out in 2 selected villages, Muang Phaem (more than 95 % of the time staying in the field) and Aela (7 days) which were closest to the gibbon populations L1 and L2 respectively. Attitude study of Karen in Ban Luk Pagor (31 families) and Ban Mae U-Mong (32 families) was done during February 2005.

3.8 Local participation

In order to encourage local participation, two of the sanctuary staff were selected as research assistants to participate in some part of this study, such as distribution survey of the gibbon using triangle loud calls technique (adopted from Brockelman & Srikosamatara, 1993), setting up study trails, plant phenology study and forest structure measurement, so they can learn and understand more about the research and methodology. Local knowledge concerning gibbon and their food plants and location in their habitat were used in the study. Occasional meeting between Karen people of Muang Phaem and Lahu people of Ban Aela about land use and wildlife conservation was done, so that collaboration between villages was initiated. Local NGOs and government sectors also joined the meeting that was partly on the issue of wildlife conservation.

3.9 Data analysis

3.9.1. Statistical calculations

The computer program Microsoft Excel 2000 was used for statistical calculations for quantitative data including behavioral data (frequency of vocalizations, feeding time) human activities (frequency of gun sound), vegetation or habitat structure (tree high, diameter, canopy cover, tree species density, species relative abundance), climatic study (average rainfall, average temperature, average minimum maximum temperature), food plants (proportion of each categorizes, percentage in each season).

3.9.2. Comparisons for function of 5 subtype of forest

Detailed data on utilization of the gibbons in each kind of food plant in each sub types recorded through out the study were used in analysis.

3.9.3. Population analysis.

All populations and related data such as risk factors (hunting rate, birth and death rate, habitat alteration, fragmentation), were used to predict the future survival of the gibbons.

- **3.9.4 Conservation status analysis.**

- Direct factors (demography, poaching, hunting, deforestation rate, logging activities, and community altitude in conservation)

- Indirect factors (government policy on land used management, agricultural contribution programs, tourism program, and government staff altitude in conservation) Data used in this analysis are human activities (collecting of timber and non timber forest product).

CHAPTER IV
RESULTS

4.1 Distribution

In general, the feature of the forest inhabited by each gibbons populations in Nam Lang area are slightly different from place to place for microhabitat such as plant species composition, but, however, one characteristic shared by all the places were inaccessible limestone and granite cliffs that protect them from hunting and also from being followed. This kind of geographical barriers (to be accessed) compared to other regions has contributed to the survival of the gibbons in this area. Most of the group found inhabited the forest at the streams site adjacent to or relatively close to Karen village (ranging from 300 m to 3.5 km). In opposite, none of them had been found close to Lisu villages (except in community wildlife protected forest). The type of forest that I usually found the gibbons were covered mainly by Seasonal Deciduous hardwood +bamboo, fire-damaged Forest, Rugged limestone terrain and some part of secondary growth. During my study, February, 2004 to February, 2005, at least 9 groups have been found lived close to Karen (Sgaw Karen) villages, possibly 2 groups lived close to Tai Yai village and other two groups lived in inaccessible forest area (200 m away from the high way) of Pang Ma Pa district head office. For the populations in Huai Pooling (Karen), Manora (Karen), only interview survey had been done. The characteristics of all populations inhabited Nam Lung river (Nam Lang basin) are presented in Table 4.1. The distribution of confirmed gibbon populations in Mae Hong Son province presented in Map 4.1 (Bird-eyed view) and Map 4.2 (closer view).

4.1.1 Distribution of gibbons in Nam Lang basin.

Population L1 (G1-G4) (in SPDWS and used forest), inhabited Huai Jaran, the temporary stream, which drain the water to Huai Nam Phaem during rainy season. This population comprised of at least 20 individuals of 4 groups. The distribution of each group show in Map 4.3 and 4.4.

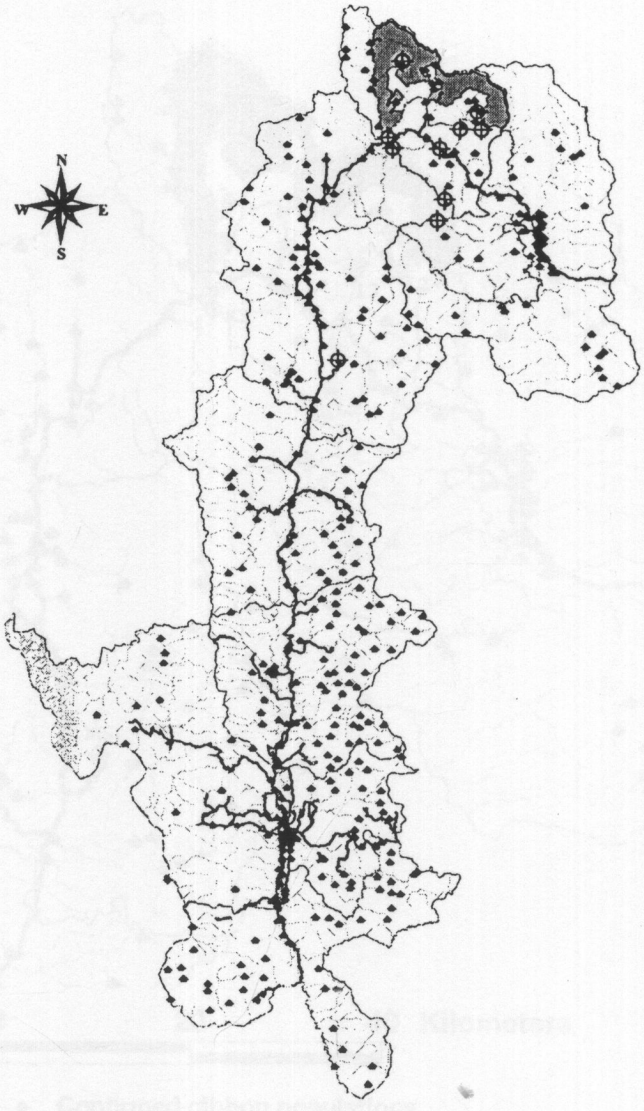
Table 4.1. Distribution of the gibbons in Nam Lang basin

Pop.	The nearest River/stream	Nearest village	Races	No. of groups	No. of animals.
L1	HNP, HJR, HTC, HL, HNL	Ban Muang Phaem	K	4	20
L2	HR, HPM, HP	Ban Muang Phaem, Aela	K+La	3	15
L3	HNL	Ban Tham Lod	TY	2	6*
L4	HNL	Ban Sop Pong	Li	2	12*
L5	HM or HJP	Ban Luk Pagor and Ban Mae U-Mong	K	1	4
L6	6 unknown streams	Ban Manora	K	6	30*
Total	15 (streams)	7 (villages)	4 (races)	16	87

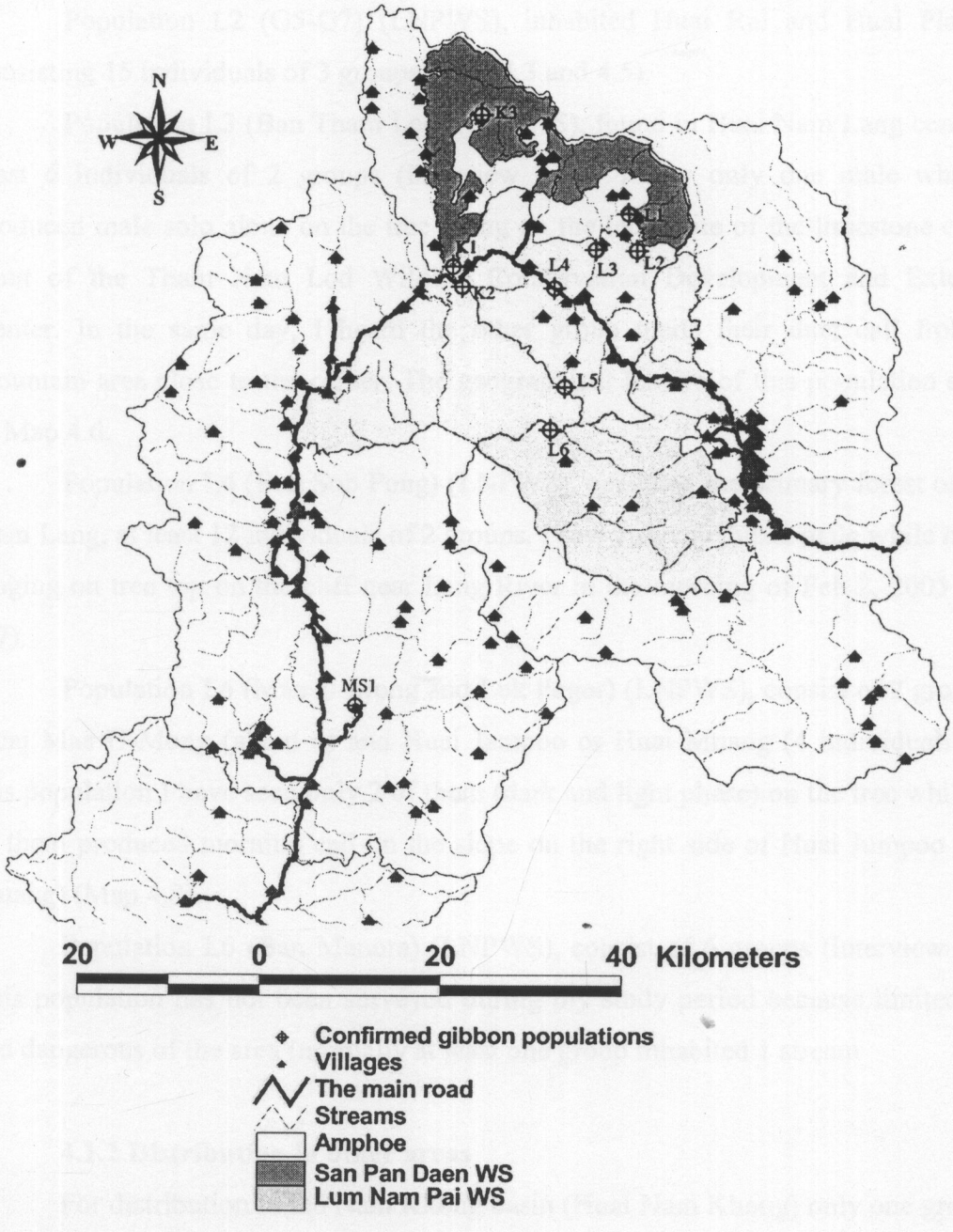
Note: *Possible maximum number by interviewing tvillagers, HNP=Huai Nam Phaem, HJR=Huai Jaran, HTC=Huai Tico, HL=Huai Luk, HR=Huai Rai, HPM=Huai Plamung, HP=Huai Pong. HNL=Huai Nam Lang, HM=Huai Muang, HJP=Huai Jumpoo, K=Karen, La=Lahu, TY=Tai Yai, Li=Lisu

Brief explanation of each population.

1. Population L1 (Main population), occupied preserved forest of Ban Muang Phaem and Huai Jaran (right side of Huai Nam Phaem, consisting 20 individuals of 4 groups).
2. Population L2 (Huai Rai and Huai Plamung), consist of 15 individuals of 3 groups.
3. Population L3 (Ban Tham Lod), consist of about 6 individuals of 2 groups.
4. Population L4 (Ban Sop Pong), consist of at least 12 individuals of 2 groups
5. Population L5 (Ban Mae U-Mong and Ban Luk Pagor), one groups, at Huai Jumpoo (about 4 individuals).
6. Population L6 (Ban Manora), consist of 6 groups of about 30 individuals.



Map 4.1. The distribution of villages in Mae Hong Son and distribution of confirmed populations of white-handed gibbon in upper part of the province.



Map 4.2. The distribution of 10 gibbon populations at Nam Lang (L1-L6), Nam Khong (K1-K3) and Nam Tok Mae Surin NP (MS1).

Population L2 (G5-G7) (LNPWS), inhabited Huai Rai and Huai Plamung consisting 15 individuals of 3 groups (Map 4.3 and 4.5).

Population L3 (Ban Tham Lod) (LNPWS), found in Huai Nam Lang consist at least 6 individuals of 2 groups (interview data). I saw only one male while he produced male solo alone on the tree rising on the ledge site of the limestone cliff in front of the Tham Nam Lod Wildlife Conservation Development and Extension Center. In the same day, I heard the other group made their duet call from the mountain area close to the center. The geographical feature of this population shown in Map 4.6.

Population L4 (Ban Sob Pong) (LNPWS), occupied the primary forest of Huai Nam Lang, at least 12 individuals of 2 groups. I saw only one black male while he was singing on tree top on the cliff near Lang River in the morning of Feb 2, 2005 (Map 4.7).

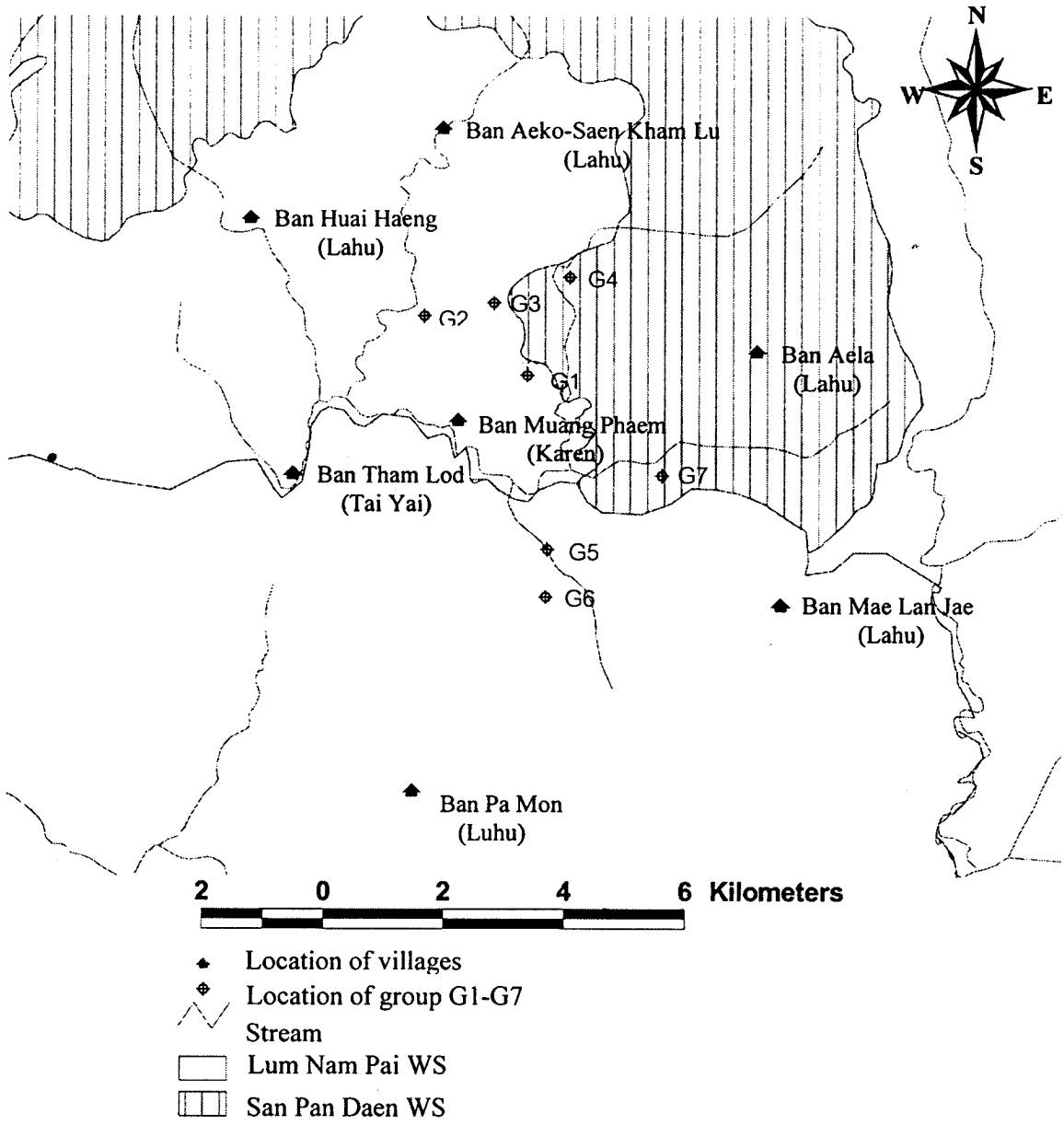
Population L5 (Mae U-Mong and Luk Pagor) (LNPWS), consist of 2 groups at Huai Mae U-Mong (about 4) and Huai Jampoo or Huai Muang (4 individuals). For this population I have seen only 2 of them (dark and light phase) on the tree while one of them produced morning call on the slope on the right side of Huai Jumpoo (Huai Muang) (Map 4.8).

Population L6 (Ban Manora) (LNPWS), consist of 6 groups (interview data). This population has not been surveyed during my study period because limited time and dangerous of the area (normally at least one group inhabited 1 stream

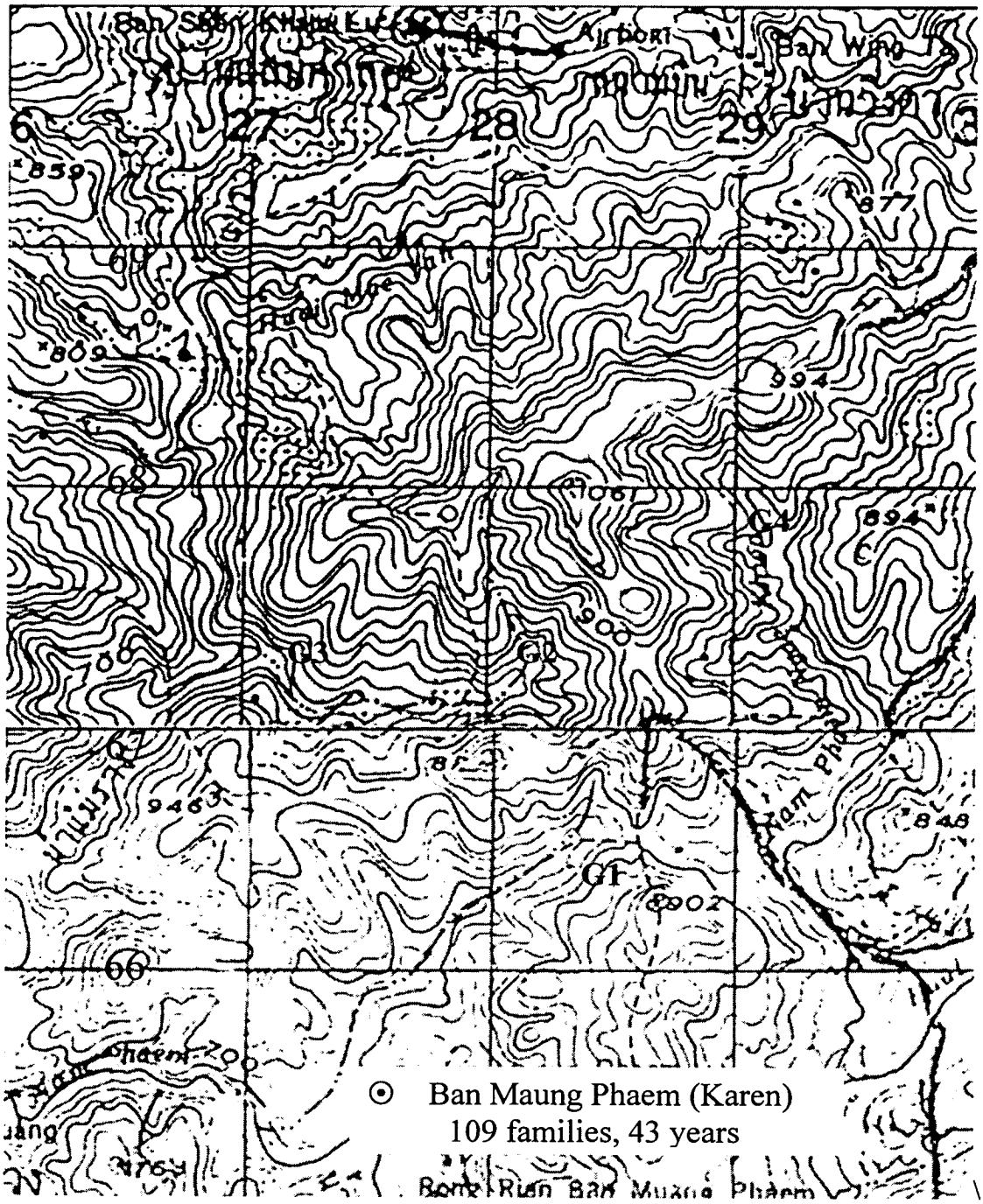
4.1.2 Distribution in other areas

For distribution in the Nam Khong basin (Huai Nam Khong) only one group in Huai Nam Pong had been surveyed during 2002 for few days by listen to their call. Only 2 groups of about 7 individuals had been reported by the villager (Lua).

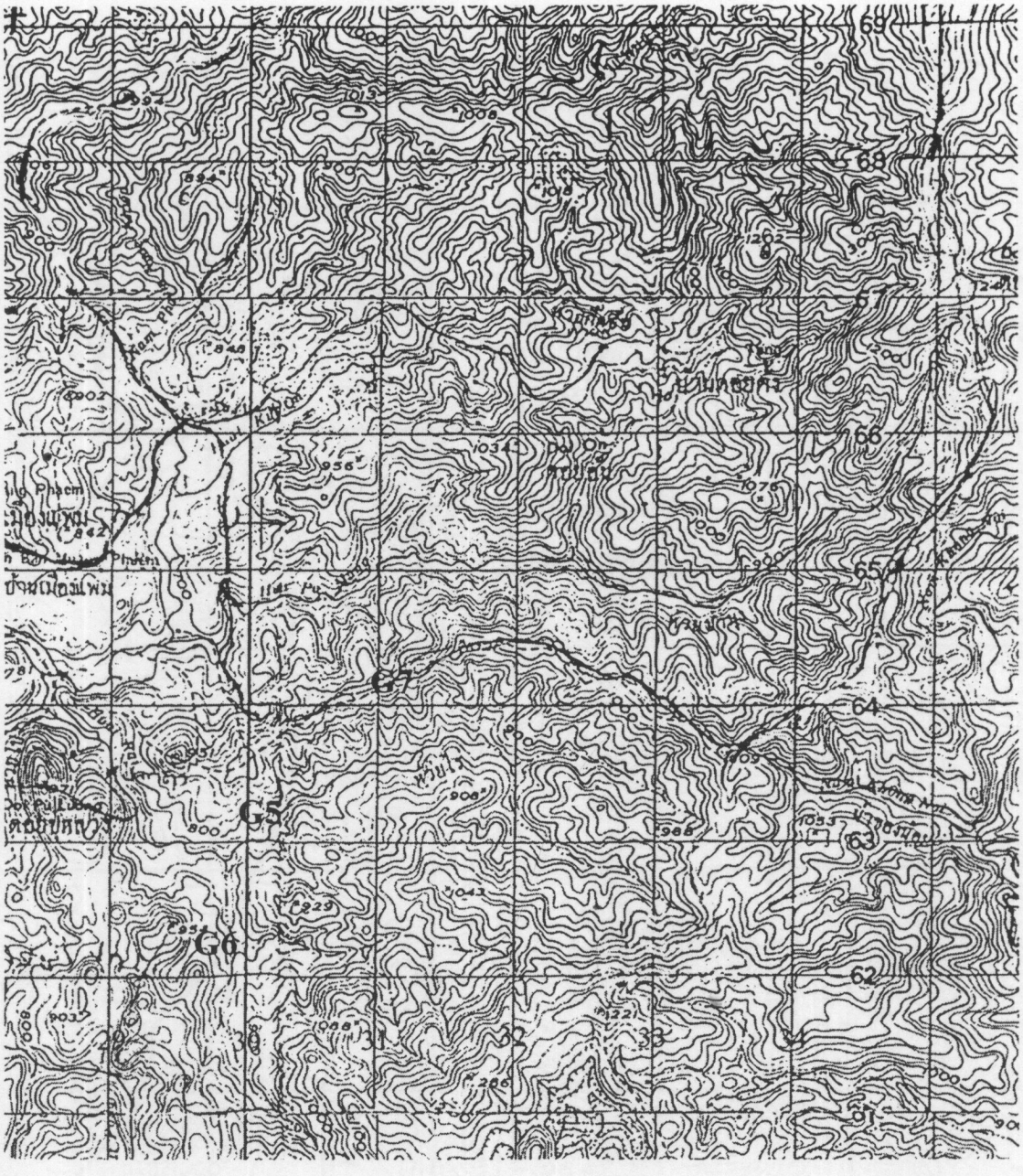
- Population K1 (Nam Khong river): This population confirmed firstly during May 2003 by my preliminary study using vocalization survey. This population was reported to consist of about 6 individuals of 1 group. Colonization, consist of both dark phase and light phase but mostly dark phase (Map 4.9).



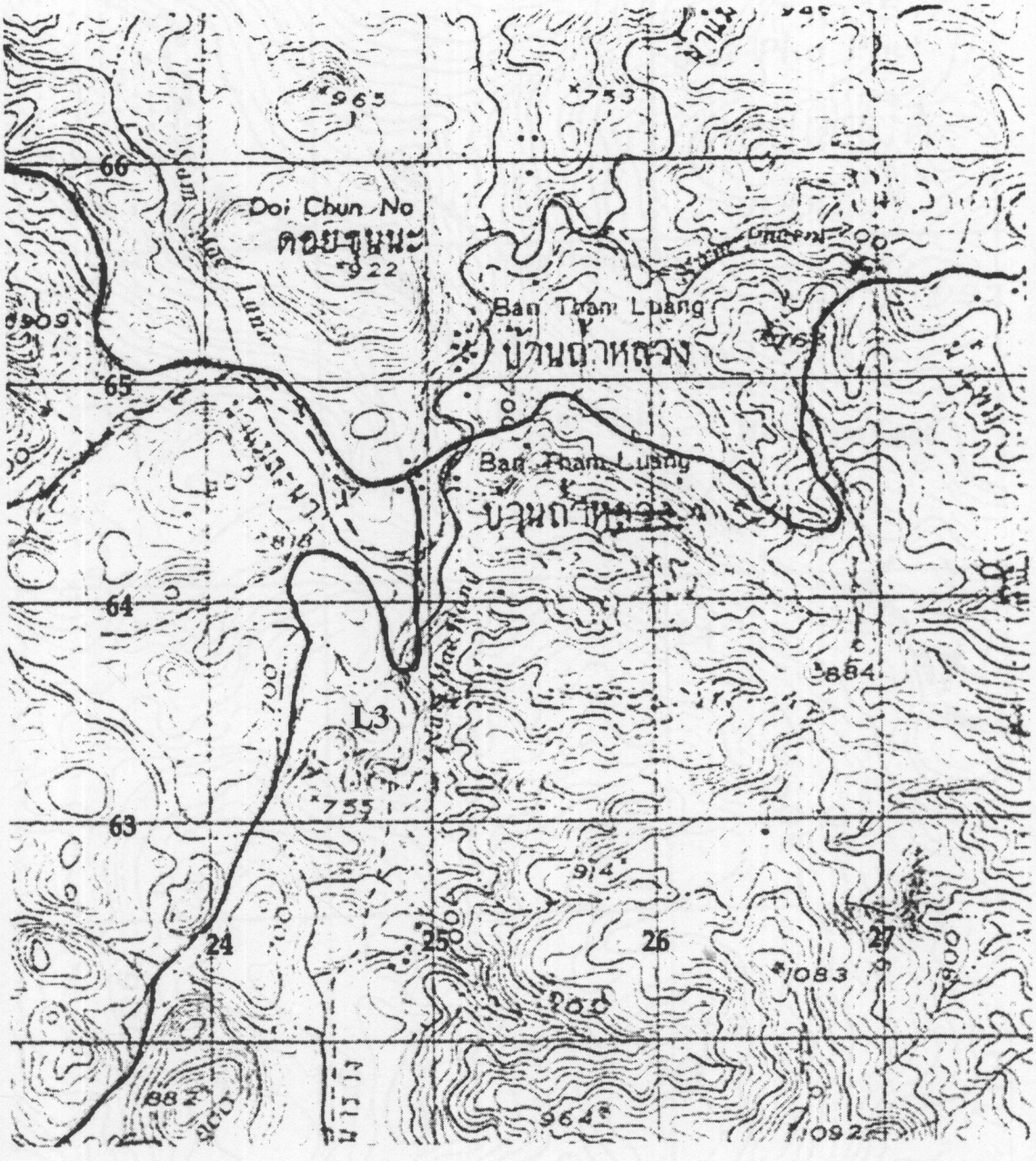
Map 4.3. The distribution of population L1 (G1-G4) and population L2 (G5-G7) which surrounded by Karen, Lahu and Tai Yai villages in Lum Nam Pai WS, San Pan Daen WS, and used area where home to population L1.



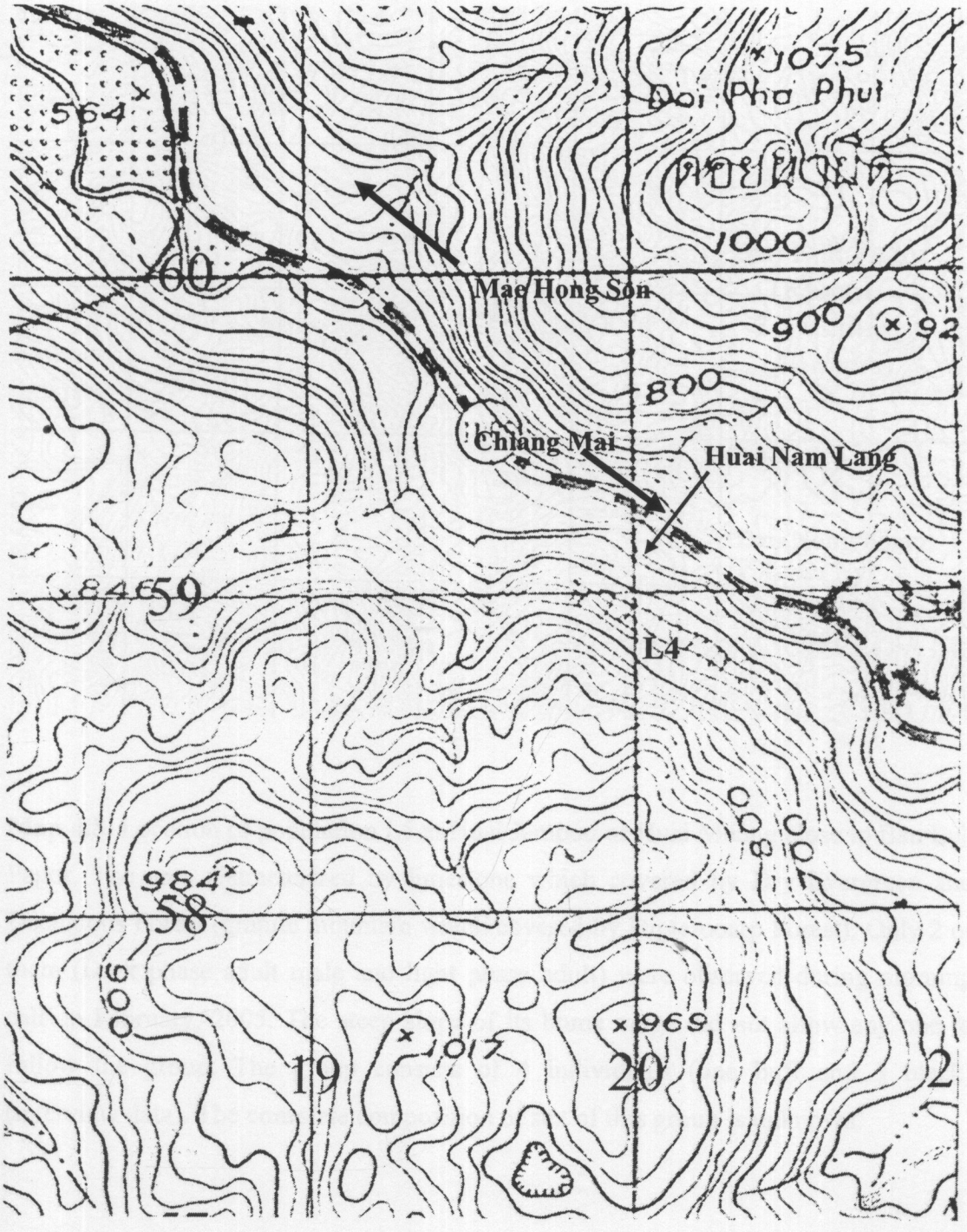
Map 4.4. Location of population L1 which consist of the main study Group (G1), Huai Tico Group (G2), Huai Luk Group (G3) and Hua Phaem Group (G4).



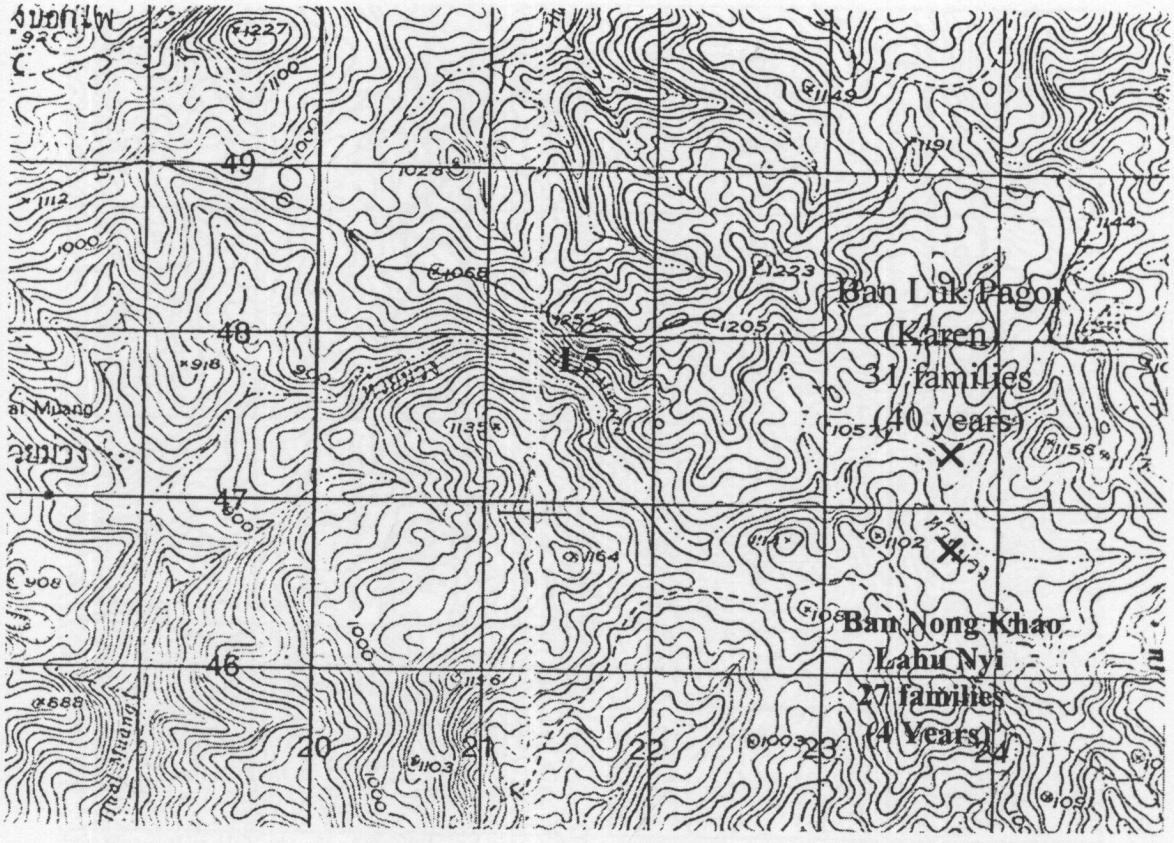
Map 4.5. Location of population L2 which comprise of Huai Rai 1 or Tham Yao group (G5), Huai Rai 2 Group (G6), and Huai Plamung Group (G7). All groups inhabited the forest that comprise a very steep area which impossible to follow them for a whole day.



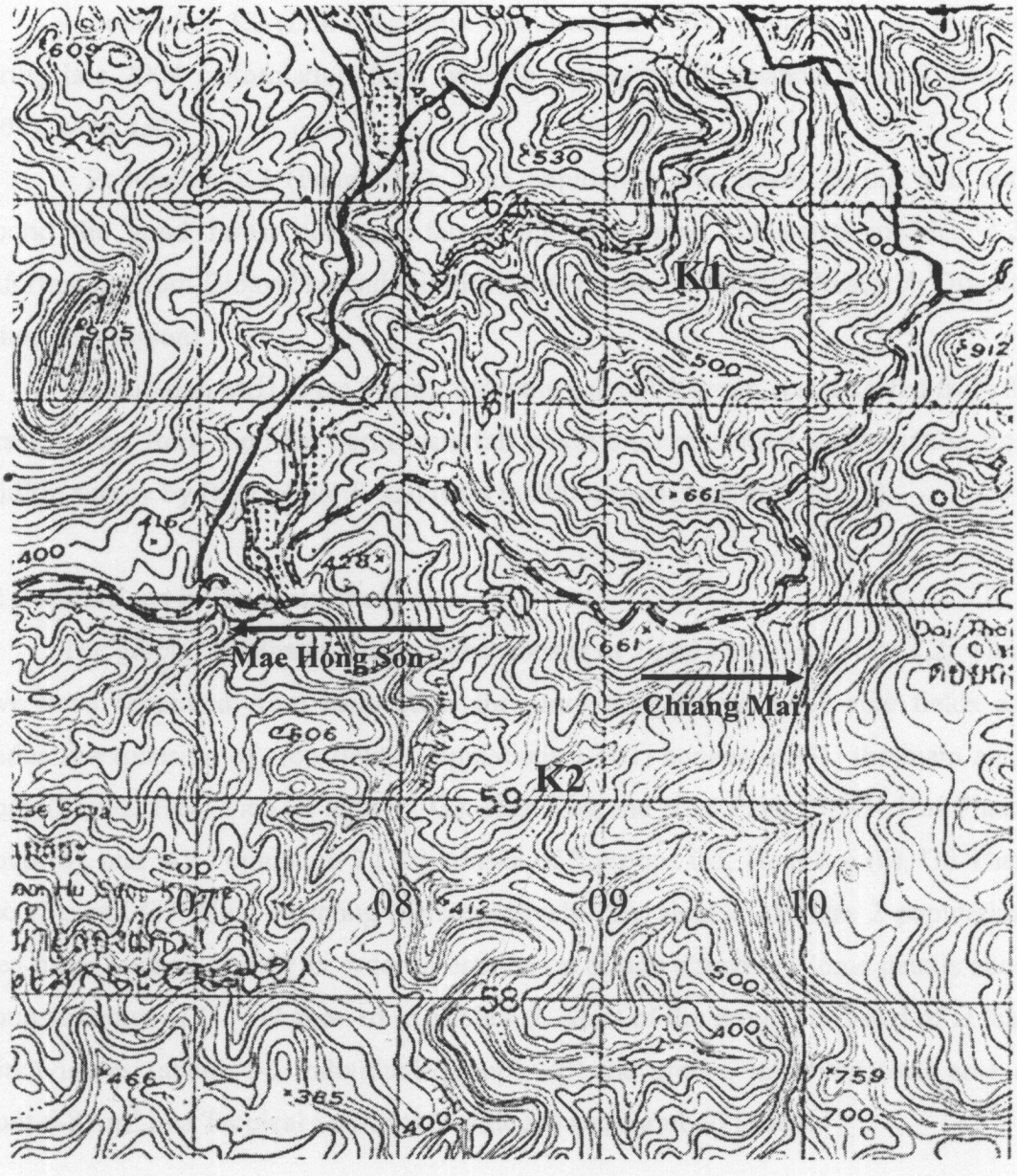
Map 4.6. Location of population L3 at Ban Tham lod. The habitat is fragmented by roads (black lines).



Map 4.7. Location of Population L4 (Ban Sop Pong), which bordering to semi-protected forest, Lisu's crop fields and the Chiang Mai –Mae Hong Son highway.



Map 4.8. Location of population L5 at Huai Jampoo or Huai Muang close to Ban Luk Pagor. The area characterized by limestone which covered by Dry Evergreen and Deciduous Forest (granite mountain which covered by Dipterocarp Forest). Only 2 of them (Dark phase adult male and light phase adult) were observed during morning call on February, 2005. The steep slope of its home range did not allow any one to follow the group. The group consists of 4 individuals (one buff and 3 black) (interview data). The complete composition of sex of this group is unknown.



Map 4.9. Location of population K1 (Huai Nam Pong) at good forest patch near by Nam Khong river close to Lua village, Ban Huai Nam Pong. This population consist of at least 1 group probably 2 groups. Location of population K2 adjacent to Ban Luk Khaolam (Lahu), consist of at least 1 group, the real number this group is still unknown. This map indicated permanent habitat fragmentation by the highway.

- Population K2 (Luk Khaolam): Vocalization of this population was recorded during late 2004 (information from wildlife survey by Bidayabha, T. and team in 2004) (Map 4.9).

- Population K3 (Pang Bon): This population was heard during mid 2004 around the good forest not very far to the main road (indicated in Map 4.2). (information from Bidayabha and wildlife survey team of Wildlife Research Division in northern region)

- Population MS1 (Mae Surin): Morning calls of 1 group was detected from the forest not far from the Mae Surin waterfall wildlife guard station. (information from wildlife survey by Bidayabha, T. and team in 2004) (indicated in Map 4.2)

4.2 Populations in the main study site

The gibbon in Muang Phaem forest consist of 2 populations (L1 and L2) which have been separated from each other for more than 20 years by rice fields and gradually expansion of crop fields. Populations 1 (L1) consist of G1, the main study group (5), G2, Huai Tico (at least 4), G3, Huai Luk and Huai Palat (5), G4 Hua Phaem group (6), and 4). Population 2 (L2) consist of 3 groups G5, Huai Rai (6), G6 Tham Yao (5), and G7, Huai Plamung (4) respectively. The details of these 2 populations need more intensive study in order to estimation of age structure. Some details about group structure of G1-G7 showed in Table 4.2. Most of the group consisted of at least 4 individuals (about 4-6 individuals/group). All the groups inhabited total area of about 6-8 km^2 in a Tropical Seasonal Deciduous and Bamboo Forest.

4.3 Home range

The home range of each group in population L1 and L2 characterized mainly by Seasonal Deciduous and Bamboo Forest (more than a half) mixed with Secondary growth forest, and surrounded by Dipterocarp and Pine Forest. The main study group (G1) used an area of about 61 ha (using ArcView GIS 3.2a) for calculated of forest patch adjacent to the village (Map 4.10). For the exact home range size of each groups of population L1 need more effort time to define. The distance between each group was usually about 1 km on average. Each groups inhabited the various level disturbed primary forest and secondary forest which has been preserved by Ban Muang Phaem

Table 4.2: The members of each group in populations L1 (G1-G4) and L2 (G5-G7) in the study site of Muang Phaem Forest.

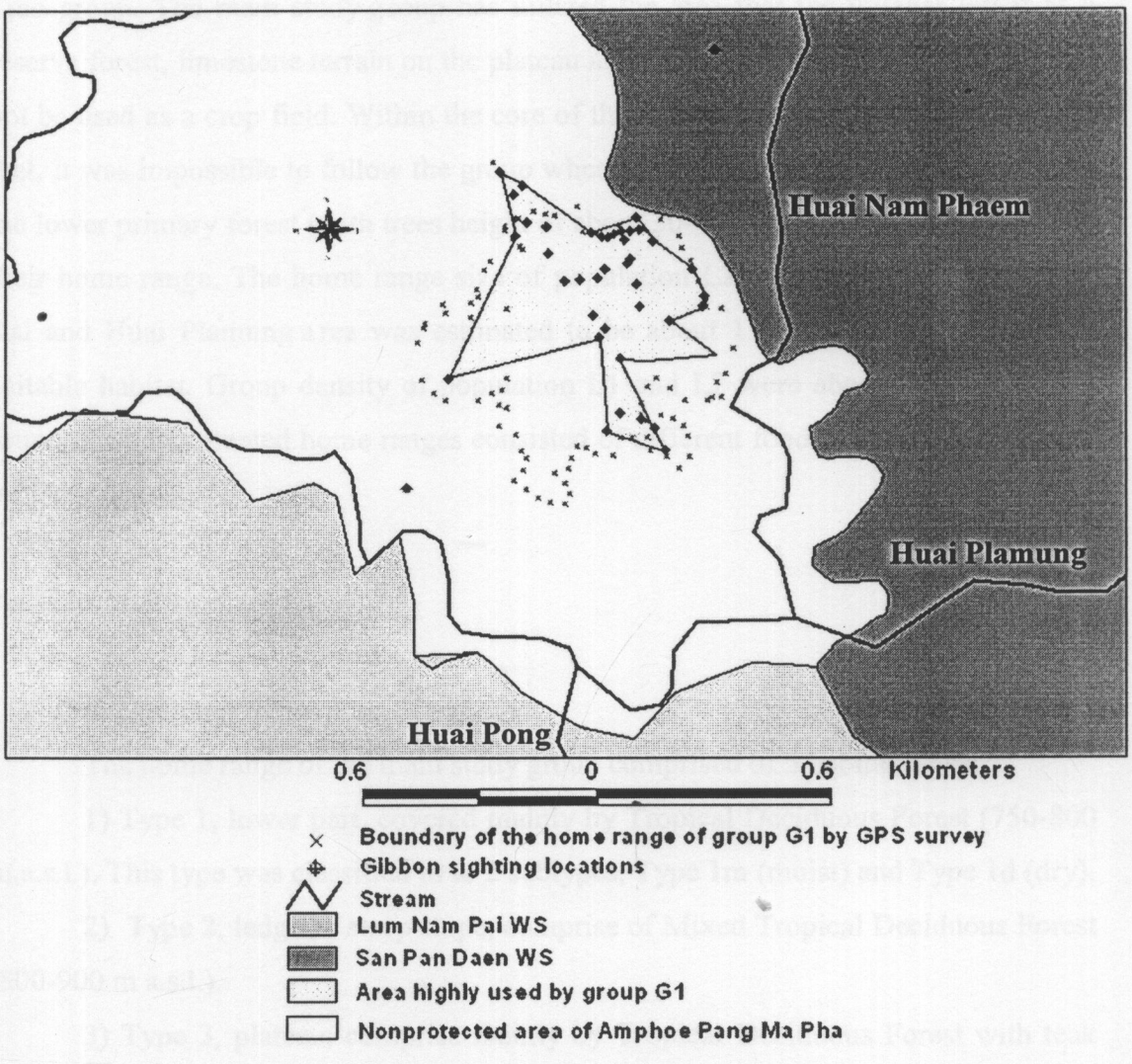
Population	Group	Adult male	Adult female	Subadult 1	Subadult 2	Juvenile	Weaning (infant)	Total
L1	G1 (MG)	D (>12Ys)*	D (>12Ys)*	D (fm) (<8 Ys)*	D (fm) (<5 Ys)*	-	D (<2Ys)**	5
	G2 (HLG)	L or D	D or L	D	**2 D fm (hunted by S and K)**	D	-	4
	G3 (HTCG)	D	D	D	D	D	-	5
	G4 (HPG)	D	D	D	D	D	D	6
L2	G5 (HRG1)	D	L	D	D	L	-	5
	G6 (HRG2)	D	D	D	D	D	D	6
	G7 (HPMG)	**L m (hunted by L)**	D	D	L (fm)	D	-	4
	Total	5-6 D	5-6D, 1-2L	7D	5D, 1L	4D, 2L	3D	**35**

Note: MG=Main study group, HLG=Huai Luk group, HTCG=Huai Tico group, HPG= Hua Phaem group, HRG=Huai Rai group, HPMG=Huai Pla Mung group, D=dark phase, L= light phase, K=Karen, S=Shan, L=Lahu.

- Juveniles of all populations almost the same age except for that of G5 which seem older than those of the other groups.

* Age estimated from count back from birth interval of gibbon cycle (about 3 years)

** Estimated by considering the size and degree of independent from the mother.



Map 4.10. The home range of the main study group (G1) and the location of plant study plot and streams. Notice that the home range is located outside the protected area.

people in order to sustaining water supply. Group G1 spends most of time in their home range (the smallest distance to the home range boundary from the village is about 200 m), with only few time visiting the area bordering the home range Huai Tico group. The main study group has utilized the area that the villager left it as a reserve forest, limestone terrain on the plateau and the ledge near the cliff site that can not be used as a crop field. Within the core of the home range of group G1, I realized that, it was impossible to follow the group when they cross the steep slope that joined the lower primary forest (with trees height of about 30-40 m) and the higher plateau in their home range. The home range size of population L2 (3 groups) located at Huai Rai and Huai Plamung area was estimated to be about 1 km^2 based-on the area of suitable habitat. Group density of population L1 and L2 were about 1 group/ km^2. I found these fragmented home ranges consisted of different food plant species (depend on forest types).

4.4 Habitat structure

4.4.1 General features

The home range of the main study group comprised of 5 habitat types:

1) Type 1, lower part, covered mainly by Tropical Deciduous Forest (750-800 m.a.s.l.). This type was classified in to 2 subtypes, Type 1m (moist) and Type 1d (dry).

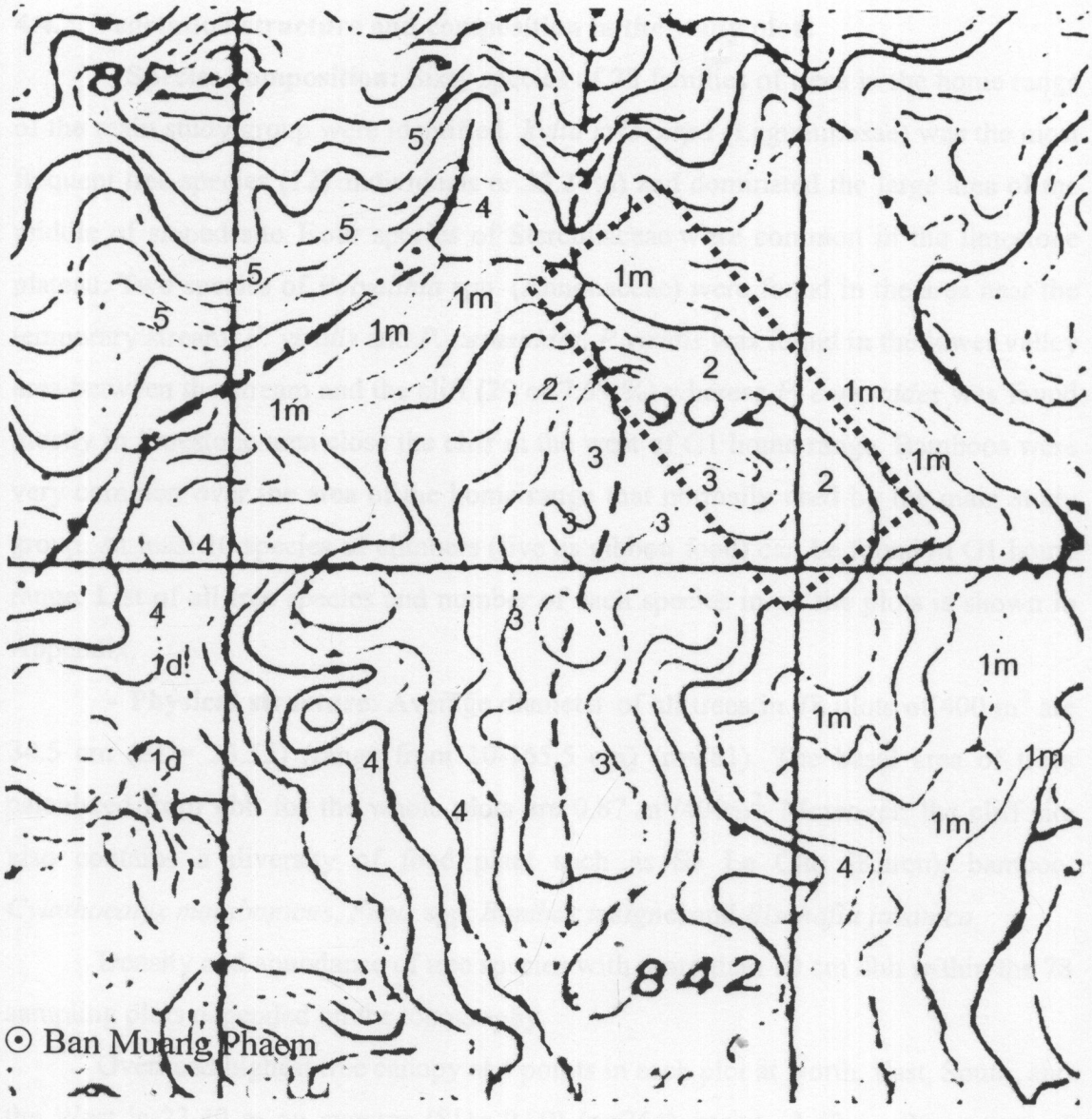
2) Type 2, ledge or steep slope, comprise of Mixed Tropical Deciduous Forest (800-900 m a.s.l.).

3) Type 3, plateau, comprise mainly by Tropical Deciduous Forest with teak (850-900 m.a.s.l.).

4) Type 4, consist mainly of secondary growth in the valley or slightly slope areas (750-800 m.a.s.l.).

5) Type 5, is eco-tone area of Tropical Mixed Deciduous Forest and Pine-Deciduous Dipterocarp Forest (800-850 m.a.s.l.).

Each type contains different plant communities but always includes 1 out of 2 common species of bamboos of this area. The distribution of each type is presented in Map 4.11.



Map 4.11. The features of home range of the main study group. The upper zone of plateau-like area in the center in which covered by Deciduous and Bamboo Forest support the gibbon as a feeding place during the beginning of winter. The area in the dotted rectangle played an important role as the main sleeping site and effective shelter for the group. 1m= moist lower Deciduous, 1d= dry lower Deciduous, 2=ledge site, 3=plateau, 4=secondary forest, 5=eco-tone between Deciduous and Pine Forest.

4.4.2. Vegetation structure and composition in the study plots

- **Species composition:** Sixty species of 28 families of trees in the home range of the main study group were identified. *Xylia xylocarpa* (Leguminosae) was the most frequent tree species (127 individuals or 33.24%) and dominated the large area of the middle of sloped site. Four species of Sterculiaceae were common in the limestone plateau. Two species of *Polyalthia* spp. (Annonaceae) were found in the area near the temporary stream, *P. viridis* and *P. cerasoides*. *P.viridis* was found in the lower valley area between the stream and the cliff (29 or 7.59 %) whereas *P. cerasoides* was found mostly in limestone area close the cliff in the west of G1 home range. Bamboos were very common over the area of the home range that normally used by the main study group. At least 10 species of climbers (five as gibbon food) can be found in G1 home range. List of all tree species and number of each species in all the plots is shown in Appendix.

- **Physical structure**: Average diameter of all trees in 78 plots of 400 m^2 are 34.5 cm (SD= 23.55) (range from 10-165.5 cm) (n=381). The basal area of trees calculated from dbh for the whole plots are 0.87 $m^2/400m^2$. Moreover, the cliff site also contains a diversity of food plant such as Se Le Cho (Karen), bamboo, *Cylathocalyx matabanicus*, *Ficus* spp, *Bombax insigne*, and *Bischofia javanica*.

Density and abundance of tree species with more than 10 cm dbh within the 78 sampling plots depended on the topography.

Overhead highest tree canopy at 4 points in each plot at North, East, South, and the West is 23.49 m on average (SD= 9.99) (n=264), range 2-42 m. Percentage of canopy gaps is 14.4 on average in rainy season (n=320). However, percent canopy cover varies seasonally. The numbers turn to near zero in summer in some site, especially on the plateau and cliff site. On the plateau area, which is covered by limestone deciduous forest with bamboo, nearly 100 % of all the trees lose their leaves on December while more than a half of trees of Deciduous Forest lose their leaves and some species such as *Xylia xylocarpa, Anogeissus acumimata Bauhinia variegata* and some species start flowering.

4.5 Climate

4.5.1 Temperature

Temperature in the study site ranged from 6 – 41°C throughout the year. Average minimum and maximum temperature during summer (before the first rain), rainy, and winter (after rain) seasons are 15-36°C, 21-32°C, and 8.5-32°C, respectively. Distribution of minimum and maximum daily temperature in each months show in Figure 4.1. The difference between maximum and minimum temperature during summer (Feb-Apr), rainy, (May-Sep) after rain (Oct-Nov) and winter (Dec-Feb) seasons were 20.42°C, 10.36°C, 16.72°C and 23.5°C on average, respectively.

4.5.2 Rainfall

During the study period, 1,598 mm of rainfall (93 rainy days of 168 days of raining season) was recorded. Minimum and maximum rainfall ranged 0.2 and 62.5 mm respectively. Average rainfall was about 17.18 mm/single raining day, and 53.26 mm per month in the raining period of the year studied. There were 3 peaks periods of rainfall during June to September, 2004. Distribution of yearly rainfall recorded in Muang Phaem village is shown in Figure 4.2. Number of raining days ranged from 1-14 days continuously. There was flooding during late July to mid August, 2004 after 2 weeks of continuous raining. The big flood cause erosion in many areas including the bank along Huai Nam Phaem and this caused decreasing space for cultivation area.

4.6 Diet

4.6.1 Food plants

In this study, 57 species of 18 families of confirmed and possible food plants were found distributed in the home range of the main study group G1 and 2 tree species of group G2 and G4 (Table 4.3). Twenty nine species of food plants (including 10 figs) had been observed to be eaten by the group G1 (Table 4.4), 8 species have a strong evidence to be eaten by the gibbon such as seed found in feces, fruits dropped with tooth print on the peel (Table 4.5), 13 species based on data from other studies

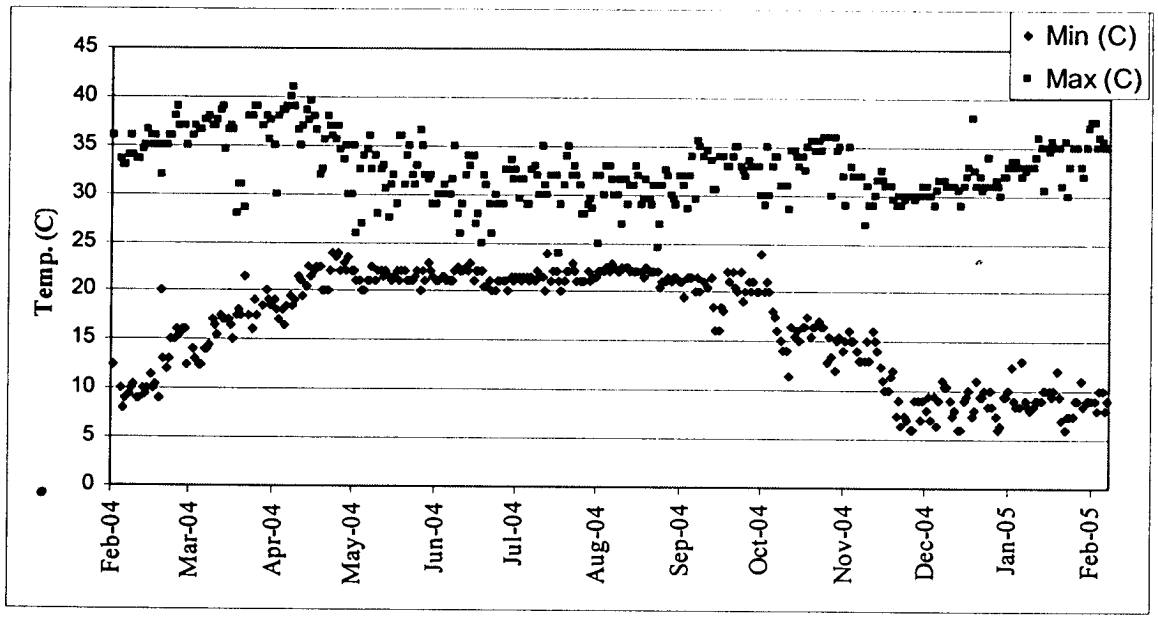


Figure 4.1. Year round temperature in Ban Muang Phaem, adjacent to the home range of the main study group. In dry season, the difference between lowest and highest temperature is relatively high.

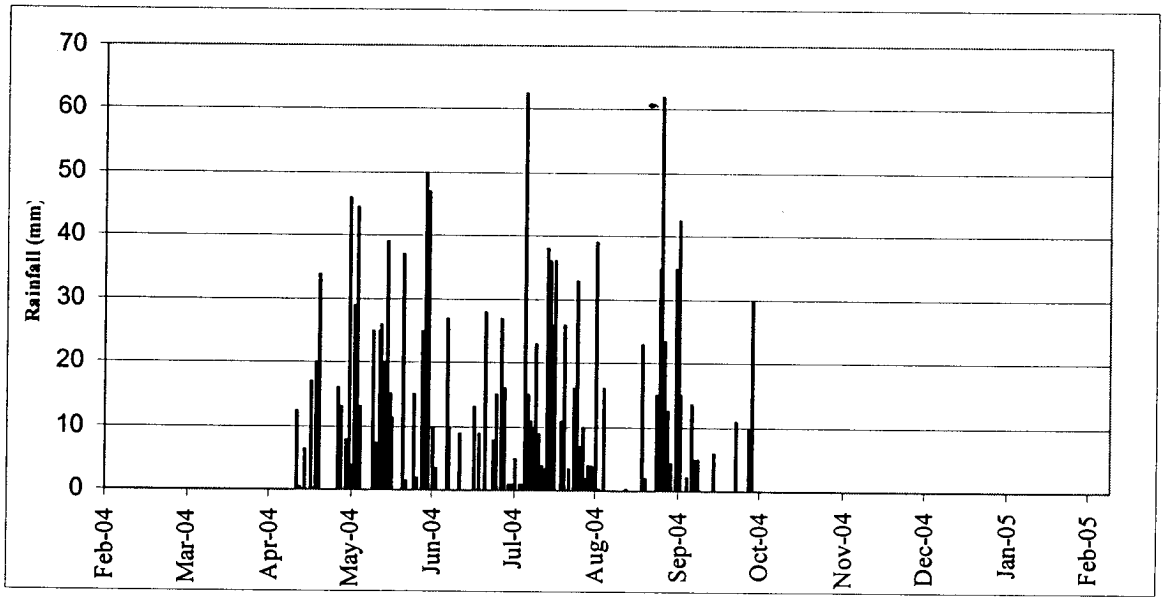


Figure 4.2. Period and volume dynamics of rainfall in the study site (recorded every 24 hrs) in Ban Muang Phaem. The peak of rainfall occurred randomly within rainy season, which have clear boundary to a dry period of summer and winter.

(Table 4.6), 9 species were classified as a potential species by using local knowledge (Table 4.7). *Ficus* spp dominated or were high abundance species of food tree grown in the home range. *Polyalthia viridis, Xylia xylocarpa, Mitrephora vandaeflora* and *Grewia eriocarpa* were most abundant of the other trees. Each species mentioned found grew in clump in their favorable area of each species. This probably can explain why the home range of the gibbons in this area is relatively large compared to those of Evergreen forest in KYNP or in HKKWS for instance. Base on plant habits, food plants of group G1 were categorized in to 8 categories including 30 (52.6%) trees, 10 (17.5%) figs, 7 (12.3%), 7 (10.5%) climbers, (3.5%), 6 (10.5%) shrubby trees, 2 (3.5%) bamboos, 1 (1.8%) epiphyte orchid, 1 (1.8%) parasite (Figure 4.3). Food plants in the home range of group G1 were divided in to 6 categories according to part eaten, 10 (22.2%) fig fruits, 28 (62.2%) other fruits, 4 (8.9%) flowers and 3 (6.7%) leaves (Figure 4.4). Photographs of each of food plants taken during the study shown in Appendix. The following are some detail of some food plants eaten or can be eaten by the gibbons.

Aeschynanthus andersonii (Gesneriaceae): On September, 2004 through the telescope, I observed one of them (probably adult male) brachiated toward the them and took the red flower from the parent clump that attached to the trunk of *P. viridis* at 15 m high. While the gibbon hanging and chewing part of flower I saw the flower in the other hand of the animal. It was about half a minute feeding before moved to the steep slope area to join the group. The event happened at the gibbon valley close to the plant plot number 65. The plant distributed around the steep slope area and the lower area of the home range where dominated by *P. viridis* and *Xylia xylocarpa*.

Antidesma sootepense (Euphorbiaceae): This plant can be found scattered over the area, especially in the lower area of the primary forest, and never been found around the plateau. For this plant need more observation to confirm whether gibbon can eat them.

Anthocephalus chinensis (Rubiaceae): This plant usually growth at the stream sites. I and the helper observed adult female (dark phase) and her young (dark phase) of group G6 on the tree on 3 December 2004. After we walked close to the tree the female moved away from the tree to the higher tree nearby while the juvenile still

Table 4.3: Phenology of flowering (top row for each species) and fruiting (bottom row) of food plant of the main study group at Muang Phaem Forest covering the area of population L1 and L2 (2 species from the home range of G2 and G4)

Species	Location	Abundance	Plant habits	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Aeschynanthus andersonii C.B. Clarke	val+sl	2	EO												
Alangium Kurzii Craib. (potential)	no detail*		T												
Anacolosa ilicoides Mast. (from G4)	sl	1	T												
Antidesma sootepense Craib.	val+st	3	ST												
Anthocephalus chinensis (Lam.) A. Rich ex Walp.	st	2	T												
Aporosa villosa (Wall. Ex Lindl.) Baill.	pt	1	T												
Artocarpus lacucha Roxb.	val	1	T												
Baccaurea ramiflora Lour.	val	2	T												
Balakata baccata (Roxb) Esser.	val	1	T												
Bambusa sp 1	val+sl+pt	5	B												
Bambusa sp 2	val+sl+pt	5	B												
Bischofia javanica Bl.	sl+st	2	T												
Bombax insigne Wall.	sl+pt	3	T												
Cyathocalyx martabanicus Hook.f. & Thomson.	sl+val	3	T												
Dillenia spp (3 species) (*D. aurea, D. parviflora, D. indica*)***	val	2	T												

Table 4.3: Phenology of flowering (top row for each species) and fruiting (bottom row) of food plants of the main study group at Muang Phaem Forest covering the area of population L1 and L2 (2 species from the home range of G2 and G4) (cont.)

Species	Location	Abundance	Plant habits
Dimocarpus longan Lour.	pt	2	T
Diospyros coaetanea (Craib) Fletcher.	val	1	T
Diospyros glandulosa Lace.	st	1	T
Elaeagnus latifolia L.	val	2	C
Ficus spp (10 species).	pt, sl, val	5	Fi
Flacourtia indica (Burm.f.) Merr.	val	2	ST
Grewia eriocarpa Juss.	pt	4	ST
Lannea coromandelica (Houtt.) Merr.	pt	1	T
Mangifera sp.	val	2	T
Melodinus cambodiensis Pierre ex Spire.	sl	1	C
Microcos paniculata L.	val	3	T
Mitrephora vandaeflora Kurz.	val	2	T
Mucuna pruriens L. DC.	val+pt	1	C
Phyllanthus emblica L.	val	3	T
Polyalthia cerasoides (Roxb.) Benth. ex Bedd.	sl	4	ST

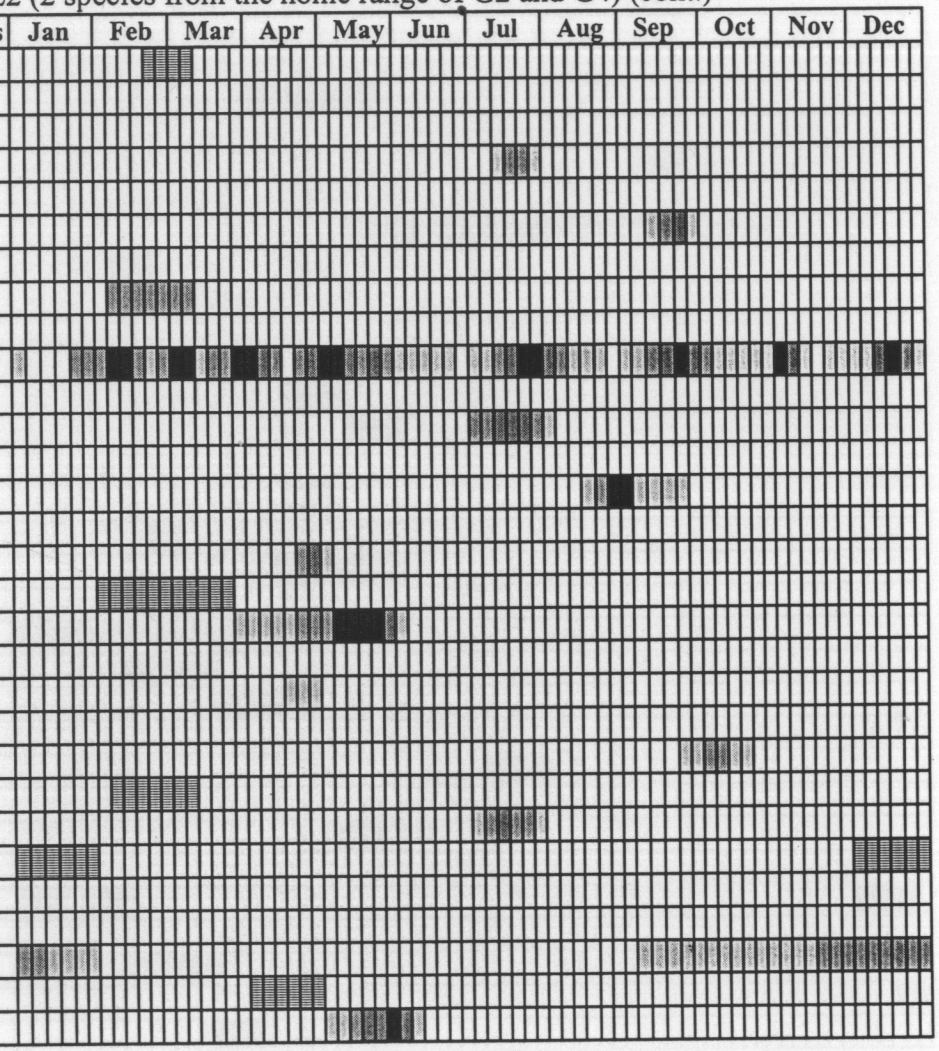


Table 4.3: Phenology of flowering (top row for each species) and fruiting (bottom row) of food plants of the main study group at Muang Phaem Forest covering the area of population L1 and L2 (2 species from the home range of G2 and G4) (cont.)

Species	Location	Abundance	Plant habits	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Polyalthia viridis Craib.	val	5	T												
Protium serratum Engl.	pt+sl	3	T												
Schleichera oleosa (Lour.) Oken	pt	3	T												
Scurrula sp.**	val+sl	5	Pa												
Spondias pinnata (L.f.) Kurz.	val+sl	2	T												
Syzygium sp.	val+sl+pt	4	T												
Tinospora crispa (L.) Miers ex Hook.f. & Thomson	val	3	C												
Vitaceae (wild grape) (*Tetrastigma* sp)	val+sl+pt	5	C												
Xylia xylocarpa (Roxb.).	val+sl	5	T												
Ziziphus rugosa Lam.	pt	5	ST												
Nato-jor-zoo (Karen).	val	3	T												
Sa-glee-po (Karen).	sl	2	T												
Ta-ju-or-sa (Karen). (*Tetrastigma* sp.)	val+st	2	C												
Tu-bor-khe-khor (Karen). (*Tetrastigma* sp.)	val+st+sl	1	C												
Ze- blor-mae (Karen).	val	3	T												

Table 4.3: Phenology of flowering (top row for each species) and fruiting (bottom row) of food plants of the main study group at Muang Phaem Forest covering the area of population L1 and L2 (2 species from the home range of G2 and G4) (cont.)

Species	Location	Abundance	Plant habits	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ze-do-sa (Karen). (from G2)	st	1	T												
Ze-le-cho (Karen).	sl+pt	4	ST												
Ze-sor-je (Karen).	sl	3	T												

Note: pt= plateau with diffused limestone, sl=slope site or on cliff, st=stream site, val=valley or plain
1= rare (1-5), 2=low (5-10), 3 medium (11-14), 4=high (16-20), 5 very high (>20)
B=Bamboo, C=Climber, EO=Epiphytic Orchid, Fi=Fig, Pa=Parasite, ST=Shrub or Shrubby Tree, T=Tree, uk=unknown

represent peaking time of fruiting
represent high available
represent fair available
represent poor or only few left
represent flowering

* = Data from plant sample colected by villager (local knowledge)
** = Need more species identification
*** = Tentative species identification

Table 4.4. Food plants observed eaten by gibbons of group G1 at Muang Phaem Forest (also includes 1 species from group G4).

Species	Family	Part eaten	Obs. days	Habitat types	Size (cm)	Color	Behaviors
Observed food plants							
Aeschynanthus andersonii	Gesneriaceae	fl	26-Sep-04	1m, 2	(Flower)	r	chewing
*Anacolosa ilicoides**	Olacaceae	fr	18-May-04	5	2.3x2.5	r	chewing
Anthocephalus chinensis	Rubiaceae	fr	12-Mar-04	1m, 2	4.5-6	y	move out,
Bambusa sp 1 (medium)	Gramineae	lb	26-May-04	1m			chewing,
Bambusa sp 2 (large)	Gramineae	lb	27-Jul-04	1, 2			chewing
Bischofia javanica	Euphorbiaceae	fr	26-Sep-04	1m, 5	0.6-0.7	b	chewing
Bombax insigne	Bombacaceae	fl	18-Dec-04	eco 1 and 3, 3	12 (length)	w	chewing
Ficus spp.(10 spp)	Moraceae	fr, ys	year round	lm, ld,1, 2, 3	0.5-3.5(l)	, b, y, d	chewing
Grewia eriocarpa	Tiliaceae	fr	9-Sep-04	3	0.6-0.8	dp	chewing
Mangifera sp.	Anacardiaceae	fr	May	1m	3-5x4-6	g	searching
Mitrephora vandaeflora	Annonaceae	fr	27-Jul-04	eco 1 and 3	2-2.5x2.5-4	y	chewing
Mucuna pruriens	Leguminosae	fl	14-Dec-04	1m, 3	4.3	p	chewing
Na-to-jor-zoo (Karen)		fr	18-Jul-04	1m,d,	2.6-3x3-4.6	b	chewing
Polyalthia viridis	Annonaceae	fr	31-Jun-2003	1m	2.1-2.5x2.8-5.1	b	on fruiting tree
Protium serratum	Burseraceae	fr	17-Sep-04	eco1 and 3	0.8-1.1	dr	chewing
Sa-glee-po (Karen)		fr	30-May-04	eco1 and 2	1.6-2x2.3-3	r	chewing
Scurula sp**	Loranthaceae	fl	3-Feb-05	eco1 and 3, 1m	no measuremen	o	chewing
Schleichera oleosa	Sapindaceae	fr	22-Sep-04	eco1 and 3, 3	1.8-2.6x1.8-2.6	y	on fruting tree
Syzygium sp.	Myrtaceae	fr	1-Jun-04	eco1and 3, 1m, 3	no measuremen	dp	chewing
Tetrastigma sp. (grape)	Vitaceae	fr	May-04	1, 3, 4	2x2	r	chewing

Note: fl=flower, fr=fruit, lb= leaf base, ys=young shoot, type 1m, 1d, 2-5 (see section 4.4), b=black, eco=ecotone, dp=dark purple dr= dark red, g=green, o=orange, p=purple, w=white, y=yellow * observed feeding by group G4, ** species identification is unlclear

Table 4.5. Food plants eaten by gibbons of group G1 by various evidences at Muang Phaem Forest.

Species	Family	Part eaten	Obs. days	Habitat types	Size (cm)	Color	Signs
Balakata baccata	Euphorbiaceae	fr	29-Jul-04	1m	0.8x1.2	dp	seed in feces
Cyathocalyx matabanicus	Annonaceae	fr	9-Mar-04	1m	7x7	gy	gnawed peel
Melodinus cambodiensis	Apocynaceae	fr	29-Apr-04	1m	7X7	o	teetch print
Polyalthia cerasoides	Annonaceae	fr	29-Jul-04	eco 1and 3	0.6-0.8x0.6-0.8	r	seed in feces
Ta-ju-or-sa (Karen)	Vitaceae	fr	Dec-04	1m	2.5-3.2x2.5-3.2	y	peel
Tinospora crispa	Menispermaceae	fr	8-May-04	1m	1.5-1.8x1.5-1.8	y	peel
Tu-bor-khe-khor (Karen)	Vitaceae	fr	7-Mar-04	1m, 2	2.5-2.8x2.5-2.8	gy	seed in feces
Ze-sor-je (Karen)	Meliaceae	fr	5-Aug-04	1, 2	2.8-3x3-3.2	cr	teetch print

Note: fr=fruit, type 1m, 1d, 2-5 (see section 4.4), eco=ecotone, cr=creamy, dp=dark purple, g= green, gy=greenish yellow, o=orange, r=red, y=yellow

Table 4.6. Plants recorded as gibbon food plants in other studies and found in the home range of group G1 at Muang Phaem Forest

Species	Family	Part eaten	Peak of fr/fl	Habitat types	Size (cm)	Color	References
Aporosa villosa	Euphorbiaceae	fr	May	1d	0.7x1	y	Suwannakerd, 2001
Artocarpus lacucha	Moraceae	fr	May	1m	no data	y	Bhumpakphan, 1988
Baccaurea ramiflora	Euphorbiaceae	fr	Jun	1m	2.5x2.5	y, dr	Suwannakerd, 2001
Dimocarpus longan	Sapindaceae	fr	non fruiting	1, 3	no data	b	Bhumpakphan, 1988
Dillenia sp 1	Dilleniaceae	fl, fr	Jul	1m, 1d	2x2	y	Bhumpakphan, 1988
Dillenia sp 2	Dilleniaceae	fl, fr	Jul	1m, 1d	2.5x2.5	y	Bhumpakphan, 1988
Dillenia sp 3	Dilleniaceae	fl, fr	Jul	1m, 1d	3.5x3.5	y	Bhumpakphan, 1988
Diospyros glandulosa	Ebenaceae	fr	late Sep	1m	5-5.5x5-5.5	y	Kanwatanakid, 2000
Flacourtia indica	Flacourtiaceae	fr	Jul	1m, 4, 5	4.5	b	Bhumpakphan, 1988
Lannea coromandelica	Anacardiaceae	fr	late Apr	1m	0.7x1	no data	Suwannakerd, 2001
Spondias pinnata	Anacardiaceae	fr	Oct-Dec	1m	3.2x3.7	yg	Bhumpakphan, 1988
Xylia xylocarpa	Leguminosae	fl,fr	Jan-Feb (fl)	1m, eco1and 3	seed plant	rb	Bhumpakphan, 1988
Phyllanthus emblica	Euphorbiaceae	fr	, Oct-Mar	1m, 5	no data	Pg	Bhumpakphan, 1988

Note: fl=flower, fr=fruit, type 1m, 1d, 2-5 (see section 4.4), b=black g= green, gy=greenish yellow, o=orange, Pg=pale green, pi=pink, r=red, rb=reddish brown, y=yellow, yg=yellowish green

Table 4.7. Food plants of gibbons named by villagers of Ban Muang Phaem.

Species		Part eaten	Peak of fr/fl	Habitat types	Size (cm)	Colors
Alangium kurzii	Alangiaceae	fr	no data	1m	no data	b
Antidesma sootepense	Euphorbiaceae	fr	Jan	1m, 5	<0.5	b
Diospyros coaetanea	Ebenaceae	fr	late Jul	1m	4.5x3.5	y
Elaeagnus latifolia	Elaeagnaceae	fr	Jan-Mar	1m	1.5-2x3	o
Microcos paniculata	Tiliaceae	fr	Oct	1m	0.9-1.2	b
Ze-blor-mae		fr	Apr	1m	1-1.2x1.2-1.3	y
Ze-do-sa*		fr	Apr	1m	5.5x8	Pg
Ze-le-cho		le	Jan-Feb	1, 3	(Leave)	pi
Ziziphus rugosa	Rhamnaceae	fr	Apr	eco 1d and 3	1.2-1.4	y

Note: fr=fruit, le=leave, type 1m, 1d, 2-5 (see section 4.4), eco=ecotone, b=black o=orange, Pg=pale green, pi=pink, y=yellow * in the home range of group G2 (Huai Luk group)

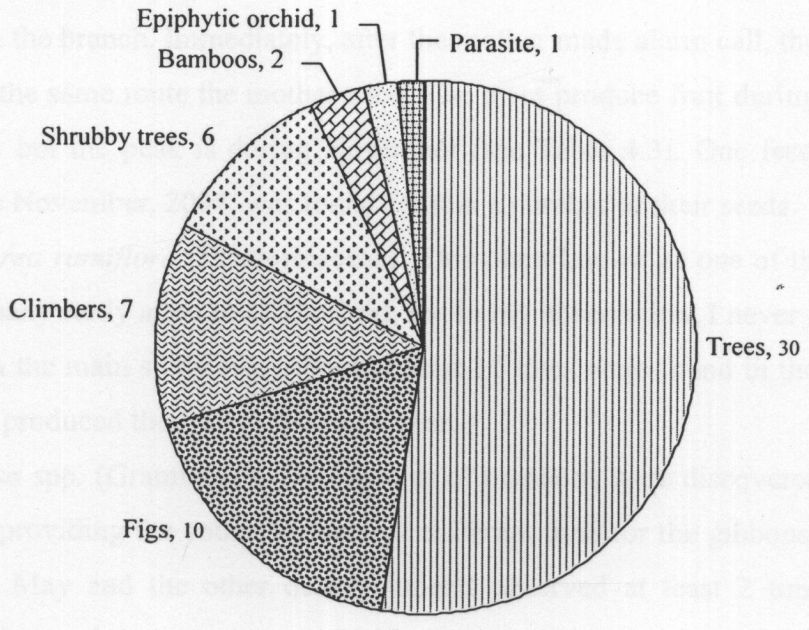


Figure 4.3. Proportion of food plants classified from plant habits in the home range group G1 in Muang Phaem forest.

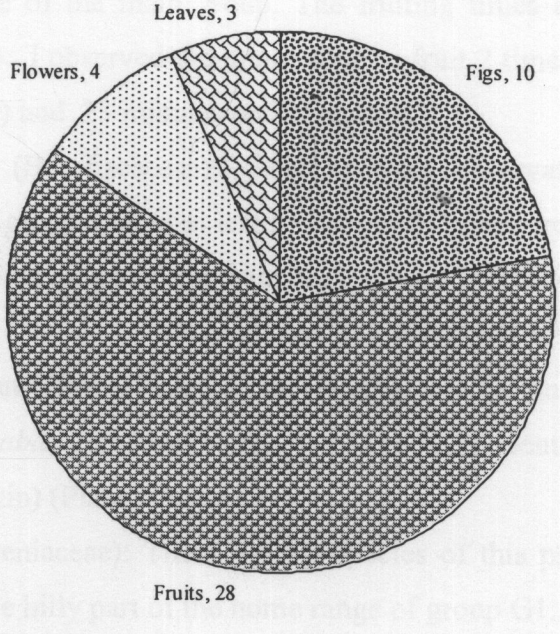


Figure 4.4. Proportions of food plants classified by part eaten of group G1. Data from my observation, distinct confirmed evidences, and from local knowledge were included.

stayed quite on the branch. Immediately, after the mother made alarm call, the juvenile moved follow the same route the mother used. The plant produce fruit during October to late January but the peak is during November (see Table 4.3). One feces sample collected in the November, 2004, was found contain a number of their seeds.

Baccaurea ramiflora (Euphorbiaceae): This plant known as one of the gibbon food plant in many study areas over Thailand, but in my observation, I never found the gibbon eat it in the main study site. About at least 10 trees were found in the site and not all of them produced the fruit in the same year.

Bambusa spp. (Gramineae): Two species of bamboos were discovered play an important role providing the young shoots in 2 different time for the gibbons, the first species during May and the other during June. I observed at least 2 times of 47 minutes each observed the group spent significant time fed on bamboos (pick and put into the mouth while the young mostly play around) over their home range. Many of bamboo young shoots with chewing sign at the proximal end of its young leaves were found under bamboo clamps (Plate 6 (a) and (b) Appendix).

Bischofia javanica (Euphorbiaceae): Three individuals of this species were found in the home range of the main group. The fruiting times among them were different, about 2 months. I observed the group feed its fruit 2 times at the same tree, 90 minutes on September) and 23 minutes on November.

Bombax insigne (Bombacaceae): From direct observations and flower dropped, I found that the group visited at lest 5 times at the same tree. At least 8 trees were found within the home range of the main study group and all of them flowering in slightly different time. The group move around the flowering tree (40m tall) for a significant time (more than 40 min) rested on its branches and fed on its white flowers.

Cyathocalyx martabanicus (Annonaceae): I found 2 evidents in the site (fruit with teeth print on fruit skin) (Plate 7 Appendix).

Dillenia spp (Dilleniaceae): There were 3 species of this plant distributed in lower area surrounding the hilly part of the home range of group G1. I have never seen the gibbon feed on it during the study.

Diospyros coaetanea (Ebenaceae): Only one of them was found beside the road beside the road of the village in the ridge of the home range where difficult for the gibbon to reach.

Ficus spp. (Moraceae): Ten species of figs in the home range of group G1 were observed eaten by the gibbon group G1 through out the year of my study. The difference of fruiting and ripening time of each species and slightly overlapping among individuals of the same species has clear function to the survival of the gibbons in this dry habitat, especially when others food plant is lacked. Compare to other fruit plants, *Ficus* sp found to have relatively high and stable production. For the large figs, which high about 35-40 m with canopy shade about 30- 40 m could provide food for the group and others animal for about 10-15 days. Identification of 6 species of figs namely, *F. kerrzii F. altissima, F. benjamina, F. microcarpa, F. concina, F. curtipes corues* were confirmed.

Flacourtia indica: (Flacourtiaceae) I found one within the core area of the home range. It produced not many fruits and only 2 trees were found out side the home range of group G1. I have never seen the gibbons ate it, whereas the villager likely to eat this fruit.

Grewia eriocarpa Juss (Tiliaceae): I found this plant dominated the area especially in the area near the ridge of plateau and near the cliff site at elevation of 900 m.a.s.l. This plant played a role during late rainy till early cold season. I had observed the group fed on it 2 times (during September, 2004) on the plateau where they mixed with *Bombax insigne, Graminea* sp, *Tectona grandis, T. pyramidadus, Terminalia alata, Protium serratum* and 3 species of *Sterculia* sp for instance.

Mangifera sp. (Anacardiaceae): Since they are found in low density in the area where the gibbon can reach, so the role of this plant relatively low in the home range of the main study group. Many of them were found outside the home range of group G1. I observed one time while the group visited the tree and fed on it.

Melodinus cambodiensis (Apocynaceae): Two of them were found at 2 locations in the home range of the studied group. One fallen fruit of tooth's print on fruit skin was observed and photographed.

Mitrephora vandaeflora (Annonaceae): I observed 1 time during one of them feeding on it at the ridge of the home range adjacent to the new crop field that just cleared it the year 2003 (after about 10 years succession).

Mucuna pruriens (Leguminosae): I observed one of group G1 fed on it during travel back visiting the fruiting foraging. The gibbon spent about 1 minute on it before

moved back to feed on *F. kerzii*. The gibbon probably took this plant for supplement because it is rare in their home range.

Polyalthia cerasoides (Annonaceae): I have seen this plant grow in only some area within the home range of the main study group. About 10 trees were found in the lime stone area. The gibbon took them as supplement food choice because their abundance and production were relatively low.

Polyalthia viridis (Annonaceae): Although the density of *P. viridis* is relatively high and high production especially in summer, but the gibbons seem to eat them for sometimes in case of no any other fruit of choice. The cause that explain this may be they did not like the taste of the fruit. The main function of this plant is to provide the food for their competitors such as great hornbill (*Buceros rhinoceros*), mountain imperial pigeon (*Ducula badia*) and squirrels. During the year 2003 during the peak of the plant fruiting time I had seen *D. badia* flying over and fed on them sometimes.

Protium serratum (Burseraceae): I found about 10 of this plant distributed in the site, only one time observing while the group feeding on it.

Schleichera oleosa (Sapindaceae): Due to its long fruiting time (4-5 months), *S. oleosa* can compensate food for the gibbons during rainy and winter period that lack fruit.

Scurrula sp. (Loranthaceae): This plant is one of the most important food for gibbons during dry season in this area. Feces examination of 2 samples collected in March 2004 and of February 2005, showed significant proportion in the feces (about 20-30% in weight). The plant usually found growth on the upper branches of tall tree canopy, mostly on *Xylia xylocarpa* which grow in high density in lower area. This shows that plant–plant relations have a role in contributing survival of animals.

Spondias pinnata (Anacardiaceae): I had observed the group moved around this plant during late phase of their fruiting time (October-February), but have never seen the group fed on it during my study.

Syzygium sp. (Myrtaceae): This plant bare fruit during middle period of rainy season. I have seen group G1 fed on this plant in June after late morning call. The distribution of the plant is clumped in some area.

Tetrastigma sp. (Vitaceae): The gibbon relied on this juicy fruit during rainy season especially when most of others fruits still uneatable, especially during the time

between dry and rainy season. I had observed the group fed on this fruit many times. I had seen a lot of skin of the fruits on the ground for many times. The taste of this fruit is great but the unripe one should be carefully avoided because its toxicity to soft tissue.

Tinospora crispa (Menispermaceae): Only about 10 of the fruit covers were found on the ground. So I think the gibbon eat their seeds but no any feces evidence confirm that weathers they swallow their seed or not. But it is possible for them to swallow the seed because the fruit have the same size with *Tetrastigma* sp.

Xylia xylocarpa (Leguminosae): This plant can be found in the slope and lower area in highest density, but its function as diet of the gibbon are not very distinctive as its indirect function serving as the host tree for *Scurrula* sp that like to grow in the top of its canopy. In the secondary forest, I found small and medium size of this tree growth in relatively high number. Those tree always been cut when the villager want to clear the land for cultivation.

Ze-sor-je, Karen: (*similar to Aglaia grandis*) (Meliaceae) My field helper once observed 3 of the group fed on its fruit at the gibbon cliff (the location I named for me to communicate with my helper, Arun). The group spent about 10 minutes on the tree and did not move away even the group saw the helper and his dog. However, the production of the fruit is very low during my study time.

4.6.2 Fecal analysis

- Seed found in the feces

Seven samples of feces were collected within the home range of the main study group on March 4 (2 samples), March 6, late March, July 29, November 8, December 2004, and February 3, 2005. Visual estimates of dried seed found that *Ficus* spp were a major component in all the samples in different proportion in the range 40-100 %. Percentage of *Ficus* spp in feces found highest in March and lowest in July (Figure 4.5 and Table 4.8). Feces collected in July contain 4 species with low seed of fig while only 2 species with seed of figs were found in March including figs. Photos of seeds found in feces show in Appendix Plate 11.

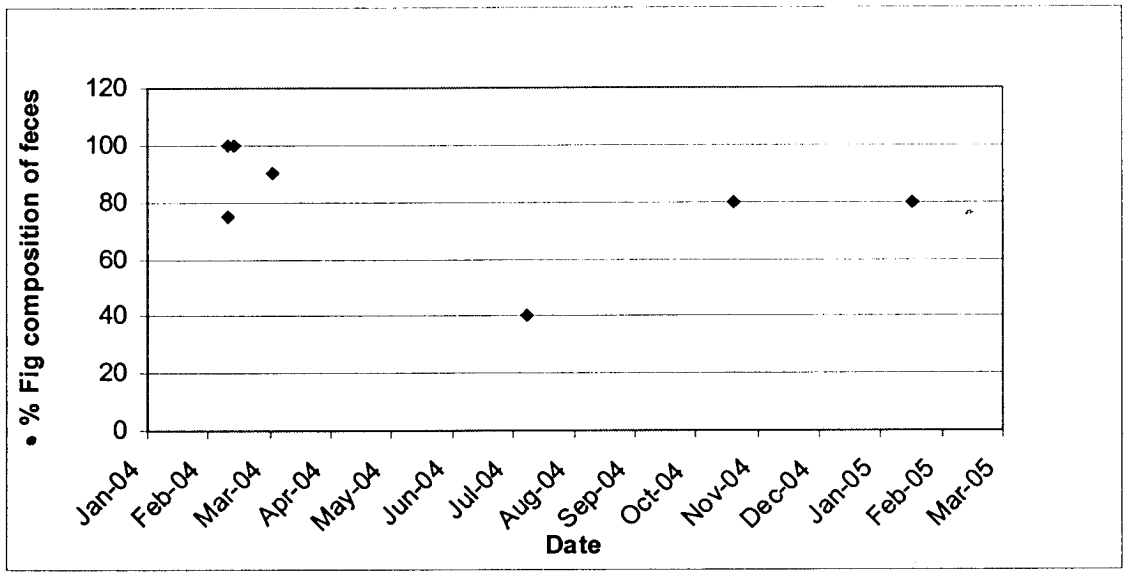


Figure 4.5. Proportion of fig seed (by eye estimation) in gibbon diet found in feces of the main study group collected in different time within the home range. During late July, figs found in relatively low percentage (40%) because during that time there were many other fruits available.

Table 4.8. Composition of seeds and insects by eye estimation in dry feces dropped by the member of the main study group.

Feces collected	Sample collecting dates	% of *Figs*	% Tree seed	% Climber	% *Scurrula* sp	Ins.
Sample 1 (vf)	4/3/04	75	0	5 (1seed)	20	X
Sample 2 (f)	4/3/04	85, 15 (2 spp.)	0	0	0	X
Sample 3 (f)	6/3/04	100	0	0	0	X
Sample 4 (f)	Late 3/04	90	10			X
Sample 5 (f)	29/7/04	40	60 (4spp.)	0	0	X
Sample 6 (vf)	8/11/04	80	20	0	0	X
Sample 7 (vf)	3/2/05	80	20	0	0	Y

Note: vf =very fresh (less than 12h), f (more than 12 h) X = not found, Y = found

- Insect found in feces

Sometimes the member of group G1 was observed searching and pick up some thing in their hand and ate them. (possibly they search insects from the bark on the surface of *Xylia xylocarpa*) I notice that, only some group member performed this behavior only about 5 minutes during resting and playing time after the first feeding bout. In December, at Huai Plamung, I observed the subadult light phase female fed on something which was attached on the surface of the leaf of Fagaceae. That time the plants still have their leaves while most of the tree loss their leaves. The gibbon picked up the leaf and put it in her mouth before throwing away on the ground. I found that, Dipterocarp Forest surrounding the home range of each group play a role as the insect food source. The home range is characterized by Dry Evergreen Forest and a kind of Deciduous Forest. From fecal analysis (collected on February 3, 2004), I found at least 3 species of insects including *Stagmomantid* sp. 1 species of Hymenoptera and unknown larvae stage mixed in the feces (Appendix plates 13-17).

4.7 Behavior

4.7.1 Ranging

Observing main study group (4,492 minutes of 73 observation days), I found that the group have systematic pattern of traveling. When the group has to move from place to place during day activities, they move slowly in order to check for safety for all the members of the group, especially the infant and the adult female. Data on daily travel distant and space used are difficult to gain because habituation was not successful. It seems to be that the group is permanently afraid of human. The places visiting by the group depend on distribution of food plants and their phenology. Large figs which plenty of fruit attract group to visit. The group spent more time on bamboo (2 main species) feeding on base of young leaves during May and July. The bamboo provided not only food for the gibbon but also for an important traveling route. The group visited the fruiting trees although the location of the tree was very closed to crop field and the village. This showed that the area is safe for them. But, however, the main study group and other groups have shown some degree of human avoidance influencing ranging pattern of them.

It was difficult to estimate the group range per day because very few time I could follow the group for all day long. However, in my observation, distances the group travel a day is depended mainly on number of species of food plants available during that time. In case of ripening large figs the group stayed around (normally fig) for a few day especially on summer when there the area was lack of food. Therefore, ranging of the group depend mainly on phenology and distribution of productive food plants during that time.

In case of the group traveled more because of disturbance by human activities, I did note as a special case. Only one time I observed the group emitted group duet from the edge of the home range.

- Traveling and dashing

When the group had to travel, the adult male and one of subadult usually led the group and were followed by the adult female with her clinging young, and last by one of the subadult. At least 4 times the male lead the group (12, 13, 18, May and 18 December, 2004). For the bamboos in the area, they were not only food provider, but also play an important role for traveling of the gibbon (Plate 4.1 a). There is a gap of time between the first one and the last one of the group. During travel the adult male is the most awared one compared with the rest of the group. Sequence of the group leader and the last were different sometimes, but the reason is not clear. One of the reason is depended on the position of the group member at that time especially when the group encountered humans. I noticed that when the group moved in the territory of Greater racket-tailed drongo, the bird always mimicked their call. At least 5 times on May, 2004 the bird mimicked the gibbon call. I used their mimicked as my best guide to locate the group. The sound produced by this bird was not very similar (like the call of young gibbon) but distinct enough from normal call to say that they try to mimicked.

When encountering humans, the adult female with her young (weaning) usually dashed away first, followed by adult male and 2 subadults respectively (about 4 observations). Sometimes subadult 1 and subadult 2 (classify by size and gibbon family structure) stayed behind, especially in the open forest on the plateau. Unlike the previous cases, sequences of individuals during foraging time or normal traveling, sub adult 1 and sub-adult 2 moved first and followed by adult male and adult female and

her baby (2 of 3 cases) which usually the last in traveling. Sometimes the adult male is the leader (1 of 3 of observations).

- Sleeping site selection

Five locations were recorded as sleeping sites, 1) at gibbon cliff, leafless *Xylia xylocarpa*, 2) on bushy *Cyathocalyx matabunicus* at the lower Steep slope site of gibbon valley, 3) on bushy *Cyathocalyx matabunicus* line C on the edge of the lime stone plateau, 4) up on bamboo (the biggest bamboo species found mostly at cliff site) branches at gibbon valley, 5) in the tree raise at inaccessible part on lower area of gibbon valley. The time setting down for a night sleeping tree was varied from very early afternoon 14.02 to late evening at 16.45 (n=6). Sleeping place they chose were a single standing tree or bamboo which have thick leaves or big branch and not connect to another branches and usually in the middle of the cliff. The distances between members of the group rank from 30-50 m. By naked eyes, it was very difficult to see them when they stay quiet. The gibbon moved away when the distance between sleeping tree and me was too closed (less than about 30 m) even I can see them or not. During traveling they move for some distance and stay for a while to detect the enemy or human, then keep going to the top or safety zone on the cliff. Date and time the main study group got in to the sleeping sites show in Table 4.9.

- Setting down for the night

Each of the members of the main study group was observed chosen isolated trees which located around a high slope area near the cliff site for their sleeping places. The tree not very tall (about 15-25 m). The sleeping places that I found are usually on the higher branches or tree which covered by a lot of leaves and sometimes on the lower big branches which they could hide from human. So it is not easy to see them by naked eyes (to see them we have to use pair of binoculars). One of the most favorite sleeping tree which they chose is *Cyathocalyx matabanicus* (Karen call "To-a-gor") which usually found distributed steep slope around the slope area or close to the stream. Bamboos were one of the plant that the gibbons usually used for sleeping place at night (2 observations). The gibbons stay and sleep on the single bamboo branch (of the largest species) for the whole night (Plate 4.1, b).

Table 4.9. Night sleeping sites and places of the main study group.

Date	Time	Species of the sleeping trees	Sleeping place heigh (m)	Location of sleeping sites
12/5/03	16.52	*Xylia xylocarpa*	15	at gibbon cliff
24/5/04	16.01	(Bamboo area)	>15	at line C fig cliff
30/5/04	16.45*	(moving to gibbon cliff area)	-	lower Plug Krabue (pk)
30/10/04	15.05*	Bamboo	15 on slope area	on bamboo grow at ledge site
18/12/04	14.02-15.18*	*Cyathocalyx martabanicus*) and bamboo	20 from slope area, 15 on bamboo top	at gibbon valley upper route
25/2/05	17.40	*Cyathocalyx martabanicus*	20-25	C 260 (study trail C)

Note * = start to setting down for the night. No star = the group already there at the time of sighting.

(a)

(b)

Plate 4.1. The use of bamboo by the gibbon for all year long, the gibbons used them for their daily life in many ways, such for as there traveling routes (a) and sleeping places (b). The photographs above were taken from the plateau ridge at October 30, 2004.

- Territory defense

One time during December, 2004, I saw the subadult gibbon chasing the Phayre's langur (*Semnopithecus cristatus*) in the late morning. This behavior is very swift and involved only one gibbon. All the family produced some calls during chasing. Defending by using great call are not clear in this site because each group usually spend most of their time only in there own territory. The conflict between Assamese macaque (*Macaca assamensis*) and the main study group has never been observed. Competition between the group and the couple of great hornbills was observed one time while the group chased the 2 hornbills from the branch of ripening fig on May, 2004 without fighting and with no aggressive expression. The 2 hornbills just fly away to the location nearby. During they fly away, unavoidably, the birds saw me and started to made alarm calls The calling last about 2 hours and stopped when I left the area. Few minutes after their call, the gibbons left the fig and started their *ooaa* call intercept with 4-5 female great calls from the location that they often used for morning calls. The group kept calling for about 20 minutes and then stopped while the 2 hornbills keep producing very loud aggressive alarm calls.

4.7.2 Feeding

Feeding and resting behavior were related. The main study group spent about 21 minutes on average (SD=7.3) (n=8) resting before the next feeding bouts. From my observations, group G1 usually feed 2-3 times a day. Distribution of feeding observed during the study range from 6:47 to 14:28 (Figure 4.6). Frequency of feeding time (in 36 effort days) recorded during 7:00-14:00 (1 hour interval) was almost equal, range from 8-11 times (n=72). Only 1 feeding observed after 14:00 (14:28). The group spent about 37.9 minutes/feeding bout (range from 5-110, SD=26.2) (n= 28) (Figure 4.7). *Ficus* spp were frequently observed (42.8 % n=28) of other 10 food species. The details of feeding time of each plant species observed is presented in Table 4.10, and 4.11. From my observations, I found that feeding bout depended on food choices, amount of food available at that time, species of food plant and the safety of feeding area. The group spent more time in large tree with high production and high percentage of ripening fruit such as diverse species of figs. Time spent feeding determined by the position of food tree, amount of ripened fruit, species of food plants

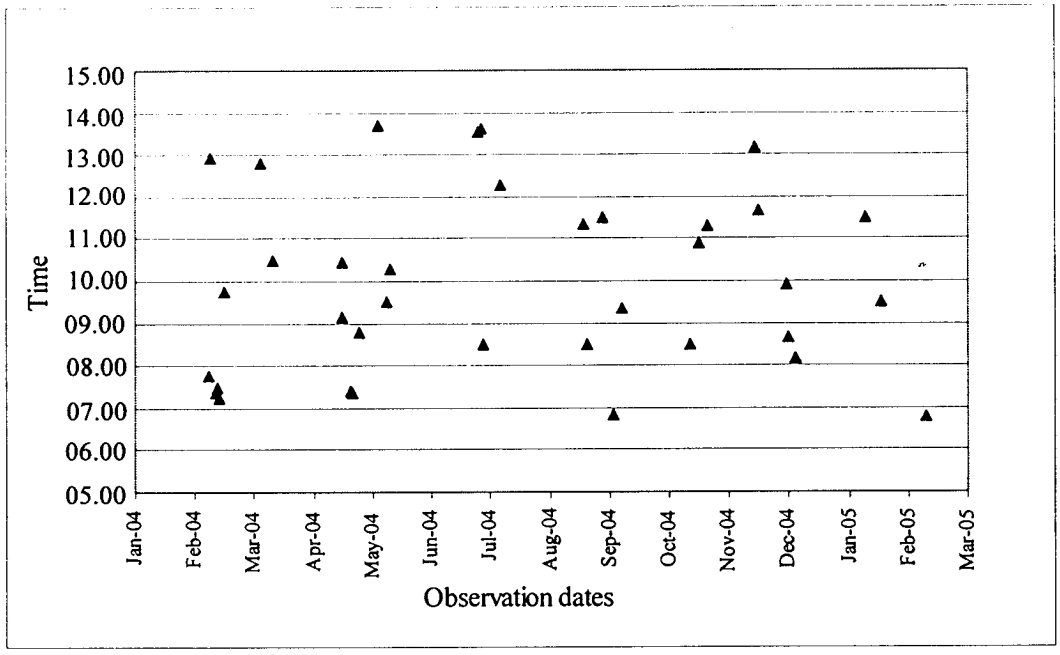


Figure 4.6. Times at which gibbons were observed to be feeding for the main study group.

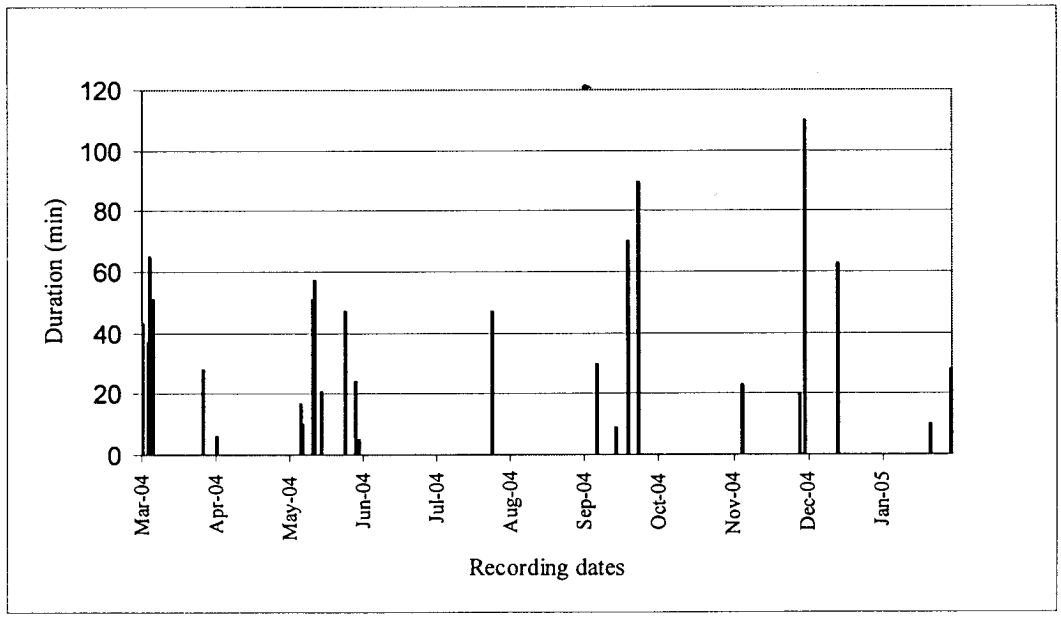


Figure 4.7. Distribution of feeding bouts of the main study group. In each season duration of feeding bout varies due to food available during that time.

Table 4.10. Time spent feeding on each plant species each day of the main study group from 25 Feb, 2004 to 25 Feb, 2005.

Date/sp.	*A. andersonii*	*A. chinensis*	*Bambusa* spp. 1	*Bambusa* spp. 2	*B. javanica*	*B. insigne*	*Ficus* spp.	*G. eriocarpa*	*M. vandaeflora*	*M. pruriens*	Nato-jor-zoo	*P. viridis*	*P. serratum*	Sa-gle-po	*S. oleosa*	*Scurrula* sp.	*Syzygium* sp.	*Tetrastigma* sp.
2 Mar 04							43											
4 Mar 04							37											
5 Mar 04							65											
6 Mar 04							65											
27 Mar 04							28											
7 May 04																		17
12 May 04[2]							51 30											
13 May 04							57											15
16 May 04							21											
21 May 03																		8
26 May 04			47															
30 May 04														24				
1 Jun 04																	5	
31 Jun 04												30						
18 Jul 04											5							
27 Jul 04				47					11									
30 Jul 03											10							
9 Sep 04								30										
17 Sep 04													9					
22 Sep 04															70			
26 Sep 04	2				90													
8 Nov 04					23													
2 Dec 04							20											
3 Dec 04*		5																
4 Dec 04							110			3								
18 Dec 0[2]						63 40												
19 Dec 04						77												
26 Jan 05							10											
3 Feb 05																28		
Total			94		113													

Note: All numbers represent time of feeding bouts (minute). *=eaten by G6 (L2).
[2]= two bouts in one day.
Underlined numbers indicate that the group stop feeding after disturbance.

Table 4.11. Time of feeding on different food plants by the gibbons in Muang Phaem forest during 2003-2005.

Plant species	Date	Time of feeding	Plant part eaten	Number of gibbon feeding	Height (m)
Aeschynanthus andersonii	26 Sep 04	10.27-10.29	fl	1	15
*Anthocephalus chinensis**	3 Dec 04	11.15-11.20	f	2	10-20
Bambusa sp 1(smaller)	26 May 04	13.41-14.28	lb	4	7-14
Bambusa sp 2 (larger)	27 Jul 04	12.17-13.04	lb	2	8-15
Bischofia javanica	26 Sep 04 8 Nov 04	09.20-10.30 11.18-11.41	f	5 5	20-30
Bombax insigne	18 Dec 04 19 Dec 04	09.55-10.58 08.39-09.57	fl	3 2	33-38
Ficus spp.	2 Mar 04 4 Mar 04 5 Mar 04 6 Mar 04 27 Mar 04 12 May04 13 May 04 16 May 04	12.55-13.38 07.21-07.58 07.28-08.23 07.14-08.05 12.05-12.33 07.25-08.16 11.36-12.06 07.30-08.27 08.05-08.26	f	4 4 4 4 4 4 4 4 4	10-40
Grewia eriocarpa	9 Sep 04	08.31-09.01	f	4	8-15
Mitrephora vandaeflora	27 Jul 04	13.04-13.15	f	1	25-30
Mucuna pruriens	4 Dec 04	13.27-13.30	fl	1	8-10
Nato-jor-zoo (Karen)	30 Jul 03 18 Jul 04	07.10-07.20 08.30-08.35	f	4	10-20
Polyalthia viridis	31 Jun 03	11.45-12.00	f	4	15-40
Protium serratum	17 Sep 04	11.31-11.40	f	1	10-20
Sa-gle-po (Karen)	30 May 04	09.03-09.27	f	4	10-25
Schleichera oliosa	22 Sep 04	06.50-08.00	f	4	10-25
Scurrula sp.	3 Feb 05	09.30-09.58	fl	2	25-40
Syzygium sp.	1 Jun 04	10.18-10.23	f	2	15-35
Tetrastigma sp.	21 May 03 7 May 04 13 May 04	07.42-07.50 10.26-10.43 12.21-12.35	f	3 1	10-30

Note:*=eaten by group G6, fl=flower, f=fruit, lb=leaf base. Underlined numbers indicate that the group stop feeding after they was disturbed.

and human traffic in the feeding area.

In the feeding time, I clearly found that not all of them feed, but at least one of them played a role detecting the invader by stay quietly or carefully moved around the feeding group. During observation I found many times the subadult or adult male acted as a guard while adult female and her young feeding on the tree that closed to human traffic route. I observed many times that one of them searching around the bark of tree such as figs and *Xylia xylocarpa* for instances, probably for supplement insect food.

4.7.3 Vocalization

At least 1,762 minutes was spent listening and recording all groups of population L1 and L2 vocalizations (mostly G1). In this study (mostly the main study group, group G1). The following are the main call type produced by the main study group and their neighbor groups

-Morning calls

The main study group called 48.46 % of total observation days (61 out of 130 vocal surveyed effort days) and more than a half of morning calls included great calls (55.73 %) that range from 1-11 times for one duet bouts. The main study group morning calls was recorded every time as possible. Distribution of starting and stopping time ranged shown in Figure 4.8. Distribution of starting time of morning calls (15 minutes interval) of L1 ranged from 06:45-11:48 h, mostly during 07:45-08:15 h (18) and 08:45-09.15 h (21) (n=91) and L2 range from 06:15-11:32 h, mostly during 09:00-09:45 h (15) (n=44) (Figure 4.9). Average starting time of morning calls of the study is 09:19 h, range from 06:45-12:45 h. Nevertheless, on average, the group likely to start morning calls slightly late in winter (09:20, n=14) when compared to summer (09:07 h, n=27) and rainy (08:36, n=20) (Figure 4.10). The frequency of calls between seasons is not different (43.7 % in winter, 46.5 % in summer, and 47.7 % in rainy season). An average starting time of morning call for all groups were 09:10 (n=109).

The main study group started singing mostly during 07:45-08:15 h (13) and 08:45-09:15 h (11) (n= 61). Calling after 12.00 h were very few and usually happened when some of the group member encountered the observer (call usually emitted by adult male but adult female join sometimes) (Figure 4.11). The adult female tended

to call after adult male. Distribution of starting time of the main study group and all groups during summer (March-April), rainy (May-September), late rainy (October-November) and cold (December-February) are showing in Figure 4.12 and 4.13. The main group spent on average 26.19 minutes/bout (range from 1-99) (n=61, SD=27.81) (Figure 4.14), and of all the groups spent time for morning calls 20.77 minutes/bout (range from 1-99) (n=117, SD=23.75) (Figure 4.15). The distribution of time spent in each time class of group G1 show in Figure 4.16 and 4.17. Group G1 called usually one time a day, only 6 days the group called 2 bouts/day. Alarm call together with *wow* and *ooaa* usually been produced when they see human in the territory. If they detect human, they usually move to another place carefully. The mother always went along with her clinging young. Great call of adult female of each group can be differentiated distinctively.

Starting time from 4 April to12 May, 2002 was 07.09 h (05:18-09:30) (n=7). During that time there are cloudy and rain start falling. Starting time for the year 2003 from April 20 - June 30 was 08.45 h (n=41). Average starting time of morning calls in May 2003 and May 2004 were 07.53 and 07.47 h respectively.

- Intergroup involvement in vocalizations: In this kind of fragmented habitat and low group density of my study site, the frequency of call interaction between groups is relatively low. Only 14 times did more than one group called in the same day. Only in 9 cases did more than 2 groups involved in morning vocalization in overlap time (7 cases of 2 groups interaction and 2 cases of 3 groups interaction). There were 4 cases each between G1-G3, 2 cases between G1-G5 and 1 case of G2 and G3 that may be considered as vocal interaction between groups.

- Great call: The characteristic of Great call of each group are unique. Data recorded in the field showed that, there are significant different between Great call among group and populations. I heard 2 times 3 individuals involved in producing this call in the same bout. From this, it is possible that there are 3 females in the group (if the young male never made Great call for all of their life). Sometimes, after they fled, the group start calling again from a far distance (about 300 m away).

Group G1 (group Huai Pong Jarun): Great call made by group G1 last about 15.55 seconds/bout (10-22) (SD=2.4, n=62). Time interval between bouts was 2.09 (SD=1.14, n=58).

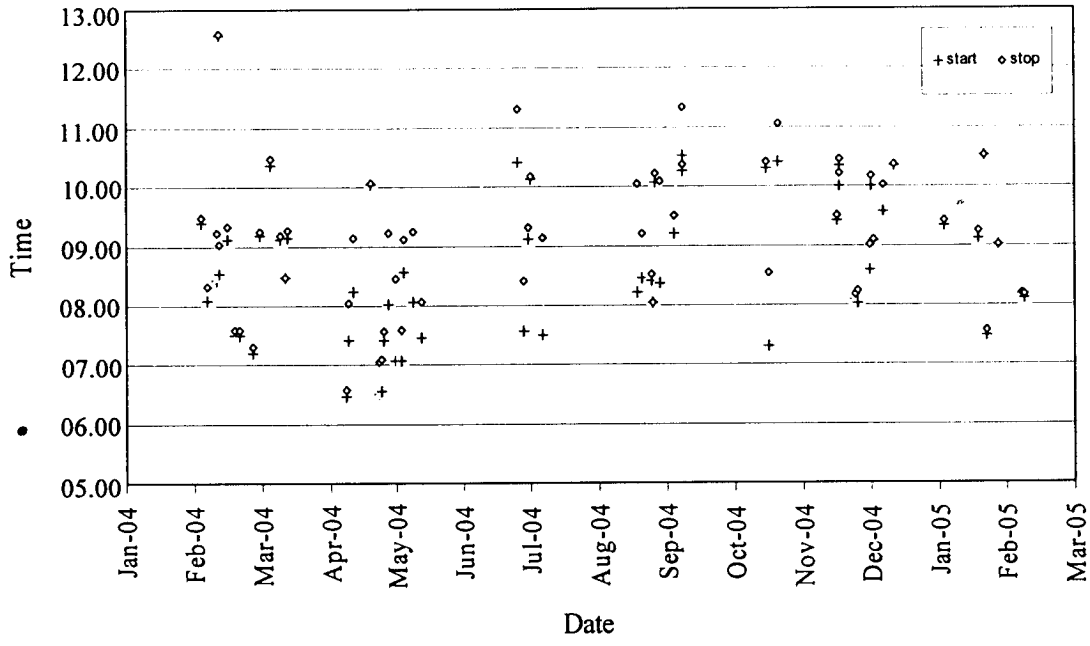


Figure 4.8. Distribution of starting and stopping time of morning calls of the main study group recorded mostly in 2004.

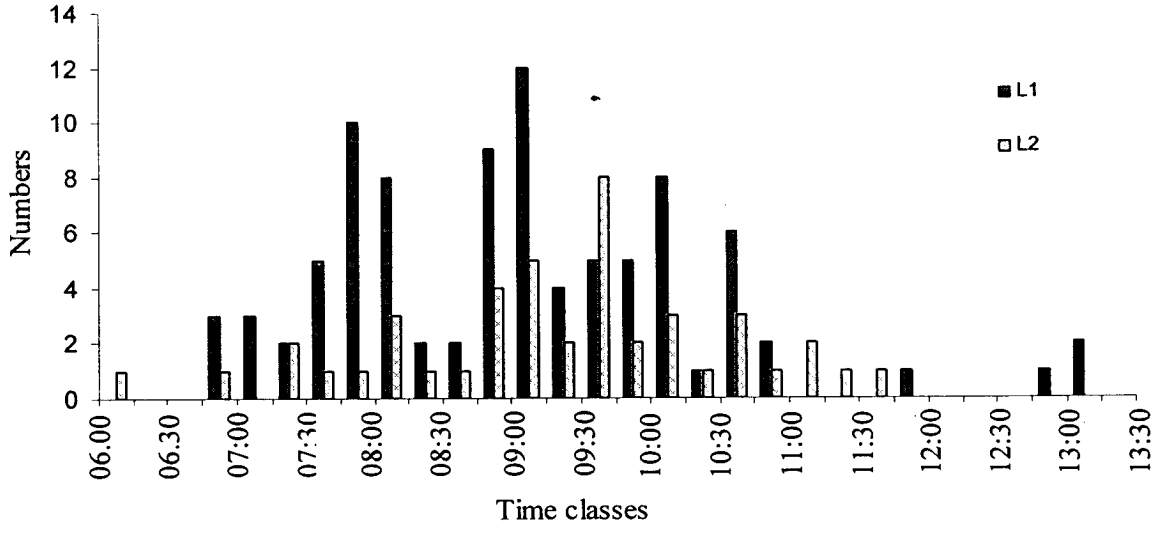


Figure 4.9. Frequencies of starting times of 2 populations in Muang Phaem forest, L1 showed 2 peaking periods 07:45-08:15 h and 08:45-09:15 h while L2 started calling mostly around 09.00-09.45 h.

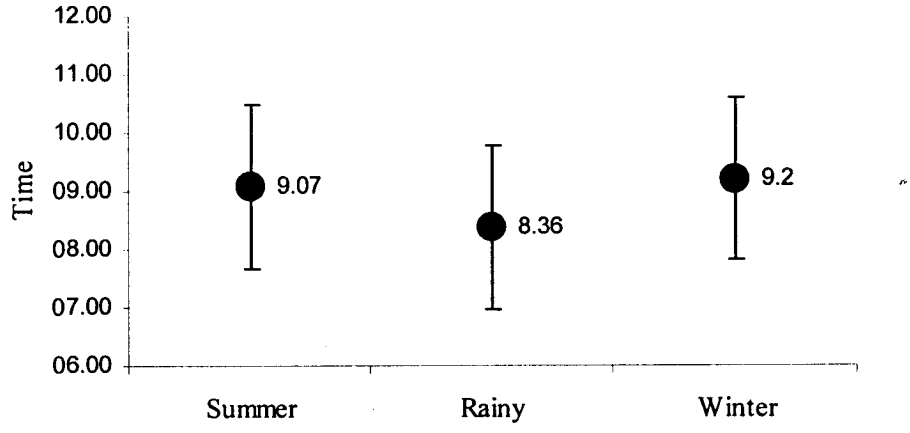


Figure 4.10. Average (±SD) starting time of morning calls of the main study group during summer, rainy, and winter (cold) season were 09:07, (±1.40) (n=14) and 08:36 h, (±1.40), (n=27), 09:20 h, (±1.27) (n=20), respectively. The group calls relatively late during winter.

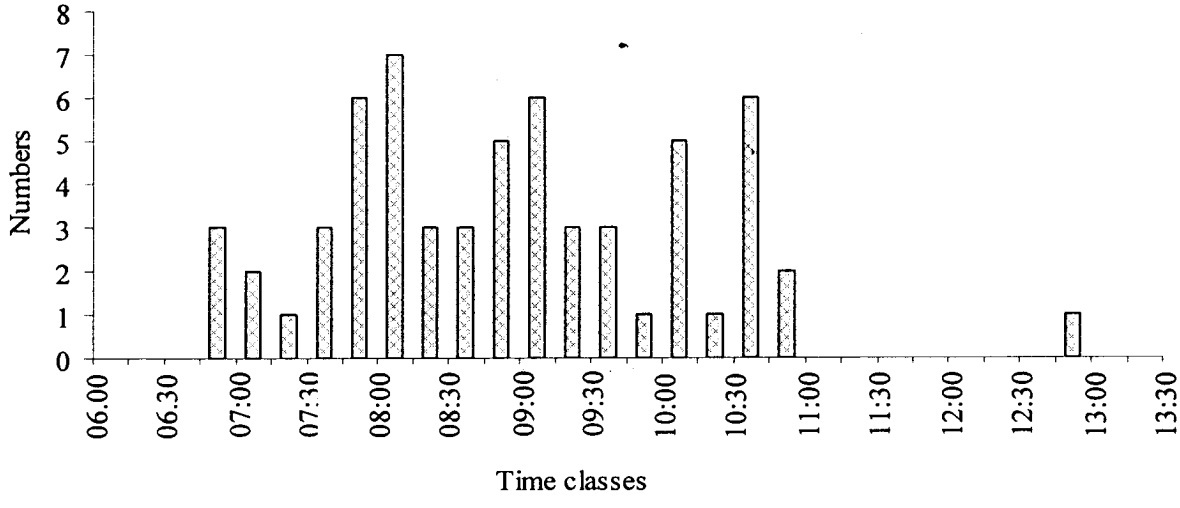


Figure 4.11. Frequency of starting time in each time class (15 min interval) produced by group G1. The peak time of morning calls for the group is 07:46-09:15 h.

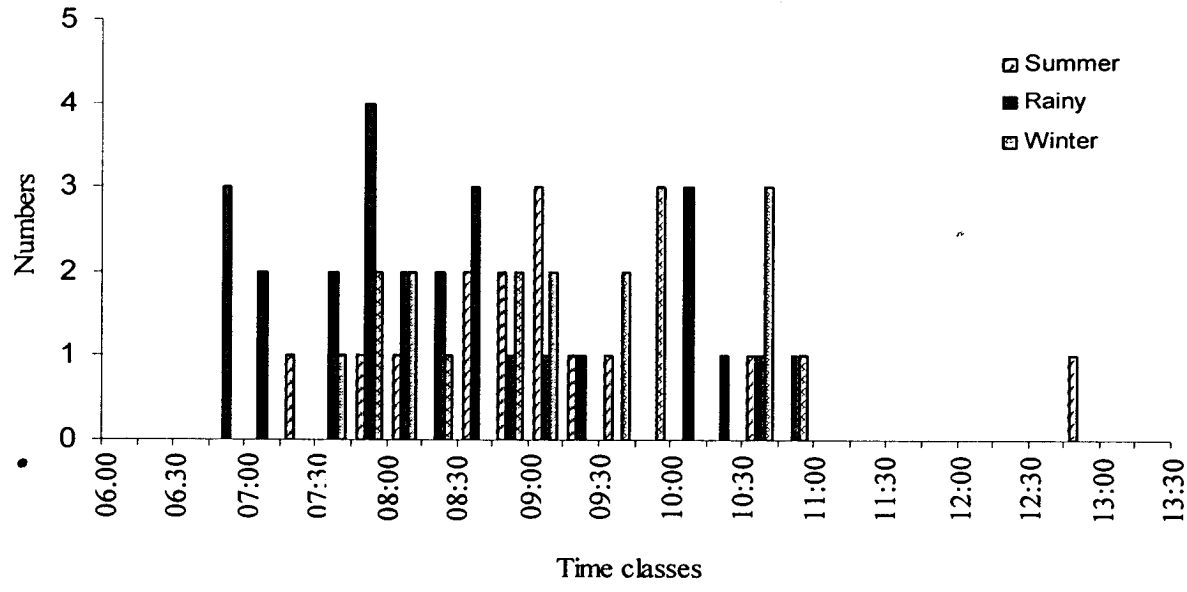


Figure 4.12. Seasonal comparison of frequency of starting time of morning calls emitted by the main study group. The group started their morning duet mostly 08:30-09:15 h in the summer, 06:45-08:45 h in rainy season and 07:45-10:45 h in winter.

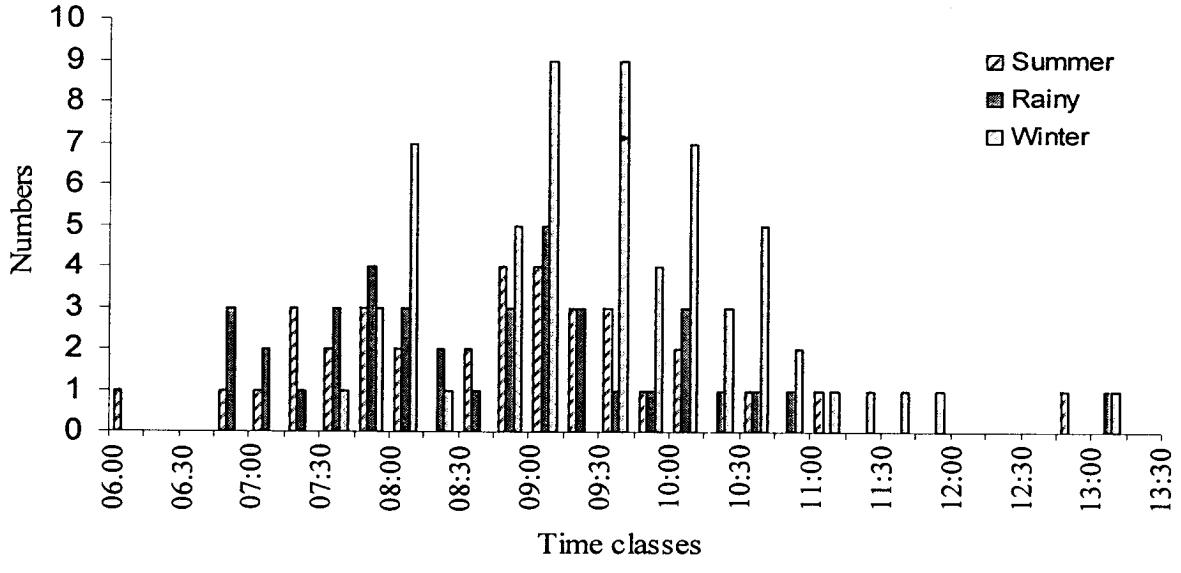


Figure 4.13. Seasonal comparison of frequency of starting time of morning calls emitted by all the groups, 07:45-09:45 h during summer, 06:45-10:15 h during rainy and 08:00-10:45 h during winter.

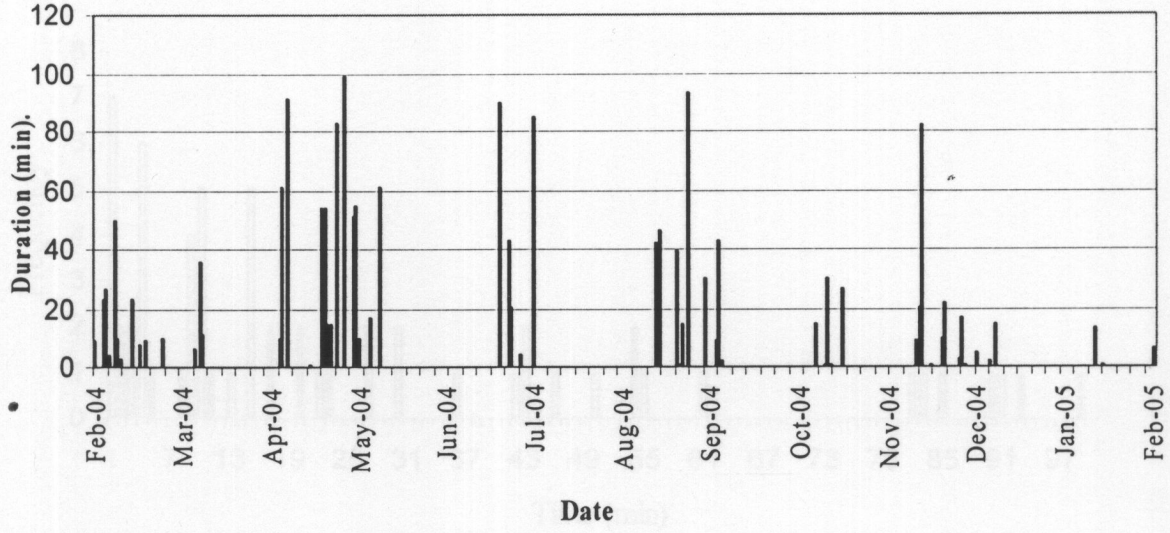


Figure 4.14. Duration of call bouts produced by the main study group. They lasted irregularly through out the year of study, but it last longer during rainy season.

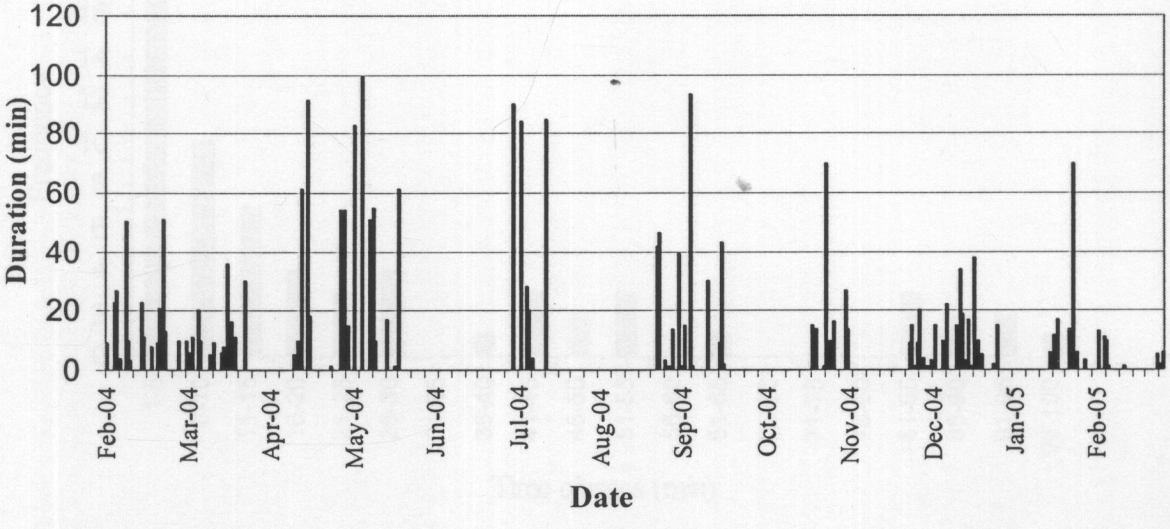


Figure 4.15. Duration of call bout periods of all groups of populations L1and L2. Calling during rainy season (May to mid October) (in the middle), shown last longer compared to summer and winter.

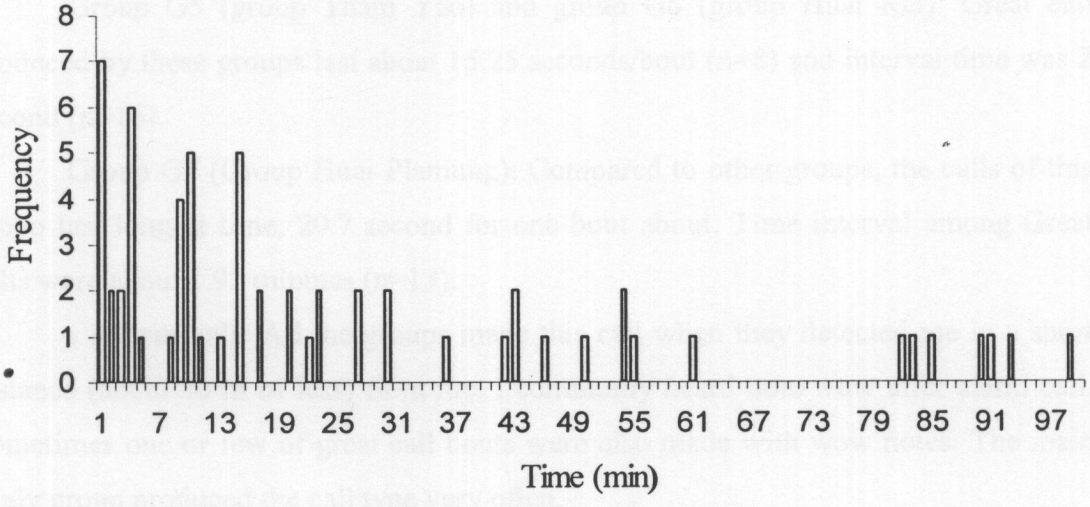


Figure 4.16. Distribution of duration of call bouts (min) of the group G1 through out the year.

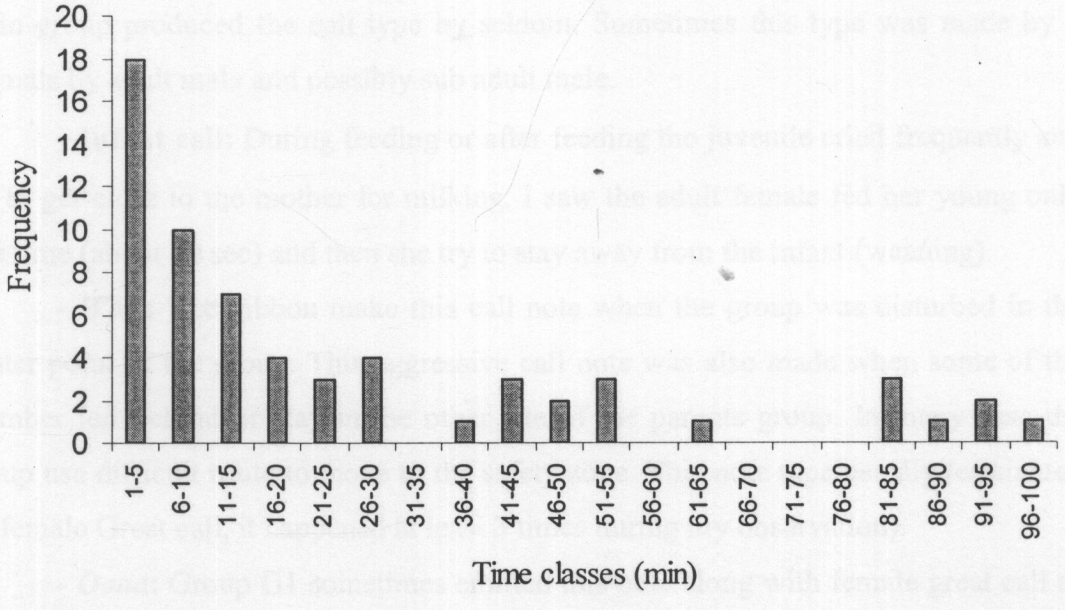


Figure 4.17. Frequency of call bouts in time classes of 5 min interval of the group G1.

Group G2 (group Huai Luk): Great call made by this group last about 11 seconds/bout (n=5). Time interval between each bouts was 2 (n=4)

Group G5 (group Tham Yao) and group G6 (group Huai Rai): Great call produced by these groups last about 15.25 seconds/bout (n=8) and interval time was 2 second (n=16).

Group G7 (Group Huai Plamung): Compared to other groups, the calls of this group last longest time, 20.7 second for one bout about. Time interval among Great calls were about 1.92 minutes (n=13).

- **Alarm call:** All the groups made this call when they detected me in a short distance (about 50 m of less) from me. I commonly heard note wow after alarm call. Sometimes one or few of great call bouts were also made with wow notes. The main study group produced the call type very often.

- **Male solo:** I had observed the adult male singing alone on the tree branch near the edge of the home range close to the village. He spent more than 1 hour that day. The period of male solo usually last longer than other call type. Adult male of the main group produced the call type by seldom. Sometimes this type was made by 2 animals by adult male and possibly sub adult male.

- **Infant call:** During feeding or after feeding the juvenile cried frequently and try to get close to the mother for milking. I saw the adult female fed her young only one time (about 10 sec) and then she try to stay away from the infant (weaning).

- ***Wow*:** The gibbon make this call note when the group was disturbed in the center point of the group. This aggressive call note was also made when some of the member left behind or stay in the other site of the parents group. In many case the group use difficult route to move to the safety zone. This note type usually terminated by female Great call, it happened at least 3 times during my observation).

- ***Ooaa*:** Group G1 sometimes emitted this note along with female great call of female. They mostly call in group. The stimulant of this note are not clear in my study. One time the group made this note following aggressive alarm call of the 2 great hornbills after they detected me within their territory (at the cliff site, North east of the home range of G1). I heard, in this case this note was intercepted by a female great call. During May, 2004, I heard the group made this note for many times from about 09:00-12:00 h.

Weather and vocalization: The influence of weather factors on calling such as rain, temperature, wind, and others were not clear but it was evident that the main group calls late on the day of fog.

4.7.4 Human avoidance behavior

- **Hiding and patrolling**: The main study group shows this behavior very often during my observation (Plate 4.2 and 4.3). Up on the food tree at the feeding time, it was always one of the member (usually adult male or subadult) stay quiet or be hind on the tree or did a short patrol around the food tree while the rest of the group were feeding. So, not all of them fed in the same tree in the same time, but usually one gibbon remained behind or nearby in some distant (about 20-30 m) to detected invaders who come from some direction. After feeding time all members of the group took a rest quietly, some sitting and look around and downward, some show some grooming behavior, except the juvenile who normally played with the mother and 2 subadults. Unlike another members, the juvenile in this age fail to keep quiet because it cries very often especially when need to stay with the mother and need for milk. I saw the juvenile suckling one time during feeding time. The mother allows her young only about 10 seconds for milking time. The age of her offspring during that was about 2 years (I first sight the baby on May, 2003 that time the young spent most of the time clinging on the mother abdomen).

- **Quiet behavior:** Since, about the past decade, many of gibbons have been hunted by Bala Lahu who directly came to the area for hunting purpose. They had set a hunting camp and start unlimited hunting. The villagers said during that time of big hunting, surrounding forest once full of a voices of gibbons heard from many directions became completely quiet, the forest later lack of gibbon song. They have started calling again about the past 5 years. At that time a lot of gibbons were killed and reduced the frequency of calling in order to avoid being hunted by those non-rule hunters. During my study this behavior happened sometimes.

- **Alarm calls of others animal:** The gibbon has learned using alarm calls of other animals in the area such as a Great hornbill, white-ramped sharma, Racket-tailed drongo, dove, and also squirrel detecting human traffic in the home range. In

(a)

(b)

Plate 4.2. Hiding behavior. The gibbons can use the branches of leafless big trees to hide from detecting by human. The infant sitting at higher branches of *Bombax insigne* (a), while the adult female stay quietly few meters away on the lower branches of the same tree (b).

(a)

(b)

Plate 4.3. Hiding and human avoidance behavior. The adult gibbon group G1stayed quietly on the small branch (30-35 m high) after the group detected me (a). The adult gibbon (probably male) looking toward me during feeding on fig which grow on the cliff site (b).

November, 2004, I noticed, group G1 stopped singing immediately after the bird made alarm call when they detected my visiting.

4.8 Threats to gibbons caused by human activities.

4.8.1 Gibbon hunting and gun shooting

During my study at least 3 gibbons were hunted. The Bala Lahu in Karen experience are the most skilled and dangerous hunters in this area. They hunt almost every kind of wildlife including gibbon and hornbill. Target areas for them are so wide, likely to hunt everywhere by using a local made gun. Number of gun sound heard during Feb, 2004-Feb, 2005 were at least 121 times, mostly in day time from 6:00 until the sun set, mostly from 6:00-9:00 (data excluding June 2004, first half of July 2004, August 2004, October 2004 and late Jan 2005). Percentage of gun sound recorded in total observation day during the study was 31.70 % in summer 2003 (n=41) and 31.43 % in whole year of 2004 (n=140). Gun sound recorded of total observation day during summer, rainy and winter were 27.3 % (n=33), 30.8 % (n=52) and 31.1% (n=61) respectively (Figure 4.18). I found not very different for frequency of gun shooting per day between the year 2003 and 2004 (0.63 (n=41), 0.82 (n=140) and among 3 seasons (0.64 (n=33), 0.96 (n=52), 0.92 (n=61) respectively) (Figure 4.19). Frequency of gun sound during the day in each season showed in Figure 4.20. The most popular weapon the hunters and the villagers usually used are traditional hand made long gun which widely used every where in the country and its neighbors.

4.8.2 Wildlife hunting

All tribes surrounding my study site still hunt wildlife for food. Since, Shan people have been threatened by the war for a long time, higher rate of subsistent hunting for survival have brought in to the area and resulting in much more negative impact to forest and wildlife both in Thailand and Myanmar site.

4.8.3 The country development policies

Due to the government policy concerning land use, resulting in devastation of vast areas of the forest in Mae Hong Son province. All types of forest, including,

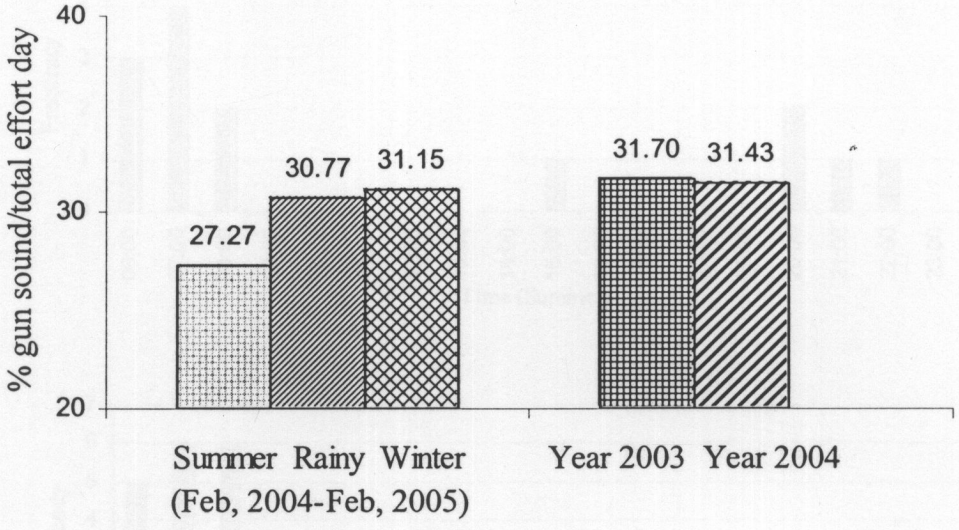


Figure 4.18. Percent frequency comparisons of gun sound heard in Muang Phaem forest (surrounding the home range group G1) among 3 seasons and between the year 2003 and 2004.

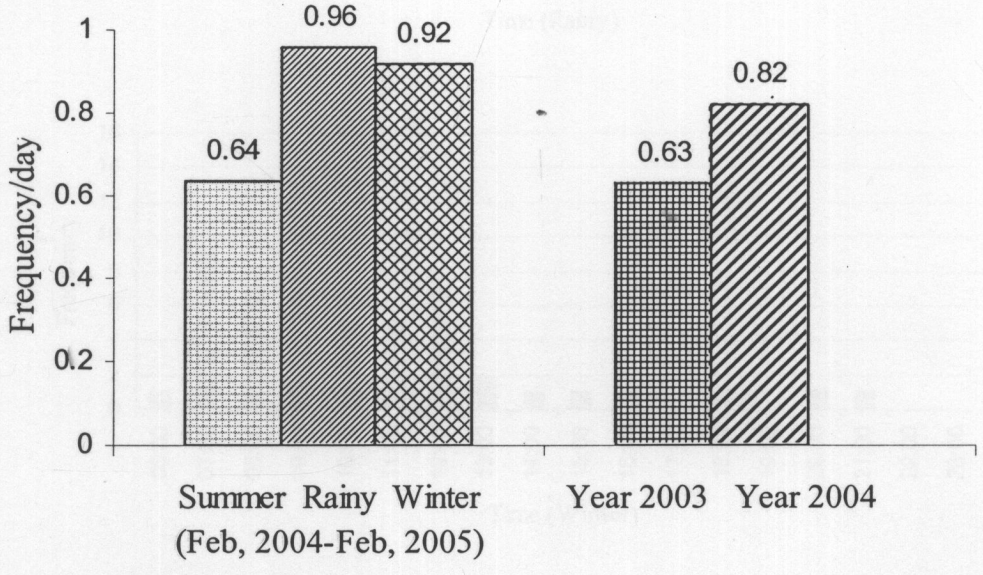


Figure 4.19. Comparisons of average frequency of gun sound/day among 3 seasons recorded during February 2004 to February 2005 and between the year 2003 and the year 2004 in Muang Phaem Forest.

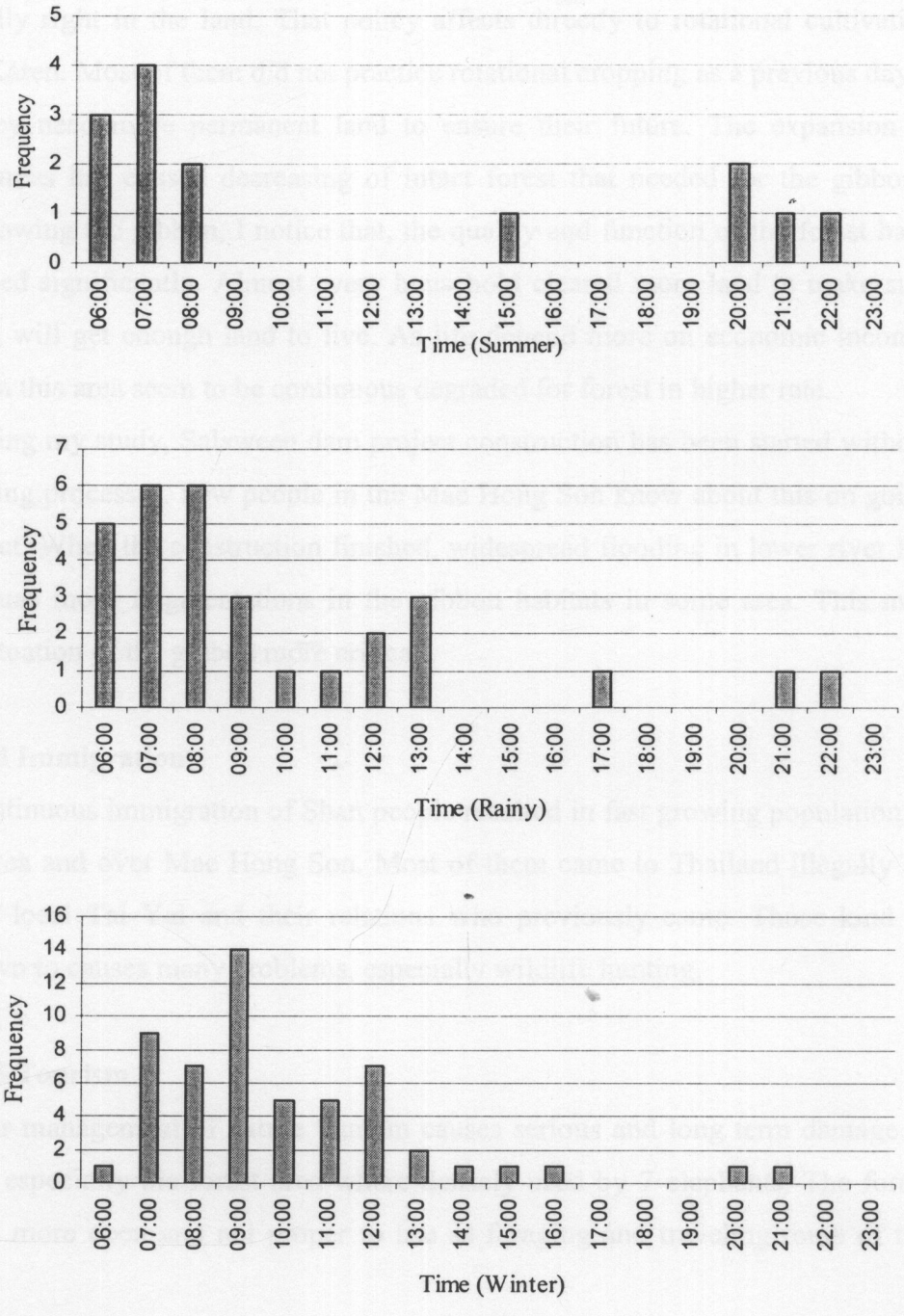


Figure 4.20. Distribution of gun sound (total of 121) recorded in summer (Feb-Apr), rainy (May-Oct) and winter (Nov-Jan) seasons from Feb 2004-Feb, 2005.

primary forest, secondary forest in my study site have permanently damaged in order to the legally right in the land. That policy affects directly to rotational cultivation system of Karen. Most of them did not practice rotational cropping as a previous day. Instead, they need more permanent land to ensure their future. The expansion of cultivated areas has caused decreasing of intact forest that needed for the gibbons. During following the gibbon, I notice that, the quality and function of the forest have been changed significantly. Almost every household cleared more land to make sure their young will get enough land to live. As life depend more on economic income, majorities in this area seem to be continuous degraded for forest in higher rate.

During my study, Salaween dam project construction has been started without public hearing processes. Few people in the Mae Hong Son know about this on going Mega project. When the construction finished, widespread flooding in lower river Pai possibly cause more fragmentations in the gibbon habitats in some area. This may cause the situation of the gibbon more critical.

4.8.4 Immigration

Continuous immigration of Shan people resulted in fast growing population in the study area and over Mae Hong Son. Most of them came to Thailand illegally by the help of local Tai Yai and their relations who previously came. Those kind of people known to causes many problems, especially wildlife hunting.

4.8.5 Tourism

Poor management of nature tourism causes serious and long term damage to the habitat, especially the forest area where densely used by 7 elephants. The forest has become more open and not proper to use as foraging and traveling route of the gibbons.

4.8.6 Crops, rice fields and fragmentation (old and new)

The year of the study, vast succession area of old crop field or secondary growth near the village were cleared for cropping that will take place around May to June in rainy season (Plate 4.4 and 4.5). Most of rice field inherit from previous hill

tribe group, Tai Yai, for more than 40 years. Extensions of croup field reduce contact forest and cause fragmentation in case of clearing in the corridor area.

4.8.7 Annual forest fire and large domesticated animals.

Annual forest fire cause continuous degradation of the forest and suppress succession process (Plate 4.6 a, b) Around late February to mid of March of every year, the fire has started to come out. Most of area in Mae Hong Son annually burned in order to many purposes. The main thing is agricultural practice which they have performed for long time. Study about forest fire and its effects in this area was considered as poor level. Almost the villagers seem to be familiar to forest fire.

Over grazing by free ranging buffalos and cows cause severe damaging to bamboos over the home range of the gibbons. Nearly 100 % of bamboo clumps growing in areas that the animal can accesses were eaten; only old bamboo trunks of more than 4 years were left behind. Due to cow having small and narrow horns, thery can reach through out the bamboo clump and eat up all their shoot (Plate 4.7 a).

4.8.8 Logging.

Every year (my observation from 2003-2005), the villagers cut down a big tree to build a new houses (Plate 4.7 b). The impact of logging to the gibbon is reducing canopy for their traveling routes, foraging disturbance, and fragmentation for example. During the study both old and new logging site were found spread over the Muagn Phaem Forest. Top 3 of high used tree were 1) *Tectona grandis* 2) *Lagerstroemia cochichinninsis* 3) *Eriolaena candollei.*

4.8.9 Road effects (the main road and local use road).

The main road established during the past 40 years has separated the forest of Mae Hong Son forest in to 2 main sites (Map 4.1). In the year of my study, the villagers cut more roads for motorcycle to transport their agricultural products during the harvest season in October to November. Good road that facilitate transportation of agricultural products leading to higher rate of forest destruction. Lahu Nyi people live in Aela village (4 km northwest of Ban Muang Phaem) depend mainly of the road that

(a)

(b)

Plate 4.4. Crop field near the home range of group G1. Ten years old secondary forest was clear during January, 2003 due to rotation cultivation practice of Karen and influenced by government policy. The back ground is the home range of group G1 during summer) (a) and rainy of the year 2004 (b).

(a)

(b)

Plate 4.5. Crop fields and rice fields. The upper land crop field (a) and lower plain of rice field along the Huai Nam Phaem (b) are the potential barriers that separated population L1 and L2 for more than 20 years.

(a)

(b)

Plate 4.6. Forest fire and domestic animals. Annual ground forest fire causes by annual burning from slash and burn cultivation is common in the study site and other area in Mae Hong Son (a). Severely disturbed bamboo clump by over grazing of domestic cows and buffalos is commonly seen over Muang Phaem forest and surrounding forest (b).

(a)

(b)

Plate 4.7. Karen man giving salt solution to his free ranging cows roaming in the home range of population L2 (a). Cutting a big tree for a new house is common in this area. At least 3 new established logging sites were found during the year of 2004 in the home range of group G1 (b).

facilitate product transportation. This cause more forest invading to produce more crop production for sell. Aela people though that the only one way to earn the money is to grow more crop for sell, out of this they can not do any thing to survive in this area. The rate of deforestation is much less than today if there has no good road to the village.

4.8.10 Conflicts between minorities

Conflict between Karen of Muang Phaem (Karen) and Lahu of Aela (Red Lahu Nyi) as competitor for natural resources has existed for more than 15 years and now still on the way. The conflict has now become more serious since the population has increased. The Karen population in Ban Muang Phaem are now more than 400 in 109 households, about 123 individuals in 25 household in Ban Aela, and about 150 individuals in 34 households in Aego. The population of all villages are significantly growing up.

4.9 The villagers of Ban Muang Phaem

Although Karen in Ban Muang Phaem showing their nature of typical Karen descended from their ancestor such as, respect to the nature, living in easy and comfortable ways, perform rotational crop planting, avoid any kind of conflicts (most of them are relatives and live very close), but many thing have changed. Most man in the village can speak Thai very well, but few of woman aging older than about 40 speak Thai (Most of Karen woman don't communicate much to people out site). However, the unbelievable history of Karen related to forest and their kindly manners seem to me a hopeful sign that will facilitate to conservation work in the future. At the present, some of their beliefs still function very well such as, all of them are forbidden to some wildlife including gibbon, great hornbill etc (excluding other hornbill), and if one does not obey or does something out of the way, they will be blamed by the community. Karen in Ban Muang Phaem responds to the outside people or outside projects in different ways. Their basic wisdom and knowledge and kindness are distinct among hill tribes. But any way, Karen there showed strongly desire to fight against all kinds of threats from outside world and people in order to eliminate all kind of problems that tend to have vital impact to the community. On the other way, this

kind of defensive mechanism may contribute in conservation of their respective tradition, culture and nature.

4.10 Sanctuary staff and their role of in wildlife protection.

During my field data collecting period, I have seen the changes inside the wildlife sanctuary. There was a different skill among the sanctuary staffs because they came from different background. The sanctuary staffs (SPDWS) comprised of an equal number of ethnic minorities, including Thai, Thai Yai, Karen and Lahu Nyi. Most of them came from the villager from various locations. All of them worked as my helpers in the study in different ways.

Due to an instability of manpower and translocation of a sanctuary superintend resulting in vulnerable in protection of wildlife and there habitat. In this new born sanctuary caused a difficulty of conservation work. There was no training concerning wildlife conservation provided for them. Most of them have to travel between working place and their house, this wastes a lot of time in wildlife protection. More than half of them need to be trained for their role in wildlife conserving in this complicated area other wise we are far to achieve our aim of conservation.

4.11 Conservation status of the gibbon in Huai Nam Lang

In the past, there were no activities for conservation has been initiated for saving the gibbons or the rest of wildlife species. Hunting by Bala Lahu has cause continuous decreases of the gibbon populations around Ban Muang Phaem and another places of Mae Hong Son (interview information form 7 surveyed villages).

There have been conflicts both in the village, among the villages and stakeholders for natural resources exploitation, and this has made a barrier to achieve the purpose of conservation. In the past, there was no collaboration work on natural management in this area. The lack of ecological knowledge and poor management of natural resources, resulting in the big loss of biodiversity of the area. In early 2004, vast areas especially secondary growth once function as wildlife shelter have been cleared to provide the empty land area where benefit to human in term of economic value. More than a half of succession (almost 100 % are old crop field abandoned for about 5-10 years) and vast area of primary forest surrounding my study site were

cleared during the early 2004 and 2005. This response of the local people to the government policy caused the gibbon home range size to become more limited and degraded in quality.

CHAPTER V
DISCUSSION

ECOLOGY

Distribution and population status

It is interesting that, the occurring of gibbon populations in this study area (n=7) were mostly found in the forest close to the Karen villages and their cultivated land with population size of 3-6 groups/population. The population size seem to be related to the distance of their home range to their village. This information indicates that the Karen people in this area have long played the role of conservation for the ape throughout their history. Karen's culture has been widely known as the effective tool for natural conservation, but poorly be used in the field of conservation. However, their distinct role has been affected by the main active-hunter, Lahu from Bala as well as Shan people. Apart from hunting impact, one of the main causes that limited the gibbon distribution in some area and reduce the power of such a wildlife protection tool of Karen is the failure of inside education among them. Nevertheless, the large and intact Karen community seems to have a better situation compared to small and isolated community. For the role of Luhu and Tai Yai's culture in conservation heard to function in the past but mostly disappeared at the present.

For the distribution in other area in Mae Hong Son still poorly known and need more survey to make it more clear for the real status of the gibbons in the province.

Most gibbon populations in the area seem to be decreasing gradually even though most of those groups are still reproductive and have enough food supply. Hunting by Lahu Nyi from Bala and Shan people that can happen any time is the main cause of the decreasing population. Without immediate effective protection effort, the gibbons in this area are in crisis of local extinction. Data support this interpretation is hunting of 3 gibbon in Muang Phaem forest during the year 2004 by Shan, Lahu Nyi from Bala for food and Karen boy (<15 years) by accident (he thought that the animal

was the monkey which the villager occasionally hunt for food). That even made the death rate reach to nearly 10 % during the year 2004 for population L1 and L2.

The loss of an adult male group G7 (Huai Plamung group) during the summer, 2004 has brought the group immediately to crisis, but hopefully, the replacement by the male from neighboring group, G4 (Tham Yao) and G5 (Huai Rai group), may help the situation. The gibbons in the area are at risk to be hunted by chance by general hunting especially when the hunters set a camp and spent just a few days in the gibbon home range or near by forest.

Factors that contributed to sustain their population are 1) relative large area/group 2) sufficient food supply 3) the influence of Karen prohibition of eating of gibbon 4) steep slopes of the home range.

To sustain gibbon population in this area we need to 1) provide more larger and proper habitat for all population by limiting and managing the use of forest in local level. 2) for some populations such as the main study population (L1 and L2), we have to make the habitat corridors in order to contribute gene flow to reduce inbreeding pressure 3) establish the monitoring and conservation programs continuously.

Within each population in the main study site it may consist of related families so that low genetic diversity or inbreeding pressure could cause extinction in the long future. To make thing more understandable, long term observation is suggested.

In global scale, there are many social gathering and population analysis models created for wildlife conservation, but at the end the problems still remain. For the PHVA model for large population strongly need cooperation between field ecologist and modeler in order to make use and identify important information that poorly known such as poaching, migration route, isolation, etc. However, the purpose and focus of the work shop were not clear especially for wild population (Brockelman, 1994). This modeling although considered as one of a good tool for monitoring animal status to understand extinction trends which useful for management programs, but in high fragmented small population like in Mae Hong Son it may not proper to use this tool. Rather, field study analysis, and knowledge-based actions are much more important maintaining gibbon populations.

Habitats

In broad view, most gibbon range in Mae Hong Son are continuously degraded by various human activities such as, nature tour, expanding of crop field, domestication, ground forest fire, subsistent cutting, illegal logging, settlement of new village.

Gibbon habitat in Muang Phaem forest is also degraded gradually because the over used for agricultural and domestication purpose. A high number of cows and buffalos cause a continuous damage to the seedling and ground plant and especially bamboo which important for the gibbon in many ways. From my observations, I found that about 99 % of bamboo clumps in all habitat type (mentioned in the result) except type 2 (at inaccessible ledge) were severe disturbed. I found just few of bamboo clumps have new bamboo trunk escaped from eaten by those animals. Although Karen Ban Muang Phaem has used bamboo in high proportion annually, especially young bamboo (2-4 months), to make a bamboo string to use in various purposes, but, however, they are not ready to realize those impact of their activities to this invaluable plant.

Annual ground forest fire which very common in this area, is one of the major causes of degradation of the habitat. In the period of 3 year experience in Ban Muang Phaem, I found the successful level of fire control and management by them is very low even the training and meeting on this had been prepared in the early. The lack of understanding about long-termed impact of the ground forest fire may be the radical cause limiting the successful of fire protection. In the case of Ban Muang Phaem, one of the main problem on this is communication problem inside the village. The chief of the village can not reach all of his people especially the opposite and some villager who never involve in the community activities. These people are the cause of forest fire inside the fire break line. In the period of 3 years, the ground forest in home range of G1 also cause by those kind of inside people.

Today all minorities have to restrict to the area, so the need of permanent house and land is much higher. Each year the need of big tree for house construction is very high. So in the future the forest will be destroyed more and directly affect to the gibbon in various ways. Therefore, forest management is urgently needed.

Diet

In 61 ha home range with diversity of food plants available in different time, could support group G1 and sympatric populations of other animals including at least 4 great hornbills (1 family), one male of Assamese macaque (*Macaca assamensis*) and one Phayre's langur and 109 families of human (*Homo sapiens* L.) through out a year. As at other study sites, fruits are the main composition in gibbon diets. But, in this study the proportion of fruit is quite high due to the lack of information on other food categories. The exact proportion of each category needs more observations.

-Fruits

Among 45 of fruit species (including 10 species of fig), the most important plant for the gibbon in the home range is *Ficus* spp, which played a role as a certain food source through out a year long. Species identification of figs in this study is not complete because the limitation of time, imperfect plant samples and unavailable of plant taxonomist during the study time. For the wild grape (*Tetrastigma* sp.) is the gibbon favorite juicy fruit. Without this plant, it may be problematic for the gibbons during early rainy season. Future expansion of crop fields may affect directly to viable number of wild grape for the main study group, G1.

-Flowers

Scurrula sp is the most important while other species of this category were the supplement for the gibbons. Both observation and fecal analysis confirmed that group G1 feed on their flowers in significant amount during the overlapping time of winter and summer because the lack of foods. The relative abundance of this plant related to relative abundance of *Xylia xylocarpa*. The demand for *X. xylocarpa* for fire wood may affect directly to abundance of the plant. So, energy source management, especially, fire wood is also needed to ensure the available number of the plant which important for the survival of the gibbons in this habitat.

-Leaves

In my study only 3 species of this category (2 species of bamboo and Se-le-co) were confirmed to be eaten by the gibbons due to unsuccessful habituation. Further study should be carried out to fill the gap.

The diversity of food plant in the range of population L1 and L2 as the results explain us that Seasonal Tropical Deciduous forest are needed to be protected and conserved in order to ensure the survival of the gibbons as long as possible.

Observing of aggressive behavior of the subadult gibbon of group G1 toward Phayre's langur and great hornbill in some cases may tell us that sometimes the territory did not have enough food available. However, the presence of 20 great hornbills around the home range of Population L4 also shows that this area is worth conserving as a refuge of wildlife.

- **Fecal analysis**

Fecal analysis is a powerful method to study the gibbon diets, especially when continuous observation is impossible. But in this study area, the steep slope is the main limited factor for the method.

It may problematic for analyzing the insect eaten by the gibbon from the feces because the contamination of the insect that already in the fruit eaten by the gibbon. It is possible to found both contaminations and food insect in one sample. So, the study of insect in the fruit also needed in order to improve the error of fecal analysis.

Behavior

- Sleeping site selection

As the result of Reichard, (1998), from my observation, I found most of the time the study group went to their sleeping place several hours before the last light. But sometimes I also observe the group traveling to their sleeping site at 16:50 h on May 30, 2004. The reason for that probably because 1) there was low predator in this area and they have more time to feed, 2) they may detected some predator such as python which cause them have to change their sleeping site.

- Human defense

Gibbon group G1 show that, they still scare to the appearing of human. Most of feeding time I notice that not all of them feed but usually at least one of them acted as a detector for the group. During traveling, the male always act as the leader of the group. The reason of their scare to human because of hunting of another wildlife is common in the home range especially during my absence from the site.

Factors determine group ranging

-Human traffic

Apart from season and fruit available in time space, human activities has played a role to determine the ranging pattern of the gibbons in this area, as their home range is located in a highly used forest both in community forest of the Karen Ban Muang Phaem and protected forest of both sanctuaries (SPDWS and LNPWS). Observing group G1 and other groups, I found that, all the groups could not tolerated encountering human in all cases. The group usually avoid the area that using by the villagers. The adult male showed his leadership over the group members to make the decision of daily traveling for various purposes while the female and the rest of the group usually follow him. Normally, after encountering, the group did not return to the place in the same day or even more if they have other food choice.

-Habitat feature

In limestone formation habitat of my study site, the factor that significantly influence to ranging pattern is the inaccessible and steep slope of the area within the home range which function as the best shelter for them. That kind of feature minimizes horizontal distance of group traveling which help them to conserve the energy budget for living in the unique habitat. Instead, the vertical vector group traveling is higher. The proportion between these 2 perpendicular directions is interesting and this can explain the characteristic of the habitat well.

-Fragmentation of the habitat

One of the most influential factors for ranging of the gibbons is the fragmentation of the home range. Most of home range edge of group G1 surrounded by agricultural area such as rice field crop field and road. Only one side of about 200 m width that located in the north part of the home range functions as the habitat corridor for the group to contact with other groups with in the population L1.

Factors influencing vocalizations

- Season

From the result show that all group start to call late in winter. More time effort for listening to their vocalization between seasons among different populations in Mae

Hong Son may tell us more about the effect of climatic factors on gibbon vocalizations.

- Fragmentation

In fragment habitat and low group density in my study site, the gibbons seem to call less due to less conflict between groups as in the result, only 8 times that more than 1 group involve in morning vocalization in overlapping time and only 3 times that 3 groups involved in vocalizations. However, more intensive study and comparison study with others populations are needed to understand more about this.

- Energy saving

In case of no conflict between group due to competition for resources and mate, the group may call fewer than those of high conflict like in KYNP.

- The loss of adult male

In the case of strong hunting condition, the group clearly produced less calls or even do not call for a long period, as happened in Ban Muang Phaem forest about 10-15 years ago during a big hunting time by Lahu from Nam Khong. For the case of Huai Pla Mung, the pattern of vocalization of the group completely change because the loss of adult male. That kind of call may induce male gibbon from neighbor group (G5 and G6) to replace the previous male. Investigation of this group is interesting.

- Distance between subgroup

In my study, I found 3 cases (G1, G2 and G6) that indicated interaction between subgroup, one sub group (I think sub group of foraging subadult) produced great call by one animal answering the main subgroup without mixing with any other calls.

CONSERVATION

Hunting

At present, hunting performed by diverse group of hunter is still the main problem for survival of the gibbons and also other wildlife species. The recent knowledge and attitude about the value of wildlife among Karen and surrounding hill tribes is similar, they do not understand at all about the role or the functions except for foods. This situation affect strongly to restricted territorial animal like gibbon, they

can be hunted easily if only they decide to hunt. Therefore, without immediate actions, the gibbon will soon be extinct from the region.

Contradiction of education and conservation

After one year staying in the village I would like to conclude that, almost 100 % of adult Karen show less concern to the value of their own unique knowledge and skills while most of young generation has been sent to study outside the village. Unlucky, during my study period, the school in the village can not present proper knowledge for their children, so they have to send their children to study out site the village very early (about 5-6 years old). The new generation (usually more than 9 years old) has to stay in the resident of the school in long period so that they have less time in the village to learn and absorb Karen life style from their own parent. When they come back to the village, I notice that most young Karen, especially male, behave in different way of the typical Karen and look over and ignore their own culture. This kind of phenomenon need to be underlined also if we want to conserve the culture which make positive effect to gibbon and their habitat. This has a strong influence to decreasing of gibbon population in Mae Hong Son. However, increasing population among hill tribes resulting in stronger competition for natural resources between them and affect to the efficiency of local traditional wildlife conservation. Moreover, the economic pressure from outside world has negative effect to their life style. The villagers depend more and more on money and left behind their wisdoms inherited from ancestor.

Habitat quality

This study showed that the gibbon can use diverse type of the forest but big and tall trees are the most important in many aspects for this arboreal ape. Comparisons of habitat structure with other areas such as HKKWS or KYNP may help to explain more about this factor. The gibbons need a significant number of tall trees for their daily activities, for sleeping places and for shelter. To improve the habitat quality in Muang Phaem forest we need to find the way to stop damaging forest cause by some activities such as elephant riding tourism which benefit a few for short time, but cost the rest of the wild communities. I found that cliffs are also needed since this

kind of topography gives them the best place from which to detect hunters, and cliffs also make the gibbons difficult to be followed. Regarding the diversity of food plants, the places of choice that support the survival of gibbon in this area consist of primary forest with tall trees adjacent to the steep slope or cliffs.

For degradation over grazing of domestic cattle (cow and buffalo) should be solved immediately.

Small population and inbreeding depression

Since those of populations reported in this study are relatively small, and most of people may think it is useless to do conservation due to inbreeding pressure, but in some population there are hopeful for restoration. Twenty years isolated population, L1 and L2, are needed to be reconnected by establishing of forest corridors to reduce in breeding pressure and to restore population size. For others gibbon populations in Mae Hong Son, more conservation attempts are needed by surveying immediately in order to identify their conservation status.

In Mae Hong Son, in the past 30 years, there was convinced evidence recorded in hill tribe memories. Interviewing old villagers could provide us a lot of important information about the history of wildlife population in the area which useful for conservation plans.

Gibbon conservation

As we know, in the past, among tribal communities in northern Thailand, wildlife management has been automatically integrated in their beliefs and cultures and traditions as many know, but this has changed through time in order to adapt to limitation of natural resources. Those kind of adaptations in human societies of all nationalities on earth is the main causes of natural destruction. This has started in very early stages of social development programs which are controlled by government administration teams who poorly use scientific information, especially in the field of ecology, available to them to make policy decisions and country development plans.

Although the Karen of Ban Muang Phaem (and most of communities) have a sufficient influence to conserve the gibbons in the area, it was impossible for them to stop hunting by coexisting hill tribes. Some distinct reasons that explain the limitation

to conservation in Ban Muang Phaem are 1) The village of Ban Muang Phaem has been surrounded by Lahu and Tai Yai villages, and this made a difficulty for conservation; 2) the forest is the immigration routes that has been used by Shan and others (and wildlife) who has came the country site since the war between Shan and Myanmar. In order to save the gibbon, collaborative projects between Muang Phaem and surrounding villages have been encouraged to find the solutions in order to meet the needs of area based conservation. Before the study there were few actions carried out for wildlife conservation. Effective patrolling time should following the gun shooting time in the study in order to reducing degree of disturbance of the habitat.

- Due to the conflict between Karen and neighboring hill tribe (Lahu and Tai Yai) which has lasted for about 15 years, it has been needed the help and intervention from outsider. Such as, researcher who know the situation well enough and can work close and deep in the area. In order to initiate cooperative resource management among them, we have to start the pioneer projects that can break an ice between heterogeneous communities.

In order to restore the gibbon population, some wildlife benefit traditions and ancestor's teaching need to be restored among the hill tribes who still live close to gibbon and others wildlife habitat.

The lack of personal or poor concern for their status and threats, and limitation of budget are the major cause of extinction. Leighton and Whitten (1984) suggested that, gibbons may not be the symbol to be used for promoting forest conservation because their number still high in some country. This indicated the gap of conservation during that time and conservation activities were based on priorities of each species. Only sexy or flagship species were of concern and invest in. Till now, insufficient updated data contributing to management plans for wild population is still a problem.

Cultural, traditional and knowledge inheritance among hill tribes related to gibbon populations

Interview information showed that, it was difficult for hill tribes themselves to keep their own knowledge, ancient teaching and forbidden practices. For instance, in the past, Thai Yai, Lahu, Lisu, Lua, and Karen did not hunt many of wildlife species including the gibbon and great horn bill but now many of them have ignored there

culture and started hunting opportunistically. In the past and even today, not only Karen forbids to hunt the gibbon, but also Lahu and Tai Yai. So that, one of the main causes of weakening of such a protection is the failure of education among the high land Only Karen still practicing forbids strongly to hunt the gibbon, so most gibbon populations always found near by Karen villages except some case that some rule was pronounced such as Sop Pong population (L4) people in this area.

Human activities and ecological service of the forest

Since Karen community has long been practicing agriculture, so most of their time is used for cropping. During my study the villagers of Ban Muang Phaem spend most their time preparing the land for plantation, collecting timber and non timber product from the home range of group G1. All families have their own domestic animals including elephant, buffalos and cows. From 2001-2004 population of elephant, buffalo and cow rise. (from 7 up to 8 for elephants, 490 up to 518 for buffalos and 199 up to 275 individuals for cows. This number is extremely large for the forest to sustainable support. For pigs and chickens as they use for daily life and traditional use for spiritual scarify are almost stable in number. The higher population growth of cows than buffalo resulting in much more affect to bamboo because the cow approach the bamboo shoot in the middle of bamboo clump because their horn is much small than of buffalos. So, population control of all species of domestic animals especially cow have to be done as soon as possible in order to maintain the carrying capacity of gibbon habitat in the near future. Bamboo in most area within and around the home range of the main study group have been threatened in very high degree and tend to be died if the villagers do not protect them from their yearly use and over grazing by their free ranging animals.

In the morning, the villager starts to walk into the woods and crop field of their own or of their neighbors at about 8:00 h. They usually went back to the village about 17:00 to prepare fast dinner while we usually find a group of young man with guns back from the wood after hunting for bush-meat or common squirrel and some kinds of birds. After dinner they usually selected the house to go and talk about funny thing. Karen by their nature, likely to communicate with each other and this life style has been performed since the ancestors.

In Mae Hong Son, in overview, all minorities practice monoculture. Each year the crop field has been extended. As populations of high land people in Mae Hong Son have risen each year, the primary forests have declined gradually in order to clearing for satisfying their supplementary needs.

In terms of conservation status and resource management, Karen people in Ban Muang Phaem have exploited much more than the services of the forest can provide, leading to the lose of diversity without real protection action. Most of them practice the same thing (mass movement) such as community labor sharing system which had been used for a long time. By the way, the lack of diverse thinking or universal thing among the village resulting in imbalance the social system. Moderately, I think, this kind of social commonly affect to balance the diversity of surrounding ecosystem.

Transboundary wildlife management strategy has been proposed for long time as a wise solution for biodiversity conservation between 2 neighbor countries. But in this area it seems problematic because of the complexity of war and drug within that zone. One possible solution for wildlife problem is establishment of wildlife refuge in some proper area such as Ban Aela and Ban Muang Phaem forest where various wildlife species can be found frequently as shown by my results.

The role of the sanctuary for gibbon conservation

Since the establishment of the San Pan Daen Wildlife Sanctuary in 1999, the better protection for gibbon and all wildlife has been started through the protection of the forest area from land clearing and from expansion of crop field by the hill tribes from surrounding villages (Ban Aela and Ban Tham Lod). The set up of the Nam Phaem wildlife guard station was highly used in the early phase of the operation. A patrolling unit of 6-10 staffs was carried out almost every week. Unfortunately, after moving of the sanctuary chief who is the key person establishing the sanctuary in 2003, protection system of the sanctuary became weak and collapsed. One of the good staff decided to apply for the other job while the rest of them still work at the low level of protection. So during my study period, the wildlife protection was inactive. The role of most of peripheral staff was much lower than it should be. This resulted in vast area of forest was cleared by all hill tribes in different proportion. This paragraph

was the explanation of an important of the chief and wildlife protection team for conservation.

The sanctuary field staffs consisted of local hill tribe including Karen, Lahu, Tai Yai, and Thai. It is incomparable for the quality of work among them because they have their own skill and experiences. The diversity of tribe among the staff is the advantage on work. A strong chief can encourage them to work in team. However, one of limitations of the efficiency of protection is the attitude of the sanctuary man power.

Recruitment of dedicated person like the former chief of HKKWS, Mr. Seub Nakhasathien, the departed well known conservationist, is far from a dream. So site-based co-management between the two sanctuaries, communities, local governor and researcher is one of the practical way. The fate of the gibbons and other wildlife species in the area depend mainly on immediate action of all stakeholders, the sanctuary alone could not cover this complicated problem. Moreover, conservation and training program for the staff is necessary.

CHAPTER VI
CONCLUSIONS

Distribution

A high number of gibbon groups have been found in the main study site, Muang Phaem forest (Sgaw Karen), the proximal part of Nam Lang water shed in Pang Ma Pa district. In Ban Manora village (Sgaw Karen) about 6 groups have been reported occurring in Ban Manora forest (Karen), but no information of fragmentation of each group. One of the large populations in Mae Hong Son was reported in Huai Poo Ling, Muang district (communication with the villager). The rest of populations are very small mostly 1-2 groups which lack detailed information. Two populations in Muang Phaem forest, mentioned before, are completely isolated and need to be protected immediately.

Food plants

At least 45 food plants were discovered in this study. Availability of each species varies seasonally as shown in the results. The most abundant and basic food plants for the gibbon for all seasons are *Ficus* spp. At least 10 species of fig have been observed eaten by group G1. Each species provide the gibbons as basic food both in different and the same period in a year (mostly in different time). *Schleichera oleosa* is the most long last fruit provider for the gibbon (May to October). The gibbons seldom took the flowers of *Aeschynanthus andersonii* during September to October. *Mucuna pruriens* was available during January to February. I notice that, usually only one of group G1 took this flower during foraging time. This plant probably play role as supplement food for the gibbons. Food plants eaten by the main study group during the dry season are *Xylia xylocarpa* (flower), *Ficus* spp (fruit and young shoot), and *Scurrula* sp (flower).

Plant phenology

There was a variation of phenology of some food plants such as *Polyalthia viridis*.

Comparison of observations during 3 summers (2002-2004) I found that, it is possible to predict duration of flowering time but not for their fruiting time. In 2004, fruiting time of *P. viridis* showed the change significantly (the third year of my observations). Most of them delayed their fruiting time till December to January (stay long in resting stage of their flowering, last from April to December, 2004). Most of them started producing a lot of fruits about January 2005 and will be ripe during April 2005. So, this plant skipped fruiting for one year after at least 2 years of regular fruiting time. To explain this kind of dynamic it need to be study more in longer time period.

Mangifera spp: At least 4 species of this plant were found within the home range of group G1 and can probably be found in surrounding area. Each individuals of this high production plant produced their fruit every 2 years. Ripening time of this species reached to the peak around May and June. The utilizing of other parts of this plant by the gibbons needs more investigation.

Habitat capacity

Although the forest seems to provide the gibbons for the present time survival, but food shortage may take place in the near future if no action to stop tree cutting and fragmentation of the forest near by their home range. Drought in particular year may possibly cause some effect to the gibbon because of lack of water in the stream that needed in summer. Over population of cattle that grazing in the gibbon home is the main problem of habitat capacity for long term supporting.

Behaviors

Ranging

The main study group spent most of their time budget in a day within the home range of about 61 ha. Only two times that group G1 had been observed in the valley near the Huai Luk or Huai Tico home range. The location highly used by the group

is around the primary forest and the steep slope site or ledge site in the middle of the slope which functioning as the most safety shelter for them.

Feeding

The time of feeding for the main study group vary from 2-3 times a day depending on abundance and diversity of food plants in each season. In summer the gibbons have to travel far to find available food. From the result of my observations, it was clear that gibbon have enough food due to variety of food plants. In dry season they feed mainly on *Ficus* spp and *Scurrula* sp. They spend significant time visiting the bamboo (2 dominant species) during May to June feeding on its young shoots so bamboo also play an important role for the gibbon during the time that most of the fruits not ready to be consumed. Although there are a large amount of *P. viridis* within about 2 month during summer time but the group was observed few time feeding of the plant.

Singing

As the study of Carpenter (1940), all the groups of population L1 and L2 call late during winter (08:00-10:45) compared to summer (07:45-09:45) and rainy season (06:45-10:15). In this study, the starting time of morning calls rank within 4.30 hs, 4.15 hs and 4.00 hs in winter, summer and rainy season respectively. Group G1 start their morning calls during 07:45-09:15 where as it start from 08:30-09:00 in Chiang Dao study site (Carpenter, 1940). Starting time of morning calls defined by rainfall and cold temperature and the thickness of morning fog. The main study group did not stop their calls even it raining, but however they will stop calling if the rainfall became heavier in some level and their loud call can not be heard by the other groups. In the foggy morning all the group usually started their call relatively late or did not call. Character and pattern of great call was observed more similar among intra-population but not among inter-population. In rainy season call bouts last longer than summer and winter.

Threats by humans

1. The overuse and improper use of natural resources via domestication of cows and buffalos in the forest cause long term damaging to gibbon habitat. In general, the villagers seem to familiar with the degraded environment. Most of them think that it is not the problem and very few of them think in opposite way. Most of their activities are concerning daily survival and economical improvement. In Muang Phaem village, there are only some teaching about the Karen way using and care or forest and wildlife as in the book of "Pajedchan panyaprach" explained by Promsao and Silaruk (1999) from the memory of Karen tales of Porluang Jorni Odochao (Karen from Nam Mae Wang, in Chiang Mai). Some impressive wording written in the book is "One gibbon die the seven level of forest sad and deplore", "One hornbill die 7 figs sorrow and lonesome, 7 mountain ranges dejected and lonely". Now a day these kinds of sentences are very difficult to hear and tend to lose moderately.

2. Wildlife hunting cause both direct and indirect effect to the gibbon fate. Riding elephant tourism were the main cause of permanent damaging of the habitat (more fragmentation and forest gap)

3. Farming at the same area does not impact much to the gibbons but future crop field may causes critical impact to them because the affect of habitat fragmentation.

Suggestions for gibbon conservation

Government sectors

For the government officials, especially local government, are needed facilitating gibbon conservation program. I would like to propose the first 3 priorities which need to be initiated, firstly, ecology and conservation education programs have to be carried out in gibbon range communities such as Ban Muang Phaem, Ban Aela and Ban Tham Lod, secondly, placement of supportive projects into gibbon range communities and thirdly, restoration programs for hill tribe culture and nature also strongly required.

More dedicated people who have a good willingness working with local communities should be recruited. Persons with different skill and knowledge should

be encouraged to involve in wildlife conservation. Those people may be found along the way, after the public aware the problem. Hopefully, at that time the solutions method may be comprised of diverse culture, knowledge and skill of different hill tribes, local NGOs and local governor.

Strengthening of local Thai NGOs in Mae Hong Son and national NGOs such as Wildlife Fund Thailand (WFT) is necessary for conservation work, since it acts as catalyst of collaboration between the governments and local communities, not as protestor of government as many people have thought.

Necessarily, all major projects such as Salawin Dam project which will cause great impacts to Karen communities and wildlife along both sides of the river have to be considered carefully based on moral and scientific information. Research on conservation is needed in this moment in order to find the effective way for us all to involve saving our invaluable wildlife and nature.

Staffs of the wildlife sanctuary

Staffs of Nam Phaem wildlife guard station can work better with the chief who have willingness and realize wildlife problems in the area. They need to be trained more in the concept of community-based wildlife conservation which quite sensitive and complicated. Collaboration of the sanctuary staffs (both SPDWS and LNPWS) and the patrolling police or soldiers should be encouraged in order to strengthen the team.

People of Ban Muang Phaem

Base on the information of 3 years period, I would like to conclude that, outside intervention is necessary for the condition in Ban Muang Phaem and its neighbors, because it seems almost impossible for them to point out and start to involve in solving the problems of local extinction of gibbon and other wildlife species. Surrounding context and their new lifestyle are the barrier to realize or understand the importance and role of wildlife in another aspects especially for our survival in the future. However, their conservation culture, way of life and respect to the nature in one of the strong advantage in management of natural properties (Santasombat, 2001). In the history of Ban Muang Phaem, there are 4 distinct

examples that support my suggestion are, 1) the successful establishment of fishing free zone, called in Thai "Wang Pla" of the village. That fruitful project was proposed and led by one monk who had visited the village more than 10 years ago. Significantly, the success was influenced strongly by their background of respective and beliefs in powerful spirits which control and have strong influence to their fate. 2) The establishment of community reserved forest also initiated by the same monk during that time. 3) Community forest project called in Thai "Wanasart Chumchon" also heard to solve the problem of forest clearance by Lahu nearby. After the project was over, forest destruction has been started again. 4) Thai-Germany project in 1991, that project contributed a working skill concerning rural development for participants, including the present chief of the village. Moreover, other key person in the history of the village that can cause the difference is the teacher. One teacher during about 20 years ago had played a great role for his student and the villagers, since he proposed many ideas that benefit education and community development but after he moved out from the village most of his projects were abandoned.

Since their daily life depend more on cash, so the community behavior cause more impact to wildlife and their habitat. In Ban Muang Phaem, economical competition among each family route should be underlined as one of the main problems of cooperation in wildlife and habitat management.

People of Ban Aela

Although the size and population of people of this village is relatively small compared to Ban Muang Phaem, but the location of the village is in the core area of wildlife migration route where most sensitive for the survival of wildlife. Their activities influence directly to wildlife and their habitat. Vast area has been cleared during transition period of the sanctuary since 2003. Surprisingly, I experience that some number of people of Aela have a strong attitude of wildlife conservation which poorly known by outside people. Discovering those kinds of people is hopeful for wildlife conservation. Participation and cooperation of this small community will benefit to wildlife conservation efforts.

Summary

The results of this study once again has confirmed the importance of diversity of plants for the survival of wildlife who are also important for diversity of plant. For Karen, they realized this mutual relation along their history, and those with their knowledge and attitude has been reflected to our eyes via their life which harmony with the nature. The existing of the gibbons in this area is one of the strong evidence for their contribution for wildlife conservation. However, in the modern world, their role has been changed, and Karen alone can not protect the gibbon and other wildlife as in previous days. Therefore, restoration and application or integration of their own knowledge and culture are needed to help the situation.

Besides habitat loss and fragmentation combine with hunting, there are more gibbon problems found in this area. Everything happening inside and outside the area such as the condition inside the home rage, government policies, the war along the border and in Myanmar have affected the gibbons. This means that the problems in this area so far are much more complicated than many people have thought. Therefore, more continuous and intensive study about gibbon distribution and population of the area are needed while local actions for gibbon conservation have to be developed and improved in the same time. Otherwise we will lose them forever.

REFERENCES

ALTMANN, J. 1974. Observational study of behavior: Sampling methods. *Behaviour* 49:227-265.

BHUMPAKPHAN, N. 1988. Ecology of white-handed gibbon (*Hylobates lar* Linn.) & Phayre's langur (*Presbytis phayrei* Blyth) in Huai Kha Khaeng Wildlife Sanctuary. M.Sc. thesis, Kasetsart University, Bangkok, Thailand. 131 pp.

BORRIES, C., E. LARNEY, K. KREETIYUTANON AND A. KOENIG. 2002. The diurnal primate community in a dry evergreen forest in Phu Khieo Wildlife Sanctuary, Northeast Thailand. *Nat. Hist. Bull. Siam Soc.* 50(1):75-88.

BROCKELMAN, W.Y. 1975. Gibbon population and their conservation in Thailand. *Nat. Hist. Bull. Siam Soc.* 26:133-157.

BROCKELMAN, W.Y. AND D.J. CHIVERS 1984. Gibbon conservation: Looking to the future, Pages 3-18 in H. Preuschoft, D.J. Chivers, W.Y. Brockelman and N. Creel. (Eds.), *The Lesser Apes: Evolutionary and Behavioural Biology*, Edinburgh University Press. 709 pp.

BROCKELMAN, W.Y. AND S. SRIKOSAMATARA. 1993. Estimation of density of gibbon groups by use of loud songs. *American Journal of Primatology* 29: 93-108 pp.

BROCKELMAN, W.Y. 1994. PHVA Workshop: Learning to help the gibbons of Thailand. *Primate Conservation* (14-15):58-63.

BROCKELMAN, W.Y. 1998. Study of tropical forest canopy height and cover using a point-intercept method. Pages 521-531 in F. Dallmeier and J.A. Comiskey. (Eds.), *Forest Biodiversity Research Monitoring and Modeling: Conceptual Background and Old world Case Study*. Man and Biosphere series. Volume 20. UNESCO, Paris, and Parthenon Publishing, New York.

BROCKELMAN, W.Y., U. REICHARD, U. TREESUCON AND J.J. RAEMAEKERS. 1998. Dispersal, pair formation and social structure in gibbons (*Hylobates lar*). *Behav. Ecol. Sociobio.* 42:329-339.

BROCKELMAN, W.Y. 2005. Ecology and social system of gibbons. In B.M.F. Galdikas, N. Briggs, L.K. Sheeran, G.L. Shapiro and J. Goodall (Eds.), *All Apes Great and Small.* Volume II. Kluwer Academic/Plenum Publishers (in press).

CARPENTER, C.R. 1940. A field study in Siam of the behavior and social relation of gibbon (*Hylobates lar*). *Comparative Psychology Monographs* 16:1-212.

CHAPMAN, C.A. AND C.A. PERES. 2001. Primate conservation in the new millennium: The role of scientists. *Evolutionary Anthropology* 10:16-33.

CHEN, N. 1995. Ecology of black-crested gibbon (*Hylobates concolor*) in the Ailao Mt. Preserve, Yunnan, China. M.Sc. thesis, Mahidol University. 133 pp.

CHIVERS, D.J. 1977. The lesser apes, Pages 539-598 in Prince Rainier III of Monaco and Bourne, G.H. (Eds.), *Primate Conservation.* Academic Press, New York.

CHIVERS, D.J. 1984. Feeding and ranging in gibbons: A summary, Pages 267-281 in H Preuschoft, D.J Chivers, W.Y. Brockelman and N. Creel (Eds.), *The Lesser Apes: Evolutionary and Behavioural Biology.* Edinburgh University Press.

CHIVERS, D.J. 2000. The swinging singing apes: fighting for food and family in far-east forests, Published. Pages 1-28 in *The Apes: Challenges for the 21st Century.* Chicago Zoological Society, Brookfield, Illinois. 376 pp.

ELLEFSON, J.O. 1974. A natural history of white-handed gibbon in the Malayan peninsula, Pages 1-136 in Rumbaugh, D.M. (Eds.), *Gibbon and Siamang,* Volume III. Graphische Betriebe Coop Schweiz, Basel. 209 pp.

FUENTES, A. 2000. Hylobatid communities: Changing views on pair bonding and social organization in Hominoids. *Year book of Physical Anthropology.* 43:33-60.

GARDNER, S., P. SITTISUNTORN AND W. ANUSANSUNTORN. 2000. Tree of the North of Thailand. Kobfai publication. Bangkok, Thailand. 545 pp.

GEISSMANN, T. 2003. Symposium on gibbon diversity and conservation: Concluding resolution. *Asian Primates.* 8(3-4):28-29.

GITTINS, S.P. 1982. Feeding and ranging in the agile gibbon. *Folia Primatol* 38:39-71.

GITTINS, S.P. 1983. Use of the forest canopy by the agile gibbon. *Folia Primatol* 40:134-144.

GOODWIN, J.W. AND J. AUGUSTINE. 1975. Primate research center program of the national institutes of Health, Pages 1-3 in W.J. Goodman, and J. Augustine (Eds.), *Primate Research*. Plenum Press, New York and London. 122 pp.

KANWATANAKID, C. 2000. Characteristics of fruits consumed by the white-handed gibbon (*Hylobates lar*) in Khao Yai National Park, Thailand. M.Sc. thesis, Mahidol University, Bangkok, Thailand. 136 pp.

KAWAMURA, S. 1961. A pilot study on the social life of white-handed gibbon in northern Thailand. *Natural and Life in Southeast Asia* 1: 159-169.

KHAMYONG, S., D. SANCHANTHONG AND T. PARATHAI. 2003. Quantitative flora diversity of forests in Pang Ma Pha District. Mae Hong Son Province. Report to Biodiversity Training Program (BRT), Bangkok. 316 pp.

LEIGHTON, D.R. 1987. Gibbon: Territoriality and monogamy. Pages 135-145 in B.B. Smuts, D.L. Cheney, R.M. Seyfarth, R.W. Wrangham and T.T. Strucsaker (Eds.), *Primate Societies.*: University of Chicago Press, Chicago and London.

LEIGHTON, D.S.R. AND A.J. WHITTEN. 1984. Management of free-ranging gibbons. Pages 32-43 in H. Preuschoft, D.J. Chivers, W.Y. Brockelman, N. Creel. (Eds.) *The Lesser Apes: Evolutionary and Behavioural Biology*. Edinburgh University Press. 709 pp.

LEKAGUL, B. AND J. MCNELLY. 1977. *Mammals of Thailand*. Kurusapha Ladprao Press, Bangkok. 758 pp.

MARSHALL, J.T., J.R. BRUCE, A. ROSS AND S. CHANTHAROJVONG. 1972. The species of gibbons in Thailand. *Journal of Mammology* 53 (3): 479-486.

MAXWELL, J.F. AND S. ELLIOTT. 2001. Vegetation and vascular flora of Doi Sutep Pui National Park Northern Thailand. Biodiversity Research and Training Program (BRT), Bangkok. 205 pp.

MUANGKHUM, K. 2001. Home range and seasonal forage of the white-handed gibbon (*Hybates lar*) in Huai Kha Khaeng Wildlife Sanctuary. M.Sc. thesis, Kasetsart University, Bangkok, Thailand. 123 pp.

NETTELBACK, A.R. 1993. Zur Öko-Ethologie freilebender Weisshandgibbons (*Hylobates lar*) in Thailand. Unpublished M.Sc. dissertation, Zoologishes Institut und Museum, Universität Hamburg.

PALOMBIT, R.A. 1994. Dynamic pair bonds in Hylobatids: Implications regarding monogamous social systems. *Behaviour* 128 (1-2):65-101.

PALOMBIT, R.A. 1997. Inter–and intraspecific variation in the diets of sympatric siamang (*Hylobates sydactylus*) and lar gibbons *(Hylobates lar*). *Folia Primatol* 68:321-337.

PROMSAO, K AND B. SILARUK. 1999. Seven level forest: learned man knowledge. Knowledge Foundation, Amarin Printing & Publishing Public company Limited, Bangkok, Thailand. 190 pp. (Thai)

REICHARD, U. 1991. Zum Sozialverhalten einer Gruppe freilebender Weisshandgibbons (*Hylobates lar*). Unpublished M.Sc. dissertation, Göttingen: Georg-Agust Universität.

REICHARD, U. 1998. Sleeping site, sleeping place, and presleep behavior of *gibbons (Hylobates lar) American Journal of Primatology* 46:35-62.

RAEMAEKERS, J.J. 1984. Large versus small gibbons: Relative roles of bioenergetics and competition in their ecological segregation in sympatry. Pages 209-218 in H. Preuschoft, D.J. Chivers, W.Y. Brockelman, N. Creel. (Eds.) *The Lesser Apes: Evolutionary and Behavioural Biology*. Edinburgh University Press..

RAEMAEKERS, J.J. 1978. Change through the day in food choice of wild gibbons. *Folia Primatol* 30:194-205.

RAEMAEKERS, J.J. AND P.M. RAEMAEKERS. 1984a. The ooaa duet of the gibbon (*Hylobates lar.*) A group call which triggers other groups to respond in kind. *Folia Primatol* 42:209-215.

RAEMAEKERS, J.J. AND P.M. RAEMAEKERS. 1984b. Long-range vocal interactions between groups of gibbons (*Hylobates lar*). *Behaviour* 95:26-44.

RAEMAEKERS, J.J., P.M RAEMAEKERS AND E. HAIMOFF. 1984. Loud calls of the gibbon (*Hylobates lar*): repertoure, organization and context. *Behaviour.* 91:146-189.

SAMITINAND, T. 2001. *Thai Plant Names.* The Forest Herbarium, Royal Forest Department. 810 pp.

SANTASOMBAT, Y. 2001. Ecotourism, culture diversity and natural management. Biodiversity Research and Training Program (BRT). Nopburee Press. Chiang Mai. 234 pp. (Thai).

SANTISUK, T. 1988. An account of the vegetation of northern Thailand. *Geological Research* Volume V, Frans Steiner Verlag Wiesbaden GMBH, Stuttgart. 101 pp.

SRIKOSAMATARA, S. 1980. Ecology and behavior of the pileated gibbon (*Hylobates pileatus*) in Khao Soi Dao Wildlife Sanctuary, Thailand. M.Sc. thesis, Mahidol University, Bangkok, Thailand. 157 pp.

SRIKOSAMATARA, S. 1984. Ecology of pileated gibbon in southeast Thailand. Pages 242-257 in H. Preuschoft, D.J. Chivers, W.Y. Brockelman, N. Creel. (Eds.) *The Lesser Apes: Evolutionary and Behavioural Biology.* Edinburgh University Press. 709 pp.

SRIKOSAMATARA, S. AND W.Y. BROCKELMAN. 1987. Polygyny in a group of pileated gibbons via a familial route. *Int. J. Primatol.* 8 (4):389-393.

SRIKOSAMATARA, S., S. NAOSAWAT, S. LAOYEEPA AND V. SUTEETHORN. 1999. Status of mineral licks and wildlife in Mae Hong Son and their potentials for ecotourism industry, Pages 826-831 in Baimai, V. et al. (Eds.), Research Reports on Biodiversity in Thailand. Biodiversity Training Program (BRT), Bangkok. 892 pp.

STEINMETZ, R. AND R. MATHER. 1996. Impact of Karen villages on the fauna of Thung Yai Naresuan Wildlife Sanctuary: A participatory research project. *Nat. Hist. Bull. Siam Soc.* 44:23-40.

SUWANNAKERD, S. 2001. Ecology and social behavior of white-handed gibbons (*Hylobates lar*) at Tham Nam Lod Wildlife Conservation Development and Extension Center, Mae Hong Son. M.Sc. thesis, Chiang Mai University. Chiang Mai, Thailand. 119 pp.

SUWANVECHO, U. 1997. Behavioral study of maturation of white-handed gibbon (*Hylobates lar*) at Khao Yai National park, Thailand. M.Sc. Thesis, Mahidol University, Bangkok, Thailand. 153 pp.

SUWANVECHO, U. 2003. Ecology and interspecific relations of two sympatric Hylobates species (*H. lar and H. pileatus*) in Khao Yai National Park, Thailand. Ph.D. Thesis, Mahidol University, Bangkok Thailand. 171 pp.

TILSON, R., K. CASTLE, J. SUPRIATNA, K.J. GURMAYA, W. BROCKELMAN AND S. TUNHIKORN. 1993. Multi-disciplinary strategic planning for gibbon conservation in Thailand and Indonesia, Pages 177-197 in Wallis, R.A., (Eds.), *Primate Conservation: The role of zoological park.*

WHITHINGTON, C. AND U. TREESUCON. 1991. Selection and treatment of food plants by white-handed gibbon (*Hylobates lar*) in Khao Yai National Park, Thailand. *Nat. Hist. Bull. Siam Soc.* 39:111-122.

APPENDIX

Plate 1. Figs above had been observed eaten by the main study group, unknown 1 (a), *F. benjamina* (b), *F. kerrzii* (c), *F. altisima* (d), unknown 2 (e) and unknown 3 (f).

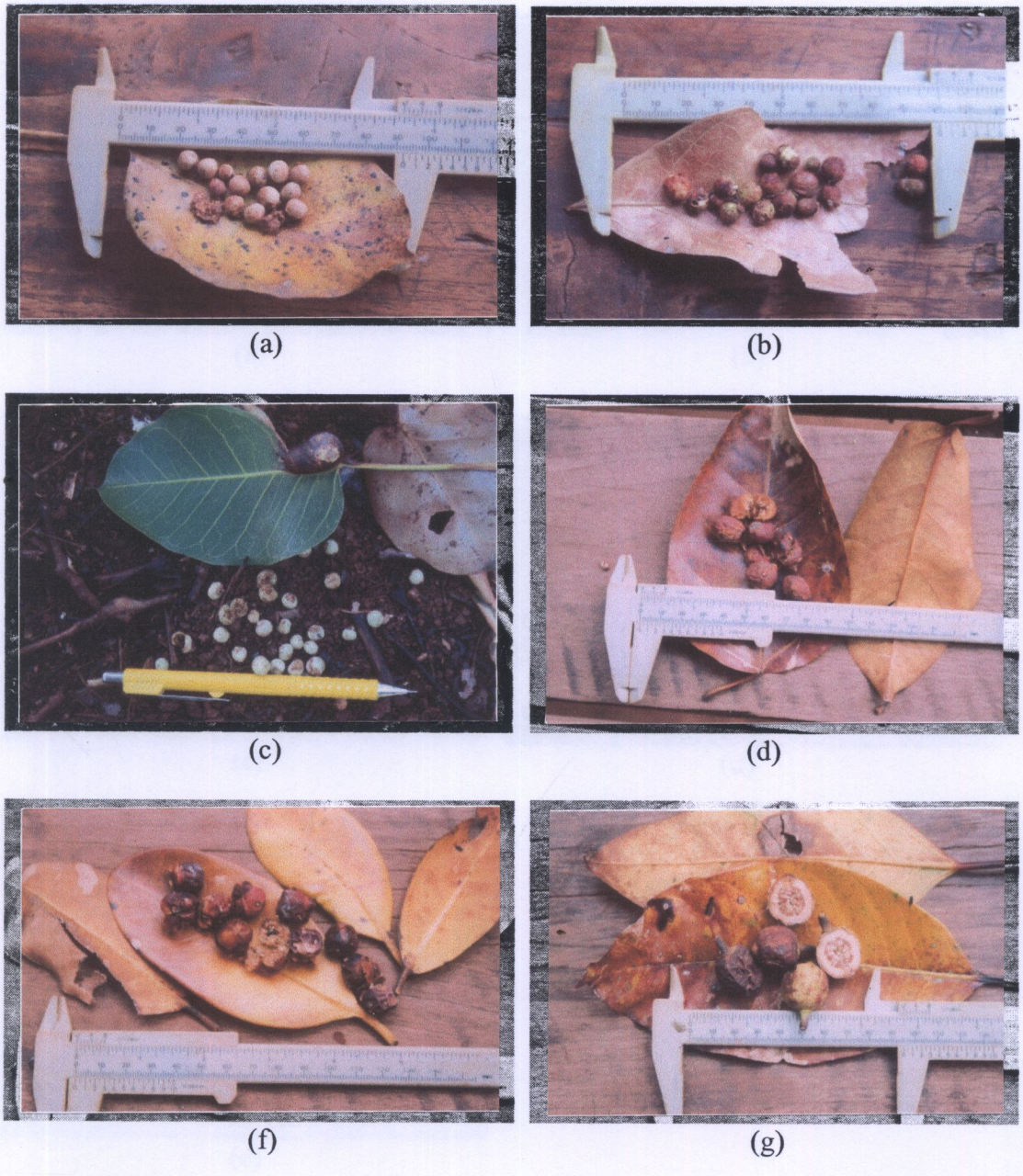


Plate 2. Fig in photo (a) and (b) had been observed eaten by the gibbons group G1, and 4 species in photo (c), (d), (e), and (f) were found in the home range of the main study group.

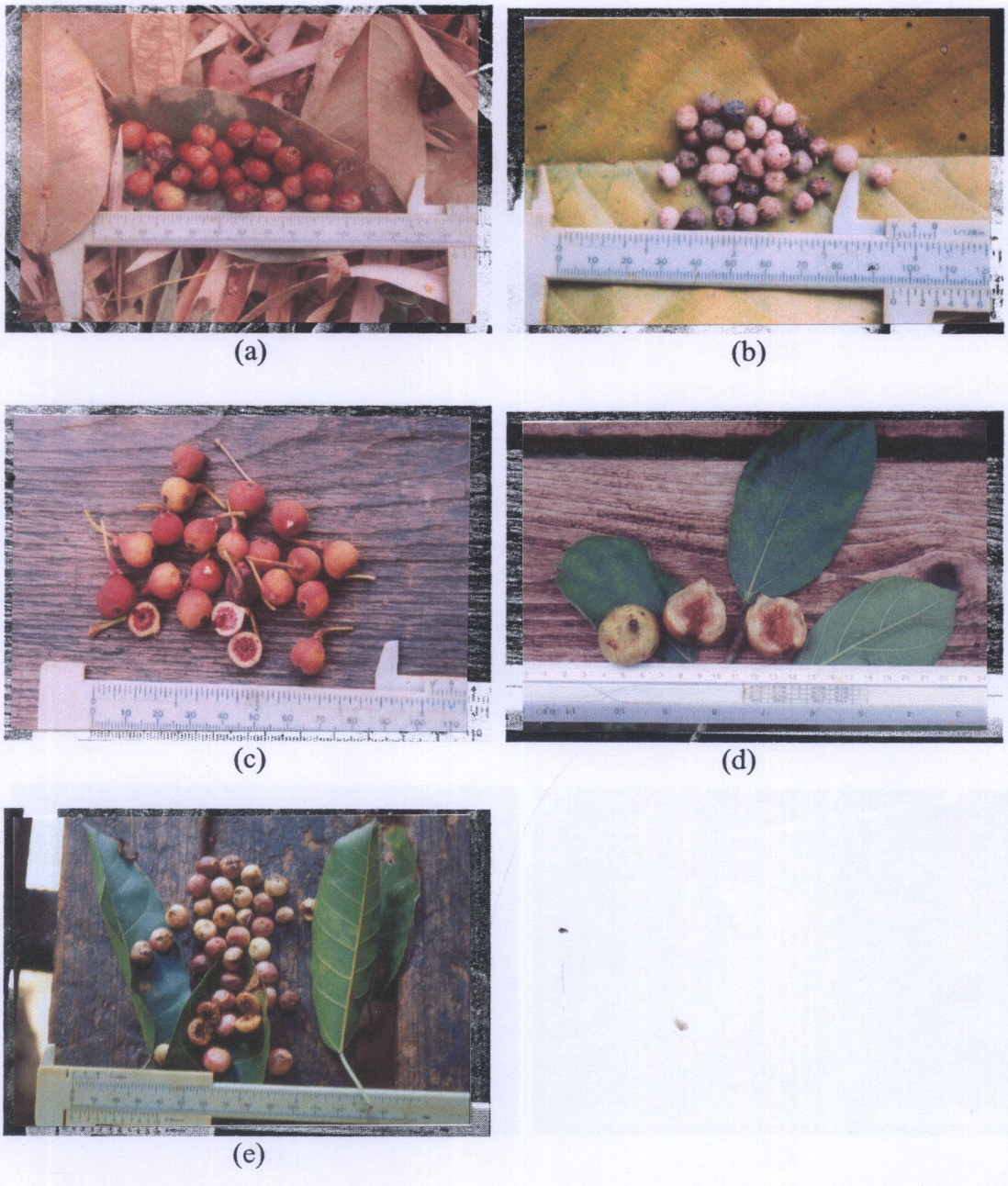


Plate 3. Fig in photo (a) was found at the home range of group G6 (Huai Rai group) during mid of March 2004, figs in photo (b) and (c) found beside the road, at the edge of the home range of group G1, photo (d) is the fig that found in secondary growth (January 2005) which already been cleared for cropping in Jan 2005, photo (e) is the fig that bear a plenty of fruits in December 2004 and observed eaten by the gibbon.

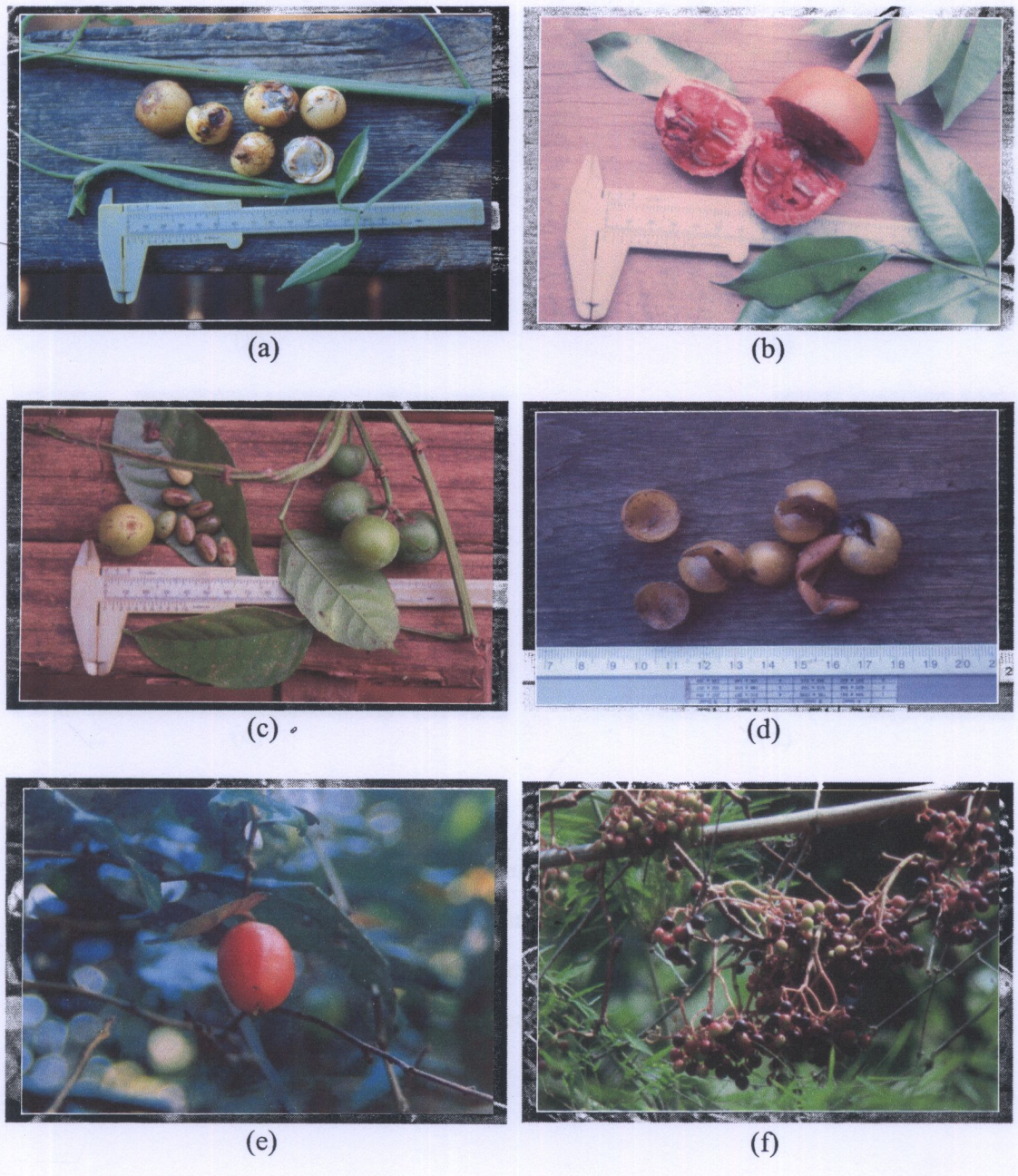


Plate 4. Ta-ju-or-sa (Karen) (Vitaceae) (a), *Melodinus cambodiensis* (b), Tu-bor-khe-khor (Karen) (Vitaceae) (c), *Tinospora crispa* (d), *Elaeagnus latifolia*, (e) and wild grape (Vitaceae) (f).

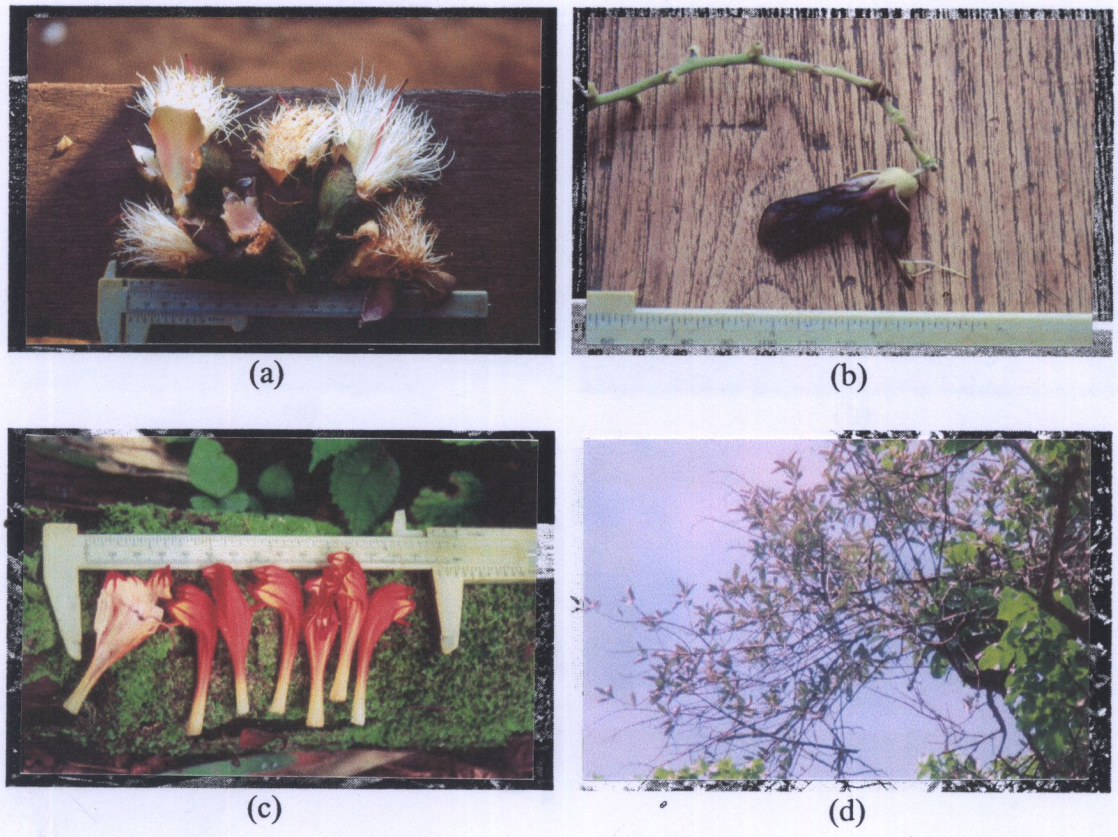


Plate 5. Flowers observed eaten by the main study group *Bombax insigne* (a), during mid December and *Mucuna pruriens* (b) during mid December (c) *Aeschynanthus andersonii* during late September and (d) *Scurrula* sp. during late February. The main food are (a) and (b), for (b) and (c) was selected sometimes.

(a)

(b)

(c)

Plate 6. *Bambusa* sp. 1 shoots (a), *Bambusa* sp. 2 shoots (b) and Ze-le-cho (Karen) (c).

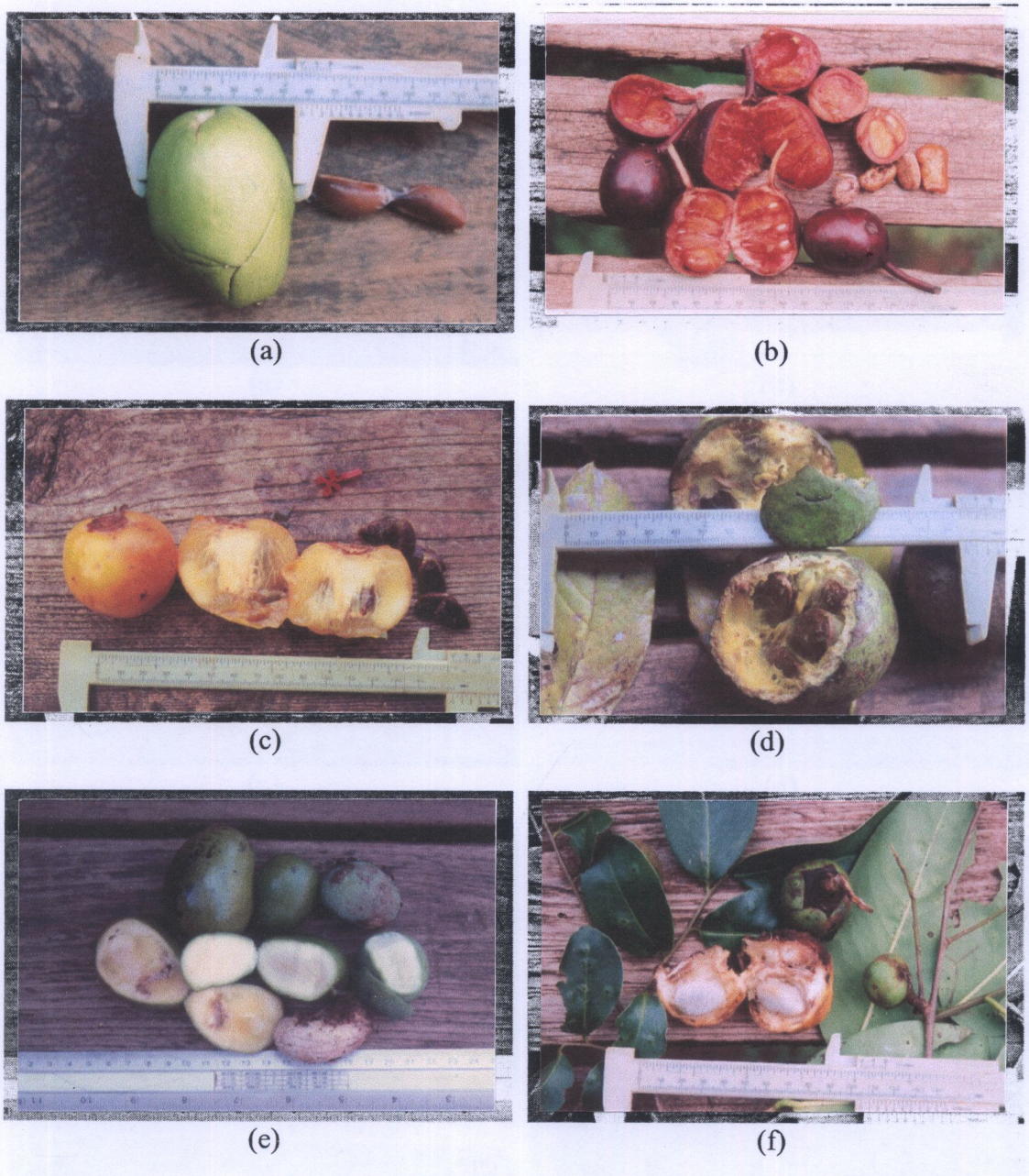


Plate 7. Ze-do-sa (Karen) (a), Nato-jor-zoo (Karen) (Annoniaceae) (b), *Diospyros glandulosa* (c), *Cyathocalyx martabanicus* (d), *Mangifera* spp (e), *Diospyros coaetanea* (f).

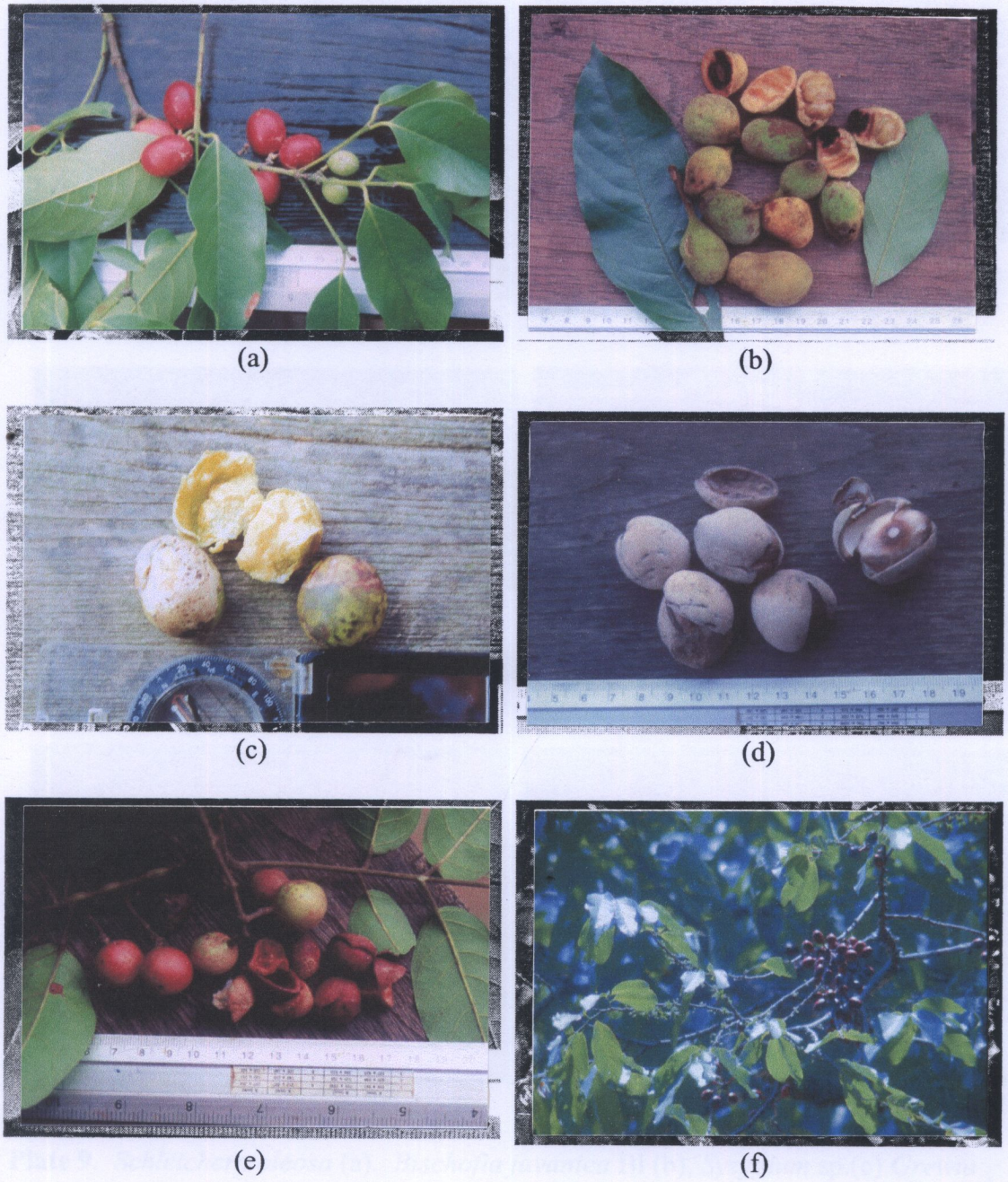


Plate 8. Sa-glee-po (Karen) (a), *Mitrephora vandaeflora* (b), *Spondias pinnata* (c), Ze-sor-je (*Aglaia grandis*) (d), *Protium serratum* (e), *Polyalthia viridis* (f).

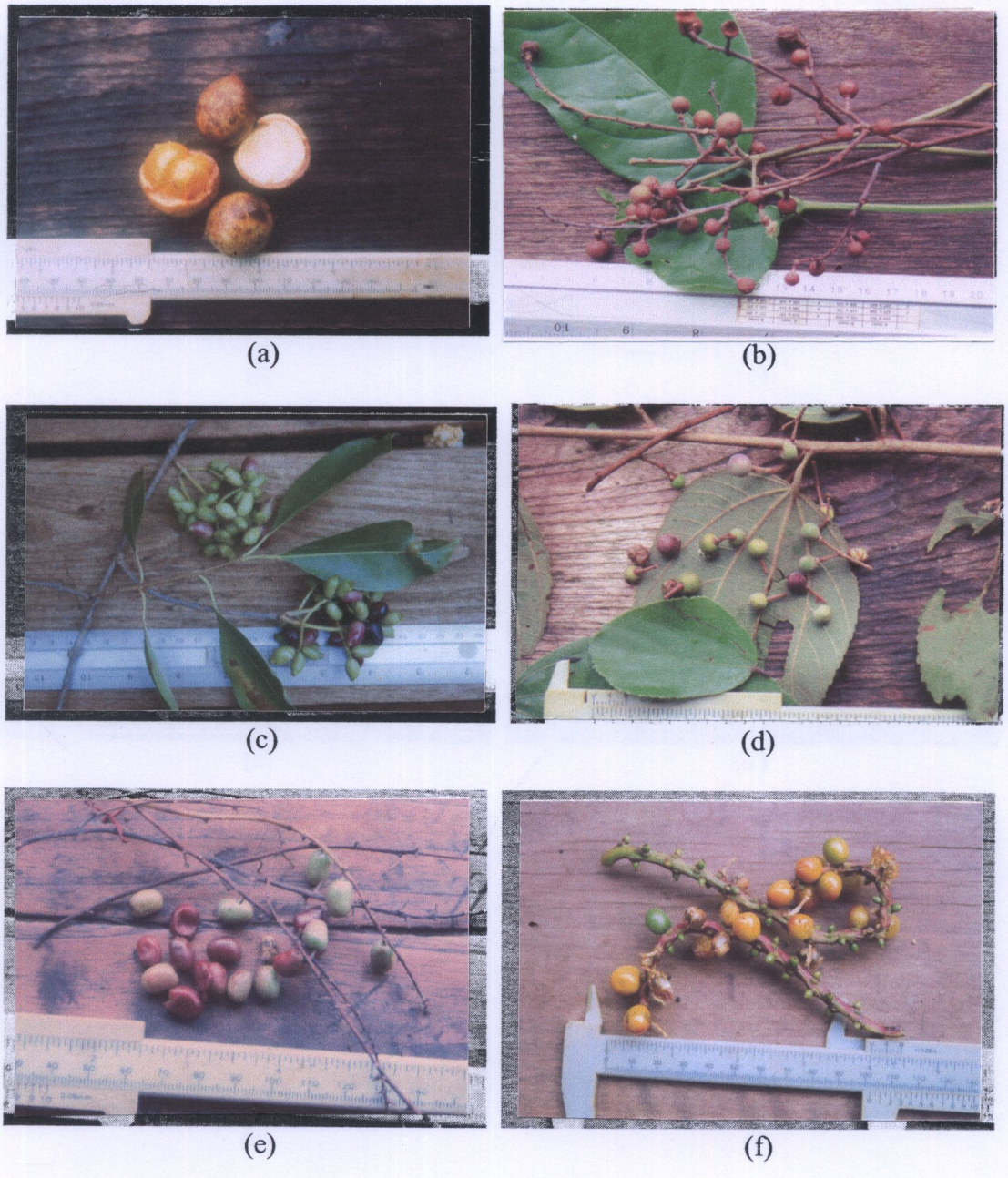


Plate 9. *Schleichera oleosa* (a). *Bischofia javanica* Bl (b), *Syzygium* sp.(c) *Grewia eriocarpa* Juss (d), *Lannea coromandelica* (e), Ze-blor-mae (Karen) (f).

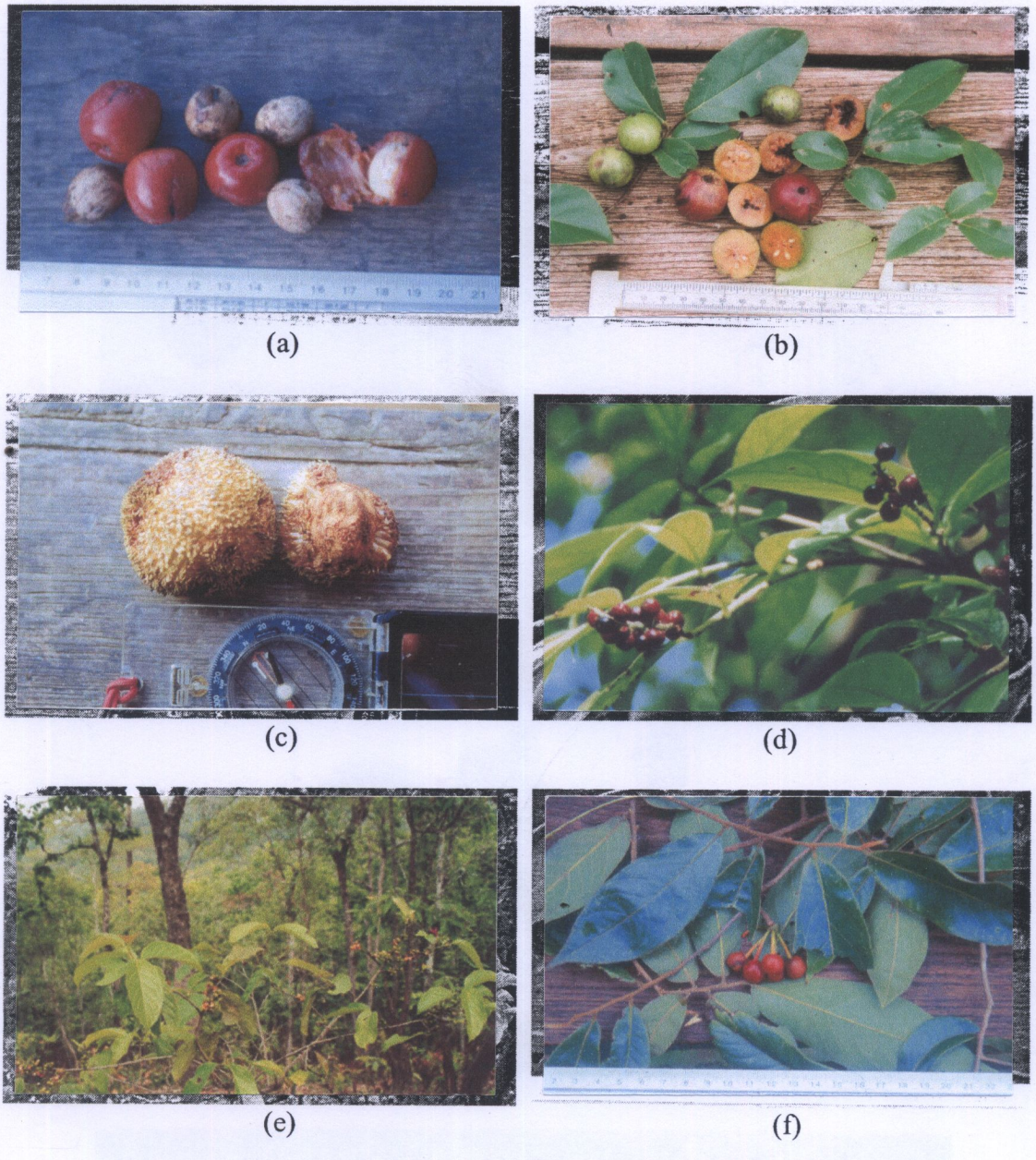


Plate 10. *Anacolosa ilicoides* (a), *Flacourtia indica* (b), *Anthocephalus chinensis* (c), *Antidesma sootepense* (d), *Aporosa villosa* (e). *Polyalthia cerasoides* (f).

Plate 11. From left to right, *Schleichera oleosa, Polyalthia cerasiodes and Balakata baccata* (a) which extracted from feces collected on 29 July, 2004. Flower part of *Scurrula* sp. found in the feces collected on 2 March 2004 (b).

Plate 12. Close up photo of *Polyalthia cerasiodes* (a), *Balakata baccata* (b)

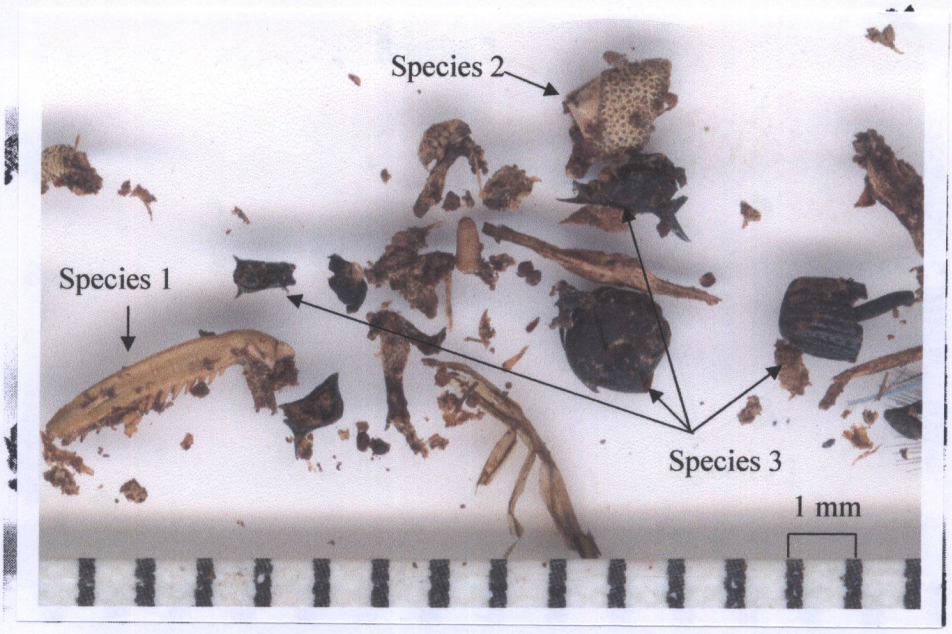


Plate 13. Showing parts of insects of at least 3 species found in the feces collected within the home range of the main study group on February 3, 2005.

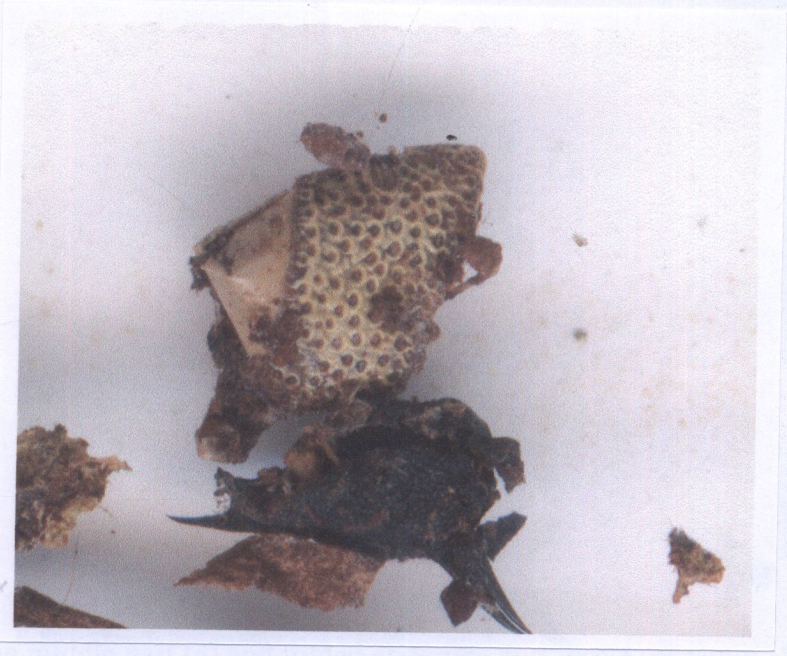


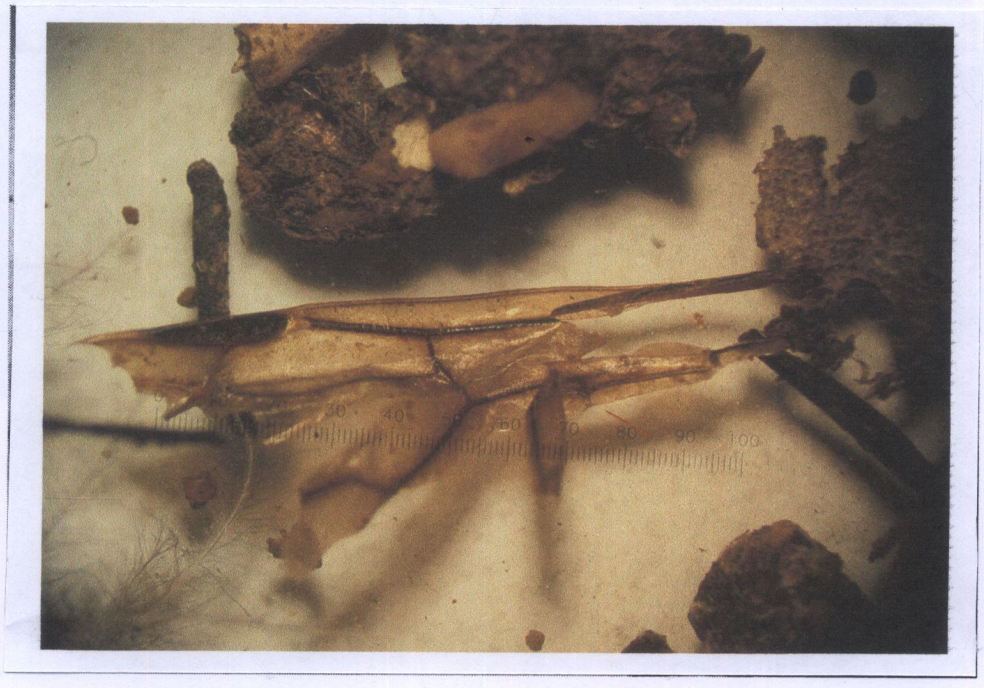
Plate 14. The close up of above photograph showing part of 2 pieces of insects from faeces collected on February 3, 2005.

(a)

(b)

Plate 15. The middle part (a) and folded abdomen part insect (possibly Hymenoptera) (arrow) from the same faeces of plate 14.

(a)



(b)

Plate 16. Showing part of insect found in fresh feces collected on February 2005 in the home range of group G1, front leg of mantid (a), wing part of Hymenoptera (b).

Plate 17. Showing head part of larvae found in same feces as plate 13-16.

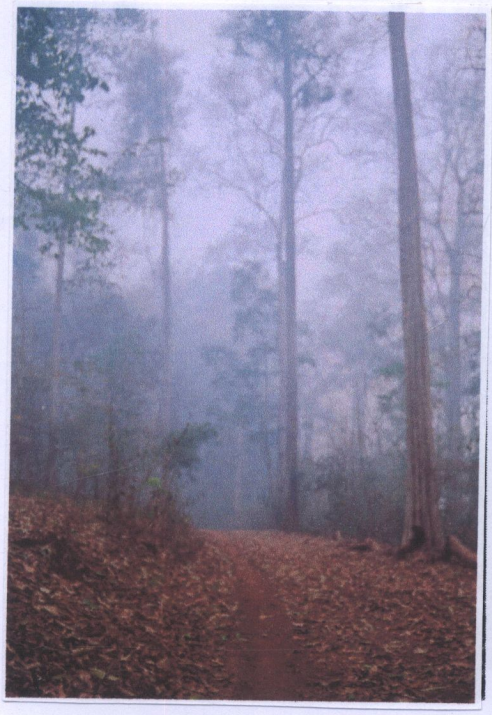


Plate 18. Tropical Deciduous and Bamboo Forest (750-800 m.a.s.l.) which consist of, *Polyalthia viridis,* various species of *Ficus* sp, *Xylia xylocarpa*, as a common species. (Lower part of the home range of the main study group) (Type1m).

(a)

(b)

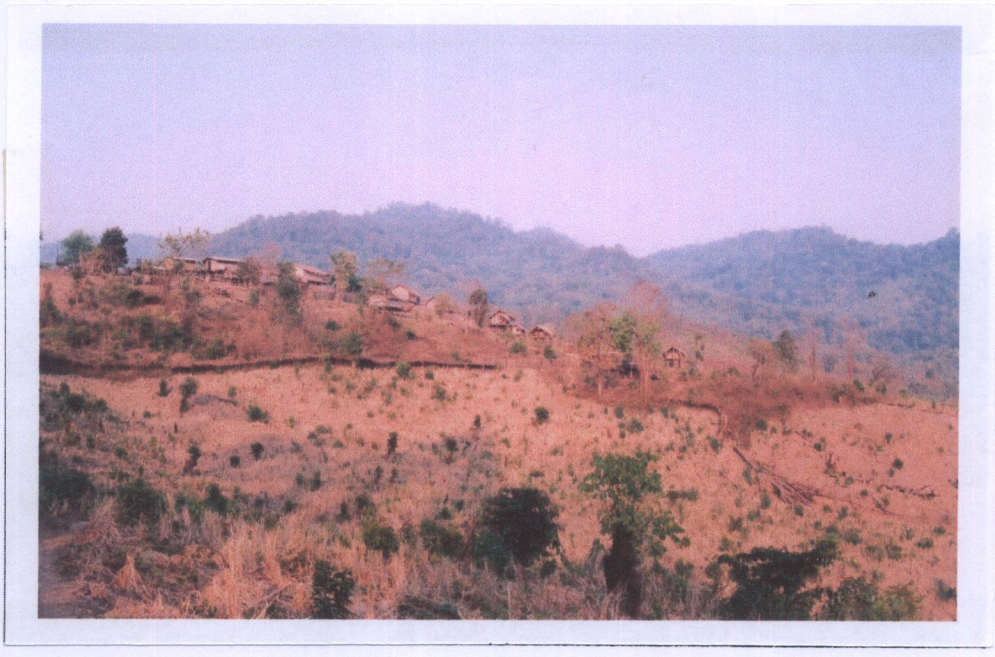
Plate 19. Mixed Deciduous and Bamboo Forest around the cliff site at 800-900 m.a.s.l. (type 2). The group are traveling to the food source downward (a), and one of them (arrow) resting on the tree standing on the ledge site of type 2 (b).

Plate 20. Tropical Mixed Deciduous Forest with teak stand (850-900 m.a.s.l.) on the plateau consisting of *Tectona grandis, Shorea siamensis, Terminalia alata,* as a common species (the upper part of the home range of the main study group) (type 3).

(a)

(b)

Plate 21. Ecotone of Deciduous and Bamboo Forest and Pine-Deciduous Dipterocarp Forest (800-900 m.a.s.l.) (a and b), which consist of *Pinus merkusii* and *Pinus kesiya* on the top (type 5).



(a)

(b)

Plate 22. Feature of Lahu village, Ban Aela. Unlike Karen, Lahu likely to establish their village at the plain on the hill top surrounded by crop field (a), the Lahu bamboo house, the place for my short staying in this village (b), about 500 m behind the house is G7.

(a)

(b)

Plate 23. The adult female of group G1 showing her fearless to the observer, photo (a) during feeding time on 40 m tall *Bombax insigne*, while the adult male always fear to human presentation (b).

Trees in 78 plots in the home range of group G1

Families	Species	Thai name	Num.	%
Alangiaceae	*Alangium kurzii* Craib.	สลีดง	1	
Annonaceae	*Mitrephora vandaeflora* Kurz.*	ปอแสด	9	
	Polyalthia cerasiodes (Roxb.) Benth. ex Bedd.*	กระเจียน	3	
	Polyalthia viridis Craib.*	ยางโอน	29	7.6
Anacardiaceae	*Semecarpus cochinchinensis* Engl.	รัก	2	
	Spondias pinnata (L.f.) Kurz	มะกอก	1	
Apocynaceae	*Holarrhena pubescens* Wall. ex G.Don.	โมกหลวง	7	
Bignoniaceae	*Fernandoa adenophylla* (Wall. ex G.Don) Steenis	แคบิด	3	
	Gmelina arborea Roxb.	ซ้อ	1	
	Oroxylum indicum (L.) Kurz.	เพกา	1	
	Stereospermum colias (Buch.-Ham. ex Dillwyn) Mabb.	แคทราย	1	
Bombacaceae	*Bombax ancep* Pierre	จิ้วขาว	6	
	Bombax insigne Wall.*	จิ้วป่า	2	
Burseraceae	*Protium seratum* Engl.*	มะแฟน	6	
Combretaceae	*Anogeissus acuminata* (Roxb. ex DC.) Guill. & Perr	ตะเคียนหนู	6	
	Terminalia alata Heyne ex Roth.	รกฟ้า	10	2.6
Datiscaceae	*Tetrameles nudiflora* R.Br.	กะพง	5	
Dilleniaceae	*Dillenia* sp (small size)*	ส้าน 1 ใบเล็ก	1	
	Dillenia sp (big leaf size of over 50 cm)*	ส้าน 2 ใบใหญ่	2	
	Dillenia sp. (medium size)	ส้าน 3 ใบกลาง	1	
	Dillenia parviflora Griff.*	ส่านหิ่ง	3	
Dipterocarpaceae	*Shorea siamensis* Miq*	รัง	3	
Euphorbiaceae	*Aporosa villosa* (Wall. ex Lindl.) Baill.*	เหมือดโลด	1	
	Baccaurea ramiflora Lour.*	มะไฟป่า	1	
	Bischofia javanica, B. javensis Blume*	ประดู่ส้ม	1	
	Croton roxburghii N.P.Balakr.	เปล้าหลวง	3	
	Mallotus philippensis Müll.Arg.	คำแสด	1	
	Phyllanthus emblica L.	มะขามป้อม	7	
Fagaceae	*Quercus kerrii* Craib.	ก่อแพะ	5	
Guttiferae	*Garcinia* sp.		1	
Labiatae	*Premna pyramidata* Wall. ex Schaur.	สักขี้ไก่	8	
	Tectona grandis L.f.	สัก	4	
	Vitex limonifolia Wall.	ตีนนก	1	
Lauraceae	*Cinnamomum caudatum*	(อบเชย)	1	

* = Gibbon food plants

Families	Species	Thai name	Num.	%
	Litsea monopetala (Roxb.) Pers.	กะทัง	2	
	Phoebe lanceolata (Wall. ex Nees) Nees	ตองหอม	7	
Leguminoceae	*Albizia lucidior* (Steud.) I.C.Nielsen	ปันแถ	1	
	Bauhinia variegata L.	เสี้ยวดอกขาว	16	4.2
	Xylia xylocarpa (Roxb)	แดง	127	33.2
Lythraceae	*Lagerstroemia calyculata* Kurz	ตะแบกแดง	2	
	Lagerstroemia cochinchinensis	ตะแบก	9	
	Lagerstroemia floribunda Jack	ตะแบกผิวเรียบ	2	
Meliaceae	*Aglaia grandis**		1	
	Aphanamixis polystachya (Wall.) R.Parker	ตาเสือ ตุ้มดง	3	
	Chukrasia tabularis A.Juss.	เสียดกา	3	
Moraceae	*Ficus* spp.	ไทร	10	2.6
Rubiaceae	*Catunaregam spathulifolia* Tirveng.	มะเคว็ด	1	
	Meynia pubescens	มะหนามนึ้ง	1	
	Tarennoidea wallichii (Hook.f.) Tirveng. & Sastre.	คอไก่	1	
Simaroubaceae	*Harrisonia perforata* (Blanco) Merr. *ScanS*	คนทา	2	
Sonneratiaceae	*Duabanga grandiflora* (Roxb. ex DC.) Walp.	ลำพูป่า	1	
Spindaceae	*Dimocarpus longan* Lour.	ลำไยป่า	4	
	Schleichera oleosa (Lour.) Oken.*	ตะคร้อ	5	
Staphyleaceae	*Turpinia pomifera* (Roxb.) DC.	มะกอกพราน	4	
Sterculiaceae	*Pterospermum grandiflorum* Craib.	ตองเต่าขน	2	
	Eriolaena candollei Wall.	ปอเลียง	7	
	Sterculia pexa Pierre	ปอบ้าน-ปอขาว	2	
	Sterculia urena Roxb. Var.	ปอตือก	2	
	Sterculia villosa Roxb.	ปอตูบหูช้าง	4	
Tiliaceae	*Grewia eriocarpa* Juss.*	ปอลาย	25	6.5
	20 Unknown species			
		Total	**381**	

* = Gibbon food plants

Data sheet for overhead tree height (m) in 4 directions of each plot.

Plot no.	North	East	South	West	Location	UTM	Note

BIOGRAPHY

NAME Mr. Pathom Yimkao

DATE OF BIRTH 12 May 1971

PLACE OF BIRTH Songkhla, Thailand

INSTITUTE ATTEND

Chulalongkorn University, 1990-1996:
Doctor of Veterinary Medicine

Mahidol University, 2000-2005:
Master of Science (Environmental Biology)

RESEARCH GRANT

Biodiversity Research and Training Program (BRT)
In the year 2004-2005

E-mail: tu_wild@yahoo.com