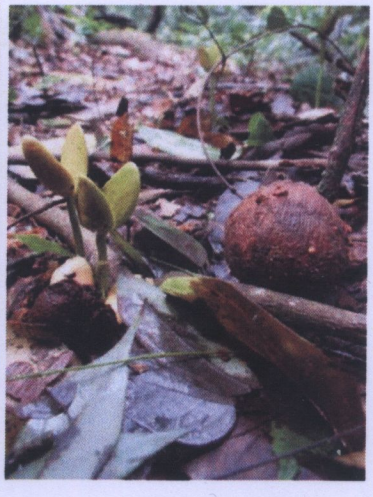
Final Report

Seed dispersal of pileated gibbons (*Hylobates pileatus*) at Khao Ang Rue Nai Wildlife Sanctuary

Project number: BRT R352014



Final Report

Project title (Thai): การศึกษาการแพร่กระจายเมล็ดไม้ของชะนีมงกุฎ (*Hylobates pileatus*) ใน เขตรักษาพันธุ์สัตว์ป่าเขาอ่างฤาไน

(English): Seed dispersal of pileated gibbons (*Hylobates pileatus*) at Khao Ang Rue Nai Wildlife Sanctuary

Project number: BRT R352014

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This study was supported by the Biodiversity Research and Training Programme (BRT R352014).

Executive Summaries in English:

The project "Seed dispersal of pileated gibbons at Khao Ang Rue Nai Wildlife Sanctuary" focused on the seed dispersal ecology of the pileated gibbon (*Hylobates pileatus*), an endangered primate restricted to a small range in Southeast Asia. An intensive study of seed dispersal by the pileated gibbon, conducted on one gibbon groups (Group A) previously habituated to observers from previous research (2005-2008). The target group was followed from night tree to night tree for fives day a month, to investigate their feeding ecology and behavior from January and December 2009. We collected the faecal samples, recorded the time and exact location of all depositions and enter into a geographic information system via Arcview GIS 3.2 software. Faecal samples were count and identified. We used gut retention times as 20.0 h to estimate the dispersal distances.

We estimated home range size of Group A by using minimum convex polygon, to approximately 60.9 ha for the whole year. Group C had 54 ha, and home range of Group E was 52 ha. The target group travelled 2,703 ± 215 (SE) m per day on average. Fruit is the major diet of pileated gibbon about 69 percent of total feeding times. Following by young leaves, flowers and arthropods as 20, 7, and 4 percent respectively. We found the pileated gibbon visit food source on average 9.4 + 0.45 (SE) sources/day (range 3-18 sources/day). They had the defecation rate on average 6.0 ± 0.28 (SE) times/day (range 2-13 times/day, n = 60). Pileated gibbons defecated throughout their active period (05h28-15h55). They had the highest defecation rate during 06h00-06h59 (22.9%).

The average dispersal from the feeding sites and deposition sites was 243 ± 11 (SE) m. There are a few seeds that drop at the parent trees (4 percent) while some seeds were dispersed quite far as 797 m. Almost 70 percent the gibbons deposited the seed more than 150 m.

Our findings show that pileated gibbons are frugivore which is very important on seed dispersal agent as they consume large amount of fruits. They can disperse many seeds from the parent sources. Moreover, their ranging behaviour also helps on the seed dispersal process as they had long travel and usually enter almost throughout their home range. Hence, these results of this study can guide pileated conservation and provide recommendations for their management in term of gibbons are vital to the survival of fruiting tree populations and maintenance of tropical forest dynamics and diversity.

Executive Summaries in Thai:

โครงการ "การศึกษาการแพร่กระจายเมล็ดไม้ของชะนีมงกุฎ (*Hylobates pileatus*) ในเขตรักษาพันธุ์สัตว์ป่าเขาอ่างฤาไน" มีวัตถุประสงค์เพื่อศึกษาการแพร่กระจายเมล็ดไม้ในป่าโดยชะนีมงกุฎ ทำการติดตามและเก็บข้อมูลชะนีกลุ่มเป้าหมาย (Group A) ที่เชื่องแล้วหนึ่งกลุ่ม ติดตามชะนีตั้งแต่เวลาชะนีตื่นจนถึงเวลาที่ชะนีเข้านอนเพื่อศึกษานิเวศวิทยาการกินอาหาร และพฤติกรรมในรอบวัน ใช้วิธี minimum convex polygon สำหรับคำนวณหาพื้นที่อาศัยของชะนี รวมถึงการเดินทางในรอบวัน โดยใช้โปรแกรม Arcview GIS 3.2 ทำการบันทึกและจำแนกชนิดอาหารที่ชะนีใช้ประโยชน์ จับพิกัดทางภูมิศาสตร์ของต้นไม้เหล่านี้ และนำมาลงในแผนที่พื้นที่อาศัยของชะนีกลุ่มเป้าหมาย ในส่วนของขี้ชะนี เก็บขี้ของชะนีทุกครั้งเพื่อนำมานับ จำแนกชนิด ในการประเมินระยะทางการแพร่กระจายของเมล็ดไม้เราใช้อัตราการการขับถ่ายของเมล็ดไม้ของชะนีมงกุฎที่ 20 ชั่วโมง

จากการศึกษาพบว่าพื้นที่อาศัยของ Group A มีขนาด 60.9 เฮกแตร์ ส่วน Group C และ Group E มีขนาด 54 และ 52 เฮกแตร์ ตามลำดับ ชะนีกลุ่มเป้าหมายเดินทางเฉลี่ย 2,703 ± 215 (SE) เมตรต่อวัน อาหารหลักของชะนีได้แก่ ผลไม้คิดเป็น 69 เปอร์เซ็นต์ รองลงมาได้แก่ ใบอ่อน ดอก และสัตว์ในกลุ่มแมลงและแมง คิดเป็น 20, 7, 4 เปอร์เซ็นต์ ตามลำดับ ชะนีใช้ประโยชน์ต้นอาหารเฉลี่ยจำนวน 9 ต้นต่อวัน ชะนีมงกุฎขับถ่ายตลอดทั้งวัน โดยมีอัตราการขับถ่ายเฉลี่ย 6 ครั้งต่อวันซึ่งมีอัตราการขับถ่ายสูงสุดในช่วง 06h00-06h59 หรือคิดเป็น 22.9% เปอร์เซ็นต์

ชะนีสามารถแพร่กระจายเมล็ดไม้ได้ในระยะทางเฉลี่ย 243 ± 11 (SE) เมตร เมล็ดไม้ที่ตกอยู่บริเวณต้นแม่มีเพียง 4 เปอร์เซ็นต์ ในขณะที่เมล็ดไม้บางชนิดสามารถไปไกลได้ถึง 797 เมตร กว่า 70 เปอร์เซ็นต์ที่ชะนีสามารถนำพาเมล็ดไม้ไปได้ไกลถึง 150 เมตร

จากผลการศึกษาชี้ให้เห็นว่าชะนีมงกุฎมีความสำคัญในการแพร่กระจายเมล็ดไม้ภายในป่า เนื่องจากชะนีกินผลไม้เป็นอาหารหลัก มีพื้นที่อาศัยขนาดใหญ่และเคลื่อนที่เป็นระยะทางไกลทั่วไปในป่า ชะนีจึงเป็นสัตว์ป่าที่มีบทบาทสำคัญในการช่วยกระจายเมล็ดไม้โดยการนำพาเมล็ดไม้ห่างไกลจากเรือนยอดของต้นแม่ ซึ่งช่วยเพิ่มอัตราการงอกและอัตราการรอดของเมล็ดไม้ จึงกล่าวได้ว่าชะนีเป็นตัวสำคัญในการช่วยรักษาความสมดุล และพลวัตรของกล้าไม้ภายในป่า ดังนั้นการอนุรักษ์ชะนีจึงเป็นการช่วยรักษาป่าได้อีกทางหนึ่ง

INTRODUCTION

Seed dispersal is an essential part of tropical rainforest regeneration which supports the idea that frugivores are vital to the survival of fruiting tree populations and maintenance of tropical forest dynamics and diversity [Chapman & Chapman, 1995; Link & Di Fiore, 2006; McConkey & Chivers, 2007]. Many studies have shown that dispersal indeed increases the recruitment probability of seeds that are moved away from parental crowns [Hurtt & Pacala, 1995; Schupp et al., 2002].

Gibbons are frugivorous, potentially play an important role in the dispersal of seeds of trees and lianas in the evergreen and moist deciduous forest of tropical Asia [Chivers, 1984; McConkey & Chivers, 2007]. They are long distance dispersers, transporting seeds away from the parent source [Gittins & Raemaeker, 1980]. The study of seed dispersal patterns is the foundation for understanding survival, recruitment, and population dynamics of tropical forest [Cain et al., 2000; Schupp et al., 2002; Wang & Smith, 2002; Webb & Peart, 2001].

Pileated gibbon (*Hylobates pileatus*) has a distribution restricted to west of the Mekong River Basin in southeastern Thailand, Lao, and Cambodia. They are listed as endangered [Brockelman et al., 2008] and also in Appendix 1 of CITES. The gibbon is one of the most threatened primates that can disappear from the forest as a result of habitat loss, and illegal hunting for food, wildlife trade, and research [IUCN, 2010; Phoonjampa & Brockelman, 2008].

Little is known about seed dispersal by the pileated gibbon. Therefore, in this study, we will investigate the specific role of the species in dissemination and spatial distribution of seeds. We will look at this within gibbon home ranges and estimate dispersal distances on their travel routes and by following daily ranging patterns. This will help us also understand the dynamics of lowland evergreen forest. Furthermore, the field research will focus on the role of gibbon in restoring disturbed forest (past logging area) using Khao Ang Rue Nai Wildlife Sanctuary in Southeast Thailand as an example.

OBJECTIVES

a) Determine the day range and territory use of the target pileated gibbon group in term of their contribution to seed dispersal
b) Characterize the seed dispersal and defecation patterns of the pileated gibbon
c) Obtain seed database in KARNWS

STUDY SITES

Khao Ang Rue Nai Wildlife Sanctuary (KARNWS) is located in Southeast Thailand. It lies between 101.35° - 102.05° East longitude and 13.00° - 13.20° North latitude (Figure 1). General topography of the area is mostly composed of corrugated plain and rolling hills which have the height range from 30-820 m above the mean sea level. All of KARNWS was logged, selective logging (mainly targeting very tall trees) had occurred before 108 km^2 was gazetted as wildlife sanctuary in 1977 which have no logging thereafter. However, logging still occurred in the rest area until 1989. In 1992, large areas (922 km^2) were adding to KARNWS and some areas (49 km^2) added more in 2001, total covering 1,079 km^2 [Forestry Research Center, 1995; Royal Forest Department, 2001].

This area belongs to Indochinese biota [Woodruff, 2003] which has high biodiversity, comprising dry-evergreen forest and mixed deciduous forest. The climate of KARNWS is largely influenced by seasonal monsoons with the average rain annual was 1,200 mm (1997-2006). The dry season last from October-March and the wet season last from April-September. The minimum mean temperature is 20.3°C and the maximum mean is 33.1°C (Chachoengsao Wildlife Research Station, unpublished data).

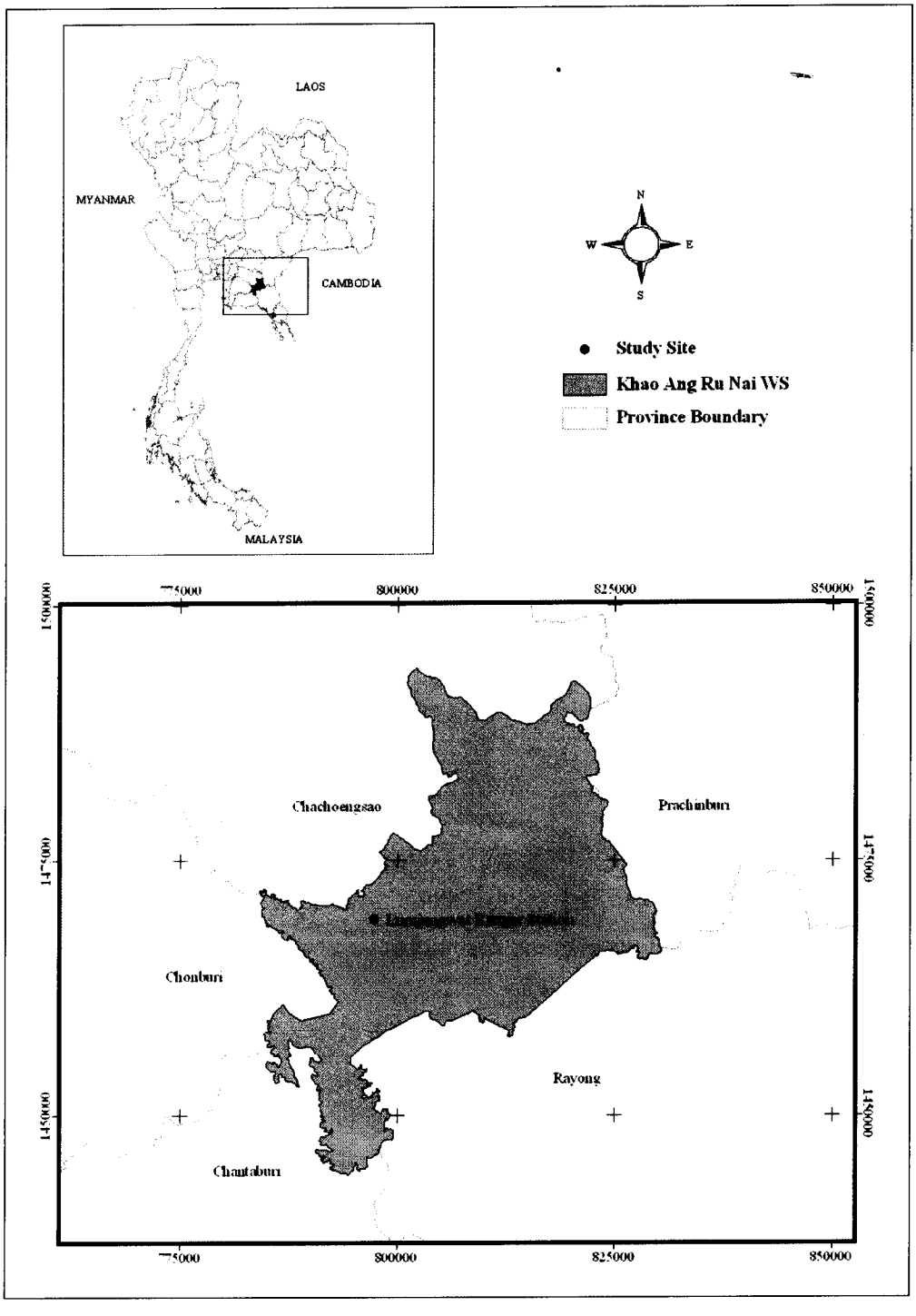

Figure 1 Map of Khao Ang Rue Nai Wildlife Sanctuary, Thailand and locations of pileated gibbons study sites (Lumjungwat Ranger Station)

METHODS

1.1) Pileated gibbon feeding and behaviour observation study

We studied pileated gibbons from January through December 2009. Behavioral and diet data were collected from one habituated gibbon group. We observed the target groups continuously from night tree to night tree on five consecutive days per month (n=60) by five minutes scan sampling. The record of the behavior of one individual in one scan is termed one observation. Feeding activity is defined as manipulating a food item and bringing it to the mouth and whether seeds are swallowed, spit, crack, or prey upon when handle [Link & Di Fiore, 2006; Poulsen et al., 2001]. We also recorded the duration of all of the focal animal's feeding bouts. The observers record the position of the target groups every 30 min by using GPS and located the gibbon groups into Arcview GIS 3.2 software. We estimated the groups' home range as the minimum convex polygon (MCP) of all the locations we recorded throughout the year. Daily path length (DPL) was investigated as sum of the straight line distance (in meters) between consecutive GPS points.

Both food species and food item (fruit, fig, young leaf, flower, and other) were recorded for every feeding observation. All gibbons' foods items identified following [Smithinand, 2001]. The location of all feeding trees was plotted in each group home range.

1.2) Faecal samples

We collected the faecal samples from adult animals as many as possible. But not all seeds were found because it was difficult to find them in the dense vegetation. We also recorded the time and exact location of all their depositions and enter into a geographic information system. Each faecal sample was count and identified by the expert botanists who familiar with the flora of KARNWS. Seeds that could not be identified in the field will be brought to the National Park, Wildlife and Plant Conservation Department's herbarium for identification.

1.3) Retention times and dispersal distance

To assess temporal patterns of defecation across the day, this method following [Poulsen et al., 2001], the number of defecations recorded will be grouped during each hour and examined as a function of sampling effort during those hours. We also determine the defecation patterns in relation to daily activity patterns. The idea that the gibbon might advantageously adapt their defecation patterns to their feeding, foraging and resting strategies to avoid the energetic cost of carrying a ballast of non-nutritional seeds in their guts during travelling will be tested.

Due to the gibbons use of multiple trees of each food species, it is impossible to measure the actual dispersal distance from the parent tree to the deposition site [McConkey & Chivers, 2007]. Therefore, we use gut retention times observed for the target group [McConkey & Chivers, 2007]. The group have to followed continuously without losing sight [Link & Di Fiore, 2006].

As gibbons live in small group and foraging together but the adult males leave the group occasionally. Hence, we determined the seed dispersal using only female data.

RESULTS

1) Group ranging

Home Range and Daily Path Length

Data were collected from one habituated group, Group A, and two groups not completely accustomed to the observers, Group C and Group E. Group A contains 3 individuals: one adult male, one adult female, and one infant (3 years old) (Figure 2) while Group C and E have five individuals. We defined "home range" as the total area used by the group in a given period [Gittins & Raemaeker, 1980]. We estimated home range size of Group A, by using minimum convex polygon (MCP), to approximately 60.9 ha for the whole year. Group C had 54 ha, and home range of Group E was 52 ha (Figure 3). In each month, the target group used at least 32 percent of entire home range or 19 ha (range 32-70 percent; 19-43 ha) (Figure 4). It took almost a year to cover the entire area (Figure 5).

Daily path length data from 60 full days (night tree to night tree, 12 months) following Group A traveled 2,703 ± 215 (SE) m per day on average. September show the highest average path length as 4,296 m whereas February show the lowest average path length as 1,748 m (Figure 6). During movements, the group made use of routes that coincided with the routes used in the previous days.

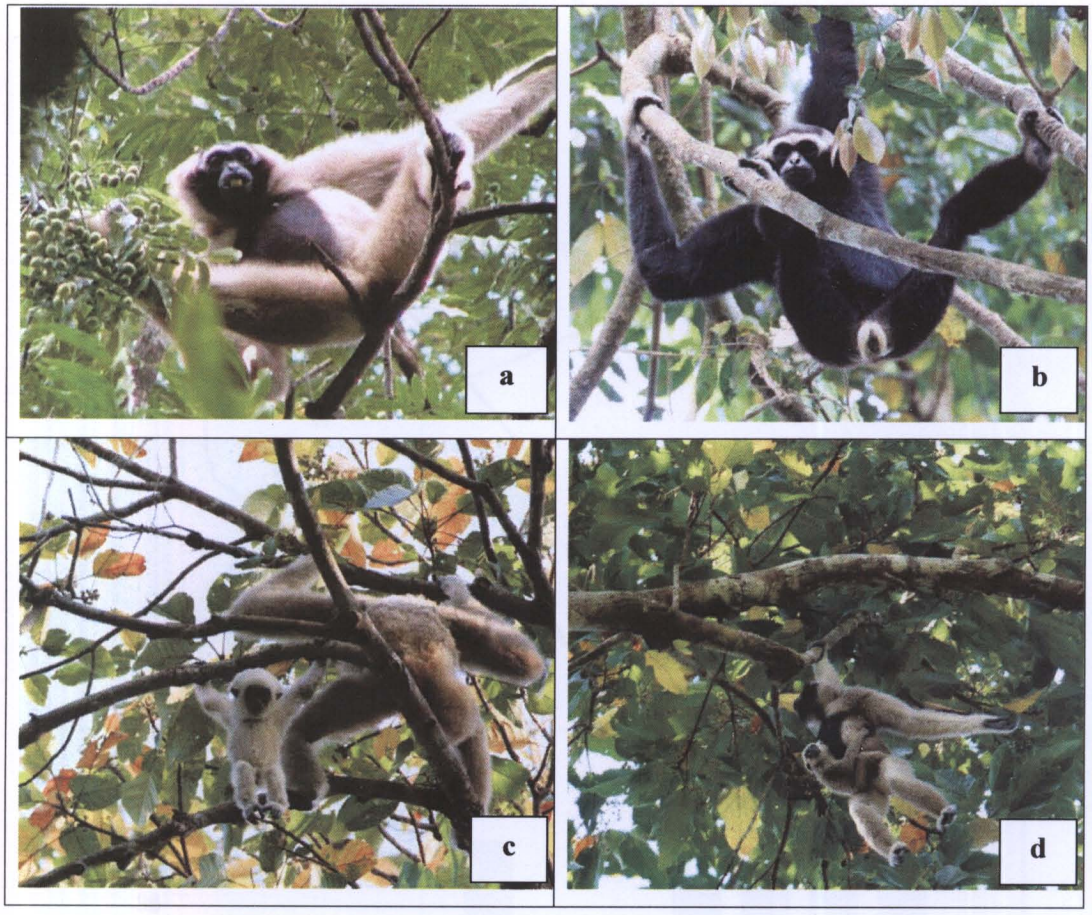

Figure 2 Pileated gibbon-Group A at KARNWS

a Adult female

b Adult male

c-d Adult female & Infant

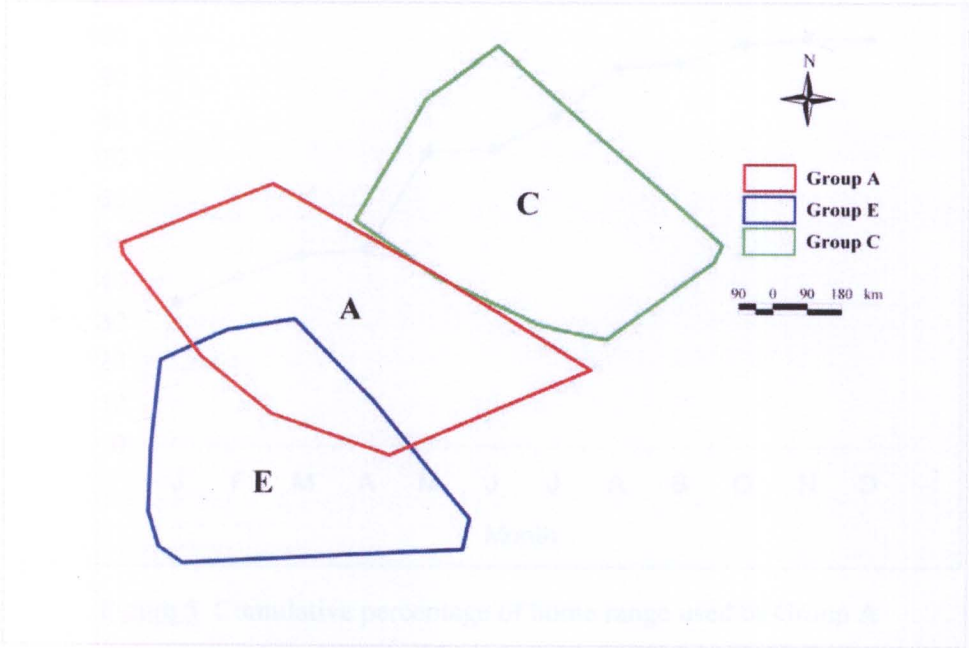

Figure 3 Home range of KARNWS gibbons by MCP

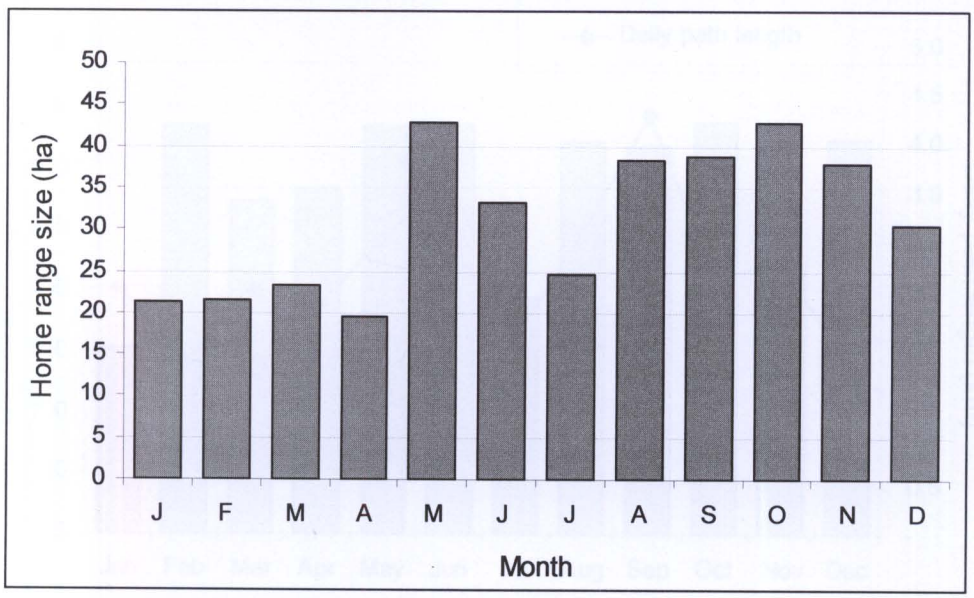

Figure 4 Monthly home range used of KARNWS gibbons

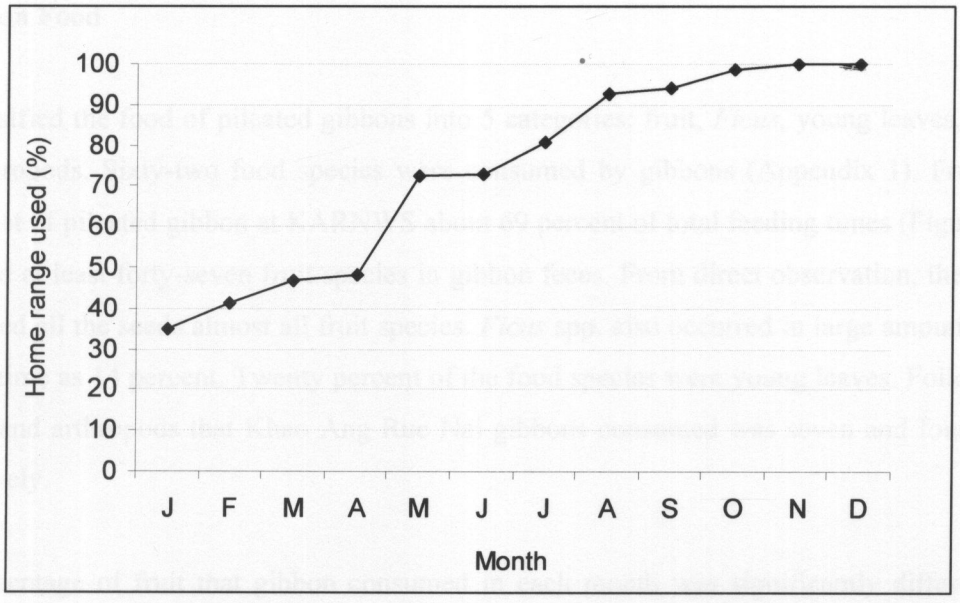

Figure 5 Cumulative percentage of home range used of Group A

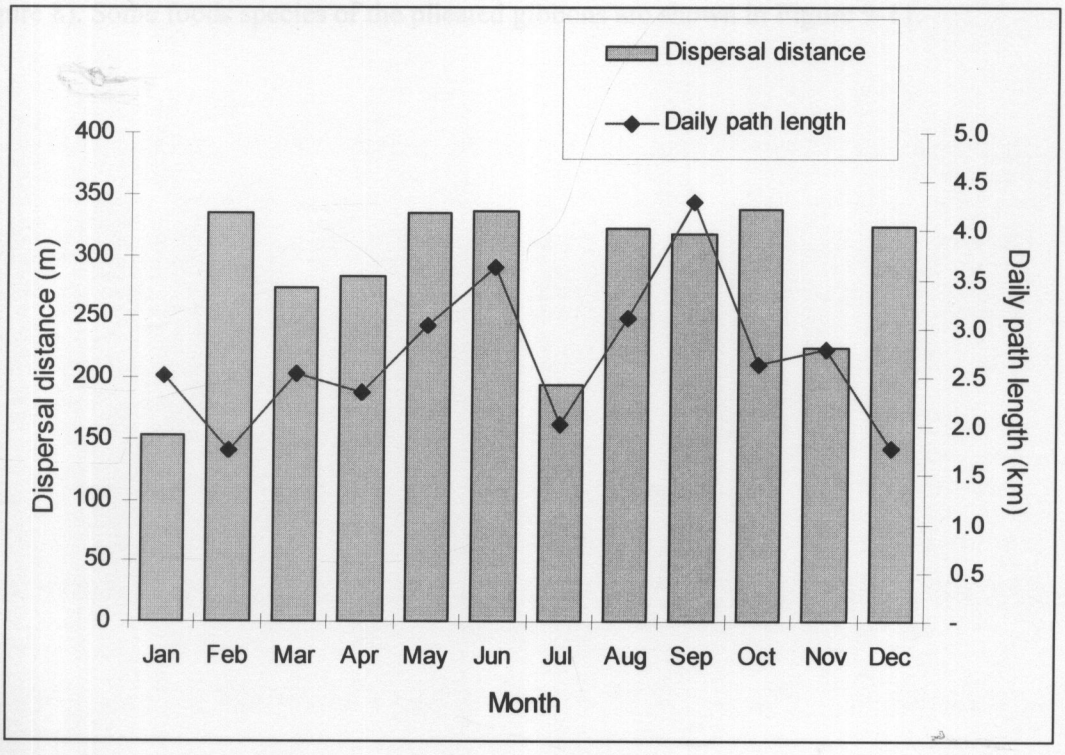

Figure 6 Average monthly daily path length of Group A (show by line graph) and bar values represent the seed dispersal distances over 12 months

2) Gibbon Food

We classified the food of pileated gibbons into 5 categories: fruit, *Ficus*, young leaves, flowers, and arthropods. Sixty-two food species were consumed by gibbons (Appendix 1). Fruit is the major diet of pileated gibbon at KARNWS about 69 percent of total feeding times (Figure 7). As we found at least forty-seven fruit species in gibbon feces. From direct observation, the gibbons swallowed all the seeds almost all fruit species. *Ficus* spp. also occurred in large amount of their feeding time as 14 percent. Twenty percent of the food species were young leaves. Following by flowers and arthropods that Khao Ang Rue Nai gibbons consumed was seven and four percent respectively.

The percentage of fruit that gibbon consumed in each month was significantly different from other food items (Wilcoxon signed ranks test: $z = -2.667$, $P<0.01$, $N=12$). The average percentage of fruit was 70 (range 38-49) while other food items was 30 percent (range 11-62) (Figure 8). Some foods species of the pileated gibbons are shown in Figure 9-11.

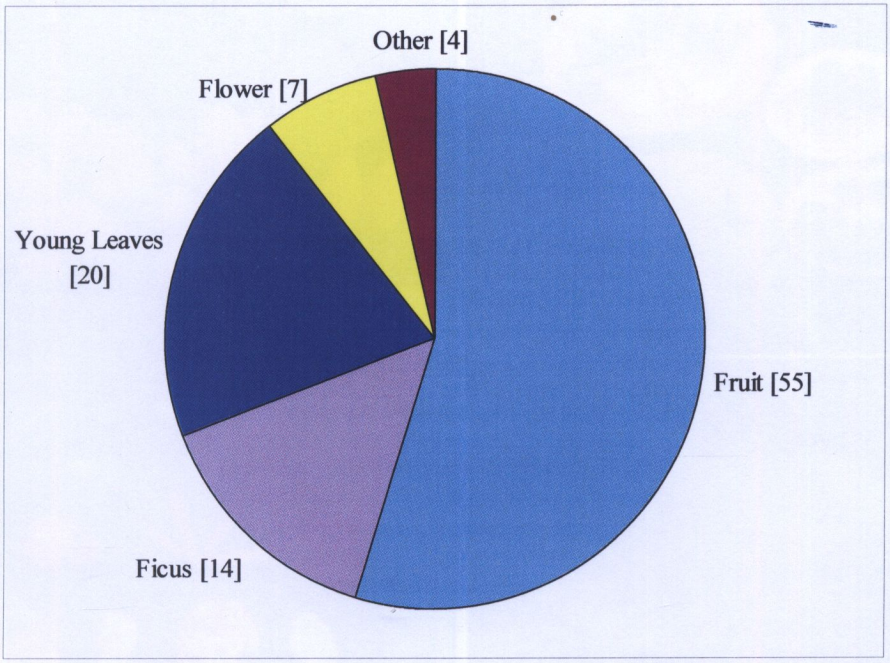

Figure 7 Percentages of observations on feeding time of pileated gibbons

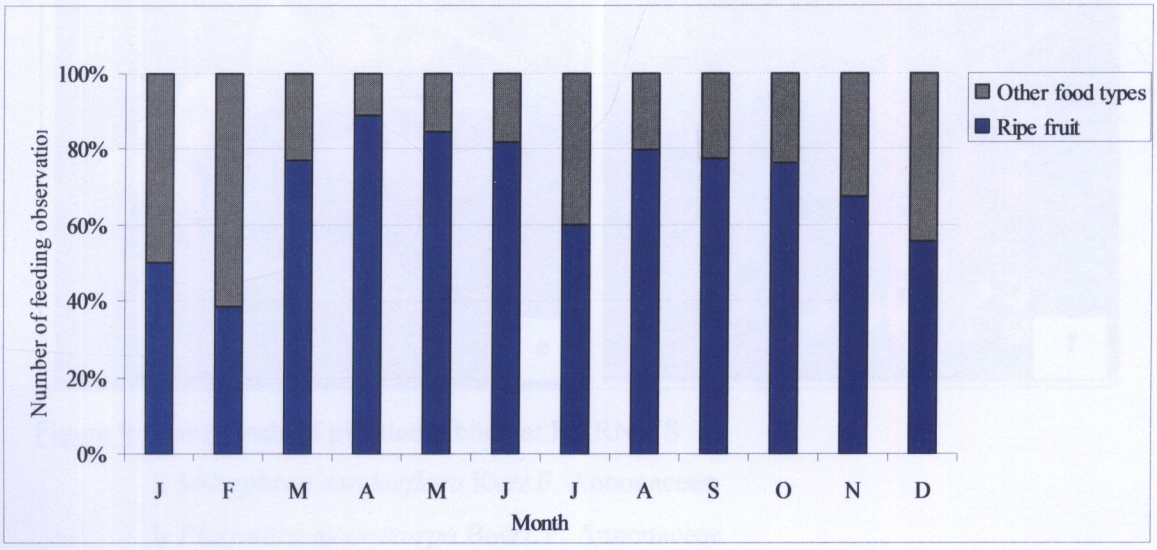

Figure 8 Percentages of food items consumed by pileated gibbons in each month

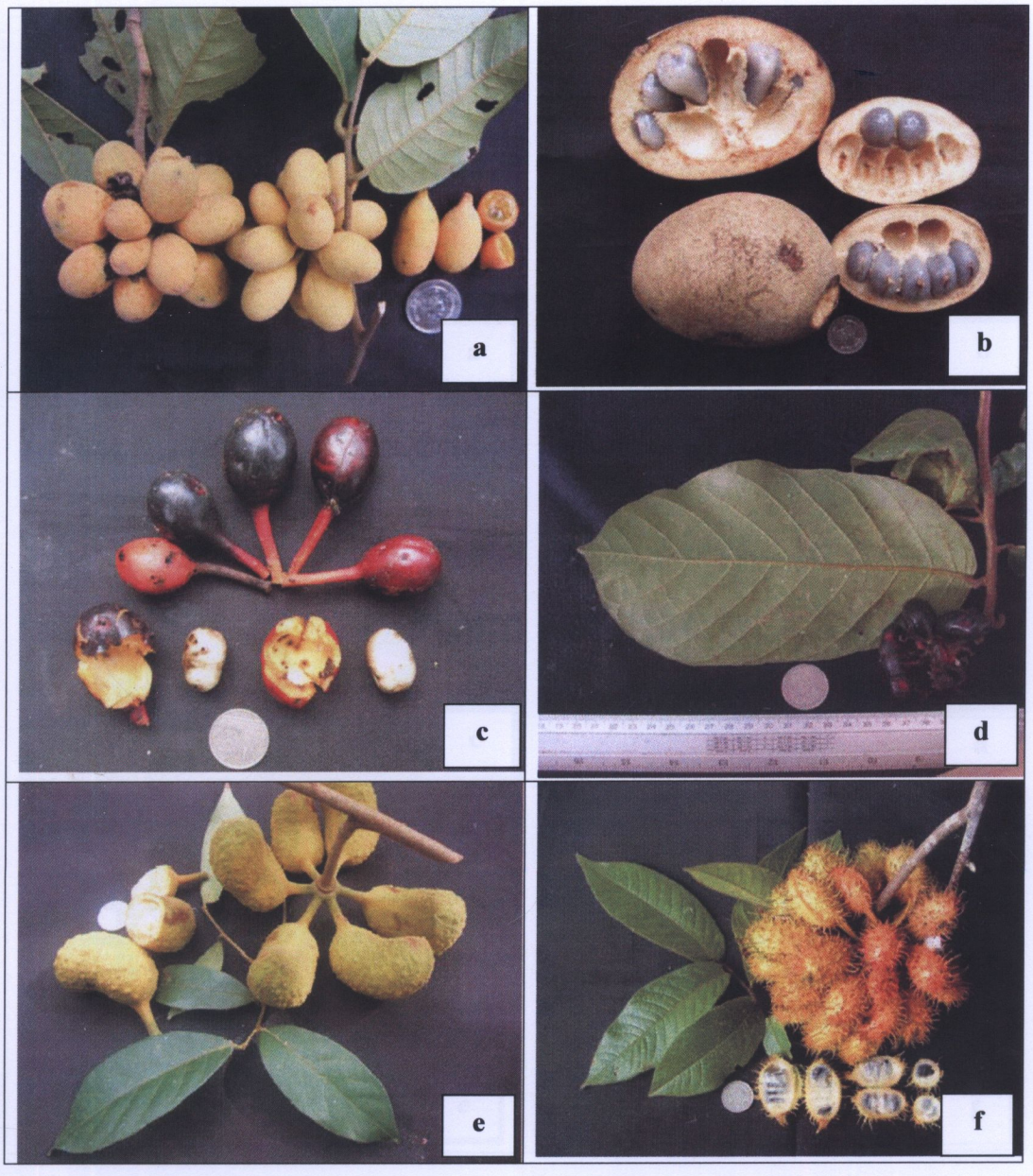

Figure 9 Some foods of pileated gibbon at KARNWS

a *Mitrephora vandaeflora* Kurz F. Annonaceae

b *Platymitra macrocarpa* Boerl. F. Annonaceae

c *Polyalthia* sp. Craib F. Annonaceae

d *Uvaria cordata (Dunal)* Alston F. Annonaceae

e *Uvaria dac* Pierre ex Finet & Gagnep. F. Annonaceae

f *Uvaria fauveliana* (Finet & Gagnep.) Pierre ex Ast. F. Annonaceae

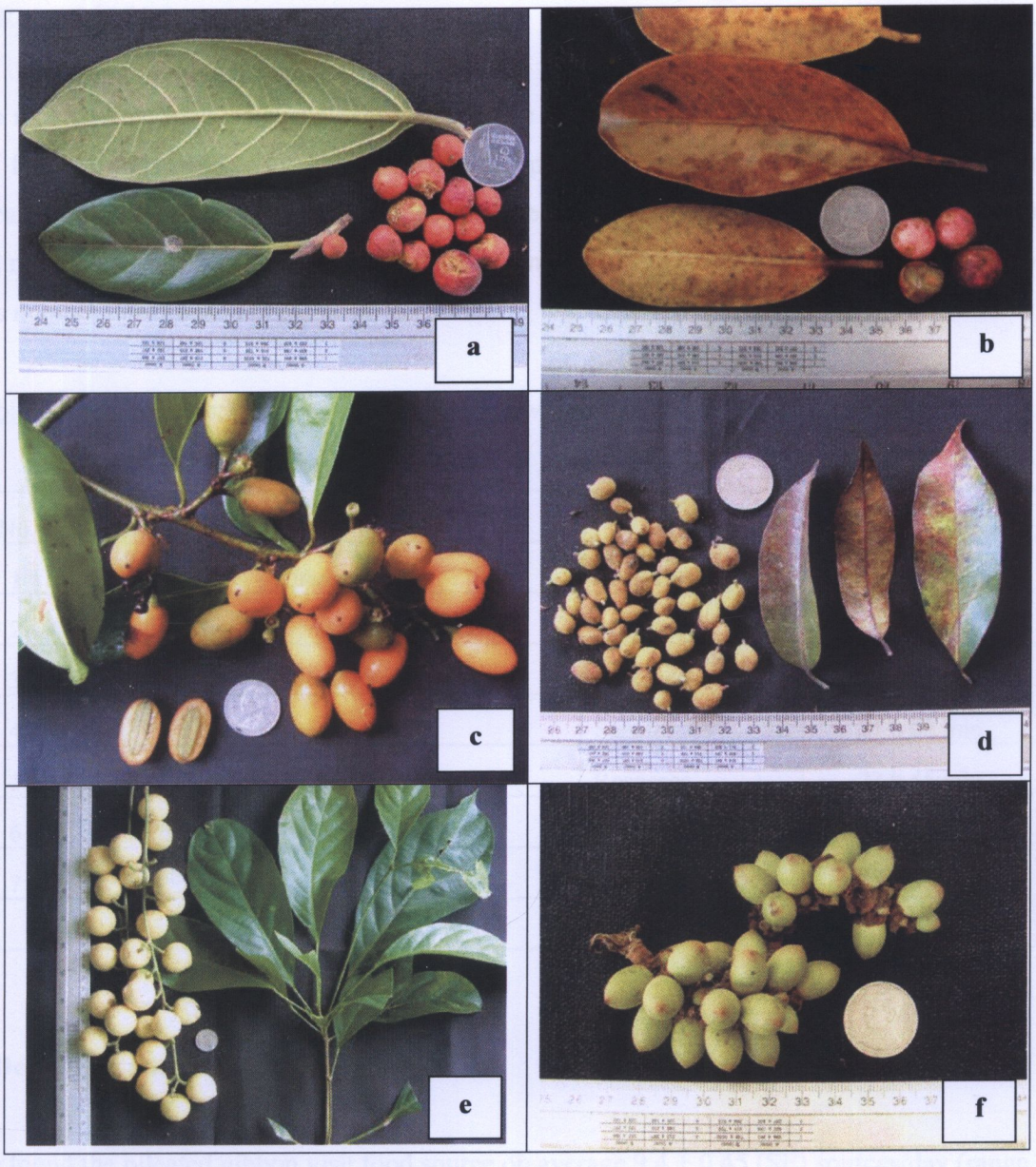

Figure 10 Some foods of pileated gibbon at KARNWS

a *Ficus pubilimba* Merr. F. Moraceae

b *Ficus sumatrana* (Miquel) Miquel. F. Moraceae

c *Erycibe elliptilimba* Merr. & Chun. Pellegr. F. Convolvulaceae

d *Artocarpus nitidus* Trecul F. Moraceae

e *Baccaurea ramiflora* Lour. F. Euphorbiaceae

f *Gnetum macrostachyum* Hook.f. F. Gnetaceae

3) Retention Time

We recorded the food species gibbons feed in the first time on the third day until it appearing in the feces. Unfortunately, we obtained very few plant species to investigate the retention times because the gibbons normally feed on the same feeding trees on the consecutive days. Minimum gut retention we obtained was average 20.0 h (range 16.15 – 22.45 h, n = 7) (Table 1). We used this number to estimate the dispersal distances.

Table 1 Average retention times of plant species whose seeds swallowed by gibbons

No.	Thai Name	Species	Family	Retention Time
1	เลือดควาย	*Knema elegans*	Myristicaceae	19 h 45 min
2	หาดหนุน	*Artocarpus gomesianus*	Moraceae	17 h 28 min
3	ตาลเสี้ยนป่า	*Xantolis* sp.	Sapotaceae	21 h 35 min
4	ตาลเสี้ยนป่า	*Xantolis* sp.	Sapotaceae	21 h 02 min
5	นูดต้น	*Prunnus grisea*	Rosaceae	22 h 45 min
6	นูดต้น	*Prunnus grisea*	Rosaceae	22 h 21 min
7	สังเครียดลางสาด	*Aglaia silvestris*	Meliaceae	16 h 15 min
Average				20 h

4) Defecation and Dispersal Distance

We found the pileated gibbon visit food source on average 9.4 $\pm$ 0.45 (SE) sources/day (range 3-18 sources/day). They had the defecation rate on average 6.0 $\pm$ 0.28 (SE) times/day (range 2-13 times/day, n = 60). Pileated gibbons defecated throughout their active period (05h28-15h55). They had the highest defecation rate during 06h00-06h59 (22.9%) (Figure 11).

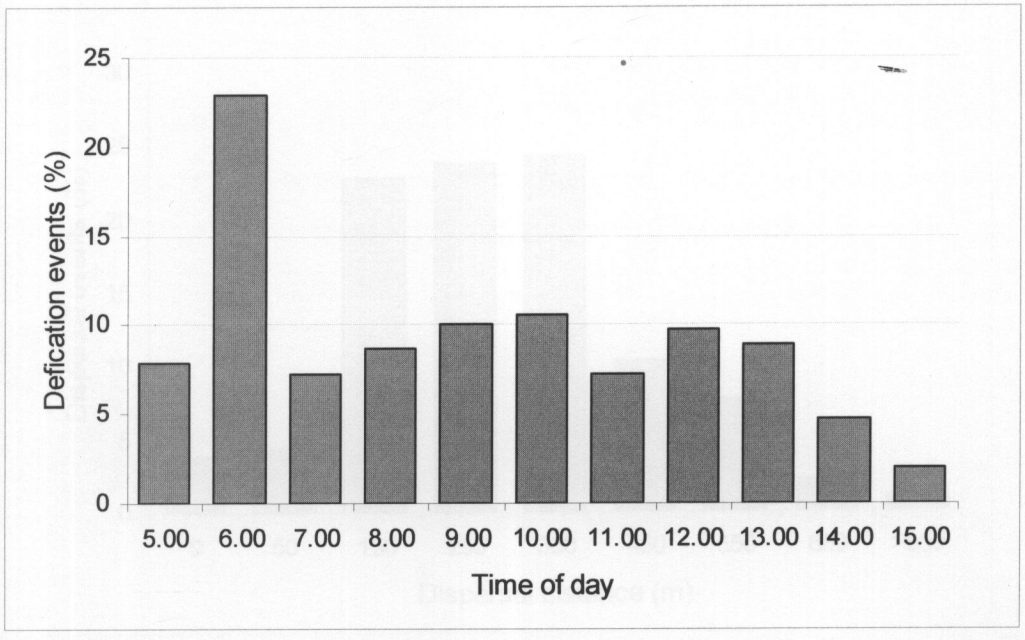

Figure 11 Percentage of defecation events in different time of day

The average dispersal from the feeding sites and deposition sites was 243 ± 11 (SE) m. There are a few seeds that drop at the parent trees (4 percent) while some seeds were dispersed quite far as 797 m (n = 185 deposited events). Almost 70 percent the gibbons deposited the seed more than 150 m (Figure 12). Seed dispersal distance varied among the month and not correlated with the daily path length (Pearson's correlation, r = 0.243, P = 0.223) (Figure 6).

We also calculated the efficiency of the seed dispersal distance by the gibbons via the ranging sites and retention times (20 h). The dispersal distance came from all the feeding bout positions to the probability of the sites that the gibbons will be defecated within 20 h. The results show that most of the seeds will be defecated and far away from the feeding sites almost 80% (n=1,129) and only 2 percent that the seeds drop under the feeding sites (Figure 13). Interestingly, some seeds can be dispersed more than 1,000 m away (2 percent).

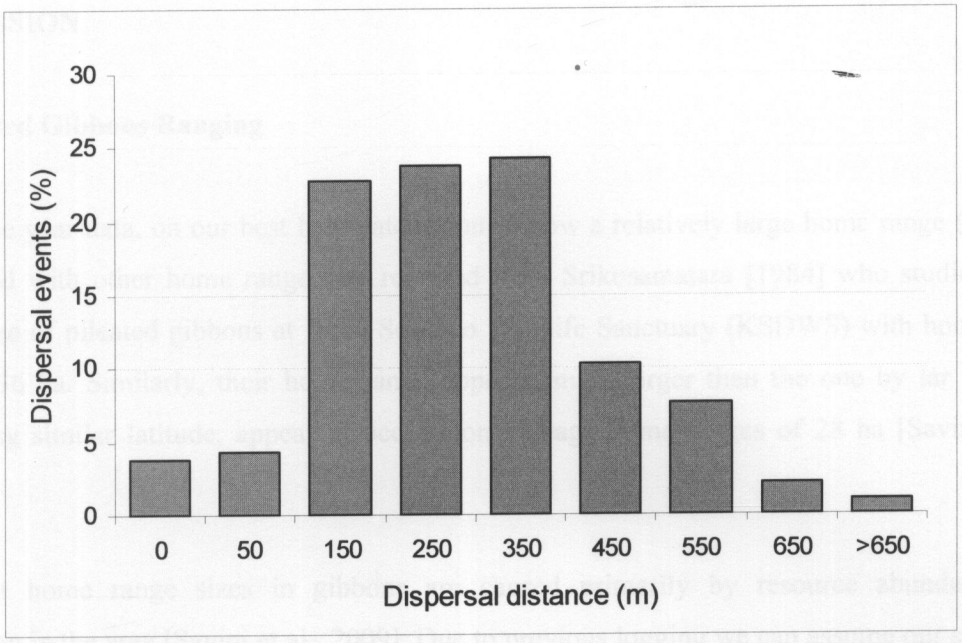

Figure 12 Seed dispersal distance of pileated gibbon at KARN

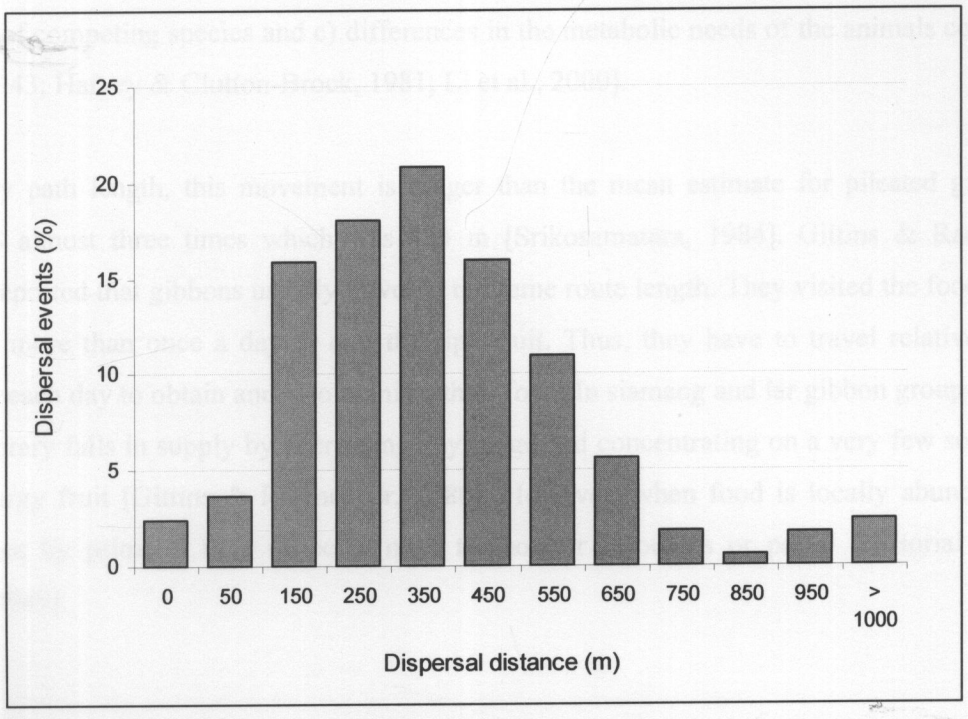

Figure 13 The efficiency of the seed dispersal distance by the gibbons via the ranging sites and retention times (20 h)

DISCUSSION

1) Pileated Gibbons Ranging

From one year data, on our best habituated group, show a relatively large home range (60.9 ha) compared with other home range size reported from Srikosamatara [1984] who studied home range size of pileated gibbons at Khao Soi Dao Wildlife Sanctuary (KSDWS) with home range size of 36 ha. Similarly, their home range appears much larger than the one by lar gibbons, inhabiting similar latitude, appear to occupy on average home ranges of 28 ha [Savini et al., 2008].

Different home range sizes in gibbons are caused primarily by resource abundance and dispersion in the area [Savini et al., 2009]. Due to previous logging we can assume our study site of relative low quality, as several plant species were cut and are now under represented in the area. Moreover, other factors that might also affect home range size are a) population density, b) number of competing species and c) differences in the metabolic needs of the animals concerned [Burt, 1943; Harvey & Clutton-Brock, 1981; Li et al., 2000].

For daily path length, this movement is longer than the mean estimate for pileated gibbon at KSDWS almost three times which was 833 m [Srikosamatara, 1984]. Gittins & Raemaeker [1980] reported that gibbons usually travel in the same route length. They visited the food source daily or more than once a day to cull the ripe fruit. Thus, they have to travel relatively long distance each day to obtain and also monitor their food. In siamang and lar gibbon group respond to temporary falls in supply by decreasing day range and concentrating on a very few sources of high-energy fruit [Gittins & Raemaeker, 1980]. However, when food is locally abundant, the movement by primates may reflect a need to monitor resources or patrol territorial borders [Peres, 1989].

2) Pileated Gibbons Food

Fruit is the major diet of KARNWS gibbon which similar to pileated gibbon at KSDWS, fruit was the most frequently eaten food (69% of their feeding time); the fruits they consumed were usually yellow, orange or red [Srikosamatara, 1984]. For other small gibbons such as lar gibbon, feeding pattern are similar: ripe fruits with soft, juicy pulp, and bright colors (red, orange, yellow, and purple) are the most consumed fruits relative to fruit availability and abundance in the forest [Bartlett, 2009; Chivers, 1984].

3) Pileated Gibbons Dispersal

Frugivores play an important role of tropical forest dynamics process [Corlett, 1998]. Among primates, gibbons are frugivores which is very important on seed dispersal agent as they consume large amount of fruits and their ranging behavior [Corlett, 1998; McConkey & Chivers, 2007]. The results show that pileated gibbons are selective feeders as they are concentrating on the large amount of fruit. They usually swallowed the whole seeds of fruits or removed the rind first if necessary. Pileated gibbons can support such rational as they can dispersed at least forty-seven fruit species with more than 200 m on average from the parental sources and only four percent drop under the parent trees. Moreover, their ranging behaviour also helps on the seed dispersal process as they had long travel and usually enter almost throughout their home range which similar to other gibbon species [Chivers, 1984; Gittins & Raemaeker, 1980]. Other studies also confirm that gibbons to be effective seed dispersers for example, Borneo hybrid gibbons (*Hylobates mulleri* x *agillis*) dispersed a few seed under parent trees and more than 90 percent were dispersed greater than 100 m [McConkey & Chivers, 2007].

IMPORTANT NEXT STEPS

1) Previous behavioural observation gibbons group has to be habituated to the presence of the observer. This part of the work shows the larger difficulties and requires patience and effort. As we spent almost 8 months in this process for the gibbon group A. The data present here obtained from only from one group (Group A). Hence, more habituated group needed for comparative data.

2) Continue study on the seed dispersal of pileated gibbons including seed survivors and seed fate.

3) Determine the relationship between seeds size and retention time which effect to dispersal distance.

4) We can use the retention time data from certain species to predict other food species in gibbon home range in term of dispersal distance.

5) Educational awareness should be conduct along with the intensive ecological study. As the gibbons are good seed dispersers, highly charismatic, endangered, and excellent indicators of pristine habitat ecological quality. It might help the people to understand the importance of gibbons in the tropical ecosystem.

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Appendix 1 List of pileated gibbons food at KARNWS

No.	Family	Species	Habit
1	Anacardiaceae	*Mangifera cochinchinensis* Engl.	T
2	Ancistrocladiaceae	*Ancistrocladus tectorius* (Lour.) Merr.	C
3	Annonaceae	*Anomianthus dulcis* (Dunn) J. Sinclair	C
4	Annonaceae	*Desmos chinensis* Lour.	C
5	Annonaceae	*Meiogyne hainanense* (Merr.) Ban	T
6	Annonaceae	*Miliusa horsfieldii* (Benn.) Baillon ex Pierre	T
7	Annonaceae	*Mitrephora vandaeflora* Kurz	T
8	Annonaceae	*Platymitra macrocarpa* Boerl.	T
9	Annonaceae	*Polyalthia* sp.	T
10	Annonaceae	*Uvaria cordata* (Dunal) Alston	C
11	Annonaceae	*Uvaria dac* Pierre ex Finet & Gagnep.	C
12	Annonaceae	*Uvaria fauveliana* (Finet & Gagnep.) Pierre ex Ast.	C
13	Annonaceae	*Uvaria grandiflora* Roxb. ex Hornem. *var.flave* J. Sinclair	C
14	Annonaceae	*Uvaria hahnii* (Finet & Gagnep.) J. Sinclair	C
15	Annonaceae	*Uvaria harmiltonii* Hook.f.& Thomson	C
16	Annonaceae	*Uvaria lurida* Hook.f. & Thomson	C
17	Apocynaceae	*Willughbeia* sp.1	C
18	Apocynaceae	*Willughbeia* sp.2	C
19	Asclepiadaceae	*Hoya* sp.	C
20	Bombacaceae	*Bombax anceps* Pierre *var.cambodianse*	T
21	Convolvulaceae	*Erycibe elliptilimba* Merr. & Chun.	S
22	Convolvulaceae	*Erycibe* sp.	C
23	Dipterocarpaceae	*Shorea henryana* Pierre	T
24	Euphorbiaceae	*Baccaurea ramiflora* Lour.	T
25	Gnetaceae	*Gnetum macrostachyum* Hook.f.	C

Appendix 1 (cont')

No.	Family	Species	Habit
26	Guttiferae	*Garcinia* sp.	T
27	Irvingiaceae	*Irvingia malayana* Oliv. Ex A. W.Benn.	T
28	Lauraceae	*Litsea myristicaefolia* (Wall. ex Nees) Hook.f.	T
29	Lauraceae	*Phoebe paniculata* (Nees) Nees	T
30	Meliaceae	*Aglaia edulis* (Roxb.) Wall	T
31	Meliaceae	*Aglaia grandis* Korth.ex Miq.	T
32	Meliaceae	*Aglaia silvestris* (M. Roem.) Merr.	T
33	Meliaceae	*Sandoricum koetjape* (Burm.f.) Merr.	T
34	Meliaceae	*Walsura pinnata* Hassk.	T
35	Moraceae	*Ficus altissima* Blume	T
36	Moraceae	*Ficus callophylla* Blume	T
37	Moraceae	*Ficus drupacea* Thunb.	T
38	Moraceae	*Ficus geniculata* Kurz	T
39	Moraceae	*Ficus kurzii* King	T
40	Moraceae	*Ficus pubilimba* Merr.	T
41	Moraceae	*Ficus subcordata* Blume	T
42	Moraceae	*Ficus subglobosa* C.C. Berg	T
43	Moraceae	*Ficus sumatrana* (Miquel) Miquel.	T
44	Moraceae	*Ficus virens* Aiton	T
45	Moraceae	*Artocarpus chama* Buch.	T
46	Moraceae	*Artocarpus nitidus* Trecul	T
47	Myristicaceae	*Knema elegans* Warb.	T
48	Oleaceae	*Myxopyrum* sp.1	C
49	Oleaceae	*Myxopyrum* sp.2	C
50	Orchidaceae	*Dendrobium friedericksianum* Rchb.f.	EO

Appendix 1 (cont')

No.	Family	Species	Habit
51	Orchidaceae	*Dendrobium palpebrae* Lindl.	EO
52	Rhamnaceae	*Ventilago maingayi* Laws.	C
53	Rhizophoraceae	*Carallia brachiata* (Lour.) Merr.	T
54	Rubiaceae	*Rothmannia eucodon* (K.Schum.) Bremek.	T
55	Rubiaceae	*Anthocephalus chinensis* (Lam.) A. Rich ex Walp.	T
56	Sapindaceae	*Litchi chinensis* Sonn.	T
57	Sapindaceae	*Nephelium hypoleucum* Kurz	T
58	Sapindaceae	*Xerospermum noronhianum* (Blume) Blume	T
59	Sapotaceae	*Xantolis* sp.	T
60	Tiliaceae	*Microcos tomentosa* Sm.	T
61	Tiliaceae	*Grewia* sp.	C
62	Vitaceae	*Tetrastigma* sp.	C

Remark: T = Tree, C = Climber, EO = Epiphytic Orchid, S = Shrub

Attachment 1.1 Project summarized (1 January 2009-31 December 2009)

Activities	Expected results	Results
1.Gibbons habituation	Obtain more one habituated gibbon groups.	We still got only one habituated group.
2. Feeding and behavior observation	Data of home range, territory, day range.	- Home range of Group A by minimum convex polygon (MCP) was 60.9 ha. Group C had 54 ha, and Group E was 52 ha. - The gibbons traveled 2,703 m per day on average. - September show the highest average path length as 4,296 m whereas February show the lowest average path length as 1,748 m.
3. Gibbons foods and defecation rate	Data on fruit availability in the study area	- Five categories: fruit, Ficus, young leaves, flowers, and other. - Fruit is the major diet of gibbons about 69 percent following by Ficus, young leaves, flowers, and arthropods as 14, 20, 7, and 4 percent respectively. - They visit food source on average 9.4 sources/day. - They had defecation rate on average 6.0 times/day. - They had high defecation rate during 06h00-06h59 or 22.9%.
4. Seed dispersal	Data on seed dispersal of pileated gibbons	- The average dispersal from the feeding sites and deposition sites was 243 m. - There are a few seeds that drop at the parent trees (4%) while some seeds were dispersed quite far as 797 m. - Almost 70 percent the gibbons deposited the seed more than 150 m.