CHAPTER 5

RESULTS: BREEDING ACTIVITIES

Asian Paradise Flycatchers are monogamous and both males and females take part in nest-building, incubation, brooding, and feeding the nestlings. They start breeding in mid-March to end-July. Thirty-six nests of the Asian Paradise Flycatcher were found at both study sites: 25 at the Chiang Dao Wildlife Research Station and 11 in Khao Pra-Bang Khram Wildlife Sanctuary (7 in Krabi and 4 in Trang). The nests were found at different stages of use and also varied according to the type of characters of the male attending them (Table 5.1). The breeding activities were divided into three parts: nest building period, incubation period, and nestling period.

Table 5.1 Number of nests of each type of male in both study areas together with the stages of breeding at which they were discovered.

Nest stage at which found	Chiang Dao Wildlife Research Station		Khao Pra-Bang Khram Wildlife Sanctuary		Total
	RL	RS	RL	WL	
Nest Building	6	2	1	none	**9**
Egg Laying	5	1	none	2	**8**
Incubation	6	1	2	4	**13**
Nestling	4	none	1	1	**6**
Total	**21**	**4**	**4**	**7**	**36**

5.1 NEST-BUILDING BEHAVIOUR

Nine of 36 nests were found during nest-building at both study sites. The Asian Paradise Flycatcher starts to build a nest after forming a pair. Nest materials were composed of mosses and liverworts, a black, hair-like fungus, fine plant stems, dry grass, spider webs, and other materials (Figure 5.1). Both male and female share all the breeding activities included with nest building during the breeding season (Figures 5.2 - 5.3). The nests are open, deep, cup–shaped (Figure 5.4), and placed on the end of a low branch of understorey woody vegetation in shady sites usually hidden in dense vegetation. Nests were built in the fork of low woody vegetation (Figures 5.5 – 5.6). The nest materials were woven sewed and pressed together until becoming very tight. Construction materials were bound densely together with spider webs. Mosses and liverworts were used to decorate and reinforce the outside of the nest. The black , hair-like fungus usually lined the inside of the nest a few days before the eggs were laid. Nesting period ranged from 10 – 17 days. The height of the nests ranged from 0.75 - 2.5 m. above the ground (Figure 5.7). Nest characteristics are presented in Table 5.2. The proportions of nest materials in both study sites are shown in Table 5.3 and Figure 5.8. Figure 5.9 shows the species number of moss and liverwort species in the two study sites. The nest proportions in both sites were similar and there were no differences in the nest proportions of nest materials for both study areas (Kruskal – Wallis test: all n.s.) (Figures 5.10 – 5.11).

Figure 5.1 Nest materials of the Asian Paradise Flycatcher divided into 6 components: 1 = Mosses and liverworts, 2 = black, hair-like fungus, 3 = fine plant stems, 4 = dry grass, 5 = spider webs, and 6 = other materials (dried leaves, bark).

Figure 5.2 Nest – building by a female at the Chiang Dao site.

Figure 5.3 Nest – building by a male at the Chiang Dao site.

Figure 5.4 Nest characteristics with exterior (A and C) and interior sides (B and D) at Chiang Dao (above) and Khao Pra-Bang Khram (below).

Figure 5.5 Nests are built in a fork of woody vegetation with fine plant stems, dry grass, and fine twigs at the bottom; Chiang Dao site.

Figure 5.6 Nests are built in a fork of woody growth as the nest bottom and bound densely together with spider webs; Chiang Dao site.

Figure 5.7 The above ground height of nests ranged from 0.75 - 2.5 m. at Chiang Dao (left) and Khao Pra-Bang Khram (right).

Table 5.2 Measurements of nest characteristics at both study sites.

Nest No.	Male type	Nest above ground (cm)	Nest characteristics diameter (cm)				Number of forks at the nest	Elevation (m)
			Length diameter		Width diameter			
			Outer	Inner	Outer	Inner		
1	RL	150	6.03	4.12	8.20	6.66	2	550
2	RL	90	7.90	3.75	6.50	5.50	2	575
3	RL	157	8.00	3.85	7.40	6.40	2	600
4	RS	120	8.72	4.43	7.13	6.22	2	540
5	RL	100	9.23	4.63	6.68	5.10	2	550
9	RL	134	8.72	4.13	8.17	6.50	2	550
10	RL	145	7.07	3.88	6.87	5.50	2	500
13	RL	145	8.72	5.12	7.92	6.51	4	500
16	RS	89	8.35	2.77	8.55	6.55	2	500
19	RL	94	5.30	4.30	8.23	6.45	2	475
21	RL	121	6.35	4.05	8.33	5.85	2	575
22	RL	145	5.95	3.67	8.34	5.80	3	550
23	RL	137	8.72	4.47	8.21	6.37	2	500
25	RL	157	7.62	3.84	6.40	4.94	2	590
28	RL	156	7.88	4.67	7.20	6.58	2	520
30	RS	102	10.30	4.24	7.82	6.15	2	550
32	RL	118	8.88	4.46	8.17	7.12	2	600
33	RL	75	7.68	4.71	9.20	7.37	2	525
34	RL	162	7.33	3.79	7.57	6.15	2	550
36	RL	150	7.93	3.93	7.51	5.75	2	570
38	RL	225	9.07	4.62	7.88	6.67	2	590
40	RL	250	7.63	4.16	8.70	6.50	2	70
41	WL	184	9.96	4.40	8.07	6.09	2	80
43	RL	209	8.33	5.00	9.27	6.70	2	75
44	WL	145	7.70	5.50	6.67	6.17	2	80
45	WL	125	10.56	4.48	8.33	6.44	2	150
46	WL	153	9.48	5.12	8.00	6.27	2	125
47	WL	200	6.60	4.95	7.94	6.35	2	125
48	WL	250	8.27	5.00	7.59	6.16	2	120
49	WL	158	8.66	4.73	8.22	5.71	2	85
50	RL	130	8.42	4.20	8.17	6.85	3	150
Range		75-250	5.30-10.56	2.77-5.5	6.40-9.27	4.94-7.37	2-4	70-600
Mean		147.61	8.11	4.35	7.85	6.24	2.13	404

Table 5.3 Proportion of nest materials and nest material proportions (n = 21).

Male Type	Nest Weight (g)	Moss and Liverwort (g)	Black, hair-like fungus (g)	Fine plant stems (g)	Dry grass (g)	Spider web (g)	Other material (g)
RS	4.61	0.52	0.73	0	3.19	0.10	0.07
RL	5.35	1.38	0.52	0	3.04	0.41	0
RS	4.70	1.68	0.09	0.46	1.54	0.14	0.79
RL	5.05	0.91	0.54	0	2.91	0.50	0.19
RL	7.16	2.07	0.65	1.85	2.29	0.30	0
RL	4.79	1.12	0.48	2.67	0.09	0.11	0.32
RL	4.88	1.76	0.26	0.33	2.45	0.08	0
RL	5.75	1.36	0.59	0.15	3.56	0.07	0.02
RL	4.35	1.55	0.42	0.43	1.86	0.09	0
RL	5.26	1.07	0.20	0.70	3.02	0.27	0
RS	5.10	0.95	0.54	0.09	3.40	0.12	0
RL	5.29	1.81	0.37	0	2.75	0.20	0.16
RL	6.44	0.04	0.97	1.23	3.84	0.21	0.15
RL	3.82	2.02	0.47	0	1.14	0.19	0
RL	5.34	3.22	0.35	0.07	1.60	0.10	0
RL	8.34	3.21	1.40	0	3.55	0.08	0.10
RL	7.01	1.09	0.51	1.29	3.77	0.12	0.23
WL	7.84	2.99	0.66	0	3.80	0.21	0.18
WL	10.14	1.22	1.77	0	7.01	0.14	0
WL	7.39	0.14	0.60	0	6.41	0.24	0
WL	7.52	2.88	1.22	0	3.17	0.16	0.09
Average	6.01	1.57	0.63	0.84	3.07	0.18	0.21
Max.	10.14	3.22	1.77	2.67	7.01	0.50	0.79
Min.	3.82	0.04	0.09	0.07	0.09	0.07	0.02

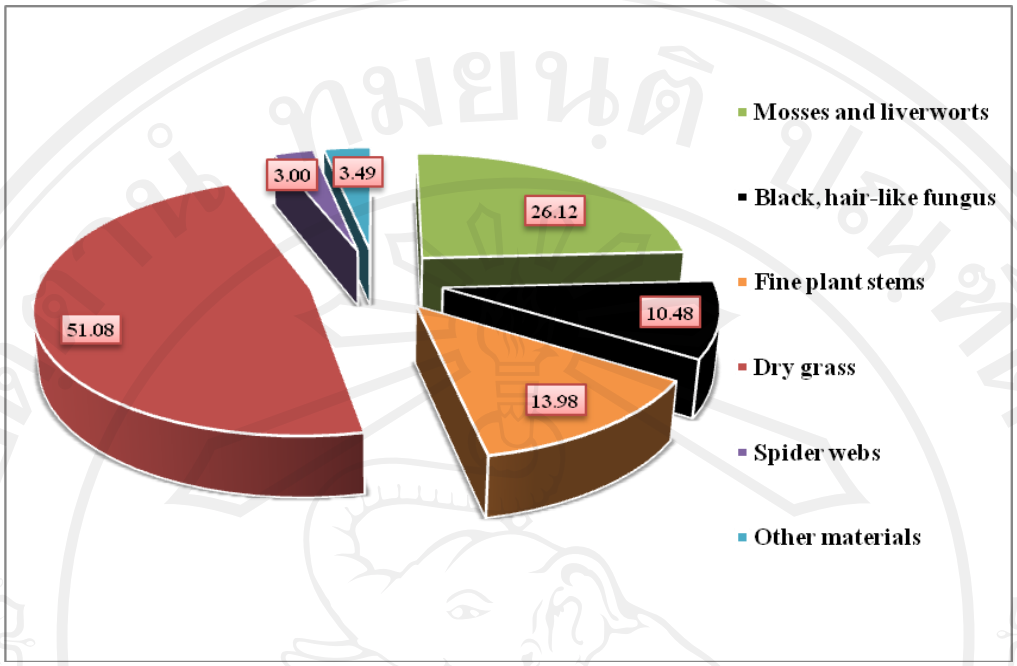

Figure 5.8 Nest materials and their percentage (n = 21).

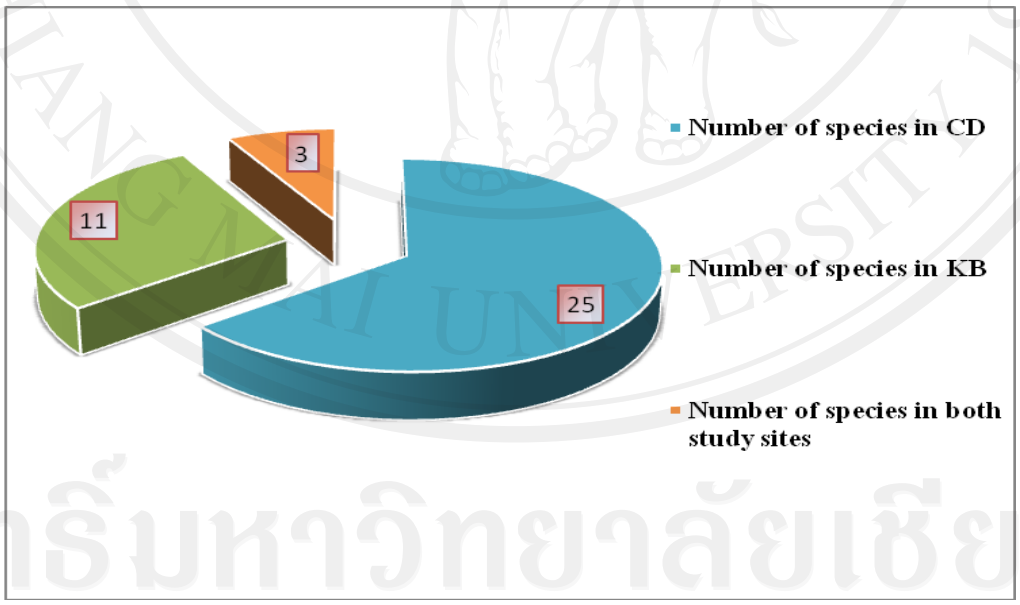

Figure 5.9 Number of species of mosses and liverworts in nest material at Chiang Dao Wildlife Research Station (CD) and Khao Pra-Bang Khram Wildlife Sanctuary (KB) (n = 21).

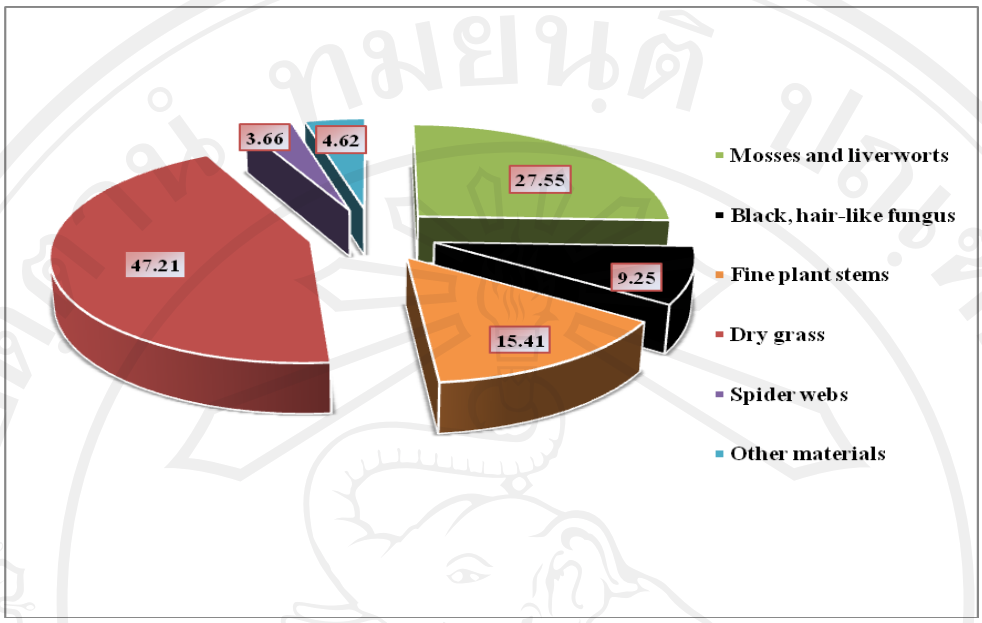

Figure 5.10 Type of nest materials and their percentage at Chiang Dao (n = 15).

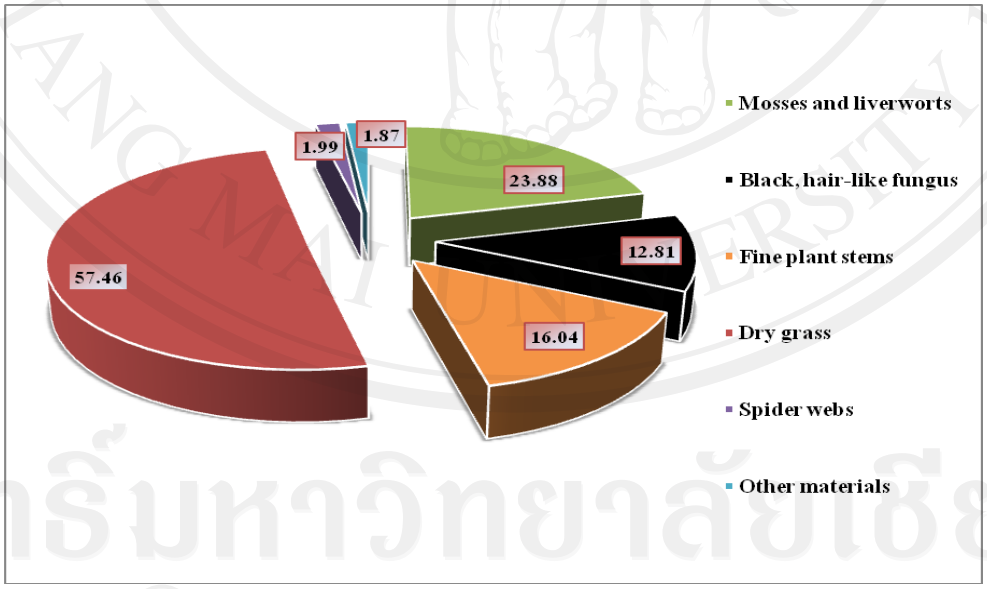

Figure 5.11 Type of nest materials and their percentage at Khao Pra-Bang Khram (n = 6).

Twenty–five nests of the Asian Paradise Flycatcher were found at Chiang Dao Wildlife Research Station during this study. Nest numbers 1, 2, 3, 4, 5, 9, and 10 were found during the breeding season in 2005. Nest numbers 12, 13, 14, 16, and 19 were found during the breeding season in 2006. Nest numbers 21, 22, 23, 25, 28, 29, 30, 31, 32, 33, 34, 36, and 38 were found during the breeding season in 2008. The position of each nest is shown in Figure 5.12. Total nest distributed in 1,000 m^2. Most nests were found along small, seasonally-dry streams. The breeding territory of nest was closely in range about from 50 – 400 m. Nest numbers 21 and 31 were closest beingt only about 50 m apart, whereas nest numbers 13 and 19 were the farthest at about 400 m.

Eleven nests were found at Khao Pra-Bang Khram Wildlife Sanctuary (7 nests in Krabi and 4 nests in Trang) during two years study. Nest number 40 was found during the breeding season in 2008. Nest numbers 41-50 were found during the breeding season in 2008. The position of each nest is shown in Figure 5.13. Most nests were found along small, seasonally-dry streams. The breeding territory of nest was closelet in range about from 500–4000 m. Nest numbers 45 and 46 were closest at about 500 m apart, whereas nest numbers 41 and 42 were farthest at about 4000 m.

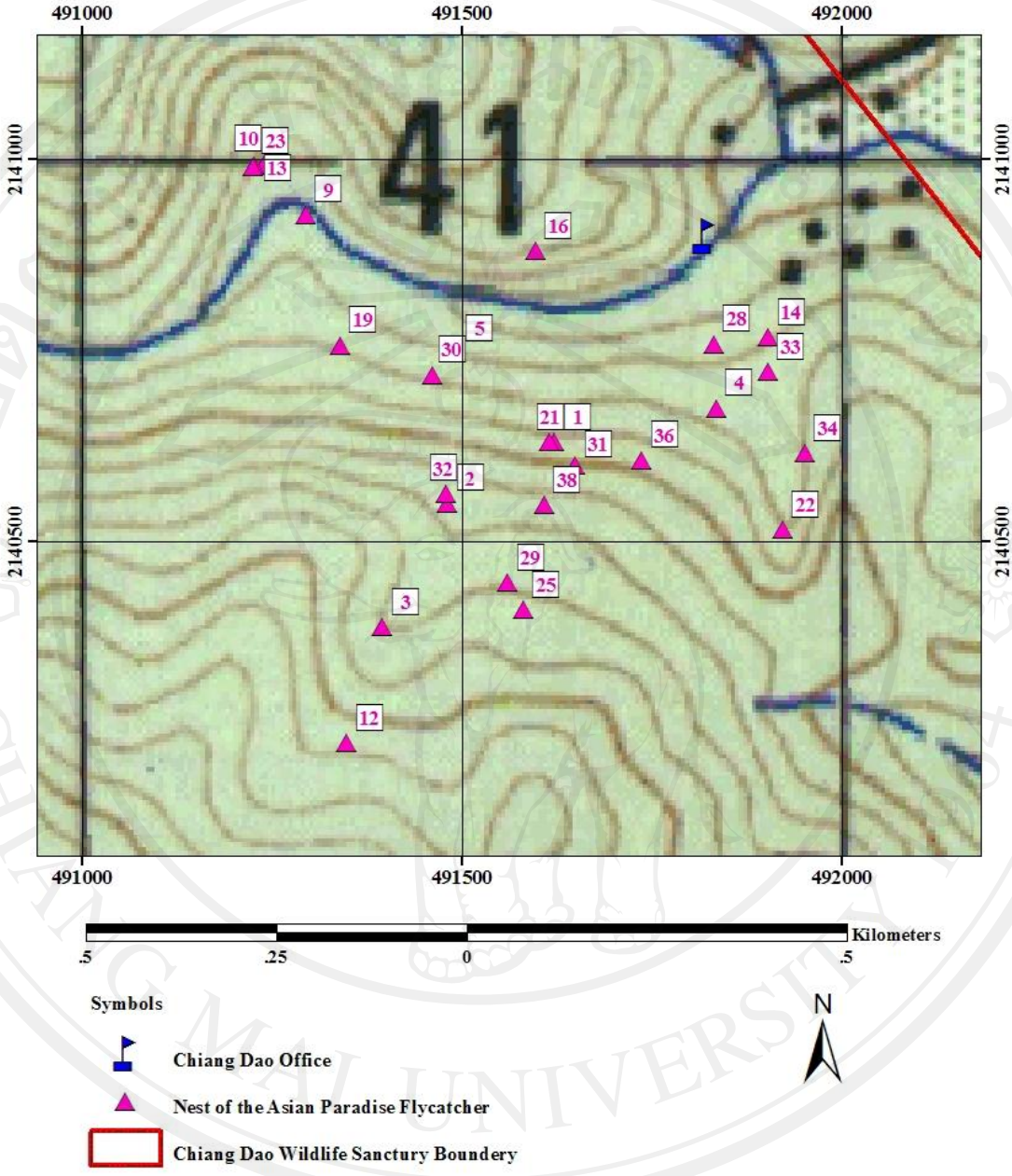

Figure 5.12 Twenty–five nest positions at Chiang Dao Wildlife Research Station. Data pooled from three years' study (2005 – 2006 and 2008).

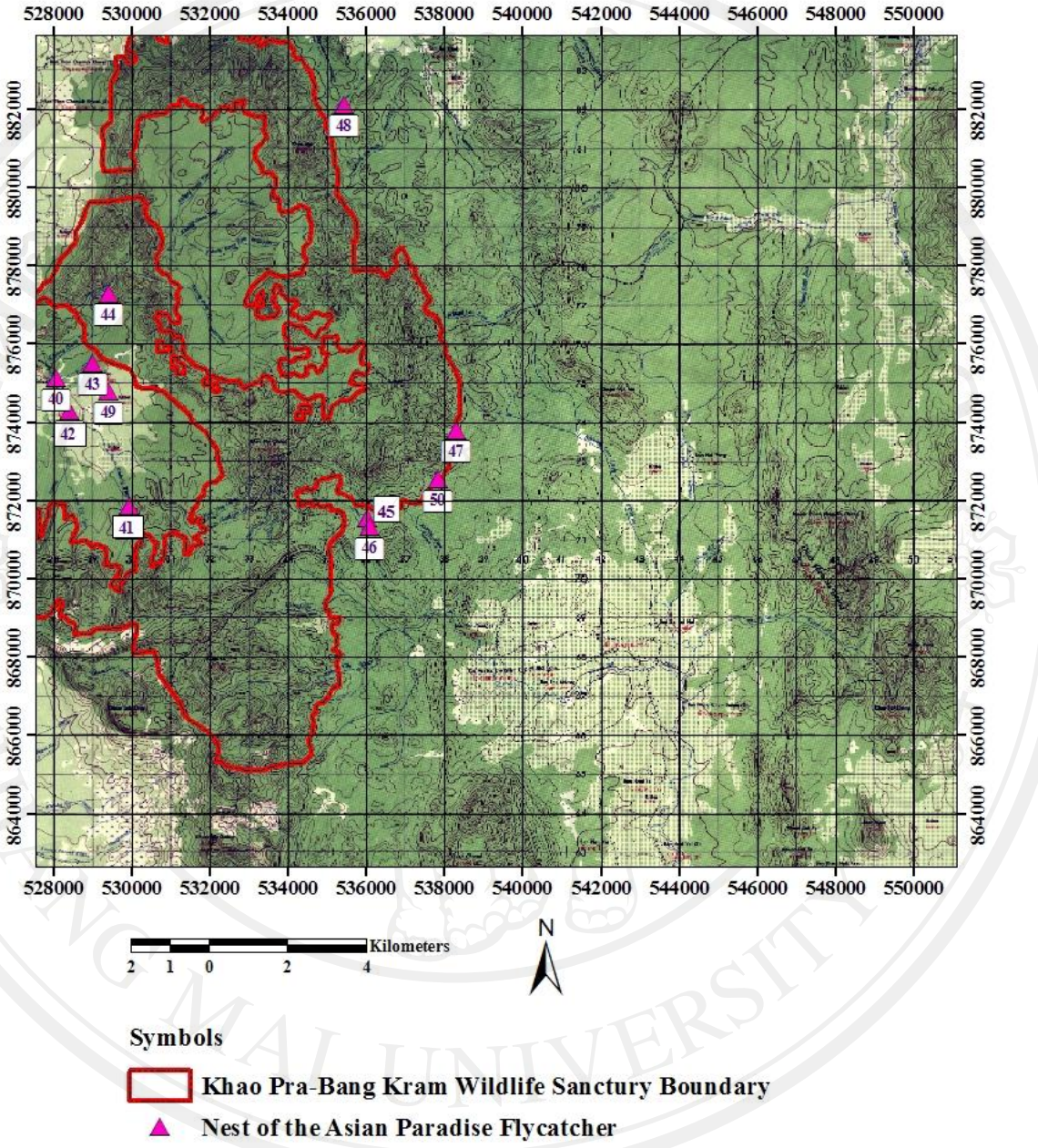

Figure 5.13 Eleven nest sites at Khao Pra-Bang Khram Wildlife Sanctuary.

Data pooled from two years' study (2008 – 2009).

5.2 EGGS AND INCUBATION BEHAVIOUR

5.2.1 Clutch size and egg characteristics

The clutch-sizes of the Asian Paradise Flycatcher ranged from 2 - 4 eggs, but mostly 3. There were three eggs in twenty – seven nests, two in four nests, and four in the remaining two nests. One egg was laid each day in the early morning (0600–0800) until the clutch size was complete. Eggs varied in shape (from almost ovoid to nearly conical), were smooth, coloured pink-beige, and finely speckled with brown (Figure 5.14). Eggs measurements are shown in Table 5.4. The average egg size was 15.1 ±0.4 x 20.3±1.0 mm (n=53) and the average weight was 2.4±0.1 g (n=22).

5.2.2 Incubation Behaviour

Data from 17 nests were observed during the study period. A total of 273 h of observations were analysed. The eggs were incubated by both the male and female. Incubation occurred on the date of the last egg laid (Figures 5.15). The incubation period lasted 12–15 days (mean 13.00 ± 1.22 s.d., n = 14).When a nest was found for which unable to confirm the egg laying date, the laying date was determined by counting 13 days backwards from hatching. The greatest period of incubation by females was 40.63 minutes, whereas for males it was 34.61 minutes (Figure 5.16). There was no significant difference in incubation times between males and females (Mann–Whitney U-test). The longest incubation time by long - tailed males type was 35.95 minutes, whereas for short–tailed males type it was 34.18 minutes (Figure 5.17). There was no significant difference in incubation time between the long–tailed male type (RL and WL) and short–tailed male type (RS) (Mann–Whitney U-test). Thirteen of 27 nests were hatching success (48.15 %). Twelve nests (44.44 %) were lost during incubation or egg laying which were caused mostly by predator. The eggs

in two nests (7.41 %) were broken by a tree fall (see Figure 5.18).

Table 5.4 Egg measurements of the Asian Paradise Flycatcher, at both sites. n = 53, except n of weight n = 22

Male Type		Width (mm) n = 53	Length (mm) n = 53	Weight (g) n = 22
All males	Range	14.0-15.9	18.3-22.8	2.0-2.5
n = 53	Mean	15.1	20.3	2.4
	S.D.	0.4	1.0	0.1
RL males	Range	14.2-15.6	18.3-22.8	2.0-2.5
n = 35	Mean	15.1	20.2	2.4
	S.D.	0.3	1.1	0.2
WL males	Range	14.5-15.9	20.5-22.5	2.3-2.5
n = 6	Mean	15.4	21.4	2.5
	S.D.	0.5	0.8	0.1
RS males	Range	14.0-15.5	19.5-21.2	2.0-2.5
n = 12	Mean	14.7	20.1	2.4
	S.D.	0.4	0.5	0.1

Figure 5.14 The clutch size and egg characteristics of the Asian Paradise Flycatcher at the Chiang Dao Site.

Figure 5.15 Eggs are incubated by both the male and female the Chiang Dao site.

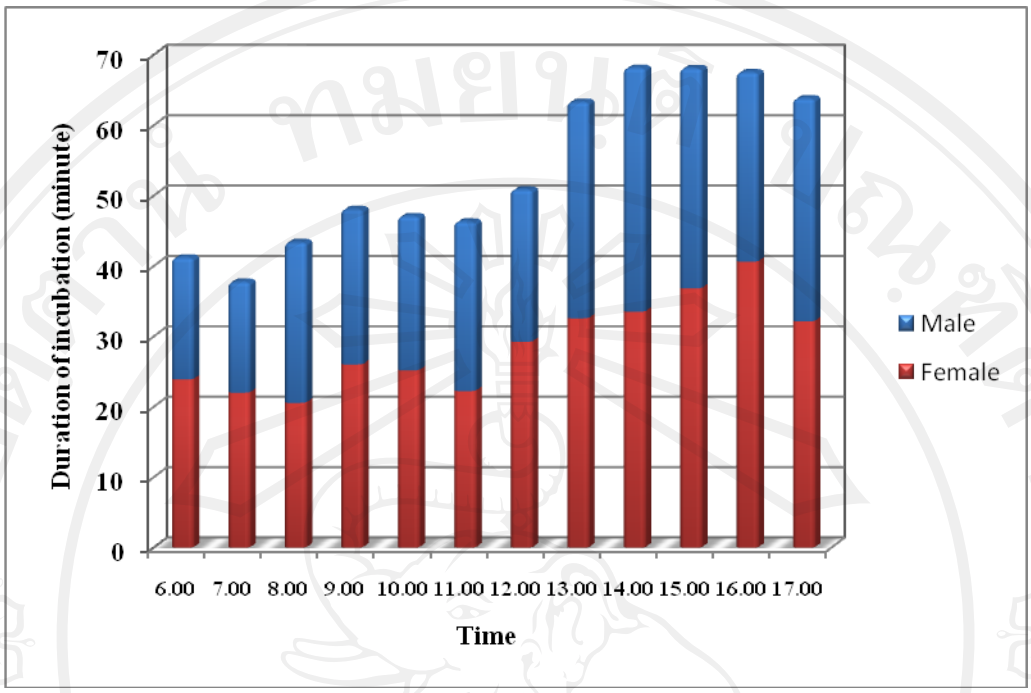

Figure 5.16 Time of incubation by males and females at both site.

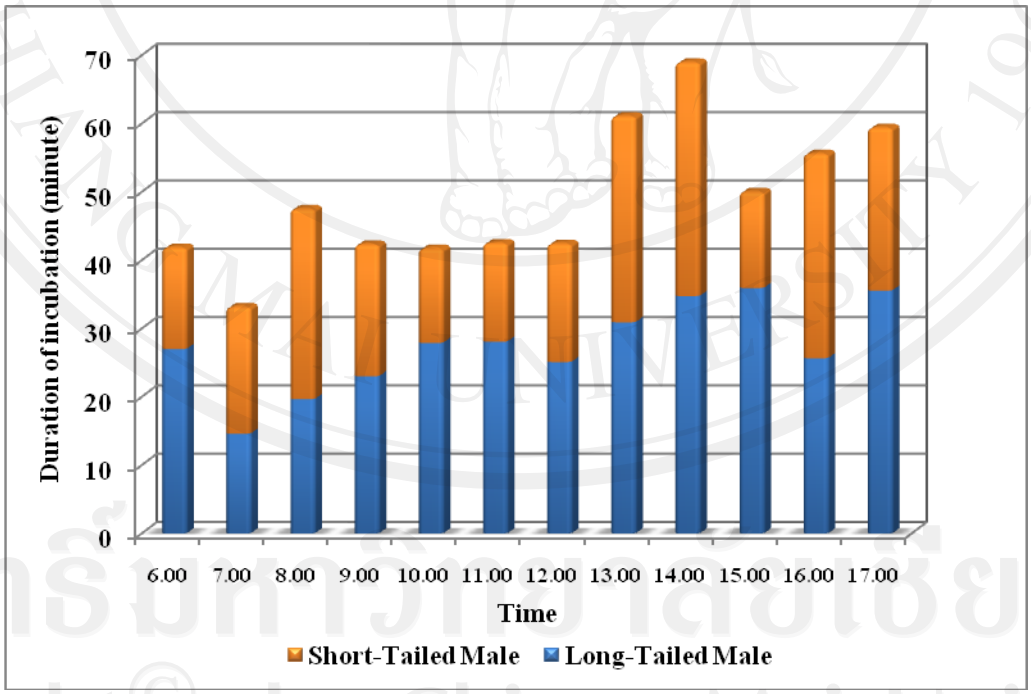

Figure 5.17 Comparison of incubation time of between long–tailed males and short – tailed male.

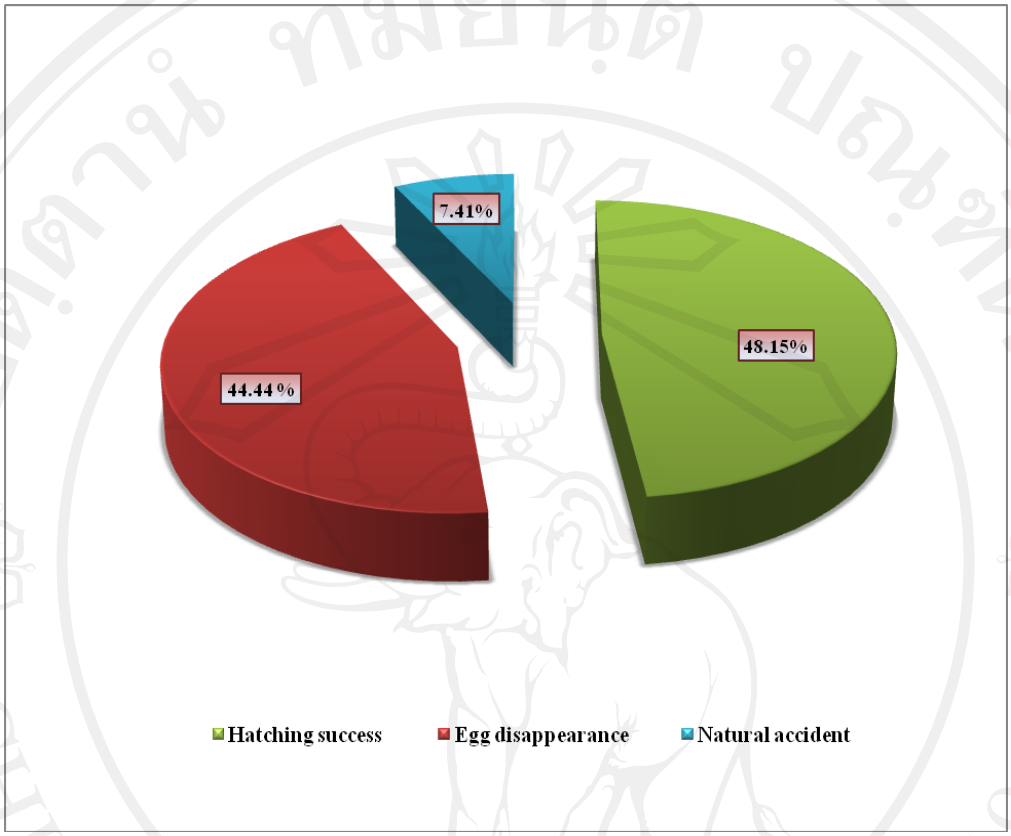

Figure 5.18 Percentage of eggs hatching successful at both study sites.

5.3 PARENTAL CARE BEHAVIOUR

Behavioural data from twelve nests were obtained during the study period. There were three nestlings in seven nests and two in five nests. A total of 479 hours of observations were analysed. Parental care behaviour was contributed by both males and females which started when the first nestling hatched (Figures 5.19 – 5.21). All nestlings in the clutch hatched usually in the same day from 0600 – 1200 hrs. (Figure 5.22). After the nestling hatched, the egg shell was moved out of the nest by a parent.

5.3.1 Feeding visits

Both parents feed the nestlings with many type of insects including: larvae and imagines of dragon-flies (Odonata), orthopterans (Orthoptera), larvae and imagines of butterflies and moths (Lepidoptera), larvae and imagines of flies (Diptera), bugs (Hemiptera), and other (unidentified insects). The diet of nestlings seemed to be influenced mostly by accessibility of prey. When it was sunny, there were many flying insects, *e.g.* Odonata, Lepidoptera, Diptera, and Hemiptera. When the birds were foraging on the ground, they carried Orthoptera to the nest. The parents carried and fed the prey to one nestling for each feeding visit. The parents usually contact the nestlings with a feeding call before feeding them. The nestlings make a begging posture by stretching their necks out trying to reach the parent's bill and open their gapes until the yellow palate was visible. During the nestling period (from hatching to 5 days old), both parents usually captured the prey many times before feeding to the nestlings, whereas during the late nestling period (from 6 days old to fledgling) both parents provided prey whole in the first time visiting.

The frequency of feeding in the nest increased as the nestlings grew older until on day 5. During the late nestling period, the number of feeding visits dropped an continuously almost until fledging on day 11. Both parents participated similarly in feeding the nestlings, except on day 11 when female visited the nest more than the male, but the difference was not significant (Mann – Whitney U – test: Z = -0.854, n male, n female = 12, 12; n.s.) (Figure 5.23). In addition, the frequency of feeding visits by the long – tailed male type (RL and WL) seemed to be more than the short – tailed male type (RS), but the difference was not significant (Mann – Whitney U – test: Z = -1.134, n long–tail male, n short–tailed male = 10, 2; n.s.) (Figure 5.24).

After the nestlings were fed, they excreted a feces sac. Both males and females usually eliminated this feces sac by consuming it during the early nestling period, whereas in the late nestling period the feces sac was moved away from nest by a parent.

Figure 5.19 Feeding visits by a RL male at Chiang Dao.

Figure 5.20 Feeding visits by a WL male at Khao Pra – Bang Khram.

(Trang Province).

Figure 5.21 Feeding visits by a female at Khao Pra – Bang Khram.

(Trang Province).

Figure 5.22 Nestlings hatching on the same day at Chiang Dao.

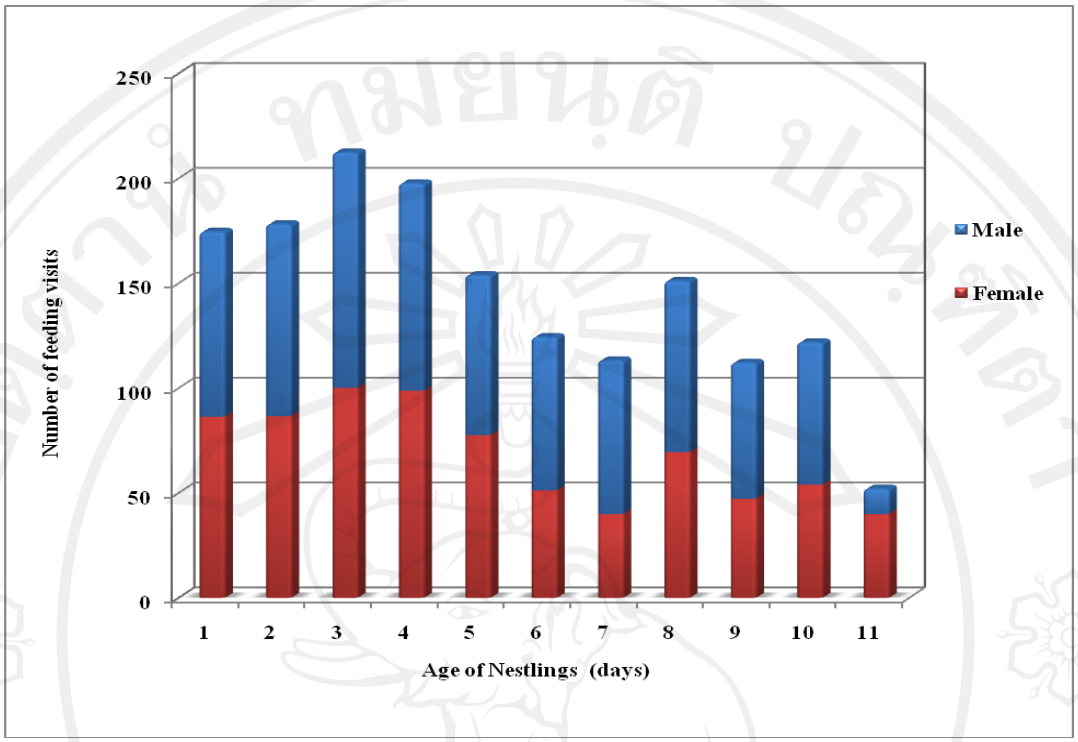

Figure 5.23 Number of feeding visits by males and females at both sites.

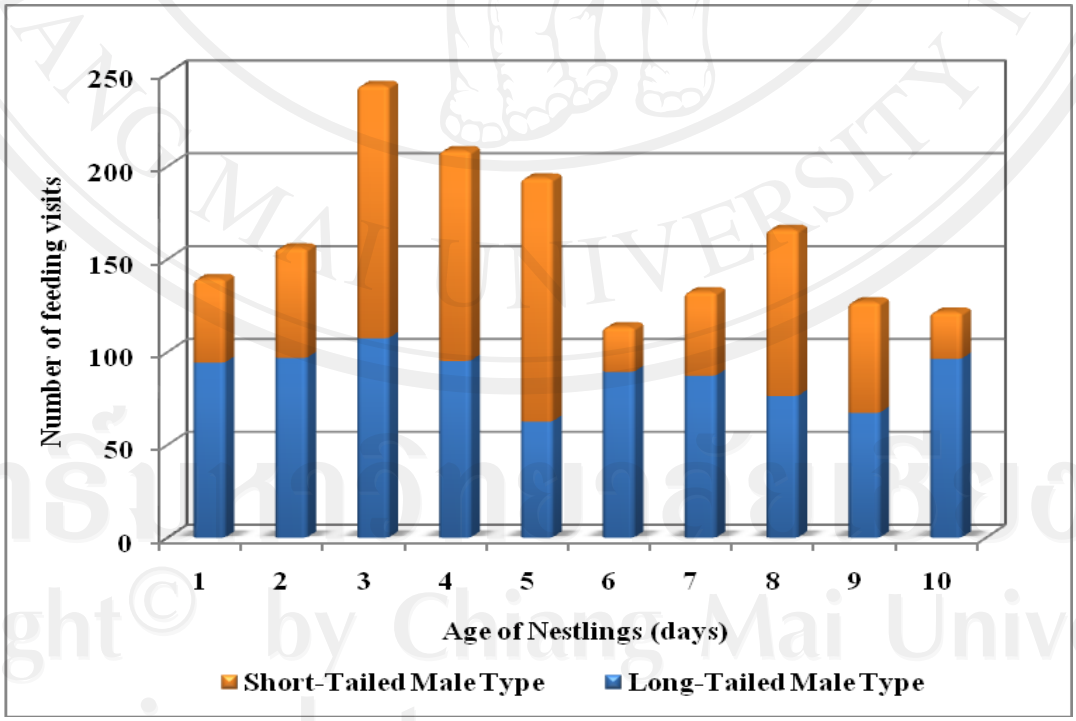

Figure 5.24 Number of feeding visits by two male types.

5.3.2 Nest attendance and brooding

Both males and females spend time at the nest for feeding and brooding the nestlings. The frequency of nest attendance increased as the nestlings grew older. Visits stopped on the fledging date (day 11), but the frequency of brooding increased as the nestling grew older, particularly during the early nestling period. Sometimes, both the male and female arrived at the nest for feeding and perched at the nest without brooding the nestling (Figures 5.25 – 5.26). Male participation was significantly higher than female in nest attendance of the nestlings (Mann – Whitney U – test: frequency of nest attendance: $Z = -2.200$, n male, n female = 11, 11; $p = 0.028$), whereas there was no significant difference in number of brooding visits by males and females (Mann – Whitney U – test: $Z = -0.631$, n male, n female = 8, 8; $p = 0.574$). In addition, the frequencies of nest attendance and brooding visits were compared between long–tailed male type (RL and WL) and short–tailed male type (RS). Long–tailed male types participation was slightly higher than the short–tailed male type in nest attendance of the nestlings, whereas there were nearly participated in brooding visit (Figures 5.27 – 5.28). There was no significant difference in the frequencies of nest attendance and brooding visits between the long–tailed male type and short–tailed male type (Mann – Whitney U – test: frequency of nest attendance: $Z = -1.346$, n long-tailed male type, n short-tailed male type = 8, 8; $p = 0.193$; frequency of brooding visit: $Z = -0.159$, n long-tailed male type, n short-tailed male type = 8, 8; $p = 0.879$).

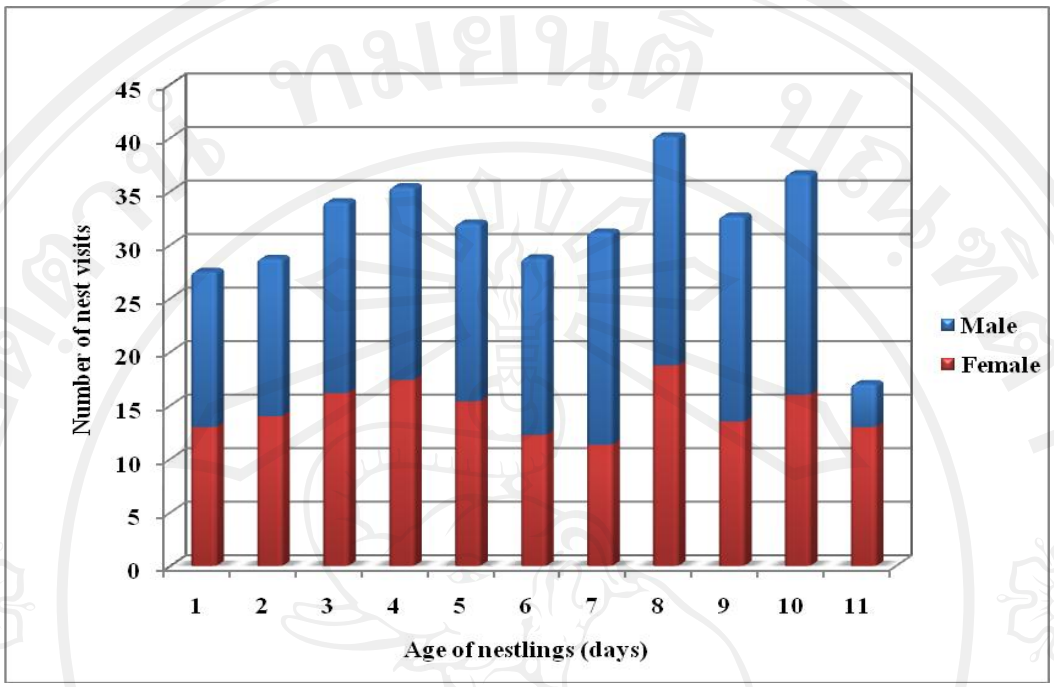

Figure 5.25 Number of nest visits by males and females.

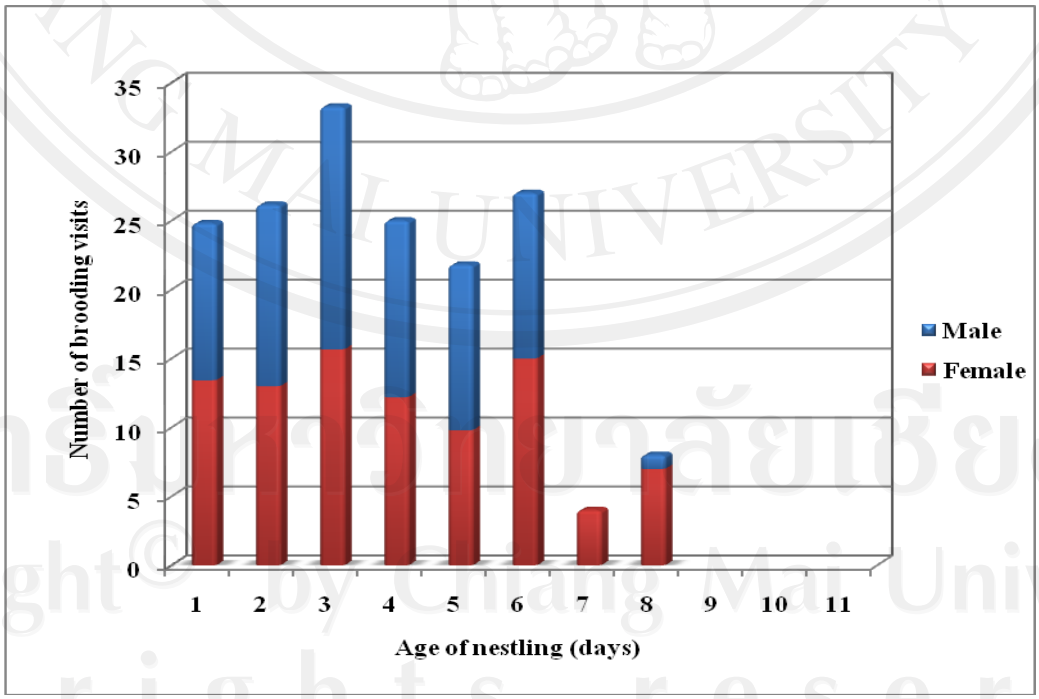

Figure 5.26 Number of brooding visits by males and females.

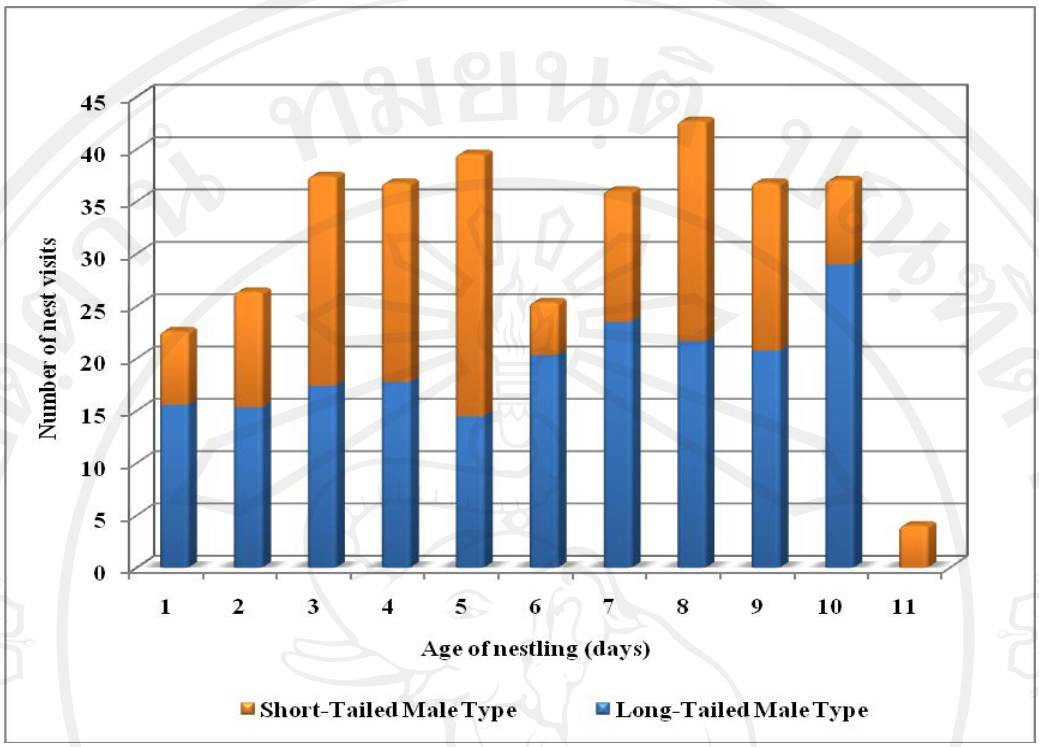

Figure 5.27 Number of nest visits varied according to the male type.

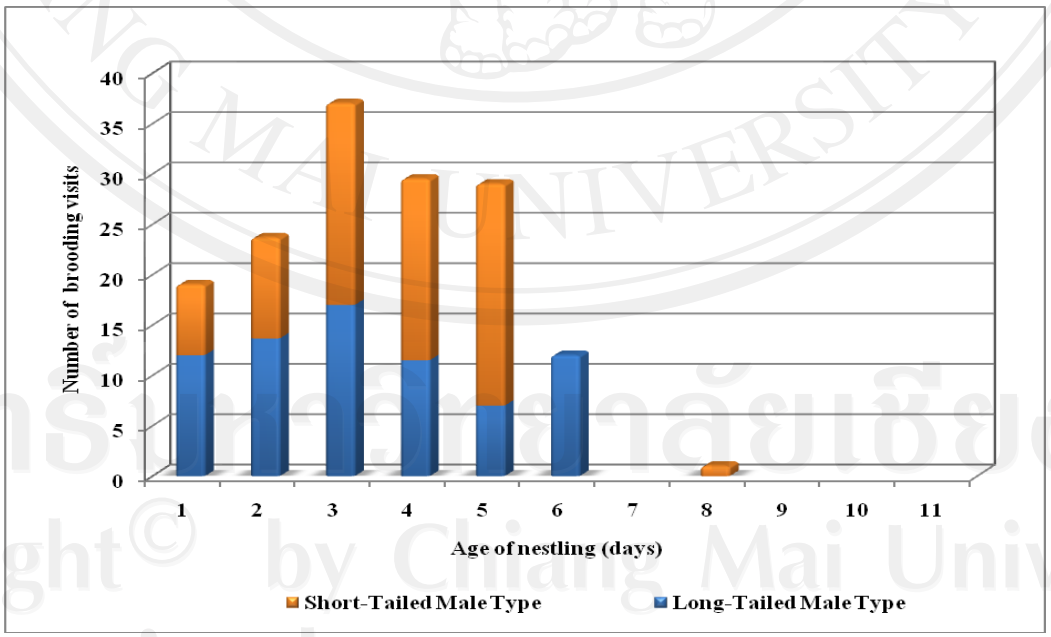

Figure 5.28 Number of brooding visit varied according to the male type.

5.3.3 Growth of Nestlings

The nestlings at hatching were almost naked, and very sparsely covered with natal down; their eyes were closed for some time after hatching, and they were incapable of locomotion (Figures 5.22 and 5.29). They had pinkish, transparent skin, through which entrails and yolk-sac were visible, and flesh-coloured legs. The bill had a dark tip and soft, pale yellow edge, and the palate was yellow inside the gape. The plumage developed gradually, and this was divided into 4 stages (Figure 5.29). A-stage: the feather germs were not visible (day 1). B-stage: the feather germs appeared continuous under the skin in all the pterylae. The allula feathers and primaries pierced the skin (up to day 4). C-stage: the skin was punctured by dorsal contour feathers. At this stage, the dorsal contour feathers and primaries were pins with a rufous tip (up to day 7). D-stage: the nestlings were almost completely covered with rufous contour feathers. The rufous vanes of flight and dorsal feathers were more than half the total length of the feathers (from day 7 onwards). The nestlings left the nest on day 10-11 before they were able to fly well. The yolk-sac was visible after hatching and grew smaller until day 4. The nestlings opened their eyes on day 4-5, at first in the form of a thin slit, with complete eye opening following on day 7-8. The light pink body, bill, and wings darkened from the first day. The nestlings first preened themselves on day 6-7.

Twenty-nine nestlings from 11 nests were measured, but the numbers measured varied each day. Bill, wing and tarsus lengths, together with body weights, of nestlings are shown in Figure 5.30. All the measurements highly correlated with the age of the nestlings during the period of their stay in the nest, except that body weight in the last day before fledging was slightly lower. Mean bill, wing, and tarsus lengths

at 10 days were 10.4, 48.2, and 21.5 mm respectively, and the body weight was 14.7 g. The body sizes of nestlings of RL and RS males were also compared during the nestlings first ten days of life. The growth curves of nestlings of RL and RS males were nearly identical (Figure 5.31) and there were no significant differences in body sizes between the nestlings from RL and RS males (t-test, $p>0.05$). The sample sizes nestlings was too small to make a definite conclusion.

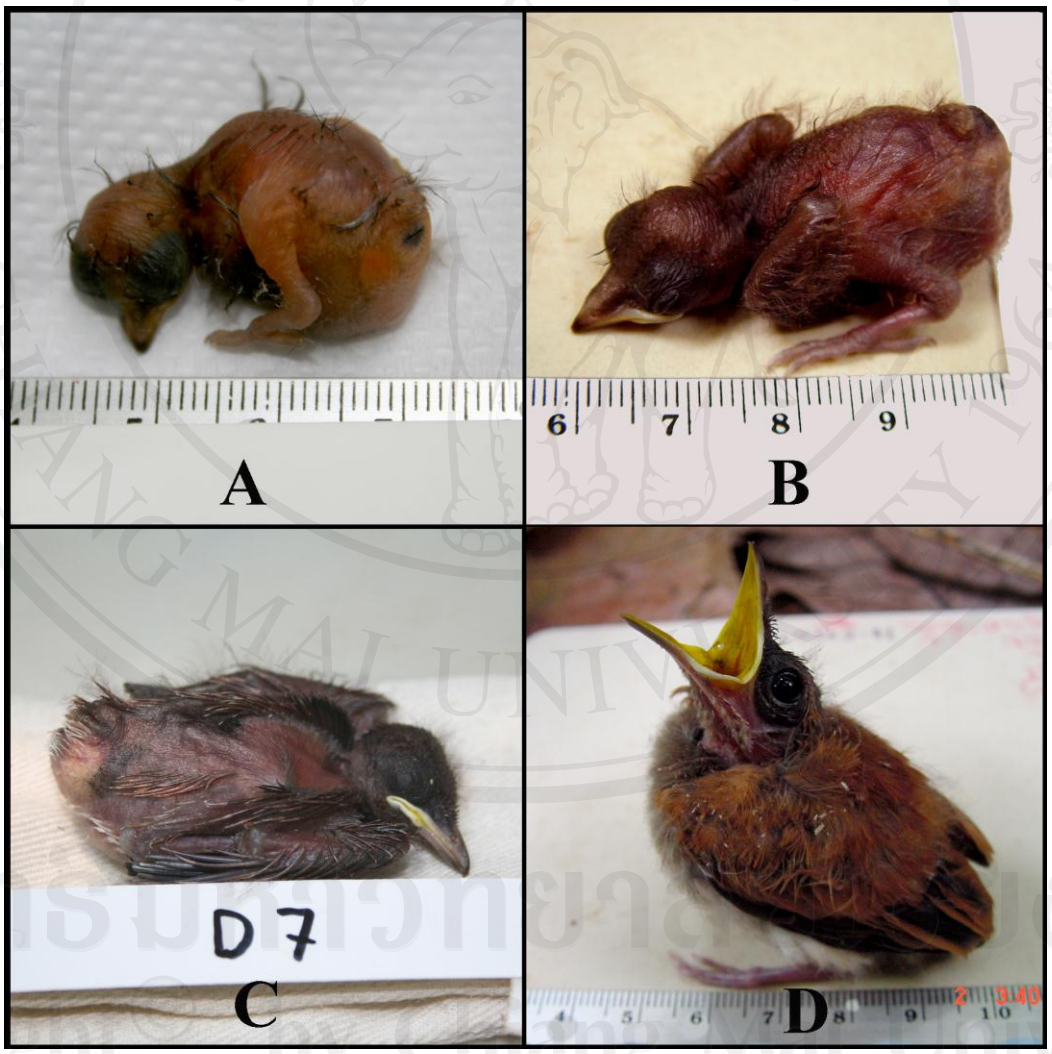

Figure 5.29 The four stages of plumage development in nestlings.

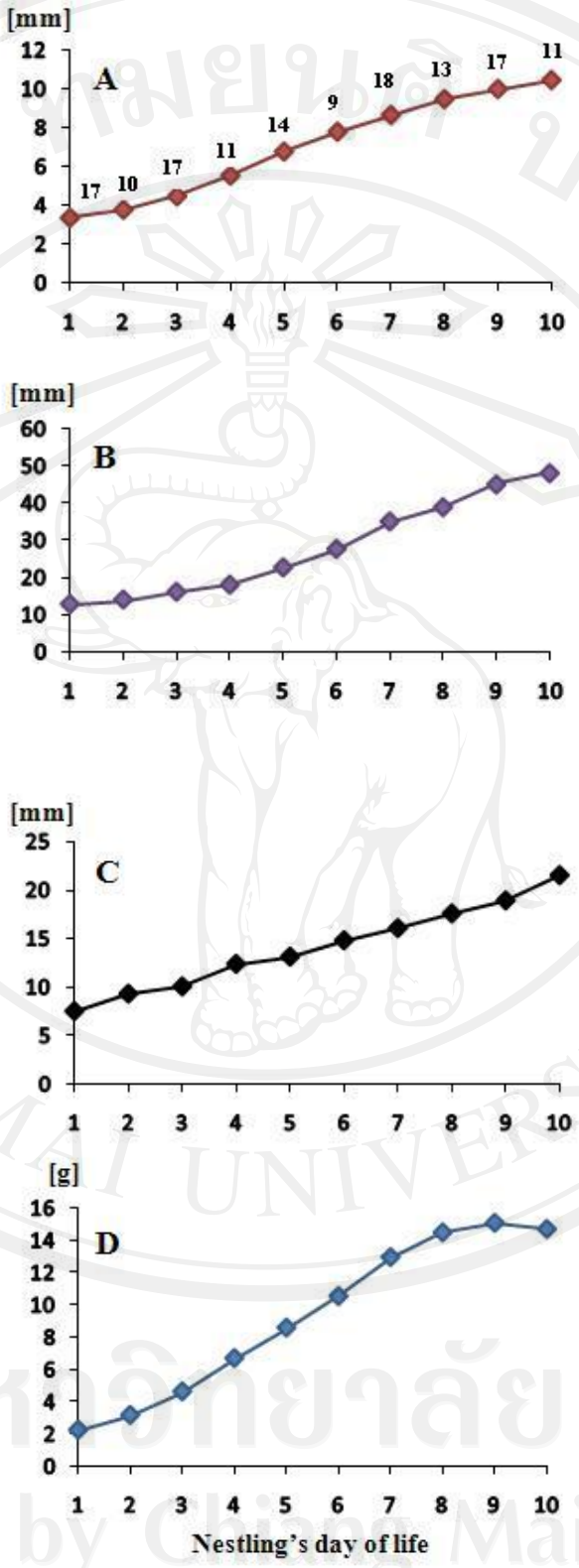

Figure 5.30 Growth curve of nestlings: **A** bill length, **B** wing length, **C** tarsus length, **D** weight. Labels show the number of nestlings.

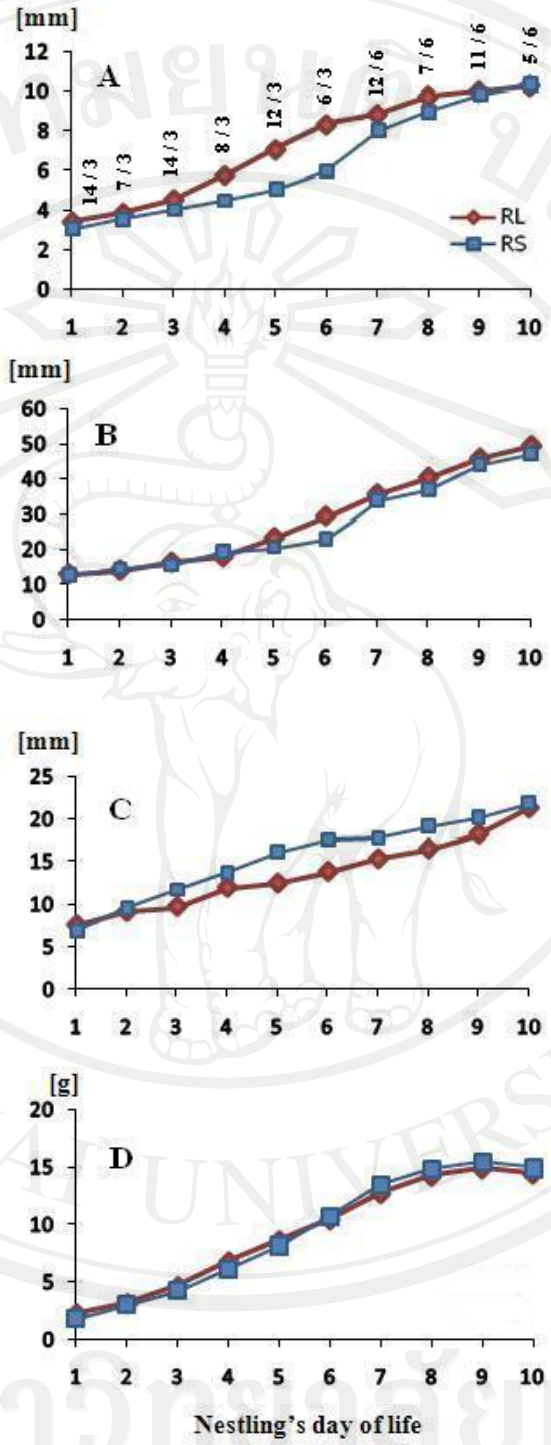

Figure 5.31 Growth curves of nestlings: **A** bill length, **B** wing length, **C** tarsus length, **D** weight. Labels show the number of nestlings from nests of RL / RS males.

A successful breeding cycle lasted 24–30 days, including 2–4 days of egg-laying, 12–15 days of incubation, and 10–11 days of parental care of nestlings in the nest. Fledgling success was 44.4 % from 13 RL male type nests, 1 from WL male type nest and 2 from RS male type nests (Figure 5.32).

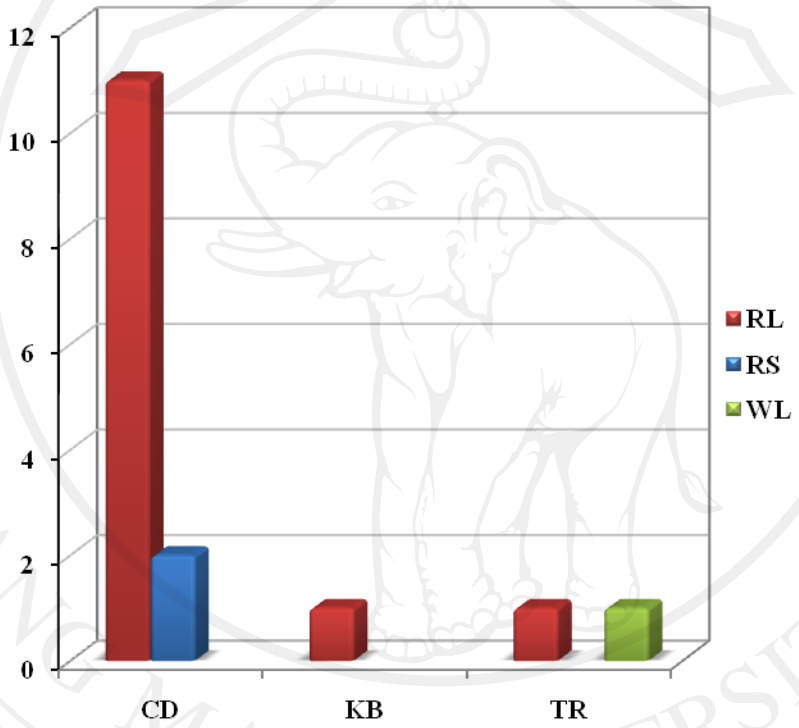

Figure 5.32 Percentage of successful fledgings in both sites according to male type.