Habitat Utilization of the White Ear-lobed Red Junglefowl (*Gallus gallus gallus*) In the Khao Ang Rue Nai Wildlife Sanctuary, Chachoengsao Province, Eastern Thailand

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ABSTRACT

The habitat utilization of white ear-lobed red junglefowl (weRJF), *Gallus gallus gallus*, in Khao Ang Rue Nai Wildlife Sanctuary, Chachoengsao province, Eastern Thailand was studied during March 2011 to April 2012. Three types of habitat were classified as the roosting, foraging and nesting sites, with 40, 20 and six different sites, respectively, studied. All habitats were located in dry evergreen forest. The roosting habitats were in open areas with a low ground vegetation density and at most sites (9/10) females roosted in the same roosting branch as the male, with only one case where females roosted separate from the male was found. There was no significant difference in all the measured physical and biological traits for the roosting habitat between the breeding season and the non-breeding season except for the tree density and humidity. The roosting habitat of males showed a significant difference in the perch-to-trunk distance between male and female. Most foraging locations (12 / 20) were close to the roosting habitats. There was no significant difference between male and female foraging habitats or between the breeding and non-breeding seasons. With respect to the roosting and foraging habitats of male and female RJFs in the breeding season, no significant difference in all the physical and biological traits measured was found except for the temperature. In the breeding season, males and females foraged in flocks of 5 to 15 individuals, the largest flock being comprised of two males and 13 females, while in the non-breeding season males and females foraged individually. Nesting sites were located under tree stubs and surrounded by ground vegetation with an average height of 39.8 ± 7.1 cm above ground level, which they likely use as a shelter. Nests were oval in shape and bedded with dry leaves. The foraging and nesting habitats of females in the breeding season used significantly different tree sizes and depth of ground leaf litter, but were not significantly different for all the other measured physical and biological variables.

Key Words: habitat utilization, white ear-lobed red junglefowl, Khao Ang Rue Nai wildlife sanctuary

INTRODUCTION

In Thailand, there are two subspecies of Red jungle fowl (RJF): the red ear-lobed *Gallus gallus spadiceus*, which is distributed from the North to the South of Thailand, and the white ear-lobed RJF (weRJF), *Gallus gallus gallus*, which is distributed in a much narrower range, being found only in parts of Eastern Thailand, such as in Khao Ang Rue Nai Wildlife Sanctuary (KARNWS), Chachoengsao and Chanthaburi province and overlaps with the red ear-lobed RJF subspecies at Pak Thong Chai district northwards to Khao Yai National Park (Meckvichai, 2009). Wanghongsa reported a large weRJF population of some 149 individuals in the KARNWS over the 1079 km^2 area (Wanghongsa, 2009). Previously, the KARNWS was subject to degradation or destruction by trespassers using it for logging and farming but at present there are no more human activities in this lowland forest. The KARNWS is composed of more than 90% dry evergreen forest with smaller patches of residual plantations and farmland. There are 666 recorded species of wild animals, including a large population of elephants (Wanghongsa *et al*., 2008). The breeding season of the weRJF is annual and in this area it starts in November and continues until May with the non-breeding season then being from June to October. The ranging area of males was reported to be 9.81 ha. (within 34 days) and for females was 10.2 ha. (in 18 days) (Wanghongsa, 2009), but these previous studies have not included any data on the foraging habitat and nesting sites of weRJFs. In addition, there are Siamese firebacks (*Lophura diardi*) living in the KARNWS as well and they may use the same niche as the weRJF. Such potential competition and the lack of any comprehensive database on the ecology of weRJFs are the principal reasons for the requirement for further research on weRJFs in this area. Although the weRJFs can be productive and breed in captivity, the pure wild breed is quite rare and has possibly cross bred with domestic chickens, while the natural wild population nowadays is still decreasing due to over hunting, and habitat loss and fragmentations. Moreover, more comprehensive ecological information of their habitat utilization is required for any effective conservation management and their continued survival in the wild. The aims of this research were to study the habitat utilization of weRJF, including the roosting and foraging habitats in the breeding and non-breeding seasons and the nesting site in the breeding season. The results of this study will provide the basic data for help in decision making in wildlife management and conservation of KARNWS.

MATERIALS AND METHODS

Study area

The study area was located in the Northern part of the KARNWS, Klongtaglao district, Chachoengsao province in Eastern Thailand (Fig. 1) and focused on the area around the Chachoengsao Wildlife Research Station.

The habitat used by the weRJF was surveyed each month, for a week per month, all year round and so included the breeding season (November-May) and the non-breeding season (June-October). The habitat type and microhabitats used be weRJF for roosting, foraging and nesting were recorded.

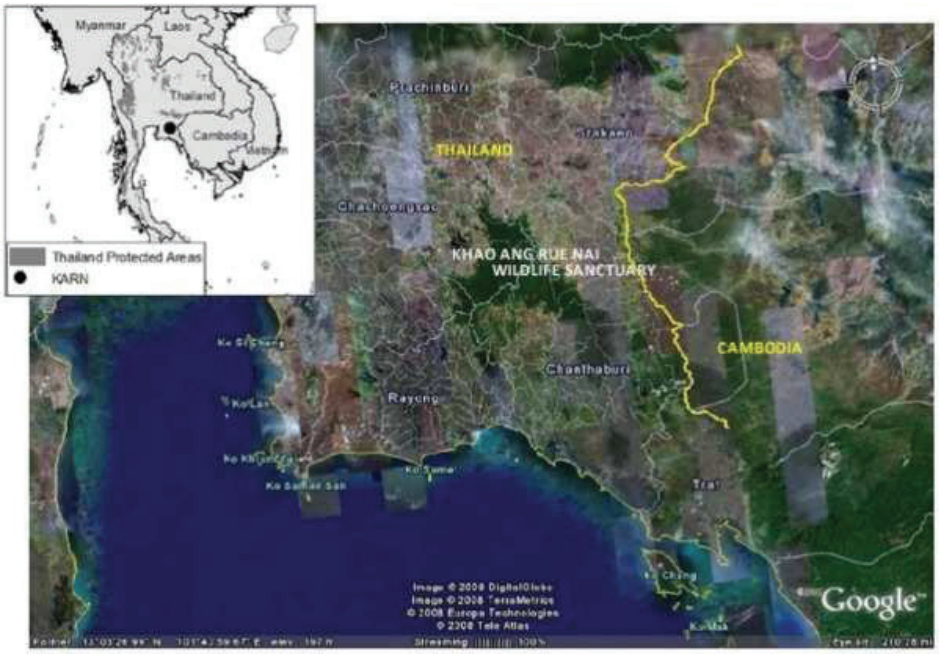


Figure 1. Study area: Khao Ang Rue Nai Wildlife Sanctuary (KARNWS)

Roosting habitat

The roosting habitat was separated into the physical and biological factors, following Wanghongsa (2009), and measured and recorded accordingly. The physical factors were the air temperature (thermometer), relative humidity (hydrometer) light intensity (light meter) and time of the morning that weRJF descended from their roosting point to the ground. The altitude above mean sea level (amsl) and monthly precipitation were also noted. The roosting trees were recorded in the Universal Transverse Mercator (UTM) coordination system with GPS.

The biological factors studied were the characteristics of the roosting tree, in terms of the tree species, roosting tree height, tree DBH (diameter at breast height, measured at 1.3 m above the ground), and those of the perching branch in terms of the branch height above the ground, diameter and distance from the trunk of perching branch. In addition, the roosting flock size and gender were recorded.

Roosting trees were located as previously reported (Collias and Collias, 1967; Wanghongsa, 2009). Briefly, the roosting site was initially located by the position of the crowing male in the early morning before they descended from roosting tree. In addition, in the non-breeding season, weRJFs usually roost together in the same tree, which then allows the observation of a pellet-pile under the roosting point. Females always roost in the same tree, and typically the same branch as the male weRJF. The behavior of weRJFs at each roosting site was also recorded.

The tree and ground vegetation densities at the roosting habitat were estimated using the point centered quarter method (Bonhum, 1989 in Wanghongsa, 2009). When the pellet pile was

located it was used as a core center. The nearest tree in each quadrate was measured (so at least four trees at the center were estimated). In addition, every tree in each quadrate at distance of 20 m from the center was recorded.

The vertical density of the roosting habitat was estimated using a 20-cm color code graduated 2-m long PVC pole. Holding the PVC pole vertically at 0, 5, 10 and 20 m distance from the center point in each quadrate, the number of 20-cm colored bars that were covered by plants was visually determined and recorded, and then used to calculate the proportion height as a percentage prior to average the vertical density (Rabinowitz, 1999).

The canopy cover was estimated using a 6-cm mirror with 25 grid intersections, holding the mirror at the center point, and visually noting the number of intersections that were covered by the canopy in the four directions. From this the average canopy cover (%) was derived.

Foraging habitats

The foraging habitat was separated into the same physical and biological factors, and measured and recorded accordingly, as that for the roosting habitats outlined above. In addition, for the biological factors we studied the diversity and abundance of the potential food species available. The seeding plants and grasses were determined by estimating the total ground area covered by them, whilst small vertebrate and invertebrates were evaluated from four replicated random sampling plots of 1 x 1 m, where the percentage of vertebrate and invertebrate food abundance were estimated as the number of individuals per total plot area. The depth of the litter was measured at the same places that the soil fauna was sampled and so was recorded as the average depth from four random sampled plots. The foraging behavior of weRJF's was also observed by direct observation and recorded.

We located the foraging habitat by direct visual observation in addition to detection of the digging or scratching holes and foot prints of RJF. In the breeding season we followed male weRJFs by their crowing, whilst females were followed by direct observation to find the foraging area in both the breeding and non-breeding seasons.

Nesting habitat

The nesting habitat was studied by direct observation and focusing on open areas to find the nests and so their habitat. The nesting habitat was separated into the same physical and biological factors and measured and recorded accordingly, as that for the foraging habitats outlined above. The size, position, and construction material of the nest were recorded as well as the clutch size and any evidence of predation or predators, such as footprints.

Human disturbance

The level of human disturbance was studied by measuring the distant from any human settlements to each respective weRJF nest site and the frequency of human activities within 15 m from the nest. We graded human activities into the four categories of (i) no human activity, (ii) humans walk past, (iii) cars and / or motorcycles pass, and (iv) weRJFs are subjected to hunting.

Statistical analysis

Data are presented as the mean ± standard deviation (SD), derived from the indicated number of individuals or categories. The statistical significance of difference between means was tested using the Mann-Whitney U-test, accepting a p-value of equal to or less than 0.05 as significant. Specifically, differences between the different physical and biological factors characterized in the roosting and foraging habitats in the breeding and non-breeding season between males and females and between the non-breeding and breeding seasons, and between the foraging and nesting habitat of females in the breeding season.

RESULTS

The study site is located at the Northern part of the KARNWS at coordinates N13^{0}24' and E101^{0}52'. During March 2010 to March 2011, 40 roosting habitats (male = 30, female = 10), 20 foraging habitats (male = 14, female = 6) and six nesting habitats were defined and studied. All habitats were located in dry evergreen forest, at an altitude of 86 to 123 amsl. The mean annual temperature was 27.55 ± 1.37 ^{o}C, average humidity was 91.6 ± 4.9% and a mean of rainfall of 4.66 ± 4.03 mm per month (Chachoengsao Wildlife Research Station, 2011).

Roosting Habitat

From direct observation, male weRJF calls (crows), sought and claimed a suitable roosting site and jumped to get on it. Before they alighted from the roosting site and glided down to the ground they would crow thoroughly in several directions, and this was especially marked in the breeding season, although sometimes they jumped to another branch(es) before descending so as to choose a better point to land. The data for the roosting habitat of weRJF in this study is based upon the 40 roosting sites found (male = 30, female = 10). At all bar one roosting site (9/10) females roosted in the same roosting branch as the male but in one case females were found separate from the male roosting tree. Typical images of a roosting habitat, tree and a pellet on the ground below a roosting site are shown in Figure 2.

(a) (b) (c)

Figure 2. The roosting habitat of weRJFs. Images show a typical (a) roosting habitat, (b) roosting tree (weRJF shown in red circle), and (c) pullet.

The roosting sites of male and female weRJFs showed no significant difference in the mean tree height (9.01 ± 3.78 m and 10.17 ± 4.50 m, respectively), tree DBH (0.13± 0.05 m and 0.12 ± 0.05 m, respectively, perching branch height (4.48 ± 1.26 m and 4.25 ± 1.59 m), perch

branch diameter (5.85 ± 1.59 cm and 5.21 ± 1.98 cm) or perch to trunk distance (4.45 ± 2.9 m and 6.93 ± 3.32 m).

When comparing the physical and biological factors of the roosting habitat of weRJF between the breeding and non-breeding seasons (Table 1), all the factors were found to not be significantly different except for the tree density ($p = 0.001$) and relative humidity ($p = 0.006$). When comparing the male and female roost sites for all the measured factors across the year, no significant difference was noted for all of them except for the perch-to-trunk distance ($p = 0.042$). In the breeding season, none of the physical and biological factors measured were significantly different between males and females.

Table 1. The physical and biological factors (mean ± 1 SD) of the roosting habitat of *G. g. gallus* (weRJF) in the breeding and non-breeding seasons

Variable	Breeding season (n = 33)	Non-breeding season (n = 7)
*Tree density (tree/m^2)	0.10 ± 0.34	0.14 ± 0.29
DBH (m)	0.13 ± 0.06	0.10 ± 0.02
Ground vegetation density (tree/m^2)	0.09 ± 0.53	0.10 ± 0.42
Canopy cover (%)	75.3 ± 13.9	77.9 ± 7.21
Vertical density (%)	53.6 ± 17.2	49.9 ± 18.2
Perching branch height above ground (m)	4.34 ± 1.32	4.67 ± 1.34
Perch branch diameter (cm)	5.91 ± 1.62	4.78 ± 1.70
Perch to-trunk distance (m)	5.30 ± 3.23	4.08 ± 2.54
Temperature (^oC)	25.6 ± 1.28	25.6 ± 0.55
*Humidity (%)	80.0 ± 7.9	89.0 ± 4.94
Precipitation (mm/ month)	2.11 ± 2.65	5.87 ± 4.63
Elevation (m amsl)	104.5 ± 8.0	109.8 ± 5.34

*Significantly different between the two seasons.

Foraging habitat

The foraging behavior of male and female RJFs was observed visually. After crowing, the cock was seen to glide down from the roosting tree and walk around foraging for food near the roosting tree, and then stop for a while and crow before continuing to look for food. This forage-crow-forage cycle was repeated several times, especially in the breeding season. In contrast, the female just walked around silently and looked for food. The foraging habitat of weRJFs in this study is based upon the 20 found foraging sites (male = 14, female = 6). Most foraging sites (12/20) were located close to the roosting habitats, the exceptions being that in late March, we found two couples of weRJFs eating Jumbul seeds (*Syzygium cumini*) at the garage near the Chachoengsao Wildlife Research Station office quarters. Typical images of a foraging habitat and foraging groups are shown in Figure 3.

(a) (b) (c)

Figure 3. The typical foraging habitat of weRJFs. Images show a typical (a) foraging habitat, (b) foraging group (1 male and 1 female weRJF on the road in Chachoengsao Wildlife Research Station, marked by red circles), and (c) a flock of foraging weRJFs.

With respect to the foraging sites, there was no significant difference between the mean depth of ground litter (5.83 ± 1.58 cm and 5.52 ± 1.43 cm), ground seed ground cover (49.7 ± 9.2% and 51.3 ± 9.8%) or grass ground cover (53.5 ± 8.0% and 45.5 ± 6.7%) between male and female sites. A diverse array of both vertebrate and invertebrate fauna that could act as food sources was found in both the male and female foraging habitats, being comprised of 66.52 ± 65.78 and 83.04 ± 33.85 numbers/m^2 from 15 and 17 taxonomic orders, respectively. Overall, the major invertebrate group was Insecta (82.5%), followed by Cladocera (11.7%) and Arachnida (3.6%). The niche breadth of male and female RJFs were 0.69 and 0.67 respectively, with a niche overlap between males and females of 0.88. With respect to the foraging habitat of male and female RJFs, there was no significant difference for all the physical and biological variables measured between the breeding and non-breeding seasons (Table 2), and between males and females in the breeding season except for the air groups of about 5 to 15 individuals of mixed gender, the largest flock being comprised of two males and 13 females, but in the non-breeding season they were only found foraging as individual males and females.

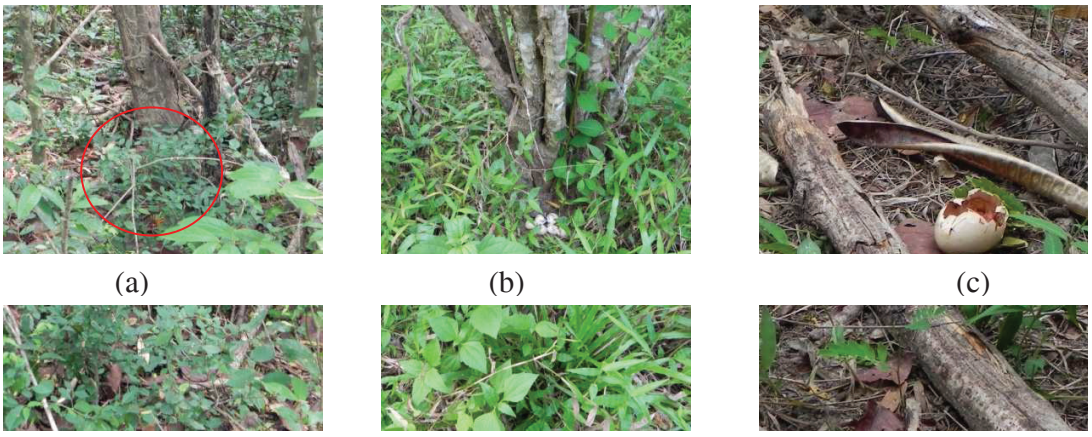
Nesting habitat.

Six nests were found, all at an altitude of 105 to 112 m amsl. Nest sites were located under tree stubs and surrounded by ground vegetation with an average height of 39.8 ± 7.1 cm above ground level, which might be used as a protective shelter. Nests were built in an oval to round shape of approximately 22.9 ± 3.8 cm width, 23.9 ± 3.7 cm length and 3.73 ± 2.39 cm depth, and were lined (bedded) with dry leaves. The clutch size varied from 3 to 7 eggs (average 4.5 ± 1.5 eggs per nest). The average depth of ground leaf litter around the nest sites was 9.0 ± 3.0 cm. The average seed and grass ground cover was 63.8 ± 11.9% and 76.5 ± 13.7%, respectively, within which invertebrates of 19 different orders were found. Insects were the major group (89.2%) followed by Arachnida (5.9%) and Cladocera (3.1%).

Table 2. The physical and biological factors (mean ± 1 SD) of the foraging habitat of *G. g. gallus* (weRJF) in the breeding and non-breeding seasons

Variable	Breeding season (n = 18)	Non-breeding season (n = 2)
Tree density (tree/m^2)	0.12 ± 0.68	0.10 ± 0.91
DBH (m)	0.11 ± 0.06	0.10 ± 0.03
Ground vegetation density (tree/m^2)	0.76 ± 0.96	0.86 ± 0.11
Canopy cover (%)	66.4 ± 19.0	74.3 ± 12.4
Vertical density (%)	36.3 ± 31.4	46.9 ± 8.0
Depth of ground litter (cm)	5.93 ± 1.26	3.50 ± 2.12
Total basal ground cover (seed) (%)	49.2 ± 9.0	59.5 ± 6.4
Total basal ground cover (grasses) (%)	50.2 ± 7.7	59.0 ± 12.4
Temperature (^oC)	29.7 ± 3.2	33.3 ± 1.1
Humidity (%)	84.0 ± 12.5	94.3 ± 2.6
Precipitation (mm/month)	2.70 ± 1.66	6.95 ± 6.90
Elevation (m amsl)	107.2 ± 9.3	108.5 ± 2.1

Typical nest site, clutch and evidence of nest predation are shown in Figure 3.



(a) (b) (c)

Figure 3. Nesting habitats of weRJFs. Images show a typical (a) hen brooding eggs (in red circle), (b) nest, and (c) destroyed egg near the nest that might have been eaten by a predator

With respect to the foraging and nesting habitats of females in the breeding season, these were only significantly different for the tree DBH ($p = 0.045$) and depth of the ground leaf litter ($p = 0.016$) (Table 3).

Table 3. The physical and biological factors (mean ± 1 SD) of the nesting foraging habitats of female weRJFs in the breeding season

Variable	Nest (n = 6)	Foraging habitat
Tree density (tree/m^2)	0.13 ± 0.89	0.15 ± 0.62
*DBH (m)	0.08 ± 0.02	0.13 ± 0.04
Ground vegetation density (tree/m^2)	0.13 ± 0.18	0.6 ± 0.96
Canopy cover (%)	63.7 ± 19.4	66.8 ± 19.2
Vertical density (%)	53.9 ± 12.6	38.5 ± 27.4
*Depth of ground litter (cm)	9.03 ± 2.99	5.52 ± 1.43
Total basal ground cover (seed) (%)	63.8 ± 11.9	51.3 ± 9.8
Total basal ground cover (grasses)	76.5 ± 13.7	45.5 ± 6.7
(%)		
Temperature (^oC)	28.9 ± 3.0	29.7 ± 2.1
Humidity (%)	75.3 ± 18.3	85.8 ± 8.7
Precipitation (mm/month)	2.48 ± 2.19	2.76 ± 0.25
Elevation (m amsl)	109.5 ± 4.2	108.7 ± 6.8
Height of screen (cm)		-
Distance from human settlement	39.8 ± 7.1	-
(m)	252.3 ± 387.9	

*Significantly different between the nesting and foraging habitats of female RJF in the breeding season

We found evidence of potential nest predator activity at 50% (3/6) of the nest sites. The distance from human settlements to each nest was highly variable (range 12 to 1031 m; 252.3 ± 387.9 m), and accordingly human disturbance was fairly common with human activity (21.7%) near the nest site being exceeded by the frequency of nests by humans walking past (43.3%) or cars or motorcycle passing (35%), but no hunting was found in this area. The relationship between all the evaluated physical factors and nests was not significant.

DISCUSSION

Roosting habitat

In this study, all of the weRJF roosting sites overlapped with their foraging habitat all year round, and were in open ground with a low tree density (0.1 tree/m^2) and high canopy cover (77.3%). The average height of the roosting branch above ground (4.42 m) and its diameter (5.7 cm), as well as the distance from the perch to the tree trunk (5.0 m), were all similar to that reported before in the same location (Wanghongsa, 2009). These are good roosting sites for RJFs because when predators attack along the roosting branch they can be detected by the shaking giving the RJFs enough time to escape. The height above ground of each roosting branch was more than 4 m, a height that is possibly safe from disturbance from elephants (Wanghongsa, 2009), given that there are plenty of elephants roaming around the study site in the KARNWS. In this study, significant differences in the tree density, humidity and precipitation levels were noted between the breeding and non-breeding seasons. The latter two reflect the general seasonal

climatic changes since the non-breeding season of weRJF is in the rainy season and so the humidity and precipitation were higher than in the dry season. Also, in the non-breeding season male weRJFs do not defend their territory, and so there are more choices for roosting sites that are comfortable for them. Only the perch-to-trunk distance was significantly different between male and female weRJFs. Females used a larger perch-to-trunk distance than males because they are lighter than males and so giving the female more time to escape from predators.

Foraging habitat

WeRJFs were found to forage in areas of low tree densities (0.13 trees/m^2), low ground vegetation density (0.08 trees/m^2) and a low vertical density (37.3%), which is likely to be the case as whilst they are searching for food they must be aware of predators. If the ground vegetation is too dense or the vertical density is too high, then they could not see approaching predators, like the foraging habitat of Hume's Pheasant (*Syrmaticus humiae*) in northern Thailand (Iamsiri and Gale, 2008). However, the results of this study for weRJFs here is different to that reported for Grey jungle Fowls (*Gallus sonneratii*) in India that use a higher density ground cover for foraging, perhaps because these areas have a higher leaf litter content that contains more insects (Subramanian *et al.,* 2008). There were no significant differences between the roosting and foraging habitats of the weRJFs because the roosting and foraging sites overlapped. When birds descended from the roosting site they typically started to look for food near the roosting site, which in terms of availability was principally comprised of insects (89.2%), but the seed (50.2%) and grass (51.1%) coverage by area was also high. Thus, whilst the actual diet composition of these weRJFs remains to be evaluated, the potential diet items of weRJFs in this study are similar to those reported for the RJF (Wanghongsa, 2009) and the green peafowl in Hua Khakheng Wildlife Sanctuary (Pinthong, 2009). However, it is in contrast with that reported for RJFs in Malaysia and India, where their major group was plant seeds (Arshad *et al*., 2000), probably caused by the limited food resources in that habitat. Collias and Saichuae (1967) and Arsirapoj (2008) reported that red ear-lobed RJFs in Western Thailand were omnivores and can eat both seeds and vertebrate or invertebrate animals. In this study site at KARNWS they have a diverse choice, and so would be likely to choose the abundant high quality food items, such as invertebrates.

Nesting Habitat

Nest sites were first recorded from only one nest in late of February, two nests in each of March, April and one in May, the latter of which was late in the weRJF breeding season being into the dry season. These results contrast with those from the related Siamese fireback (*L. diari*), where the nesting period is from April to June (Sukumal *et al*., 2010) in the dry season. Here the potentially reduced invertebrate levels is compensated for by the lower precipitation level and warmer temperature that is more suitable for egg brooding. In this study, all of the weRJF nests were found near the weRJFs' trail on a tree stub and faced with ground plant coverage, such as *Tiliacora triandra*, which provide a good shelter to protect the nests from predators. This is similar to that reported for the Hume's Pheasant (*Syrmaticus humiae*) in northern Thailand (Iamsiri and Gale, 2008). However, the footprints of a monitor lizard and palm civet were found near one nest and evidence of hunting (destroyed egg) near the nest suggests it might have been

eaten by a monitor lizard. Nevertheless, no evidence of any nest being destroyed by elephants was seen, albeit at this low sample size of just six nest sites. A significant difference in the tree DBH and depth of ground leaf litter was found between the foraging and resting habitat of females, which is likely to be because the area with a higher level of ground leaf litter may supply more was are used as food for young chicks. In this study the major food item of weRJF was likely to be termites based on that they were the most abundant invertebrates found around the nesting habitats, are easily caught and are edible. Although this requires confirmation, if correct this is similar to that reported previously for RJF in western Thailand (Collias and Saichuae, 1967), where a lot of termites were found in the crop of five downy red ear-lobed RJFs. Although the weRJFs of this study site nested near human settlements, these were the forest ranger and officials of the wildlife research station and so these sites are protected from hunting and other human activities.

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