

Roosting Territory of White Ear-Lobed Red Jungle Fowl (*Gallus gallus gallus*)

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Abstract: RJJ (red jungle fowl) (*Gallus gallus gallus*) is territorial birds. Only males advertise and defend territory by means of crows and combat fighting in severe cases. Crows are testosterone dependent and use up to 4-5% of their basal metabolic rate. Crows are individual voice signatures which differ in tone, duration and vibration. Crows together with radio-telemetry were used here to locate night roosts of dominant males. Between 2005 and 2009, 10 despots were intensively monitored. Outermost locations of individual's roosts were connected to form territory and a distance of 50 m was buffered to individual's territory to yield home range. Data indicated strong site fidelity of dominant males. The longest territory tenure was 31 months. The life time territory of males was on average 10.24 ha (± 1.73 SE) and a home range was 17.59 ha (± 2.15 SE). Average yearly territory varied between 5.48 and 10.88 ha per individual and rarely overlapped. Some roosts were used repeatedly at the same point. In the night, RJJ was relatively safe and difficult to approach both vertically and horizontally. Roost site selections were thus a trade-off between security and territory proclamation.

Key words: RJJ, *Gallus gallus gallus*, territory, home range, crow, Khao Ang Rue Nai.

1. Introduction

Spaces are one component in basic necessities of organisms to compete for [1]. Space requirements vary spatially and temporally across species and individuals. However, there are strong relationships between space requirements and body size [2, 3], and between space and breeding condition [4]. Moreover, space quality influences mate choice [5], dispersal decisions [6] and breeding success [7].

In ecology, there are two technical terms for spaces: home range and territory, which are well defined. Odum and Kuenzler [4] classically and simply defined a home range as a definite area where animals restrict their activities and a territory as those restricted areas where animals defended against conspecifics. The mechanism of territory declaration and defenses is

worth studying. In gibbons, calls are signals for territory rights [8]. In large predators such as tigers, a number of techniques are used to signal territory ownership: scrap marks on trees and on the ground, faeces and urines [9]. Generally, visual, olfactory and auditory communications are among signals that animals use to convey a message of territory tenure. Fighting combats over territory rights rarely occur because such confrontations might result in death or injury.

RJJ (red jungle fowl) is territorial birds. Only males advertise and defend territory by means of crows and combat fighting in severe cases. Dominants produce a series of simple crows with four-note-sounds, read *Ee-er-erk-er* [10]. Crows are testosterone dependent [11] and use up to 4-5% of their basal metabolic rate [12]. Crows, thus, are considered to be very cheap, but most metabolically effective in this species. Crows are individual voice signatures [13], which differ in tone,

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duration and vibration and were used briefly to track male's movement in India [14]. Crows together with radio-telemetry were used here to explore territory size of dominant male RJF.

1.1 Study Area

Roosting territory of RJF was investigated in intensive studying areas where population density [15] and food habits [16] were examined. Briefly, the study was carried out in Khao Ang Rue Nai Wildlife Sanctuary (KARN, 13°00'-13°32' N and 101°37'-102°02' E), eastern Thailand. The investigation was concentrated in and around area of dry evergreen forest circular to Chachoengsao Wildlife Research Station. The study area encompassing about 50 ha was relatively flat. One reservoir and 2 ponds were constructed at the turn of this century to supply consumption water to government offices and to supplement water in dry season to large animals such as elephants, banteng, guar etc. Elephant trails and trapping trials were available, making closed monitoring RJF more easily. A herd of 24 elephants was reported to frequent the areas [17].

2. Material and Methods

Roosting territory delineation of RJF was conducted as a concomitant work of the food habits and capture-recapture study of the bird from October 2005 to May 2009. Several ecological investigations were conducted concurrently and supplemented one another.

N. E. Collias and E. C. Collias [14] used crow sound to track movement of RJF flocks in India. It was intensively elaborated here. To document territories, night roosts were located in December 2005 by only crow sound following the methods of N. E. Collias and E. C. Collias [14], but in 2006 telemetry was employed to help locate night roosts coupled with vocalization of some individuals. The work was concentrated in trapping areas where trails facilitated access to the birds in early morning.

Trapping configurations and trapping protocol were reported in Wanghonga and Hayashi [15]. Transmitters (frequency ranges from 171-172 MHz, manufactured by Holohil Systems Ltd. Carp Ontario Canada, weight: 12.45 g, battery life: 24 months) were fitted to noosed cocks. In total 12 cocks were transmitter-fitted, five in 2006 and seven in 2007. Of the 12 radioed-cocks, four individuals (named according ring numbers M267, M272, M281 and M298) remained in the study area encompassing 50.09 ha. Two males (M253 and M272) monitored earlier were caught using decoy chickens and a series of nooses set circular to the tethered decoy. All males were also banded with numbered-metal rings sized 11A, manufactured by Lambournes (B'Ham) Ltd UK. Initially, a decision was made to use radio telemetry to track daily movements of the cocks. However, experiments with hidden transmitters, placing 10 cm above ground with protruding antenna similar to that attached to the birds, disclosed an error from triangulations of 30-50 meters at a receiver's distance of 300-400 meters, probably due to dense vegetations. Finally, a decision was concluded to use radio telemetry to track night roosts of cocks to supplement our crow sound locations because errors with 30-50 meters were large enough to distort the true home range of RJF whose daily range was about 60-80 meters from the roosting place according to Collias et al. [18] and daily dispersals of 98 m for males and 153 m for females from trapping data [15]. Therefore, night roosts of four individuals were located by dawn crow and triangulations and night roosts of another six males were located by only crow sounds. Additionally, tracking night roosts by telemetry and crow sound revealed an error of 3-5 meters based on GPS (global positioning system) devices. It was thus certain that sizes of territory obtained from delineating roost sites were relatively less distorted because observers had enough time to locate the position of birds that were performing dawn crows and the birds rarely moved when crowing.

To learn to differentiate the crows of males,

observers were asked to carefully and repeatedly listen to the playback of dominant crows recorded in early morning while being aided in direction by telemetry until they could distinguish crow sounds of the assigned male. In the field, early in the morning at about 05:00-05:30 skilled observers were asked to eavesdrop on morning crows of the assigned males that were closely monitored by the same group of observers. All crews patiently stalked the RJF as close as possible for listening to the crows. When heard and located, we recorded the time of the first crow, numbers of crows, and the descending time onto the ground for further ecological studies. We allowed the RJF to forage for 2 hours after descending, and then we enthusiastically searched for the night perches. To determine the exact night perches we searched for pellets on the forest floors. When detected, pellets were collected and preserved for analysis, and perches were identified, measured and GPS marked.

2.1 Data Interpretation

A minimum convex polygon [19] was employed to estimate roosting territory. In doing so, the outermost locations of perch UTM (universal transverse mercator) of each individual male were connected to form a polygon that encompassed 100% locations. The specific computer program ArcGIS was used to calculate each area. To estimate home range, the territory size was buffered with 50 meters. A distance of 50 meters was added to the territory areas to make up the full home range because ranging areas of free ranging RJF were not farther than 50 meters from night roosts [20]. Trapping data [15] revealed also that daily movement of RJF males was 98 meters. Such distance could be interpreted as a radius of 49 meters, which corresponded to daily ranging radius of 50 meters.

3. Results and Discussion

Between December 2005 and May 2009, ten dominant males (Table 1) were intensively monitored;

however, all males were not monitored every year. Four of the ten males were monitored in 2005-2006, six males in 2006-2007, six males in 2007-2008 and 5 males in 2008-2009. The longest territory tenure was 31 months belonging to M281. The shortest tenure was that of M563 with about six months. Unfortunately, M272 died on 22 January 2007 and his area was replaced by M298 and M279 died on 18 February 2008 and his territory area was occupied by M600. The deaths were ascribed to predation while the birds had entangled in nooses set for a capture-recapture study [15]. At the end of the 2009 breeding season, 5 males, M281, M298, M600, M274 and M563, were still alive.

During the course of study, 680 perches, belonging to 96 species of plants were identified and reported elsewhere [16]. In brief, trees accounted for 64.41%, followed by climbers (27.65%), shrubs (6.91%) and bamboos (1.03%) respectively. Perches were on average 4.22 m from tree trunks and 5.31 m above the ground, which was difficult to approach both vertically and horizontally. Individual night roost location changes varied between 15 and 114 perches (Table 1).

In total 1,632 night-perches were identified. Of these, 111 night-perches were examined from unknown females and cockerels and 1,521 night-perches were explored from 10 males with 569 perches. Of the 680 perches, 423 were used only one and 257 perches were re-used between 2-59 times. Interestingly, when returned to the same perches, males used exactly the same location on the branch if available. Moreover, neighboring cocks, whose territory overlapped, used the same perches of some plants as well.

Overall, the size of individual territories was on average 10.24 ha (± 1.73 SE) and mean yearly territory size varied between 5.48 ha (± 1.37 SE) and 10.88 ha (± 1.55 SE), whose medians were not significantly different (Kruskal-Wallis Test, $\chi^2_3 = 6.31, p = 0.098$)

Table 1 Territory and home range of RJF (numbers in parentheses indicate numbers of perches).

Cocks	Duration	No. perches	Total size (ha)		Yearly occupied areas (ha)								Note
			Territory	Home range	Dec. 05-May 06		Jun. 06-May 07		Jun. 07-May 08		Jun. 08-May 09		
					Territory	Home range	Territory	Home range	Territory	Home range	Territory	Home range	
M253	Dec. 05-Feb. 08	114	12.53	20.35	9.41 (72)	16.68	6.85 (43)	13.42	6.17 (46)	12.34	-	-	
M272*	Dec. 05-Jan. 07	58	4.79	10.02	3.38 (15)	8.24	3.60 (50)	8.04	-	-	-	-	Died
M259	Jan. 06-Apr. 08	81	7.91	14.29	5.28 (48)	10.89	6.85 (42)	12.91	5.60 (32)	11.44	-	-	
M267*	Feb. 06-Apr. 08	51	11.39	19.08	3.84 (29)	8.95	9.91 (36)	17.23	8.41 (26)	16.61	-	-	
M281*	Oct. 06-Apr. 09	61	22.35	32.69	-	-	7.09 (19)	13.62	10.83 (30)	18.17	14.22 (33)	22.98	
M279	Jan. 07-Feb. 08	35	8.44	15.91	-	-	1.94 (10)	6.33	6.36 (29)	13.42	-	-	Died
M298*	Aug. 07-May 09	71	15.53	23.96	-	-	-	-	7.64 (34)	14.79	13.73 (41)	21.41	
M600	Oct. 08-May 09	42	4.7	12.4	-	-	-	-	-	-	11.70 (42)	19.4	
M274	Apr. 08-May 09	15	8.71	15.52	-	-	-	-	-	-	8.71 (15)	15.52	
M563	Dec. 08-May 09	41	6.06	11.65	-	-	-	-	-	-	6.06 (41)	11.65	
Mean ± SE			10.24 ± 1.73	17.59 ± 2.15	5.48 ± 1.37	11.19 ± 1.91	6.04 ± 1.16	11.92 ± 1.64	7.50 ± 0.79	14.46 ± 1.05	10.88 ± 1.55	18.19 ± 2.06	

1. * Transmitter-fitted cocks.

2. Some trees/plants were used by several individuals.

3. Medians of the mean territories were not significantly different (Kruskal-Wallis Test, $\chi^2_3 = 6.31, p = 0.098$) and medians of the mean home range were also not significantly different (Kruskal-Wallis Test, $\chi^2_3 = 6.18, p = 0.103$).

Buffering 50 meters to the territory yielded the mean home range size of 17.59 ha (± 2.15 SE) and mean yearly home range varied between 11.19 ha (± 1.91 SE) and 18.19 ha (± 2.06 SE), whose medians were not significantly different (Kruskal-Wallis Test, $\chi^2_3 = 6.18$, $p = 0.103$) as well. Polygons of individual territories are depicted in Figs. 1-4.

Naturally, RJF are diurnal, spending the day wandering on the forest floors. They seek night roosts before dusk and spend the entire night on perches. Roughly, RJF spend half of their life on perches. Thus, perches are critical and special places for not only RJF, but also for all diurnal animals whose decisions might influence their overall life-expenses. This is because during the night they sit or rest very still for hours. Nocturnal and arboreal predators such as civets, wild cats and some snakes are very active at night. They might come across, while intentionally searching for their preys, RJF that roost on easily accessible locations. Choosing where to perch therefore may be an inherited survival strategy gained from past experiences.

Territories and home-ranges of cocks monitored more than one year indicated a spatial fluctuation. Usually, size of areas occupied by animals depends upon breeding condition [4] and habitat alteration [21]. Such a fluctuation can be ascribed to the fact that in different years certain despot's harem members varied as normally hen selected mates according to comb attributes [22, 23], which, in turn, influenced habitat quality. Flock formation [16] indicated different numbers of hen formed in the harem. In addition, newly assumed despots seem to be occupied larger area in the first year than the averaged territories of the losers. M600 who replaced M279 occupied territory 181.93% larger than that of M279 and that of M298 which took over territory of M272 was 118.91% larger. It is plausible that the new despots took reconnaissance over new area not familiar or less familiar with before permanently settle his own tenure. This is supported by the roosting studies in that

numbers of roost sites were used only one time.

Normally, in breeding season, cocks performed dawn and dusk crows. To human hearing, dawn crows may be clearly identified at about 400-500 meters from crows, depending on wind directions. This is because cocks utter crow from perches high above the ground and background noises are still minimized in early morning. However, dusk crows could only be recognized at shorter distances, even though cocks performed on perches, probably due to background noise interference such as calls of some other bird species and noises from human activities. From vocalizations, a dominant could determine the locations of their neighbors and initiate responses, usually by means of crow exchanging to keep neighboring cocks away from his occupied area. By listening and responding to the rival's crows, cocks might determine and anticipate the location of their neighbor's perches. The present study did not find confronting cocks intruding further to perch inside territory of his neighbor. This was obvious that territories rarely overlapped between neighboring cocks. Nonetheless, those that slightly overlapped as shown in Figs. 1-4 have taken place when cocks engaged in responding to some other males at opposite side of the intruder as a cock usually had more than two neighbors to respond. Furthermore, in some instances, e.g. between M600 and M563, an overlap took place in late breeding when territory defense was minimized and a rival retreated to the core areas where he remained until next breeding season. This was confirmed by a heap of pellet underneath of some roosts, which indicated that such roosts were used repeatedly

In a free ranging population of RJF at San Diego Zoo, there were ten permanent and 18 ephemeral roosts for 130-170 birds [18] that roosted in flocks of 6-30 individuals. This is contradictory to the present study. Cocks in our study area roosted alone whereas hens roosted in groups on nearby trees. This is probably due to the fact that cocks normally

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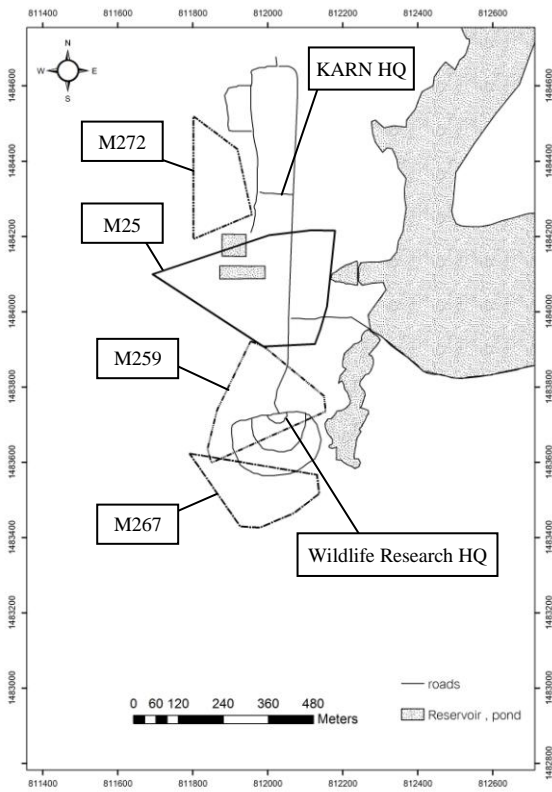


Fig. 1 Territories of 4 cocks investigated in 2005-2006.

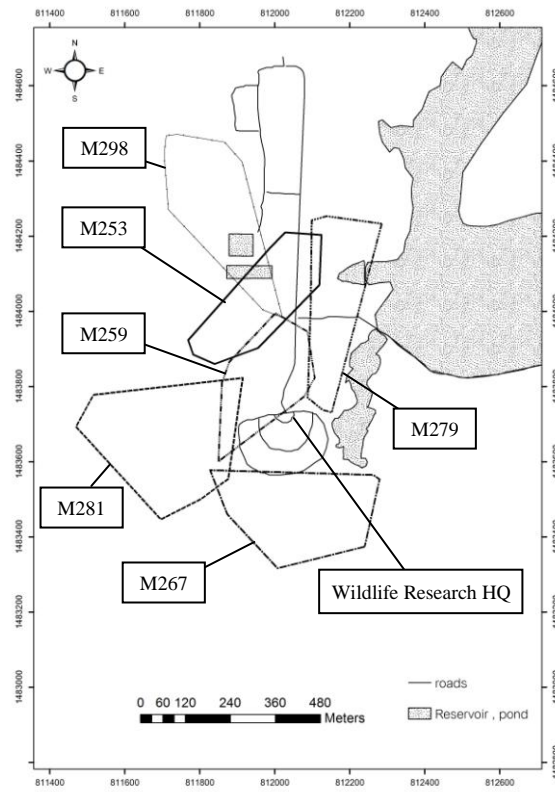


Fig. 3 Territories of 6 cocks investigated in 2007-2008.

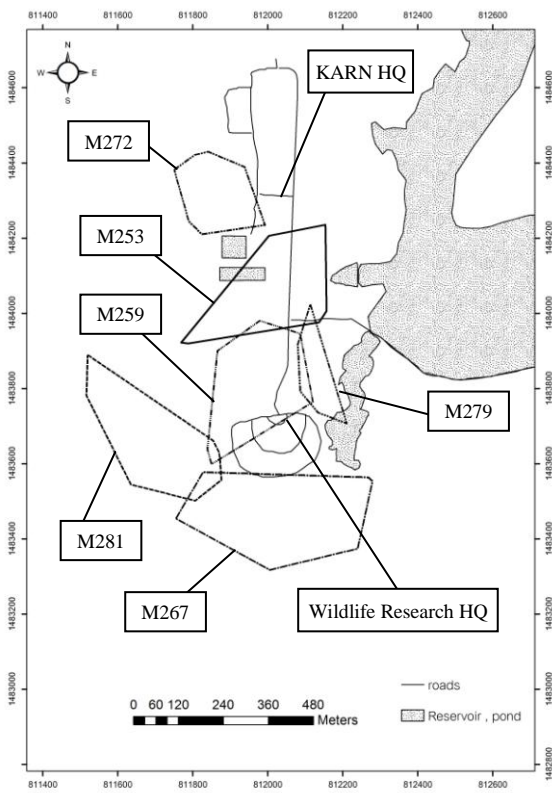


Fig. 2 Territories of 6 cocks investigated in 2006-2007.

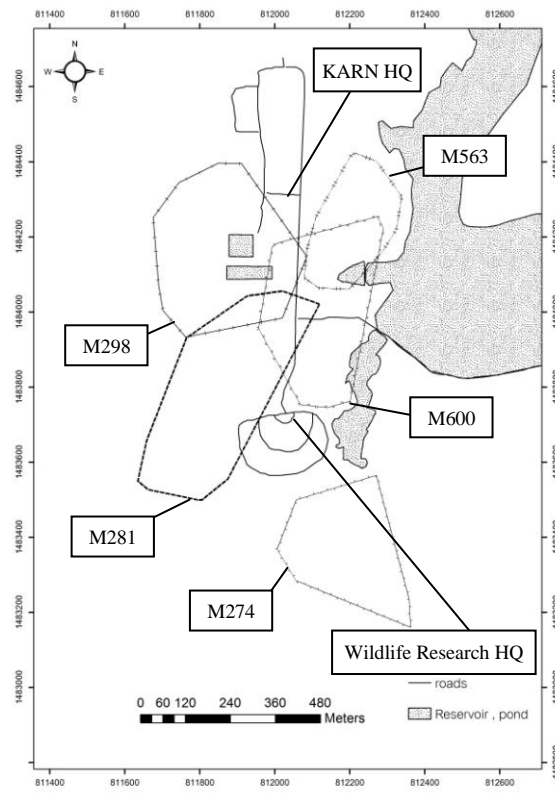


Fig. 4 Territories of 5 cocks investigated in 2008-2009.

performed wing flapping and night crows regularly. The characteristics of night roosts almost at the tip of branches [16] made it impossible for them to perch in flocks and to also perform wing flapping. Compared to crowing, wing flapping required more space and created more vibrations. In addition, flock roosting might make them more easily located by predators. Consequently, males tend to perch singly on different trees not very far from hens that roosted in a small group. Some roosts were repeatedly used while a number of roosts were used only one time. As cocks occupied numerous roosts, which tree to roost could not be anticipated by observers, but when trees had been located as a roost site either by crow direction or by telemetry, the exact points to perch on that tree could be rightly predicted. In a number of roosts, a leave was placed below the perches for collecting pellets. Roosts permanently on a few trees as in the case of San Diego Zoo may be dangerous as predators might be able to locate by smell and by sound produced during crows and wing flapping. In the study area the maximum number of different roosts for one cock was 114 in about 50 ha of study area. Of the 680 roosts identified during the course of study, 569 roosts were used by 10 males. This also implied that roosts were sporadically occupied which contradicted to domestic chickens [24, 25] whose roosts are permanent and used repeatedly. This is probably due to the fact that the domestic ones benefit from some shelters and protections against predators provided by man.

Though, it was obvious that territory of RJF was well-defined, size of territory was relatively large. Great Argus pheasants (*Argusianus argus*) in Sumatran rainforest occupied a territory of 14.5 ha [26] for three months in breeding season. The pheasants are 2 times bigger than RJF and their territory was 141% that of RJF. Both are polygamous, terrestrial and omnivores. It was plausible that RJF occupied comparatively large area because of numerous conspecifics roaming in his area. Density study [15] uncovered an ecological density of 1.61-2.01

individuals per hectare. Extrapolating this density to numbers of birds revealed that, in one territory of cocks may sustain 12-15 birds. The density of the great Argus was 0.3-4.5 birds per sq.km [27]. Again, it can be extrapolated to the population of 0.04-0.65 bird in one Argus territory. This may cause RJF to encompass very large areas in relation to their body size as the resources were shared by the conspecifics.

4. Conclusions

Dominant males of white ear-lobed RJF exhibited high site fidelity. The longest territory tenure was 31 months. The life time territory of males was on average 10.24 ha (± 1.73 SE) and a home range was 17.59 ha (± 2.15 SE). Yearly territory varied between 1.94 and 14.22 ha per individual and rarely overlapped. Some roosts were used repeatedly at the same point. In the night, RJF were relatively safe and difficult to approach both vertically and horizontally. Roost site selections were thus a trade-off between security and territory proclamation.

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