ORIGINAL ARTICLE

Territorial defense of the red-whiskered bulbul, *Pycnonotus jocosus* (Pycnonotidae), in a semi-wild habitat of the bird farm

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Abstract

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The territorial behavior of the red-whiskered bulbul, *Pycnonotus jocosus*, was studied in the semi-wild habitat of a bird farm compound in the District of Chana, Songkhla Province, the south of Thailand. The male and female birds were bred and reared in the farm till they reached maturity following which they were released to the wild. A mating pair was later formed and their territory established in the farm area. A decoy was used to simulate a natural intruder to the defended area. Ten test stations were sited in the four cardinal points of the compass and with reference to the farmhouse. The experiments were conducted during the pre-nesting and nesting periods. It was found that territorial boundary was marked by the resident male's aggressive calls and threat displays to the decoy. The territory covered an area of approximately 0.3 hectare in which it was used for foraging and nesting. The size remained the same in both pre-nesting and nesting periods, but the territorial behavior during the nesting period was evidently more vigorous than that in the pre-nesting period. The intensities of territorial behavior had been hypothesized to be associated with diurnal foraging rhythms. But the finding was contradictory to this prediction. There was no significant difference in the intensity of territorial behavior ($P > 0.05$) at the three time regimes in the morning, at noon, and in the afternoon. It was suggested that the resident bird's aggressive behavior might be associated with the degree of hunger pang.

Key words : red-whiskered bulbul, territorial behavior, territory size

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บทคัดย่อ

สุนทร โสตถิพันธุ์

พฤติกรรมปกป้องอาณาเขตของนกปรอดหัวโขน *Pycnonotus jocosus* (Pycnonotidae) ในสภาพกึ่งธรรมชาติของฟาร์มเลี้ยงนก

ว. สงขลานครินทร์ วทท. 2546 25(5) : 553-563

ศึกษาพฤติกรรมปกป้องอาณาเขตของนกปรอดหัวโขน *Pycnonotus jocosus* ในสภาพกึ่งธรรมชาติของฟาร์มเลี้ยงนกในอำเภอจะนะ จังหวัดสงขลา ภาคใต้ของประเทศไทย เลี้ยงนกปรอดหัวโขนเพศผู้และเพศเมียในฟาร์มจนโตเต็มวัย จากนั้นปล่อยนกสู่ธรรมชาติ นกจะเริ่มจับคู่ และสร้างอาณาเขตภายในฟาร์ม ใช้นกต่อเป็นตัวล่อแทนการบุกรุกของนกในธรรมชาติ กำหนดจุดทดสอบพฤติกรรมปกป้องอาณาเขต 10 จุดรอบตัวบ้านซึ่งเป็นฟาร์มนก ในแนวทิศเหนือ-ใต้ ตะวันออก-ตะวันตก ทำการทดสอบในช่วงก่อนทำรัง และขณะทำรัง พบว่านกเจ้าถิ่นตัวผู้จะแสดงพฤติกรรมปกป้องอาณาเขตด้วยการร้อง และแสดงพฤติกรรมคุกคามนกต่อ อาณาเขตที่ปกป้องมีขนาดประมาณ 1.85 ไร่ (0.3 เฮกตาร์) ซึ่งเป็นบริเวณที่ใช้หาอาหารและสร้างรัง พบว่าอาณาเขตที่ปกป้องมีขนาดคงที่ทั้งในช่วงก่อนทำรังและช่วงขณะทำรัง แต่พฤติกรรมการปกป้องอาณาเขตในช่วงขณะทำรังมีความรุนแรงมากกว่า ผู้วิจัยตั้งสมมุติฐานเกี่ยวกับความรุนแรงในการแสดงพฤติกรรมว่ามีความสัมพันธ์กับช่วงการหาอาหารในรอบวัน แต่จากการศึกษาพบว่าไม่เป็นไปตามสมมุติฐานที่ตั้งไว้ ความรุนแรงของพฤติกรรมปกป้องอาณาเขตในช่วงเช้า กลางวัน และเย็น ไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ (P>0.05) สันนิษฐานว่าพฤติกรรมก้าวร้าวของนกเจ้าถิ่นจะเกี่ยวข้องกับระดับของความหิว

ภาควิชาชีววิทยา คณะวิทยาศาสตร์ มหาวิทยาลัยสงขลานครินทร์ อำเภอหาดใหญ่ จังหวัดสงขลา 90112

It is rare to find an animal that spends its entire life in nomadic wanderings, because suitable habitat for a species is generally limited. Typically, an individual will locate an acceptable living space and remain there unless forced to leave by competitors or changing climatic conditions (Alcock, 1979). It was reported that territory holders were often less vulnerable to predators and gained foraging opportunities that promoted rapid growth, which increased their survival chances and reproductive success (Grant, 1997). Yet despite the limited availability of good homes, only some species defend their chosen living place against intruders, and many of these are territorial only for some fraction of the year (Alcock, 1979).

A territorial boundary may be marked by 'territorial song' as commonly used by various species of birds (Catchpole, 1979) or by scents (Stoddart, 1976; Krebs & Davies, 1981). If such advertisement does not discourage intruders, then chases and actual fighting may follow. A territorial animal prevents other individuals from exploiting the resources contained within its territory. Usually a territory owner is aggressive only toward members of its own species, as these are most likely to use up its valuable resources (Giller, 1984).

The red-whiskered bulbul, *Pycnonotus jocosus*, is a songbird found in most South-East Asian countries. It inhabits villages, cultivation, secondary growth and forest edge (King *et al*., 1984). Lekagul & Round (1991) described the bird as being tall, having an erect black crest and thin black malar stripe joining a blackish partial necklace. There is a small red spot below the eye which is difficult to discern. The cheeks and underparts are white. Tail coverts are red underneath. Its upperparts are uniform brownish, with white-tipped outer tail feathers. The bird lives in open country, scrub, clearings. It can produce a varied, musical whistled phrase. As the bird's physical appearance and its beautiful song are enticing to bird lovers, they have been prone to be caught and reared as caged birds. This has resulted in a dramatic decrease in the number of

the birds in the wild to the extent that it has been listed as a protected animal according to the Thai Wildlife Protection and Reservation Act 1992 (Chantalay, 2001).

Studies of the animal territorial behavior have mostly been conducted in the wild where sympatric species competed for living space (Blank & Ash, 1956; Seymour, 1974; Ryder, 1975; Keeley, 2000). Understanding of bird territorial behavior in a semi-wild or semi-natural habitat is quite limited. Preliminary observation of the response of a resident male red-whiskered bulbul, *Pycnonotus jocosus*, to a decoy in a bird farm showed some promise in undertaking an empirical study of its territorial defense with a view to broadening an understanding of the bird's territoriality. The bird farm was found to be an ideal place for two main reasons. First, the bird was set free to roam the entire home range. Second, its nest sites were established within the range. The study site was considered free from external disturbances.

The experiments were conducted to answer two main questions. Did a resident male red-whiskered bulbul in a semi-natural habitat exhibit territorial behavior during pre-nesting and nesting periods? If so, what were key factors that affected territorial behavior of the bird and the territory size it defended?

Materials and Methods

A. Resident birds

The resident birds were a pair of male and female red-whiskered bulbuls, *Pycnonotus jocosus*, aged 2 years. They were bred in the farm, kept in a cage and hand fed till they became fully grown as avid adults (approximately 1 year old) which could be recognized by their red whiskers and pinkish undertail coverts. The two birds were released to the wild following which they formed a mating pair and later became permanent residents of the farm. At the end of the year after an initial release, the pair started copulating and nesting. Nest sites were observed to be mainly on the mango tree near the farm house, although they might occasionally build their nests in a lime tree and in the bush nearby. The farmhouse has been a replete and reliable food source to the birds, though additional food is to be obtained from some food crops in the vicinity. The birds flew to a rendezvous near the house where they were fed with live mealworms and banana. The provision of food helped foster a strong bond between the birds and a farm owner. In this study, the house was therefore designated as a reference center from which distances of test stations were measured. As only the male was observed to be easily provoked by others of its male rivals, it was therefore chosen to be an experimental subject.

B. The decoy

The decoy, a male bird, was also bred in this farm. It was kept in a cage from the time when it had been taken out of the nest. Its own parents and a farmer helped feed the chick until it became fully grown. The adult bird was trained by the farmer to sing a varied whistled phrase by keeping the bird close to other mature male birds. The decoy was taken away from the farm and reared at the author's house for three months which proved sufficient to make it become a complete stranger to the resident male bird once it was brought back to the farm.

C. The study site

The study site is an undisturbed open country with scrub and clearings in the District of Chana, Songkhla Province, southern Thailand. It is a small village where houses are sparse. A bird farmhouse is situated beside the gravel road which connects the village to the main highway. The farmhouse is flanked by rubber plantations and a coconut grove. Dominant plant species are *Hevea braziliensis, Parkia speciosa, Tamarindus indica, Citrus aurantifolia, Citrus hystrix, Mangifera indica, Archidendron bubalinum*, and *Cassia siamea*. The habitat has been occupied and somewhat well protected by the resident male red-whiskered bulbul as only on a rare occasion did we find another male bird of the same species flying into the defended area. And when this accidental incursion occurred,

the intruder was suddenly intercepted and driven away by the resident male.

D. Conceptual framework & assumptions

In this study, the territory of the red-whiskered bulbul, *Pycnonotus jocosus*, was defined as "an area protected from incursions by others of its conspecifics". This was in line with the concept proposed by Hinde (1956). The area defended was a place where the resident birds foraged and established their nest sites during the breeding period.

Once a territory is established, a resident male will advertise its occupation of the area by an aggressive call. Any intruder which comes close to it will be driven away, especially a rival male of the same species. In addition, the resident bird normally shows a threat display to an invader by moving its body sideways, jerking its head up and down, and raising the two wings. If a bluffing charge attack does not dispel a trespasser, the resident male may engage him in a brief but intense physical battle. This seldom causes physical damage other than the loss of a few feathers. If the encounter was allowed to continue and the actual combat was unavoidable, this would potentially cause injuries to the birds. Every precaution was therefore made to prevent such an encounter because subsequent experiments would be jeopardized as a losing bird was found to be so scared that it did not respond to the victor's provocative song. A preliminary test had shown that the resident male bird would attack the decoy in about 10 minutes. Beyond this limit, it would take hours if the attack was to take place. For practical purposes, therefore, it was deemed sufficient to expose the decoy to the resident for 10 minutes. Territory defense was considered as being realized when the resident bird showed the threat display at close range to the decoy and the time was recorded.

E. Experimental procedure

Using the criterion described earlier, the territorial defense was tested at 10 stations (B $\rightarrow$ K, Figure 1) sited at the four cardinal points of the compass: lying to the north, east, south and west of the farmhouse (A, Figure 1).

At each station, the cage containing the decoy was hung up from a tree branch about 1.5 meters above the ground. Every attempt was made to make sure that the cage was completely or partially concealed from any visual disturbances. Upon completion of a test session, the decoy would be shielded off from any potentially subsequent attack by the resident male which would then be indirectly forced to fly back to the farmhouse. Approximately 5-minute interval was intermitted before starting another test at the next station. Time (in minutes) spent by the resident bird from the time of hanging the cage to the time of launching an attack was recorded. Mean time spent for territorial defense was later computed.

QUESTION I:

Did a male resident red-whiskered bulbul in a semi-wild habitat exhibit territorial behavior? If so, was the bird territorial only for some fraction of the year? How large was the size of the territory? Was it elastic, stretching to its upper limit during the pre-nesting period and becoming compressed during the nesting period?

HYPOTHESES:

(1) The male resident bird in a semi-wild habitats exhibit territorial behavior only during the nesting period.

(2) To be economically defendable, the resident male bird would defend an area as large as it could to cover food resource and its breeding site.

(3) The territory size during the pre-nesting period was bigger than that during the nesting period.

METHOD I:

The study was carried out during the pre-nesting period (October-November 2001) and the nesting period (January 2002). For each of the study periods, the experiments were conducted every week for five weeks. At each visit, all 10 stations were tested starting from the farthest possible station as it had been previously observed

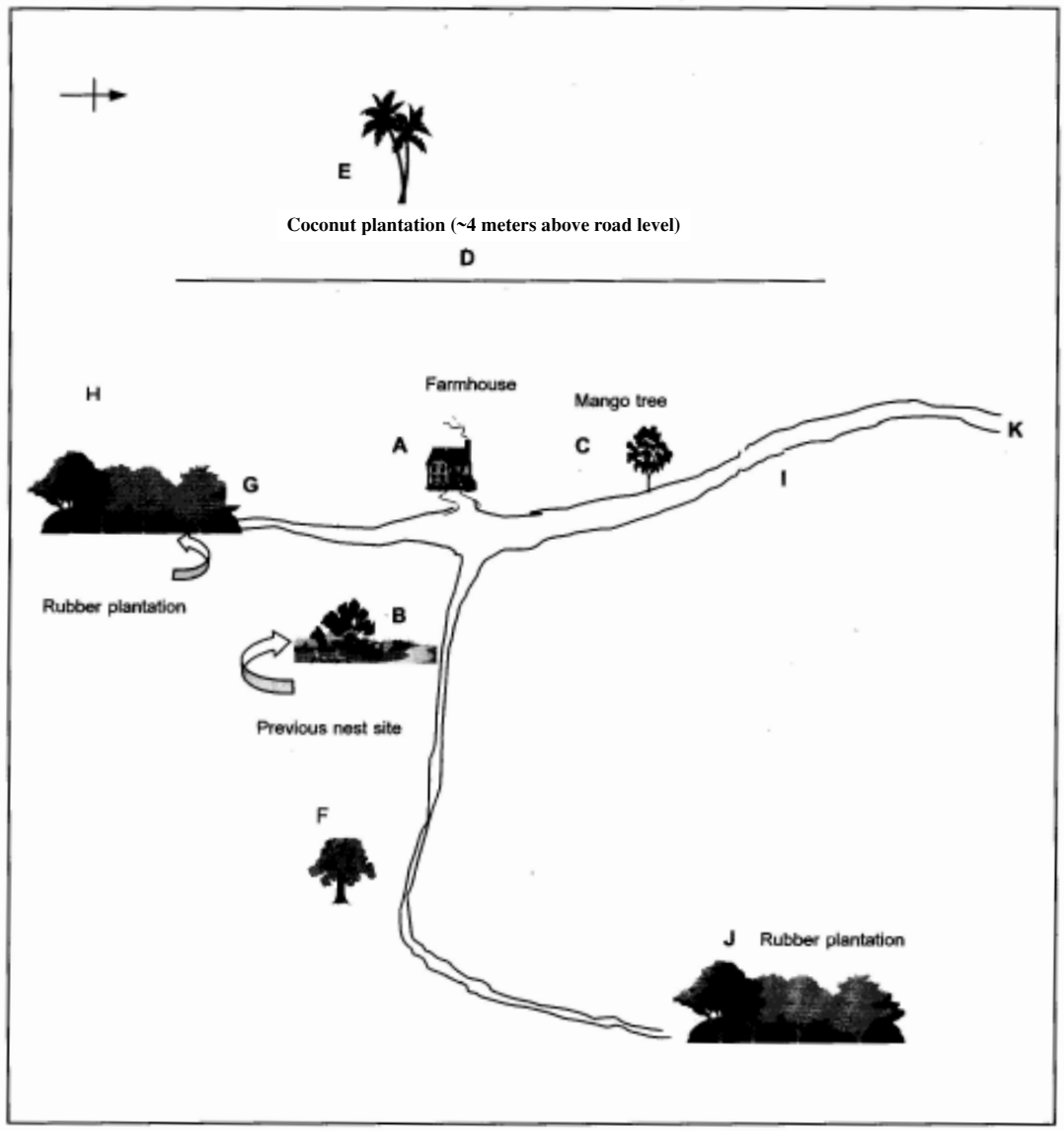

Figure 1. An experimental layout of 10 stations where the tested were conducted. A = farmhouse, B = previous nest site, C = mango tree, F = *Archedendron bubalinum*

that placing the decoy at the nearer station to the farmhouse would induce the resident to follow the decoy to the next. The experiment was begun in early morning (~7.00 a.m. local time), and finished up in the same morning (~11.00 a.m.). In order to minimize the experimental bias, the test directions were therefore designed as follows:

Week 1 north → south, then east → west
Week 2 south → north, then west → east
Week 3 east → west, then north → south
Week 4 west → east, then south → north
Week 5 north → south, then east → west

The experimental procedure was carried out as described in Section E. At each station, the time spent by the resident bird from the time of hanging the cage to the time of starting the attack was recorded, its behavioral patterns described, and photographs taken.

The data obtained were used to construct a territory boundary and to estimate its size. The stations with positive territorial response were marked on the overall layout of the farm area. Theoretically, a territory holder will be most aggressive near the center of its territory. As he moves away from the center his attacks upon his male rival are less violent, and there comes a point at which he is equally likely to attack or escape when his male rival approaches (Manning, 1973). Based on this principle, the territory boundary was constructed by drawing the lines through the points at which the resident bird showed his balance between attack and escape, and the defended area was estimated.

QUESTION II:

What were key factors affecting the bird's territorial behavior ?

HYPOTHESES:

(1) Nesting period and time of day had some effects on the resident bird's territorial behavior.

(2) The intensity of territorial behavior was strong in the morning, became waned later at noon, and rose to its peak again in the late afternoon.

METHOD II:

(1) Experimental data from Method I were used for the analysis of the extent to which pre-nesting and/or nesting periods affected the bird's territorial defense.

(2) To keep other interference to a minimum, the experiment on the intensity of territorial behavior was conducted only at station B where the territorial defense was found to be most intense (result from METHOD I). Three time regimes were used; 0700-1000 hours was designated as morning session, 1100-1400 hours as noon, and 1500-1800 hours as late afternoon. The experiments were carried out only during the pre-nesting period in order to avoid other variables that might occur during the nesting period. They were repeated 3 times at weekly intervals. For each visit the test was repeated 3 times at each time regime. Mean time spent for territorial defense was then averaged from the 9 replications. Other standard procedures were similar to those used for the test of Hypothesis I.

Results

I. Territorial behavior

Of the ten stations tested, territorial behavior was clearly exhibited by the resident male red-whiskered bulbul at 6 stations as summarized in Table 1. The bird announced and defended its territory by aggressive calls, threat display, and eventually attacked the decoy. Based on the time spent by the resident bird before launching an attack (Table 1), it was found that the bird exhibited the strongest territorial defense near the center of his territory (stations B,C). As the decoy was moved away from the center, his attacks upon the trespasser were less violent (stations I, G, F, D). And there came a point at which the resident male bird was equally likely to attack or escape (stations K, H, J, E). This point could be called the boundary of the bird's territory.

The intensities of territorial behavior expressed by the resident male red-whiskered bulbul during pre-nesting and nesting periods were compared by histograms as shown in Figure 2. The intensities of the positive response at 6 test stations were expressed in 1/ time unit (minutes). It was found that the red-whiskered bulbul exhibited a stronger behavior during the nesting period. It was obvious that the territorial behavior was extremely strong at stations C and B. The response gradually subsided when the caged bird was moved farther away from the farmhouse.

II. Territory size

The data obtained from METHOD I enable the author to construct the territory boundary. The primary objective in making an assumption about the shape of the defended area was to facilitate a rough estimate of its magnitude rather than to determine its precise configuration. The shape of the territory could be visually assumed to be a quadrangle (Figure 3). Based on Figure 3, the quadrangle GDIF is the sum areas of triangles

Table 1. Time spent (minutes) for eliciting territorial defense of the resident male red-whiskered bulbul. Distances were measured (meters) from the farmhouse according to the four cardinal directions of the compass: north (N), south (S), east (E), west (W)

	Stations (code, distance, direction)									
	C 20 m N	**I 50 m N**	**K 110 m N**	**G 30 m S**	**H 50 m S**	**B 19 m E**	**F 46 m E**	**J 72 m E**	**D 29 m W**	**E 38 m W**
Pre-nesting										
Territory defense	+	+	-	+	-	+	+	-	+	-
Time spent	1	3	>10	5	>10	1	3	>10	4	>10
Nesting										
Territory defense	+	+	-	+	-	+	+	-	+	-
Time spent	0.2	1	>10	0.7	>10	0.3	2.5	>10	1	>10

Mean times spent (minute) from 5 replications were rounded
(+) signifies Territory defense whereas (-) stands for "no Territory defense".

GDI and GFI. An area of a triangle is calculated by the use of ½ × base of a triangle × height, where the base is 80 meters, the heights of GDI and GFI are 29 meters and 46 meters respectively. Therefore, the areas of GDI + GFI are $[(½ \times 80 \times 29) + (½ \times 80 \times 46)]\ m^2 = 2986 m^2$ or ≅ 0.3 hectare.

III. Fixed action patterns of territorial behavior

Upon hearing of the song of the decoy, the resident bird would locate the whereabouts of the intruder, orient itself towards that direction and fly to the nearest possible spot to the decoy (Figure 4a). After a brief exchange of provocative songs,

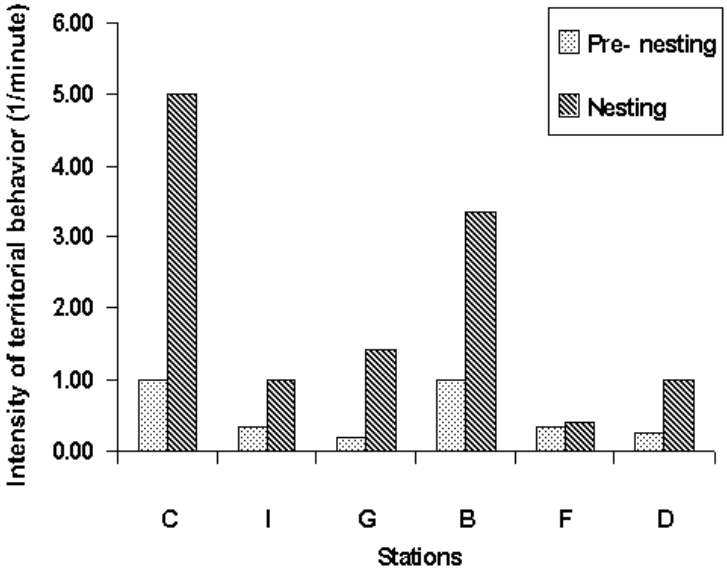

Figure 2. Intensity of territorial defense during pre-nesting and nesting period at 6 stations

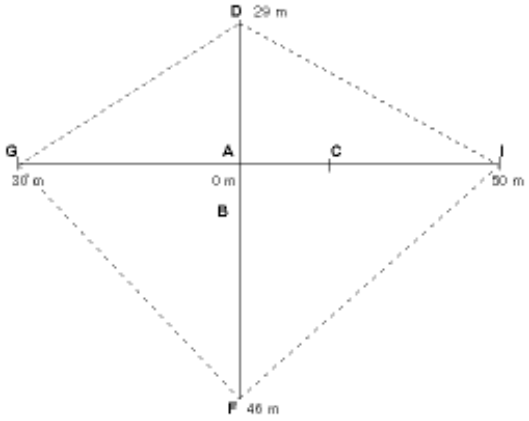

Figure 3. Graphic estimates of the sizes and shapes of the resident bird's territory. A GI axis represents the road which runs along the front of the farmhouse. B, C, D, F, G, I represent the test stations where the tests of territory defense are positive. The territory assumes the shape of a quadrangle whose area is approximately 0.3 hectare.

the resident male moved closer to the decoy or flew directly to the cage depending upon the intensity of the response. Usually, the territory holder spent time showing threat display by moving its body sideways, alternated by jerking its head up and down, and raising the two wings (Figure 4b). Eventually, the behavioral pattern would end up in an actual combat which resulted in the resident winning the fight. The territory holder would then chase the decoy around the cage or remain at the spot for a while before flying away (Figure 4c).

IV. Effect of time regime on territorial behavior

The Analysis of Variance revealed that the three time regimes in the morning, at noon, and in the afternoon have no significant effect on the intensity of territorial behavior (Table 2).

Discussion

The fact that the resident male red-whiskered bulbul, *Pycnonotus jocosus*, in a semi-wild habitat of the bird farm exhibited threat displays and launched an attack against the incursion of the decoy at 6 out of 10 test stations was considered indicative of its being territorial.

The bird was territorial in both pre-nesting and nesting periods, but the territorial defense was found to be most vigorous at the nesting period as indicated by a markedly shorter time spent for eliciting an attack (Figure 2). This had some biological significance as it would drive off any

Table 2. Responses of resident bird to the decoy at different times of day expressed as a function of time (seconds) required for eliciting territorial defense (n=9).

Intensities of territorial response (expressed in time units: seconds)	Time of day			*F*-value	*P*
	Morning	Noon	Evening		
Mean±S.E.	76.67±3.33	83.33±4.41	80.00±5.00	0.600	0.579 NS

NS = not significantly different at $P>0.05$, (one-way ANOVA).

a b c

Figure 4. Fixed action patterns of territorial behavior
a. The resident male perched upon the bamboo rod and kept a certain distance to the decoy.
b. A line drawing of threat display shown by the red-whiskered bulbul before the ambush
c. A combat following the threat display which eventually resulted in the resident winning the fight.

accidental intruders to the territory, and thus increase the survival value of the young. The territorial behavior was also intense near the center of its territory, a place where a farmhouse and its nest sites were located. The bird was raised here by hand feeding when it was still a chick until it became fully grown. The farm house is a place where food is plentiful and reliable throughout the day. As a consequence, the bird might have long been conditioned to recognize the farmhouse as its "food center". It was therefore worth its effort to defend the area (Brown, 1964). Whenever the caged bird was placed at the above station, it took just a few seconds or even a flash of seconds for the resident bird to reach the cage and attack the decoy straightaway.

The resident male bird was observed to maintain a remarkably tight control over certain locations. It spent only 0.2 minute (12 seconds) and 0.3 minute (18 seconds) at sites C and B respectively before launching an attack during the nesting period. It was found out later that site B had been formerly used for nesting, but was later deserted to avoid predation on eggs and young chicks by snakes whereas site C is the current nesting site. As far as sites B and C are concerned, the strong response by the resident bird to the incursion of the decoy can be interpreted as a phenomenon called "site attachment" or "site fidelity" (Switzer, 1997; Tinbergen, 1957).

The territory covered an area of about 0.3 hectare. It was a defended area where the pair obtained food and built nests. Hypothetically, the territory should be elastic. Interestingly, it was found that the size remained stable in both pre-nesting and nesting periods which was contradictory to our prediction. The finding by Gauthier (1987) showed that a male resident bird during the nesting period would defend a smaller area than that of the pre-nesting period. He indicated that territory size was inversely correlated with the density of food and density of broods. He pointed out that the birds reserved their energy during the breeding season by protecting a smaller area. This study was conducted in a semi-wild habitat which differed from the natural conditions in at least two main aspects. First, the young chicks were separated from the total care of their parents within weeks with a view to stimulating the birds to start pairing as soon as possible. It was simply a commercial reason of the bird farming strategy. Though the chicks were kept in an incubating cage and

were mainly fed by the farm owner, their parents would still frequent the cage and feed their young with insects and live worms obtained from the territory. As a consequence, the birds were not compelled to guard their nest. Consequently, the territory size remained stable because there were no apparent internal and external pressures. Second, the bird farm in which the area was defended was well protected by the farm owner for fear of trespassing by all forms of intruders. Practically, the resident male bird had never been forced out of its territory.

Eberhard and Ewald (1994) noted that food availability and intrusion pressure were important determinants of territory size. However, the two factors were not found to constrain the territory size of the red-whiskered bulbul under the study conditions. Food for the resident birds was plentiful and reliable whereas intrusion was a rare incident. There was just one occasion when the intruder trespassed the territory edge at Site G and was suddenly intercepted by the male resident bulbul. The intruder was driven out of the territory after a brief battle.

As for the other four sites where the male resident bird showed no territorial defense, station E was located in the coconut grove which had no apparent biological requisites to be defended. When the decoy was moved a little closer to the farmhouse, the resident bird responded mildly to the call of the decoy. At station H, the site was on the side of a busy road where there were cars, motor bikes, and passers-by moving up and down the road and causing loud noise. The author could not find a more suitable site around the station as any attempt to get closer to the site would entail the intrusion of personal property. Station J and K were the farthest of all and were considered 'out of bounds' of the resident bird's territory.

Field experiences indicated that the intensity of red-whiskered bulbul's aggression was highest in the morning and later waned at around noon. It would rise to the second peak, milder than the first, in the late afternoon. But the result from this study was contradictory to the author's observation in the wild: the resident male bird maintained the same level of its behavioral intensity at the three time regimes. However, it was reported that a common daily routine of singing was a 'bigeminus' or doubled peaked pattern, consisting of a marked peak in singing at or before sunrise (the 'dawn chorus'), followed by a smaller peak around dusk (the 'dusk chorus') (Aschoff, 1966 *cited by* Thomas, 1999). Similarly, Stocker & Huber (2001) found that hunger and food affected crayfish fight strategies: hungry crayfish escalated fights more rapidly than satiated individuals. As the resident male bird in this study was raised under unnatural conditions where food was plentiful and reliable, the bird could therefore be said to be well fed and might not experience hunger pang. It followed that the level of territorial aggressiveness remained the same throughout the day. It is worth noting many studies which have demonstrated that male aggression is regulated by testosterone. The conversion of testosterone to estradiol by brain aromatase is also known to regulate male aggression in the breeding season (Soma *et al*., 2000). The research work on the effects of an aromatase inhibitor on territorial aggression of male song sparrows led Soma, *et al*. to hypothesize that sex steroids regulate male aggression in spring and winter, but the endocrine mechanisms vary seasonally. Presumably, the hormonal control of the territory owner's aggression may be an ultimate cause of the degree of behavioral intensities.

It could be concluded that the red-whiskered bulbul in a semi-wild habitat exhibited territorial behavior to defend its food source and nest site as did the bird species in the wild. The territory boundary was stable during both the pre-nesting and nesting periods, but the male resident bird was more aggressive in the nesting period. The intensity of territorial behavior did not change with the three time regimes. Regular provision of food by the farmer and hormonal mechanism might play a part in sustaining the intensity of territorial behavior.

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