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Variation in Home Range Size Exhibited by Red Junglefowl (*Gallus gallus spadiceus*) in Oil Palm Plantation Habitat, Malaysia

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Abstract.- A Radio telemetry study on Red Junglefowl (*Gallus gallus spadiceus*) was conducted in oil palm (*Elaeis guineensis)* plantation at Sungai Sedu Estate, Selangor, Malaysia from October 1996 to July 1997. The main objective of the study was to examine the ranging behaviour of the species. Four Red Junglefowls (3 males and 1 female) were caught using decoy and leg trap method. They were then equipped with single stage 16 g transmitters and were radio-tracked using Mariner 57 receiver. The radiolocation was taken every 30 minutes by triangulation. The results show that the daily and monthly home range size of male was greater than that of a female. Similarly the home range size of a male without a female was greater than with a female. Environmental factors such as temperature, relative humidity, sunshine duration and cloud cover have no effect on the size of home range. The movement (distance travelled) contributes 49.1% of the variability on home range size. The total daily movement of male was greater than that of a female. The Red Junglefowl travelled more in the morning than in the afternoon and evening. In general, the size of home range varies according to several factors such as when the male is establishing and defending its territory. Habitat destruction and predators may also affect the home range size.

Key words: Oil palm plantation, Red Junglefowl, radio tracking, home range size, movement, environmental factors.

INTRODUCTION

The Red Junglefowl (*Gallus gallus*) is an ancestor bird of poultry (Darwin, 1887) and has five sub species. It is widely distributed in South and East India, Myanmar, Southeast China, Indo-China, Malaya Peninsula to Sumatra, Philippine islands, Fiji and New Guinea (Delacour, 1977). In Malaysia, the sub species of Red Junglefowl (*Gallus gallus spadiceus*) is widespread up to 1500 to 1700 m above sea level in mainly drier parts of low land forest (Madoc, 1956; Symes, 1968), but it is often seen in clear fields besides rivers and particularly in oil palm, rubber, tea and timber plantation (Tweedie, 1983; Davison, 1985-86; Abdullah and Babjee, 1982). The Red Junglefowl quite easily adapt to different habitats such as primary forest, secondary growth, bamboo groves and small woods near cultivation (Siti Hawa Yatim, 1992; Anonymous, 1992).

The Red Junglefowl is highly opportunistic and omnivorous bird. It takes *Vitex pubescens* (Luban fruit) and also eats Tapioca roots (Collias and Collias, 1967). Medway and Well (1976) reported that the diet of Red Junglefowl contains a wide variety of insects, among them termites and ants are predominant. It also takes 81% plant material and 19% animal material (Arshad *et al*., 2000). The Red Junglefowl breeds throughout the year where as the peak months are June and December (Arshad and Zakaria, 1999).

An organism's home range is defined as an area where an animal carries out its routine activities such as food gathering, searching for mate and caring young (Burt, 1943). The detailed quantitative analysis of an organism's home range is important because it can provide an insight into the area required for such activities. Radio-telemetry, which is widely used in wildlife research, can give reasonably accurate information (depending on the accuracy of fixes) about movements and activity pattern (Cochran and Lord, 1963). Very few studies have used radio-telemetry to examine the ecology and home range sizes of Gallus species. In case of Junglefowls, only a study has been done on two Red Junglefowls (one male and one female) and two Green Junglefowls *Gallus varius* (one male and one female) in Indonesia to see the difference in behaviour between both species. The transmiter life was only 7 days and the study period was only 2 days for Red Junglefowl and 4 days for Green

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Junglefowl (Hayashi *et al.*, 1984). Short study period may not be sufficient to accurately describe the pattern of movement. A more detailed study over a long period of time is required in order to examine the Red Junglefowl movement behaviour. Therefore present study was conducted with the objective to determine the home range size and elucidate the factors which affect the home range of Red Junglefowl in oil palm plantation with the aid of radio-telemetry.

STUDY AREA AND METHODS

The study was conducted between October 1996 to July 1997, in oil palm plantations (dominated by the *Elaeis guineensis* species), at Sungai Sedu Estate, Selangor, Malaysia. The age of the plantations varied from 4 to 25 years. The study site is located about 60 km south-west of Kuala Lumpur (101° 35' E and 2° 50' N. In order to radio tracking the Red Junglefowl, the traditional method i.e. leg traps and decoy was used to trap the birds for twenty days (75 traps for five days and 225 traps for 15 days were used in 8 year and 4 year old oil palm plantations respectively; S.M.A. Babjee personal communication). The trapped Red Junglefowls were equipped with single stage transmitter weighed less than 3% (16 g with magnetic switch) that emitted pulsed signals on channels 154 MHz (Hill and Robertson, 1987). They were fitted with a nylon cable and tied to the right wing joint and released at the place of captured (Stephen, 1978). The signals were detected during radio tracking with a Mariner 57 portable receiver and a three-element hand-held Yagi antenna. Single stage transmitters (Biotrack, Wareham, and U.K.) were used and their life span of about eight months having probable range of about 150 m (McGowan, 1992).

Each radio-tracking location was obtained by triangulation from at least three mapped positions (Kenward, 1987; Mech, 1983). Radio position of each bird was recorded every 30 min. during the day, an interval that was judged to be sufficiently short to allow an adequate sample size of an individual's movement. The total fixes taken in each day were from 25 to 27 (Koeppl *et al*., 1975). The period of radio tracking was from 5 to 6 days in every month except in October that was 4 days for a female. The distance of movement was calculated from one to another fix (Davis *et al.*, 1948). The total daily distance was calculated from the place of leaving the roosting tree in the morning to the place of next roosting tree in the evening. The data on environmental variables such as temperature, relative humidity, cloud cover and sunshine duration were also taken during the time of each fix. The humidity and temperature were measured by a whirling scycrometer. The sunshine duration and the cloud cover were recorded by visual observation.

Data analyses

All analyses were parametric and done by using Statistical Analysis System software (SAS Institute Inc., 1994). Throughout this paper, we present means $\pm$ SE as appropriate. The analyses of data of home range size and movement were performed by using the CALHOME software package (Kie *et al*., 1994). The area used during each day and each month was estimated by minimum convex polygon (MCP) (Mohr, 1947). The choice of MCP as home range estimator was based on its wide spread use (Harris *et al*., 1990; Bekoff and Mech, 1984). Briefly MCP gives the total area defined as the line drawn around the outermost fixes enclosing all others (Mohr and Stumpf, 1966; Kenward, 1987).

The stepwise regression method of adding and removing variables until a model is reached where no more variables are eligible for entry or removal was used (Norusis, 1993). The regression analysis (stepwise) was done to investigate which variables (movement, temperature, relative humidity, sunshine duration and cloud cover) influenced home range size. The regression analysis (stepwise) was also done to examine which variables (temperature, relative humidity, sunshine duration and cloud cover) affect the movement of Red Junglefowl. One-way analysis of variance (ANOVA) was done to examine the difference of daily home range size of each individual between months. One-way ANOVA was also done to determine the significant difference of movements (every 30 min) among time period. The time period was defined from 0730 to 1200 h as morning, 1201 to 1400 h as afternoon and 1401 to 1900 h as evening. The total daily movement of each bird was

recorded during diurnal activity (distance traveled from departure to roosting time). One-way ANOVA tests were used to examine differences in daily and monthly home range size exhibited by males. Duncan's Multiple Range Test was used to compare the means. Student's t-test was used to examine the significant difference of the male home range with and without female (Steel and Torrie, 1980). We pooled the data of all males to calculate the mean daily and monthly home range size.

RESULTS

Three Red Junglefowls (2 males and one female referred to as Male I, II & Female) were trapped in the month of October 1996. Male I and Male II were trapped in the 8-year old oil palm plantation and the females in the 4-year old oil palm plantation. A third male (Male III) was caught in February 1997 in the 4-year old oil palm plantation. All trapped Red Junglefowls (4 birds) were monitored for ranging behaviour. The data of Male I, Male II, Male III and Female were collected for 7 months (November to May), 3 months (November to January), 6 months (February to July) and 10 months (October to July) respectively.

The Male I stayed in the 4-year and 8-year old oil palm plantation for about 50 days but then moved to old oil palm plantation nearby (25-year old oil palm plantation) and never returned to trapping site. The Male II stayed for 3 days in the 8-year old oil palm plantation and then it also moved to the same old oil palm plantations. The female left the 4-year old oil palm plantation on the 11th day of after radio tagged and moved to old oil palm plantation and never returned to trapped site. However the Male III moved continually from one place in the area of 4-year old oil palm plantation and area nearby throughout the study period (Fig.1). The study indicated that the Red Junglefowl changed its used area frequently. The details of home range size of each bird are as follows:

There was no significant difference of daily home range size of Male I within months (F=2.14, df=6, p>0.05). The minimum and maximum daily home range size varied from 0.5 to 17.3 ha in December respectively (Table I). The minimum monthly home range size was observed in February (3.3 ha) and maximum was in December (230 ha) (Table 2). During the study period, the Male I was frequently observed with a female. There was a significant variation between daily home range size of Male I with and without a female (t = -2.13, p<0.05). The daily home range size without a female (4.5±1.2 ha) was larger than with a female (1.8±0.1 ha).

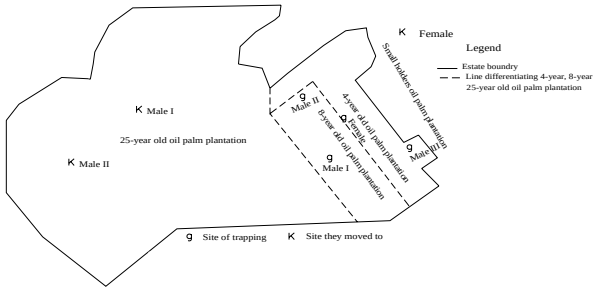

Fig. 1. Map of the Sungai Sedu Estate showing the trapping sites of Red Jungle fowls and sites they moved to during radio-tracking work.

The daily home range size of Male II indicated significant variation between months (F=3.66, df=2, p<0.05). Daily home range size of Male II in the month of January was significantly different from the month of November. The minimum daily home range size was observed in December and November (0.7 ha) and maximum was in January (8.2 ha) (Table I). The minimum monthly home range size was 5.3 ha in December and maximum was 11.8 ha in January (Table II).

The daily home range size of Male III between months indicated significant difference (F=4.95, df=5, p<0.05). The mean daily home range size of Male III in February was larger than other months. The minimum daily home range size was noticed in the month of May (0.3 ha) and maximum was in February (6.4 ha; Table I). The minimum monthly home range size was 2.6 ha in May and maximum was 16.3 ha in March (Table II).

The daily home range size of the Female between months was not significantly different (F=1.21, df=9, p>0.05). The minimum daily home range size was 0.3 ha in the month of October and December and the maximum was 2.0 ha in the month of December (Table I). The minimum monthly home range size was 1.3 ha in March and maximum was 9.1 ha in December (Table II).

Table I.- The daily home range size (mean ± SE and range) in ha of male I, II, III and female in different months in oil palm plantations at Sungai Sedu Estate. Means with same letters are not significantly different with each other using Duncan's multiple range test.

Month	Male I	Male II	Male III	Female
October	-	-	-	0.78 ± 0.34a (0.30-1.80)
November	4.20 ± 0.91a (1.28-7.00)	1.97 ± 0.43a (0.70-3.09)	-	0.73 ± 0.14a (0.40-1.22)
December	5.84 ± 2.85a (0.50-17.30)	1.58 ± 0.20ab (0.70-2.14)	-	1.12 ± 0.25a (0.30-2.00)
January	1.61 ± 0.23a (0.94-2.64)	4.11 ± 1.13b (1.47-8.20)	-	0.64 ± 0.13a (0.30-1.18)
February	1.77 ± 0.04a (1.62-1.91)	-	3.59 ± 0.81a (1.51-6.40)	0.73 ± 0.12a (0.44-0.98)
March	1.61 ± 0.19a (1.11-2.23)	-	1.97 ± 0.45ab (0.79-3.82)	0.56 ± 0.04a (0.46-0.69)
April	2.10 ± 0.48a (0.69-4.03)	-	1.30 ± 0.15b (0.95-1.70)	0.95 ± 0.13a (0.63-1.35)
May	2.07 ± 0.28a (1.44-3.31)	-	0.79 ± 0.27b (0.30-1.68)	1.17 ± 0.37a (0.50-2.40)
June	-	-	1.75 ± 0.40b (0.77-2.76)	1.78 ± 0.93a (0.67-5.49)
July	-	-	0.87 ± 0.34b (0.34-2.21)	0.61± 0.27a (0.31-0.99)

Table II.- The monthly home range size in ha of Male I, II, III and Female in different months in oil palm plantations at Sungai Sedu Estate

Month	Male I	Male II	Male III	Female
October	-	-	-	3.98
November	34.01	5.44	-	2.11
December	230	5.30	-	9.10
January	7.96	11.82	-	1.68
February	3.30	-	12.95	1.48
March	4.50	-	16.30	1.30
April	5.96	-	3.69	2.77
May	4.74	-	2.60	3.78
June	-	-	7.17	7.10
July	-	-	3.34	2.33

Home range variation

The daily home range among males of Red Junglefowl showed no significant variation (F=1.74, df=2, p>0.05). Similarly monthly home range among males of Red Junglefowl also showed no significant variation (F =0.69, df=2, p>0.05). The mean daily home range size of male (2.4 ± 0.3 ha) was greater than that of the female (0.9 ± 0.1 ha). The mean monthly home range size of male (22.4 ± 14.0 ha) was also greater than that of the female (3.6 ± 0.8 ha). The total home range size of Male I was the largest (312.5 ha).The total home range size of Male II, III and Female was 148.2 ha, 22.8 ha and 49.1 ha respectively.

Relationship between home range size, movement and environmental factors

The results of the analysis of variance by multiple regression shows that movement was significantly related to home range size (F=128.75, $p<0.05$; $R^2=0.491$). The resultant stepwise regression present at the following equation:

Home range size = -1.598 + 0.003dis

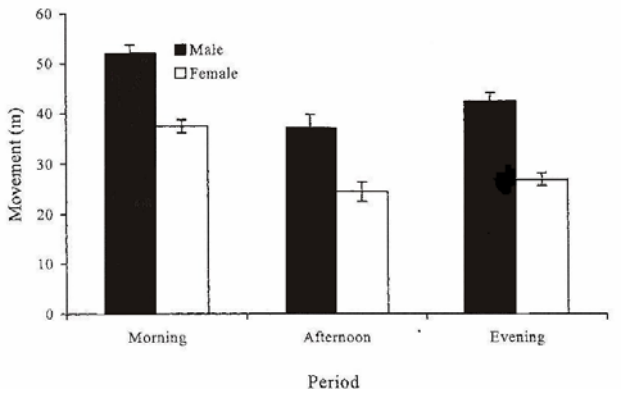

Fig. 2. Movement of male and female Red Jungle fowl (every 30 min.) in morning, afternoon and evening.
Note: Vertical lines represent ±SE

This could be inferred that the movement accounts for 49.1% in total variation in home range size of Red Junglefowl.

The movements of male in the morning, afternoon and evening were greater than that of the female (Fig. 2). There was a significant variation in movements of Red Junglefowl among period of the day (F=25.28, df=2, p<0.05; Fig. 3). The results showed that Red Junglefowl moved more in the morning than in the afternoon and evening. The

movement in the evening was greater than that in the afternoon. The total daily movement covered by male (1106.2±36.8 m) was greater than that of the female (792.6±30.8 m).

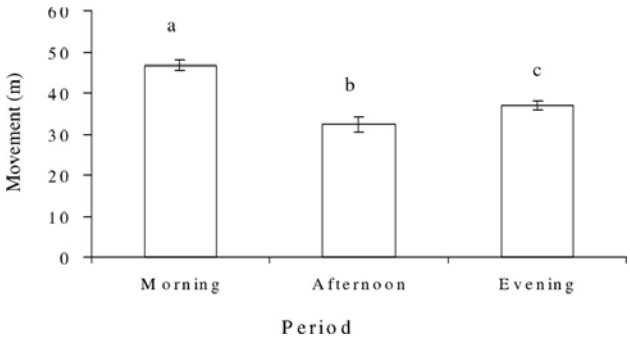

Fig. 3. Movement of Red Jungle fowl (every 30 min.) in the morning, afternoon and evening in oil palm plantation at Sungai Sedu Estate. Mean with different letters above bars are significantly different each other using Duncan's multiple range test. Vertical lines represent ± SE.

The results of an analysis of variance by multiple regression shows that environmental variables have no significant effect on the daily movement of Red Junglefowl ($F=2.41$, $df=4$, $p>0.05$).

DISCUSSION

An underlying assumption of radio tracking studies is that the animal being tracked is moving freely through the environment, responding to stimuli, and behaving in a manner similar to non-tagged animal (Glass *et al*., 1992). In this study the birds were trapped with minimal disturbance and they displayed foraging/ranging behaviour typical of undisturbed birds.

Multivariate regression analysis revealed that 49.1% of the variation in Gallus home range size was attributed to the daily movement patterns. This shows that not only movement influence the home range size but other factors such as rainfall, habitat condition, food distribution, finding mate and territory defence also contribute to some extent in increase or decrease in home range size (Grahn *et al*., 1993).

The environmental factors do not play any role on the movement of Red Junglefowl. These results supported the finding of Bridgman (1994) who reported that snow and low temperature did not appear to restrain Mikado Pheasant (*Syrmaticus mikado*) activity, as tracks and birds were observed in the snow. Thus, environmental factors such as temperature, relative humidity, sunshine duration and cloud cover may not be important factors influencing the Red Junglefowl home range size.

Red Junglefowls move frequently to perform their daily activities such as feeding, defence of territory and caring of young. In general, the movement of Red Junglefowl was found more in the morning and less in the afternoon and evening. Consequently some factors such as high temperature in the afternoon and rainfall during the day might limit ceased the movement of the Red Junglefowl.

Beebe (1918-22) stated that the home ranges of individual Red Junglesfowl (*Gallus gallus murghi*) were of quite limited size being sedentary birds and did not incline to wander. However in this study, it was found that the size of the home range of Red Junglefowl varies. This was due to several factors as discussed below.

Mating

In our study, male Red Junglefowl exhibited considerable variation in home range size. Males tended to increase the size of their home range opportunistically when establishing a new territory or whether looking for a mate. The home range size of Male I in the month of November and December was larger because he was found without a mate in these months. During this period he tried to establish a new territory but was pushed away by other dominant/territorial males in the areas. In December, he moved to a new area (see Fig. 1) and succeeded in establishing its new territory. In the month of January, he was observed with a female. The Male II moved from a place where it was trapped to a new area to search for a mate (see Fig. 1). He was able to establish the territory in November. The reason of increased home range size in January was that he was observed with a female. On one day the female flew away but within the same plantation area. The male began to search for her. As soon as he entered the territory of another male, he was pushed back. It took two days for him

to relocate the female. The searching of the mate was the main reason for the increase in the home range size. The home range of Male III in the months of February and March was larger due to finding a mate. In February, the territorial crowing of Male III was heard when he tried to occupy another male territory. Both males were crowing in a close distance. Until the month of May, Male III entered the territories of several males but could not establish its own permanent territory. Only after in June he managed to establish a territory and thus, succeeded in finding a mate. The results seemed to be consistent with Brown (1962) who stated that if a male wanted to mate, he must not only cover enough area to contact unmated females, but he must also exhibit a sufficient degree of dominance in that area to ensure a chance of being accepted by a female. Ping *et al*. (1998) also noticed in Elliot's pheasant (*Syrmaticus ellioti*) that changes of home range were related to breeding behaviour.

Variation in home range size was also influenced by the presence of new, additional males entering the territories of our established males, or the presence/absence of females. In March, a new male entered the Male I feeding area when the Male I was with a female. Male I immediately left his mate and flew about 80 m towards the approaching male and started to show his dominance in the area by crowing. When his mate crowed, he at once flew back towards her and followed her. In February, two non-territorial males roosted near the roosting site of Male I. When both of them left the roosting tree, the Male I ran in an aggressive manner towards them to fight. Both males ran away and when they left, he ran back towards the female. This behaviour was also observed three times in other months. It was often observed that when a female Red Junglefowl departed her roosting tree in the morning, a male immediately rushed towards the female for mating. This pattern of behaviour was clearly shown by Male II. It was seen that the male departed the roosting tree earlier than two females roosted on the same tree. The two females left the roosting tree one by one. The male rushed first to one of them and followed her aggressively for mating but she flew away. Then he followed the second female in the same manner but she also flew away. This behaviour has resulted in a bigger home range size.

The size a female home range was also affected if it followed a male. In October 1996, the Female (radio-tagged) left her existing mate and followed another male to a smallholder's oil palm area. In May 1997, she moved to the area of previous months (December 1996 to February 1997) to visit another male. During the period of ten months observation, the Female had been attracted to six males. The same finding was given by Brown (1962) who stated that if a female is to have a choice of males, her home range must overlap that of several males.

The home range of a male Red Junglefowl was larger than that of a female. This might be due to the activity of finding a mate and to protect its territory. Similar observation was reported by Porter (1977), who stated that home range of wild Turkey *(Meleagris gallopavo)* male was larger than the female. McGowan (1992) also noticed that home range size of male Malaysian peacock pheasant was larger than the female.

Habitat destruction

Habitat loss and alteration also affects the size of the home range of Red Junglefowl. In December, the home range of the Female (radio-tagged) was increased because the owner of the plantation cleared all undergrowth vegetation by cutting and using herbicides, and left little green cover. Similarly in the month of February, most of the previously used areas of her were burned due to fire in peat soil and damaged the oil palm trees and under growth. Most of her feeding grounds were destroyed. Therefore, she compelled to move to other areas that had sufficient green cover. Ping *et al*. (1998) also highlighted that shrub layers are the most important factor in the home range of female Elliot's pheasant. Thus the destruction of the undergrowth vegetation would be one causal factor for the Red Junglefowl to move to other areas nearby.

Predation

Variation in home range size may also be a reflection in changes in predation risk. In January, it was observed that a stray dog attacked the Male I but he managed to escape and moved to other area. Similarly, in the month of March three dogs

attacked Male I and a female. Both flew to a safer place but in different directions. As a result the Male I started to search for his companion (the female) and thus, increased its home range size.

Other factor

In June 1997, there was a dry season and no water was available near the Female feeding area. She might be expanding her home range due to searching for water source and dust bathing area because the peat soil became suitable bathing site after burning. Similar finding was given by Yue-hua and Guang-mei (1992).

CONCLUSION

This study revealed that habitat damage due to cutting of under growth, using of herbicides, fire and predators affect the territory of the Red Junglefowl. The public education is required to allow some vegetation cover, control of fire and predators in oil palm plantations.

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