# The Ecology of Barn Owl *Tyto alba* in ricefield as biological control of ricefield rat *Rattus argentiventer*

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## Introduction

Rat is a serious pest of rice crop in Malaysia. Conservative estimates varies from 5% to 18% (DOA in Hafidzi *et al*, 1999). The use of barn owl *Tyto alba* to control rats in ricefield has been established in the ricefield. The objective of the study is to quantify the effectiveness of *T. alba* in controlling rats in ricefield as published data is unavailable, unlike *T. alba* in oil palm (Lenton, 1984). As in oil palm, *T. alba* numbers were boosted by providing artificial nest boxes which the barn owl readily used. Since the implementation of the barn owl programme, the rat damage on rice crop was substantially reduced from 12% to < 2% (Hafidzi *et al*, 1999).

## Materials and Methods

The study was conducted in the ricefield area of Tg. Karang, Selangor, from August 2001 to November 2002, which spanned over three planting seasons , i.e one dry season crop from February to May 2002 and two wet season crop from August to November, 2001 and 2002. Two study sites were chosen i.e. at Sawah Sempadan and at Sungai Burung, both in the district of Tanjung Karang

### Prey composition

Regurgitated castings or pllets were collected in and around nest boxes and perching sites in the ricefield area and pooled into monthly samples. Individual pellet were dried at 60° C for at least 48 hours, and then soaked in 0.5 M NaOH. The pellets were teased apart and contents recorded. Smaller skull were designated as juveniles. If a skull is lacking measurements of femur and humerus will be used to distinguish juveniles from adults.

### Prey preferences and daily prey uptake

Different age categories of ricefield rat *Rattus argentiventer* i.e. juveniles, sub adults and adults obtained from the field were weighed and released into the feeding box and offered to a single captured barn owl in an aviary. In the first feeding experiment nineteen rats (3 adults, 9 sub-adults and 7 juveniles) were released and in the second, eighteen rats (3 adults, six sub-adults and 9 juveniles). The daily prey uptake based on the three age categories were recorded.

### The effects of wet and dry season on barn owl propagation

Monthly census were carried out at Sungai Burung from January to December 2002. Eighteen artificial nest boxes, distributed at 45 hectare per box were censused for nest occupancy, given by the proportion of nest box with eggs; number of owlets and fledging adults. Owlets were considered fledgling adults at 8 – 9 weeks from hatching. The census were divided into dry sesason and wet season crop to compare *T. alba* propagation between the two seasons.

### Effect of Nest box density on hunting area.

Fifteen artificial nest boxes were set up in August 30, 2001 in a designated area at Sawah Sempadan, where none has been established. The nearest nest box was more than one kilometer away to reduce impact on owl movement from neighbouring nest boxes. The boxes were arranged in three clusters consisting of five boxes covering an area of 5 ha. (plot A), 10 ha. (plot B) and 20 ha. (Plot C). Six adult barn owls, four females, one each from Plot A and B and two from Plot C. The two males were from Plot A and B. Each owl was weighed, sexed and attached with a radio transmitter, harnessed to its back and carried as a backpack. Signals were detected with a radio receiver (Custom Electronics, Urbana) and positions of the owl on the ground were pinpointed on a map drawn to scale. Triangulation technique was employed to map the probable location of each owl. Individual owl was tracked for five consecutive nights from 7 p.m. to 7 a.m, and the locations recorded at two hour intervals. Total area covered by the barn owl was calculated by the minimum convex polygon method.

Rat damage analysis.

Rat damage assessment was conducted on both wet and dry season crops at Sawah Sempadan and Sungai Burung. Damage assessment was carried out during tillering (4 weeks after seeding), booting (9 weeks after seeding) and harvesting (two weeks before harvesting). The method was to sample 100 quadrats of paddy hills ($0.25m^2$ for tillering stage; $0.5m^2$ for booting and harvesting stages) along ten parallel transect, ten quadrats, 5 m apart, to a transect line. Calculation for damage follows Buckle (1994):

$$\% \text{Damage} = \frac{a \times c}{b + c}$$

Where : a = number of damaged hills out of 100 sampled

.b = number of undamaged tillers in the hills with damage

.c = number of damaged tillers in the hills with damage

## Results and Discussion

### Prey items

Pellets analysis shows that rat is the dominant prey of the barn owl, constituting 93.7% of the whole prey. The remainder were common shrews (3.6%) and birds (2.7%). There were three rat species identified i.e. *R. argentiventer, R. tiomanicus* and *R. r. diardii. R. argentiventer* formed the primary diet with 80.87% of identifiable rat prey (n=115) compared to *R. tiomanicus* (12.18% n=14) and *R.r. diardii* (6.95% n=8). In the oil palm plantation, 99.1% of prey items were rats (Lenton, 1984). He also found that *R. tiomanicus* is the most common rat species in oil palm with 89.78% of the prey item. The rat species composition from both Lenton's and this study suggests that diet of barn owl is influenced by the rat species composition.

### Rat Prey Selection and daily uptake

On the average, juvenile rats constitute only 28.4%% of the total rat prey . However a higher proportion of juveniles were taken in January (61.1%) and July (69.2%). The largest number of pellets collected was in November but juveniles comprised only 25.8% of that monthly uptake. These figures suggest that the prey composition is influenced by the ricefield rat's reproductive cycle, which in turn is influenced by phenology of paddy crop. At Tanjung Karang, rice is harvested in late November and May, and peak population of rats occurs 1-2 month after paddy was harvested. This explains the higher proportion of juveniles in the diet during those months. However, feeding experiment in the aviary shows that barn owl prefers medium size rat (50-80g) over by juveniles (<50g) and adults (>80g). Size of prey may have to do with handling time and cost benefit ratio. Similar result was found by Lee and Hoo (1999) where barn owl in cocoa plantation prefers medium size rat. From the feeding experiment, barn owl consumes at least two rats in per night with an average daily consumption of 173 g rats per day. In oil palm plantation, barn owl can consume 90 g of rats per day or equivalent to two average size rats per day (Lenton, 1984).

Propagation of barn owl in wet and dry season

Census showed there were two breeding seasons i.e. from January to April and from June to September. Occupancy rates throughout much of the dry and wet seasons were consistent i.e. 72.2%. However, census in November and December shows that occupancy during the wet season can go as high as 83.3%. This indicates that occupancy rates may vary from season to season and from year to year depending on various factors. Hafidzi *et al.* (1999) showed that, based on a yearly census carried out from 1993 – 1997, in the same area, proportion of boxes with eggs were consistently higher during the first planting season (December to January) than the second planting season (July to August). They also found that the proportion of boxes with owlets were generally twice in February and March compared to September. Therefore it can be deduced that wet and dry season may influence nest box occupancy rates, but these requires a wider census over a number of years. Smal (1988) showed that nest box occupancy of *T. alba* in oil palm plantation varied from month to month. He also found there was a marked seasonal variation, with relatively few boxes being occupied in April and May and that peak occupancy, as high as 80 – 90%, were recorded from October to January (Smal, 1988). Lee and Ho (1999) found that nest occupancy rate in cocoa reached 70% at peak breeding season.

Result shows that *T. alba* produce more eggs during the dry season i.e. mean clutch size of 5.38 compared to 4.07 during the wet season. Percent hatching was also higher in the dry season i.e. 85.7% compared to wet season 79.2%. These differences were not significant, but it indicates that egg production per breeding pair may be higher during the dryer season. This suggests that *T. alba* may responds in a functional way towards prey availability (Erlinge *et al.*, 1984). In the dry season, food resources may be limited and therefore rats may rely heavily on the rice crop, increasing its density in the ricefield. This in turn may increase the hunting success of *T. alba*. Higher food intake leads to a higher clutch size and hatching success. However, the rate of fledging between dry and wet season was similar i.e. >

93%. This suggest that the lower clutch size and hatching success during the wet season is compensated for by a correspondingly high fledging rates. In oil palm plantation the average clutch size is 6.6 (Lenton, 1984). The higher clutch size reflects the higher density of rats in oil palm, which may reach 300 – 400 per hectare (Wood, 1969). In contrast, density estimates of rats in ricefield ranged from 120 – 240 rats/ha. (Leung *et al.*, 1999). Oil palm plantations can sustain higher rat population as food is almost available throughout the year, in the form of oil palm fruits, as opposed to paddy fields which are seasonal. The continuous breeding season from June/July to Sepetmber/October and followed by a second clutch from October to January (Smal, 1988), is suggestive of this fact..

Rat damage analysis in wet and dry season

Incidence of rat damage at Sungai Burung in both wet and dry seasons at the tillering stage were less than 2% . In the wet season, damage levels did not exceed 2% at all stages of growth. However, damage recorded in the dry season crop showed a marked increase from 1.34% to 3.22% and 3.39% at the booting and harvesting stages respectively. Rats only start to breed during the rice crop reproductive stage, producing the first litter during the booting stage and subsequent litter during the ripening stage and shortly after harvest (Leung *et al.*, 1999), which partly explains the higher damage during ripening and harvesting. Besides, during dry season, as there is less alternative food available, rat converge on paddy for food.

On the other hand, damage levels at Sawah Sempadan were low and stable in both the wet and dry season crops. This can be attributed to the higher density of nest boxes in Plot A (5 ha), Plot B (10 ha) and Plot C (20 ha). At such higher density, *T. alba* may have a better control of rats. The damage levels for both seasons on Plot A, Plot B and Plot C were $0.65 \pm 0.10\%$, $0.78 \pm 0.28\%$ and $1.57 \pm 0.15$ % respectively.

Effect of nest box density on movement of barn owl, T. alba

Range area of barn owls were negatively influenced by nest box density. Female owls hunt near nest box with range sizes of 5.79 ha in Plot A (5 ha/box), 14.98 ha. in Plot B (10 ha/box) and an average home range size of 18.84 ha (17.05 ha and 20.63 ha) in Plot C (20 ha/box). From observations females stay close to their nest box (167-212 m) and rarely fly into another female's territory. Males on the other hand ranged over a greater area, engaged in more exploratory flights (200 – 348 m from nest box) and encompassing several nest boxes. Males in Plot A and Plot B had range sizes of 34.18 ha and 39.65 ha respectively. These shows that males are less influenced by nest box density, although this need to be substantiated with more radio telemetry data.

***Rat damage in different densities***

There is an inverse relationship between damage and nest box density. Damage levels in the Plot A (5 ha/box) and Plot B (10 ha/box) were lower than damage levels in Plot C (20 ha/box). Damage in Plot C was significantly higher than Plot A at the booting stage ($P < 0.05$), but the latter was not significantly different to Plot B. For comparison damage at Sungai Burung (nest box density of 45 ha/box) were significantly higher at both booting and harvesting stages. At tillering stage, the number of rats are low and barn owl may have to forage over larger area to fulfill its daily food requirements. When the rice crop reaches the booting stage, rats start to produce the first litter (Leung, *et al*, 1999) and population increases rapidly in the field, producing higher crop damage. The second litter is usually born during the ripening stage, which leads to still higher damage as is apparent in this study, and third litter arrives shortly after harvest (Leung, *et al*, 1999).

## Conclusions

Rat is the major prey of the barn owl in ricefield area with the ricefield *Rattus argentiventer* rat being the dominant prey species. Composition of prey size/age is subjected to their availability but seems to prefer sub-adults or medium size rat when these are available. Damage tend to be higher at the booting and harvesting stage during the dry season crop. Nest box occupancy is higher during the wet season but clutch size is higher during the dry season, suggesting some form of compensatory mechanism to maintain a stable owl population. Nest box density influence damage level of rice crop during the booting and harvesting stage but not during the tillering stage. Female barn owls hunt around the nest box and the home range size is negatively influenced by nest box density. On the contrary, males range over a larger area, often encompassing home range of other males, and are not influenced by nest box density. This study suggest a nest box density of 1 box per 5 – 10 ha to keep damage levels to rice crop to less than 1%

## Benefits from the study

One of the unanswered question in the management of barn owl in ricefield is what would constitute an effective nest box density for adequate control of rats. This study determines based on radio telemetry results and damage assessment that 1 nest box per 10 ha would be the optimum density. At 1 box per 10 ha. Density was shown to reduce damage by rats to rice crop by at least 1 fold. The study also shows that putting up a box every 5 hectare produce the same result as in 1 box per 10 ha. This would cut cost by 50% as well as such density is thought to induce interspecific aggression.

## Patent(s), if applicable:

Nil

## Stage of Commercialization, if applicable:

Nil

## Project Publications in Refereed Journals

**Hafidzi, M.N.** and Mohd, NA'IM. (2003). Prey selection by barn owls in rice fields in Malaysia. Pp 220-223 In: "Rats, Mice and People: Rodent Biology and Management", eds. Singleton, G.R., L.A. Hinds, C.J. Krebs and D.M. Spratt, ACIAR Monograph No. 96, 564 pp. (ACIAR – Australian Centre for International Agricultural Research).

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*Graduate Research*

| Name of Graduate | Research Topic | Field of Expertise | Degree Awarded | Graduation Year |
|---|---|---|---|---|
| Muhammad Naim | The ecology of barn owl in ricefield | Biological control of rats | Thesis completed and submitted | |

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