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Barn owl – Development and food utilization

(Burung pungguk jelapang – Pertumbuhan dan penggunaan makanan)

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Key words: barn owl, development, predation, food utilization

Abstrak

Pertumbuhan burung pungguk jelapang telah dikaji dalam makmal. Kesemua telur daripada empat kumpulan yang sebanyak 7, 6, 5, dan 4 biji telah menetas dengan 3, 5, 5 dan 4 anak burung yang mencapai dewasa. Jarak waktu menelur antara telur pertama dan yang terakhir ialah 8–22 hari bagi keempat-empat kumpulan telur dan pertumbuhannya tidak seragam. Corak pertumbuhan adalah sigmoid dengan hubungkait yang polinomial antara pertumbuhan dan berat badan. Kitar pertumbuhan daripada telur sehingga dewasa ialah 80–92 hari. Pada mulanya, pertumbuhan perlahan dan perbezaan berat badan kecil. Peringkat ini diikuti dengan perbezaan yang besar pada berat badan dan jumlah makanan. Dalam keadaan ini, dengan sekali makan burung tersebut boleh bertahan sehari dua. Kanibalisma dan kematian anak burung masih berlaku walaupun mangsa (makanan) didapati lebih daripada yang diperlukan. Tiada lebih mangsa yang dibunuh mahupun pembaziran makanan menunjukkan bahawa burung pungguk berkesan dan cekap dalam penggunaan sumber makanan. Jumlah purata tikus yang menjadi mangsa burung pungguk daripada peringkat telur sehingga dewasa ialah 553 ± 69 ekor. Berat badan burung betina pada peringkat penebaran ialah 550 g dan berat badannya melebihi 600 g semasa pembiakan. Ini mencerminkan keperluan tenaga dan pemakanan yang lebih tinggi pada peringkat pembiakan. Faktor berat badan ini merupakan cara yang mudah untuk memantau aktiviti dan peringkat hidup burung pungguk di ladang dengan gangguan yang minimum. Kajian tersebut menunjukkan bahawa burung pungguk jelapang berpotensi membiak tiga kali setahun apabila makanan mencukupi.

Abstract

Barn owl growth and development was successfully studied in the laboratory. Out of four broods of 7, 6, 5 and 4 eggs, total hatching of all were noted with 3, 5, 5 and 4 reaching full fledged owls. Asynchrony development with intermittent egg laying of 8–22 days between the first and last egg among the broods was noted. Development was sigmoid with a polynomial relationship between age and body weight. The development cycle from egg incubation to full fledged owls ranged from 80 to 92 days. Initial slow growth and low variation in body weight were followed by subsequent large variation in body weight and food/ prey consumption where a meal could sustain the owl for 1–2 days. In the presence of excess preys, chick mortality and cannibalism still occurred among owls. Prey capture was without excessive kill and consumption was efficient without wastage, an indication of effective and efficient food resource utilization. The total number of

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preys consumed by the broods from egg incubation until dispersal of full fledged owls averaged 553 ± 69 rats. Females had body weight of about 550 g during non-breeding and dispersal phase. The body weight exceeded 600 g during breeding (egg laying and incubation phase). This reflects on the higher energy and nutritional requirements for breeding. This body weight factor is a simple and easy tool for monitoring the activity and phases of the owls in the field, to minimize disturbing their establishment. The study showed that owls have the potential for breeding three broods a year provided there is ample food.

Introduction

The barn owl (*Tyto alba* Scopoli) is globally better understood because of its close association to human settlement (Lenton 1980). It is primarily a predator of small mammals with varying amounts of birds, amphibians, reptiles and arthropods. In England and Wales, 97% of its diet were small mammals with birds comprising the remainder (Glue 1967), whereas in Italy the diet was 95.7, 2.8, 1.3 and 0.2% small mammals, birds, arthropods and amphibians/ reptiles respectively (Renzoni and Lovari 1977). In Malaysia, the diet has been predominantly rats and mice. The abundance of barn owls, especially in Peninsular Malaysia, has been attributed to a favourable habitat (plantation interspersed with clearings and human settlement), a rich food source, *i.e.* rats (the dominant vertebrate pest), and the provision of nesting boxes (Duckett 1986; Lee 1997).

The barn owl is being exploited as a biological control for rats in oil palms, rice and cocoa fields (Duckett 1991; Shamsiah and Goh 1991; Lee 1997), although there is rather limited information. Lenton (1980) studied the growth and development of barn owls with five broods ranging from one to eight chicks. Of a total 33 eggs laid and incubated, only 15 hatched in the five broods. There was no information pertaining to the daily number of preys (food) consumed in each brood nor weight change of maternal female throughout the study. This paper reports on the growth and development of barn owls in relation to their food (rat prey) utilization under laboratory conditions. The age and weight relationship was also examined.

Materials and methods

Four pairs of owls (each pair comprised a male and female) were obtained from nesting boxes in cocoa-coconut fields of MARDI Hilir Perak and maintained in laboratory rooms (4 m x 5 m x 3 m) with concrete floor. The ceilings and walls of each room were layered with wire-netting (mesh size 1 mm x 2 mm). A nesting box was placed at one upper corner and another in the opposite corner of each room. A 0.5-m zinc sheet band was maintained along all the walls at 1 m above the floor to ensure the rat prey remain at ground level.

On the first day of owl introduction at 0800 h, 2–3 adult rats (>80 g body weight) were placed in each room. These rats were allowed to roam freely (with rat pellet as food on the floor) to serve as prey (food) for the pair of owls. Rats that had been taken were replaced at 0800 h the next day. The nesting boxes were inspected daily while the adult females were weighed every 2–3 days for 100–121 days. Within this duration, egg laying, incubation, young hatching and development until full fledged young adults with dispersion were noted. Young chicks hatched were weighed daily and their growth recorded until full fledged young owls or upon death. Regression analysis to determine the relationship of age to weight was undertaken from the data collected. During the growth and development phase of the young, the number of rats available daily as prey in each room was ensured in excess of the respective owl brood by two.

Daily prey uptake and consumption was recorded during nesting box inspection at 1600 h, in addition to 0800 h, to determine prey feeding.

Results

The four pairs of owls collected from the cocoa-coconut fields in MARDI Hilir Perak weighed 450–560 g *(Table 1)*. Although both sexes were similar in appearance, the males were slightly larger though lighter in weight. The males also had brighter white feathers and less yellowish specks below the neck. During inspection of nesting boxes, the males always flew out first followed by the females. An increase in weight of females was noted, and by egg-laying phase, the females weighed 610–660 g. The total number of eggs per brood ranged from four to seven, with 100% hatching success. In broods of seven and six chicks, four and one death respectively occurred in the course of development. Eggs were laid intermittently, with an interval of 8–22 days between the first and last egg laid for all the broods.

The body weight of the breeding females was noted to fluctuate during the breeding cycle *(Table 2)*. Body weights of all females increased to >600 g (620–700 g) during the egg-laying/incubation phase. However, egg incubation with a gradual hatching of young was accompanied with a decrease in female body weight. By the last egg hatch, the females had body weight of about 550 g (range 520–580 g). Adult females had relatively constant weight of about 550 g until the dispersal of the full fledged young owls. By then, the body weight of the adult females had increase to about 600 g. Weight increase continued until the next egg-laying phase where it reached 610–660 g.

Graphically, growth of the owl was sigmoid. Early slow growth (initial 5–6 days) was followed by more linear (30–32 days), then slow and subsequently decline. Low variations in weight (± <10 g) at 5–6 days old were noted to fluctuate widely (± >50 g) at 42 days and beyond *(Figure 1)*. Regression analysis of age to body weight

Table 1. Some parameters of the barn owl in breeding phase

Brood	Adult body wt. (g)		Interval to egg laying (days)	Body wt. (g) at egg laying	No. of eggs in brood
	Male	Female			
A	450	540	14	610	7 (22)
B	482	560	8	620	4 (9)
C	502	532	24	660	6 (14)
D	510	550	17	640	5 (8)

Values in brackets indicate duration in days between the first and last egg laid

Table 2. Body weight of adult female barn owls during different phases of development

Brood	Body wt. (g) during four phases			
	Egg incubation	Hatching and young development	Fledging and dispersal	Egg laying
A	540–620	550–600	560–620	610
B	560–640	520–600	540–600	620
C	570–700	540–600	540–600	660
D	550–680	580–620	560–600	640

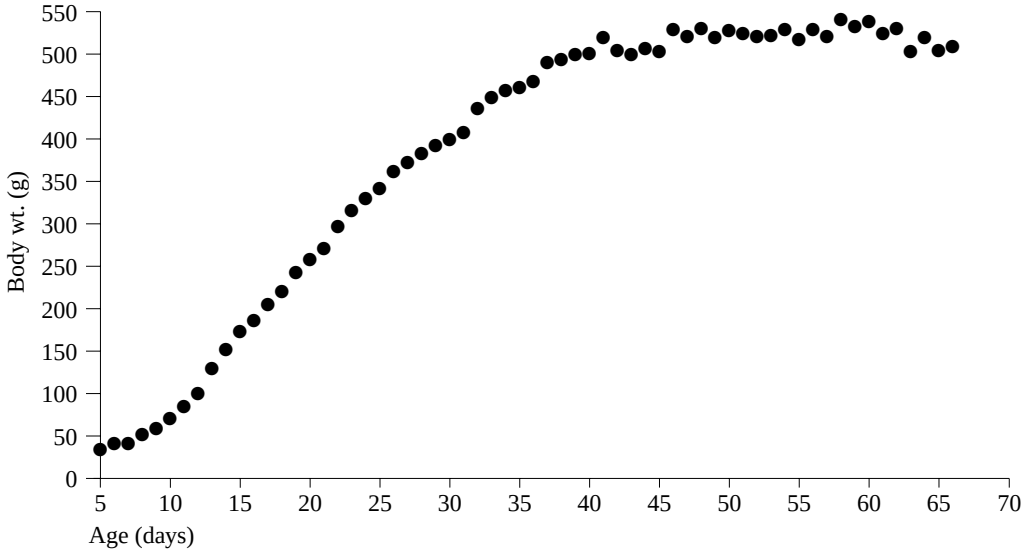

Figure 1. Relationship between age and body weight of barn owls

Table 3. Average daily rat consumption by barn owls during different phases of development

Phase	No. of rats consumed
Egg incubation	2–3
Hatching and young development	
Week 1	3–5
Week 2	4–7
Week 3	5–8
Week 4	5–9
Week 5–7	6–8
Fledging and dispersal	5–8
Egg laying	2–3

(where y = body weight, x = days) until 58 days was
$y = 20.08 + 9.93x + 0.307x^2 + 0.006x^3$
($r^2 = 0.97$; C.V. = 9.71)
and a log transformation gave
$y = 1.73 + 0.023x$
($r^2 = 0.7543$, C.V. = 9.05)
For a duration of 66 days,
$y = 35.21 + 13.42x + 0.13x^2 + 0.004x^3$
($r^2 = 0.97$; C.V. = 10.1)
and a log transformation gave
$y = 1.77 + 0.021x$
($r^2 = 0.7266$; C.V. = 9.40)

The daily number of rats preyed increased from 2–3 during the egg-incubation phase to 3–9 in the hatching and young development phase *(Table 3)*. In the latter phase, although 5–8 rats were killed over the night, 2–3 decapitated rats were found in the nesting boxes at 0800 h. By 1600 h, these decapitated rats had been fed upon; leaving behind remnants of the skin, tail and the lower hind feet. None of the rats present in the room were preyed upon during the day. Towards the bird fledging and dispersal phase, the number of rats preyed upon declined and was less than the number of owls present in each brood. The total number of prey consumed tabulated for each owl family throughout the duration of the study was 466 rats for the first brood of seven eggs with three reaching fledging owls, 530 for the second brood of four eggs, 616 for the third brood of six eggs with one mortality and 600 for the fourth brood of five eggs where all reached fledging adults.

The raised owlings took to flight at an average age of 58.2 ± 6.1 days (range 52–71 days) and an average body weight of 522.0 ± 31.2 g (range 427–564 g) *(Table 4)*. By then, the body weight had declined slightly. The duration of egg incubation averaged

Table 4. Development parameters of each barn owl egg

Egg no.	Brood A				Brood B				Brood C				Brood D			
	I.D. (days)	H.D. (days)	Flight (days)	Wt. (g)	I.D. (days)	H.D. (days)	Flight (days)	Wt. (g)	I.D. (days)	H.D. (days)	Flight (days)	Wt. (g)	I.D. (days)	H.D. (days)	Flight (days)	Wt. (g)
1	32	1	61	520	34	1	57	440	32	1	61	482	30	1	67	500
2	32	3	61	446	32	2	58	440	31	2	D.23		35	3	68	490
3	34	9	61	446	30	3	56	435	30	4	64	502	30	8	69	540
4	31	17	D.52		31	6	56	427	31	7	66	560	32	11	71	564
5	35	20	D.59						34	11	66	510	33	13	71	560
6	34	23	D.59						33	14	68	512				
7	35	27	D.30													

I.D. = incubation duration
H.D. = hatching day, duration between the first and the last egg hatched
Flight = duration of young growth to flight
Wt. = body weight at flight
D. = death of owling days after the egg hatched

32.3 ± 1.7 days (30–35 days). Egg hatching day (duration between the first and last egg hatch) varied between broods. It ranged from 5 days in a brood of four eggs to 26 days in a brood of seven eggs. The shortest duration of young growth to flight at day 56, excluding a 6-day hatching interval and inclusive of 31 days of incubation showed that the development cycle was 81 days. Based on this calculation method, the longest development cycle was about 92 days. Chick death was noted in the brood of seven where the last four chicks died on the 3th, 35th, 36th and 39th day respectively after hatching. Cannibalism of the 4-day-old chick which had just died was noted. Similarly, a death was noted in the brood of six on the 23rd day.

Discussion

Two nesting boxes were provided in each room to ensure that ample resting sites were available to each pair of owls. A wire mesh enclosure facilitated free roaming of the rats (prey) as well as the owls (predator). A band of zinc sheet at 1 m above the floor prevented the free roaming rats from jumping and scaling up the walls thereby interfering the nesting of the owls. The ability of all the four pairs of owls to proceed with a breeding cycle and with 100% hatching success indicated that there is apparently no constraints of spatial requirement for hunting and maneuverability, and probably food resource is a more important factor. This also suggests that the barn owls probably do not need a large territorial base and their dispersion is more influenced by food/prey availability and distribution. This study showed that barn owls can be laboratory bred for introduction and dispersion purposes.

The barn owls conform to the norm of being active only in the night and all the rats were preyed within the nights. During the day, all owls were at rest within their nesting boxes. The decapitated rat carcasses noted at 0800 h had become only remnants of the skin, tail and hind feet at 1600 h showing

that the young do feed during the day. The need for intermittent night and day feeding of the young during the early few weeks is also reflected in the low weight gain and variation between the young. At this chick-caring phase, although rats available for predation exceeded the brood by more than two, the number of prey taken was never more than the brood size.

Without synchrony of egg hatching, young developing chicks would still be present when others are towards the fledging phase. One or none decapitated rat carcass was encountered in the nesting boxes, showing that the growing chicks consumed more at each feeding as they aged and would eventually do away with day feeding. This accounts for the high weight gains and variations recorded for the fully fledged birds. In nature, these birds would be able to survive through a day without food. Daily weight changes of single owls from 550 g to 450 g and vice-versa, a fluctuation of ± 100 g, possibly indicated consumption of a prey or no prey. A meal is able to sustain an owl for 1–2 days.

The taking of prey and feeding in the brood is apparently highly efficient and without wastage. Although more rats were available for predation in all the rooms, prey capture was without excessive killing and excess rats were allowed to roam. The owls showed efficient food utilization within the brood as they always consumed the whole rat. If there are any remnants, it would only be the skin, tail and lower hind feet bones. The predator strategy is such that the food and resource supply for the next meal is ensured.

The weight of female barn owls can be a useful indicator of their field state and condition. It is apparent that owls weighing around 500 g are dispersing or in play and seeking roosting. Within the range of 600–700 g, the female owls are mostly in egg-laying and incubation phase. In the field without the calling sounds of young chicks, such female body weights would indicate the on-set of a breeding cycle. This phase of activity demands for high energy and food reserves from the female. Once caring and development of young occur, the female parents will weigh about 600 g and less. In the field, this phase is easily noted with the calling sounds of young subsequent to disturbance of the nesting boxes.

Asynchrony young development and sigmoid growth of owls were similar to that in the field (Lenton 1980; Lee 1997). The egg-incubation period of 32–35 days was similar to Lenton's (1980) finding and did not differ from that of other studies (Baudvin 1975; Bunn and Warburton 1977). The extended duration of egg laying lengthened the egg-incubation duration from 30 to 59 days. Taking the development cycle to be about 92 days, within a year, it is possible for barn owls to have three cycles of development provided that food resource and nests are ample and available. However, the two breeding seasons in nature (Lenton 1980; Lee 1997) are probably related to the bimodal season of crop yield in plantations and dual monsoon pattern of Peninsular Malaysia. Log transformation of growth rates at 58 day and 66 day had gradients (0.023 and 0.021) that did not differ much from each other (p >0.05). However, their sigmoid polynomial equations differed. The log transformation values were similar to that of Lenton (1980). An analysis of the 66-day equation was undertaken in view of the longest duration for a chick to reach flight in this study was 66 days. The 58-day polynomial equation is more meaningful as the K-value of 20 was closer to the chick weight of 18–20 g at birth. Furthermore, the average fledging bird upon flight was 58 days with a body weight of 522 g. No comparison could be made with that of Lenton (1980) as no such regressional analysis was made.

Chick mortality noted despite the availability of ample food resource was probably natural. Furthermore, it occurred with brood sizes of six and seven indicating that crowding may be a factor. Lee (1997) noted chick mortality with cannibalism

occurred with field brood size of seven, with only five reaching full fledged owls, and with brood sizes of five, in most cases all birds reach fledgling stage. In field conditions other than over-crowding, food resource may be a critical factor. Elsewhere, studies also indicate the occurring of chick mortality with cannibalism in field broods (Baudvin 1975; Hoekstra 1975; Lenton 1980).

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References

Baudvin, H. (1975). Biologie de reproduction de la chouetee effraie (*Tyto alba*) en Cote d'Or: premiers resultats. *Jean-le-Blanc* ***14:*** 1–51

Bunn, D. S. and Warburton, A. B. (1977). Observations on breeding barn owls. *Br. Birds* ***70:*** 246–56

Duckett, J. E. (1986). The barn owl in Malaysia. *Planter, Kuala Lumpur* ***62:*** 531–5

—— (1991). The establishment and increase of barn owl (*Tyto alba* javanica) populations for rat control in Malaysian oil palm plantations. Paper presented at the Int. conf. on biological control in tropical agric., 27–30 Aug. 1991, Kuala Lumpur. Organizer: MAPPS

Glue, D. E. (1967). Prey taken by the barn owl in England and Wales. *Bird Study* ***14:*** 169–3

Hoekstra, B. (1975). Two cases of cannibalism of the barn owl, *Tyto alba. Limosa* ***48:*** 118–20

Lee, C. H. (1997) Barn owl for field rat control in cocoa. *J. Trop. Agric. and Fd. Sc.* ***25(1):*** 43–54

Lenton, G. M. (1980). The ecology of barn owls (*Tyto alba*) in the Malay Peninsular with reference to their use in rodent control. Ph. D thesis, Univ. of Malaya, 253 p.

Renzoni, A. and Lovari, S. (1977). The food habits of the barn owl in an area of Central Italy. In *Report on the proceedings of World Conf. on Birds of Prey* (Chancellor, R. D., ed.) 1975, Vienna, p. 276-80. Vienna: Int. Council for Bird Preservation

Shamsiah, M. and Goh, N. S. (1991). The use of barn owl (*Tyto alba*) to control ricefield rats – An experience in Seberang Perak. *MAPPS Newsletter* ***15(2):*** 20

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