

Breeding Behaviour and Diet of the Australian Kestrel *Falco cenchroides* on the Southern Tablelands of New South Wales

by CHRIS BOLLEN, 'Richmond', Kippilaw Road, Goulburn, N.S.W. 2580

Summary

The active nests of two pairs of Australian Kestrels *Falco cenchroides* were observed for a total of 132 hours in the 1988 and 1990 breeding seasons at Goulburn, N.S.W. Both nests were in hollows in eucalypts in pastoral land. Courtship, parental behaviour, sex roles and fledging are described. Five young fledged from five eggs in 1988, and three young fledged from four eggs in 1990. The Kestrels' breeding diet for both years combined was 2% mice, 19% small birds, 53% reptiles and 26% arthropods by number, mostly small birds (59%) in 1988 and skinks (64%) in 1990. Birds contributed most by biomass in both years (60-87%). Capture of avian prey, and dust-bathing behaviour, are described.

Introduction

The Australian Kestrel *Falco cenchroides* has been the subject of several studies on diet and breeding biology (Sharland 1931, Genelly 1978, Olsen et al. 1979, Olsen & Olsen 1980, Cupper & Cupper 1981, Baker-Gabb 1984, Hollands 1984). For a widespread and common raptor, these studies have been few in number and there is little information on breeding behaviour. The Australian Kestrel is less known than some other kestrels in populous countries, for instance the Common Kestrel *F. tinnunculus* is one of the world's most studied raptors (Village 1990). This paper presents the results of observations on the Australian Kestrel's breeding behaviour over two breeding seasons near Goulburn on the Southern Tablelands of New South Wales.

Study area and methods

Goulburn (34°45'S, 149°40'E) is in a pastoral landscape. The study site is in an area of open, grassy paddocks with remnant patches of Candlebark *Eucalyptus rubida* and Yellow Box *E. melliodora* woodland. Observations were made on two different Kestrel pairs, in 1988 (November, nestling period to fledging) and 1990 (September-December, courtship to fledging). Both nests were also visited in December, in the post-fledging period. 1988 and 1990 were years of above-average rainfall at Goulburn.

In 1988, nest observations of 1-4 hours per day were made over 15 days between 6 and 29 November (total 38 hours), starting between 0725 and 1720 h, and finishing between 0920 and 1905 h. In 1990, nest observations of 1-7.5 hours per day (1-6 h per session) were made over 25 days between 25 September and 22 November (total 94 hours), starting between 0540 and 1535 h, and finishing between 1100 and 1815 h. These sessions were distributed between the phases of the breeding cycle as follows: 36 hours over 6 days in the pre-incubation period; 25 hours over 9 days in the incubation period; 33 hours over 10 days in the nestling period. In 1990, the nest was inspected daily on each visit around laying and hatching times, and visited around fledging time, to record the dates of these events.

Observations were made from a canvas hide on a 6 m tower, at a distance of 4 m in 1988 and 7 m in 1990, with the aid of a 20 x 50 telescope and 8 x 40 binoculars. In 1988 a seeing-in party was used occasionally throughout the observations, although I often approached the hide alone. It appeared that once the observer was invisible in the hide, the Kestrels seemed to forget human presence, returned to the nest and behaved naturally.

Results

In 1988 the male Kestrel was fully adult with grey head and tail. In 1990 the male was a yearling, with rufous head and tail, which indicates that immature males can breed successfully.

Nest sites

Both nests were in hollows in Candlebarks. The 1988 nest was a large north-facing hollow in a live tree. The 1990 nest was a well-protected hollow c. 1 m deep in the broken-off, east-facing horizontal limb of a mostly dead tree. The eggs were laid on small chips of wood, and no lining was seen in the hollows.

Courtship and copulation

Around Goulburn, pairing appears to take place in early September. Courtship feeding was underway at least 10 days before the laying of the first egg, and continued to occur throughout the prelaying period. The male transferred food to the female in the nest tree. However, as laying drew near, food transfer was more commonly at the hollow. Prey deliveries were characterised by loud, upslurred chittering or tremulous screaming *keek...keek...keek...* calls (1 per second) by the female, and occasionally slow, clicking calls *tic...tic...tic* (1 per second) by the male. The female was by far the more vocal. Occasionally during this period, the male entered the hollow. The male fed the female on average 1.4 times per hour of observation (range 0.8-2.3 times per hour), most frequently during the morning and on small items: 39 skinks and 11 arthropods (Table 1).

Copulation was observed on every day during the pre-incubation period, peaking in frequency during the laying period and declining once the female started incubation (0.3 times per hour prelaying, 0.8 times per hour in the laying period). Copulations occurred on average 0.7 times per hour of observation in the pre-incubation period, throughout the day. Mating usually followed prey transfer by the male, although in the mornings it occurred without food transfer. Copulation took 4-5 seconds and was characterised by much calling by both birds. The call was a faster and more strident version of the *keek...keek...keek* call. Copulation was last seen three days after the clutch was complete.

Eggs and incubation

In 1988, a clutch of five eggs was laid and all hatched. Projecting back from the fledging date (29-30 November) gave a laying date of early October (incubation period 4 weeks, nestling period 1 month: Olsen & Olsen 1980). In 1990, laying also occurred in late September/early October: first egg on 28 September, fourth egg on 4 October, with a laying interval of two days between each egg. Incubation appeared to commence with the laying of the third egg. The female spent 20% of observation time in the hollow on 28 September (first egg laid); 25% on 29 September; 25% on 30 September (second egg laid); 35% on 1 October; 94% on 2 October (third egg laid); 95% on 3 October; and 92% on 4 October (fourth egg laid). Three of the eggs hatched, on 30 and 31 October and 2 November, after an incubation period of 28-29 days.

Most of the incubation was done by the female, which spent 91% of observation time in the hollow during the incubation period. The male covered the eggs while the female was feeding on prey brought by him. This usually took no more than about 5 minutes as prey items were small. On one rainy day when the female was absent, the male covered the eggs for about two hours. Throughout this period he appeared restless, and frequently came to the hollow entrance, calling.

The male continued to supply all the female's food during the incubation period. He landed in the nest tree and called the female, and she collected it from him and ate it on a nearby perch. During these visits the female constantly gave the *keek...keek...keek* call. The male fed the female 0.9 times per hour of observation during this phase of the cycle, throughout the day, mostly on small items: 1 small bird, 12 skinks and 9 arthropods (Table 1). Late in the incubation period the female sat tight, and did not fly from the nest until the tree was climbed and the hollow was reached for inspection.

Table 1

Prey items observed at two Australian Kestrel nests at Goulburn, N.S.W., November 1988 and September-November 1990. Source for prey weights: Baker-Gabb 1982.

Species	Weight (g)	1988		1990		Total	
		n	%	n	%	n	%
House Mouse <i>Mus musculus</i>	17	3	11			3	2
Red-rumped Parrot <i>Psephotus haematonotus</i>	63	1				1	
Richard's Pipit <i>Anthus novaeseelandiae</i>	23			1		1	
House Sparrow <i>Passer domesticus</i>	25	15				15	
Common Starling (juv.) <i>Sturnus vulgaris</i>	75			4		4	
Unidentified small birds	20			3		3	
Total birds		16	59	8	8	24	19
Grass Skink <i>Lampropholis guichenoti</i>	2	3	11	65	64	68	53
Grasshoppers	2	5		12		17	
Spiders	2			2		2	
Unidentified arthropods	1			15		15	
Total arthropods		5	18	29	28	34	26
Total		27		102		129	

Table 2

Prey partitioning between the sexes in two Australian Kestrel pairs during the nestling period, 1988 and 1990 (summarised from Table 1). Numbers are totals delivered by each sex in each year. In 1990, items delivered by the female were caught by her after the male disappeared half way through the nestling period.

Prey species	1988		1990	
	male	female	male	female
Mouse	1	2		
Parrot	1			
Pipit				1
Sparrow	13	2		
Starling			1	3
Unidentified small bird			2	1
Skink	1	2	12	1
Grasshoppers	1	4	3	2
Unidentified arthropods			3	3
Total	17	10	21	11



(a)



(b)



(c)



(d)



(e)



(f)

a. Male Kestrel at hollow
c. Three-week-old chicks with sparrow
e. Fully fledged with small bird prey

b. Three-week-old Kestrel chicks
d. Fully fledged with skink
f. Young Kestrel in flight

Plate 7 a,b,c,d,e,f

Photos: Chris Bollen

Nestling period and parental behaviour

In 1988, observations started when the nestlings were about a week old. For the first few days of observation the chicks were brooded almost constantly by the female, but thereafter she stopped brooding them by day (unless it rained) and began perching in nearby trees or hunting. The female always flew from the hollow when the hide was entered, but she was not aggressive. All five nestlings fledged on 29-30 November (chicks 1 and 2 on 29 November; 3, 4 & 5 on 30 November). Feathered nestlings had a pale yellow cere and blue-grey orbital skin.

The adults brought food to the nest between 0900 and 1900 h; 27 deliveries were observed in 38 hours (0.7 per hour, or one every 80 minutes). They used a dead tree c. 40 m from the nest to transfer prey items. During the first week of observation the male always came to this perch, and the female always flew to collect the prey then take it back to the nest to feed the chicks. When the female began to hunt as well, the male came straight to the nest and fed the chicks if she was absent. When the male approached the nest tree with food he gave the staccato *ki-ki-ki-ki* shrill chattering call. When he landed on the transfer tree and the female landed next to him to collect the prey, both adults and the nestlings all gave the slow *keek...keek...keek...* call. The young continued to call until one of the parents landed on the hollow. The female gave the slow ticking call, apparently to urge the male to hunt, and also when she was arriving alone at the nest hollow to brood the chicks.

In 1990, the pattern was similar in the early nestling period. When the chicks were under 10 days old they were brooded almost constantly by the female, and the male provided her with food. The female's time spent in the hollow declined from 91% of observation time in the first week of the nestling period, to 63% in the second week and 23% in the third week. By the time the chicks were two weeks old, the female began hunting. Feeding rates averaged 0.9 deliveries per hour, including some large items: 7 birds, 13 skinks and 11 arthropods (Table 1). During the 1990 season the male disappeared when the chicks were about two weeks old, but all three young fledged. The female's feeding rate was slightly lower than the male's (0.8 vs 0.9 deliveries per hour), but she brought larger items (Table 2). Fledging dates were 30 November (chicks 1 & 2) and 2 December (chick 3), giving a nestling period of 30-31 days.

Feeding rates

As noted above, feeding rates in 1990 declined from the pre-incubation period (1.4 deliveries per hour) to the incubation and nestling periods (both 0.9 deliveries per hour) with an increase in the proportion of large prey (birds) in the diet. The overall feeding rate throughout the cycle in 1990 averaged 1.1 deliveries per hour, and changed through the day. The mean feeding rate in two-hour blocks, from 0600-0800 h in the morning to 1600-1800 h in the afternoon, was 0.3, 1.5, 1.0, 0.8, 0.8 and 0.6 deliveries per hour. There were few deliveries in the first two hours of daylight (earliest delivery 0704 h) then a peak in mid to late morning (0800-1200 h). This suggests that the male and later the female were feeding themselves in the early morning, before bringing prey to the nest. The latest delivery was at 1709 h.

Fledging

The young fledged in late November and early December, and the first flights of the young were separated by up to 48 hours. During this period there was much calling by the female to the young, perhaps to entice them to fly. Early in this period the fledglings made many short flights from the nest tree to nearby trees, but they were still fed at the hollow by the adults and still roosted in the hollow at night after they

had all left the nest. When the nestlings had fledged, the female continually flew around above a human intruder, while uttering the *ki-ki-ki-ki* call. Fledglings had pale blue-grey orbital skin, more rufous rump and tail than the adults (same colour as the back), and a pale hind border to the wing (pale tips to the secondaries and inner primaries).

Post-fledging period

Little information was obtained. In 1988 the juveniles were still being fed by the parents in nearby trees, and seemed not to have acquired hunting skills, about two weeks after they fledged. They were not seen again. In 1990 a different family of Kestrels (not those observed through the cycle) was visited. For the first two weeks after the young fledged, they were fed in nearby trees by the parents. A week later they were flying out to the parents to collect prey. Six weeks after they fledged, two young birds were hovering and fluttering to the ground with open wings to catch grasshoppers. Therefore, hunting skills are acquired somewhere between three and six weeks after fledging. Juveniles of intermediate age have been observed hovering but not diving or making captures (S. Debus pers. comm.). In the hand, a recently fledged juvenile c. 2 months old had pale grey-green orbital skin (S. Debus pers. comm.), therefore the change from blue-grey to yellow probably occurs early in the first year.

Diet

During both years the Kestrels fed on a variety of small mammals, birds, reptiles and arthropods (Table 1). In 1988 the main prey observed was small birds, but in 1990 the other pair preyed mainly on skinks. One pair took many House Sparrows *Passer domesticus*, and the other took several juvenile Common Starlings *Sturnus vulgaris* and smaller birds. Vertebrates, particularly birds, contributed by far the greatest biomass (98%, birds 87% in 1988; 90%, birds 60% in 1990). Overall, the diet was 2% mice, 19% birds, 53% lizards and 26% arthropods by number; and 5% mice, 74% birds, 14% lizards and 6% arthropods by biomass. Arthropods were carried in the bill and anything larger was carried in the feet before being transferred to the bill upon arrival at the nest.

Prey partitioning between the sexes is shown in Table 2. In 1990, the female Kestrel took a greater proportion of large prey: three out of the four Common Starlings and five out of the eight birds, and few lizards and arthropods compared to the many taken by the male (mean prey weights: male 7 g, female 25 g). In 1988 the situation was the reverse: most of the (small) birds were taken by the male, including a Red-rumped Parrot *Psephotus haematonotus* which he delivered (mean prey weights: male 20 g, female 10 g). These differences may be related to the fact that in 1988 the male was an adult, whereas in 1990 the male was immature and probably a less experienced hunter of avian prey.

Hunting behaviour

During the 1990 nestling period, two noteworthy observations of hunting behaviour were made. The first was the attempted capture of a nestling Starling by the female Kestrel. She was perched in the nest tree when she made a long, slanting dive and grabbed at something on the side of the tree. This happened twice, and a check through the telescope revealed that she had been attempting to seize a young Starling which had been at the edge of its hollow. It had seen her coming and retreated deeper into the hollow to avoid her grasp. A few days after this incident, the female captured a juvenile Starling from a flock feeding on the ground. She dropped from the nest tree in a short glide with wings half-closed, and as the flock of Starlings scattered she seized a juvenile just off the ground and mantled over it. She fed from the Starling

for about 20 minutes before flying up to a nearby tree then finally, after it was much lighter, to the nest to feed the nestlings.

Dust-bathing

Three times during the early nestling period, the female Kestrel flew to the ground below the nest tree. She then proceeded to shuffle herself around in the soil for approximately three minutes before flying back up to the nest tree.

Discussion

Most aspects of the Kestrels' breeding behaviour and vocalisations at Goulburn were similar to those reported elsewhere, for instance courtship and parental roles (Sharland 1931, Cupper & Cupper 1981, Price-Jones 1983, Hollands 1984). Laying dates, incubation and nestling periods also agree with previous work (Olsen & Olsen 1980). The Australian Kestrel's breeding biology is similar to that of other kestrels, particularly the Common Kestrel (Village 1990). The breeding diet, including the importance of small birds by biomass and the Kestrel's ability to kill Starlings, is also similar to other studies, particularly at Sutton 70 km south-west of Goulburn (Olsen et al. 1979, Baker-Gabb 1984). The Kestrels at Goulburn took small mammals, birds, reptiles and arthropods, as elsewhere, but the proportions differed, as might be expected from regional and annual variation in conditions and prey availability. Feeding rates at Goulburn were much lower than recorded elsewhere: Cupper & Cupper (1981) and Hollands (1984) observed 12 and three feeding visits per hour to nestlings respectively. However, the Kestrels observed by Cupper & Cupper were feeding mainly on arthropods and those observed by Hollands were feeding on skinks and arthropods, compared to the high proportion of bird prey in this study. Dust-bathing has apparently not been reported previously for the Australian Kestrel, although known for other small falcons (e.g. European Hobby *F. subbuteo*: Fiuczynski, quoted in Metcalf 1989).

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