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Front Cover: Male Blue-winged Kookaburra, northern Western Australia © Guy Pardey

Breeding behaviour and nestling diet of Blue-winged Kookaburras *Dacelo leachii* on Magnetic Island, North Queensland

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Abstract

The breeding biology of the Blue-winged Kookaburra *Dacelo leachii* has been well-studied in the Northern Territory (NT) but levels of provisioning to their young across the nestling period have not been documented and there is little relevant information from Queensland. We monitored the complete nest cycle of a pair of Kookaburras on Magnetic Island, North Queensland. Consistent with NT data, incubation and nestling periods were ~25 days and 39 ± 2 days, respectively. Tapping sounds indicated that four eggs hatched. The nestlings were fed relatively evenly throughout daylight hours, in contrast with the NT where they were rarely fed in the afternoon. The provisioning rate peaked during the middle (Days 17–25) of the nestling period. Of 273 nestling food items, 48.4% by number, and 74.9% by estimated volume, comprised reptiles, while 75 items (10.4% by volume) comprised arthropods. The male provided more prey items than the female, especially arthropods, but there was no difference in the daily volume of prey they delivered. Of the three fledglings, one disappeared within a few days of fledging, two remained with the parents for at least six months and one was seen with them 10 months post-fledging. As most Kookaburras in the NT breed in groups with helpers, further studies of the social organisation, breeding behaviour and fledging success of the species in a range of sites in Queensland would be useful.

Introduction

The Blue-winged Kookaburra (BWK) *Dacelo leachii* is a very large kingfisher (38-41 cm), slightly smaller than its closest relative the Laughing Kookaburra *D. novaeguineae* (LAK), with which its range overlaps in eastern Queensland (Higgins 1999; Andersen *et al*. 2018). The sex of adult BWKs is easily identified by the colours of tail feathers (Plate 1). They defend year-round territories and territorial and breeding behaviours include displays of 'hole-showing', where one clings to the edge of a tree hollow (or similar site) and calls (Higgins 1999). Early notes on clutch size, nest sites and breeding season of the BWK in Queensland were made by collectors and observers in the late 19th and early 20th centuries (e.g. North 1901; MacGillivray 1914; Harvey & Harvey 1919), augmented by Thomson (1935) and Lavery *et al*. (1986). The breeding biology and behaviour of the BWK are reasonably well-known from a long-term study in Kakadu National Park (NP) in the Top End of the Northern Territory (Curl 2005), but rates of provisioning of young across the nestling period have not been documented, and there is no detailed information about its breeding behaviour in Queensland. Given differences in climate and habitats, and the presence of sympatric LAKs, BWK populations in eastern Queensland are likely to differ from the Northern Territory (NT) population in some aspects of their ecology and breeding biology.

Plate 1. Male (left) and female (right) Blue-winged Kookaburra (Susan Chisholm and Vincent Bugeja)

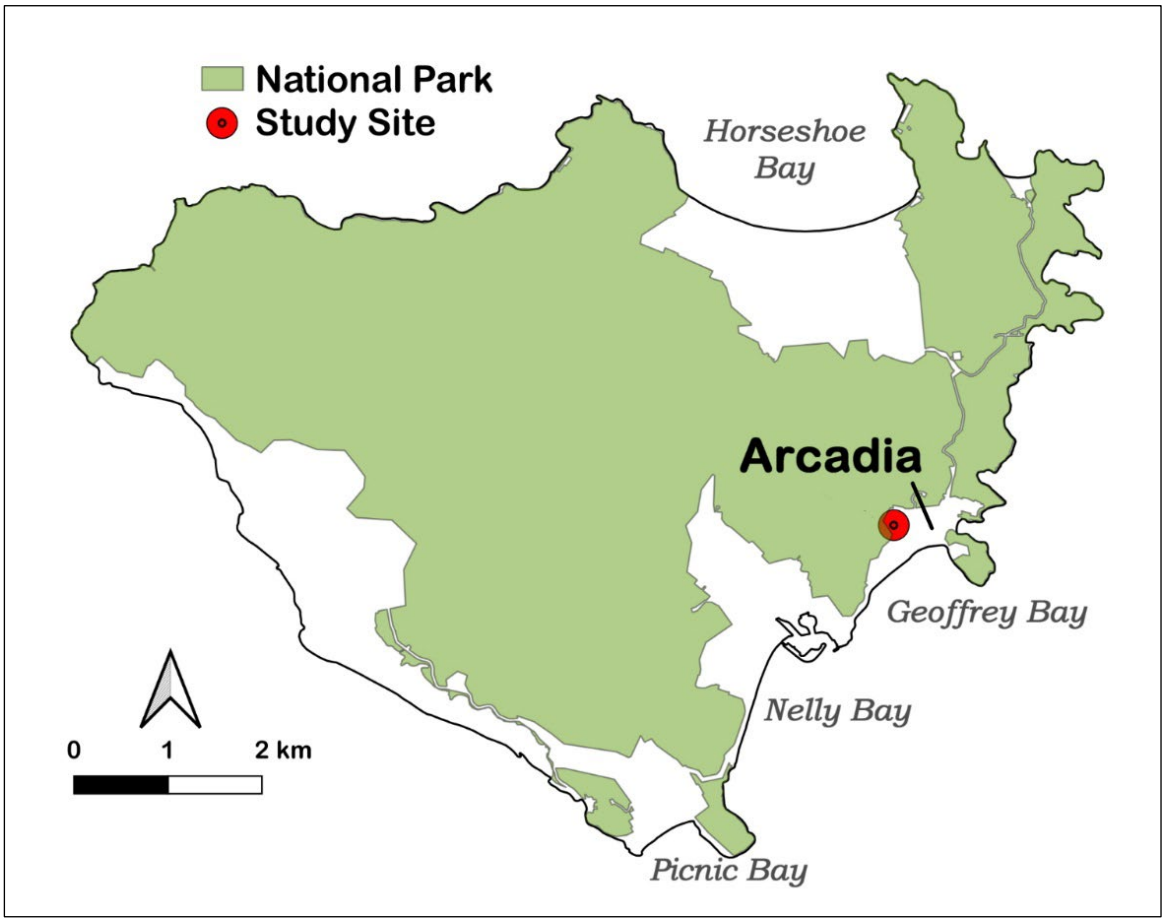


Figure 1. Location of study site in the village of Arcadia, Magnetic Island, North Queensland. The regional city of Townsville lies 8 km to the southwest of Picnic Bay.

Study area and methods

The study site was an 802 m^2 block within a recent (~seven years) 5.5 ha residential subdivision in the village of Arcadia, Magnetic Island (19°9'S, 146°51'E; Fig. 1). Magnetic Island is a large (~5,100 ha) continental island within the Great Barrier Reef, located ~8 km offshore from the regional city of Townsville, North Queensland. The climate is monsoon-tropical with seasonal summer rainfall to 1,100 mm (BoM 2019). In the 1980s the resident human population of ~2,500 was concentrated on small lowland plains behind the four main bays (Porter 1983; ABS 1988). The BWK is a common breeding resident on the island, although less common there than the LAK (Wieneke 1988).

We resided in Arcadia from August 1985 to October 1988 and made opportunistic observations of both kookaburra species. A pair of BWKs was observed on our house block in all months, except after October 1987, when a group of three was recorded twice, in non-breeding seasons. In 1987–1988 we monitored breeding by a BWK pair close to the house, and in this paper summarise our observations of the provisioning and diet of nestlings, as well as an estimate of the incubation period. Observations of interactions with sympatric LAKs will be presented elsewhere.

The subdivision was in mixed *Corymbia* woodland (Class II-9, Sandercoe 1990; Regional Ecosystem 11.3.9, Queensland Government 2023) on a small coastal plain (20 m above sea level), with weathered gravelly soils on clay. By 1987 houses had been built on about 20 of the 60 blocks in the subdivision and most vacant land retained some original vegetation. Fragments of vine thicket occurred on a creek gully 50 m to the south, as well as on the focal and adjacent blocks. The ephemeral Petersen Creek, 110 m east of the site, was lined with large Weeping Paperbarks *Melaleuca leucadendra*, native figs and palms. The front garden was planted with native flowering shrubs, but the rest of the house block was left in its natural state, including twelve mature eucalypts.

From 30 October 1987 to 9 January 1988 a BWK pair nested in a tree hollow ~5 m from the (highset) house deck. We observed the birds from ~15 m to minimise disturbance, using a Tasco 853TR 15x–90x end-view telescope with tripod (usually set at 30x) and 7x20 binoculars. We did not record our periods of observation, but while the nest was occupied we moved all possible daily activities to the deck and avoided joint absences. Over 38 days of nestling feeding we were both absent on two days (Day 10 and Day 11) and on three days of heavy rain (Days 32–34) we went outside only if BWK calls were heard. We noted the food items and times of deliveries to the nest, sex of the parent bird, perches used, and interactions with other species. As the hatching order of chicks was unknown, 'first', 'second' and 'third' refer to fledging order. Reptiles were identified using Cogger (1983) and with advice from Queensland National Parks and Wildlife Service and experienced residents.

To estimate the size of prey items we kept a paper template on the outdoor table with dimensions of the body, tail and bill length of male and female adult BWKs. To assess the relative importance of each prey type (e.g. arthropods, frogs, reptiles) brought to the nest by the two parents, we used estimates of prey body length as a proxy for volume (Legge 1999) or mean body length for items that were identified to species (including tail for reptiles, if present). A nominal length of 25 mm, the length of the smallest item identified to species, was attributed to unidentified prey. In describing the size of prey we class items <10 cm as 'small', 10–49 cm as 'medium' and 50+ cm as 'large'. To investigate variation in provisioning contributions we calculated the mean number of prey delivered per day, and its total estimated length. The

nestling period was divided into five 7-day stages: (1) Days 1–7; (2), Days 8–9 and 12–16; (3), Days 17–23; (4), Days 24–30; and (5), Days 31–37. There were no observations on Days 10–11, and observations on Day 38 were combined with Day 37 for analyses. Although we did not feed the birds, the parents occasionally delivered 'barbeque food'. Despite following the birds on foot and by car, and advertising in the weekly community newsletter for information, we failed to locate the source of this unnatural food.

Statistical tests were conducted in Microsoft Excel. We conducted two-way analysis of variance (ANOVA) to compare the mean number of daily prey items and the mean daily total estimated length of prey provisioned per nestling stage by each parent. To reduce the effect of variability in daily records, data were square-root transformed before analysis. Following ANOVA, two-tailed t-tests (for equal or unequal variance as appropriate) were used for post-hoc tests between pairs of nestling stages. Chi-squared tests for goodness of fit were used to compare the numbers of each prey type provided by the male and female across all stages of the nestling period, and the numbers each contributed of the two main prey types ('arthropods' and 'reptiles') during the peak provisioning stage. Due to the small numbers of amphibian prey, they were combined with 'reptiles'. To identify important factors contributing to the Chi-squared results, we calculated standardised residuals and considered values of >|2| as significant.

Additional breeding records of BWK were provided by the Royal Australasian Ornithologists Union (now BirdLife Australia) Nest Record Scheme (NRS). Nomenclature follows the International Ornithological Congress (Birds Queensland 2021) for birds, and Jackes (2010) for plants. Queensland bioregions are as defined by the Queensland Government (2022). Sunrise and sunset times at Arcadia were obtained from Geoscience Australia (2022).

Results

Nest site, perches and stages of nesting

The nest hollow (Plate 2) faced a clearing to the east and was 9 m from the ground in a branch of a Pink Bloodwood *Corymbia intermedia* that was ~20 m high (dbh, 23.1 cm). The male and female engaged in hole-showing behaviour during October, often flying between three perches (N1-N3, Plate 2) 3-4 m from the nest hollow, usually in the sequence N3-N2-N1. The male was seen feeding the female a number of times from 20 to 29 October, most frequently on a dead branch on the adjacent tree (S1, 7 m from the nest hollow; Plate 2). Perches N1 and N2 were used most often when the parents were changing-over during incubation, and when delivering food to the young, while S1 was frequently used after exiting from the nest. Food was only occasionally brought to the nest directly from other trees.

The period from the first sign of incubation to the first sound of intense tapping from the nest (presumed to be a chick hatching out of its egg) was 25 days (Table 1). The period from the first 'tapping' to the last was ten days and the time from hatching to fledging was estimated as ~37–41 days. The first young to fledge (Plate 3) dropped almost to the ground then flew up to a branch above S1, and was fed from S1 by both parents. It was larger than the second, which fledged two days later, while the third – which fledged five days after the first – was much smaller than either and disappeared several days after fledging.

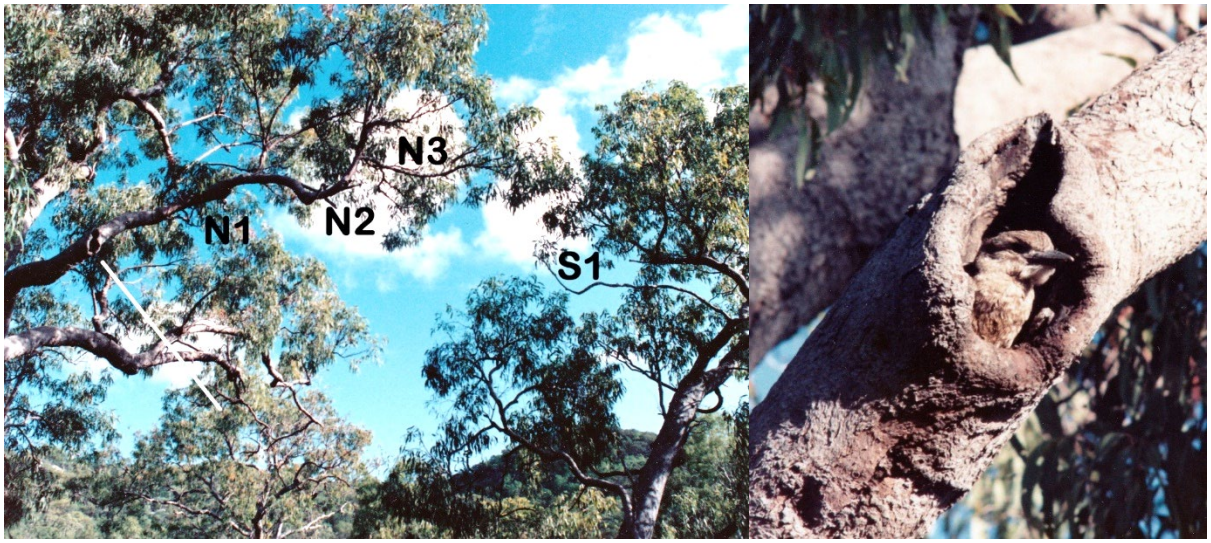


Plate 2. Left, nest hollow of Blue-winged Kookaburras, and perches on nest tree (N1, N2 and N3) and adjacent tree (S1). Right, largest chick at front of nest hole two days before fledging (E. Scambler).

During incubation and brooding the male was seen to roost in the canopy of the nest tree but after all young had fledged the nest tree was no longer used as a roost. Both adults were seen feeding two young near the house until 24 January, about three weeks after fledging. The group then foraged elsewhere, returning periodically to chorus on trees near the house. The adults regularly called with hole-showing at the nest hollow, joined in this display by two immature birds on 4 July and one on 25 July.

Provisioning of nestlings and diet

Food provisioning was recorded on 38 days, from 28 November 1987 to 4 January 1988. Of the 273 food items recorded, 132 (48.4%) comprised reptiles, though this group accounted for c.75% of food by volume (Table 2). In addition to ten Blue-tongued Skinks *Tiliqua scincoides* we recorded two large skinks with pink tongues and longer tails which were probably Pink-tongued Skinks *Cyclodomorphus gerrardii* (Appendix 1). No mammal prey were recorded, and although many small birds were nesting within the BWK territory at the time, none of the prey items were identified as nestling birds. Almost two-thirds (64%) of the prey items were small, 10% were large and 26% were medium-sized. The smallest prey identified was ~25 mm (a robber fly, Asilidae) and the largest was a snake or legless lizard of ~90 cm. The first large prey items were delivered in Stage 2 of the nestling period, on Days 8 and 12. Of the 23 large items delivered by a known sex, 11 were brought by the male and 12 by the female, and the latter brought the two largest.

The quantity of prey varied significantly over the nestling period (ANOVA, F=3.739, df=4, n=259, p=0.009), as did the volume of prey (F=5.392, df=4, n=259, p=0.001). Provisioning peaked during Stage 3 and the first two days of Stage 4 (Days 17-25 of the nestling period) (Fig. 2), although on Day 37 (the day before the first young fledged), 19 items totalling ~223 cm in length were provided, mostly (79%) by the male. Of 259 prey items where the parent delivering food was sexed, the male provided 157 (61%), exceeding the mean numbers of daily prey contributed by the female in all stages except Stage 2, when their contributions were equal (Fig. 3a). Across all nestling stages, the male provided significantly more prey items per day than the female (2-factor ANOVA, F=5.895, df=1, n=259, p=0.018). The male contributed significantly more arthropods than the female (χ^2=18.80, df=3, n=236, p=0.0003).

Table 1. Summary of nesting and subsequent observations of Blue-winged Kookaburra pair and young at Arcadia, Magnetic Island, 1987–1988. F, female; M, male.

Date	Activity
1987	
12–19 Oct	Regular hole-showing
21 Oct	M excavating in hole, dust pouring out
20–29 Oct	M feeding F on various perches, mostly on perch S1
30 Oct	From 16:00 hrs, M and F alternated in the hole
2 Nov	F fed in the hole by M. Both incubating by day. M roosting in canopy of nest tree
23 Nov	Loud tapping in hole: 10:30, 12:00, 17:00 hrs
25 Nov	Loud tapping in hole: 12:00 hrs
27 Nov	Loud tapping in hole: "all day"
28 Nov	Loud tapping in hole: 07:00 hrs; M took tiny skink into hole: 14:30 hrs
29 Nov	Loud tapping in hole: noon
30 Nov	Loud tapping in hole: 06:45-08:40 hrs
2 Dec	Loud tapping in hole: 06:30-07:00 hrs
13 Dec	Food-begging calls of young audible
21 Dec	Food-begging calls much louder
1988	
2 Jan	Young #1 fed at front of hole: 07:35 hrs
4 Jan	Young #1 fledged: 07:50 hrs; Young #2 showing in front of hole
6 Jan	Two young in nest tree canopy (06:45 and 19:45 hrs)
9 Jan	Third (very small) young fledged (09:25 hrs); seen only for next few days

Although the male contributed 55% of the prey volume over the entire nestling period, there was no significant difference between the sexes in terms of the volume of prey delivered per day (2-factor ANOVA, $F=1.766$, $df=1$, $n=259$, $p=0.189$). Unlike that of the female, the male's contribution to daily prey volume increased progressively from Stage 1 to Stage 5 (Fig. 3b). However, the female provided 64% of the volume of prey (Fig. 3b) during Stage 3, when she provided significantly more reptiles and fewer arthropods than the male ($\chi^2=15.63$, $df=1$, $n=60$, $p<0.0001$).

Table 2. Number and types of 273 food items delivered to nest by Blue-winged Kookaburra pair on Magnetic Island, north Queensland. F, female; M, male; U, sex unidentified.

Food type	F	M	U	Total	% by no.	% est. volume
Arthropods	14	57	4	75	27.5	10.4
Reptiles	60	66	6	132	48.4	74.9
Frogs	1	4	0	5	1.8	1.2
Barbeque	13	21	1	35	12.8	12.0
Not identified	14	9	3	26	9.5	1.6
Total	**102**	**157**	**14**	**273**	**100**	**100**

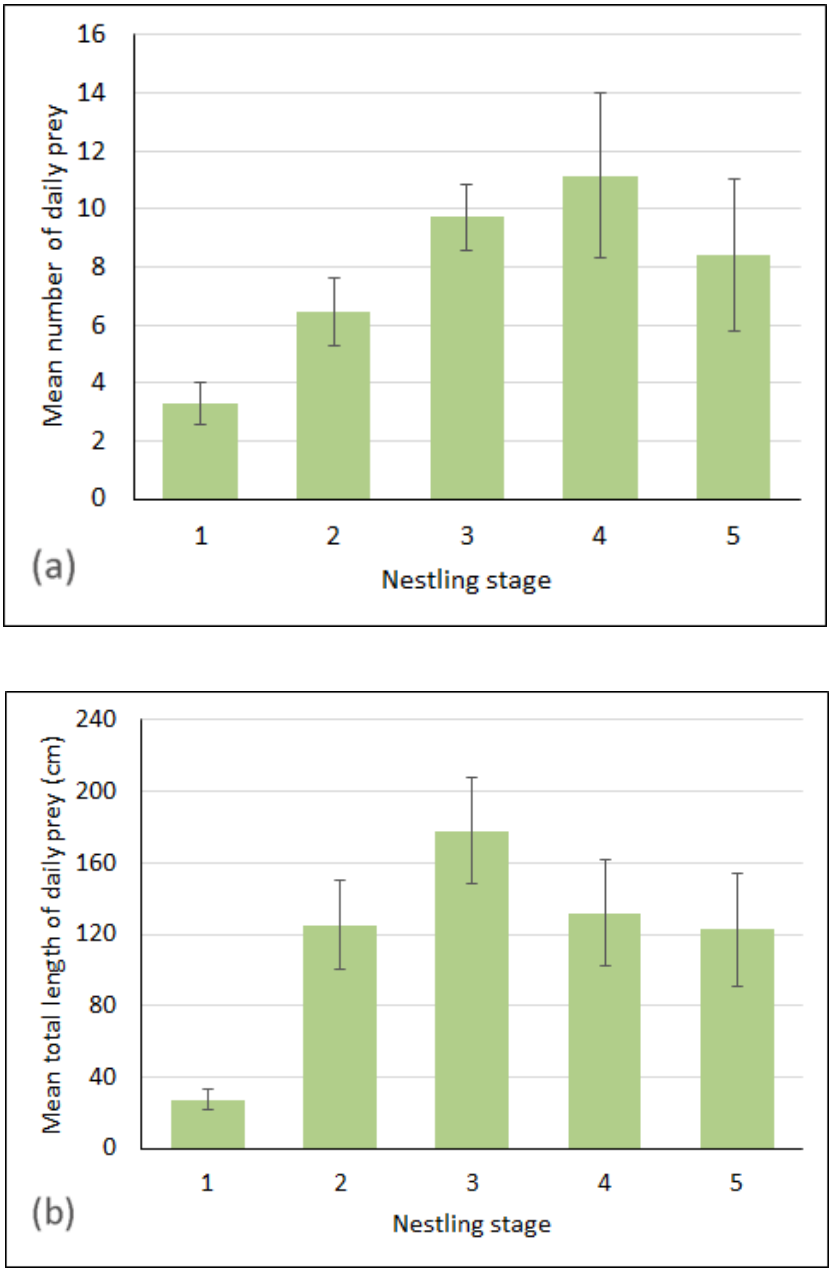
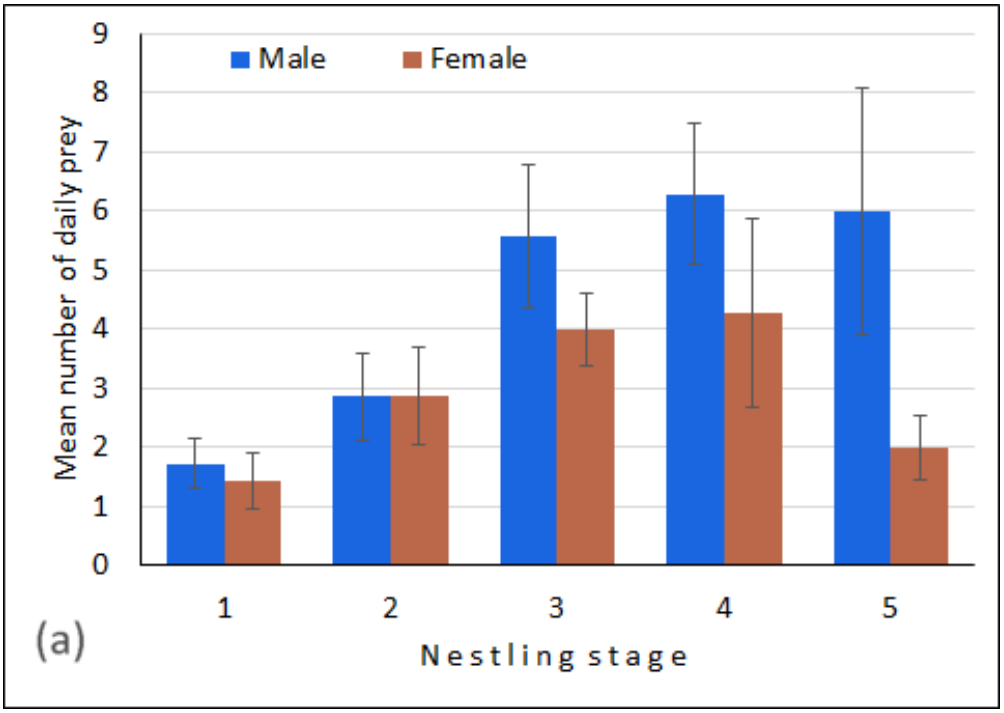


Figure 2. (a) Mean numbers of daily prey per nestling stage, ±SE (n=273); (b) Mean estimated total length (cm) of daily prey per nestling stage, ±SE. Stage 1, Days 1–7; Stage 2, Days 8–9 and 12–16; Stage 3, Days 17–23; Stage 4, Days 24–30; Stage 5, Days 31–37. There were no data for Days 10–11 and data for Days 37–38 were combined.

Between 22 December and 3 January the male (three times) and the female (twice) took food into the nest but emerged with the food and ate it themselves, while the nestlings made food-begging calls. These "failed feeds" (Legge 1999, p. 53) comprised 2% of the total number of provisioning visits for each parent. The parents were also seen eating food delivered to, but dropped by, the fledglings. On the third day after fledging, a fledgling was provisioned with a legless lizard or snake ~70 cm long (head first). Half the length (~35 cm) was swallowed immediately but after 17 min, 15 cm remained and wrapped around the fledgling's head and beak, and the young tried to 'bash' it. After 31 min, 5 cm still remained. The whole reptile took 60 min to swallow.



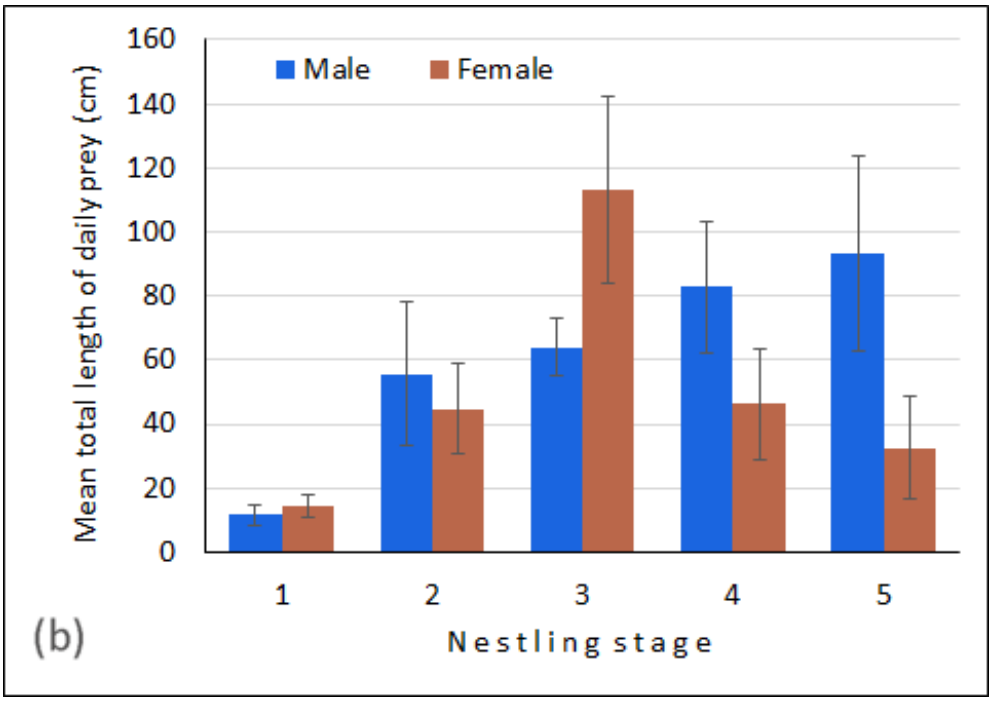


Figure 3. Food items delivered by each parent in each nestling stage (n=259). (a) mean [± SE] numbers of daily prey; (b) mean [± SE] estimated total length of daily prey (cm). Stages as in Figure 2. Excludes 14 food items where the parent was unidentified.

On four occasions between Day 14 and Day 37 post-hatching, one of the parents delivered 3-5 barbeque items in quick succession, 2–5 min apart. We received no response to our advertised appeal for information about supplementary feeding of BWKs in Arcadia. We saw only Laughing Kookaburras being fed near the beach front, some 560 m from the nest site. BWKs did not solicit food from us at any time during our three years' residence. All food

deliveries were recorded after sunrise (05:26–05:40 hrs). Of 14 deliveries after sunset (18:35–18:55 hrs), 11 were made by the female and one by the male, while in two the parent was not identified. However, the presumed male was seen foraging under a streetlight 160 m from the nest tree after 20:00 hrs. Provisioning continued throughout daylight hours with a peak between 18:00 and 19:00 hrs, and a smaller peak between 07:00 and 09:00 hrs (Fig. 4). There was no significant difference between the sexes in time of day of provisioning visits to the nest (χ^2=4.373; df=6; n=259; p=0.63). Despite our continued surveillance, the last provisioning of nestlings was seen 30 min after the first young fledged.

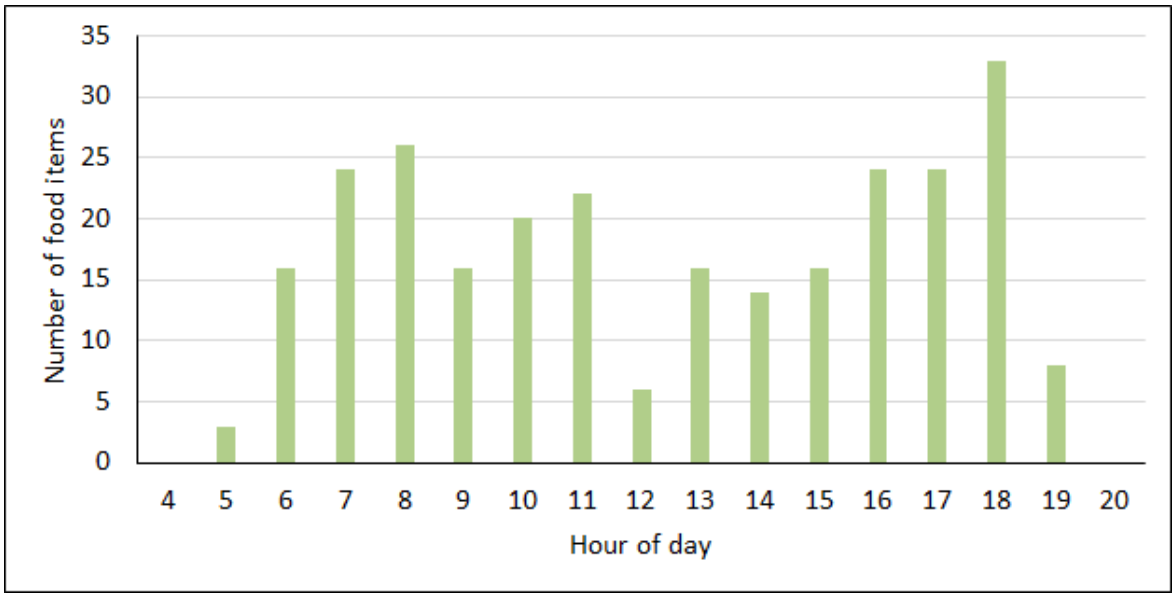


Figure 4. Time of food deliveries at Blue-winged Kookaburra nest at Arcadia, Magnetic Island (n=269). Excludes four feeding observations with time recorded as 'morning'.

Interspecific interactions

A Brushtail Possum *Trichosurus vulpecula* occupied the nest hollow during September and early October 1987, descending the tree after dusk to forage each evening. BWK hole-showing intensified from 12 October and on 19 October, the possum was heard hissing continually during the day. The next day a possum (presumably the same) was seen denning in a dead tree ~20m away. This cavity was open on both sides and after two days the possum moved elsewhere. While nesting, the BWK pair swooped on domestic cats (four times), Pheasant Coucals *Centropus phasianinus* (twice) and nesting Bush Stone-curlews *Burhinus grallarius* (twice). All attacked animals were on the ground within 50 m of the nest tree.

Recently-fledged young and adults were dive-bombed by Pied Currawongs *Strepera graculina*, a Forest Kingfisher *Todiramphus macleayii*, Helmeted Friarbirds *Philemon buceroides* and Black-faced Cuckooshrikes *Coracina novaehollandiae*, the last persistently for over a week. The female BWK once reciprocated by swooping at the Cuckooshrikes with a two-syllable squawk and the male once chased away a Pied Currawong perched on the dead tree. The BWKs evaded contact in flight, but while perched, they gave half-pecks or snapped the bill at their assailants. However, when the male BWK began chorusing on the dead tree on one occasion, a Helmeted Friarbird swooped and contacted him; the BWK flew to a nearby tree and gave a short call. The BWK pair showed no signs of disturbance or flight initiation (Weston *et al*. 2012) due to our presence on the house deck.

Discussion

Clutch size, fledging rate and interspecific interactions

Assuming that the consistent, loud 'tapping' sounds we heard from the nest were chicks pipping the egg (Hindwood 1947, p. 120), and that it can take up to 48 hours for BWK chicks to exit the egg (Higgins 1999), then four, not three eggs, were presumably laid and hatched in the Arcadia nest, although only three young fledged. The species lays up to five eggs, although clutches of five are rare (Higgins 1999). In the NT, non-supplemented groups laid two or three eggs, and the mean clutch size was 2.35 (n=26) (Curl 2005), but elsewhere the latter was 2.8 (n=26; Higgins 1999). If there was a fourth nestling in Arcadia it might have been killed by siblings, but the more common cause of BWK chick loss is starvation from its siblings' domination of food supplies (Curl 2005, p. 226).

Of more than 90,000 records contributed to the NRS to 1999 (Robin 2001) only eight concerned the BWK. Excluding this study, there were two records from Queensland, three from the NT and two from Western Australia. Eggs were recorded in September (three nests), November (one nest) and January (one nest). Clutch size was known for three nests (C3 x 2, C2 x 1), and at least one nestling was sighted in five nests, one of which (on Thursday Island) fledged two of three nestlings. Combining the Thursday Island data with this study, five nestlings fledged from a presumed total of seven eggs (71%), which is higher than the mean fledging rate for eggs in 45 breeding attempts covering favourable and difficult seasons in the NT (~55%: Curl 2005, p. 197). The possible laying of four eggs, fledging of three nestlings and survival of two fledglings imply a high level of resources in the Arcadia pair's territory.

BWKs in Kakadu NP, NT, and LAKs in Victoria, may be deterred from nesting in traditional hollows taken over by possums or bees (Parry 1973; Curl 2005), but in this study the possum was presumably expelled due to continuous harassment by the BWKs. As in Kakadu NP, nesting BWKs at Arcadia made a few antagonistic gestures to perceived predators on the ground. The pair tolerated considerable harassment by smaller birds, but mobbing kookaburras can be risky. Poiani & Yorke (1989) observed a LAK catch and beat to death one of a group of mobbing Bell Miners *Manorina melanophrys*.

Provisioning of nestlings and diet

Our estimates of incubation and nestling periods at Arcadia were similar to those of Curl (2005) in Kakadu NP. The significantly higher number of provisioning visits by the male BWK at Arcadia is consistent with results from Kakadu NP (Curl 2005, p. 181). However, our study is the first to report details of (1) the number and volume of prey items delivered to the young in each of five nestling period stages; (2) the size of prey delivered each day by each parent; and (3) the incidence of failed provisioning attempts by BWKs attending nests. The pattern of provisioning at Arcadia across three nestling stages was consistent with that for LAKs in the ACT, which corresponded with growth phases of the young (Legge 1999). The growth stages of BWK young in the NT (Curl 2005, pp. 236) were similar to those for LAKs (Higgins 1999), so provisioning rates at BWK nests at different stages would be expected to be similar. Curl (2005, p. 238) noted that there was "still a high food supply" to one nest on Day 21, as occurred in this study, but also that the provisioning rate declined in the three days before fledging. The high provisioning rate at the Arcadia nest on Day 37 was therefore unusual (see below).

In contrast to the pair of BWKs at Arcadia, male parents in unassisted pairs of LAKs in the ACT fed longer prey to nestlings than female parents at peak nestling growth stages (Legge 1999, pp. 52-53). The lack of significant differences between the Arcadia parents in this respect was apparently mainly due to the male's delivery of many arthropods at the peak of provisioning (Stage 3), whereas the female delivered more reptiles and thus exceeded the male's overall contribution in that stage. Multiple feeding visits to nests are energetically costly, and as female BWKs are larger than males, with concomitant higher maintenance demands, the Arcadia female may have concentrated on prey with a high value-for-effort (e.g. Legge 1999, p. 55). The proportion of failed feeding attempts by the BWK female (2%) is the same as for LAK female parents and LAK male helpers aged 2 or more years (Legge 1999, p 53). However, the proportion of failed feedings by male parent LAKs was lower (0.3%) than that of the BWK male (2%). Although the reason for these failures is unknown, their incidence further indicates that the level of food supplies in the BWK territory in this season was more than adequate to achieve the fledging of three young.

In Kakadu NP, BWKs foraged extensively in morning and evening twilight, with little or no activity from noon to 18:00 hrs, and 50% of food provisioning visits to the young were before 08:00 hrs or after 18:00 hrs (Curl 2005, p. 140). The nestlings on Magnetic Island were provisioned more evenly through the day than in Kakadu NP, particularly during the afternoon, but it is unclear to what extent our few crepuscular records (and the low number of records between 12:00 and 12:59 hrs) were due to gaps in our observations. Maximum daily temperatures in the main breeding months (September–December) are 5-10°C lower on the island than in Kakadu NP (BoM 2019), and the island frequently experiences a cooling effect from afternoon sea breezes, which can be expected to affect the activities of BWKs and their prey. The absence of provisioning visits to the nest hollow after the first young fledged on 4 January, despite continued surveillance, suggests that the second and third young were not fed during daylight hours while they remained in the nest. This is consistent with Curl's (2005) finding that after one chick had fledged, the remaining young, even if well-grown, lost weight in the nest because the adults preferentially provisioned the young outside the nest.

In our study reptiles were outstandingly important as nestling food, but this diet may not be typical of all BWK groups on the island. In Kakadu NP the proportions of different foods varied with the habitat of each BWK group (Curl 2005), and on a rocky foreshore at Geoffrey Bay, only 700 m from our study site, adult BWKs have been observed hunting crabs exposed at low tide, and feeding them to fledglings (Vandhana, pers. comm.). The absence of crustaceans in the diet of nestlings in this study implies that the territory of the BWK pair did not extend to the foreshore. Consistent with Curl's (2005) observation that BWKs rarely prey on other birds in Kakadu NP, we did not observe birds being depredated on Magnetic Island. At Nelly Bay (see Fig. 1), the sole record of a BWK preying on birds in many years of nest observations involved nestlings of Australasian Figbirds *Sphecotheres vieilloti* (J. Wieneke, pers. comm.). Curl (2005) found mammal prey remains in 0.6% of pellets regurgitated (by parents and young) in nest hollows, but as BWKs were never observed taking mammal prey in hundreds of daylight observations he concluded that mammals were taken during twilight. As we had few twilight records, it is possible that we missed mammal prey being taken to the nest.

Parry (unpublished, cited in Higgins 1999) found that 10% of the diet of LAK nestlings outside Melbourne comprised "pieces of meat" (sample size unknown), which is similar to the ~12% human-supplied foods in the present study. Although Curl's (2005) study included a food-supplemented wild BWK group which nested earlier than non-supplemented groups in the NT, the timing of the Magnetic Island nesting event was consistent with other BWK nests

in the region (Lavery *et al*. 1968). Our observation of a newly-fledged BWK taking an hour to ingest a large reptile greatly extends an observation of nestlings taking "more than 15 minutes" to do so (Hopkins 1957), though we found no detailed records for nestlings and none for fledglings.

In Kakadu NP two-thirds of BWK pairs nested in groups (Curl 2005), but the frequency of helpers in Queensland, including on Magnetic Island, is unknown. Further studies of the nesting behaviour of BWKs in a range of climatic zones and habitats in Queensland would be useful to determine whether the social organisation and breeding behaviour observed in this study are typical. BWKs in the NT were extremely wary, with up to ten days required to locate a single nest (Curl 2005, p. 4), but in many areas of Queensland they are more habituated to people, potentially facilitating further studies.

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Plate 3. Female Blue-winged Kookaburra, near Townsville (Rodney Appleby)

Appendix 1. Food items delivered to Blue-winged Kookaburra nestlings at Arcadia, Magnetic Island, North Queensland.

Food type	Details
Arthropods (75)	
Insects	Grasshoppers; crickets; stick insects; mantids; cockroaches; cicadas; large beetle larvae ('witchetty grubs'); beetles, including 'Rhinoceros beetles' *Xylotrupes gideon* (11); a large piece of honeycomb or wasp nest; green tree ants *Oecophylla smaragdina* (on a skink, possibly adventitious); moths; robber fly
Arachnids	Spider (1); Centipedes, ~13 cm (2)
Reptiles (132)	
Geckos	Velvet Gecko *Oedura sp.* (2) and unidentified species (2)
Legless lizards	Burton's Legless Lizard *Lialis burtonis* (5); other long, slender reptiles (legless lizards or snakes), 10–90 cm (13)
Skinks	Large number of unid. small skinks, ~5–10 cm, including *Ctenotus sp*. (15); Blue-tongued Skink *Tiliqua scincoides* (10); *Carlia sp*. (1); unidentified large skinks (2), probably Pink-tongued Skink *Cyclodomorphus gerrardii*
Monitors	Black-tailed Monitor *Varanus tristis,* ~50 cm (2); unid. specimen (1)
Frogs (5)	Several green tree frogs *Litoria* sp.; unid. large brown amphibian
'Barbeque' food (35)	
Cooked	Fish; mince (hamburger); meat with fat; fried fish with batter; bacon; king prawn. Cooked crab shells found under nest tree.
Uncooked	Slab of raw meat