

Parental care and growth rates of New Zealand pigeon (*Hemiphaga novaeseelandiae*) nestlings

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Abstract Parental and nestling behaviour of New Zealand pigeon (*Hemiphaga novaeseelandiae*) was observed from August 1998 to March 1999 at Motatau Forest, Northland, New Zealand. Four successful nests from three pairs were monitored using infra-red cameras and direct observation. Incubation was shared (female: dusk till 0643-1106 hrs; male: remainder of the day). Three stages of daytime nestling care were apparent: full-attendance brooding by either parent (day 0 to day 8-12); female-only brooding (day 9-13 to day 12-26); and feeding only (day 13-27 to fledging) except in wet weather. Females brooded the nestlings for significantly longer than did males. Young nestlings were fed more frequently, and for longer, than when older. Parents appeared to select fruit of pigeonwood (*Hedycarya arborea*) and nikau (*Rhopalostylis sapida*) for feeding nestlings. Development and growth was rapid and one nestling weighed 565 g (similar to adult weight) by day 26. Feathers first appeared on day 5-8.

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INTRODUCTION

The New Zealand pigeon, or kukupa (*Hemiphaga novaeseelandiae*) is a nationally threatened species (Tisdall 1994) whose populations in Northland have declined due to the combined effects of nest predation, food competition with introduced species, and hunting (Pierce *et al.* 1993). Published observations of its nesting behaviour include accounts of location and dates of nesting, aspects of egg incubation, brooding and feeding of nestlings, nestling development and fledging, and nesting success and clutch overlap (e.g., Clout *et al.* 1986, 1988, 1995; Pierce 1993; James 1995; Pierce & Graham 1995; James & Clout 1996). These studies have involved mainly visual observation of nesting behaviour, although James (1995) did use video recording to monitor nests.

In Northland, nesting of New Zealand pigeons begins in July and continues until January (Pierce & Graham 1995), and is probably stimulated by food

supply, especially of fruit (Clout *et al.* 1995). A single egg is laid and incubated for 28-29 days by both parents, with the female incubating from late afternoon and through the night until mid-morning (Pierce 1993; James 1995). The nestling normally fledges in 28-35 days (Pierce 1993), but with extremes of up to 52-56 days recorded (James 1995). The biology of New Zealand pigeon is summarised in Higgins & Davies (1996) and Mander *et al.* (1998).

In this study we used continuous video monitoring to examine the detail of chick rearing and parental care at successful New Zealand pigeon nests.

METHODS

Between August 1998 and March 1999, four successful nests of New Zealand pigeon were monitored at Motatau Forest, a 350 ha broadleaf-podocarp forest remnant located midway between Whangarei and Kaikohe in Northland.

Time-lapse (approx. 1 frame/sec.) video cameras and infra-red light sources (Innes *et al.* 1994) were used to monitor the nests. Nests 1 and 3 were monitored for part of the nestling rearing

stage, nest 2 from hatching to fledging, and nest 4 from soon after laying to fledging. Nests 1 and 3 involved the same (radio-tagged) male and, presumably, the same female. The distance from camera to nest varied from approximately 10 m at nest 3 to 1 m at nests 1, 2, and 4, after the camera was incrementally moved closer to the nests. Whenever possible, intervening vegetation was gradually removed.

A total of 1262 real-time hours of video was collected but filming of nests was not continuous because of battery failure and other causes. The start and finish times of behaviours were determined to the nearest second using freeze-frame, with the date and time imprinted on the videotape at the time of recording. Durations of behaviours and activities were determined as a percentage of the amount of videotape viewed. Information recorded from the tapes included nestling age, identity of parent (either by behaviour or presence/absence of back-pack radio transmitter), feeding start and finish times, brooding and incubation start and finish times, nestling behaviour and activity, other relevant observations, and times of dawn and dusk. A nestling feeding episode was timed from when a parent first passed food to the nestling until the last food was passed, and included pauses between food passes. Where a pause lasted more than 1 min, the next feeding was recorded as another episode.

Nestlings at nests 1, 2, and 4 were weighed to the nearest gram every 2-3 days. Weights were obtained only when the nestlings were not being brooded during the day (to prevent desertion by parents) and weighing continued until approximately day 30 after which we felt that disturbance to nestlings might cause premature fledging.

Nestling diet was determined by searching for excreted seeds deposited on or under the nest. Adult diet and other behaviours were recorded from direct observation of adult birds.

RESULTS

Incubation

One nest was monitored throughout incubation (nest 4) and the adults incubated the egg for almost 100% of observed time (Fig. 1). The female incubated from just before dusk to between 0643 hrs and 1106 hrs in the morning, with the longer incubation spells occurring late in the incubation period. The male incubated for the remainder of each day. Incubation was in two to five spells per 24-h period, and spells varied in duration (hr:min:sec) from 00:00:39 to 16:06:05 (\bar{x} = 7:22:30, n = 9, sd = 7:06:44) for females and 00:00:44 to 8:16:25 for males (\bar{x} = 2:42:05, n = 7, sd = 3:29:32). The duration of the changeover period (when neither parent was incubating) ranged from

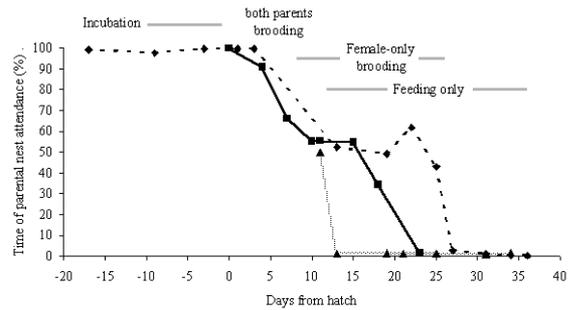


Figure 1 Percentage of a 24-hour day for which New Zealand pigeons attended nests at Motatau, Northland: squares - nest 1; triangles - nest 2; diamonds - nest 4.

00:00:23 to 00:11:01 and averaged 2 min (n = 16, sd = 00:02:42). Approximately once each hour the parents undertook egg or nest maintenance, usually lasting 30-60 s.

Brooding of nestlings

Three stages of nestling care were apparent: a full-attendance stage (day 0 to day 8-12) when both parents brood the nestling throughout the day, a female-only brooding stage (day 9-13 to day 12-26), and a feeding-only stage (day 13-27 to fledging) when the nestling was generally not brooded (Fig. 1). Periods of brooding varied from 10:25:14 to 17:09:46 (\bar{x} = 11:43:52, n = 23, sd = 00:03:57) for females and 1:18:27 to 8:20:05 (\bar{x} = 3:11:54, n = 8, sd = 00:03:15) for males. During the feeding-only stage, short daytime brooding bouts by either parent (18 min to 2 h) occurred occasionally during wet weather. The duration of the changeover between parents during the full-attendance stage was variable (0:00:24 to 0:43:37), increasing after day 6 to a maximum of 2:58:53. The nestling was predominantly down-covered when brooding during the day ceased.

Feeding of nestlings

Following hatching, the nestling was fed approximately once an hour, with no feeding occurring from around dusk to just past midnight. As the nestling aged, feeding occurred progressively later in the morning. Nearer fledging, feeds occurred approximately 2 h after dawn. Also, the interval between feeds increased (Fig. 2) and the duration of feeding bouts decreased (Fig. 3). Overall, fewer feeds occurred in the afternoon than in the morning.

The number of feeds per 24-h period for older (>3 week) nestlings was 2-3. The number of feeds for recently hatched nestlings was more frequent, with over 30 recorded for one 24-h period.

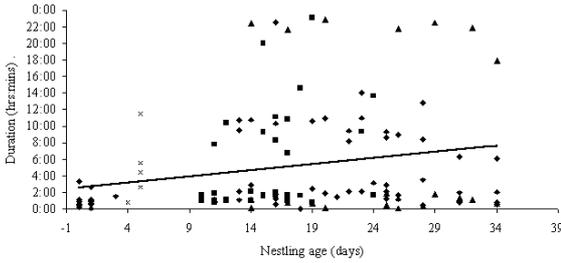


Figure 2 Duration of interval between feed times of New Zealand pigeon nestlings, Motatau, Northland. Solid line is a linear regression line ($y = 0.0062x + 0.107$) fitted to all data points: squares - nest 1; triangles - nest 2; crosses - nest 3; diamonds - nest 4.

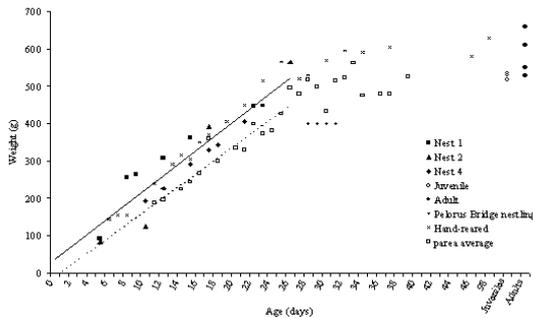


Figure 4 Comparison of growth between 1998/99 parent-reared New Zealand pigeon nestlings (nests 1,2,4) from Motatau, Northland, a 1986 parent-reared nestling from Pelorus Bridge, Marlborough (Clout *et al.* 1988), a 1992 hand-reared nestling from Peacock Springs, Christchurch (A. Richardson unpubl. data), and 17 1991-93 parent-reared parea nestlings (Powlesland *et al.* 1994). Weights of 1998/99 wild-caught juveniles and adults from Motatau are given for comparison. Solid line is a linear regression line ($y = 18.663x + 19.272$) fitted to the average growth of parent-reared Motatau nestlings. Dotted line is a linear regression line ($y = 17.751x - 30.001$) fitted to the average growth of parent-reared parea nestlings over the same age range as those obtained for Motatau nestlings.

Often, the nestling seemed unaware of the return of the parent before feeding. However, when the returning parent was seen, the nestling could become quite active and would rapidly flutter its wings. Begging behaviour was generally not observed and most feeding bouts were initiated by the parent making bill contact with the nestling.

Nestling growth and development

Weight gain of nestlings is shown in Figure 4. Growth was rapid and one of the chicks had reached 565 g by day 26. Change in body weight was proportionally largest (14-21.3% per day) up to

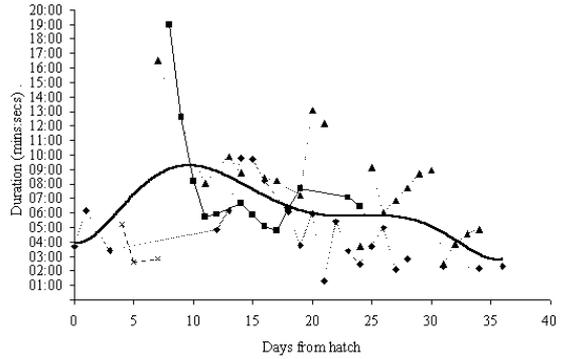


Figure 3 Average duration of New Zealand pigeon nestling feeding bouts at Motatau, Northland. Solid line is a polynomial regression line ($y = 4E-10x^6 - 4E-08x^5 + 2E-06x^4 - 3E-05x^3 + 0.0002x^2 - 0.0001x + 0.0027$) fitted to all data points: squares - nest 1; triangles - nest 2; crosses - nest 3; diamonds - nest 4.

day 8 and then decreased to 0.5-3.4% per day from day 21. No flattening in the slope of the growth curve was evident over the period when nestlings were weighed at Motatau.

Plumage development was very rapid, with feathers apparent at the date of our first inspection (days 5-8).

Diet of adults and nestlings

We observed 134 feeding episodes by adult birds and determined the proportional species composition of 386 seeds found at nest sites. We assumed that seeds found at nest sites were indicative of nestling diet, being either deposited by the nestling, or brooding parents. No defecation by either nestlings or brooding parents was seen on videotape.

Adults, including non-breeding individuals, were observed consuming the fruits of nikau (*Rhopalostylis sapida*) (43%), taraire (*Beilschmeieda tarairi*) (33%), pigeonwood (*Hedycarya arborea*) (13%), puriri (*Vitex lucens*) (7%), supplejack (*Ripogonum scandens*) (3%) and kohekohe (*Dysoxylum spectabile*) (1%). The diet provided to nestlings differed in that nikau (62%) and pigeonwood (35%) were favoured and taraire seed (3%) was the only other fruit identified. The earliest that the large (29 mm long) seed of taraire was found at a nest was when the nestling was nine days old.

Copulation

At 0900 on 7 December 1998 (11 d before estimated date of laying), the pair at nest 4 was observed copulating. The copulation site was under the canopy on the outer branch of a taraire tree. No solicitation or pre-copulatory behaviour was noted.

The male approached the female, mounted and copulated for approximately 3 s. Both birds then preened for approximately 2 min, and then the female left and began feeding.

Other observations

Nestlings and parents were very active on the nest, especially during the day, and often shifted position, preened, or pecked at nest material. Rain- and sun-bathing by nestlings was observed on several occasions. As nestlings grew older, activity (especially wing flapping) increased markedly until 2-4 days before fledging, when nestlings often moved away from the nest and out of camera view. The parents and nestling would meet at the nest for feeding during this time.

No reaction was observed to visits to the nest by other birds (probably silvereye *Zosterops lateralis*), tree weta *Hemideina thoracica*, or spiders. No introduced mammals were observed at the nests, presumably due to their scarcity as a result of the intensive predator control programme.

DISCUSSION

Copulation display

Pre-mating courtship seems common among species in Columbidae (Gibbs *et al.* 2001). That no courtship display was associated with the observed copulation in this study is unusual. Display flights followed copulation between New Zealand pigeons at Wenderholm (James 1995).

Incubation and brooding

There were four stages of parental care during the nesting of the New Zealand pigeon: incubation, full-attendance brooding involving both parents, female-only brooding, and feeding only. Parental investment was greater by females, which incubated and brooded for longer, undertook more brooding bouts, and contributed longer feeding bouts than males.

The nestling was left unattended at night when as young as 13 days old and approximately 125 g whereas James (1995) recorded nestlings being left unattended during the night only when near fledging at Wenderholm Regional Park, north of Auckland. The observation of nestlings not being brooded during the day after day 9-13 is consistent with James' (1995) observations, although he recorded nestlings dead in the nest after cold weather at this stage. In this study, parents returned to brood the nestling during bad weather, although not for its full duration. The short duration of changeovers at dawn and dusk during incubation and full-attendance stages, as well as functioning to maintain thermoregulation for the nestling, may also minimise opportunities for predation by morepork (*Ninox novaeseelandiae*).

Multiple incubation bouts (involving either of the parents more than once) (nest 4) and brooding bouts (nest 1) in a 24-hr period have not previously been recorded.

Nestling feeding and foods

Times of feeding of the nestling confirm James' (1995) observations. Whilst the number of feeds per 24-h period for older (>3 week) nestlings seemed similar to James' average of 2.5, the number of feeds for recently hatched nestlings was much greater, with over 30 being recorded for one 24-h period (*c.f.* James' average of 2.3 per 24 h).

The proportions of different species of fruit seeds under the nests indicate that New Zealand pigeons favour pigeonwood and nikau fruit for feeding to nestlings during the study period. Pigeonwood has a high gross energy value due to a 21.4% lipid component and a 9.9% protein content (Williams 1982). Although no nutritional data are available for nikau, it is an important food of New Zealand pigeon in northern New Zealand (Pierce 1993).

Taraire was not an important food for nestlings at Motatau although it is elsewhere (James 1995). Taraire is a member of the Lauraceae family, which is known for the high lipid content of the fruit pulp (Crome 1975; McEwan 1978; Stiles 1993). Powlesland *et al.* (1997) found that plant species with high lipid and carbohydrate content promoted early and prolonged nesting by parea (Chatham Island pigeon *Hemiphaga chathamensis*).

The small size of nestlings found with taraire seeds indicates that they may be capable of ingesting quite large objects.

Nestlings at Motatau were heavier than the only other known wild weight (400 g at day 28-31) of a New Zealand pigeon nestling found at Pelorus Bridge, South Island (Clout *et al.* 1988), and were comparable with growth rates of the generally heavier parea in the Tuku area of Chatham Island (Powlesland *et al.* 1994). However, any difference in growth rates between New Zealand pigeon nestlings at Motatau and parea nestlings at Tuku is not statistically significant, possibly due to the large variances within the observed weights of nestlings at Motatau. The long interval between feedings (up to 22:25:39) of young (day 14) nestlings and good growth rates suggests a high nutritional value for the nestlings' diet at Motatau.

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