BREEDING AND FLEDGING BEHAVIOUR OF THE CHATHAM TAIKO (MAGENTA PETREL) *PTERODROMA MAGENTAE*, AND PREDATOR ACTIVITY AT BURROWS

RACHEL B. JOHNSTON[1], SUSAN M. BETTANY[1], R. MIKE OGLE[1], HILARY A. AIKMAN[1], GRAEME A. TAYLOR[2] & MICHAEL J. IMBER[2]

[1]Wellington Conservancy, Department of Conservation, PO Box 5086, Wellington, New Zealand
[2]Science & Technical Centre, Department of Conservation, PO Box 10-420, Wellington, New Zealand
(mimber@doc.govt.nz)

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SUMMARY

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Breeding and fledging activity of the Chatham Taiko or Magenta Petrel *Pterodroma magentae* were observed from October 2000- May 2001 during 3696 h of video surveillance at 16 burrows. Additional video-monitoring was done during 1999/2000 (486 h), 2001/02 (703 h) and 2002/03 (590 h). Laying in one burrow, and incubation changeovers in three, were observed. Three chicks were fed on average every 3.86 days (March-April) until the desertion period. Parental visits, shared equally by the sexes, lasted 33 minutes - 26.3 h, and ceased between 22 April and 9 May, causing desertion periods averaging 16 days (range 9-23 d, n=6). Five chicks first emerged on 21 April-1 May. Time chicks spent outside the burrow increased approaching fledging, while wing-flapping rate increased, then decreased. Mean fledging date was 15 May (range 6-27 May, n=18). Desertion periods were longer on the leeward side of the colony (mean 22 days, n=3) than on the windward side (mean 11 days, n=3), and more leeward fledglings crashed attempting to leave (75% vs 33%). Rats (Black *Rattus rattus* &/or Polynesian *R. exulans*) were the only predators observed on video. All 38 recorded rat visits seemed benign, although 63% involved burrow entry, but visitation rate was highest in April when chicks were large.

Keywords: Chatham Taiko, Magenta Petrel, *Pterodroma magentae*, Chatham Island, video-monitoring, breeding behaviour, chick-rearing, fledgling behaviour, rats

INTRODUCTION

Endemic to Chatham Island, New Zealand, the Critically Endangered Chatham Taiko or Magenta Petrel *Pterodroma magentae* is one of the world's rarest seabirds (Heather & Robertson 1996) with a total population estimated at 100-150 birds (Taylor 2000, Aikman *et al*. 2001). It is a moderately large (c. 475 g), white-bellied gadfly petrel, summer-breeding in and restricted to the South Pacific near the Subtropical Convergence and to sub-Antarctic seas. Taiko are now known to breed only in forest 4-6 km inland, in and near the Manuel & Evelyn Tuanui Nature Reserve around the Tuku-a-tamatea (Tuku) River and a tributary in south-west Chatham Island (44º 04'S, 176º 36'W). The upper Tuku Valley, which holds most Taiko burrows, runs SSW, so that numerous burrows on its west side are to leeward of the prevailing NW-SW winds. This had implications for departing fledglings there.

Between October 2000 and May 2001 video-monitoring of Taiko breeding activity was undertaken at burrows in Tuku Valley. The specific objectives were to:

1. Determine the identity of Taiko visiting each burrow by colour bands, if present,
2. Observe incubation behaviour,
3. Determine feeding patterns during chick-rearing,
4. Establish dates of first emergence and departure by fledglings, and
5. Record visits to burrows, and activity, by potential predators.

Feral Domestic Cats *Felis catus*, Wekas *Gallirallus australis*, Australian Possums *Trichosurus vulpecula* and Black Rats *Rattus rattus* and Polynesian Rats *R. exulans* were commonly found in the area where Taiko breed and often close to burrows (Imber *et al*. 1994, Ogle 2002). Predator control measures included leg-hold traps at baited or walk-through sites, well away from burrows, for larger predators; for rats, poison bait stations and Victor® and Easiset® snap-traps in the vicinity of burrows; and Fenn® traps (in protective cages) for Wekas and rats, near but not close to burrows (Ogle 2002).

Burrows have been monitored by direct observations and entrance fencing, in conjunction with predator control, since 1987 (Imber *et al*. 1994). For the first time, in the 1999/2000 season, video-monitoring was used intermittently at four breeding burrows. This 2000/01 study reports the findings of the most intensive Taiko video surveillance undertaken. We know of no other study of burrowing petrels by video-monitoring reported in the literature.

METHODS

Camera equipment

Two types of camera were used: entrance cameras (three sets) for recording activity around the burrow entrance and chamber cameras (two sets) for recording activity on the nest. Each entrance set comprised a video camera (low resolution, black and white, infrared-sensitive security camera in a custom-made waterproof housing), connected to a Panasonic Ag1070DCE 24-h time-lapse video recorder (VCR) by a c.12-m cable, and a custom-made light unit with banks of infrared, light-emitting diodes (SFH415T). The two chamber camera sets consisted of a black and white 420-line pinhole camera with five infrared light-emitting diodes for lighting, connected to a VCR outside the burrow. A Dryfit® 12v/36Ah battery powered each unit.

Entrance fence monitoring

Burrow entrances were monitored throughout the breeding season with the use of fences (small sticks spaced across the entrance). Fences were checked at least weekly from the beginning of the breeding season (early September) until burrows with hatchlings were identified by burrow-scoping, or continued burrow activity, in February. Observations in past seasons showed that most non-breeders ceased visiting in late January. Burrows were then checked every second day, and finally almost daily during the late chick-rearing and fledgling emergence phases (late April – May).

Camera set-up

Entrance fence monitoring early in the season indicated active burrows. Cameras were set up 1-2 m from burrow entrances by tying them to nearby tree trunks or stakes. To identify banded adults the camera was placed level with the top of the entrance mound, and at 45º to the entrance. During chick emergence the camera was moved back to extend the field of view around the burrow entrance. Burrows were illuminated at night by an infrared light positioned beside the camera, usually on the same tree, and directed into the burrow entrance. To ensure minimal risk to birds, potential routes used by Taiko, for landing and walking to take-off sites, were avoided when positioning all components of the video-recording unit.

Chamber cameras were inserted through black plastic piping of 30-mm internal diameter that had previously been installed into the vacant nest chamber utilizing a study hole. The pre-focused camera was positioned at the very end of the tubing to prevent reflection. The camera was anchored within the piping using insulation tape and the study hole lid well secured in place. The VCR and battery were positioned outside the burrow and away from possible Taiko routes.

The burrow camera was monitored nightly or continuously with the VCR on the 24-h time-lapse mode (5.55 frames/s). Videotapes were changed daily. For the entrance camera, the VCR was set to run from just before dusk to just after dawn, usually on the 12-h mode (10 frames/s). Normal speed is 50 frames/s. Videotapes were changed daily, but every second day if 24-h mode was used. Date, time and record mode were superimposed on the recorded picture.

Videotape viewing

All videotapes were viewed from start to finish on fast-forward mode but, when a Taiko or predator was seen, tapes were viewed at normal speed. Because rats may move very quickly through the camera field on fast-forward, the viewer might miss them. Therefore, two videotapes per month from each of the three main groups of burrows were watched at normal speed to count predator visits accurately (compared to fast-forward, no difference was measurable). Taiko and predator video footage were transcribed onto activity log sheets from which the hours of recording, number of birds per night and number of predators per night could be calculated.

Identification of individual Taiko was possible from black and white colour band and numbered metal band combinations, with no more than two bands per leg. These were put on the birds when captured at the burrows, on the ground nearby, or at the light station in the lower Tuku Valley where many were originally caught (Crockett 1994). Tail-mounted, 2-g transmitters were taped to all fledglings when they began to emerge to trace those that crashed in the forest when attempting to depart, so that they could be returned to their burrows when found next day, or taken to the coast after two to four crashes.

Video-monitoring coverage

Sixteen burrows were video-monitored from October 2000 to May 2001, totaling 3696 h (850 h chamber, 2846 h entrance). The number of video hours at any one burrow ranged from 20-764 h. Effective recording hours and the month of recording differed between burrows depending on the birds' activity, the timing of camera set-up and removal, and technical problems. Most coverage was during December and January (incubation). Chamber cameras were used at two burrows only during incubation. April (late chick-rearing) and May (fledgling emergence and departure) also received a relatively high coverage.

Additional entrance monitoring was done in 1999/2000 (four burrows, December-February, 486 h) and in 2001/02 (four burrows, April-May, 703 h) (M. Ogle unpubl. data), and in 2002/03 (11 burrows, September-October, 590 h) (H. Schlumpf unpubl. data).

RESULTS

Adult identity and activity

Taiko identity was confirmed at 12 of the 16 burrows monitored by video in 2000/01. At five burrows only one adult bird was identified as present (four males and one female). No breeding occurred at

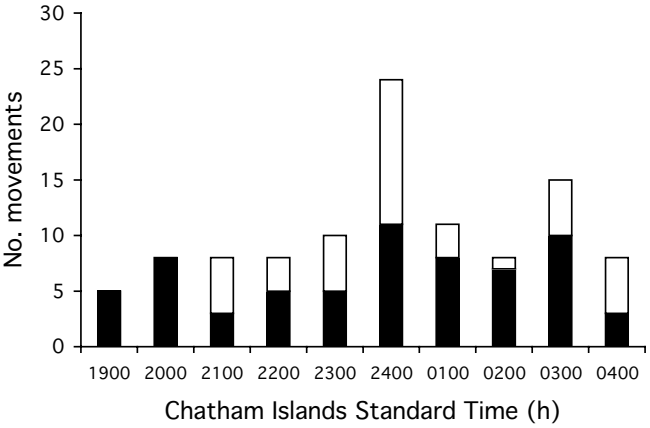

Fig. 1. Activity of breeding (shaded) and non-breeding (clear) Chatham Taiko at burrow entrances on Chatham Island during October-April 2000/01 by hour of night. Includes entries and exits, but repeated movements in and out by the same bird were recorded as only one movement.

any of these. The identity of breeding birds was confirmed at six of the 10 burrows where eggs were laid.

Adult activity from October to April, as measured by appearances (entry or exit) at burrow entrances, occurred throughout the night (Fig. 1), both for breeders and non-breeders. We observed no indication that the video equipment and infrared light disturbed the birds' behaviour.

Incubation behaviour

A chamber camera was first installed on 14 November 2000, when the burrow was unoccupied. Video surveillance was carried out every second night from 22-28 November, and then nightly until 22 December (356 h of observations) (Table 1). The female was first recorded on 26 November, one hour after full darkness, and laid after 54 minutes of nest preparation and 11 minutes out of camera view. On 30 November the male arrived 1.5 h after full darkness. There was a decrease in activity, notably of repositioning egg or body and preening, as his 16-day shift progressed (Table 1). The second incubation changeover on 16 December was completed within 6 minutes. Video-monitoring continued for a further five nights and the female incubated for at least 10 days. Times off the egg would be mainly to defaecate outside the burrow, or to gather nest material.

TABLE 1
Behaviour of a pair of incubating Chatham Taiko from 26 November (egg-laying) to 21 December 2000, expressed as the number of times each act was initiated, as observed during nightly video surveillance

Date	Sex	Reposition egg or body	Move material	Leave egg unattended	Preen
26 Nov.	F lays	0	3	0	0
27 Nov.	F	no obs.	no obs.	no obs.	no obs.
28 Nov.	F	2	1	0	1
29 Nov.	F	6	0	0	15
30 Nov.	F	7	3	0	8
	M	3	2	0	0
1 Dec.	M	6	0	0	3
2 Dec.	M	7	0	0	14
3 Dec.	M	9	1	0	11
4 Dec.	M	5	0	0	4
5 Dec.	M	3	1	2	5
6 Dec.	M	1	0	1	7
7 Dec.	M	1	1	0	2
8 Dec.	M	3	1	0	0
9 Dec.	M	1	0	0	0
10 Dec.	M	1	0	0	1
11 Dec.	M	0	0	0	1
12 Dec.	M	0	0	0	2
13 Dec.	M	0	0	0	1
14 Dec.	M	3	2	0	3
15 Dec.	M	0	0	0	1
16 Dec.	M	1	0	0	1**
	F	3	2	0	1**
17 Dec.	F	3	1	0	1
18 Dec.	F	1	0	0	2
19 Dec.	F	5	2	1	2
20 Dec.	F	0	0	0	1
21 Dec.†	F	1	0	0	3

**Mutual preening

At a second burrow, monitored almost continuously (434 h) from 15 January–6 February, the final changeover (male-female) on 16 January at 24h00, taking only a few minutes, should have almost coincided with hatching (laying *c*. 25 November, incubation *c*. 53 days). However, the embryo had died in late incubation, so the information obtained thereafter was of little value. She left after four days of erratic incubation. The male returned after 10 days, which would perhaps normally have been his first chick-feeding visit. He incubated for 10 days till he also departed.

An entrance camera at a third burrow was run from 29 December-21 January. On 31 December, and 4 and 9 January an adult (probably the female) came out briefly to collect nest material around the entrance, or to excrete. The only change-over during this period was on 12 January.

Parental visits during chick-rearing

The only video recording in February at a successful breeding burrow was at a burrow during early chick-rearing. All three recorded visits over seven nights (31 January-7 February) were by the female. However, she stayed over on two days, so the chick was effectively visited and probably fed on five nights (0.71 visits/night). Subsequent observations showed a decrease in the frequency of chick-feeding visits from March to April as chicks grew (Table 2). There was no difference between the sexes in the frequency of visits. Time adults spent at the burrow during a single visit ranged from 33 minutes to 26.3 h. The average time for five male visits was 174±149 minutes (range 33-350 minutes), and for eight female visits it was 193±117 minutes (range 67-415 minutes). These determinations exclude visits where the adult stayed over during the day. The longest intervals between feeds were 11 days in March (detected by fencing), and 17 days in April (from video monitoring).

Parental visits occurred at any time of night but with a concentration in the first three hours of darkness. Of 18 timed visits, eight were during the period 18h00-21h00, four during 21h00-24h00, three during 24h00-03h00 and three during 03h00-05h00. The last visits were between 22 April and 9 May (mean 29 April) in 2001 (n=3) and 2002 (n=3).

TABLE 2
Parental feeding visits of Chatham Taiko during late chick-rearing in 2000/01, observed by video-monitoring of burrow entrances

Month	Burrow	Hours recorded	Number of nights	Number of visits	Visits /night	Female visits	Male visits
March	A	112	12	4	0.33	3	1
	B	85	9	4	0.44	2	2
April	A	180	20	2	0.10	1	1
	B	145	20	6	0.30	4	2
	C	179	20	5	0.25	1	4
Total		**701**	**81**	**21**	**0.26**	**11**	**10**

Fledgling behaviour

The dates of first emergence of five chicks (three in 2001, two in 2002) ranged from 21 April to 1 May (mean 25 April). For the three chicks intensively observed in 2001, there was an increase in time spent outside the burrow each night as they approached fledging, but behaviour varied. One remained inside the burrow for about half of each night until four nights prior to fledging. Another was regularly spending over half of each night outside the burrow in the 2.5 weeks before fledging. The frequency of wing exercising increased, then decreased. The highest rate of wing-stretching and flapping was by the chick that fledged first.

At the beginning of the emergence period, time of first exit was generally during the period 24h00-02h00 for all chicks. As two of the chicks approached fledging, both began emerging earlier (eventually during 17h00-20h00). In contrast, the third chick continued to emerge much later; often from 01h00-02h00, until departure.

Fledging dates of 18 chicks (six in 2000, five in 2001, seven in 2002) were 6-27 May (mean 15 May). Desertion periods were 9-23 days (mean 16 days, n=6). Of 18 fledglings studied (2000-2002), 61% failed their initial fledging attempt and were rescued next day from the forest. Three fledglings from the leeward side of Tuku Valley had desertion periods of 22 days (range 22-23) compared to the 11 days (range 9-12) of three in windward sites (data available for 2001 and 2002 only). Their times from first emergence to departure were also longer (24 and 27 days vs 16 days for the windward fledgling, 2001 data). The former were also more likely to be rescued (75% of 12 vs 33% of six).

Predator visits to Taiko burrows

Rats were the only predators observed, and were recorded at six of the 16 burrows under intermittent surveillance from October - May 2000/01, including all three with chicks. No effects of rats on Taiko adults, chicks or eggs were observed.

Twenty-five rat visits were recorded during 2846 h of video surveillance, or 0.009 visits/h (Table 3). Median time per visit was 61 s; 72% lasted less than one minute. The majority of visits occurred between 19h00-21h00, and 52% involved burrow entry. Rat visitations were highest in April. Late November through February (egg to early chick stages) is the period of Taiko vulnerability to rat predation, late January–early February being the most vulnerable time when chicks have just hatched and are alone most of the time. Only one rat visit in 487 h was recorded in January-February 2001 (0.002/h).

However, from December 1999 to February 2000 there were 0.027 rat visits/h (486 h), suggesting that rat numbers were higher that breeding season. In the 2002/03 season, 590 h of video observations during late September-October. showed only one rat visit (0.002/h), similar to the 2000/01 rate for October (Table 3).

TABLE 3
Frequency (visits/h) of rat visits and entries to ChathamTaiko burrows, as observed by video-monitoring during the breeding season, October-May 2000/01

Month	Hours of observation	Number of rat visits	Rat visits/h	Mean visit length(s)	Number of entries
October	331	1	0.003	51	0
November	316	0	0	0	0
December	374	3	0.008	138	3
January	401	1	0.003	89	1
February	86	0	0	0	0
March	294	3	0.010	199	2
April	505	12	0.024	31	6
May	539	5	0.009	27	1
Total	**2846**	**25**	**0.009**	**61**	**13**

DISCUSSION

Video monitoring of Taiko burrows was a valuable means of identifying individually colour-banded birds, and observing activities (incubation changeovers, parental visits, fledgling emergence, predator visits) with minimal disturbance of the birds. The main challenge in band identification was getting a clear still frame of each leg, and distinguishing between shiny metal and white bands in the black-and-white picture.

Incubation

The incubation pattern in Taiko seems essentially identical to that in Grey-faced Petrels *Pterodroma macroptera gouldi* (Imber 1976, Johnstone & Davis 1990), and Cook's Petrels *P. cookii* (Imber *et al*. 2003), and probably is the general pattern in this genus. After laying the female incubates for a few days until relieved by the male, or he takes over immediately. Most of incubation is then achieved in three main spells of about equal length (male-female-male), with hatching about the end of this. Females usually hatch, briefly guard and feed the hatchling. The three visits by a female Taiko during 1-6 February to her young chick were consistent with this.

Chick-feeding

Results, based on only three observed burrows, were insufficient to be conclusive. The low feeding rate in April was largely due to 16 nights without a feed to one chick whose male parent made only two visits in 32 nights. He disappeared late next season. Thus there may not usually be such a decrease in the feeding rate from March to April.

Fledgling behaviour from emergence to departure

The aerodynamic problem affecting fledglings from burrows on the leeward side of Tuku Valley delayed their attempts to leave, as they searched for suitable take-off sites or awaited favourable wind. They were then more likely to crash when attempting to depart. Their desertion periods of up to 23 days, and intervals from first emergence to departure of up to 27 days, are unusually long for a petrel (MJI, GAT pers. obs.). Leeward fledglings in Tuku Valley will need to continue to be monitored carefully, to ensure that they depart without excessive delay and in good condition.

Predators

Despite the network of poison stations and traps, a few rats managed to visit burrows but no actual predation incidents were detected. Significantly, no rat visits were seen during 16 January-10 February in 2001, the period when petrels are most vulnerable (undefended hatchlings). Video observations in 1999/2000, 2001/02 and 2002/03 also showed rats to be the only predators visiting burrows, and that Taiko were unharmed in the particular

periods observed. The peak of rat numbers seen in April corresponds with the characteristic, autumnal, post-breeding peak of rodent numbers in New Zealand (pers. obs.). However, cessation of rat trapping in early April may also have contributed to this peak of sightings.

Feral cats are possibly the predator most dangerous to Taiko, especially for fledglings emerging from burrows. As yet no cats have been observed on video but the potential threat is still there, as 69 cats were trapped in the area throughout the 2000/01 season (Ogle 2002). A Taiko humerus only a few years old, found near a breeding burrow in 2001, in an area that had no trapping until 2000 when burrows were found there, seemed to bear signs of cat predation (A.J.D. Tennyson pers. comm.).

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