INCUBATION AND EARLY CHICK-REARING IN THE GREY-BACKED STORM PETREL *(Garrodia nereis)*

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ABSTRACT

The breeding of the Grey-backed Storm Petrel at Houruakopara Island in the Chatham Islands (44°06'S, 176°31'W) was investigated and the nest site, egg, and chick are described. Both parents incubated the egg in poorly synchronised shifts averaging 1.9 days, generally followed by a desertion period of 2.7 days. Eggs hatched from mid-November, and the chick was brooded by either parent for up to 4 days after hatching. Chicks were fed on average every 1.6 days and the size of each feeding increased with age. The average daily increase in body weight was 12.6%, and by 17 days the weight of the chicks equalled that of the adults.

Evidence of competition for nest sites within the species and with Broad-billed Prions *(Pachyptila vittata)* and Little Blue Penguins *(Eudyptula minor)* is discussed and a list of food items taken from regurgitations is presented.

INTRODUCTION

The Grey-backed Storm Petrel *(Garrodia nereis)* has a circumpolar, subantarctic distribution, breeding at Tristan da Cunha, Gough, Marion, Prince Edward, Crozet, Kerguelen, South Georgia, and the Falkland Islands (Croxall 1984). In the New Zealand region, it is known to breed on the Chatham, Antipodes and Auckland Islands and is suspected to breed on islets off Campbell Island (Imber 1985). Imber gave an outline of breeding in New Zealand, and some information on aspects of the breeding cycle at the Crozet Islands was reported by Despin *et al.*(1985), but it remains one of the less studied subantarctic storm petrels.

During the late spring and summer of 1987 I visited the Chatham Islands with the Department of Conservation's Taiko research team. This paper reports the results of observations of breeding Grey-backed Storm Petrels on Houruakopara Island between 14 November and 6 December, particularly incubation and the growth and development of the chick.

STUDY AREA AND METHODS

Houruakopara Island is about 400 m south of Chatham Island at 44° 06' S, 176° 31' W. It is a small island rising to 37 m. About half the land area of c. 5 ha is a low promontory of bare rock on which a colony of 130 pairs of White-fronted Terns *(Sterna striata)* nest; the rest has a low forest of *Dracophyllum arboreum, Olearia* sp. and *Hebe* sp. with an understorey of *Astelia* sp. and other low shrubs. A narrow dense belt of New Zealand flax *(Phormium tenax)* rings the forested area and also grows in scattered pockets

on the rock promontory. Most of the colony of about 300 pairs of Grey-backed Storm Petrels nests in the flax along with similar numbers of Broad-billed Prions *(Pachyptila vittata)*, Little Blue Penguins *(Eudyptula minor)* and a few Sooty Shearwaters *(Puffinus griseus)*.

I marked nests with plastic tape and marked attending birds with numbered metal bands. I did not try to sex the birds. I examined nests daily until I realised that some incubating birds were likely to abandon their egg as a result of frequent handling. Thereafter I inspected most nests every 2-5 days. Adults did not abandon nests with chicks, and I examined and weighed the chicks daily.

RESULTS AND DISCUSSION

Nest site and egg

Unlike other storm petrels, which usually nest in burrows or rock crevices, *G. nereis* lays its egg in cavities formed at the base of dense vegetation (Carrick & Ingham 1967). On Houruakopara Island the nest chamber generally occupied spaces underneath sheaves of dead flax leaves or in "fissures" between the bases of living flax leaves and rhizomes. The nest chamber had no real lining, although shredded flax leaves were often present.

The usual clutch was one egg, but 3 (8%) of the 37 nests I found held two eggs. I found no three-egg clutches as reported by Imber (1985). Of 41 eggs examined, 39 were elongate ellipsoid but 2 (5%) were pyriform. Their ground colour was white with a light scattering of reddish-brown spots more or less restricted to one end but occasionally extending more sparsely over the whole egg.

Eggs on Houruakopara Island were slightly smaller and less heavy (Table 1) than the eggs of birds breeding at the Crozet Islands (Jouventin *et al.* 1985). The ratio of egg weight to adult weight was 25.9%, compared with 28.1% at the Crozet Islands, although Imber (pers. com.) found a ratio of 29.2% for freshly laid eggs at the Chatham Islands. The adult birds of both populations were of similar weight. I did not record the dimensions of live birds on Houruakopara Island, but Table 2 compares the dimensions of Crozet Island birds (Jouventin *et al.* 1985) with those of 48 study skins in the National Museum of New Zealand, which were collected in the New Zealand region (7 from Chatham, 15 from Antipodes, 9 from Campbell and 17 from the Auckland Islands). Birds from both areas were of similar size, and the small differences in the length of the culmen and tarsus probably arose from shrinkage of dried museum material. In the New Zealand region, females had longer wings than males.

TABLE 1 — Weights (g) and dimensions (mm) of *Garrodia nereis* eggs

	This study	Jouventin *et al.* (1985)
Weight (g)		
Mean S.D.,range (n)	8.4 ± 0.9, 6.8 – 9.9 (18)	9.0 ± 0.7, 8.5 – 10.0 (8)
Length (mm)		
Mean S.D.,range (n)	31.2 ± 1.0, 29.2 – 33.0 (9)	33.2 ± 1.9, 31.6 – 37.5 (8)
Breadth (mm)		
Mean S.D.,range (n)	23.2 ± 0.6, 22.0 – 23.9 (9)	24.3 ± 1.1, 22.7 – 25.7 (8)

TABLE 2 — Weights (g) and dimensions (mm) of *Garrodia nereis* adult birds

	This Study	Jouventin *et al.* (1985)
Weight (g): mean S.D.,range (n)		
males and females	32.5 ± 2.3, 29.0 - 37.0 (9)	32 ± 5, 25 - 42 (16)
Culmen (mm): mean S.D.,range (n)		
males	12.8 ± 0.5, 12.0 - 13.8 (23)	
females	13.0 ± 0.4, 12.4 - 13.8 (23)	
males and females	12.9 ± 0.5, 12.0 - 13.8 (46)	13.6 ± 0.7, 12.5 - 15.0 (18)
Tarsus (mm): mean S.D.,range (n)		
males	31.4 ± 1.4, 28.3 - 35.2 (23)	
females	32.6 ± 1.3, 30.3 - 35.3 (24)	
males and females	32.0 ± 1.4, 28.3 - 35.3 (47)	32.6 ± 1.4, 30.0 - 34.0 (18)
Wing (mm): mean S.D.,range (n)		
males	126 ± 4, 116 - 137 (24)	
females	132 ± 3, 127 - 139 (24)	
males and females	129 ± 5, 116 - 139 (48)	127 ± 6, 116 - 134 (18)

Incubation

I followed nest attendance and incubation at nine nests containing one egg. Both partners incubated, alternating between shifts averaging 1.9 ± 1.1 days (range 1-5 days, n = 30). On all but one occasion, shifts were followed by a desertion period lasting 2.7 ± 1.2 days (range 1-7 days, n = 26). Jouventin *et al.* (1985) followed four incubation shifts at one nest and found that the shift length varied from 1-3 days (mean 1.5 days) and that each of three shifts at another nest was followed by a desertion lasting 3.0 ± 2.0 days (range 1-5 days). In the present study the egg was left unattended for a total of 70 (55.6%) of 126 egg-observation days, and using the data of Jouventin *et al.* (1985), I calculated that the eggs of *G. nereis* at the Crozet Islands were deserted for about 50% of the egg period, compared with about 36% for the Black-bellied Storm Petrel *(Fregetta tropica)* and 28.2% for Wilson's Storm Petrel *(Oceanites oceanicus)* at the same localities. In contrast, the eggs of the White-faced Storm Petrel *(Pelagodroma marina)* on Whero Island, New Zealand, were deserted for only 12.9% of the total egg period (Richdale 1965).

Three days is the longest desertion period I know of for an egg that later hatched, but I do not know how the cumulative length of desertions or their timing during incubation influences hatching sucess.

Temporary egg desertion during incubation, a common feature in Procellariiformes, is probably an adaptive mechanism by which the egg can survive long periods of chilling when adverse climatic or feeding conditions prevent the parents returning to the nest (Boersma & Wheelwright 1979). However, my quantitative data should be treated with caution as repeated handling of incubating birds may sometimes have caused premature desertion. Indeed Richdale (1965) commented that the span of incubation in *P. marina* was hard to observe accurately because the birds readily deserted the nest after being handled. Without observer interference (assuming good weather and feeding conditions) the incubation shifts might become longer (and the desertions shorter) and could approach the figure of 5 days reported

by Imber (1985). In future work, incubating birds should be handled only to mark them, for example, with paint rather than metal bands, so that individuals can be recognised without being removed from the nest.

One nest containing a single egg was incubated by three birds. If the three incubating birds are called A, B, and C, and a period of desertion O, the daily sequence of nest attendance over 20 days was ABOCCAOBBBOAOCBBBCCC. I do not know whether this was co-operative breeding (Emlen 1984) or a frustrated breeder showing inappropriate parenting behaviour as a result of competition for nest sites (McLean *et al.* 1987).

Nests with two eggs

Although storm petrels usually lay only one egg (Crossin 1974), I found three nests with two eggs. Two such clutches were being incubated when first found but were permanently abandoned early in the study. The third nest had only one cold egg when first examined on 18 November and was incubated for only 2 days (20 & 21 November) and then deserted until 30 November, when two eggs were present. The eggs were left unincubated until 4 December, when a new bird was sitting on one remaining egg. Imber (1985) has reported that competition for nest sites frequently results in two or even three eggs being laid in the same nest, and two-egg clutches of *P. marina* (Richdale 1965) and the White-throated Storm Petrel *Nesofregetta albigularis* (Crossin 1974) were also attributed to two females. In such circumstances they reported that the extra egg was often infertile or abandoned from an earlier nesting and, almost invariably, none survived to hatching.

Birds may have been unable to recognise their own egg, or at least did not reject those laid by other birds because, on one occasion, when I replaced a damaged egg from one nest with one that had been abandoned and had rolled out of another nest, it was readily incubated by both foster parents.

Hatching

The hatching period was protracted. When I arrived on the island on 14 November, hatching was just beginning. During the next 22 days only 9 (22%) of 34 single-egg clutches hatched. Imber (1985) implied that, in the New Zealand region, eggs hatch from mid-November to the end of January, whereas at the Crozet Islands hatching was confined to the first two weeks of February (Jouventin *et al.* 1985). The laying period in storm petrels, other than those breeding at high latitudes, is usually protracted (Imber 1983) and the differences in timing and length of the hatching period between the two regions are probably caused by the influence of climate on the laying period or other factors such as seasonal availability of food (Croxall 1984).

The empty egg shells were not expelled from the nest chamber and were gradually pulverised by the activities of the birds.

Description of the chick

At one day old the chicks were covered with smoky-grey down about 2.0 cm long. On the ventral surface two bands of paler down, whitish-grey but sometimes almost white, run forward from the base of each leg, gradually

broadening and uniting on the breast. The throat, cheek and face from the base of the bill to just behind the eye were bare, as in *F. tropica* (Beck & Brown 1971). The crown of the head was covered in down, as in *Oceanites oceanicus* (Roberts 1940) and Leach's Storm Petrel *Oceanodroma leucorhoa* (Ainslee & Atkinson 1937) and there was no bald patch as in the British Storm Petrel *Hydrobates pelagicus* (Lockley 1932) or *Pelagodroma marina* (Richdale 1965).

The eye was fully open by the second day. The bill and claws were black but the legs, toes and webs were whitish flesh, becoming greyer from 8 days onwards, until by 14 days they were wholly black, as in the adult. The first quills to emerge were those of the scapulars (9 days), followed by the secondaries and their coverts (10-11 days) and then the primaries and their coverts (12-13 days). At 12-14 days old and thereafter, feather tracts were clearly discernible on the back and the breast.

Chick rearing and food

I followed brooding shifts of the newly hatched chicks in five nests, at which the patterns of attendance at the nest were AAOO (2 nests), AAAO,AAOB and AOOB (one nest each). I did not find adults at the nest by day later than 4 days after the chick hatched. An initial brooding period is common to many storm petrels, including the Madeiran Storm Petrel *Oceanodroma castro* (Allan 1962), *Oceanites oceanicus* (Beck & Brown 1972) and *Hydrobates pelagicus* (Davis 1957a & 1957b), but is absent in others such as *Fregetta tropica* (Beck & Brown 1971).

Chicks grew rapidly (Figure 1) and by 17 days their weight equalled that of the adults. The maximum weight reached was not determined. From the data in Figure 1, I calculated the average daily rate of growth during this period to be 1.74 g per day, the daily increase in body weight being 12.6%, which agrees closely with the 13.0% derived from the data of Despin *et al.* (1972). Chicks were fed on average every 1.6 ± 0.6 days (range 1-3 days, $n = 23$) and the size of each feeding increased with the age of the chick (Figure 2).

Storm petrels often regurgitated food when handled during the chick brooding period, and the lag period shown in Figure 1 over the first few days of growth may have been a result of chicks not getting this food. I found that regurgitation samples of nesting birds contained remains of crustaceans. M.J. Imber examined the samples and confirmed his earlier observation (Imber 1981) that the major food items were planktonic larvae of the cirriped *Lepas australis*, but euphausiids *(Nematoscelis megalops, Nyctiphanes australis)* and two species of amphipod, one of which was *Parathemisto gaudichaudii*, were also present.

Interference by other species

I found four nests with damaged eggs and one with a badly mauled chick as well as two eggs and one chick (2-3 days old) which had been expelled from the nest chamber. Broad-billed Prions and Little Blue Penguins, which were both common on Houruakopara Island, nesting in burrows under the flax, were the most likely cause of interference at the nest. By trampling the ground adjacent to their burrows, prions and penguins left large areas

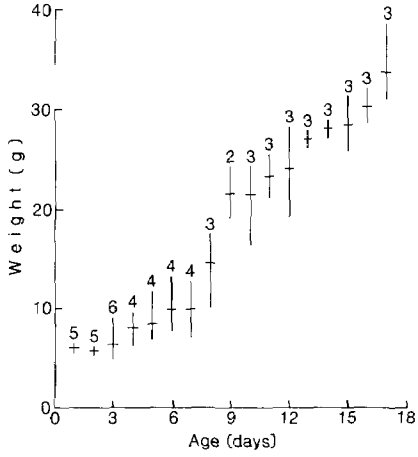

FIGURE 1 — Weight increase in *Garrodia nereis* chicks. Mean, range and sample size

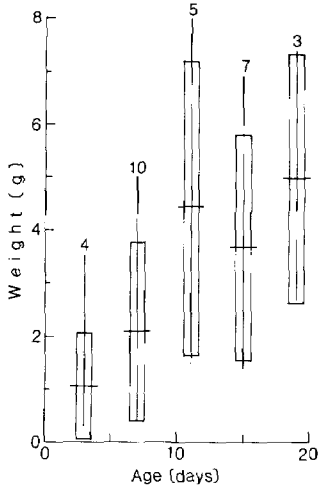

FIGURE 2 — Weight of food given to *Garrodia nereis* chicks during four-day periods. Mean ± standard deviation, range and sample size

of bare earth under the flax, making it unsuitable for storm petrels, which were more abundant where the flax grew on soil too shallow for prions and penguins to burrow. If storm petrels tried to nest in the denser parts of the prion and penguin colonies, the trampling by the larger birds would probably displace or damage their eggs and chicks.

In Tasmania, Gillham (1963) amd Brothers (1981) reported that Short-tailed Shearwaters *(Puffinus tenuirostris)* displaced *Pelagodroma marina* from

mutually favoured burrowing areas. Similarly, Richdale (1965) found evidence of competition between *P. marina* and prions on Whero Island. The storm petrels suffered not so much from aggression by the prions, but from the fact that their nests just happened to be in the prions' way.

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