KERMADEC PETRELS *PTERODROMA NEGLECTA* ON PITCAIRN ISLAND SUFFER BREEDING FAILURE DUE TO INTRODUCED PREDATORS

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Kermadec Petrels *Pterodroma neglecta* are polychromatic trans-equatorial migrant petrels that breed solely on tropical islands in the South Pacific from Norfolk and Lord Howe islands, off Australia, to San Ambrosia and the Juan Fernandez islands, off Chile (Marchant & Higgins 1990, Brooke 2004, Onley & Scofield 2007). They have also bred in very small numbers on Round Island, Mauritius, in the Indian Ocean in recent years (Brooke *et al.* 2000); 150 000–200 000 pairs are estimated to breed worldwide (Brooke 2004). They differ from many petrels in being surface-breeders, making only a hollow scrape, often under vegetation (Brooke 2004), and they are asynchronous breeders. On the Meyer islands (Kermadec group) and on Henderson Island, the petrels are present on eggs mainly from November through June, but with a peak in February and March (Brooke 1995a, Veitch & Harper 1998). Breeding dates on Motu Nui, Easter Island, and on the Juan Fernandez islands are similar (Lönneberg 1921). On the Kermadec islands, petrels may breed annually or semi-annually, or even less often (Veitch & Harper 1998). This timing fits with the numerous records of migrating Kermadec Petrels across the North Pacific from Japan to Mexico during June–November (Marchant & Higgins 1990).

Here we report the breeding of Kermadec Petrels on Pitcairn Island and include the phenology and fate of nests. Pitcairn (25.07°S, 130.11°W, Fig. 1) is a very small (4.6 km^2) island between Australia and South America. It is a British Overseas Territory and has a permanent population of <50 people. The vegetation has been heavily modified, and Pacific rats *Rattus exulans* were introduced during Polynesian expansion in the South Pacific >1 200 years ago (Weisler 1995), and are still present following a failed eradication attempt in 1997 (Hilton & Cuthbert 2010). House mice *Mus musculus* were introduced in 1942 and remain on the island (Williams 1960, pers. obs.). Cats *Felis catus* are also present in low numbers following a failed eradication attempt in 1997. The presence of these introduced predators has resulted in a severely depauperate avifauna (Wragg 1995), and many seabirds are now restricted to breeding on offshore rocks and stacks (Williams 1960, Brooke 1995b). Indeed, introduced rodents are found on many oceanic islands and cause considerable damage to native ecosystems (Atkinson 1985, Croll *et al.* 2005). Seabirds, which often lack behaviours to defend against terrestrial predators, are severely affected by introduced vertebrate predators such as rats, cats and mice (Jones *et al.* 2008, Hilton & Cuthbert 2010, Medina *et al.* 2011, Croxall *et al.* 2012). Seabirds on islands with introduced predators have lower reproductive success and more variable demographic rates; they often show population declines (Wanless *et al.* 2007, Lavers *et al.* 2010, Cuthbert *et al.* 2013, Major *et al.* 2013).

Following Kermadec Petrels' extermination on Raoul Island, Kermadec group, today many breed on remote, uninhabited islands in the Pitcairn group, where there are estimated to be 30 000 pairs on Ducie, 10 000 pairs on Henderson, and approximately 100 pairs on Oeno (Brooke 1995b). The nearest colonies to the Pitcairn group remain on rat-free islets off Easter Island (Murphy & Pennoyer 1952, Marchant & Higgins 1990), >2000 km east of Pitcairn Island. Kermadec petrels have not previously been recorded from Pitcairn Island, likely owing to the predation of eggs and chicks by introduced mammals (Williams 1960, Brooke 1995b).

Observations of Kermadec Petrels on Pitcairn were made between 13 March and 19 May 2015. They were seen flying over the island by day, and we located their nests on the slope on Garnet's Ridge above Christian's Cave (Figs. 2, 3). Nests (n = 8) were visited every 5–8 d. The area is moderately sloping and grassy (roughly 15 × 25–40 m), with scattered shrubs and six to 10 small trees set within adjacent steep cliffs, making it virtually impossible to access without rope assistance. Incubating birds could be watched easily through binoculars and a spotting scope. They were found nesting on the surface between tree roots and boulders in low vegetation, with the contents easily observed from a house 150–200 m away, or from the ridge above (5–15 m away) using 10 × 42 binoculars or a 40× scope.

We estimated hatching dates by taking the mid-point between the first observation of a chick and the previous nest visit. Dates of nest failure were also taken as the mid-point between observations with an active and failed nest. We also estimated laying dates by assuming an incubation period of 50–55 d (Oliver 1955, Marchant & Higgins 1990, Brooke 1995a). In our efforts, we found that chicks hatched from 14 April to 6 May 2015 (mean ± SD: 27 April ± 7 d; n = 7; one nest had not hatched by the time we departed). On the basis of hatch date, we estimated that eggs were laid from 23 February to 21 March 2015, having also observed the exact laying date of one nest (16 March). Of the seven nests observed, all produced chicks, but none fledged young. All chicks disappeared 5–15 d after hatching (mean ± SD: 11 ± 5 d, n = 7). Similar to other locations, as noted above, it appears likely that birds on Pitcairn have a similarly protracted breeding cycle, although whether the birds breed sub-annually (e.g. Ashmole 1963, Hamer *et al.* 2002) owing to the high rates of nest failure is unknown.

Although our sample of nests was small, that they all failed within 15 d of hatching suggests that the likely cause was introduced rodents, either rats or mice. Mice often target recently hatched chicks, killing them within days after the adults cease brooding (Dilley *et al.* 2015), and rats likely do the same.

Previous expeditions to Pitcairn did not find breeding Kermadec Petrels (Williams 1960, Brooke 1995a, b), and no specimens known to be from Pitcairn exist in museums. We doubt, however, that this is a recent colonization, and we suspect that their presence, in low numbers, may have been overlooked in the past. Pitcairn Islanders are familiar with the bird, and recognize it as one of three *Pterodroma* spp. present (along with Phoenix Petrel *P. alba* and Herald Petrel *P. heraldica*). Introduced mammalian predators could well have quickly reduced or extirpated the species (Brooke 1995a, Brooke *et al.* 2010), as they have other seabirds.

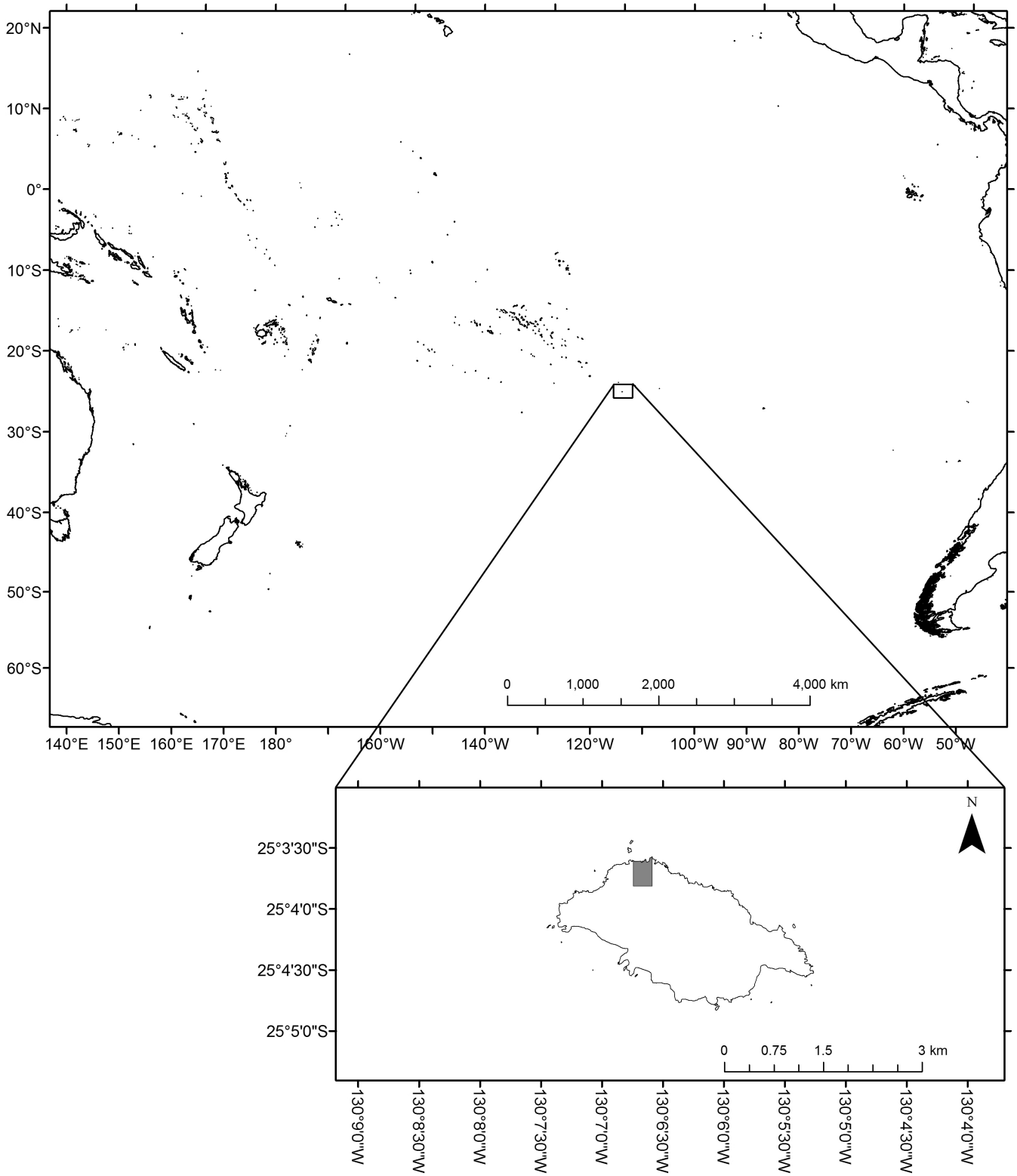

Fig. 1. Location of Pitcairn Island in the Pacific Ocean; in the inset, the Kermadec Petrel nesting site at Garnet's Ridge is indicated in grey.

Elsewhere, Kermadec Petrels respond positively to the eradication of introduced vertebrates. On Raoul Island, Kermadec islands, they numbered in the hundreds of thousands of pairs in the late 19th century, but had been extirpated by rats and cats by 1967 (Merton 1970, Meredith 1991, Holdaway & Anderson 2001) and are only now beginning to return (Bellingham *et al.* 2010, Veitch *et al.* 2011). Kermadec Petrels on Phillip Island, off Norfolk Island, returned in 1986 (Coyne 2010, Priddel *et al.* 2010). The combination of human habitation and introduced rats, mice, and cats on Pitcairn Island likely means that seabird populations will continue to suffer breeding failure on the main island.

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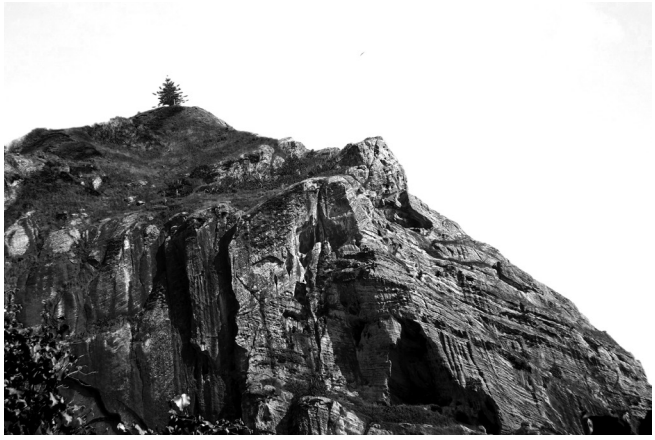

Fig. 2. Kermadec Petrel nesting site on part of Garnet's Ridge, Pitcairn Island. Nests were located in the vegetation just above the cliff. Photo by A. Schofield.

Fig. 3. Aerial photograph of Garnet's Ridge, Pitcairn Island, with the location of the Kermadec Petrel nests outlined in black. Photo courtesy of Pitcairn Natural Resources Division.

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