A SUCCESS STORY: BREEDING OF BURROWING PETRELS (PROCELLARIIDAE) BEFORE AND AFTER THE ERADICATION OF FERAL CATS *FELIS CATUS* AT SUBANTARCTIC MARION ISLAND

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SUMMARY

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Greatwinged Petrels *Pterodroma macroptera* and Blue Petrels *Halobaena caerulea* bred more successfully after the eradication in 1991 of feral domestic cats *Felis catus* at subantarctic Marion Island. The larger Whitechinned Petrel *Procellaria aequinoctialis* did not show such improvement, although percentage burrow occupancy in the late breeding season increased significantly between 1982/83 and 1988/89 for that species, suggesting decreased cat predation during this period of cat control. Breeding success and burrow density of selected species of burrowing petrels should be monitored to ascertain the rate of recovery of their populations now that Marion Island is cat-free.

INTRODUCTION

Feral domestic cats *Felis catus*, first introduced in 1949, are now extinct at sub-Antarctic Marion Island (46° 55'S, 37° 45'E), following a successful eradication programme that commenced in 1977 (Bester & Skinner 1991, Bloomer & Bester 1992). The last cats were trapped in July 1991 and continued trapping to March 1993 yielded no further kills or signs of live cats (Bester 1993).

Burrowing petrels (Procellariidae), including chicks, formed the main prey of the cats (van Aarde 1980, van Rensburg 1985, Bloomer & Bester 1990). Cat predation resulted in low breeding success of burrowing petrels (e.g. Schramm 1983, Fugler *et al.* 1987, Newton &

Fugler 1989) and an assumed reduction in population sizes, as evidenced by low burrow densities in comparison to those at nearby Prince Edward Island, which has always been cat-free (Schramm 1986). The effects of cat predation on breeding success of burrowing petrels have also been shown by higher levels of late-season burrow occupancy for three species within cat-free exclosures compared to controls (van Rensburg & Bester 1988).

The breeding success of one species of burrowing petrel, the winter-breeding Greatwinged Petrel *Pterodroma macroptera*, improved from 0% to 59.6% over the period 1979 to 1990 as a result of the reduction of cat numbers due to the eradication programme (Cooper & Fourie 1991).

In this paper we report new information on breeding success of the Greatwinged Petrel at Marion Island before and after the eradication of feral cats, as well as that of two summer-breeding burrowing petrels: the Whitechinned Petrel *Procellaria aequinoctialis* and the Blue Petrel *Halobaena caerulea*.

METHODS

The breeding success of Greatwinged Petrels was assessed by AvNM in 1991, following the techniques and in the same area as described by Cooper & Fourie (1991). Essentially, regular observations were made, from prior to laying until chick departure, of the contents of marked burrows provided with removable observation plugs (Sinclair 1981, Schramm 1983) . Whitechinned and Blue Petrels were similarly monitored in the 1991/92 austral summer, the former species in the vicinity of the meteorological station, the latter at Long Ridge, where breeding success of Blue Petrels had also been recorded previously (Fugler *et al.* 1987). Unpublished information on Whitechinned Petrel breeding success, collected at Marion Island in the 1980/81 summer by A. Berruti, is also reported.

In three summer seasons (1986/87-1988/89) the occupancy of Whitechinned Petrel burrows on Junior's Kop and in Nellie Humps was assessed by MNB, JPB and D.D. Muller following the methodology of van Rensburg & Bester (1988). This entailed placing a row of match sticks, soaked in formalin to avoid disturbance by introduced house mice *Mus musculus*, at burrow entrances and scoring visitations by their displacement. Burrows were inspected on alternate days for the last two weeks of the months December to March. Disturbed match sticks, along with signs of recent burrowing activity, recent scratch marks, newly discarded feathers and calls from within burrows were taken as evidence of continued breeding. The absence of signs of visits during the second half of the breeding season was considered indicative of breeding failure. "Breeding success" for Whitechinned Petrels in these burrows was taken to be the percentage of the total number of burrows occupied at the start of the breeding season that were still being visited towards the end of the season (van Rensburg & Bester 1988). This percentage burrow occupancy is not equivalent to the usual measure of breeding success, expressed as the percentage of chicks fledged per eggs laid, which was available for burrows provided with observation plugs, since it presumably included burrows in which no eggs were laid. For example, eggs were later recorded in only 53 (76%) of 70 Greatwinged Petrel burrows that contained adult birds on 19 May 1991 prior to any eggs being laid. For Whitechinned Petrels in 1991/92 the comparable figure was 86%. This suggests that "breeding success" calculated from burrow occupancy by the method of van Rensburg & Bester (1988) will be too low, since burrows in which no eggs were laid would have been included. However, nest visitations after failure would compensate for this bias to some degree, as would the fact that chick departure of Whitechinned Petrels occurs in April at Marion Island (unpubl. data), allowing for failures to occur after March.

RESULTS

Breeding success of Greatwinged Petrels in 1991 was 64.2% (n=53), of Whitechinned Petrels in 1991/92 21.8% (n=55), and of Blue Petrels in 1991/92 64.0% (n=50) (Table 1). Breeding success of Whitechinned Petrels in the earlier 1980/81 study was 36.2% (n=47). No signs of cat predation (Cooper & Fourie 1991) were seen in the 1990s' studies or in the earlier Whitechinned Petrel study of 1980/81.

The percentages of Whitechinned Petrel burrows still occupied in March for the years 1986/87, 1987/88 and 1988/89 were 69.0% (n=71), 72.8% (n=66) and 75.8% (n=91). This increase is not significant ($X^2 = 0.93$, $p > 0.5$).

DISCUSSION

It is clear that for two species, the Greatwinged and the Blue Petrel, breeding success has increased markedly since the eradication of cats at Marion Island, but not for the Whitechinned Petrel, where no significant difference was detected between years ($X^2 = 1.84$, $P > 0.1$, Table 1). As reported by Cooper & Fourie (1991), an improvement in breeding success of the Greatwinged Petrel had already occurred in 1990, prior to cat eradication (Table 1), albeit when the remaining number of cats was very low.

Whitechinned Petrel burrow occupancy percentage in March 1982/83 was 55.6% (van Rensburg & Bester 1982), significantly lower than in the same month in 1988/89 ($X^2 = 4.12$, $P < 0.05$), although not when compared with 1986/87 ($X^2 = 1.52$, $p > 0.05$). In 1982/83 cat exclosures had significantly higher burrow occupancy percentages of Whitechinned Petrels than did controls (as they did for Greatwinged Petrels), suggesting that, at that time, cat predation was having an effect on breeding success.

TABLE 1

BREEDING SUCCESS (%) OF BURROWING PETRELS (PROCELLARIIDAE) BEFORE AND AFTER THE ERADICATION OF FERAL CATS AT MARION ISLAND

Year	Greatwinged Petrel	Blue Petrel	Whitechinned Petrel	Source
		Before cat extinction		
1979	0.0 (47) *			Schramm (1983)
1980	0.9 (39)			Schramm (1983)
1980/81			36.2 (47)	This study
1982	20.5 (53)			Newton & Fugler (1989)
1982/83		23.5 (17)		Fugler *et al.* (1987)
1984	0.0 (35)			Newton & Fugler (1989)
1990	59.6 (47)			Cooper & Fourie (1991)
		After cat extinction		
1991	64.2 (53)			This study
1991/92		64.0 (50)	21.8 (55)	This study

*Sample sizes in parentheses.

Whitechinned Petrels, mainly chicks, formed a relatively small part of the diet of cats: frequency of occurrence of remains in cat stomachs in three studies between 1974 and 1989 ranged from 0.9% to 8.6% (van Aarde 1980, van Rensburg 1985, Bloomer & Bester 1990). Van Rensburg & Bester (1988) attribute this to the species' large size, aggressive nature and low density. The low breeding success of Whitechinned Petrels in 1980/81 and 1991/92 may have been due to increased predation by Subantarctic Skuas *Catharacta antarctica*, which regularly investigate burrows fitted with observation plugs. In March 1992 several earth plugs were seen by JC to be loosely fitting due to having partially dried out, thus potentially allowing access to skuas. Breeding success of the Whitechinned Petrel varied from 12-54% at South Georgia in the absence of predators other than Subantarctic Skuas (Hall 1987), so the percentages obtained at Marion Island may not be abnormally low.

Breeding success of some other burrowing petrel species studied at Marion Island before the eradication of cats has also been low: 7.9% for Softplumaged Petrels *P. mollis* in 1979/80, for instance, although in that season Kerguelen Petrels *Lugensa brevirostris* bred at a more respectable 53.3% (Schramm 1983). Based on small samples, Salvin's Prions *Pachyptila salvini* had a hatching success of 44% and a fledging success of 73% in 1980/81 (Berruti & Hunter 1986). This species, which formed a large percentage of the diet of cats (van Aarde 1980, van Rensburg 1985, Bloomer & Bester 1990), was found by van Rensburg & Bester (1988) to have bred more successfully in cat exclosures than in control areas in 1982/83. Grey Petrels *Procellaria cinerea*, a winter-breeding species, had zero breeding success in two of three years of study prior to the eradication of cats, although sample sizes were small. Overall, only three chicks fledged from 23 burrows studied during the period 1979 to 1984 (Newton & Fugler 1989). Common Diving Petrels *Pelecanoides urinatrix* have not been recorded breeding at Marion Island since 1952 (Rand 1954), despite subsequent investigations (van Zinderen Bakker 1971, Schramm 1986). As a consequence, it has been assumed that the species is extinct at Marion Island, due to cat predation (van Aarde 1980, Brooke 1984, Williams 1984). Feral cats can therefore be seen to have affected the breeding of most, if not all, the burrowing petrel species of Marion Island.

Improved breeding of burrowing petrels at Marion Island following the eradication of cats represents a success story. As the larger numbers of birds fledging from successful post-cat breeding efforts mature and join the breeding population an increase in the numbers of occupied burrows should occur. Perhaps at some time next century burrowing petrels at Marion Island will occur at similar densities to those of Prince Edward Island.

We recommend that the breeding success and density of selected winter and summer-breeding species of burrowing petrels at Marion Island should now be assessed at regular (perhaps five-year) intervals to ascertain the rate of recovery of their populations. However, the currently reduced populations, coupled with delayed maturity in procellariids (Warham 1990), suggest that population increases will be initially slow.

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