Breeding ecology of Antarctic petrels and southern fulmars in coastal Antarctica

Creuwels, Jeroen Cornelis Steven

BOX

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Timing of moult in the annual cycle

The timing of the moult is an aspect of the annual cycle that deserves special attention when studying species that breed in a highly seasonal environment with short summers. Like many other bird species, most procellariiformes have little temporal overlap in breeding and moult periods, due to the high energetic costs of both episodes (Stresemann & Stresemann 1966). Feather synthesis is highly energy demanding and the moult of the wing feathers might reduce flight capacity or manoeuvrability (Warham 1996). We investigated how the Southern Fulmars and Antarctic Petrels fitted their wing moult in their annual cycle, given the different timing of their breeding events.

We routinely measured the moult of the wing feathers in individuals that were banded during the season. Fulmarine petrels annually moult their primaries in a relatively simultaneous and regular manner, starting with the most innermost primary and ending with the most outermost primary. Moult scores of ten large primary remiges (the minute eleventh was not considered) were determined according to standard methods (Ginn & Melville 1983, Lowe 1989) in which feather growth was estimated on a scale of 0 (old feather) to 5 (new feather). To reduce the handling time and because wing moult is rather synchronous in fulmarine procellariiforms, only one wing was examined (Hunter 1984, Barbraud & Chastel 1998). Moulting scores were then multiplied by two, resulting in a Primary Moulting Score (PMS) of 100 when a bird has been fully moulted.

We banded birds in and outside the study areas on Ardery Island during 1996-99 and data on breeding status (active breeding, failed breeders, or unknown) were recorded when available. Individuals with a breeding failure less than 2 days ago were counted as successful breeding. We present only data of birds after 1 January, because none of examined individuals before this date were moulting. Data of three seasons were combined, because sample sizes in each year were small and no seasonal effects were found.

From Fig. 1 it is clear that Southern Fulmars start moulting earlier than Antarctic Petrels, especially if we take the differences in timing of breeding into account. For successfully breeding birds, wing moult in Southern Fulmars on average starts 41 days after egg laying, whereas in Antarctic Petrels this is after 71 days. Wing moult

in successfully breeding individuals was observed in 76.2% of the Southern Fulmars and 22.6% of the Antarctic Petrels that were examined after 1 January. In both species, the group 'Unknown' probably consisted of many non-breeding or early-failed individuals, which were able to start their primary moult about 2-3 weeks earlier. Failed breeders have a moulting pattern which falls somewhat in between the two other breeding status categories, but this sample size was small. The first completely moulted Southern Fulmars were observed in the second week of March. In Antarctic Petrels, the colony attendance declines rapidly in the second half of January (see Chapter 2), which explains the low numbers and the occurrence of only successful breeders in February.

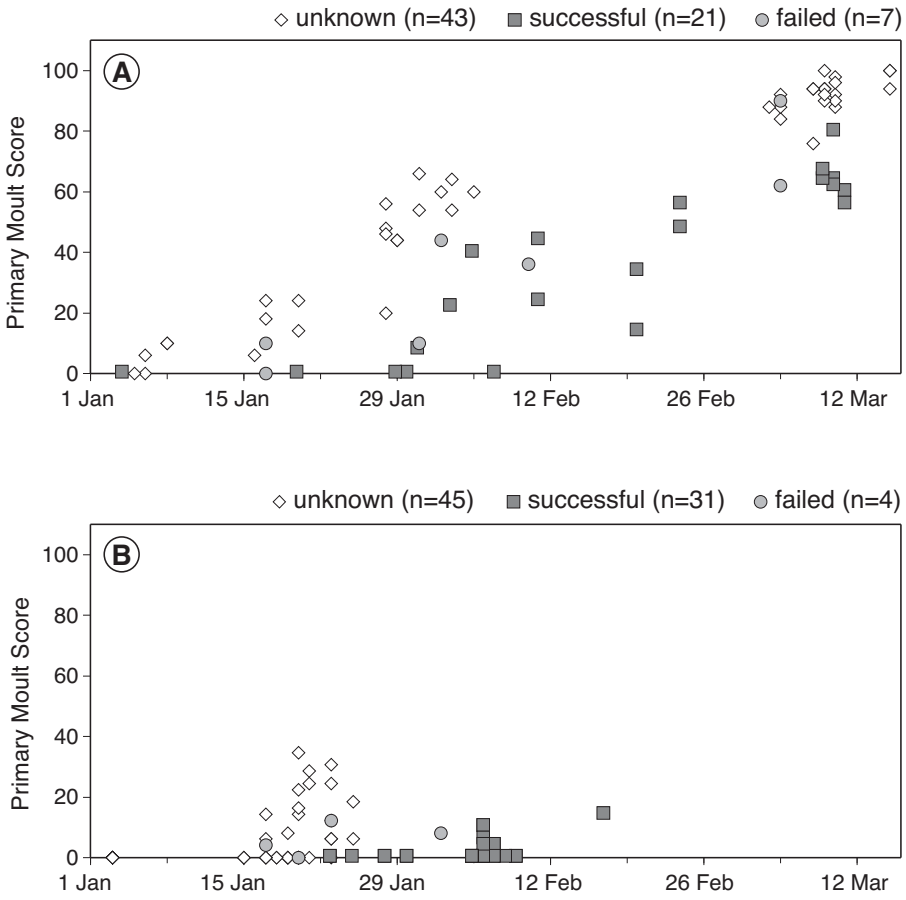

Figure 1. Primary Moult Score of Southern Fulmars (a) and Antarctic Petrels (b). Data of three years are combined and only individuals that were examined after 1 January are shown.

The rate of primary moult did not differ between the various groups with a different breeding status, probably due to small sample sizes in some categories ($F_{5,110}$ = 0.58, P = 0.713). Southern Fulmars, however, moulted their primaries earlier than Antarctic Petrels (2-way ANCOVA; $F_{1,117}$ = 84.04, P < 0.001).

It was suggested that by shifting the breeding period to the earlier part of the season Antarctic fulmarine petrels would allow time for completion of the wing moult on the breeding grounds (Beck 1970). This appeared not to be true for Antarctic Petrels. Successfully breeding Antarctic Petrels were postponing their moult until very late or even after the chick period, like Snow and Cape Petrels (Beck 1969). Antarctic Petrels might need their flight feathers for their long provisioning flights to compensate their high wing loading. Antarctic Petrels deliver relatively heavier meals to their chicks than Southern Fulmars (see Chapter 3). In order to arrive in time at their favourite habitat for moulting they might have to compress their time in the colony and to desert their chicks about a week before fledging (Chapter 3). Ainley *et al*. (2006) observed in February-March almost flightless Antarctic Petrels which had lost most of their wing and or tail feathers together with Snow Petrels in a similar condition roosting on ice floes.

Southern Fulmars start their moult already during early chick period, but we did not find that all individuals were already moulting their primaries in early January like in another colony on the coast of East Antarctica (Barbraud & Chastel 1998). Due to the late fledging date and longer moult periods (larger feathers) Southern Fulmars probably cannot avoid a temporal overlap of these two costly periods of the annual cycle, which is only possible when energy and nutrients are sufficiently available. We do not have data on individual moulting schedules, but based on a longitudinal dataset (Fig. 1) we would estimate that Southern Fulmars need about 75 days to complete wing moult. Despite reforming sea-ice in March, successfully breeding Southern Fulmars are still seen in the colony after their chicks have fledged. Thus the fact that Southern Fulmars have higher colony attendance and remain much longer at their colonies may thus not only be related to the high chick requirements that they have to satisfy, but could be also a consequence of their moulting strategy.