MODES OF MOULT OF FLIGHT FEATHERS IN ALBATROSSES

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INTRODUCTION AND METHODS

The flight feathers of a bird are the primaries which adhere to the bones (other than the pollex) of the manus or hand, the secondaries which adhere to the ulna, the alula quills which adhere to the pollex of the manus and the tail feathers which adhere to the pygostyle, the fused remnant of the dinosaurian tail. A mode is an order or pattern of replacement of feathers by moulting, the growth of new feathers which push out the old ones. Modes of moult of flight feathers in albatrosses Diomedeidae are unknown (Cramp & Simmons 1977). This paper provides data on the modes which prove to vary by age and which differ substantially from those found in their nearest relatives, the Procellariidae. Attention is drawn to the ecological problems involved including the moult season, if any.

As a result of previous work cited below on modes of moult of flight feathers in large birds, I became aware some time ago that the modes in albatrosses were not simple and that no author appeared to have dealt with the matter in any depth. I have not examined nearly sufficient birds to provide a definitive study : 10 study skins in the South African Museum and 14 frozen birds collected in 1979 by the FitzPatrick Institute for other purposes. However, I think I have seen and read enough, particularly Bloesch *et al.* (1977), to lay out the basic patterns in the family for the guidance of those who may be in a position to collect further data which will clarify or modify the views presented here or who can examine the ecological and other pressures which have induced the patterns found.

Four Shy Albatrosses *Diomedea cauta cauta*, six Yellownosed Albatrosses *Diomedea chlororhynchos* (three each of *D. c. chlorhynchos* and *D. c. bassi* distinguished by Brooke *et al.* 1980), four Wandering Albatrosses *D. exulans chionoptera sensu* Jouanin & Mougin (1979) and 10 Blackbrowed Albatrosses *D. melanophris melanophris* have been examined. These 24 specimens are randomly distributed as regards age and sex. They come from Gough Island, the Prince Edward Islands and the seas and coasts of South Africa.

RESULTS

Primaries

Juveniles, birds in their first coat of normal feathers and probably less than a year old, show no evidence of moult of the flight feathers and all feathers are of equal age, fresh or worn depending on the time elapsed since fledging. Immature birds which have started to moult flight feathers show the simple descending mode in the primaries, starting with the innermost

primary. Some Yellownosed Albatrosses, adults by plumage, also show the simple descending mode. All other adult albatrosses show wave moult or *staffelmauser*, the mode in which another descending moult starts before a previous moult has been completed. A bird showing wave moult appears to have a jumble of fresh, normal, worn, old and growing feathers and the greater the number of waves of moult that have passed down the primaries the greater the apparent jumble. In the light of this finding it is apparent that wave moult occurs in other albatrosses : the Blackfooted Albatross *D. nigripes* (Loomis 1918 who speaks of a lack of uniformity), the Shorttailed Albatross *D. albatrus* (Stresemann & Stresemann 1966 who schedule two specimens, one under the synonymous name *D. brachyura*), the Shy Albatross *D. c. salvini* (Stresemann & Stresemann 1966) and the Waved Albatross *D. irrorata* (Harris 1973). I expect that the same phenomenon occurs in sooty albatrosses of the genus *Phoebetria* but I have yet to come across any evidence one way or the other.

There are three modes of moult of the primaries found among the four families of the Procellariiformes, wave moult in the Diomedeidae, the simple descending mode in the Procellariidae and Oceanitidae (a senior synonym of the better known Hydrobatidae) and the simultaneous mode in those Pelecanoididae in which the simple descending mode does not occur (Payne & Prince 1979). Wave moult is quite widespread in large and middle size non-passerine birds (Stresemann & Stresemann 1966 : 22) to which may be added several eagles and buzzards by interpreting the data in Brooke *et al.* (1972) and Brooke (1974a & b). It probably occurs in large bustards and cranes which are said to have a jumbled mode in the primaries (Stresemann & Stresemann 1966). But the occurrence of wave moult is not just a response to increasing size since it does not occur in all large birds. The Southern Giant Petrel *Macronectes giganteus* is as large as the smaller albatrosses but irrespective of age has a simple descending moult of the primaries lasting *c.* 93 days every year, some ten days longer than the period taken by some smaller members of its family, the Procellariidae (Conroy 1972).

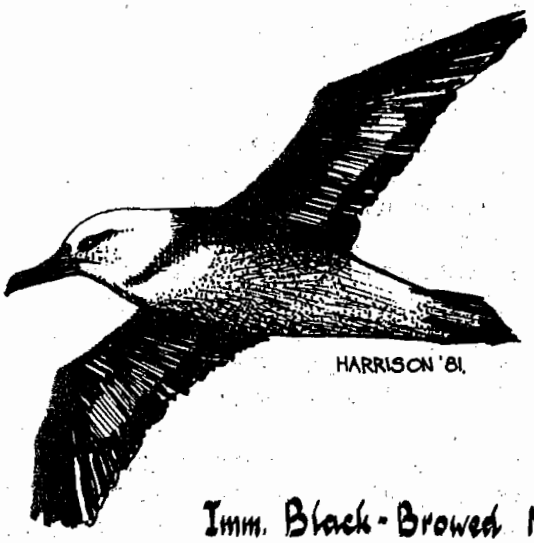
Examination of the state of the primaries provides an age character in albatrosses which can be used in combination with those provided by plumage and soft part characters. If all primary feathers are of equal age, the bird is a juvenile, i.e. probably less than one year from fledging. If the simple descending mode is present, the bird is immature. If wave moult is present, the bird is adult or nearly so. This correlation of age class and moult pattern is also found in all members of the Sulidae (Nelson 1978), some cormorants (Reed Cormorant *Phalacrocorax africanus*, Cape Cormorant *P. capensis*, White-breasted Cormorant *P. carbo* and Crowned Cormorant *P. coronatus* (pers.obs.) but not in the Shag *P. aristotelis* Potts 1971)), the White Stork *Ciconia ciconia* (Bloesch *et al.* 1977), buzzards *Buteo* spp. and eagles *Aquila* and *Hieraaetus* spp. (Brooke *et al.* 1972, Brooke 1974a & b), the Crowned Plover *Vanellus coronatus* (Edwards 1975), the Southern Ground Hornbill *Bucorvus leadbeateri* (Brooke & Kemp 1973) and doubtless many other species in which wave moult occurs.

Interrupted moult, moult ceasing before the series has been completed, is commonplace in both immature and adult albatrosses,

TABLE 1

MONTHS OF OCCURRENCE OF ACTIVE MOULT OF FLIGHT FEATHERS IN SOUTHERN HEMISPHERE ALBATROSSES

Taxon	Month	Source
Wandering Albatross *Diomedea exulans chionopters*	Feb., Sept. Oct.	This study Falla 1937: 114
Shy Albatross *D. cauta cauta*	April June, July, Oct.	Kinsky 1968: 147 This study
D. c. salvini	Feb. March	Kinsky 1968: 147 Stresemann & Stresemann 1966: 300
Blackbrowed Albatross *D. melanophris melanophris*	April May June, Nov.	This study Falla 1937: 122 This study
Yellownosed Albatross *D. chlororhynchos chlororhynchos*	July	This study
D. c. bassi	Sept., Oct.	This study
Greyheaded Albatross *D. chrysostoma*	May	Falla 1937: 127



Imm. Black-Browed Mollymawk ~ Southern Ocean.

occurring in 79 % of the individuals examined (n = 19). While adults interrupt moult to breed and so presumably avoid excessive energy consumption this does not apply to immature birds in which interrupted moult is also normal. I do not wish to guess at the reasons why immature albatrosses, and probably adults too, interrupt moult while at sea which is where they undertake most of their moulting (Berruti 1979).

Moult of the primaries is normally symmetrical in both wings and when it is not the discrepancy is normally slight. This is also true of the tail feathers. However, the secondaries and, to a lesser extent, the alula quills show little or no symmetry. An adult male Blackbrowed Albatross obtained feeding at a trawler off the Cape on 28 June 1979 had primaries 7, 8 and 9 on both sides growing and both tenth primaries had been dropped. This shortened the wingspan by *c.* 0,5 m, apparently without undue stress to the bird. In addition, all tail feathers, except both 2 which were old, were growing. This I believe to be an unusual case.

Secondaries

It seems from examining immature Blackbrowed Albatrosses that the basic mode in the secondaries is an ascending one from two centres, secondaries 1 (the outermost) and 19 or 20. Although albatrosses are diastataxic the missing secondary, original 5, does not appear to have caused another moult centre as it often does (Stresemann & Stresemann 1966). Subsequent moults of the secondaries appear to be the result of the random replacement of feathers though further evidence may show that this phenomenon is the result of wave moult, starting perhaps asynchronously, from both centres. As noted above, there is marked asymmetry in the moult of secondaries in adult albatrosses.

Alula quills

There are four functional alula quills. The basic mode is a simple descending one but wave moult occurs regularly in adults.

Tail feathers

The four albatross species examined, whether adult or immature, show a three centred mode of replacement in each side of the tail (six feathers a side). This is mode 9 of Stresemann and Stresemann (1966: 26). However, it is not rare to find aberrations in the mode which obscure it. Attention was drawn above to the parallelism of albatross and eagle modes in the primaries. It fails here since there is no change in mode with age in albatrosses as there is in eagles (Brooke *et al.* 1972). As noted above, tail moult is normally symmetrical.

Stresemann and Stresemann (1966: 25) state that in the Procellariiformes the tail normally shows a jumbled mode but that (p.301) the mode is simultaneous in the Snow Petrel *Pagodroma nivea*, the Pintado Petrel *Daption capense* and the Antarctic Petrel *Thalassoica antarctica*. In view of an aberrant Blackbrowed Albatross (discussed above) showing a nearly simultaneous moult of the tail feathers the phenomenon is probably widespread in the Order. It remains to be investigated whether the simultaneous mode is correlated with breeding in the Antarctic as Stresemann

and Stresemann (1966) believed, or with having a short tail hardly extending beyond the tail coverts which can by themselves provide most of the aerodynamic functions of the tail.

TIME OF MOULT

Kinsky (1968) believed that moult of the primaries was strictly seasonal and that different races of the Shy Albatross had different moult seasons. This seems unlikely. Moult of flight feathers has been observed in nine months of the year, the missing months being August, December and January (Table 1). The omissions are probably due to small sample size. It is possible that immatures and adults may moult at different times just as failed breeders often moult earlier than successful breeders. Attention has been drawn to the high frequency of interrupted moult which should lead to resumption of moult when conditions improve irrespective of the season. Until it is known what causes moult interruption it is doubtful that much headway can be made in determining whether a basic seasonality of primary moult occurs in albatrosses and whether this differs by taxon or age class.

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REFERENCES

BERRUTI, A. 1979. The breeding biologies of the sooty albatrosses *Phoebetria fusca* and *P. palpebrata*. *Emu* 79: 161-175.

BLOESCH, M., DIZERENS, M. & SUTTER, E. 1977. Die Mauser der Schwungfedern beim Weissstorch *Ciconia ciconia*. *Orn. Beob.* 74: 161-188.

BROOKE, R.K. 1974a. *Buteo tachardus* Andrew Smith 1830. *Bull. Brit. Orn. Club* 94: 59-62.

BROOKE, R.K. 1974b. On the material evidence of *Hieraaetus pennatus* in southern Africa. *Bull. Brit. Orn. Club* 94: 152-158.

BROOKE, R.K., GROBLER, J.H., IRWIN, M.P.S. & STEYN, P. 1972. A study of the migratory eagles *Aquila nipalensis* and *A. pomarina* (Aves : Accipitridae) in southern Africa, with comparative notes on other large raptors. *Occ. Pap. Natn. Mus. Rhodesia ser. B.* 5: 61-114.

BROOKE, R.K. & KEMP, A.C. 1973. Specimen data on *Bucorvus leadbeateri*. *Bull. Brit. Orn. Club* 93: 89-92.

BROOKE, R.K., SINCLAIR, J.C. & BERRUTI, A. 1980. Geographical variation in *Diomedea chlororhynchos* (Aves : Diomedeidae). *Durban Mus. Novit.* 12: 171-180.

CONROY, J.W.H. 1972. Ecological aspects of the biology of the Giant Petrel, *Macronectes giganteus* (Gmelin), in the Maritime Antarctic. *Brit. Antarct. Surv. Sci. Rpt* 75: 1-74.

CRAMP, S. & SIMMONS, K.E.L. 1977. The birds of the western Palearctic Vol. 1. Oxford: Oxford University Press.

EDWARDS, K.Z. 1975. Ageing by moult of Crowned Plovers, *Stephanibyx coronatus*. *Safring* 4: 20-21.

FALLA, R.A. 1937. Birds. *B.A.N.Z.A.R.E. 1929 - 1931 ser. B* 2: 1-288.

HARRIS, M.P. 1973. The biology of the Waved Albatross *Diomedea irrorata* of Hood Island, Galapagos. *Ibis* 115: 483-510.

JOUANIN, C. & MOUGIN, J.L. 1979. Procellariiformes. In: Mayr, E. & Cottrell, G.W. Check-list of the birds of the world, 1. Cambridge (Mass.): Museum Comparative Zoology.

KINSKY, F.C. 1968. An unusual seabird mortality in the southern North Island (New Zealand) April, 1968. *Notornis* 15: 143-155.

LOOMIS, L.M. 1918. A review of the albatrosses, petrels and diving petrels. *Proc. California Acad. Sci. ser. 4, vol.* 2, pt 12: 1-187.

NELSON, B. 1978. The Sulidae. Oxford: Oxford University Press.

PAYNE, M.R. & PRINCE, P.A. 1979. Identification and breeding biology of the diving petrels *Pelecanoides georgicus* and *P. urinatrix exsul* at South Georgia. *New Zealand J. Zool.* 6: 299-318.

POTTS, G.R. 1971. Moult in the Shag *Phalacrocorax aristotelis*, and the ontogeny of the "staffelmauser". *Ibis* 113: 298-305.

STRESEMANN, E. & STRESEMANN, V. 1966. Die Mauser der Voegel. *J. f. Orn. sonderh.* pp. 1-448.

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