

## Order PROCELLARIIFORMES

A rather distinct group of some 80–100 species of pelagic seabirds, ranging in size from huge to tiny and in habits from aerial (feeding in flight) to aquatic (pursuit-diving for food), but otherwise with similar biology. About three-quarters of the species occur or have been recorded in our region. They are found throughout the oceans and most come ashore voluntarily only to breed. They are distinguished by their hooked bills, covered in horny plates with raised tubular nostrils (hence the name Tubinares). Their olfactory systems are unusually well developed (Bang 1966) and they have a distinctly musky odour, which suggest that they may locate one another and their breeding places by smell; they are attracted to biogenic oils at sea, also no doubt by smell. Probably they are most closely related to penguins and more remotely to other shorebirds and waterbirds such as Charadriiformes and Pelecaniiformes. Their diversity and abundance in the s. hemisphere suggest that the group originated there, though some important groups occurred in the northern hemisphere by middle Tertiary (Brodkorb 1963; Olson 1975).

Structurally, the wings may be long in aerial species and shorter in divers of the genera *Puffinus* and *Pelecanoides*, with 11 primaries, the outermost minute, and 10–40 secondaries in the Oceanitinae and great albatrosses respectively. The tail varies in length, being forked in *Oceanodroma*, forked to pointed in other forms, usually with 12 rectrices but up to 16 in fulmars. The tarsi are light and cylindrical in aerial forms; strong and laterally compressed with legs set far back in aquatic ones. The front toes are webbed; hind toe small or absent. The proventriculus is long and glandular; the gizzard small and twisted; and the small intestine often spiral in *Pterodroma*, presumably to aid absorption of the unusual lipids in their food. Chicks are helpless and covered in down, with two coats except in some Oceanitinae. Some larger species have a darker immature plumage, and the female is often darker than the male in the great albatrosses. The male is usually larger than the female, though smaller in the Oceanitinae and some other small species. Otherwise there is little difference in appearance with sex or age, except that young birds may have more pronounced pale or dark edges to the feathers. Many have simple counter-shaded markings that often appear to have given rise to uniformly dark or, less often, to pale derivatives; some species in most groups are dimorphic or polymorphic. The more complex groups have often developed distinctive markings of the extremities.

Breed more or less colonially on offshore islands, coastal cliffs, or on hills and deserts inland, where they perform complex vocal and aerial displays. The nest is a simple scrape or cup in a burrow or natural hole, sometimes under vegetation. The s. albatrosses build large cone-shaped nests in the open; may be lined with any debris available in the area. Smaller species visit it only at night, though larger ones and those breeding on remote islands may come to nests in the open by day. Parents incubate for spells of several days in turn and generally leave the chick alone soon after it hatches, only returning at long intervals to feed it by regurgitation. In consequence the chick is vulnerable to introduced predators and some species are now greatly reduced and at least two are now extinct. Some species also periodically liable to have unsuccessful breeding seasons. Many young or even old birds may be wrecked ashore and die when they meet bad weather or suffer shortage of food on migration or in the winter. Though it has been claimed that they are also vulnerable to all sorts of pollution, the evidence is weak (Bourne 1976). There is at present anxiety about the effect of some fishing methods, such as long-lining, which may be endangering species such as the great albatrosses.

All species feed at sea on a variety of fish, cephalopods and small marine invertebrates, either socially or alone; larger species may scavenge all sorts of offal or prey on other birds. Most, except perhaps *Pelecanoides*, can digest the complex lipids formed by some marine animals (Clarke & Prince 1976), and may eject them to soil the plumage of their enemies with lethal results (Swennen 1974). Some species can digest wax (Obst 1986). Many now take wastes from whaling and fishing operations (Fisher 1952). All have long life-cycles in proportion to their size; they disperse on fledging and then prospect for nest-sites for 2–12 years in their youth. They usually lay a single large white egg annually; though a successful breeding cycle may be completed in less than a year in at least one tropical species, *Puffinus lherminieri*, it may take 2 years in larger southern ones. Before laying, the birds court for weeks or months, then go to sea for feeding. Incubation lasts 6–8 weeks, and fledging 2–9 months. Once the fat chick fledges it fends for itself, even in species that immediately make a long migration, sometimes to the opposite hemisphere.

Tendency for failed breeders and non-breeders to begin moult before successful breeders. Five strategies of wing-moult in breeding adults: (1) In albatrosses, remiges replaced in staffelmauser interrupted while breeding; in nearly all other species, primaries moulted outwards; possibly simultaneously in some diving-petrels. (2) In most subantarctic and temperate species, moult begins soon after breeding and is completed shortly before next breeding season. (3) In most tropical species, moult aseasonal, between breeding attempts; resumption of breeding apparently depends on when moult completed. (4) In trans-equatorial migrants, wing-moult delayed until they reach non-breeding quarters, where it is completed; moult rapid but no satisfactory evidence for flightlessness. In

some species, body-moult also in winter quarters; in others, at breeding grounds. (5) In some species of high latitudes, rapid moult completed in summer when they breed; some begin moult long before breeding finished.

The history of the classification of the Order is very confused, as is seen by comparing Timmermann's (1965) discussion of their Mallophagan parasites with that by Klemm (1969) of their leg muscles and that by Harper (1978) of their proteins, but it is now widely agreed that the Order is best divided into four families: Diomedidae or large to huge aerial albatrosses; Procellariidae or medium-sized, mainly aerial but sometimes aquatic, petrels, shearwaters and prions; Hydrobatidae or small to tiny, aerial storm-petrels; and Pelecanoididae or small aquatic diving-petrels.

#### References

- Bang, B.G. 1966. *Acta anat.* 65: 305-415.  
 Bourne, W.R.P. 1976. Pp 403-502. In: Johnston 1976.  
 Brodkorb, P. 1963. *Bull. Flor. St. Mus. biol. Sci.* 7: 179-293.  
 Clarke, A., & P.A. Prince. 1976. *J. Exp. mar. Biol. Ecol.* 23: 15-30.  
 Fisher, J. 1952. *The Fulmar*.  
 Harper, P.C. 1978. *NZ J. Zool.* 5: 509-549.  
 Johnston, R. (Ed.). 1976. *Marine Pollution*.  
 Klemm, R.D. 1969. *S. Ill. Univ. Monogr. Sci. Ser.* 2.  
 Obst, B.S. 1986. *Wilson Bull.* 98: 189-95.  
 Olson, S.L. 1975. *Smithson. Contr. Paleobiol.* 23.  
 Swennen, C. 1974. *Ardea* 62: 111-117.  
 Timmermann, G. 1965. *Abh. Verh. naturwiss. Vereins Hamburg NF* 8, Suppl. 1-249.

## Family DIOMEDEIDAE albatrosses

The albatrosses are a small group of some 13-16 large petrels with long wings adapted for gliding flight and with long powerful beaks adapted for seizing prey at the surface; nine species breed in our region and one other has been recorded as a vagrant. Because they are so large, they must breed in the open, where they walk well for petrels. Most s. species build substantial conical nests but n. ones, breeding in warm climates, make only scrapes. Young birds in some species have a drab plumage but adults of many species develop bolder markings with brightly coloured stripes on the bill, used in social displays when breeding. Three distinct groups occur in the Southern Ocean but the distinction between two is blurred by intermediate forms that occur in North Pacific:

(1) The great albatrosses are huge, long-winged, long- and pale-billed, short-tailed birds that glide round the world in Southern Ocean. Until recently, there were thought to be two species: the more pelagic Wandering Albatross *D. exulans* breeding on most of the subantarctic islands, which is dark with a white underwing when young, becoming more or less white with dark wing-tips when adult; and the more coastal Royal Albatross *D. epomophora*, breeding round NZ, which resembles the extreme white adult Wanderer throughout its life but has a dark cutting-edge to the upper mandible. A few birds breeding in extreme immature *exulans*-type of plumage on Ile Amsterdam in the Indian Ocean have recently been described as a third species *D. amsterdamensis* but there is continuing debate whether this is justified owing to the occurrence of similar populations in South Atlantic and round NZ (Bourne 1989).

(2) The medium-sized albatrosses *Diomedea* (*Thalassarche*), often called mollymawks, are a compact group of white-bodied, dark-backed species with brightly marked bills in adults, all five species being found in our region. They consist of two comparatively coastal species, the Black-browed Albatross *melanophrys* with main breeding colonies round South America, and the Shy *cauta* with 3-4 rather well-defined subspecies, sometimes treated as separate species, breeding in A'asia. There are also three pelagic species: Grey-headed *chrysostoma* to the south, Yellow-nosed *chlororhynchus* in subtropical South Atlantic and Indian Oceans, and Buller's *bulleri* in equivalent parts of South Pacific.

The differences between Groups (1) and (2) are rather marked and they would doubtless be treated as distinct genera if it were not that four other albatrosses with intermediate characters breed in North Pacific: Black-footed *nigripes* with plumage resembling that of sooty albatrosses, though shape differs; Laysan *immutabilis* with plumage like that of the medium-sized albatrosses (Group 2); Short-tailed *albatrus* with a sequence of plumages rather like those of Wanderer, though smaller; and the Waved *irrorata* with dark plumage except for pale head, neck and underwing. Because it is hard to make any clear distinction between these birds they are normally all included in an unusually wide genus *Diomedea*.

(3) The sooty albatrosses *Phoebastria*. Two extremely aerial, highly pelagic and rather aggressive or predatory species with fairly small bills with a groove along the lower mandible; long wings; long pointed tails; and dark plumage; nest on steep places and have vocal aerial displays.

General characters are: body, short and broad; head, large; neck, short. Wing, long and narrow, folded in three almost equal parts, p10 longest, p11 minute; up to about 40 secondaries, diastataxic. Tail, short and square in *Diomedea*, longer and wedge-shaped in *Phoebetria*, 12 feathers. Bill, heavy and composed of several horny plates; hooked; nostrils in tubes on either side. Legs, strong; three front toes joined by web; hind toe absent or vestigial. Oil gland, feathered. Sexes similar; male larger on average. Plumage mainly white except in *Phoebetria*, in which it is dark grey. Juveniles and immatures generally separable but mostly not very different from adults except in *D. exulans* and *D. albatrus*; fully adult plumage attained only after several years. Stance upright and able to walk much better than most other Procellariiformes. Swim and rest on sea buoyantly with head held high. Feed mostly on fish and squid by surface-seizing or shallow diving, but sooty albatrosses also take birds. Follow ships for scavenging.

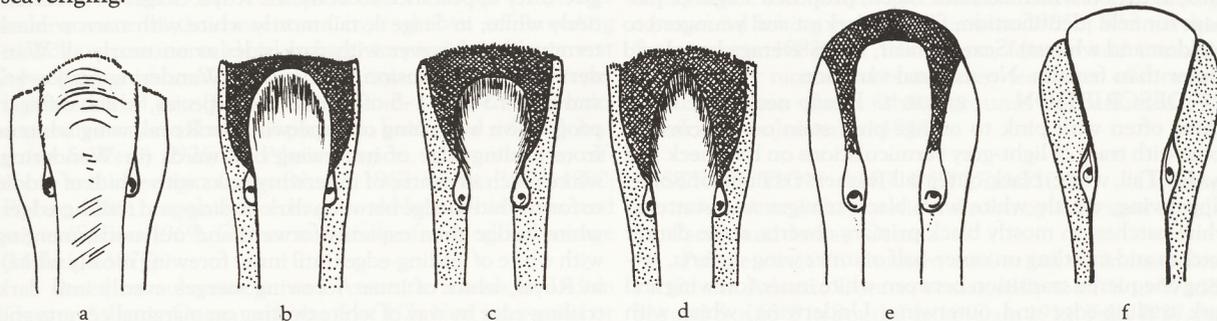


Fig. 1 Dorsal view of base of bill of small *Diomedea*

Fig. 1a Black-browed Albatross *D. melanoprys*

Fig. 1b Grey-headed Albatross *D. chrysostoma*

Fig. 1c Yellow-nosed Albatross, *D. chlorohynchos*, subspecies *chlorohynchos*

Fig. 1d Yellow-nosed Albatross, *D. chlorohynchos*, subspecies *bassi*

Fig. 1e Shy Albatross *D. cauta*

Fig. 1f Buller's Albatross *D. bulleri*

Long-lasting monogamous pair-bond. Breed colonially, pairs often returning to same site. Defend small nest-territories. Perform spectacular agonistic and sexual displays at nest in *Diomedea*; vocal aerial displays in *Phoebetria*. Eggs, white, minutely spotted reddish. Clutch-size; one; no replacement laying. Incubation by both sexes in long alternate spells. Incubation period, 2 or more months. Nestling, semi-altricial, nidicolous; hatched in down. Brooded for a short time after hatching; then left alone in nest, parents returning only to feed chick by incomplete regurgitation. Nestling period long, up to 12 months, and so in some species successful adults cannot breed annually. Young independent on fledging. Maturity reached only after several years. Some populations were reduced in the past, notably by egg-collecting, but there appear to be few threats now except that some great albatrosses are caught by long-line fishing.

#### REFERENCES

Bourne, W.R.P. 1989. *Gerfaut* 79: 105-16.

*Diomedea palpebrata* J.R. Forster, 1785, *Mem. Math. Phys. Acad. Sci., Paris*, 10: 571, Pl. 15 — south of Cape of Good Hope

The specific name means 'having eyelids' (*palpebra*, an eyelid) and refers to the white eye-crescents, which are probably no more prominent than those of Sooty Albatross *P. fusca*.

OTHER ENGLISH NAMES. Grey- or Light-mantled Albatross.

MONOTYPIC.

**FIELD IDENTIFICATION** Length 80–90 cm; wingspan 180–220 cm; weight 2.8–3.1 kg. Slender-bodied dark-headed grey and blackish albatross with very long, narrow wings; producing Siamese-cat effect (Pizzey 1980) or that of cowed monk (Murphy); characterized by long wedge-shaped tail and superb ability to fly, with little active flapping. Sexes similar; male slightly larger. No seasonal differences in plumages. Immatures resemble adults.

**DESCRIPTION ADULT.** Head, sooty brown or blackish except for a white crescent almost encircling eye (broken at lores and visible only at short range). Upperwings, dark slaty brown except for whitish primary shafts. Upperparts from nape to upper tail-coverts, grey or light grey, palest on mantle and back. Tail-feathers, blackish with pale or white shafts. Chin and throat, sooty brown, shading into pale brownish-grey breast and abdomen. Underwing, dark slaty brown. Bill slender, black with pale bluish or purple sulcus along lower mandible. Iris, brown. Legs and feet, mauve or greyish flesh. When worn, some feathers show buffish to whitish tips. **JUVENILE.** Similar to adult. Differ by having grey (not white) crescent round eye and dark shafts to primaries and rectrices; sulcus, grey, brownish or pale yellow. Older immatures show mottled plumage, especially on mantle and back.

**SIMILAR SPECIES** Can be confused only with Sooty Albatross *P. fusca*. Most Light-mantled can be distinguished by extensive light grey feathering on upperparts from mantle to rump. Immature plumages and colour of sulci are not fully investigated and some individuals are as yet inseparable (Harrison 1983). See account of Sooty Albatross for further characters that separate the two species and for comparisons with Wandering Albatross *Diomedea exulans*, Black-footed Albatross *D. nigripes* and giant-petrels *Macronectes* spp.

Strictly pelagic; usually solitary at sea or in small groups; not often seen near land when not breeding. Named 'Blue Bird' by old-time sealers and indeed can look blue in strong Antarctic light, in contrast to Sooty, which can be called only a brown bird (Murphy). Sailors and early authors called it 'Stinkpot' from its disagreeable smell, but Murphy could not notice it. Swim erect in normal fashion of albatrosses but apparently disinclined to dive for sinking objects. Gait on land

awkward and deliberate with hunched body; less agile and erect than other albatrosses except Sooty; walk little, perhaps having no need to do so on steep slopes or cliffs where they nest; do not need to run to take-off, merely launching itself into space. Flight typical of albatrosses but mostly gliding and swooping with less active flapping. Have been noticed at S. Georgia to wheel upwards till out of sight (Murphy). Persistently follow ships, probably the same birds for several days, showing no interest in bait trailed on lines but taking jetsam; fly close to ships, even between masts; can land delicately on tips of moving spars, raising wings as they do so. Control speed of flight with great ease, appearing to stand still in air; scratch head and preen belly in flight without losing ground or flapping. Parade effortlessly and gracefully to and fro in front of nesting cliffs, closely inspecting intruders (Murphy).

**HABITAT** Marine, pelagic. In summer, mainly Antarctic (Bierman & Voous 1950; Brown *et al.* 1975; Berruti 1979a; Thomas 1982; Weimerskirch *et al.* 1986), range extending into subantarctic and subtropical waters in winter (Szijj 1967; Brown *et al.* 1975). Occur further N in cool Humboldt Current off S. America than in other parts of range. In summer, immatures in s. Indian Ocean restricted to Antarctic waters (Falla 1937; van Oordt & Kruijt 1954; Stahl 1987). Preferred sea surface-temperature range in summer, 0–4 °C (Bierman & Voous 1950; Brown *et al.* 1975); preferences for salinity poorly recorded, but in Ross Sea occur where salinity 33.8–34.0 ‰ (Ainley *et al.* 1984). In Antarctic, occur in open water and iceberg-belt to edge of pack-ice or Antarctica (Falla 1937; van Oordt & Kruijt 1954; Hicks 1973); but in Ross Sea in summer, s. limit determined by –0.5 °C isotherm, not by position of pack-ice. Do not penetrate pack, which may inhibit soaring by dampening sea swells (Ainley *et al.* 1984). In breeding and non-breeding seasons, widely distributed over pelagic waters exploiting dispersed sources of food (Weimerskirch *et al.* 1986); but in Ross Sea, density increased over continental slope (Ainley *et al.* 1984), and in S. America and S. Georgia, birds regularly enter channels and fiords (Murphy; Humphrey *et al.* 1970).

Breed on subantarctic and Antarctic islands and rocky islets in Pacific Ocean, Atlantic Ocean and seas S of NZ;

breeding in large numbers on islands close to productive Antarctic feeding grounds (e.g. S. Georgia; Weimerskirch *et al.* 1986). Nest on ledges of sheltered vegetated cliffs and steep slopes, coastal or inland; nests may be placed among tussock grass, ferns, *Dracophyllum* or *Azorella* (Downes *et al.* 1959; Bailey & Sorensen 1962; Berruti 1979a; Kerry & Garland 1984; Weimerskirch *et al.* 1986); near steeply falling ground to assist take-off.

Fly at heights of up to 10–15 m above sea when foraging, using updrafts off wave fronts for lift. Fly high during courtship flights over sea or land; soar on rising air currents off cliff faces on breeding islands (Falla 1937; Bailey & Sorensen 1962). Feed at surface, occasionally making shallow dives (Murphy; Harper 1987).

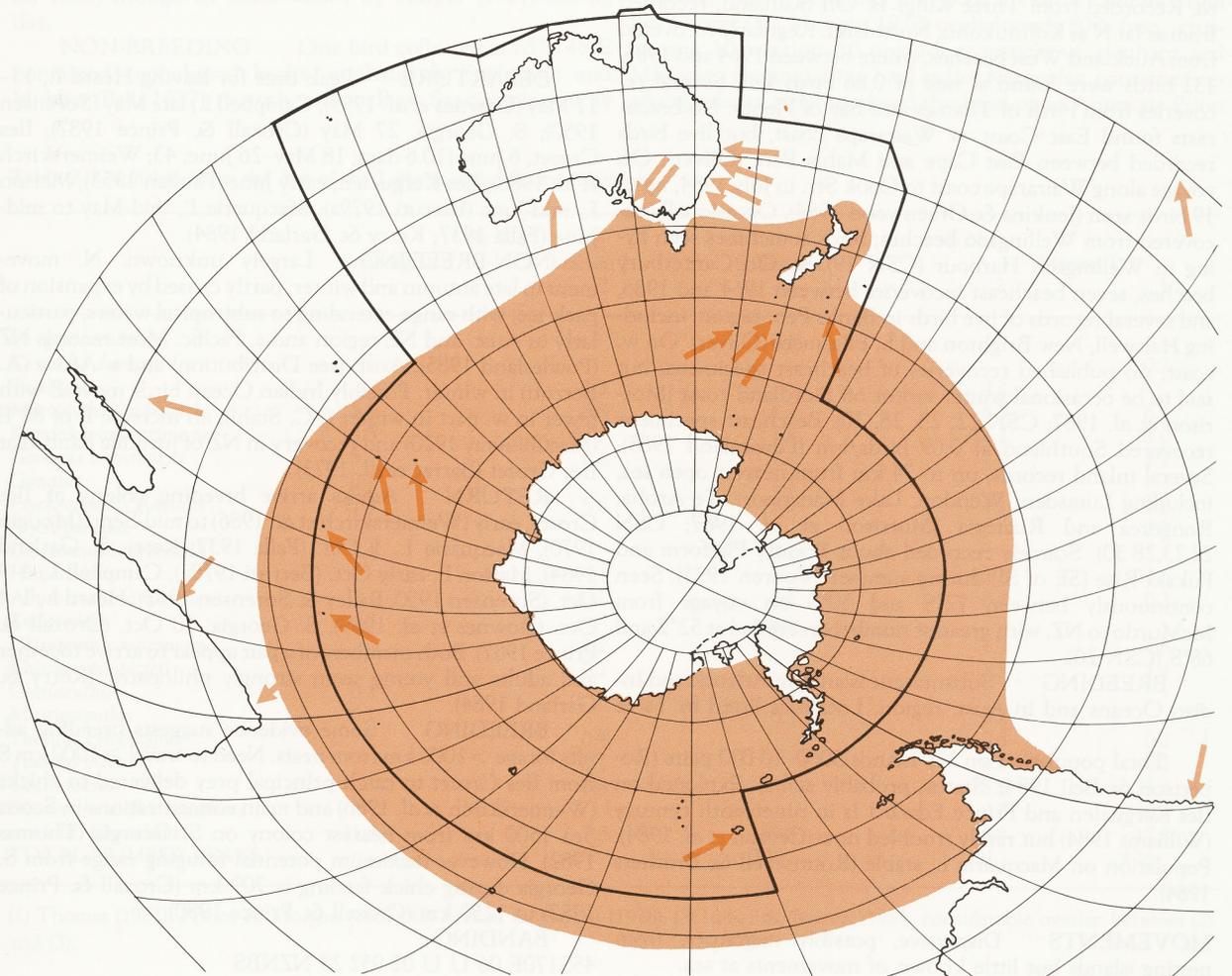
Possible predation by cats on Marion I.; large surface-nesting birds may now be at higher risk, because numbers of burrowing petrels have been reduced (Berruti 1981b).

**DISTRIBUTION AND POPULATION** Pelagic range circumpolar, from pack-ice (southernmost record 78°S, Ross Sea; Siple & Lindsey 1937) to 35°S but occasionally extending N to c. 20°S along Humboldt Current (Murphy; Watson *et al.* 1971; Harrison 1983). Breed on subantarctic islands between 46 and 55°S. Reach NZ and s. coasts of Aust.

but less common in Aust. than Sooty Albatross (Aust. Atlas).

In S. America, regular visitor to Magellanic region and Humboldt Current, N to c. 40°S, occasionally to c. 20°S (Paessler 1911, 1913; Murphy; Humphrey *et al.* 1970; Harrison 1983); accidental to s. Brazil (Teixeira *et al.* 1988). Rare to S. Africa, two records off Cape Province (Brooke & Sinclair 1978). Accidental to Rodriguez I., Indian Ocean (Rowlands 1987) and Marquesas Is (King 1967) in the Pacific Ocean; said to be accidental to Gough and Tristan da Cunha but no records published with supporting information (Williams 1987). Occur N to s. Aust. waters and Cook Str. in winter (Shuntov 1974); stragglers N to Kermadecs and nearby (Cheeseman 1890; Summerhayes 1969).

**AUST.** Probably regular in small numbers to pelagic waters of s. and se. Aust., to s. Qld in E but limits on w. and sw. coast, unknown; few acceptable published records. Few records during Aust. Field Atlas. QLD. Two beachcast, Stradbroke I., 31 July, 27 Sept. 1959 (QM015391, QM015392; Hines 1962); identification supported by Roberts (1977). Third specimen (Roberts 1973) mis-identified; no records 1975–81 (Aust. Atlas). NSW.: Three beachcast, Ballina-Evans Head, 11–12 July 1985 (NSW Bird Rep. 1985); two beachcast, near Broadwater, 14 July 1973 (NSW Bird Rep. 1973); one,



sighted, Evans Head, 7 Oct. 1973 (NSW Bird Rep. 1973); one beachcast, Mona Vale, 12 July 1973 (NSW Bird Rep. 1973); one, off Wollongong, 27 Oct. 1985 (NSW Bird Rep. 1985); one, sighted, Port Kembla, 23 June 1975 (NSW Bird Rep. 1975). VIC. Beachcast: Discovery Bay, near mouth of Glenelg R., 2 July 1950 (Hitchcock 1950); Discovery Bay, winter 1956 (Learmonth 1958); E of Lawrence Rocks, 31 May 1978; beachcast Discovery Bay, 22 Nov. 1981 (Aust. Atlas); sighting, in 1° block 39°S/148°E in e. Bass Str., 5 July 1984 (Vic. Bird Rep. 1984); sighting, in block 38°S/149°E, 2 Aug. 1985 (Vic. Bird Rep. 1985). TAS. Occasionally beachcast (Green 1989). One, E Hippolyte Rocks, 2 Apr. 1980 (Aust. Atlas); one beachcast, Waterhouse Beach, 2 Jan. 1984; one, sighted off s. coast, 11 May 1985; two, sighted, NE of Flinders I., 1 and 6 July 1985; one, off w. coast 29 Aug. 1985 (Tas Bird Reps 1980, 1984–85). SA. C. Jervis, July 1966 (SAM B28657; Parker *et al.* 1979); Goolwa, Oct. 1969 (SAM B27774; Parker *et al.* 1979); Port Gawler, Oct. 1971 (SAM B27992; Parker *et al.* 1979); Canunda Feb.–Mar. 1977 (SAM B3131; Parker *et al.* 1979). WA.: Recorded Great Aust. Bight, May 1917 (Alexander 1917), Aug. 1978 (Aust. Atlas). Early observations by MacGillivray (1920) 'near the Western Australian coast and . . . Great Australian Bight' unacceptable.

NZ Recorded in most coastal regions, but more commonly in waters S of Cook Str. (Oliver) but beachcast most frequently on beaches of Auckland West (Powlesland 1985). NI. Recorded from Three Kings Is. On mainland, recorded from as far N as Kohnukohu, Northland. Regularly recovered from Auckland West beaches, where between 1964 and 1986, 132 birds were found at rate of 0.66 birds/km. Several recoveries from Firth of Thames and Bay of Plenty. No beachcasts found East Coast or Wairarapa coast, but live birds recorded between East Cape and Mahia Pen. (Oliver). On voyage along Wairarapa coast to Cook Str. in July 1984, up to 19 birds seen (Jenkins & Greenwood 1984). Occasionally recovered from Wellington beaches; birds sometimes seen flying in Wellington Harbour (CSN 19). SI. On Canterbury beaches, seven beachcast recoveries between 1964 and 1986, and several records of live birds in Banks Pen. region, including Halswell, New Brighton and L. Ellesmere (Oliver). On w. coast, no published recoveries of beachcast specimens, but said to be occasional winter visitor off Fiordland coast (Morrison *et al.* 1987; CSN 22, 23, 28, 30). Beachcast specimens recovered Southland at 0.09 birds/km (Powlesland 1985). Several inland records, up to 74 km from nearest open sea, including Lumsden, Wendon, Lake Manapouri, Te Aroha, Rongotea and Ruatoria (Morrison *et al.* 1987; CSN 22, 23, 28, 30). Scarcely recorded about Bounty Platform and Pukaki Rise (SE of SI) during summer (Vooren 1973). Seen continuously between 72°S and 50°S on voyage from McMurdo to NZ, with greatest numbers recorded at 52°S and 68°S (CSN 20).

**BREEDING** Subantarctic islands in Atlantic and Indian Oceans and in Aust. region. Localities listed in Table 1.

Total population on NZ islands 5000–10 000 pairs (Robertson & Bell 1984). Status, probably stable. Exploited on Iles Kerguelen and Prince Edward Is in nineteenth century (Williams 1984) but rarely troubled now (Croxall *et al.* 1984). Population on Macquarie I., stable (Rounsevell & Brothers 1984).

**MOVEMENTS** Dispersive, possibly migratory, from nesting islands but little known of movements at sea.

Table 1

LOCALITY	YEAR	PAIRS
Prince Edward Is. (2)	1974–75	216
Iles Crozet (5)	1981–82	2280
Iles Kerguelen (9)	1984–87	3000–5000
Heard I. (4)	1954	200–500
Macquarie I. (6)	1971	500–700
Campbell I. (7)	1942–47	1000+
Auckland Is (1)	1972–73	c. 5000
Antipodes Is (8)	1969	<1000
S. Georgia (3)	<1983	8000

**References:** (1) Bell (1975); (2) Berruti (1979a); (3) Croxall *et al.* (1984); (4) Downes *et al.* (1959); (5) Jouventin *et al.* (1984); (6) Rounsevell & Brothers (1984); (7) Sorensen (1950); (8) Warham & Bell (1979); (9) Weimerskirch *et al.* (1989).

**DEPARTURE** Peak time for leaving Heard I., 13–17 May (Downes *et al.* 1959); Campbell I., late May (Sorensen 1950); S. Georgia, 27 May (Croxall & Prince 1987); Iles Crozet, 6 June (10.6 days; 18 May–26 June; 43; Weimerskirch *et al.* 1986); Iles Kerguelen, early June (Paulian 1953); Marion I., mid-June (Berruti 1979a); Macquarie I., mid-May to mid-June (Falla 1937; Kerry & Garland 1984).

**NON-BREEDING** Largely unknown. N. movement in late autumn and winter, partly caused by expansion of pack-ice, with range extending to subtropical waters, particularly in Aust. and NZ region and s. Pacific. Most records NZ (Powlesland 1985), Aust. (see Distribution) and s. Africa (A. Berruti) in winter. Possibly Indian Ocean birds move E with fewer in w. part in winter (J.-C. Stahl), an increase E of 80°E (MacGillivray 1920) and recovery in NZ of juvenile banded at Iles Crozet (Barrat *et al.* 1973).

**RETURN** Adults arrive breeding colony at Iles Crozet, early (Weimerskirch *et al.* 1986) to mid-Sept. (Mougin 1970), Macquarie I., 1 Oct. (Falla 1937; Kerry & Garland 1984), Marion I., early Oct. (Berruti 1979a), Campbell I., 4–9 Oct. (Sorensen 1950; Bailey & Sorensen 1962), Heard I., 1–4 Oct. (Downes *et al.* 1959), S. Georgia, 10 Oct. (Croxall & Prince 1987). Both members of a pair appear to arrive together and adults and young seem strongly philopatric (Kerry & Garland 1984).

**BREEDING** Some evidence suggests breeding adults forage >1000 km from nests. Need to travel ≥1000 km S from Iles Crozet to catch principal prey delivered to chicks (Weimerskirch *et al.* 1986) and main concentrations in Scotia Sea 1500 km from nearest colony on S. Georgia (Thomas 1982). However maximum potential foraging range from S. Georgia during chick feeding is 709 km (Croxall & Prince 1987) to 1250 km (Croxall & Prince 1980).

**BANDING**  
45S170E 06 U U 02 952 23 NZNBS

46S51E 04 P U 15 9273 134 CRBPO  
 54S158E 03 P U 4 2458 032 ABBBS  
 54S158E 03 P U 5 2345 035 ABBBS

**FOOD** Mostly cephalopods and euphausiid crustaceans but also takes fish, other crustaceans and carrion such as sea-bird and seal remains. **BEHAVIOUR.** Food usually taken by surface-seizing (Griffiths 1982; Harper *et al.* 1985; Harper 1987), also reported surface-diving, surface-plunging and shallow-diving (Murphy; Harper *et al.* 1985); of 27 observations, surface-seizing 77.8%, surface-filtering 14.8%, surface-plunging 7.4%. When surface-filtering, suck water and krill into partly open bill, securing prey simply by closing beak. Surface-plunging tern-like, dropping to water from about 0.8 m to seize prey then immediately taking off (Harper 1987). Usually feed alone (Weimerskirch *et al.* 1986) but also in groups of 2–5, sometimes in association with Wandering Albatross *D. exulans* (J-C. Stahl). Once about 3000 seen within 35-km stretch of Beagle Channel in Feb., perhaps because large numbers of dead fish were available (Humphrey *et al.* 1970). Have been seen feeding in association with pilot whales *Globiocephala* and Southern Right Whale Dolphins *Lissodelphis peronii* (Enticott 1986) and occasionally follow ships (Kock & Reinsch 1978; Robertson & Jenkins 1981). Feeding seldom seen, possibly because crepuscular or nocturnal (Berruti & Harcus 1978; Thomas 1982; Weimerskirch *et al.* 1986) though all observations by Harper (1987) during day.

**NON-BREEDING** One bird collected at 65°S 48°E contained cephalopod beaks, euphausiids *Euphausia* and blubber (Falla 1937), two others from Ross Sea contained only

*Euphausia superba* 3.9 cm (0.3; 16; Ainley *et al.* 1984) and, of four from Drake Passage, three had taken fish, one *E. superba* and one also contained penguin feathers (Linkowski & Rembiszewski 1978).

**BREEDING** At **S. Georgia** (nine adults, 37 chick regurgitations; Thomas 1982) liquid derived from the breakdown of solid food 52% wt.; of solid fraction cephalopods 45.5% wt., 95.6% freq., crustaceans 39.5, 87.0 euphausiids *Euphausia superba* 35% wt, length 5.25 cm (0.15; 20); amphipods 10% freq. incl. *Themisto gaudichaudii*, *Cylopus lucasii*, isopods, 4% freq., decapods 4% wt., 40% freq. incl. shrimps *Acanthephyra*, fish 10.9, 53.3; mainly Myctophidae, some Nototheniidae, carrion 0.4, 8.7; penguin skin, prions *Pachyptila*, possibly some cephalopods, unident 3.9. Cephalopod beaks in ten samples from chicks summarized Table 2. Mean cephalopod weight was 270 g. At **Marion I.** (Berruti & Harcus 1978), regurgitated casts contained mostly cephalopod beaks (Table 2), also fish, crustaceans and feathers from penguins and other birds. Estimated mean weight of cephalopods 295 g. Another analysis of casts collected Oct. 1974–May 1975 at Marion I. (Imber & Berruti 1981) also summarized Table 2.

At **Iles Crozet** (Weimerskirch *et al.* 1986) cephalopods predominated in 55% of 45 regurgitated samples (actual freq. 95.6, largely Cranchiidae) with fish dominant in 14 (31.1), crustaceans 18 (42.2, mostly *Euphausia superba*) and carrion 13 (40.0, mostly penguins *Eudyptes*). In earlier sample from Iles Crozet (10; Mougín 1970) cephalopods 80% freq., crustaceans 10, carrion 10 (including testicle of elephant seal *Mirounga leonina*). One bird at Iles Kerguelen contained cephalopods, an amphipod and the head of an Antarctic Prion

Table 2. Cephalopods in the diet of the Light-mantled Sooty Albatross.

	% Wt		% No		
	S.Georgia 1	Marion I. 2	S.Georgia 1	2	Marion I. 3
<i>Oregoniateuthis</i>			0.1		
<i>Taningia danae</i>					0.2
<i>Taningia</i>		0.3		0.2	
<i>Moroteuthis knipovitchi</i>	3.0	8.8	1.2	6.3	6.1
<i>Kondakovia longimana</i>	13.5	64.3	1.6	12.7	15.0
<i>Gonatus antarcticus</i>	5.4	0.8	7.2	1.9	2.1
<i>Gonatus</i>	0.7		1.2		
<i>Psychroteuthis glacialis</i>	47.5	5.6	19.9	4.1	4.0
<i>Psychroteuthis</i>					0.2
<i>Lepidoteuthis grimaldii</i>	1.4		0.3		
<i>Histioteuthis</i>		4.1		25.2	24.6
<i>Alluroteuthis antarcticus</i>	2.1	<0.1	1.5	0.2	0.2
<i>Todarodes</i>	4.7		6.0		
<i>Chiroteuthis macrosoma</i>		1.2		1.7	1.6
<i>Chiroteuthis picteti</i>		0.2		1.5	1.4
<i>Chiroteuthis</i>	0.1		0.3		
<i>Mastigoteuthis</i>	0.1		0.2	0.2	
<i>Taonius cymoctypus</i>		0.4		0.5	0.2
<i>Taonius pavo</i>		0.2		0.5	0.2
<i>Teuthowenia</i>		6.6		25.5	25.1
<i>Mesonychoteuthis hamiltoni</i>				0.5	0.4
unident. Cranchiidae	21.5	7.3	59.8	18.5	17.8
TOTAL NUMBER BEAKS			391	191	426

(1) Thomas (1982), Prince & Morgan (1987); (2) Berruti & Harcus (1978); (3) Imber & Berruti (1981); considerable overlap between (2) and (3).

*Pachyptila desolata* (Falla 1937), another only cephalopod beaks (Paulian 1953); chicks at Heard I. had cephalopod beaks  $\leq 3.5$  cm long and crustaceans, one adult had 44 cephalopod beaks and fish bones, another only fish (Downes *et al.* 1959); at Campbell I. cephalopods 60% freq., fish 60 and carrion 40 (penguin feathers; five regurgitations; Sorensen 1950).

**INTAKE** Mean interval between feeds for chicks 2.35 days (S. Georgia; Thomas 1982), 2.56 days (Marion I.; Berruti 1979a), 2.90 days (Iles Crozet; Mougin 1970), chicks gaining about 42–45 g/day (Mougin 1970; Croxall & Prince 1980). Measured size of meal at S. Georgia was 557 g (175; 320–920) but may be as high as 700 g (Thomas 1982).

**SOCIAL ORGANIZATION** At sea, usually solitary, sometimes in flocks of up to 30 (Routh 1949; van Oordt & Kruijt 1954) throughout the year. However, very high densities (3000 over c. 35 km) recorded in Beagle Channel (Humphrey *et al.* 1970). When breeding, solitary or in small groups of up to 15 nests. Little known of behaviour in non-breeding period, which spent entirely at sea.

**BONDS** Monogamous. Pair-bonds apparently life-long or long lasting. Renewed each season at nest-site during pre-breeding period (adults); unlikely that pairs associate at sea. At Campbell I., immatures observed in courtship until hatching period (Sorensen 1950). Both parents incubate eggs and tend young until fledging.

**BREEDING DISPERSION** At Marion I., usually singly or in groups of 2–3 nests, sometimes more; on coastal sites, about a third of nests in groups less than 3 m apart. At Iles Crozet, 49% birds ( $n=1908$ ) nesting solitarily, rest among groups (nests 3 m apart or less) of 2–8 nests, maximum 13 (Weimerskirch *et al.* 1986). At Iles Kerguelen, mostly solitary or in groups of 2–5 nests, maximum 15 (Weimerskirch *et al.* 1989). At Heard I., singly or frequently 2–3 pairs together (Downes *et al.* 1959). At Campbell I., mostly solitarily with groups of up to 4–5 nests spaced 1.2 m apart (Sorensen 1950). At S. Georgia, usually in groups of 4–10 pairs, occasionally solitary (Thomas *et al.* 1983). Compete with Sooty Albatross where birds occur sympatrically, but Sooty has advantage in returning earlier to reoccupy sites. Highly territorial, defending nest site from conspecifics and Sooty Albatrosses. Territory used for courtship, copulation, incubation and care of young. Non-breeding birds, or those establishing pair-bonds, gather at prominent loafing sites. Nest-sites attended for 7–8 months. After brooding completed, only non-breeders present for any length of time at breeding grounds, parents returning only to feed chicks.

**ROOSTING** At or near nest-site when breeding; on sea at other times. Birds at breeding sites observed roosting at night and during day.

**SOCIAL BEHAVIOUR** Only detailed study at Marion I. by Berruti (1981a); descriptions in Falla (1937), Sorensen (1950) and Downes *et al.* (1959). Most social interactions take place on or near nest-site. Behaviour difficult to interpret because sexes similar in plumage and behaviour and non-breeding birds not easily distinguished. Displays economical in movement, probably because little room at nest.

**AGONISTIC BEHAVIOUR** Bird occupying ledge or nest-site will threaten, or be threatened, by bird landing at or near area. Bird stares at intruder with feathers of neck, head and mantle erect and wings lifted away from body slightly; with increasing aggression, bill is opened and bird may lunge at the other, giving guttural *gaaaau* call, or snapping bill sev-

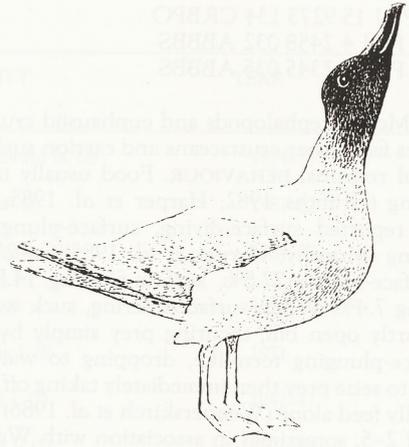


Fig. 1 Skycall (expiratory call)

eral times in rapid succession. Physical attack rare. Plumage becomes sleeked when bird shows increased tendency to flee.

**SEXUAL BEHAVIOUR** Courtship likely to consist, as in Sooty Albatross, of evolving 'conversational sequences' between partners. Displays similar to that of Sooty, except Bill-clashing replaced by Bill-thrusting in Light-mantled (Berruti 1981a). Functions of calls and displays probably similar to those of Sooty. Commonest displays are: **Sky-call Display** (Fig. 1), performed in encounters by sitting or standing birds, or by bird calling to another flying past. Bird stands erect with sleeked plumage; head and bill pointed vertically upwards with brisk movement and loud expiratory call given with slightly opened bill. Bill lowered suddenly onto breast while second syllable of call, inspiratory wheezing note, is given. Truncated display and call may be given from sitting position; bill usually not raised above horizontal nor depressed onto breast. **Bill Pointing**, in which bird reaches forward with bill, pointing at head or upperparts of partner. Slight biting movement may be made (**Gape**), but any contact is brief and gentle. Display followed by Bill Thrusting and Mutual Preening. **Bill Thrusting** (Fig. 2), in which two birds standing close together and with feathers of crown slightly raised, move heads from side to side; head of one bird directly faces the other at mid-point of side movement, head raised and exaggerated bite movement given. No physical contact is made. Tail fanned and skewed to one side at 45° angle. Both birds may then become passive or display Mutual Preening. **Mutual Preening** (F3) performed by sitting or standing birds. One bird preens feathers round head of other while recipient directs movement by tilting head. Birds sometimes preen each other simultaneously; duration, intensity and site of preening vary. Scooping, Autopreening, Paddle Walk and Scapular Action performed during agonistic encounters; may be components of more complex displays. In **Scooping**, standing bird bows slightly and lowers bill while holding head slightly to one side; bill may touch breast. Tail is fanned and skewed towards second bird and at 45° angle to ground. In **Paddle Walk**, bird moves with exaggerated up and down paddle-walking motions. An **Autopreening** bird breaks off agonistic interaction to preen its plumage, though preening movements may be rudimentary and bill remains closed. If a display, not highly ritualized. In **Scapular Action**, standing bird (usually male) places bill at junction of wing and body. Tail fanned and

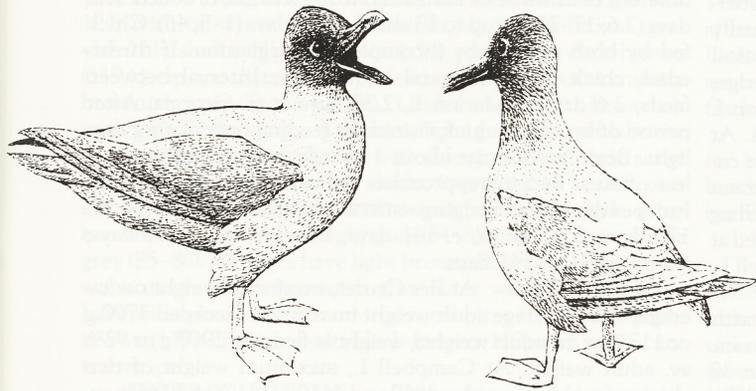


Fig. 2 Bill Thrusting

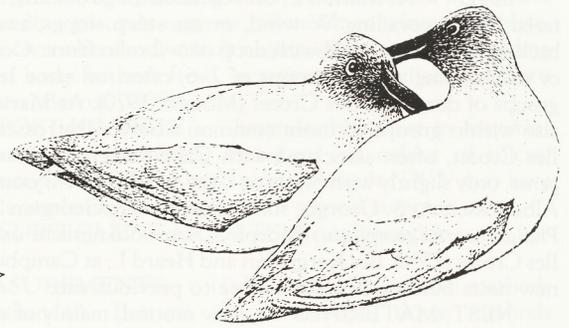


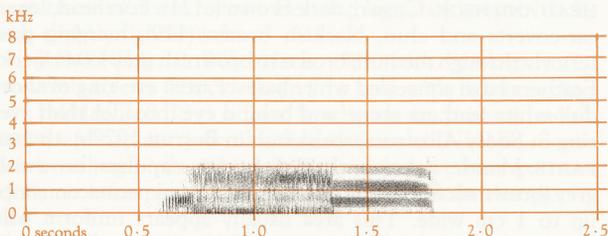
Fig. 3 Mutual Preening

skewed to one side at 45° angle to ground. Perhaps intergrading with Autopreening. Bird in isolation or with another may engage in **Foot Looking** in which it bows head between legs, occasionally touching lower abdomen with bill; biting motion sometimes given. **Aerial Activity.** Paired birds synchronize flights past breeding site and wing movements to marked degree.

**RELATIONS WITHIN FAMILY GROUP** No detailed knowledge. Both sexes build nest (at Campbell I., by female), incubate, brood and feed chicks. Chicks independent of parents after fledging.

**VOICE** Not well known; some descriptions from Marion I. (Berruti 1981a); partial descriptions in Murphy, Falla (1937) and Sorensen (1950); information supplied by A. Berruti and J-C. Stahl. Generally silent at sea (A. Berruti) except Threat Call when squabbling over food and Skycall recorded once (Murphy; J-C. Stahl). Calling restricted to breeding periods. Generally call only at nest-site, usually during day. Limited repertoire of calls. Non-vocal sound limited to Bill-snapping. No sexual differences noted. No information on individual differences or geographical variation.

**ADULT Skycall.** Characteristic two-syllable call given during Skycall Display (sonagram A): loud expiratory



W.J.M. Vestjens; Macquarie I., Mar. 1962; P26

syllable, initially shrill but becoming more trumpet-like, given with head and bill pointed vertically; bird then utters shorter quiet nasal inspiratory syllable as head and bill lowered. The first syllable louder and longer than second. Calls given by sitting birds noticeably softer. Call reflected in common names Piew, Pee-arr, Pio. Members of pair often overlap calls (Berruti 1981a). Call is integral part of Skycall Display and

circumstances discussed in Social Behaviour. Used in mate-attraction and agonistic circumstances, and when pairs establishing pair-bonds; probably also function in individual recognition as in Sooty Albatross. **Threat Call.** Birds threaten conspecifics, humans and Sooty Albatrosses with harsh throaty *gaaaaa* (A. Berruti). **Bill-snapping.** During Bill Thrusting display birds audibly snap bill as they move head from side to side (A. Berruti). Bill-snapping also used as threat to approaching conspecifics, men or Sooty Albatrosses (A. Berruti). At sea, 'hollow, ghostly trumpetings' reported when birds squabbling for food (Murphy).

**YOUNG Begging.** Chick taps parent's beak with its beak and gives short high-pitched squeaky note repeated frequently (A. Berruti). **Threat.** In response to intruders (conspecific, human, Sooty Albatrosses) chick claps beak and gives throaty gulping noise *clohp-clohp-clohp*. If intruder approaches closer, call becomes more retching sound, which may be followed by regurgitation of oil and other stomach contents (A. Berruti).

**BREEDING** Detailed studies at Marion I. (Berruti 1979a), Iles Crozet (Mougin 1970; Weimerskirch *et al.* 1986) and S. Georgia (Thomas *et al.* 1983). Some information for Iles Kerguelen (Paulian 1953; Weimerskirch *et al.* 1989), Heard I. (Downes *et al.* 1959) and Campbell I. (Sorensen 1950). Breed in simple, long-lasting pairs; solitarily or in small colonies.

**SEASON** From early Oct. (Sept. at Iles Crozet only) to mid-May-June. Laying: Marion I., 14-30 Oct.; Iles Crozet, 19 Oct.-13 Nov.; Iles Kerguelen, 28 Oct. (Thomas 1983) to early Nov.; Heard I., 24 Oct.-early Nov.; Campbell I., 31 Oct.-c. 7 Nov.; S. Georgia, c. 20 Oct.-2 Nov. Earliest arrivals at colonies: Marion I. early Oct.; Iles Crozet, 9-24 Sept. according to year; Heard I., 1 Oct.; Campbell I., 4 Oct. (later on inland sites); S. Georgia, 5 Oct. No pre-laying exodus at Iles Crozet (Mougin 1970) but possibly at S. Georgia (Thomas *et al.* 1983). Departure from colonies at fledging: Marion I., mid-June; Iles Crozet, 6 June (11 days; 18 May-26 June; 43); Iles Kerguelen, late May-early June; Heard I., 13-18 May; Campbell I., late May; S. Georgia, 15 May-1 June. At Campbell I., immatures present until late Dec.



**SITE** At Marion I., on vegetated ledge of cliffs, sheltered from prevailing W wind, or on steep slopes; usually backed by bare rockwall with drop of >2 m in front. Coastal or inland; singly or in groups of 2–6, often on same ledge; groups of dozens at Iles Crozet (Mougin 1970). At Marion I. also within groups of more common Sooty Albatrosses. At Iles Crozet, often associated with Cape Petrels *Daption capense*, only slightly with Sooty or Grey-headed *D. chrysostoma* Albatrosses. At S. Georgia, sometimes with S. Georgian Shag *Phalacrocorax georgianus* (Murphy). Some old nests re-used at Iles Crozet (25%), Iles Kerguelen and Heard I.; at Campbell I., new nests built each season, close to previous site.

**NEST, MATERIALS** Low mound, mainly of earth and mud with some plant material, usually lined with grasses. Dimensions: 15–30 cm high, 45–55 cm wide at base; cup c. 30 cm wide and 5 cm deep (Paulian 1953; Downes *et al.* 1959). When not in use, overgrown with short vegetation. Both sexes build (only female at Campbell I.), most actively 8–15 days before laying; by sitting on nest, collecting material within reach, plastering on sides of mound, rotating to do so. Not all nests reoccupied each year because birds breed only every second year, if successful.

**EGGS** Oval, broader at one end; rather smooth, not glossy; white with brown and reddish brown speckles.

**MEASUREMENTS.**

Marion I. 102.3 (2.8; 98.3–106.4; 17) x 66.7 (2.3; 62.7–70.0)

Campbell I. 102.4 (3.2; 98–107; 6) x 65.2 (1.4; 63–67)

S. Georgia 100.2 (3.0; 22) x 65.4 (2.2; 22)

Iles Crozet 103.7 (99.5–105.8; 4) x 66.9 (65.3–68.9)

Iles Kerguelen 101.8 (3.5; 98–107; 20) x 66.9 (2.4; 64.5–69.0)

**WEIGHTS.**

Marion I. 258.2 (15.3; 234–280; 17)

Campbell I. 232.7 (11.7; 6)

S. Georgia 243.0 (19.9; 22)

**CLUTCH-SIZE** One. No replacement, if lost. Biennial breeder; laying next season if breeding fails, in second season if breeding successful (Prince 1980; Weimerskirch 1982; Thomas 1982).

**LAYING** Synchronized: S. Georgia, 16 of 23 eggs laid 20 Oct. to 2 Nov.; at Iles Crozet, mean laying date 24 Oct. (2 days; 19–29 Oct.; 53), with variations of laying interval 10–24 days in different years.

**INCUBATION** By both sexes in alternate shifts, female taking first shift. At Marion I., male took 60% of incubation in 2–3 shifts, each 4–29 days long; female, 40% in three shifts, each 1–22 days long; longest shift, second by male, 24.3 days (19–29; 3). At S. Georgia, male 54% in 2–3 shifts of 3–25 days; female, 46% in 3–4 shifts of 2–24 days; longest shift fourth by male 20.3 days (18–25; n=7). At Iles Crozet, male's share 46%, female's 54%; longest shift, fifth by female, 14.3 days (8–20; 16). At Heard I., shifts of 9 and 19 days recorded. At Campbell I., first four shifts 12–17 days. Total shifts by both sexes, 5–8. **INCUBATION PERIOD.** Marion I.: 66.6 days (1.5; 65–68; 3); another egg hatched after at least 72 days incubation; Iles Crozet: 66.9 (1.4 days; 66–71; 24); S. Georgia: 69.9 days (66–70; 22); addled eggs incubated up to a week longer.

**YOUNG** Semi-altricial, nidicolous. Pipping to emergence, 4 days. Brooded continuously by both parents in alternate shifts. At Marion I., brooded for first 19.5 days (1.3; 18–21; 4), in 5–10 shifts of 1–7 days each; female brooded for 64% of time, male 36%. At Iles Crozet, brooding period 19.3 days (3.3; 14–25; 13), in shifts of 2.6 days (1.6; 1–9; 72), no

differences in share of each sex. At S. Georgia, brooded 20.2 days (2.6; 17–23; 6), up to 13 shifts of 2.9 days (1–5; 46). Chick fed by both parents by incomplete regurgitation. If threatened, chick regurgitates oil at intruder. Interval between feeds, 2.6 days at Marion I., 2.38 days at S. Georgia. After period of brooding chick visited for feeding only during daylight. Begin to exercise about 1 month before fledging. Fed less often as fledging approaches but not abandoned in nest. Independent after fledging. **NESTLING PERIOD.**: Marion I., c. 170 days; S. Georgia, c. 141 days; Iles Crozet, c. 157 days; Campbell I., c. 141 days.

**GROWTH** At Iles Crozet, maximum weight on average, 102% average adult weight (maximum recorded 3700 g or 117% of av. adult weight); weight at fledging 2900 g or 92% av. adult weight. At Campbell I., maximum weight of two chicks after 12–16 weeks: 3860 and 4450 g (141% and 163% av. adult weight respectively); weight at fledging, 3175 g (116% av. adult weight). At S. Georgia, hatchlings weighed 176.4 g (26.3; 147–240; 18); reached peak of c. 3400 g (120% ad. wt) at c. 80 days; mean absolute weight of chick 3845 g (395; 15) or 140% of adult weight; weight fell to 2590 g (220; 15) (91% ad. wt) at fledging, when growth almost complete. Age at first breeding: minimum 7 years at Macquarie I. (Kerry & Colback 1972), average 12.0 years at Iles Crozet (Weimerskirch *et al.* 1987). Observation of one bird breeding 2 years after fledging, Campbell I. (Sorensen 1950), almost certainly erroneous.

**SUCCESS** At Marion I., 31% (n=16 eggs) fledged young. At S. Georgia, 47% (n=142 eggs) between third week of incubation and Mar. At Iles Crozet, hatching success 71% (n=34 eggs), fledging success 66% (n=10 hatchlings) (Mougin 1970); average of 0.20 chicks fledged per pair per year (Weimerskirch *et al.* 1987). At Marion I., losses mostly by desertion; some accidental breakage and infertility. Chicks starved, became diseased, fell from nests, were destroyed in collapse of nest-sites, killed by skuas and possibly by giant-petrels *Macronectes* spp and feral cats (Berruti 1981b). At Iles Crozet and S. Georgia, parental desertion and chick starvation main causes of breeding failure. At Iles Crozet, mean annual survival of adults (1976–82), 97.3%, no significant variations in different years (n=90 birds) (Weimerskirch *et al.* 1987).

**PLUMAGES**

**ADULT** Definitive basic. Probably attained at post-juvenile moult; age of first breeding minimum 7 years at Macquarie I., average 12 years at Iles Crozet (see Breeding). **HEAD AND NECK.** Crown, dark brown (c121). Forehead, lores, ear-coverts and chin, blackish brown (119), merging posteriorly through medium brown to brownish grey lower neck. Feathers have concealed white bases. Partial eye-ring of short dull-white feathers above and behind eye (broader than eye-ring in Sooty Albatross; see sketch in Berruti 1979b). **UPPER-PARTS.** Mantle, upper back, and shorter scapulars, brownish grey (brownish 86) with white to cream open pennaceous tips up to 1 cm wide. This area usually appears uniform pale brown-grey to whitish, but in moulting, and perhaps worn birds, pale brown-grey with distinct creamish (c54) scalloping. Longer scapulars, grey-brown. Lower back and rump, light brownish-grey. Upper tail-coverts, brownish grey. **TAIL,** mostly dark grey-brown (dark 121); feathers have cream-white (c54) shafts. Outer two rectrices, brownish grey. **UPPERWING.** Marginal, lesser and median coverts, dark brown (greyish 121) with narrow light-brown (119C) fringes c. 2 mm wide. Secondary coverts, dark grey-brown (greyish 121) with narrow light-brown (119C) fringes. Primary coverts, dark grey-brown (gre-

yish 121). Tertiaries and secondaries, dark grey-brown (greyish 121) with off-white shafts. Primaries, dark grey-brown (greyish 121); shafts yellowish white (c54), merging to dark-brown (119A) tip on distal sixth of feather. UNDERPARTS, mostly brownish grey (brownish 86). Under tail-coverts brownish grey with white shafts. Axillaries, light grey (c85) with white shafts. TAIL, as upperside, but with pale-grey (86) gloss in some lights, strongest near feather shafts. UNDERWING. Lesser, outermost primary median, and primary coverts, dark grey-brown. Greater coverts, light grey (84-85); other coverts, pale grey (85-86). Remiges have light brownish-grey (c119C) inner webs and medium brownish-grey outer webs. All primaries have wide glossy tegmen on inner web; in p10 tegmen black-brown (119). Primary shafts black-brown (119) with white central stripe.

**DOWNY YOUNG** Protoptile, powdery grey, slightly lighter on sides of head; sparse on crown. In mesoptile, white facial mask formed by patch of short white down on lores and round eye; on crown short, dark grey-brown (greyish 121). Rest, long and woolly, dark brownish grey (grey 119B).

**JUVENILE** Differences from adult: Mantle and upper back appear brownish grey (brownish 79) with lighter scalloping; feathers, brownish grey (brownish 79) with light brownish-grey (c80) open pennaceous tips. Proximal third of primary shafts creamy white (c54), merging to blackish brown distal half of shaft. Tail shafts as adult; statements that rectrix shafts brown (e.g. Watson 1975) inaccurate.

**ABERRANT PLUMAGES** Partial albino beachcast Vic. (ARI) had white patches on hindneck, mantle, upper breast, belly and flanks.

**BARE PARTS** Based on Sorensen (1950), Berruti (1979b), specimens at MV and NMNZ, and photos in Lindsey (1986), NZRD and Aust. RD.

**ADULT** Iris, dark brown (21); light brown, greenish brown and hazel-brown also recorded. Bill, black (89-82) with narrow pale greyish blue (66 to 168D) sulcus. Tarsus and toes, light fleshy buff, often with slight grey or mauve tinge. Webs often darker and greyer (c80) than toes, especially near tips. Claws, pale-horn to whitish.

**DOWNY YOUNG** In protoptile, iris greyer than in adult. Crown almost bare, bluish-grey skin exposed. In mesoptile, iris as adults, and no bare skin on crown. Bill, black (89), developing slightly brown tinge to dark-grey sulcus while some traces of down remain. Feet and legs, dark grey to black, with slightly lighter webs.

**JUVENILE** Bill, black (89) with dark-grey or brownish sulcus. Feet, dark grey to grey with lighter webs.

**IMMATURES** Two beachcasts in primary moult (and therefore not juveniles) had dark sulci (NMNZ). Some non-breeding birds at breeding grounds have bare parts as adult; no information on when colour of sulcus changes.

## MOULTS

**ADULT POST-BREEDING** Wing, tail, greater coverts and probably body, moult at sea between breeding seasons. Wing- and tail-moult suspended at breeding grounds between Oct. and May at Marion I. (Berruti 1979a), Heard, Macquarie, Campbell and Auckland Is (MV, NMNZ). Watson (1975) recorded 'adults' growing outer primaries in Oct. and Mar., but unknown how these birds were aged. Condition of primaries of breeding adults from Heard, Macquarie, Campbell and Auckland Is consistent with staffelmauser; 5.3 (2.42;

1-8; 6) primaries replaced in winter. Uniform wear of rectrices at breeding grounds suggests tail-moult in winter complete. Unknown when body-moult begins; at beginning of breeding season body-feathers fresh, occasionally with isolated worn feathers (Berruti 1979a).

**POST-JUVENILE** Juveniles beachcast in first winter have fresh primaries. Immature (on colour of sulcus) beachcast, Vic., 23 July, with primary moult N<sup>7423</sup>1 may have been completing first pre-basic in second summer.

**SUBSEQUENT MOULTS.** No information.

**MEASUREMENTS** (1) Marion I., live adults; methods unknown (A. Berruti). (2) S. Georgia, skins; methods unknown (Nichols & Murphy 1914). Additional measurements in Falla (1937), Westerskov (1960), Mougín (1970). Information on growth of chicks in Sorensen (1950), Berruti (1979a) and Thomas *et al.* (1983).

	MALES	FEMALES
WING	(1) 559 (9.6; 546-568; 4) (2) 522.4 (13.2; 503-552; 11)	545 (17.6; 527-569; 5) 509 (14.0; 490-526; 7)
TAIL	(1) 297 (5.7; 291-302; 3) (2) 270.8 (11.8; 249-294; 11)	289 (9.9; 279-301; 5) 260.1 (13.9; 236-276; 7)
BILL	(1) 109.2 (2.1; 106.2-111.3; 4) (2) 111.4 (4.05; 103-117; 11)	105.8 (1.8; 103.5-108.2; 5) 110.0 (6.82; 98-117; 7)
TARSUS	(1) 87.6 (3.0; 84.7-91.5; 5) (2) 83.1 (1.62; 80-86; 11)	85.8 (1.4; 84.2-88.0; 5) 80.7 (1.75; 78-84; 7)
TOE	(2) 124.8 (3.46; 120-131; 11)	121.7 (2.86; 116-125; 7)

Unsexed birds. (3) Macquarie and Heard Is, adult skins (MV). (4) Antipodes, Macquarie, Campbell and Auckland Is, fresh adults (NMNZ). (5) Iles Crozet, live adults (Weimerskirsch *et al.* 1986).

	UNSEXED
WING	(3) 534 (9.3; 528-561; 7) (4) 549 (16.2; 518-569; 6) (5) 550.6 (15.1; 520-570; 18)
8TH P	(3) 311 (6.6; 303-322; 7)
TAIL	(3) 288 (20.2; 241-305; 7) (4) 288 (16.9; 261-308; 6)
BILL	(3) 108.0 (3.34; 103.3-112.9; 7) (4) 104.2 (4.07; 98.5-110.5; 9) (5) 106.4 (4.2; 98-133; 20)
TARSUS	(3) 85.2 (2.59; 82.2-90.3; 7) (4) 82.7 (1.98; 80.5-86.4; 6) (5) 84.1 (4.2; 79-95; 18)
TOE	(3) 128.2 (3.72; 122.7-130.9; 4) (4) 125.3 (4.55; 116.8-130.8; 6)

**WEIGHTS** At Marion I., in Oct.: breeding males 3360, 2800, 2840; breeding females 3140 (443; 2620-3700; 5) (A. Berruti). At Iles Crozet, Nov.-Dec.: 3150 (300; 2850-3600; 13; Weimerskirsch *et al.* 1986). NZ offshore islands (juveniles and immatures excluded); 2756 (324.8; 2050-3064; 9; NMNZ, Westerskov 1960). NZ beachcasts: 1673 (330.2; 1222-2275; 9). Definitive male and female at sea, W of Antarctic Pen., late Dec.: 2980 and 3000 respectively (Holgersen 1957). Information on weight gain of chicks in Sorensen (1950), Berruti (1979a), Thomas *et al.* (1983) and Weimerskirsch *et al.* (1986).

**STRUCTURE** Wing, long and narrow. Eleven primaries; p10 longest, p11 minute, p9 12–25, p8 37–54, p7 76–96, p6 120–138, p5 164–183, p4 207–235, p3 250–280, p2 272–318, p1 284–347. Twenty-four secondaries; seven humerals about two-thirds length of secondaries. Tail, wedge-shaped; t6 108–117 longer than t1. Bill, slender and laterally compressed; deep at base. Culminicorn, concave (illustrated in Mathews 1910–27; Mathews & Iredale 1921; Murphy). Nares, rounded, point upwards, situated near base of upper mandible, between groove of culminicorn and latericorn. Adults have about 6–10 small transverse ridges at base of culminicorn; these absent in juveniles and downy young. Feet, webbed. Middle and outer toes about equal, inner 80–85%; no hind claw.

**GEOGRAPHICAL VARIATION** None. Characters used to separate four subspecies (Nichols & Murphy 1914) found to vary when more specimens were examined (Murphy). DIR

#### REFERENCES

- Ainley, D.G., et al. 1984. *AOU orn. Monogr.* 32.  
 Alexander, W.B. 1917. *Emu* 17: 40–2.  
 Bailey, A.M., & J.H. Sorensen. 1962. *Proc. Denver Mus. nat. Hist.* 10.  
 Barrat, A., et al. 1973. *Oiseau Revue fr. Orn.* 43: 32–50.  
 Bell, B.D. 1975. Pp. 136–142. In: Yaldwyn 1975.  
 Berruti, A. 1979a. *Emu* 79: 161–75.  
 Berruti, A. 1979b. *Notornis* 26: 308–309.  
 Berruti, A. 1981a. *Ostrich* 52: 98–103.  
 Berruti, A. 1981b. *Cormorant* 9: 123–128.  
 Berruti, A., & T. Harcus. 1978. *S. Afr. J. Antarct. Res.* 8: 99–103.  
 Bierman, W.H., & K.H. Voous. 1950. *Ardea* 37 (Extra no.): 1–123.  
 Brooke, R.K., & J.C. Sinclair. 1978. *Cormorant* 4: 10–17.  
 Brown, R.G.B., et al. 1975. *Ibis* 117: 339–56.  
 Cheeseman, T.F. 1890. *Trans. Proc. NZ Inst.* 23: 216–26.  
 Croxall, J.P. (Ed.) 1987. *Seabirds: Feeding Ecology and Role in Marine Ecosystems*.  
 Croxall, J.P., & P.A. Prince. 1980. *Biol. J. Linn. Soc.* 14: 103–31.  
 Croxall, J.P., & P.A. Prince. 1987. Pp. 347–68. In: Croxall 1987.  
 Croxall, J.P., et al. 1984c. *ICBP Tech. Publ.* 2: 637–66.  
 Downes, M.C., et al. 1959. *ANARE Rep. B*, 1: 1–135.  
 Enticott, J.W. 1986. *S. Afr. J. Antarct. Res.* 16: 25–8.  
 Falla, R.A. 1937. *Rep. B.A.N.Z. Antarct. Res. Exped.*, B, II.  
 Green, R.H. 1989. *Birds of Tasmania*.  
 Griffiths, A.M. 1982. *Cormorant* 10: 9–14.  
 Harper, P.C. 1987. *Notornis* 34: 169–92.  
 Harper, P.C., et al. 1985. *BIOMASS Handbook* 24.  
 Harrison, P. 1983, 1985. *Seabirds: An Identification Guide*.  
 Hicks, G.R.F. 1973. *Notornis* 20: 231–50.  
 Hines, M.P. 1962. *Emu* 62: 62–3.  
 Hitchcock, W.B. 1950. *Emu* 50: 135–7.  
 Holgersen, H. 1957. *Scient. Results Bratigg Exped.* 4.  
 Humphrey, P.S., et al. 1970. *Bds Isla Grange*.  
 Imber, M.J., & A. Berruti. 1981. Pp. 43–61. In: *Proc. Symp. Bds Sea Shore*.  
 Jenkins, J.A.F., & E. Greenwood. 1984. *Notornis* 31: 325–30.  
 Jouventin, P., et al. 1984. *ICBP Tech. Publ.* 2: 609–25.  
 Kerry, K.R., & B.R. Garland. 1984. *Tas. Nat.* 79: 21–3.  
 Kerry, K.R., & G.C. Colback. 1972. *Aust. Bird Bander* 10: 61–2.  
 King, W.B. 1967. *Seabirds of the Tropical Pacific Ocean*. Prelim. Smithson. Ident. Manual.  
 Kock, K.-H., & H.H. Reinsch. 1978. *Beitr. Vogelk.* 24: 305–28.  
 Learmonth, N.F. 1958. *Emu* 58: 68–9.  
 Lindsey, T.R. 1986. *Seabirds of Australia*.  
 Linkowski, T.B., & J.M. Rembiszewski. 1978. *Pol. Arch. Hydrobiol.* 25: 717–27.  
 MacGillivray, W. 1920. *Emu* 19: 162–76.  
 Mathews, G.M. 1910–27. *Birds of Australia*.  
 Mathews, G.M., & T. Iredale. 1921. *Man. Bds Aust.*  
 Morrison, K., et al. 1987. *Notornis* 34: 79–80.  
 Mougou, J.-L. 1970. *Com. natn. fr. Rech. Antarct.* 40 (No. spec.): 37–61.  
 Nichols, J.T., & R.C. Murphy. 1914. *Auk* 31: 526–34.  
 Paessler, R. 1911. *J. Orn., Lpz.*, 59: 41–51.  
 Paessler, R. 1913. *J. Orn., Lpz.*, 62: 272–8.  
 Parker, S.A., et al. 1979. *An Annotated Checklist of the Birds of South Australia*. 1.  
 Paulian, P. 1953. *Mem. Inst. Sci. Madagascar, A*, 8: 111–254.  
 Pizzey, G. 1980. *Field Guide Bds Aust.*  
 Powlesland, R.G. 1985. *Notornis* 32: 23–41.  
 Prince, P.A., & R.A. Morgan. 1987. Pp. 135–71. In: Croxall 1987.  
 Prince, P.A. 1980. *Ibis* 122: 476–88.  
 Roberts, G. 1973. *Sunbird* 4: 52–3.  
 Roberts, G. 1977. *Sunbird* 8: 69–71.  
 Robertson, C.J.R., & B. Bell. 1984. *ICBP Tech. Publ.* 2: 573–86.  
 Robertson, C.J.R., & J. Jenkins. 1981. *A'asian Seabd Grp Newsl.* 16: 17–27.  
 Rounsevell, D.E., & Brothers, N.P. 1984. *ICBP Tech. Publ.* 2: 587–92.  
 Routh, M. 1949. *Ibis* 91: 577–606.  
 Rowlands, B.W. 1987. *Cormorant* 14: 31–8.  
 Shuntov, V.P. 1974. *Seabirds and the Biological Structure of the Ocean*. US Dept. Int. transl. TT 74–55032.  
 Siple, P.A., & A.A. Lindsey. 1937. *Auk* 54: 147–159.  
 Sorensen, J.H. 1950. *Dept. Sci. Ind. Res. Cape Exped. Ser. Bull.* 8.  
 Stahl, J.-C. 1987. *TAAF.MR. Rapports des Campagnes a la Mer* 84–01: 175–96.  
 Summerhayes, C.P. 1969. *NZ J. mar. freshw. Res.* 3: 560–70.  
 Szij, L.J. 1967. *Auk* 84: 366–78.  
 Teixeira, D.M., et al. 1988. *Bull. Br. Orn. Club* 108: 136–9.  
 Thomas, G. 1982. *Emu* 82: 92–100.  
 Thomas, G., et al. 1983. *J. Zool., Lond.* 199: 123–35.  
 Thomas, T. 1983. *Oiseau Revue fr. Orn.* 53: 133–141.  
 van Oordt, G.J., & J.P. Kruijt. 1954. *Ardea* 42: 245–80.  
 Vooren, C.M. 1973. *Notornis* 20: 301–10.  
 Warham, J., & B. Bell. 1979. *Notornis* 26: 121–69.  
 Watson, G.E. 1975. *Birds of the Antarctic and Sub-Antarctic*.  
 Watson, G.E., et al. 1971. *Antarct. Map Folio Ser.* 14.  
 Weimerskirch, H. 1982. *Com. natn. fr. Rech. Antarct.* 51: 437–447.  
 Weimerskirch, H., et al. 1986. *Ibis* 128: 195–213.  
 Weimerskirch, H., et al. 1987. *J. Anim. Ecol.* 56: 1043–55.  
 Weimerskirch, H., et al. 1989. *Emu* 89: 15–29.  
 Westerskov, K. 1960. *Wildlife Publ.* 61: 1–83.  
 Williams, A.J. 1984. *ICBP Tech. Publ.* 2: 627–35.  
 Williams, A.J. 1987. *Cormorant* 15: 103–5.  
 Yaldwyn, J.C. (Ed.) 1975. *Preliminary Results of the Auckland Islands Expedition 1972–1973*.



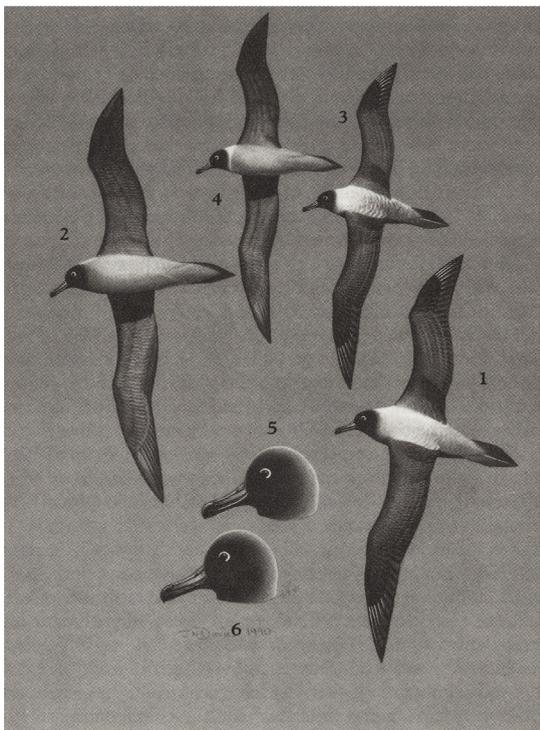
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Volume 1 (Part A), Plate 24

Light-mantled Sooty Albatross *Phoebastria palpebrata*

1. Adult, dorsal, fresh
2. Adult, ventral, fresh
3. Adult, dorsal, worn
4. Adult, ventral, worn
5. Adult, head
6. Juvenile, head

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