

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.

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Family PROCELLARIIDAE fulmars, petrels, prions, shearwaters

The family Procellariidae represents the main radiation of medium-sized 'true petrels', characterized by having united nostrils with a median septum and the outer functional primary at least as long as the next. It tends to be dominant among the birds of the Southern Ocean, though in the n. hemisphere the Charadriiformes are more numerous. The giant-petrels *Macronectes* have also developed as large scavengers and predators, showing some convergence in appearance and behaviour with the Diomedidae. The Procellariidae may be divided into four main groups with some intermediate species, which makes it hard to draw distinctions between them.

(1) The fulmars *Macronectes*, *Fulmarus*, *Thalassoica*, *Daption* and *Pagodroma* consist of seven species of surface predators and filter-feeders of rather varying structure and appearance (Voous 1949) that breed in high latitudes but may migrate along cool currents into much lower ones. *Fulmarus* appears to have colonized the n. hemisphere in the Tertiary. Six of the seven species are essentially confined to our region.

(2) The gadfly-petrels *Pterodroma* are a large series of some 30 agile species; 16 breed in our region and another six occur rarely or rather rarely. Their short sturdy bills are adapted for seizing soft prey at the surface, and their twisted intestines, for digesting marine animals with an unusual biochemistry, which are also found throughout the warmer oceans (Imber 1985). They show complex markings of face and wings that must serve as interspecific recognition-marks (Murphy & Pennoyer 1952). Some species placed in this group have an intermediate structure and intergrade with all other groups distinguished here: *Pterodroma (Lugensa) brevirostris*, which moves S in winter, has distinctly big eyes like *Pagodroma*; *Halobaena caerulea* has a plumage similar to that of prions; *Bulweria* has some structural resemblance to shearwaters. At present it is difficult to determine their precise relationships.

(3) The prions *Pachyptila* are a specialized group of six (perhaps five) very numerous species, all in our region, that show a progressive adaptation of a small, agile, cryptically coloured, fulmarine form for filter-feeding on zooplankton. There has been dispute over their classification (Cox 1980; Harper 1980) but the arrangement discussed by Fleming (1941) seems best except that the Broad-billed Prion *P. vittata* appears to intergrade with Salvin's Prion *P. salvini* through *macgillivrayi* of Ile St Paul; so they may be better treated as subspecies of the same species.

(4) The shearwaters *Procellaria*, *Calonectris* and *Puffinus* include some 20 agile species with long bills adapted to catch prey more or less under water throughout the warmer seas (Kuroda 1954); 13 species breed in our region, some migrating into the n. hemisphere; six others are chance or perhaps regular visitors. From the fossil record (Brodkorb 1963; Olson 1975); they seem to have been particularly common in the great Tethys Ocean of the middle latitudes of the n. hemisphere in the Tertiary, so this development of aquatic habits may have occurred there without competition from penguins with a subsequent return S by the more successful forms.

General features of the family are: body, ovate, or elongate in shearwaters; wings, long and narrow, 11 primaries, p10 longest, p11 minute; 20-29 secondaries, short, diastataxic; tail, short, 12 feathers; bill, heavy (*Macronectes*), slender (shearwaters), broad (prions) or stubby (gadfly-petrels), hooked, formed of several horny plates; nostrils in dorsal tube of varying length; legs set far back, laterally flattened but round in gadfly-petrels; three toes, webbed, hind toe vestigial, raised. Oil-gland feathered. Peculiar musky odour. Sexes similar, male usually larger than female. Plumage, black or grey above, white below, or all dark; light and dark morphs in some species. Juveniles and immatures usually like adults.

Cosmopolitan throughout the oceans, essentially pelagic; more abundant in cool or cold waters rich in plankton and mostly away from ice. Swim well but usually aerial except when feeding or resting. Fly with alternate swooping and flapping action close to the surface but often arcing high in some gadfly-petrels. Gait on land, a shuffling crouch, being unable to walk properly with feet set so far back; generally avoid open areas on land, being thus vulnerable to predators. Nest colonially; for the most part in burrows and cavities in all sorts of terrain, sometimes far from the sea and in mountainous areas but some species, e.g. *Macronectes*, nest on open ground. Hole-nesters usually nocturnal at colonies, when often extremely vocal, though generally silent at sea. Migratory and dispersive. Some species divide the year between s. and n. hemisphere, often migrating in large flocks that may settle on the sea in huge dense rafts. Feed mostly on fish, cephalopods and crustaceans obtained by flight-feeding, plunge-diving, surface feeding, surface-diving and underwater pursuit; hydroplaning (Murphy) is a characteristic method used particularly by prions.

Probably all defend small nesting territories to which they return regularly while undisturbed; certainly so in some hole- and burrow-nesting forms. Agonistic and sexual behaviour of nocturnal, hole-nesting species very poorly known but generally seem to have little specialization for visual displays. Tactile actions such as allopreening and billing used but olfactory and vocal communication is probably important. Breeding is usually seasonal, generally with synchronized laying, often after a pre-laying exodus but some may not nest annually; some have shorter

cycles or nest continually. For the most part, little attempt to make substantial nests. Eggs, ovate, mat, white. Clutch-size, invariably one; single-brooded; no replacement laying. Incubation by both sexes in alternate spells of 1-11 days. Single median brood-patch. Incubation period, 45-55 days. Eggshells probably always trampled in nest. Young, semi-altricial, nidicolous; hatched in down. Rarely left alone in nest for first 1-2 weeks. Cared for and fed by incomplete regurgitation by both parents. Nestling period generally shorter in cliff- and ledge-nesting species than in hole-nesters. Young attain greatest weight, often well above that of adult, some days before fledging, by which time weight has been reduced to about the same as an adult, but no clear evidence that young are totally deserted for last few days in nest. Adults and young of most species liable to eject stomach-oil in defence. Young independent at fledging. Maturity reached at minimum of 3-4 years, in some 6-12 years.

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Thalassoica antarctica Antarctic Petrel

Procellaria antarctica Gmelin, 1789, *Syst. nat.* 1: 565 — Antarctic Circle between 31° and 61°S.

The generic name is a compound of the Greek θάλασσα (sea) and οἰκέειν (to dwell) = sea dweller; specifically of the Antarctic, after type-locality.

OTHER ENGLISH NAMES Antarctic Fulmar.

MONOTYPIC

FIELD IDENTIFICATION Length 40–45 cm; wing-span 100–110 cm; weight 675 g. Distinctive, medium-sized petrel with strikingly patterned brown-and-white plumage; upperparts, brown with broad white areas on the inner primaries, secondaries and tail. In worn plumage, brown areas become bleached to tan-brown. Circumpolar in s. oceans, mainly confined to vicinity of pack-ice, occasionally straying as far N as Aust. and NZ in late winter. Typical fulmarine flight, habits and behaviour. Sexes similar; no seasonal differences. Juveniles similar to adults in fresh plumage but bill black.

DESCRIPTION ADULT. Head, mantle, back, rump, inner wing-coverts and leading-edge of upperwing, dark brown. Broad white areas on inner primaries, greater coverts and across secondaries, with narrow brown trailing-edge. Lower rump and upper tail-coverts white. Tail, white with brown terminal band. Chin and throat brown, sharply separated from white breast and abdomen. White flanks joining lower abdomen and white lower-rump. Under tail-coverts white, but dark tips to retrices visible. Underwing white with brown leading-edge to wing and outer primaries, and brown terminal spots on remaining primaries and secondaries. Brown areas of plumage sharply demarcated from white areas except for some mottling on throat and sides of neck. Bill dark brown. Iris brown. Legs and feet, greyish flesh. Marked fading occurs during summer; dark parts fade from almost black when fresh, to light brown when worn; throat and nape often become whitish.

SIMILAR SPECIES Resembles only wider-ranging Cape Petrel *Daption capense* but has distinctly different pattern above with clear-cut markings of dark brown and white, not chequered or spotted with black. In flight, glides more than Cape Petrel.

Normally restricted to Antarctic seas in summer; often the most abundant bird of the iceberg belt and also occurs among pack-ice. Fly with stiff wing-beats and glide, sometimes at great heights; hover over water before plunging and may hit water with wings outstretched. Do not usually follow ships except when large numbers gather for food round whaling vessels though individuals will circle ships and scavenge waste. Swim well, with tail held high and wings sometimes partly open. Food taken at sea surface or up to 1.5 m below by diving or plunging. Alight easily without crash-landing; squat rather than stand. Gregarious in loose flocks; often show co-ordinated flight movements. Often associate with Snow Petrels *Pagodroma nivea*.

HABITAT Circumpolar in seas of Antarctic Zone; in summer, mainly about 62–63°S, from continental coast in S to n. limit of icebergs (Ainley *et al.* 1984). Common in pack-ice and open water (Johnstone & Kerry 1976); prefer open water

near ice rather than ice itself (Ainley *et al.* 1984); N of pack, usually within 150–200 km of ice edge (Falla 1937; Ozawa *et al.* 1964), concentrating where icebergs present (Routh 1949; Ainley *et al.* 1984). Probably restricted to vicinity of ice because flight characteristics unsuited to long pelagic journeys (Griffiths 1983). In Ross Sea, common S of 65°S, most birds in waters colder than 0.5 °C and of a wide range of salinities. In Dec., highest densities (breeding and non-breeding birds) in open water over continental slope, but also high in some areas of pack-ice; lower to seaward of slope waters, where most birds are non-breeders. In Jan.–Feb., shift to N of slope waters, and density over deep waters increases (mostly non-breeders). Range contracts towards breeding areas round continental coast and inland in breeding season (Ainley *et al.* 1984). In non-breeding season, mainly pelagic; disperse over Antarctic Zone, N to near Antarctic Convergence, sea-surface temperature <3.8 °C (Szijj 1967; Duhamel 1981; Griffiths 1983); at Wilkes Stn, frequent edge of fast-ice a few kilometres from coast (Orton 1968); approach coast when sea-ice disperses and open water present (Murphy; Johnstone *et al.* 1973).

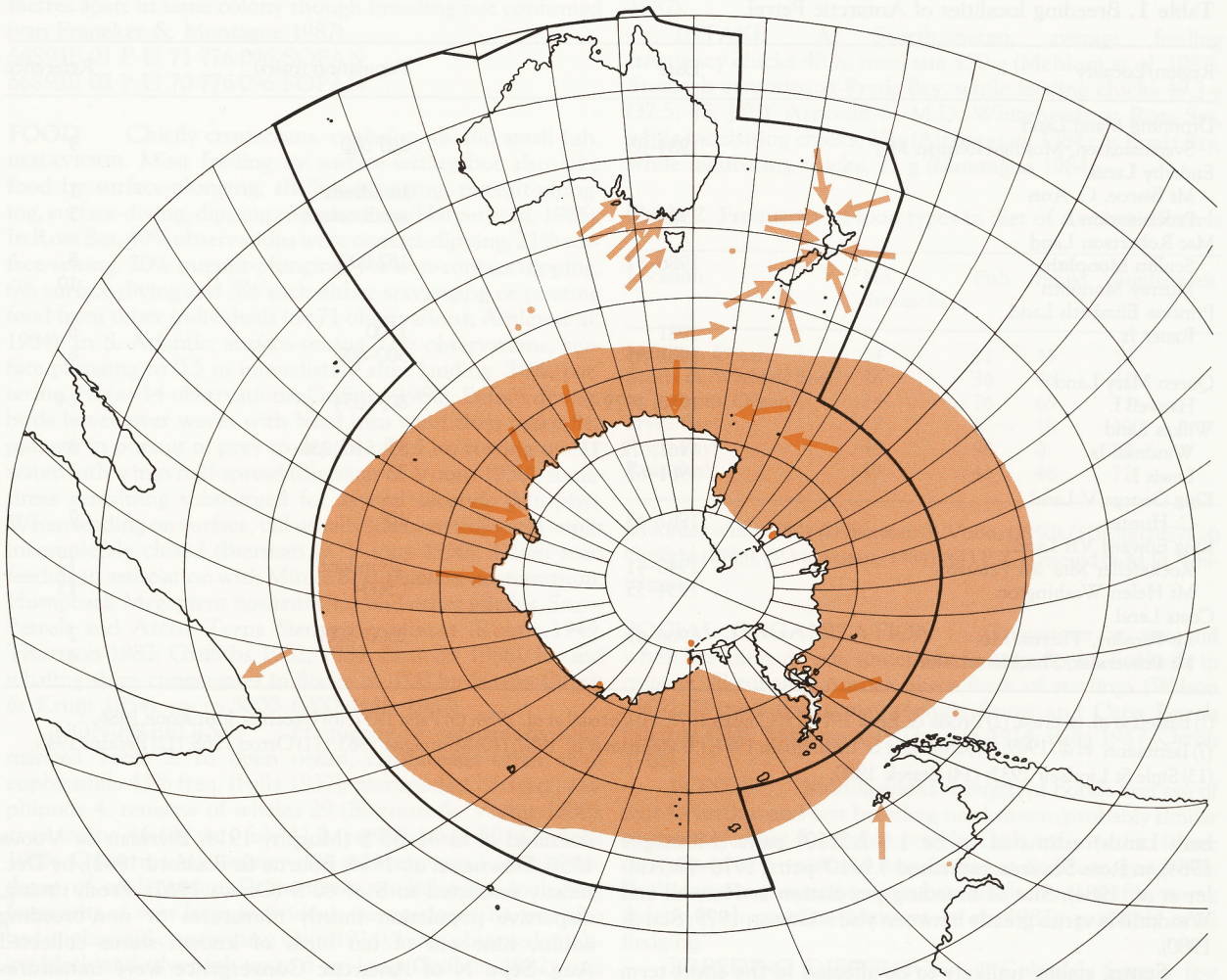
Within pack-ice, numbers highest at n. edge (Murphy; Montague 1988). Can penetrate pack; observed over pools by continental ice-shelf up to 65 km from nearest open water (Routh 1949). Widely distributed over pack-ice and open water, but prefer light pack-ice; 10–30% ice cover (Weddell Sea; Cline *et al.* 1969); 12–50% (Ross I. to Anvers I.; Zink 1981); 0–25% (Prydz Bay; Montague 1988). At Ross I., present only when s. winds >50 km/h, dispersing pack-ice and reducing ice cover. Within pack, 38% total observations over centres of leads; 32% at floe leading edges; 24% over brash-ice; 6% over ice-floes (Ainley *et al.* 1978, 1984).

Breed Antarctic mainland and inshore islands, in crevices and on ledges on cliffs, slopes, mountain ranges; many sites exposed to wind, preventing accumulation of snow (Falla 1937; Brook & Beck 1972; Luders 1977).

Rest on icebergs and floes (Falla 1937). Travelling with ships or direct flight over sea, at 50–100 m (Ainley *et al.* 1984); rarely lower than 20 m (Routh 1949). Aerial foraging; food taken at sea surface or up to 1.5 m below surface (Bierman & Voous 1950).

DISTRIBUTION AND POPULATION Circumpolar in s. seas from Antarctic coast N to c. 62°S in summer, to 48–55°S in winter. Breed coastal and inland Antarctica. Move N in winter, reaching NZ; vagrant to Aust.

Summer distribution defined by ice conditions. Between Jan.–Apr. restricted to pack-ice and surrounding iceberg belt, S of 62–65°S; farther N to 56–60°S in Weddell and Scotia Seas (Vanhöffen 1901; van Oordt & Kruij 1954; Holgersten 1957; Ozawa *et al.* 1968; Aoyanagi 1973; Flora 1981; Thurston 1982; Stahl 1987). Exceptional n. records in summer: singles at 49°S



111°E, Mar. (Buller 1905); 33°S 99°E, Mar. (Courtenay-Latimer & Quicquelberge 1966); possible record Falkland Is, Feb. (Woods 1975). Most numerous in Ross Sea and N of ice-edge between Weddell Sea and Enderby Land; abundance appears negatively correlated with abundance of Southern Fulmar *Fulmarus glacialisoides* (Hunt & Veit 1983).

June–Nov., range extends to open Antarctic waters farther N, occasionally crossing Antarctic Convergence. N. limit usually 49–52°S in S. Atlantic (Murphy 1914; Duhamel 1981; Bourne & Curtis 1985; Clark 1987), 48–50°S in s. Indian Ocean (Falla 1937; J-C. Stahl) and 48–55°S in S. Pacific Ocean (Wilson 1907; Szijj 1967; Meeth & Meeth 1983). Regular visitor to Signy I., Aug.–Dec. (Rootes 1988) and Bouvetøya (Watkins 1981; Duhamel 1981; Harris 1982). Accidental to S. Georgia, one record Aug. (Prince & Payne 1979); Falkland Is, one record Sept. (one possible summer record, Feb.) (Woods 1975); S. Africa, one record Sept. (Courtenay-Latimer & Quicquelberge 1966). In s. Indian Ocean, occasionally reaches Marion I., Aug.–Oct. (Sinclair 1981; Gartshore 1987), Iles Crozet, Aug.–Sept. (Stahl *et al.* 1984), Iles Kerguelen, Aug.–Oct. (Thomas 1983) and Heard I., July–Nov. (Downes *et al.* 1959). Single bird reported at Macquarie I., Aug. 1970 (G.W. Johnstone in Green 1977).

AUST. Accidental, all beachcast. First records 1978 at same time as wreck in NZ: Vic. (five records): Gunnamatta

Beach 13 Aug., Queenscliff 31 Aug., Port Campbell 30 Sept., Port Fairy 17 Oct., Discovery Bay 30 Aug. 1978 (Aust. Atlas; G. Bowker; M. Brady; D. Stewart; R. Thoday); Tas. (one): Henty R., Strahan, 8 Dec. (Aust. Atlas). SA: Victor Harbour, 7 Sept. 1978 (Roberts 1979). Only two later records: Vic.: one, Discovery Bay, 23 Aug. 1984 (Vic. Bird Rep. 1984); SA: one, E of Port Macdonnell, 3 June 1979 (Aust. Atlas).

NZ Regarded generally as accidental: seven records between 1936 and 1959; one in 1964; one in 1965; 10–13 between 1973 and 1985 except 1978 when wreck of 73 birds occurred Aug.–Oct.; mostly beachcast on NI but several hundreds sighted at sea, Foveaux Str., between Preservation Inlet and Stewart I., Sept. 1978 (Barlow 1979); usually recorded Aug.–Sept. but single records in Oct., Nov., Dec., Feb. and May (Barlow 1979; Veitch 1980; *Notornis* CSN *passim*). NZ beach patrol recorded 81 birds to 1983, 73 collected in 1978; on NI: 65 Auckland West, 1 Auckland East, 6 Wellington West and 4 Taranaki; on SI: 5 beachcast Southland (Powlesland 1986).

BREEDING Antarctica. Fourteen known breeding localities; summarized in Table 1.

Possibly breeding on Balleny Is (Robertson *et al.* 1980), Scott I. (Robertson Bay, Ross Sea; Harper *et al.* 1984) and Adelaide I. (Antarctic Pen.; Croxall *et al.* 1984). Total population in Prydz Bay area (Mac Robertson and Princess Eliza

Table 1. Breeding localities of Antarctic Petrel.

Region/Locality	Date	Population (pairs)	Reference
Dronning Maud Land			
Svarthamaren, Muhlig-Hoffman Mts	1984-85	207 000	9
Enderby Land			
Mt Biscoe, C. Ann		hundreds	1
Proclamation I.	1929-30	small colony	5
Mac Robertson Land			
Scullin Monolith	1986-87	157 000	8
Murray Monolith			10
Princess Elizabeth Land			
Rauer Is	1981	1100	6
	1983-85	500-800	6
Queen Mary Land			
Haswell I.	1956, 1979	80, 1054	14
Wilkes Land			
Windmill Is	1961, '72, '77	85, 510, 250	3
Lewis I.	1961-62	7	11
King George V Land			
C. Hunter	1967-68	10 ³	7
King Edward VII Land			
Rockefeller Mts: Mt Paterson	1940-41	'abundant'	12
Mt Helen Washington	1934-35	? 500+	13
Coats Land			
Mt Faraday, Theron Mts	1966-67	2500-5000	2
Mt Provender, Shackleton Mts			4

(1) Bassett *et al.* in press; (2) Brook & Beck 1972; (3) Cowan 1979; (4) Croxall *et al.* 1984; (5) Falla 1937; (6) Green & Johnstone 1986; (7) Isenmann *et al.* 1969; (8) Johnstone & Ledingham 1987; (9) Mehlum *et al.* 1987; (10) Montague 1983; (11) Orton 1968; (12) Perkins 1945; (13) Siple & Lindsey 1937; (14) Starck 1980;

both Lands) estimated to be 1.5-2.5x10⁶ pairs (Montague 1984); in Ross Sea area, estimated 3.9x10⁶ pairs, 1976-79 (Ainley *et al.* 1984). Size of breeding population at Haswell and Windmill Is varies greatly between years (Cowan 1979; Starck 1980).

Status, stable; unlikely to be affected in the short term because breeding sites are so inhospitable. Potential development of krill fishery may affect populations.

MOVEMENTS Dispersive, possibly migratory, movements poorly known.

DEPARTURE Adults leave Haswell I., 26 Apr.-1 May (Nudelman 1962; Pryor 1968; Kamenev 1969), Windmill Is, 24 May (Orton 1968). Chicks leave Lewis I. by 28 Feb. (Orton 1968). Non-breeders may depart at same time; absent from Terre Adélie until Apr.-May (Thomas & Bretagnolle 1988).

NON-BREEDING During winter, part of population remains near edge of ice (Szijj 1967; Griffiths 1983); seen occasionally at coastal Antarctic stations following break-up of fast-ice or when blizzards break up pack-ice creating open water near coast (Gain 1914; Falla 1937; Orton 1968; Johnstone *et al.* 1973; Thomas & Bretagnolle 1988). Part of population disperses N to Antarctic Convergence and beyond. In Apr., range still S of 61-63°S (Vanhöffen 1901; Aoyanagi 1973). Maximum extension Aug.-Oct. (Szijj 1967; Duhamel 1981; Chapman 1986; Clark 1987) with most records N of Antarctic Convergence during this period with similar peak in spring records at Signy I., near Antarctic continent (Rootes 1988). Extent of dispersal N of Antarctic Convergence irregular; best documented irruption 1978 to Aust. and NZ waters (see Distribution). S. contraction of range Nov. but still a few

scattered N to 41-55°S (Murphy 1914; Bierman & Voous 1950; Downes *et al.* 1959; Bourne & Radford 1961); by Dec. mostly restricted to S of 60°S (Ozawa 1967). From timing, dispersive population mostly immatures or non-breeding adults; nine out of ten birds of known status collected Aug.-Sept. N of Antarctic Convergence were immatures (Falla 1937; NMNZ).

RETURN Synchronized. Mass nw. migration observed over Palmer Stn, Antarctic Pen., 15-22 Sept. (Parmelee *et al.* 1977) with first arrivals at breeding colonies early Oct. First returns: Haswell I., 2-7 Oct. (3 years; Nudelman 1962; Pryor 1968; Kamenev 1969), Casey, 8 Oct. with most of population at nest-sites by 11 Oct. (Luders 1977); at Windmill Is, 10-20 Oct. (Orton 1968; Cowan 1979). S. of breeding sites, at Bay of Whales (78°S) first records 2-6 Oct. (2; Siple & Lindsey 1937) and near breeding sites in Mühlig-Hoffmannfjella, 9 Oct. (La Grange 1962) and in Theron Mts, 11 Oct. (Halley Bay; Brook & Beck 1972). At Terre Adélie, peak in numbers, presumably non-breeders, occurs Sept.-Dec. round colonies of other seabirds (Thomas & Bretagnolle 1988).

BREEDING In summer, remain in pack-ice over continental shelf close to breeding colonies (Ainley *et al.* 1984). Virtually absent Jan.-Mar. from Pointe Géologie, Terre Adélie, 120 km E of nearest breeding colony (Thomas & Bretagnolle 1988) and from Signy I., 2000 km N of breeding colony in Theron Mts (Rootes 1988) and scarce in summer at Palmer Stn (Parmelee *et al.* 1977). However, has been collected 850 km from nearest breeding colony in Ross Sea (Ainley *et al.* 1984) and about 1000 km from Antarctic continent in sw. Atlantic (Bierman & Voous 1950).

BANDING Two chicks banded Haswell I. recovered Ardery I., Windmill Is, 6 years later; recovered a few

metres apart in same colony though breeding not confirmed (van Franeker & Montague 1987).

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66S93E 02 P U 70 776 096 SOPAN

FOOD Chiefly crustaceans, cephalopods and small fish. **BEHAVIOUR.** Most feeding by surface-seizing but also take food by surface-plunging, shallow-plunging, pursuit-plunging, surface-diving, dipping and pattering (Harper *et al.* 1985). In Ross Sea, 40% observations were contact-dipping, 21% surface-seizing, 20% pursuit-plunging, 7% non-contact dipping, 6% surface-diving and 3% each either scavenging or pirating food from other individuals ($n=71$ observations; Ainley *et al.* 1984). In S. Atlantic, surface-seizing 57% observations, surface-plunging to 0.5 m immediately after landing, 36%, pattering 7% ($n=14$ observations; Griffiths 1982). Before diving, birds hover over waves with head into wind then make flat plunges in pursuit of prey to depths of 1.5 m, rowing under water with wings half-spread (Bierman & Voous 1950), sometimes remaining submerged for several seconds (Murphy). When feeding on surface, tail usually held vertically and wings incompletely closed (Bierman & Voous 1950). Often seen feeding in association with Minke *Baleanoptera acutorostrata*, Humpback *Megaptera novaeangliae* and other whales, Snow Petrels and Arctic Terns *Sterna paradisaea* (Routh 1949; Thurston 1982; Griffiths 1982, 1983; Enticott 1986). Round whaling ships congregates in flocks >1000 birds (van Oordt & Kruijt 1954), up to 5000–6000 (Falla 1937).

NON-BREEDING Frequency of occurrence summarized Table 2. In open ocean, crustaceans other than euphausiids 43% freq. (Falla 1937); pteropods 11% freq., amphipods 4, remains of whales 29 (Bierman & Voous 1950); crustaceans 46.6% wt., fish 42.7, cephalopods 9.7 (Griffiths 1983). Other records: winter diet at Petermann I., solely medusae of coelenterate *Desmoneta gaudichaudii*, including fragments of very large individuals (seven stomachs, one also had euphausiid crustaceans; Gain 1914); birds observed catching black-and-silver fish up to 5 cm long (Griffiths 1982); one stomach collected Drake Passage contained fish and squid (Linkowski & Rembiszewski 1978) and one collected S. Georgia contained squid beaks (Lönnerberg 1906).

BREEDING Frequency of occurrence summarized Table 2. In Ross Sea, diet varied with habitat (Ainley *et al.* 1984). Over deep ocean (seven stomachs) squid 96.3% wt.: *Gonatus antarcticus* 9.2% no., 57% freq., 125 g (35; 10), 18.0 cm (3.0; 10), *Psychroteuthis glacialis* 11.8, 43; crustaceans 3.9% wt.: *Euphausia superba* 78.9, 71, 3.7 cm (0.4; 83); over continental slope (27) squid 65.8% wt.: *G. antarcticus* 1.4, 9, *P. glacialis* 0.7, 6, *Galiteuthis glacialis* 0.7, 6, unident. 0.7, 19; crustaceans 17.4% wt.: *E. superba* 85.9, 81, unident. lysianisiids 1.4, 19; fish 16.7% wt.: *Pleuragramma antarcticum* 7.0, 53, 17.6 g (3.6; 40) standard length 14.2 cm (2.7; 40) and polychaetes 0.7, 3. At Prydz Bay (Montague 1984) *E. superba* 4.8 cm (2.7; 47) were 100% vol. in 16 of 17 stomachs of incubating birds and *P. antarcticum* ($n=2$; both 16.0 cm) 95% vol. of one of 17 stomachs. Food brought to chicks at Hop I., Rauer Arch., Prydz Bay (48 stomach-flushed samples; J.P.Y. Arnould & M.D. Whitehead; summarized Table 2) fish *Pleuragramma antarcticum* 77.5% wt., 12.5 cm (3.5; 143), 3.0 individuals/sample (2.3; 4.5); euphausiids *E. superba* 22.3, 4.7 cm (0.4; 102), 15.2 individuals/sample (14.4; 36); polychaetes 0.2. Food brought to chicks Proclamation I. euphausiids, cephalopods and small fish (Falla 1937); on Scullin Monolith, mostly euphausiids and fish, few decapods (Johnstone & Ledingham

1987).

INTAKE At Svarthamaren, average feeding frequency chicks 48 h, meal size 150 g (Mehlum *et al.* 1987). Stomach contents: at Prydz Bay, while feeding chicks 49.3 g (37.5; 48; J.P.Y. Arnould & M.D. Whitehead); at Ross Sea, while incubating chicks, 25 g (Ainley *et al.* 1984); at Prydz Bay, while incubating chicks, 31 g (Montague 1984).

Table 2. Frequency of food types in diet of Antarctic Petrels

Location	No. Stomachs	Fish	Squid	Euphausiids
se.Indian Ocean ³	14	21	43	50
Scotia & Weddell Seas ²	28	36	46	64
se. Atlantic Ocean ⁴	34	76	65	71
Prydz Bay ⁵	17	6	18	100
Prydz Bay ⁶	48	98	0	83
Ross Sea ¹	39	41	46	77

(1) Ainley *et al.* (1984); (2) Bierman & Voous (1950); (3) Falla (1937); (4) Griffiths (1983); (5) Montague (1984); (6) J.P.Y. Arnould & M.D. Whitehead.

SOCIAL ORGANIZATION Gregarious at sea and when breeding. At sea, sometimes in large flocks; flocks fly in unison, all turning at once like a flock of starlings (Wilson 1907). Winter flocks may include Snow and Cape Petrels (Sharpe 1902; Menegaux 1907; Gain 1914; Falla 1937; Orton 1968).

BONDS Monogamous. Length of bonds and age of pair formation and first breeding not known; probably similar to those of other fulmarine petrels. Only information is one bird paired at 6 years old (van Franeker & Montague 1987). Both parents assumed to incubate in alternate shifts; young fed by both parents (Mehlum *et al.* 1987), probably until fledging.

BREEDING DISPERSION Colonial, from a few nests to over 200 000 (Mehlum *et al.* 1987). Density of nests: at Mt Faraday, average 1/m² (Brook & Beck 1972); at Svarthamaren 0.76/m² (Mehlum *et al.* 1987). At Haswell I., mean distance between nests 1 m, minimum 0.3 m (Starck 1980). Nest-site territory only, consisting of nest and area within pecking distance; used for courtship, mating, nesting, feeding of young, take-off and landing.

ROOSTING Little information. Mate occasionally roosts alongside incubating bird; also roost on sea-ice and snow-banks in flocks below or near nest-site. At sea, roost on icebergs, in flocks of up to several thousand (Bierman & Voous 1950; van Oordt & Kruijt 1954).

SOCIAL BEHAVIOUR Little known; only detailed observations at Windmill Is (Luders 1977) on which account based. Displays conspicuous and easy to observe but sexes not separable in field. At sea, not aggressive; dominated by Cape Petrel when competing for food (Barlow 1979). Interactions with conspecifics and other species while at sea, not known. Apparently, ritualized displays not well developed and calls not specialized. Birds returning to site overfly it, turn into updraught and land gracefully, in contrast to awkward crash-landing of Southern Fulmar (Pryor 1968).

AGONISTIC BEHAVIOUR At Haswell I., intense competition between conspecifics for nest-sites at colony (Pryor 1968). **DEFENCE OF SITE:** both members of pair defend

site by thrusting head forward, raising feathers of neck and calling rapidly (see Voice), birds duet if both present; reluctant to spit compared with other fulmarine petrels, doing so only if handled or prevented from escaping. Conflicting evidence regarding competition with, and aggression towards, other species. At Windmill Is, either little competition with Southern Fulmars (Luders 1977) or fierce battles between the two for possession (Orton 1968); disputants may flutter with bills locked and beat each other with their wings. Yet, at Haswell I., returning Antarctic Petrels, quickly and efficiently routed any Southern Fulmars that had moved in during their absence (Pryor 1968) though violent disputes with conspecifics took place. However Antarctic Petrels take off easily from flat areas whereas Southern Fulmars have to drop from ledge and thus the two species prefer different terrains for nesting usually resulting in segregation while nesting (Luders 1977).

SEXUAL BEHAVIOUR On first arrival at colonies, pair-formation and courtship begin at once. Activities similar to those of Southern Fulmars but more frenzied, reaching a peak, with copulation, 10 days after arrival, declining to exodus; some revival after return. Pairs sit on feet, breast on ground with wings folded, most commonly facing or less often, half-facing each other, or head to tail. Displays are interrupted by short flights of 50–200 m by one bird; on return, bird that stayed starts calling *kook-kook-kook* (see Voice) (Luders 1977). **COURTSHIP DISPLAYS**: consist of **Fencing** and **Head-tossing**, always followed by resting; displays become more intense as courtship progressed. Orton (1968) noted **Head-turning** (see **Head-sweeping**, Southern Fulmar) but did not describe display and this not recorded by Luders (1977). **Fencing**: birds move head from side to side, bills touched together alternately on either side; usually performed by one of pair but, if reciprocated, each would display alternately. Varies from slow, gentle action to rapid agitated clashing of bills; latter usually accompanied by calling. **Head-tossing**: birds repeatedly throw head backwards and forwards, usually repeated 3–4 times; at low intensity, feathers under bill slightly raised and head lifted only slightly from normal position; at high intensity, head is stretched fully forward, feathers along neck raised fully and head thrown back till almost touching dorsal plumage, tail held low and slightly fanned; calling usual throughout. At high intensity, each toss lasts 0.7 s with intervals of 2 s; at most frenzied, accompanied by twisting of head at backwards extension of toss and head returned in an arc away from midline. At peak, Head-tossing may occur 6–8 times in 2 s; periods of rest shorten. **Duetting**. Members of pairs would call repeatedly. Such displays mostly by males but females respond as vigorously with Fencing, Head-tossing and Duetting at great intensity. **COPULATION** begins with preliminary fencing then mounting by male; male treads for 90–120 s, then begins **Bill-stropping**, which is similar to Fencing, but performed by male stropping bill of female from above and behind at rate of c. 4 strops/s at greatest intensity. Female responds by lifting her tail to left, male lowers his tail to right until cloacal contact made. Bill-stropping and treading continues throughout copulation; wings remain folded till towards end when male's wings dropped slightly. No post-copulatory display but birds may continue courtship displays after copulation. No ceremony reported at nest-relief but birds probably seldom together at nest once incubation started.

RELATIONS WITHIN FAMILY GROUP Little information; chicks brooded for average of 11 days and

subsequently fed by both parents (Mehlum *et al.* 1987). Two chicks banded in same natal colony were recovered 6 years later, 780 km distant but nearly side by side; suggests that fledgelings remain together in flocks for long periods (van Franeker & Montague 1987).

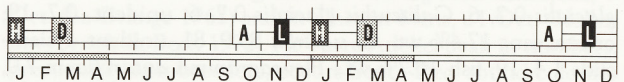
VOICE No detailed studies. At sea, usually silent; calls mainly heard at breeding stations. In general, voice described as churring, clucking and cackling call (Orton 1968). Calls used in formation and maintenance of pairs. No known sexual differences. Loud calls of Antarctic Petrels stronger and more resonant than those of Southern Fulmars. No information on geographical variation. Non-vocal sounds consist of clicking sounds made by clashing of bills during Bill-fencing and Bill-stropping.

ADULT Recognition Call: described as loud, repeated *kook-kook-kook* at a rate c. 3/s and continuing for several seconds; often given as duet. **Head-tossing Call**: usually accompanied by rapid calling at 4–5/s with bill open; cries appear to come from 'deep in throat' (Luders 1977); copulation seems to follow climax of calling. **Threat Call**: during nest-defence repeated calls with both birds joining in, resulting in duetting (Luders 1977).

YOUNG Not reported.

BREEDING Poorly known. No detailed studies. Data mainly from Brook & Beck (1972), Cowan (1979), Falla (1937), Orton (1968), Pryor (1968), Starck (1980) and Mehlum *et al.* (1987) for short periods of observation, even as little as one day. Information supplied by A.N. Cowan and J-C. Stahl. Breed in simple pairs, colonially; often in company with Southern Fulmars, Cape Petrels and Snow Petrels.

SEASON Broadly mid-Nov. to mid-Mar.; similar in all localities where recorded. Arrival at colonies: Haswell I., first 10 days Oct. (Korotkevich 1959) and 2 Oct. (Kamenev 1969), 7 Oct. with whole population returning within 36 hours (Pryor 1968); Windmill Is, 10 and 20 Oct. in two seasons (Orton 1968; Cowan 1979). At Haswell I., courtship began immediately after arrival: first seen 2 days after arrival, peak 17 Oct. (Pryor 1968). Pre-laying exodus: at Haswell, began last week Oct.; highly synchronized, no birds remaining by 2 Nov.; return began 18 Nov; by 20 Nov., at least one member of each pair present but mates did not return together (Pryor 1968); also at Haswell I., mid-Oct.–22 Nov. (Kamenev 1969); Windmill Is, between 13 and 22–26 Nov. (Cowan 1979). Laying: Haswell I., 21 Nov.–5 Dec. (Pryor 1968; Kamenev 1969); Windmill Is, started 30 Nov. (Orton 1968).



SITE Usually on broken but fairly level surfaces in snow-free areas; in clefts, crevices and on ledges on sloping rocky cliffs. Steep slopes and precipitous cliffs often used; also fairly level ground that is broken enough to provide nest sites (Falla 1937; Orton 1968; Luders 1977). Breed from coast to up to 350 km inland (Croxall *et al.* 1984). Coastal sites, 65–260 m asl (Falla 1937); in inland mountains, up to 1600 m asl (Mehlum *et al.* 1987). Colonies usually well-defined. Flat landing rocks always near site. On weather-side of slopes at Scullin Monolith (Falla 1937); in sheltered hollow at Mt Faraway (Brook & Beck 1972). At Windmill Is, locations of colonies vary slightly from year to year (Orton 1968).

NEST, MATERIALS Shallow depression in rock, lined with gravel, if available; material arranged and replaced, using feet and bill. Roles of sexes in selection, building, not known. Droppings may accumulate round nest and help to retain egg.

EGGS Elongated ovoid; rough-shelled, not glossy; white.

MEASUREMENTS: Haswell I.: 69.8 (66.9–76.0; 56) x 47.9 (46.7–49.0) (Falla 1937; Pryor 1968; Starck 1980); Windmill Is: 70 x 48.8 (Orton 1968); C. Hunter: 70.6 (64.4–76.4; 52) x 48.6 (46.0–52.0) (Falla 1937; Isenmann *et al.* 1969); Mt Paterson: 68.5–73.0 x 47.4–51.5 (n=6; Friedmann 1945).

WEIGHTS: Windmill Is, 90 (Orton 1968).

CLUTCH-SIZE One. No information on replacement laying. Doubtless single brooded.

LAYING Highly synchronized. At Haswell I., in 2 years started 21 and 26 Nov.; 75% complete after 3 days, 90% after 8; laying period at least 9 days (Pryor 1968; Kamenev 1969).

INCUBATION Assumed to be by both sexes. **INCUBATION PERIOD:** 46 days (Kamenev 1969); c. 48 days (Korotkevich 1959); >45 days (Pryor 1968); c. 46 days (Orton 1968); 40–45 days (Mehlum *et al.* 1987). Egg incubated on top of feet (Mehlum *et al.* 1987). Dates of hatching: Proclamation I., c. 6 Jan. (Falla 1937); Haswell I., start 10–12 Jan. (Korotkevich 1959; Kamenev 1969), maximum estimated at 1–3 Jan. (Starck 1980); Windmill Is, start 11 Jan. (Cowan 1979), most hatched by 15 Jan. (Orton 1968). No further information.

NESTLING Semi-altricial, nidicolous. Hatched with pale-grey down. Brooded on webs of feet for 11 days (Mehlum *et al.* 1987). At end of brood-stage apparently able to call in defence and spit oil at intruder, though adults spit oil less readily than other fulmarine petrels. **FLEDGING.** At Scullin Monolith, estimated to start 20 Feb. (Falla 1937); at Lewis I., all chicks gone by 28 Feb. (Orton 1968). **NESTLING PERIOD:** c. 45 days (Orton 1968); 42–47 days (Mehlum *et al.* 1987).

GROWTH Mean weight at hatching, 63 g. Growth from 10 to 90% of mean adult weight takes 37 days. Mean metabolic rate 83.2 kJ/kg/h; maximum 1.6 BMR at hatching, 4.3 BMR at end of brood-stage (Mehlum *et al.* 1987).

FLEDGING TO MATURITY Independent of parents at fledging. No further information, except that two 6-year-old birds were paired and near breeding or could have been failed breeders (van Franeker & Montague 1987).

SUCCESS At Haswell I., 63% of eggs survived for 37 days after peak of laying (Pryor 1968). Hatching success 70% (n=20; Kamenev 1969). At Windmill Is, success rate of 'laying and hatching', 80–90% (Cowan 1979). Most losses of eggs by rolling out of nest, freezing; flatter sites probably reduce this risk. In Prydz Bay, breeding success correlated with euphausiid and fish abundance over continental shelf waters; reduced breeding success in years when fast sea-ice persists round colonies because sea-ice affects abundance and distribution of prey. Breeding birds in this area probably rely on counter-flowing coastal and offshore wind systems to drive circulation, upwelling and mixing of waters in Prydz Bay, which provides rich feeding areas (Whitehead *et al.* in press). At Haswell I., little predation by South Polar Skua *Catharacta maccormickii* because nests not easily accessible (Pryor 1968). About 50 pairs of South Polar Skuas preyed on eggs and chicks at Svarthamaren colony (Mehlum *et al.* 1987).

PLUMAGES

ADULT Definitive basic. Age of first breeding

unknown. Lores and base of bill, grey-brown. **UPPERPARTS** and dorsal half of head and neck, blackish brown when fresh, save for white upper tail-coverts and sides of rump. Scapulars, mantle and back feathers have dark brown (c121) frosted tips. Blackish brown areas fade rapidly to dark brown (c119A) and then gradually to medium brown (c119B). All feathers have concealed white bases, which become exposed on hindneck and throat of very worn birds. Ventral surface of head and neck, and sides of upper breast also fade with wear; always slightly paler than upperparts. Rest of underparts, white. **TAIL**, white, with blackish brown tips broadest in central rectrices. **UPPERWING.** Marginal, lesser and humeral coverts, alula and median primary coverts, like scapulars. Median coverts, greyish brown (appearance caused by minute dark-brown speckling on rami) with dark-brown fringes narrower on inner edge. Secondary coverts and humerals, white. Primary coverts, dark brown (c119A); innermost have concealed white inner webs. Secondaries, white with dark-brown tips. Primary shafts, ivory-white with dark-brown tips. Inner primaries, white with dark-brown tips to outer webs. **UNDERWING.** Remiges, like upperwing. Marginal and lesser under wing-coverts, dark brown; all other coverts and axillaries, white.

DOWNY YOUNG Protoptile, pale grey (-) on upperparts, foreneck and breast. Head and underparts, white (-). Mesoptile, uniform pale grey (-) to grey-white (Falla 1937). Long bill is a useful identification character.

JUVENILE As fresh adult in first summer. Falla (1937) suggested that very worn birds in Antarctic summer are second-summer birds wearing year-old juvenile plumage (disputed by Orton 1968; Bierman & Voous 1950).

BARE PARTS

ADULT Iris, dark brown (119), sometimes with small grey (-) spots along outer ring (Bierman & Voous 1950). Bill, blackish (82) with clay-coloured rictus. Varying amount of brown at base of bill; some birds with clay-brown (39) to olive-brown proximal half of latericorn and ramicorn, most with less brown and some with none. Bill has flaky texture, flakes with narrow white edges. Tarsus, outer edge of outer toe, and dorsal surface of all toes, medium to light grey; blue-grey also reported. Webs, pink (7) to deep flesh (3); outer webs sometimes like tarsus. Claws, dark grey-horn to blackish (82).

DOWNY YOUNG Iris, bluish brown; bill, dark grey (Falla 1937); no data on feet and legs.

JUVENILE Like adult, bill with smooth texture.

MOULTS

ADULT POST-BREEDING Pre-basic. Except where stated, based on Bierman & Voous (1950) and NMNZ; applies to breeding females and adults (both sexes) of unknown status. Primaries outwards, Jan. to Mar. inclusive, starting while chicks being fed. Up to five inners but no more than three outers observed growing at once. Secondaries, Jan.–Apr. Tail practically simultaneous; usually in Mar. but sometimes earlier; Routh (1949) noted moult of tail at sea in Apr. Moult of body, observed Jan.–Apr. in both breeding and non-breeding females; no data for rest of year. Upper and under tail-coverts replaced after tail. Flaking of bill, tarsus and toes, from Jan. to Mar. inclusive (Bierman & Voous 1950).

POST-JUVENILE If Falla's (1937) assertion that juveniles can be aged in second summer is correct, then first wing-moult probably occurs in second-summer at about same

time as adult wing-moult. Two juveniles beachcast in Sept. had no body moult (NMNZ).

MEASUREMENTS Age unknown but juveniles excluded. (1) Skins (MV). (2) Fresh measurements (NMNZ, includes beachcast birds) (3) Skins collected at sea; methods unknown (Bierman & Voous 1950).

	MALES	FEMALES
WING	(1) 324.8 (11.8; 311-333; 4) (2) 321.6 (4.79; 314-327; 7) (3) 318.3 (10.08; 302-331; 10)	305.3 (297-318; 3) 318.1 (7.58; 307-330; 7) 307.7 (8.74; 292-320; 14) **
8TH P	(1) 198.8 (1.71; 197-201; 4)	188, 202
TAIL	(1) 110.3 (107-116; 3) (2) 117.4 (4.39; 112-122; 7) (3) 120.5 (5.15; 116-123; 8)	112.7 (105-120; 3) 118.7 (2.94; 106-122; 6) 116.8 (3.84; 107.5-122; 15)
TARSUS	(1) 46.4 (45.3-47.4; 3) (2) 46.0 (2.36; 42.9-49.9; 7) (3) 45.8 (1.63; 43-49; 11)	42.8 (40.5-44.8; 3) 45.7 (6.58; 44.9-46.1; 7) 43.9 (1.62; 42-48.5; 18) **
TOE	(1) 61.5 (59.1-62.8; 3) (2) 61.5 (4.25; 55.7-67.5; 7) (3) 60.7 (2.25; 57-64.5; 11)	58.9 (57.0-67.3; 3) 59.4 (1.11; 58.4-61.7; 7) 57.4 (1.88; 53-61; 18) **

WEIGHTS At sea, Jan.-Apr.; males 663 (560-780; 13); females 627 (530-770; 21) (Bierman & Voous 1950). At Dumont D'Urville, males 699 (610-780; 10); females 718 (610-805; 10) (Isenmann *et al.* 1969). Unsexed NZ beachcast birds 399 (300-525; 8) (Veitch 1980).

STRUCTURE Wing, long and narrow. Eleven primaries; p11 minute; p10 longest; p9 4-11 shorter, p8 17-30, p7 39-50, p6 60-75, p5 81-99, p4 102-125, p3 127-150, p2 150-174, p1 170-196. Twenty-four secondaries, four of tertial form. Five humerals. Tail slightly rounded; 12 feathers; t6 16 shorter than t1. Bill robust; nostril tubes one-third to two-fifths of length; bill-width and depth at base about equal; about one-third to two-fifths of length. Some culminicorn exposed (10% to 20% of length of bill). Mandibular rami straight; gular-pouch slightly distensible; not feathered. Oval nostril face forwards and upwards; septum narrow. Tibiotarsal joint not feathered. Middle and outer toes about equal in length; inner 81-90%; hallux small. According to Bierman & Voous (1950), hallux blunt in breeding birds in summer, pointed in others.

DIR

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Antarctic Petrel *Thalassoica antarctica*

- 1. Adult, ventral, fresh
- 2. Adult, dorsal, fresh
- 3. Adult, dorsal, worn

Snow Petrel *Pagodroma nivea*

- 4. Adult, ventral

Southern Fulmar *Fulmarus glacialis*

- 5. Adult, ventral
- 6. Adult, dorsal

Cape Petrel *Daption capense*

- 7. Adult, ventral
- 8. Adult, subspecies *capense*, dorsal
- 9. Adult, subspecies *australis*, dorsal

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