

## 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: Diomedeidae 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 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.

## REFERENCES

- Brodkorb, P. 1963. *Bull. Flor. St. Mus. biol. Sci.* 7: 179-293.
- Cox, J.B. 1980. *Rec. S. Aust. Mus.* 10: 91-121.
- Fleming, C.A. 1941. *Emu* 41: 134-55.
- Harper, P.C. 1980. *Notornis* 27: 235-86.
- Imber, M.J. 1985. *Ibis* 127: 197-229.
- Kuroda, N. 1954. *On the classification and phylogeny of the order Tubinares, particularly the shearwaters (Puffinus), with special consideration on their osteology and habit differentiation.* Tokyo.
- Murphy, R.C., & J.M. Pennoyer. 1952. *Am. Mus. Novit.* 1580.
- Olson, S.L. 1975. *Smithson. Contr. Paleobiol.* 23.
- Voous, K.H. 1949. *Ardea* 37: 113-22.

*Procellaria capense* Linnaeus, 1758, *Syst. Nat. ed.* 10, 1: 132 — Cape of Good Hope.

*Daption* is an anagram of *pintado*, the Spanish and Portuguese word for *painted* or *mottled*, as first applied to the bird by early sailors, and was designated as neuter by the author; named after the type-locality, the Cape of Good Hope.

OTHER ENGLISH NAMES Black-and-white, Pied, Pintado or Spotted Petrel; Cape Fulmar or Pigeon.

The best compromise seems to be **Cape Petrel**, taxonomically and historically appropriate.

POLYTYPIC Nominate *capense* circumpolar and southern oceans; *australe* Mathews, 1913, NZ area.

**FIELD IDENTIFICATION** Length 35–42 cm; wingspan 80–90 cm; weight 440 g. Distinctive medium-sized, stockily built petrel with strikingly chequered and patterned black-and-white upperparts; underparts mostly white. Widely distributed through s. oceans. Typically fulmarine in flight and behaviour; an habitual ship follower. Sexes alike; little or no seasonal or age variation, though may appear more white above in worn plumage and, at Snares Is, flight and contour feathers appear brown when worn (Jan.–Feb.). Juvenile similar to adult. Subspecies *australe* has more black on mantle than nominate subspecies, at least in fresh plumage; less distinction in worn plumage; many birds appear intermediate.

**DESCRIPTION ADULT.** Head, neck and mantle, dark slate-grey to black. Upperwing, mainly black, boldly splashed with white on bases of inner 5–6 primaries and their coverts; another patch of white on innermost greater, median and some adjacent lesser coverts. Lower back, rump and upper tail-coverts white, boldly chequered with black chevrons, becoming whiter posteriorly. Broad black band at tip of tail. Chin and throat, black, white or mottled; rest of underparts, white. Under tail-coverts, white with blackish tips. Broad black terminal band to undertail. Underwings, white with black margins. Bill, black. Iris, brown. Legs and feet, black. Subspecies *australe* has more black on mantle and back and greater density of black on upper rump; becomes paler with wear.

**SIMILAR SPECIES** Likely to be confused only with Antarctic Petrel *Thalassoica antarctica*, which has similar strongly-patterned appearance but is clean-cut brown-and-white rather than chequered and spotted black-and-white, and has much more prominent, continuous white bar along trailing-edge of upperwing. In flight, flaps more and glides less than Antarctic Petrel.

Fly with short stiff-winged glides, alternating with bursts of rather mechanical, shallow wingbeats. Usually fly low but at times, particularly in strong winds, rise higher. Dive, both from a height and from surface. Swim readily even in stormy seas, floating high and lightly with erect, buoyant posture and cocked tail. Bathe by dipping, then raising, head to sluice water onto back and spread wings. Without wind, run to take

off from sea. Follow ships and boats persistently; take scraps and offal boldly. Gregarious, especially round trawlers and whaling ships, gathering in huge noisy quarrelsome flocks. Habitually quarrel over food, however abundant; 'must fight over their food even if there are but two individuals picking at an entire whale' (Bennett 1927). Follow whales in flocks with other species; flocks gather off headlands, in harbours during storms and on icebergs. Mainly diurnal but sometimes gather round vessels and take scraps at night. Very clumsy on land; squat on tarsi, shuffle awkwardly; prefer to alight on steep slopes.

**HABITAT** Circumpolar in Antarctic and subantarctic seas, avoiding pack-ice. In summer, range contracts towards breeding sites; Antarctic birds to zone of melting sea-ice N of edge of pack-ice (Murphy; Johnstone & Kerry 1976); in NZ region, to seas round breeding islands (Johnstone & Kerry 1976). In Ross Sea, most found in cold open waters (0.0–1.0 °C) with numerous icebergs, to N of pack (Ainley *et al.* 1984). Within pack-ice, confined to n. fringes (Murphy; Ainley *et al.* 1978; Montague 1988) where ice-cover light (12–50% [Ross I. to Anvers I.; Zink 1981a], 0–25% [Prydz Bay; Montague 1988]). In winter, disperse over pelagic waters of s. seas (Stahl *et al.* 1985; Weimerskirch *et al.* 1985); in sw. Pacific, maximum n. extension of range to 19°S, where sea surface-temperature 25 °C (Cheshire *et al.* 1979); reach equatorial regions in N-flowing cool currents or upwelling of cold waters along coasts of South America and sw. Africa.

Round breeding islands, restricted to surrounding in-shore and shelf waters (Cheshire *et al.* 1979; Jenkins 1981; Robertson & Jenkins 1981; Stahl 1987; J.-C. Stahl); at Terre Adélie, main prey taken indicates foraging in open waters over continental shelf (Ridoux & Offredo 1989). Enter harbours, bays (Westerskov 1960; Horning & Horning 1974); feed as close in as edge of surf on Heard I. (Downes *et al.* 1959); in coastal waters of Iles Crozet, edge of surf and kelp banks (*Macrocystis*) preferred (Jouventin *et al.* 1982b). In non-breeding season, disperse to pelagic waters from near edge of pack-ice (Sziij 1967) across Antarctic, Subantarctic and Subtropical Zones (Rand 1962; Cheshire *et al.* 1979); northernmost extension over cool boundary currents and upwellings off sw.

Africa (Lambert 1971; Summerhayes *et al.* 1974) and w. South America (Paessler 1911, 1914; Murphy; Jehl 1973) and along South Equatorial Current in e. Pacific (Chapman 1981, 1982; Pitman 1986). On boat trips to Aust. continental shelf, found well offshore (Aust. Atlas) but occur regularly in inshore waters of Aust., NZ and South America (Jehl 1973; Milledge 1977; Harrison 1983; P.J. Curry). In sw. Africa and Argentina, most common over continental slope (Summerhayes *et al.* 1974; Rumboll & Jehl 1973).

Breed on coasts of Antarctic mainland and Pen., and Antarctic and subantarctic islands. Nest in steep rocky areas with ledges, crevices, overhangs or caves; on cliffs, slopes, rock tumbles and inshore rock stacks (Falla 1937; Downes *et al.* 1959; Johnstone *et al.* 1973; Cowan 1979; Sagar 1979; Imber 1983); at Casey, steepest cliffs avoided and terraced sites preferred (Cowan 1979). On Snares Is, used open ledges on steep lower (20 m asl) slopes; caves and overhangs on less steep, higher (50 m asl) slopes (Sagar 1979). Nest up to 300 m asl and as low as 3 m asl if protected from surf (Ardley 1936; Falla 1937; Pinder 1966; Derenne *et al.* 1974); on Heard I., where cliffs rise straight from sea, most nests close to bottom; where scree slopes at base, nest from top to bottom of cliff (Downes *et al.* 1959). Breeding sites coastal or on inland cliffs up to 3 km from shore (Downes *et al.* 1959; Pinder 1966; Derenne *et al.* 1974; Despin 1977; Cowan 1979; Sagar 1979). In Antarctica, often use exposed sites, where snow does not accumulate (Falla 1937; Watson 1975), though colonies at Vestfold Hills in sheltered positions (Johnstone *et al.* 1973); on subantarctic islands, sites sheltered from prevailing wind (Imber 1983), and breeding success lower for birds nesting in exposed situations (Sagar 1979). Most nesting areas lack soil and vegetation, but birds may nest among peat and *Poa astonii* tussock on gentle slopes on subantarctic islands (Sagar 1979).

At Heard I., roost at night on cliffs (Downes *et al.* 1959); also sleep on water; in Antarctic, rest on icebergs (Harper 1987). Glide and swoop close to sea surface; feed mostly from surface, but will make shallow dives to about 1 m (Murphy;

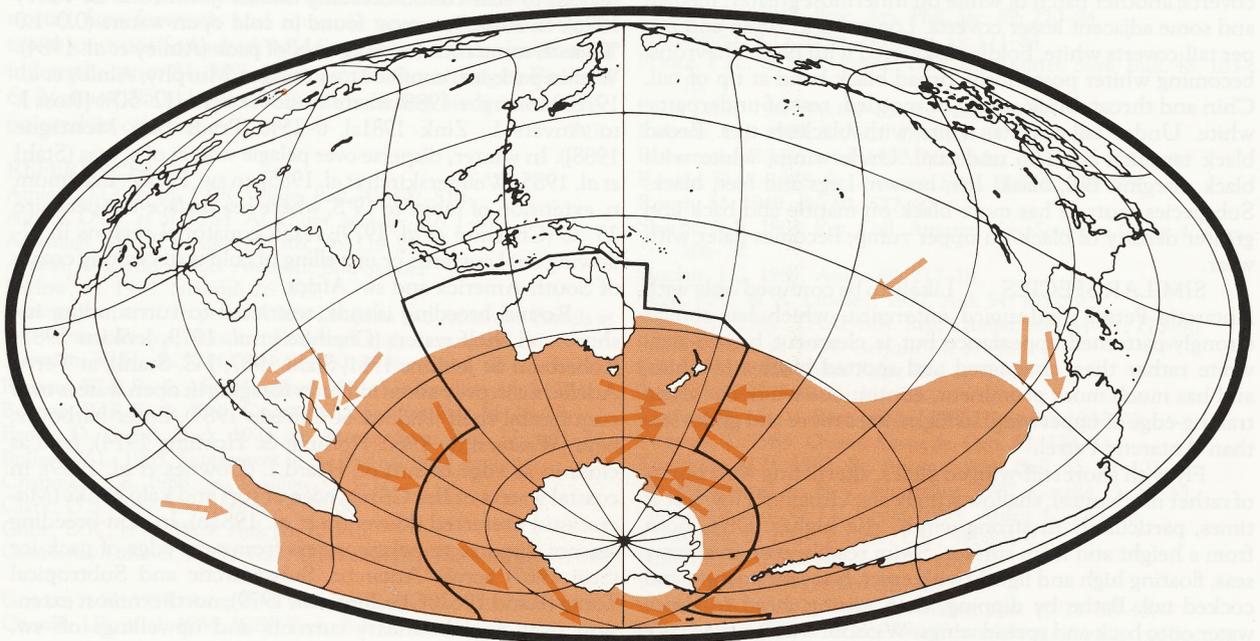
Downes *et al.* 1959).

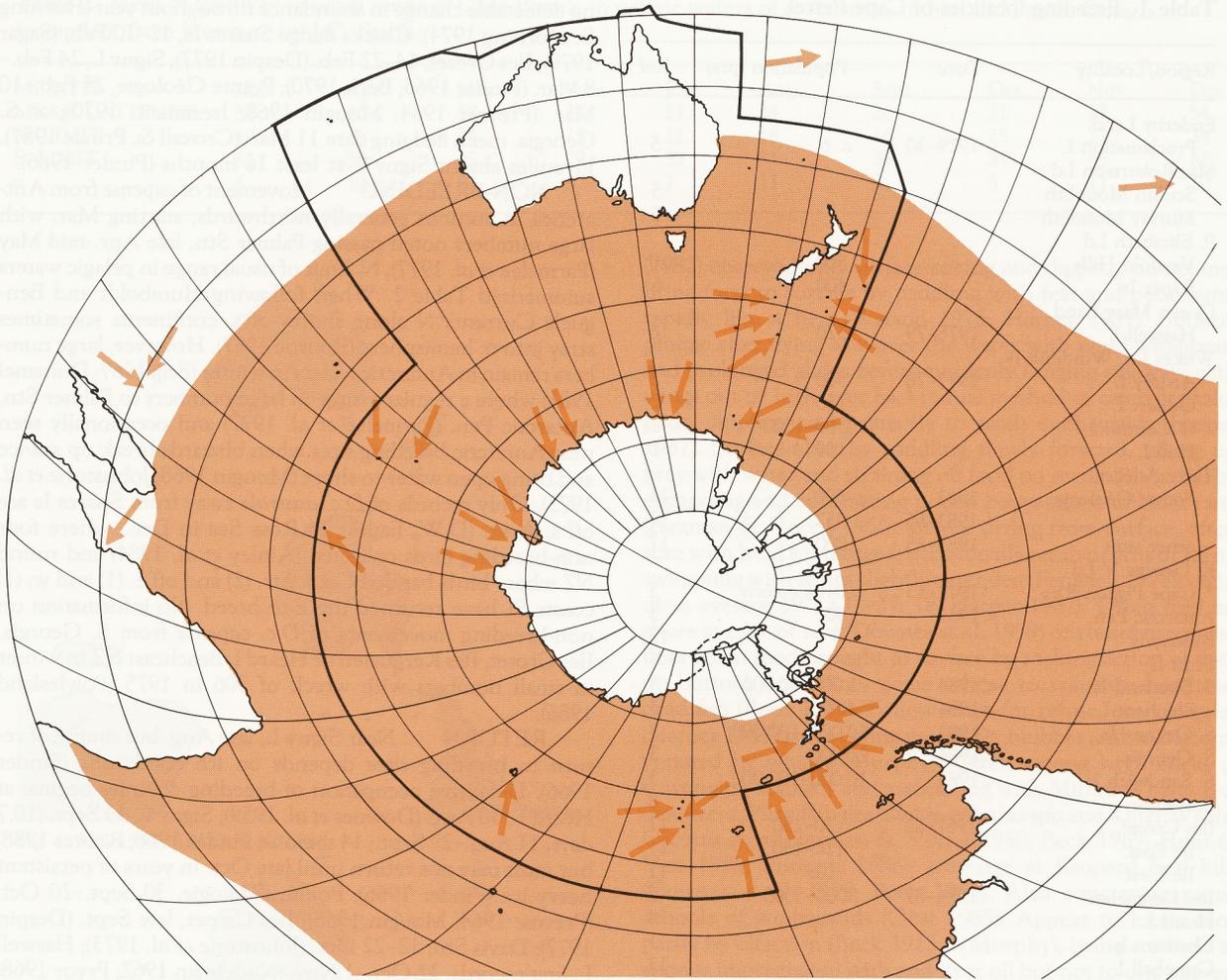
Attracted to whaling stations and sewage outfalls, and persistently follow ships, to feed on refuse (Murphy).

**DISTRIBUTION AND POPULATION** Circumpolar. Summer range mostly restricted to Antarctic waters of 60–63°S and shelf areas off Antarctic and subantarctic islands and NZ. Winter range extends from ice-edge to c. 24°S, farther N along Humboldt and Benguela Currents. Breed Antarctica, Antarctic and subantarctic islands of NZ and South Atlantic and s. Indian Oceans.

During summer, Antarctic populations mostly confined S of 51°S in the sw. Atlantic, S of 60–63°S elsewhere (Holgersen 1957; van Oordt & Kruijt 1954; Ozawa 1967; Flora 1981; Jouventin *et al.* 1982a; Mochizuki & Kasuga 1985; Stahl 1987). Round Iles Crozet, Kerguelen and Heard Is, restricted to shelf (Stahl 1987; J-C. Stahl). In NZ area, waters off SI and Campbell Plateau, S to 51–54°S (Dell 1960; Ozawa *et al.* 1968; Cheshire *et al.* 1979; Jenkins 1981; Robertson & Jenkins 1981; McQuaid & Ricketts 1984); usually only subspecies *australe* present in summer (Bartle 1974; Robertson & Jenkins 1981).

Extensive northward dispersal begins Mar.; at n. limit of range in Aug.–Sept. Usual n. limits are: Atlantic Ocean: to C. Frio, Brazil (23°S; Murphy), Angola (15–20°S; Brown *et al.* 1982) and 24–27°S in mid-ocean (Saunders 1880; Bierman & Voous 1950; Bourne & Curtis 1985); Indian Ocean: to Beira, Mozambique (20°S; Mackworth-Praed & Grant 1962), Carnarvon, WA (24°S; HASB) and 18–24°S in mid-ocean (Chapman 1982; Chapman & Cheshire 1987; J-C. Stahl); Tasman Sea and Pacific Ocean: to 27°S on e. coast of Aust. (Aust. Atlas) across ocean at 19–31°S (Fleming 1950; Hansen 1978; Cheshire *et al.* 1979), most n. extension along w. coast of South America to Punta Parinas, Peru (5°S; Murphy) and W (at least to 106°W) along South Equatorial Current between 0–12°S (Chapman 1981, 1982; Pitman 1986). Recorded at Galápagos Is, July–Nov. (Harris 1973). Regular visitor to Magellanic region, Apr.–Nov. (Humphrey *et al.* 1970), sometimes





in enormous flocks (Wilson 1907), and South Africa, May–Jan., with maximum in Aug. (Liversidge & Le Gras 1981).

Occasional or accidental to: Atlantic Ocean: Abrolhos Is, Brazil (Murphy), St. Helena (Wilkins 1923), possibly off Gabon (Bannerman 1930); Indian Ocean: off Mozambique (Chapman 1986), Mombasa, Kenya (Sinclair 1978), Mauritius and Réunion I. (Staub 1976). Pacific Ocean: Marquesas Is (King 1967). Of 12 records from n. hemisphere last century none is fully valid as probably most concerned birds liberated from ships (Bourne 1967) except report of birds following ship to Acapulco, Mexico (16°N; Lucas 1887); several unsubstantiated sightings off California (Stallcup 1976; Roberson 1980); one bird banded at Signy I. recovered at 3°N off Colombia (Rootes 1988).

**AUST.** Regular annual appearance, most frequently in winter (Aust. Atlas), but not commonly seen from shore. Mostly and almost continuously along s. coasts, but rare in Great Aust. Bight (perhaps by lack of observers) extending up e. coast normally as far as 27°S (Aust. Atlas) and up w. coast to near Carnarvon (24°S; Aust. Atlas). A flock of 250–300 birds was recorded off Sydney in Sept. 1973 (Milledge 1977).

**NZ.** Both subspecies recorded; single *capense* seen at Snares Is during two summers (P.M. Sagar). Least common in summer and autumn; in all coastal areas and Chatham and Campbell Is (NZ Atlas). Disjunct distribution at sea between

Aust. and Antarctica, which may reflect n. distribution of *australe* and more s. distribution of *capense* (Dell 1960; Ozawa *et al.* 1968; Johnstone & Kerry 1976; McQuaid & Ricketts 1984; Aust. Atlas).

**BREEDING** Localities of breeding and estimated numbers in Table 1.

Total population NZ subantarctic islands estimated 5000–10 000 pairs before 1984 (Robertson & Bell 1984). No evidence for past or present breeding at Macquarie I. (Rounsevell & Brothers 1984). So far not reported breeding on Peter Ist I. *contra* Watson *et al.* (1971) erroneously citing Hølgersen (1957) who found no evidence of nesting. No proof of breeding on Wilhelm II Coast (Reichenow 1908).

Status, satisfactory; may be affected by Black Rats *Rattus rattus* on Ile de la Possession and Auckland I. (Jouventin *et al.* 1984; Robertson & Bell 1984) and by feral cats on Ile aux Cochons (Derenne *et al.* 1976) but otherwise inhospitable nature of breeding locations protects the species.

**MOVEMENTS** Populations breeding Antarctica migratory or dispersive; subantarctic populations partly migratory or resident.

**DEPARTURE** Adults leave Antarctic Continent, Apr.: Haswell I., early to mid-Apr. (Nudelman 1962; Pryor 1968); Pointe Géologie, last sighting 27 Apr. (Prévost 1964;

**Table 1.** Breeding localities of Cape Petrel.

Region/Locality	Date	Population (prs)	Ref
Enderby Land			
Proclamation I.	1929-30	c. 6	5
Mac.Robertson Ld			
Scullin Monolith			5
Murray Monolith			5
P. Elizabeth Ld			
Vestfold Hills		500	10
Rauer Is		400	6
Queen Mary Land			
Haswell I.	1978-79	220	16
Wilkes Ld, Windmill Is			
Ardrey I.	1977-78	300	2
Odbert I.		150	2
O'Connor I.		500-1000	2
Holl I.		100	2
Terre Adélie			
Pointe Géologie	1963	c. 500	11
	1983-85	957	17
other sites	1983-85	1000	17
K. George V Ld			
Cape Pigeon Rks	1912-13	large colony	5
Antarctic Pen.	<1984	400	3
Ballyn Is			15
Scott I.			7
S. Shetland Is	<1984	1 000-10 000	3
Elephant I.	<1984	54 000	3
S. Orkney Is	<1984	10 000-100 000	3
S. Georgia	<1984	20 000	3
S. Sandwich Is	<1984	10 000-100 000	3
Bouvetøya			8
Iles Crozet	1981-82	130-250	11
Ile Poss.		120-150	11
Ile L'est		10s	11
Iles Kerguelen	1984-87	3000-5000	18
Heard I.			4
Chatham Is			1
Campbell I.			13
Snares Is			13
W. Chain	1983-84	1000s	12
Antipodes Is		300	9
Bounty Is		> 30	14
Auckland Is			13

(1) Clark (1989); (2) Cowan (1979); (3) Croxall *et al.* (1984c); (4) Downes *et al.* (1959); (5) Falla (1937); (6) Green & Johnstone (1986); (7) Harper *et al.* (1984); (8) Holgersen (1945); (9) Imber (1983); (10) Johnstone *et al.* (1973); (11) Jouventin *et al.* (1984); (12) Miskelly (1984); (13) Robertson & Bell (1984); (14) Robertson & van Tets (1982); (15) Robertson *et al.* (1980); (16) Starck (1980); (17) Thomas (1986); (18) Weimerskirch *et al.* (1989).

Mougin 1968; Isenmann 1970); Davis Stn, 4-18 Apr. (Johnstone *et al.* 1973). At sites farther N, never completely absent during winter and often near colonies in years of open sea-ice. At Signy I., S. Orkney Is, most leave late Apr. but non-breeders may stay until late May; some non-breeders present at this time are 2-, 3- or 4-year-old birds which have not spent summer at colony (Pinder 1966; Rootes 1988); at Heard I., fewer after May but some present throughout year, numbers apparently varying with availability of food (Downes *et al.* 1959); numbers at Iles Crozet decline during winter but displays on nests observed May-Sept. (Despin 1977). At Snares Is, courtship observed ashore in June (Robertson & Jenkins 1981) and

no detectable change in abundance throughout year (Horning & Horning 1974). Chicks fledge Snares Is, 12-20 Feb. (Sagar 1979); Iles Crozet, 14-22 Feb. (Despin 1977); Signy I., 24 Feb.-8 Mar. (Pinder 1966; Beck 1970); Pointe Géologie, 25 Feb.-10 Mar. (Prévost 1964; Mougin 1968; Isenmann 1970); at S. Georgia, mean fledging date 11 Mar. (Croxall & Prince 1987). Juveniles absent Signy I. at least 16 months (Pinder 1966).

**NON-BREEDING** Movement of *capense* from Antarctica in autumn generally northwards, starting Mar. with large numbers noted passing Palmer Stn, late Apr.-mid May (Parmelee *et al.* 1977). N. limit of usual range in pelagic waters summarized Table 2. When following Humboldt and Benguela Currents N along shores of s. continents sometimes stray into n. hemisphere (Bourne 1967). However, large numbers remain in Antarctic waters in winter (Sziij 1967; Duhamel 1981) where a regular visitor in large numbers to Palmer Stn, Antarctic Pen. (Parmelee *et al.* 1977) and occasionally seen near Antarctic breeding sites when blizzards break up sea-ice and bring open water to shore (Mougin 1968; Johnstone *et al.* 1973). Only records of *D.c. australe* away from Snares Is are off s. Aust. (D.W. Eades), in Ross Sea in Dec., where four non-breeding birds collected (Ainley *et al.* 1984) and round NZ where birds banded Cook Str. (2) and off e. (1) and w. (1) coasts SI have returned there to breed. No information on non-breeding movements of *D.c. capense* from S. Georgia, Iles Crozet, Iles Kerguelen or Heard I. Beachcast NZ in winter in small numbers with wreck of 306 in 1975 (Powlesland 1986).

**RETURN** Near Signy I., late Aug. but timing of return to breeding sites depends on ice conditions (Pinder 1966). Definitive occupation of breeding colonies begins: at Heard I., 30 Aug. (Downes *et al.* 1959); Signy I., 13 Sept. (10.7 days; 11 Aug.-29 Sept.; 14 seasons; Pinder 1966; Rootes 1988) but most may not return until late Oct. in years of persistent heavy ice (Pinder 1966); Pointe Géologie, 30 Sept.-20 Oct. (Prévost 1964; Mougin 1968); Iles Crozet, late Sept. (Despin 1977); Davis Stn, 12-22 Oct. (Johnstone *et al.* 1973); Haswell I., first records, 22 Oct.-1 Nov. (Nudelman 1962; Pryor 1968; Kamenev 1969); Windmill Is, 29 Oct. (Cowan 1979). Early visits occur to most breeding sites, late Aug. through Sept., especially in mild weather.

**BREEDING** In summer, breeding birds collected 1180 km from breeding colonies (Bierman & Voous 1950) with mean from S. Georgia estimated at 357 km (Croxall & Prince 1987) on basis of frequency of feeding and flight-speed. Non-breeders leave to moult when chicks fledge in early Mar., returning late Mar. (Pinder 1966). At Palmer Stn, Antarctica, scarce during summer (Parmelee *et al.* 1977) suggesting concentration of Antarctic population near breeding grounds.

**BANDING** Returns demonstrate some longitudinal movement occurs; extent unknown but probably circumpolar. Returns from Cook Str. (NZNBS) and Terre Adélie (CRBPO) summarized Figs 1 and 2. Two banded in same season in same colony at Terre Adélie, recaptured NZ, within 4 days of one another after 19 months (Weimerskirch *et al.* 1985). One bird banded Cook Str. recovered Lawrie I., 10 500 km ESE after 61 days implying minimum average speed of 172 km/day (Kinsky 1960-63).

Other records:  
69S78E 02 1+ U 44 1774 350 ABBBS  
66S93E 01 1+ U 93 962 072 SOPAN

Birds banded Signy I.: as chicks: recovered Vanuatu (1) and Chile S of 33°S (2); as adults: recovered Chile (22-36°S); unknown age: recovered to 3°N, off Colombia (Pinder 1966;

**Table 2.** Mean N limit (°S) of usual range of Cape Petrels in pelagic waters of s. Atlantic, Indian and Pacific Oceans (compiled from literature by J-C. Stahl).

MONTH	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
MEAN LATITUDE	56	46	38	27	27	24	26	31	37	54
N. LIMIT	49	35	24	25	22	18	16	25	27	34
S. LIMIT	61	58	45	29	33	31	39	35	45	62
n	5	10	9	3	7	11	9	5	11	10

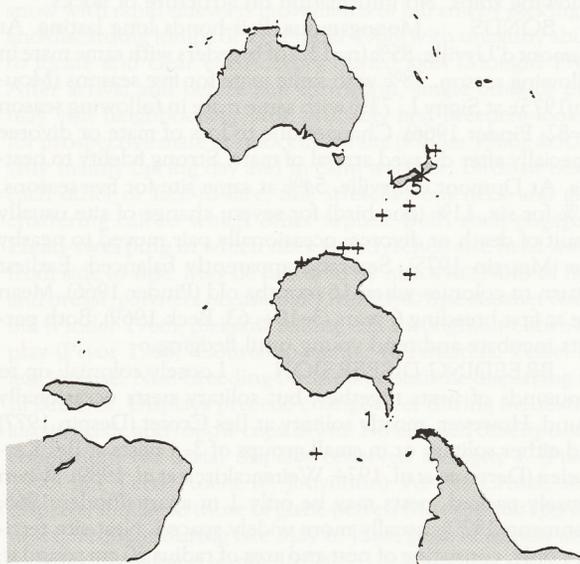


Fig. 1. 41S 174E 10X10 % NZNBS

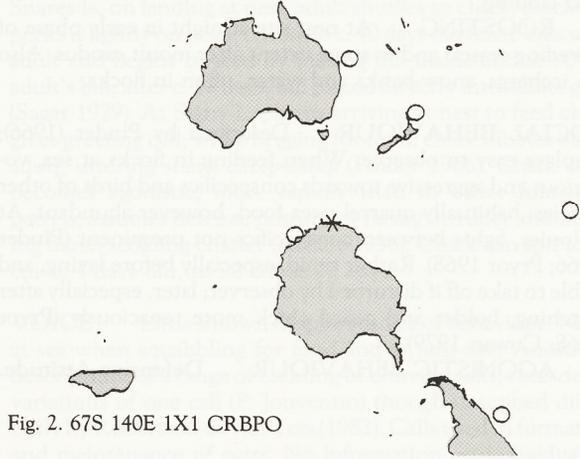


Fig. 2. 67S 140E 1X1 CRBPO

Beck 1969; Rootes 1988). Also, birds banded Weddell Sea (60°S, 24°W) recovered Cook Str. (Kinsky 1960–63), sw. Indian Ocean recovered off Namibia (Winterbottom 1960).

**FOOD** Diet varies with availability, but mainly euphausiid crustaceans, cephalopods and fish. **BEHAVIOUR** Most food taken by surface-seizing; also by surface-diving, foot-paddling, pursuit-plunging, pattering (Harper *et al.* 1985), surface-plunging, surface-filtering, hydroplaning (Harper 1987) and dipping (Griffiths 1982; contra Harper *et al.* 1985). Of 404 observations, surface-seizing 41.8%, surface-plunging 19.1, dipping 14.4, surface-filtering 10.9, surface-diving 8.2, pursuit-diving 5.2, hydroplaning 0.5 (Harper 1987); Griffiths

(1982) observed only surface-seizing and dipping. Sometimes bring food to surface by paddling with feet and peck water rapidly like a hen (Watson 1975; Harper 1987). Surface-plunge after flying low over the water with rapid wing-beats and prolonged glides before suddenly lunging sideways with wings out or high over back; usual method of catch cephalopods; dipping used primarily to catch euphausiids (Harper 1987). Surface-filter by paddling slowly forward, taking up prey with water and straining off food on serrations in bill by expanding and contracting pouch between mandibular rami (Bierman & Voous 1950). Before diving from surface, often scan with head submerged; occasionally reach depths of 1.5 m, swimming with wings slightly extended (Fenwick 1978); night dives average 19.1 s (7–27; 18; Harper 1987). Often feed in-shore at edge of surf (Downes *et al.* 1959) or round grounded floes when food brought to surface by rocking action of floes on bottom; sometimes come ashore to scavenge beachcast dead fish (Beck 1969). Follow ships for refuse, even in gales (Harper 1987) and whaling vessels for blubber and crustaceans vomited by whales (Murphy). Often among large flocks of scavenging seabirds and associating with Minke Whales *Balaenoptera*, Pilot Whales *Globiocephalus* spp and Killer Whales *Orcinus orca* (Bierman & Voous 1950; Beck 1969; Hunt & Veit 1983; Enticott 1986); scavenge at Leopard Seal kills (Downes *et al.* 1959; Beck 1969). Also congregate round schools of euphausiids (Obst 1985). Appear to locate food partly by olfaction (Beck 1915 in Murphy), being attracted to sponge impregnated with cod-liver oil but not to one impregnated with mineral oil (Jouventin & Robin 1984). Feed by day or night (Bartle 1974): 72% of observations during day, 28% at night (n=246 observations; Harper 1987).

**NON-BREEDING** In sw. Atlantic (17 stomachs; Bierman & Voous 1950), cephalopod beaks (up to 56 in one stomach) 88% freq., crustaceans 47, whale offal 53, fish 24 and molluscs 6; in Drake Passage (ten stomachs; Linkowski & Rembiszewski 1978) crustaceans euphausiids *Euphausia superba* 100% freq., *Thysanoessa* 10, amphipods *Themisto gaudichaudii* 10, salps 10; Tierra del Fuego (two; Humphrey *et al.* 1970) crustaceans 100%; in Ross Sea (four *D.c. australe*; Ainley *et al.* 1984) cephalopods 97.1% wt., 47.4% no., 75% freq. (*Psychroteuthis glacialis* 15.8% no., 25% freq., *Galiteuthis glacialis* 15.8, 25, unident. 15.8, 25), euphausiids (*Euphausia superba* 2.9% wt., 52.6% no., 100% freq., 4.4 cm, n=1); in Southern Ocean (three; Falla 1937) cephalopods 67% freq., offal 33; off Peru (two; Murphy) 500 small anomurans *Emerita analoga*, one cephalopod and laminar seaweed; primarily euphausiid and cephalopod remains (nine; Zink 1981b); one dipping bird regurgitated 22 g *E. superba* mean length 1.11 cm (0.72–1.74; 30); one cephalopod *Gonatus antarcticus* (109 g) retrieved from surface-plunging bird; 58 g of *Euphausia triacantha* regurgitated by breeding female previously seen dipping; observed taking small cephalopods (5.0–10.0 cm) and salps when diving (Harper 1987); in sw. Atlantic, four birds feeding on single moribund 40 cm cephalopod and one seen

carrying a silvery fish in its bill (Griffiths 1982); on Argentinian shelf in winter seen diving after jellyfish (Rumbold & Jehl 1977) and seen killing and eating disabled prions *Pachyptila* (Murphy).

**BREEDING** Summarized Table 3. At Prydz Bay (Green 1986) crustaceans euphausiids: *Euphausia superba*  $\geq 60.7$  freq., max. no. 34, carapace length 1.4 cm (0.2; 0.7-1.8; 93); *E. crystallorophias*  $\geq 7.1$ , 11, 0.8 (0.09; 0.7-0.9; 3), remainder crustaceans unident.; fish 7-10 cm, incl. *Pagothenia borchgrevinki* two individuals, *P. sp.* 1; unident.  $< 0.1$ , 9.6; also seen eating oil and carrion from killed Adelie Penguin *Pygoscelis adeliae* and from seal carcasses. At Terre Adélie (Ridoux & Offredo 1989) mostly euphausiids *E. crystallorophias* 35, 82, 63, 0.1-0.3 cm, *Euphausia superba* 29, 14, 33, 0.3-0.5 cm, other crustaceans amphipods *Themisto gaudichaudii* 12, -, 15, unident. Hyperiid -, -, 4 and isopods -, -, 2; fish 3-10 cm, other food carrion; *E. superba* important in first half of chick feeding period, *E. crystallorophias* dominating in second half; at same site (11 stomachs; Mougín 1968, 1975) crustaceans 73% freq., cephalopods 18, fish 9. At Haswell I. (Starck 1980) other food unident. At Hop I., Rauer Arch., Prydz Bay (J.P.Y. Arnould & M.D. Whitehead) fish *Pleuragramma antarcticum* 14.5 cm (1.2; 3), 1.28 individuals/sample (0.46; 19), euphausiids *E. superba* 4.7 cm (0.4; 99), 19.7 individuals/sample (14.7; 30). At Signy I. (regurgitations nine adults, 85 chicks; Beck 1969) crustaceans euphausiids *Euphausia superba*, other crustaceans mysidaceans *Gnathopausia* 1.1% freq., amphipods *Pontogeneiella brevicornis* 2.1, *Oradarea* 1.1, *Eurythenes* 4.2 (6-7 cm), *Cheirimedon femoratus* 2.1, *Lepidepcreum cingulatum* 1.1, isopods *Anuropus antarcticus* 2.1; fish (5-10 cm); other food gastropods *Clypea antarctica* 1.1, tunicates 1.1. Other records: Snares Is (three; Fenwick 1978) copepods 33, amphipods *Hyperia luzoni* 33, *Themisto gaudichaudii* 33, euphausiids *Nyctiphanes australis* 33% freq., *N. capensis* 67, anomurans *Munida gregaria* 33; Proclamation I. (two; Falla 1937) cephalopods; Iles Kerguelen (3; Paulian 1953) only crustaceans, one with numerous amphipods *Themisto*; Peterman I. (one; Gain 1914) and Iles Crozet (one; Mougín 1975) crustaceans; birds at Heard I. were diving to feed on the siphonophore *Pyrostephas vanhoeffeni* and the euphausiid *Thysanoessa vicina* (Downes *et al.* 1959). At Bird I., S. Georgia estimated consumption 85% crustaceans and 15% fish (Croxall & Prince 1987). May take higher proportion of *Euphausia superba* near Antarctic Pen. during breeding season (Obst 1985).

**INTAKE** Feeding frequency: at Terre Adélie, 0.68 meals/day (68; Ridoux & Offredo 1989); at S. Georgia, 0.5 meals/chick/ad./day (Croxall & Prince 1987). Mean meal size,

Snares Is, 54 g (5-75; 23 wt. increases; Sagar 1979). Stomach contents: adults while feeding chicks, Prydz Bay, 8.30 g (3.55; 40; J.P.Y. Arnould & M.D. Whitehead); Terre Adélie, 10.7 g (8.7; 46; Ridoux & Offredo 1989); non-breeding, Ross Sea, 5 g (four; Ainley *et al.* 1984).

**SOCIAL ORGANIZATION** Gregarious at sea and when breeding. Forms large flocks, gathering for food round trawlers and whaling operations, where noisy and quarrelsome. Otherwise, singly or in small numbers, habitually following ships. No information on structure of flocks.

**BONDS** Monogamous. Pair-bonds long lasting. At Dumont d'Urville, 85% (n=132) of breeders with same mate in following season, 38% with same mate for five seasons (Mougín 1975); at Signy I., 73% with same mate in following season (n=82; Pinder 1966). Changes due to loss of mate or divorce especially after delayed arrival of mate. Strong fidelity to nest-site. At Dumont d'Urville, 54% at same site for five seasons, 21% for six, 11% (one bird) for seven; change of site usually result of death or divorce; occasionally pair moved to nearby site (Mougín 1975). Sex-ratio apparently balanced. Earliest return to colonies when 16 months old (Pinder 1966). Mean age at first breeding 6 years (3-10+; 63; Beck 1969). Both parents incubate and tend young until fledging.

**BREEDING DISPERSION** Loosely colonial; up to thousands of nests together, but solitary nests occasionally found. However, mostly solitary at Iles Crozet (Despin 1977) and either solitary or in small groups of 3-4 nests at Iles Kerguelen (Derenne *et al.* 1974; Weimerskirch *et al.* 1989). When densely packed, nests may be only 1 m apart (Pinder 1966; Isenmann 1970); usually more widely spaced. Nest-site territory only, consisting of nest and area of radius 50 cm round it; used for courtship, mating, nesting, rearing young, take-off and landing.

**ROOSTING** At nest-site at night in early phase of breeding season and to some extent after moult exodus. Also on icebergs, snow-banks and water, often in flocks.

**SOCIAL BEHAVIOUR** Described by Pinder (1966); displays easy to observe. When feeding in flocks at sea, voracious and aggressive towards conspecifics and birds of other species; habitually quarrel over food, however abundant. At colonies, fights between conspecifics not prominent (Pinder 1966; Pryor 1968). Rather timid, especially before laying, and liable to take off if disturbed by observer; later, especially after hatching, bolder and guard chick more tenaciously (Pryor 1968; Cowan 1979).

**AGONISTIC BEHAVIOUR** **Defensive Attitude.**

Table 3. Breeding diet of the Cape Petrel.

Percentages	wt.				no. 2	freq.			
	1	2	3	4		1	2	4	5
CRUSTACEANS									
EUPHAUSIIDS	76	64	80	86	97	77	91	95	98
OTHER	1	12	-	<1	<1	6	15-21	5	13
FISH	23	29	5	14	3	38	35	77	16
CEPHALOPODS	-	<1	10	<1	<1	-	2	5	-
OTHER	<1	7	5	-	<1	11	7	-	2

(1) Prydz Bay, n=73, Green (1986); (2) Terre Adélie, 46, Ridoux & Offredo (1989); (3) Haswell I., 6, Starck (1980); (4) Prydz Bay, 40, J.P.Y. Arnould & M.D. Whitehead; (5) Signy I., 94, Beck (1969).

Birds crouch on nest with wings drooped and tail raised; adopted towards conspecifics or other birds. At high intensity, may be accompanied by ejection of oil at intruder (up to 2 m accurately) though infrequent before laying. Defence of nest-site begins with pair-formation on first arrival (Pinder 1966).

**SEXUAL BEHAVIOUR** Males usually arrive first at colony, soon followed by female. Single birds observed flying along cliffs as if looking for nesting sites and landing on likely ledges while making purring call. Male clears nest site of snow with rapid sideways movements of bill and by picking up and discarding lumps of ice (Pinder 1966) with uncanny ability to locate and clear even deeply buried sites (Mougin 1968). After arrival and before pair-formation, single birds or pairs may visit neighbouring sites; probably first-breeders looking for prospective mate or unoccupied site (Pinder 1966). **COURTSHIP** mainly during day and in calm weather. Birds sit beside each other or face-to-face; one stretches out neck and gives chattering call to which other replies. Both then engage in **Head-sweeping** in which neck outstretched and head waved from side to side. May be followed by **ALLOPREENING** of head and breast, partners occasionally **NIBBLING** one another round bill (Pinder 1966); pleasant trilling call throughout entire display (Pryor 1968). Courtship similar to Antarctic Petrel but less intense. Non-breeding birds may continue displaying until late Dec. Displays precede change-over during incubation; also precede and follow copulation. No detailed description of copulation. No aerial displays observed at Signy I. (Pinder 1966) nor Terre Adélie (P. Jouventin). At Iles Crozet, aerial displays, similar to those of giant-petrels *Macronectes* spp near nests; frequent during late May to June, peak of display activity after breeding (Despin 1977).

**RELATIONS WITHIN FAMILY GROUP** At Snares Is, on landing at nest, adult shuffles to chick, clucking, pecks it lightly on head; chicks to c. 40 days old fence bills with adult and begins to feed by placing bill inside and at 90° to adult's bill; after c. 40 days, bill placed directly into adults gape (Sagar 1979). At Signy I., parent arriving at nest to feed chick gives greeting call; while begging for food, chick nibbles bill of adult, uttering sharp *cheep-cheep* (Pinder 1966). Chick soon becomes agonistic, more rapidly than in other fulmarine petrels; assumes defence posture by facing intruder and uttering harsh scolding chatter (Ardley 1936). Chick can spit to 30 cm at 4 days old, to 90 cm at 12 days.

**VOICE** Little known despite studies of behaviour. Noisy at sea when squabbling for food and at nest-site. Anecdotal descriptions of a range of cackling or chirring calls; considered variations of one call (P. Jouventin) though described differently by Robertson & van Tets (1982). Calls used in formation and maintenance of pairs. No information on individual or sexual differences. No information on geographical variation. No non-vocal sounds reported.

**ADULT Cackle.** Main call; cackling *cac-cac*, *cac-cac* increasing in tempo (Watson 1975). Sonagram A shows the duet of a pair. **Landing Call**, a purring *courr* (Robertson & van Tets 1982) or a short sharp call sometimes given just before landing (Pinder 1966). **Greeting Call** a chirping *churr* (Robertson & van Tets 1982). Call when Head-sweeping, a pleasant trill (Pryor 1968). Agonistic calls at sea described as like the sound made by scraping the teeth of coarse steel comb (Murphy). No further information.

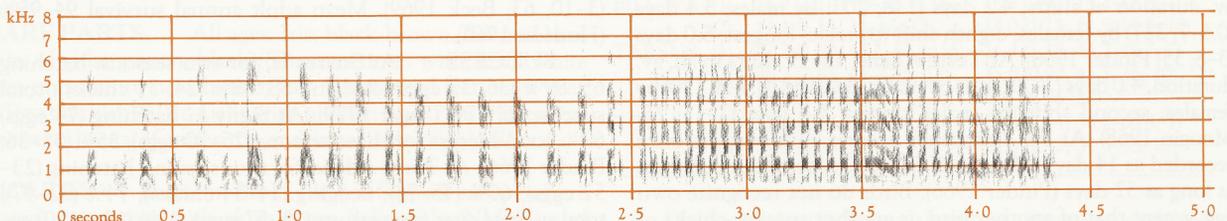
**YOUNG** Chicks beg with *cheep-cheep* call (Pinder 1966); in nest-defence chicks utter a harsh scolding chatter (Ardley 1936).

**BREEDING** Fairly well known. Studied at Dumont d'Urville, Terre Adélie (Prévost 1953, 1964; Mougin 1968, 1975; Isenmann 1970), Casey (Cowan 1979), Heard I. (Downes *et al.* 1959), Signy I., S. Orkney Is (Pinder 1966), Iles Crozet (Despin 1977) and Snares Is (Sagar 1979). Information supplied by J-C. Stahl, A.N. Cowan. Breed in simple pairs, colonially, though mostly solitarily at Iles Crozet; in company with Southern Fulmars *Fulmarus glacialisoides*, Antarctic Petrels and Snow Petrels *Pagodroma nivea*, and at Iles Crozet and Kerguelen, with Light-mantled Sooty Albatross *Phoebastria palpebrata*.

**SEASON** Broadly Nov. to mid-Mar. Occupation of colonies begins at Davis (69°S) 12–22 Oct. (Johnstone *et al.* 1973), Dumont d'Urville (67°S) 13–20 Oct. (Prévost 1964; Mougin 1968), Haswell I. (67°S) 27 Oct. (Pryor 1968), Signy I. (61°S) early Oct. but mid-Sept. in ice-free seasons (Pinder 1966), Heard I. (53°S) 30 Aug. (Downes *et al.* 1959). At Signy I., partners arrive separately within 5 days (1–12; 18) of each other; male first in 72% of cases (Pinder 1966). Occupation of sites at first discontinuous; at Terre Adélie, birds present on only 43% of days until end Oct. Mean duration of stay 2 days, daily rate of attendance 0–18, absent during blizzards (Mougin 1968). Copulation: first noted 23–28 days before laying started (Pinder 1966); at Haswell I., first on 28 Oct., peaking a week later (Pryor 1968). Pre-laying exodus: at Signy I., females left for 23 days (4; 14–32; 35); males visited intermittently during period and mostly at nest-sites several days before females returned, which they did only one day before laying (Pinder 1966). Throughout range, laying starts Nov. or early Dec.; earliest start, 4 Nov., Snares Is; latest, 1 and early Dec., Haswell I. (Pryor 1968; Kamenev 1969) and Windmill Is, Casey; most other records from Iles Crozet to S. Shetlands, last half or late Nov. At Snares Is only, laying is earlier than the usual period of last half Nov.



(Heard I.)



**SITE** On level rocky ground or stable gravel; on ledges on cliffs but usually not the steepest. Usually overlooking sea but at Iles Kerguelen and Heard I., 1 km or more inland (Downes *et al.* 1959; Derenne *et al.* 1974). Site almost always backed by vertical or overhanging rock. At Terre Adélie and Casey, usually exposed to prevailing wind; at Davis (Johnstone *et al.* 1973), Signy I. (Pinder 1966) usually sheltered; at S. Orkney Is (Ardley 1936) none sheltered. Wind prevents snowing up of nests and high irradiation at sites facing N tends to melt snow. Breeding birds return to same nest in successive seasons: at Signy I. ( $n=82$ ), 84% returned; at Terre Adélie ( $n=318$ ), 88% returned; changes occurred after loss of partner or divorce.

**NEST, MATERIALS** Small stones and gravel often in nest, used as material and often deliberately added during incubation. Scrape, 16 cm across.

**EGGS** Almost an elongate ellipse (Falla 1937); slightly more pointed at one end than the other, granular surface, not glossy; white.

**MEASUREMENTS:**

*D. c. capense:*

Signy I.: 62 (57–67; 46) x 43 (40–47) (Pinder 1966);

S. Shetland Is.: 63.2 (58.6–67.4; 27) x 43.9 (41.6–67.4) (Jablonski 1986).

Haswell I.: 64 x 44 ( $n=30$ ; Pryor 1968);

Terre Adélie: 63.8 (59.0–67.2; 28) x 43.3 (40.4–45.2) (Mougin 1968).

*D. c. australe:*

Snares Is.: 61.2 (1.9; 57.3–64.1; 36) x 42.6 (1.2; 39.9–44.7) (Sagar 1979).

**WEIGHTS:**

*D. c. capense:*

Signy I.: 62 (51–76; 46) (Pinder 1966);

S. Shetland Is.: 59.3 (54–63; 27) (Jablonski 1986);

Deception I.: 63 (53–80; 8) (Gain 1914);

Terre Adélie: 67 (55–75; 27) (Mougin 1968).

*D. c. australe:*

Snares Is.: 60 (48–67; 36) (Sagar 1979).

**CLUTCH-SIZE** One. Occasionally two eggs in nest, either from two females mating with one male or from two pairs (Pinder 1966). No replacement laying. Single brooded.

**LAYING** Well synchronized: at Snares Is, 7–20 Nov., mean 11 Nov.; Iles Crozet, 17–21 Nov. to 3 Dec., most before 29 Nov.; S. Georgia, mean 8 Dec. (Croxall & Prince 1987); Signy I., 18–25 Nov. to 6–7 Dec., mean 28–29 Nov.; laying period in 2 years lasted 14, 15 days (Pinder 1966); Terre Adélie, 24–27 Nov. to 5–9 Dec., mean 3 Dec. Egg probably laid in evening (Prévost 1953).

**INCUBATION** By both sexes. Female stays at nest after laying for 1 day on average; up to 3 days (Mougin 1968); up to 5 days (Pinder 1966). Male arrives within 24 h of laying, if not already there, and always takes first long shift. At Signy I., av. duration of shifts, 4.2 days (1–8; 203) by males; 3.4 days (0.5–7; 227) by females; eighth shift (by male) longest, 5.0 days (3–8; 35; Pinder 1966). At Terre Adélie, 13–19 shifts in all, av. duration, 4.0 days (1–11; 101) by males; 3.0 days (0.5–8; 120) by females; second shift (by male) longest, 5.4 days (2–11; 25; Mougin 1968). At Iles Kerguelen, second shift by male once recorded as 14 days (Mougin 1985). Unsuccessful incubation as long as 52 days (Pinder 1966). Birds do not recognize own egg, except that of another bird or another species; chicks of Snow Petrels have been reared by Cape Petrels (Mougin 1968). Incubating birds continue to sit on nest if egg has rolled

away and can still be seen easily. **INCUBATION PERIOD:** at Signy I., 45 days (43–48; 47); at Iles Crozet, 44, 45 days in two nests; at Heard I., c. 45 days; at S. Georgia, 45 days (Croxall & Prince 1987); at Terre Adélie, 47 days (43–50; 15).

**YOUNG** Semi-altricial, nidicolous. Pipping of egg to emergence, 30 h to 5 days (Pinder 1966; Sagar 1979). Hatched with blackish down. Brooded and vigorously defended by both parents. Brood-stage in alternate shifts lasts: at Snares Is, 8–10 days; at Iles Crozet, 10 days; at Signy I., 12 days; at Terre Adélie, 12 days (10–14; 24). Chick then sits alongside parent and does not retreat even in blizzards (guard-stage), which ends (young left alone in nest): at Snares Is, when chick 8–15 days old; at Iles Crozet, 13, 15 days old in two nests; at Signy I., when 16 days old (12–22; 30); at Terre Adélie, when 17 days old (6–27; 28). Change-overs by parents more frequent but more irregular than during incubation: at Signy I., brooding shifts averaged 1.6 days (1–8; 140) by males, 1.7 days (1–7; 128) by females (Pinder 1966). Fed by both parents by incomplete regurgitation, up to 6 meals in one bout. Chicks place bill inside that of parent and at 90° angle until c. 40 days old; later, place bill directly into parent's gape (Sagar 1979). After end of guard-stage, parent leaves soon after feeding bout (Pinder 1966). **NESTLING PERIOD:** at Snares Is, 47–57 days ( $n=20$ ); at Iles Crozet, 46, 48 days in two nests; at S. Georgia, 48 days (Croxall & Prince 1987); at Signy I., 49 days; at Terre Adélie, 47 days (45–50; 22).

**GROWTH** Weight at hatching, average 43 g; gains weight rapidly for one-third to half nestling period, then more slowly. At Snares Is, maximum 665 g, average maximum c. 568 g at 26–42 days old or c. 146% adult mass; at fledging, 404 g average ( $n=20$ ) or 104% adult mass (Sagar 1979). At Iles Crozet, maximum 440 and 640 g for two chicks after 25 and 39 days old; at fledging, one weighed 360 g. At Signy I., maximum averaged 474 g ( $n=7$ ) or 112% adult mass after 35 days old; at fledging, 359 g ( $n=7$ ) or 84% adult mass. At Terre Adélie, weight varied in each of four seasons: mean maximum 676 g (618–713) or 143% adult mass after 26–40 days old; at fledging in two seasons, 457 g (425–483) or 97% adult mass. Loss of weight more rapid in last 6 days in nest, but chick not deserted, even being fed on day of departure (Pinder 1966). Wings grow slowly to 10 days, fast to 45 days, and slow to departure, when still growing (c. 220 mm). Tarsus grows fast to 35 days, remains almost unchanged to departure at c. 42 mm. Culmen grows more slowly than tarsus to 40 days, stays same to departure at c. 30 mm (Pinder 1966). At Terre Adélie, measurements at departure: wing 225 mm (c.f. 272 mm average of 52 local adults); tail 86 mm (102); tarsus 47 mm (47); toe 60 mm (62); culmen 29 mm (30) (Mougin 1975). Primaries appear when chick 10 days old, burst sheaths at 18 days old, completely grown at c. 46 days old.

**FLEDGING TO MATURITY** Independent of parents after departure. Earliest return to colonies when 16 months old (Pinder 1966). Mean age of first breeding, 6 years (3–10; 63; Beck 1969). Mean adult annual survival 94–95% (Hudson 1966).

**SUCCESS** At Snares Is, for two seasons: hatching 65, 89% (36, 37 eggs); fledging 68, 88% (24, 31 chicks); total success 56, 57% (Sagar 1979). At Signy I.: hatching (74 eggs) 69%; total success for three seasons (25–70 eggs), 35% (33–36; Pinder 1966). At Terre Adélie, for four seasons: hatching (23–57 eggs), 60% (45–74); fledging (14–34 chicks), 74% (32–97); total success over five seasons (23–57 eggs), 43% (19–61) (Isenmann 1970; Mougin 1975). Most eggs lost at beginning and end of incubation, chiefly by desertion, failure of partner to

return and infertility, up to c. 10% at Signy I. (Pinder 1966). Most chicks lost in early stage of nestling period, especially when first left unguarded, by starvation, blizzards and predation. Great *Catharacta skua* and South Polar *C. maccormickii* Skuas take unattended eggs and chicks of all ages; sheathbills *Chionis* spp take a few eggs and chicks of all ages; Kelp Gulls *Larus dominicanus* take a few chicks. At Iles Crozet, eggs also taken by Brown Rats *Rattus rattus* (Despin 1977).

#### PLUMAGES Described for nominate *capense*:

**ADULT** Definitive basic. Most birds do not begin breeding until at least 5 years old (Beck 1969). Black plumage (all c82) discolours to brown-black with wear. **HEAD AND NECK**, mostly black. Throat may be black or white with black spots; feathers mostly white, with black tips. Worn birds may have white throats; throat variation not related to age, sex or locality (Whitlock & Whittell 1942). **UPPERPARTS**. Mantle, and sometimes uppermost back, black; feathers of mantle, black with dark grey-brown bases. Feathers of upper-back and mantle usually with irregular, concealed white subterminal band. Rest of upperparts, white with heavy black spotting, sparser near tail. Feathers, white with black tips and concealed dark grey-brown bases. Black spots become smaller with wear; in some birds with fresh plumage, over half the area of upperparts dark, in worn birds as little as 20% of upperparts dark. **UNDERPARTS**, mostly white; under tail-coverts and feathers on sides of breast and flanks have black tips. **TAIL**, black with white bases. **UPPERWING**. Marginal, lesser and primary median coverts, black. Inner half of lowest row of lesser coverts, white with black outer webs and tips. Outer half of lowest row of lesser coverts and primary coverts, white with black tips widest on outer webs. Black tips most extensive on outer primary coverts; in these feathers, white areas are concealed. Median coverts, white with black tips most extensive on outer web. Secondary coverts have black tips and outer webs; outer edge and most of inner web, white. Black more extensive on outer feathers. Secondaries, white with black tips considerably wider on outer feathers. Primaries, white with black tips; p10 has black outer web. In outer primaries, black tips make up distal half of outer web, distal third of inner web. **UNDERWING**. Remiges as upperwing. Marginal under wing-coverts, and outermost lesser, secondary and greater primary under wing-coverts, black. Other under wing-coverts white; outer under primary-coverts and innermost lesser and median coverts have black tips.

**DOWNY YOUNG** Protoptile, slaty grey (dark 79). Mesoptile, dark grey (brownish 79), off white on breast and belly.

**JUVENILE** Plumage pattern, as adult. On breeding grounds, black feathers have grey wash and those on upperparts have narrow whitish tips. These characters probably lost rapidly with wear, being absent in beachcast birds in winter.

**BARE PARTS** All ages. Iris, black-brown. Bill and bare skin of gular pouch, black (82), sometimes with small white area on tomiom near base of bill. Tarsus and feet, dark grey (83) to blackish (82), usually with pinkish (pale 7) to white areas between joints of inner toe and inner side of middle toe.

**MOULTS** Based on Beck (1969) at Signy I. except where stated; consistent with skins from Balleny Is (NMNZ) and meagre data on *australe* in NMNZ.

**ADULT POST-BREEDING** Definitive pre-basic.

Body-moult begins last week Dec., during incubation. Duration unknown but at least 4 months, since successful breeders still in moult at beginning of Apr. Adult beachcast NZ, Aug., was in body-moult (NMNZ). Tail-coverts replaced before primary moult begins. Primaries outwards, duration c. 85 days; up to five innermost primaries (NMNZ) may grow at same time. A specimen collected near Antipodes Is, 17 Feb., growing all primaries, the seven outermost being in quill (J.A. Bartle); there are other records of five outermost growing. Moulting birds may not be able to fly well (Bierman & Voous 1950) but there are no records of flightlessness. Primary moult begins in Feb. while chicks being fed. Most flight-feathers moulted at sea during post-breeding exodus; returned adults in early Apr. near completion of primary moult. Birds recorded in primary moult in May from seas round NZ and S. Shetland Is (Murphy). Secondaries moult about same time as primaries; sequence varying, complex and not properly known. Sequence suggested by Bierman & Voous (1950) inconsistent with data in Beck (1969) and NMNZ. Tail practically simultaneous, begins near end of primary moult and finishes after primaries.

**DEFINITIVE PRE-BASIC OF FAILED AND NON-BREEDERS** Sequences similar to breeding adults. Unknown when body moult begins, but still in progress at beginning of Apr. Primary moult begins in early Jan. and completed round end Mar. No information on non-breeders less than 4 years old.

**POST-JUVENILE** No information. Unusually white birds seen in breeding season probably in very worn plumage (Murphy; Beck 1970); perhaps implying some birds (presumably juveniles or young immatures) have different moult regime. This also implied by Falla's (1937) observation that in NZ seas, some July and Aug. specimens are fresh, and others worn.

#### MEASUREMENTS

*D.c. capense*: (1) Balleny Is, adults, fresh specimens (NMNZ). (2) At sea, E of S. Sandwich Is, includes juveniles, which may have narrower bills; methods unknown (Bierman & Voous 1950). (3) S. Orkney Is, live breeding adults; methods unknown (Pinder 1966).

	MALES	FEMALES
WING	(1) 272 (2.9; 263-283; 14)	271 (2.9; 266-274; 5)
	(2) 262 (6.3; 253-275; 11)	262 (6.2; 250-269; 7)
	(3) 266 (258-278; 23)	265 (257-277; 22)
TAIL	(1) 104.0 (3.12; 99-110; 14)	106.6 (2.58; 103-110; 5)
	(2) 98.8 (2.42; 94-102; 12)	101.2 (3.23; 97-107; 8)
	(3) 102 (91-110; 23)	104 (91-105; 22)
BILL	(1) 31.7 (1.19; 29.1-33.2; 16)	30.5 (1.60; 28.1-33.2; 7)
	(2) 30.9 (1.57; 28-33.5; 11)	29.4 (1.32; 28-32.5; 10) **
	(3) 31 (29-34; 23)	30 (29-33; 22)
BILL W	(1) 16.9 (1.1; 14.9-18.7; 16)	16.3 (0.97; 15.2-18.4; 7)
	(2) 14.1 (1.33; 11-16; 13)	14.0 (1.23; 11.5-15.5; 10)
TARSUS	(1) 47.2 (1.50; 45.2-50.4; 16)	46.4 (1.18; 44.7-48.7; 7)
	(2) 46.3 (0.85; 45-47.5; 13)	45.0 (0.99; 43.5-46; 10) **
	(3) 44 (40-47; 23)	42 (39-46; 22)
TOE	(1) 59.3 (1.43; 57-61.8; 16)	58.3 (1.44; 56.2-60.4; 7)
	(2) 57.5 (1.65; 55-60; 13)	54.6 (2.42; 51.5-58; 10) **

*D.c. australe*: (1) Several localities, juveniles excluded, skins (MV). (2) Snares Is, live adults; straightened chord (Sagar 1986).

	MALES	FEMALES
WING	(2) 267 (5.9; 254-276; 52)	264 (7.2; 241-280; 43) *
8TH P	(1) 164.9 (6.05; 158-177; 9)	164.4 (4.63; 158-170; 8)
BILL	(2) 31.2 (1.18; 27.8-34.9; 52)	29.9 (1.05; 27.8-32.5; 43) **
THL	(2) 78.5 (1.51; 13.8-17.0; 52)	75.9 (1.67; 71.8-79.4; 43) **
BILL W	(2) 15.3 (0.64; 13.8-17.0; 52)	14.9 (0.72; 13.2-16.3; 43) **
BILL D	(2) 13.0 (0.63; 11.8-14.4; 52)	12.4 (0.60; 11.1-13.6; 43) **
TARSUS	(2) 45.1 (1.57; 41.7-48.6; 52)	43.8 (1.82; 40.7-47.3; 43) **
TOE	(2) 61.3 (1.58; 57.8-65.3; 52)	59.1 (1.96; 54.0-63.1; 43) **

**WEIGHTS** *D.c. capense*: Signy I. breeding adults, dates unknown: males 442 (380-550; 23), females 407 (360-510; 22) (Pinder 1966). Balleny Is adults, Feb.-Mar.: males 478 (32.7; 422-528; 15), females 449 (46.0; 368-523; 7). At sea, Jan.-Mar., males 450 (405-500; 9), females 403 (375-440; 8).

*D.c. australe*: Snares Is breeding adults, just before laying, or during first two incubation shifts (Sagar 1986): males 452 (40.0; 345-577; 52), females 419 (31.0; 342-476; 43).

**STRUCTURE** Wing, long and narrow. Eleven primaries, p10 longest, p9 3-12 shorter, p8 15-22, p7 31-38, p6 46-57, p5 63-73, p4 84-97, p3 96-118, p2 117-138, p1 134-156, p11 minute. Eighteen to 19 secondaries (19-20 recorded by Bierman & Voous 1950); c. five of tertial form. Tail, slightly rounded; 14 tail feathers; anomalous birds with 15 recorded (Bierman & Voous 1950). Bill broad with gular pouch between convex mandibular rami. Nasal tube about one-quarter length of bill; nostrils point forward, upwards and slightly towards each other; narrow septum does not reach rim of nostrils. Fine serrations on tomium of upper mandible. Underside of mandibular unguis straight, pointing slightly upwards. Outer toe longest, middle toe c. 1 mm shorter, inner toe 84-90%.

**GEOGRAPHICAL VARIATION** Two subspecies recognized (Peters): subspecies *australe*, from NZ offshore islands, said to be smaller and darker than nominate *capense* (Mathews 1912). Biometrics (above) do not show significant differences between the two subspecies. Observers who have seen both subspecies (Darby 1970; J.A. Bartle; P.M. Sagar) find *australe* has smaller white patches on upperwing and the white areas of upperparts are heavily mottled black and do not extend so close to mantle. Subspecies *australe* photographed at Snares Is (A.J.D. Tennyson) form basis of illustration; have less white than any skins or photographs of known *australe*. Murphy suggested this variation due to feather wear, which substantially reduces extent of black on upperparts and upperwing (see Plumages). Varying position of most anterior upperparts feathers with concealed white subterminal band suggests appearance also affected by individual variation. Falla (1937) suggested older birds have more white but fledgeling *capense* (J.A. Bartle) and *australe* (Lindsey 1986) are not particularly dark. At present, subspecific identification of birds (away from breeding grounds) that are paler than the illustrated *australe* is probably not possible.

#### REFERENCES

- Ainley, D.G., et al. 1978. *Wilson Bull.* 90: 492-510.  
 Ainley, D.G., et al. 1984. *AOU orn. Monogr.* 32.  
 Ardley, R.A.B. 1936. *Discovery Rep.* 12: 349-76.  
 Austin, O.L. (Ed.) 1968. *Antarctic Bird Studies*.  
 Bannerman, D.A. 1930. *The Birds of Tropical West Africa*. 1.  
 Bartle, J.A. 1974. *Notornis* 21: 135-66.

- Beck, J.R. 1969. *Br. Antarct. Surv. Bull.* 21: 33-44.  
 Beck, J.R. 1970. Pp. 542-50. In: Holdgate 1970.  
 Bennett, A.G. 1927. *Emu* 26: 259-63.  
 Bierman, W.H., & K.H. Voous. 1950. *Ardea* (Extra No.): 1-123.  
 Bourne, W.R.P. 1967. *Ibis* 109: 141-67.  
 Bourne, W.R.P., & W.F. Curtis. 1985. *Sea Swallow* 34: 18-28.  
 Brown, L.H., et al. 1982. *The Birds of Africa*. 1.  
 Chapman, S.E. 1981. *Sea Swallow* 30: 45-67.  
 Chapman, S.E. 1982. *Sea Swallow* 31: 5-29.  
 Chapman, S.E. 1986. *Sea Swallow* 35: 3-12.  
 Chapman, S.E., & N.G. Cheshire. 1987. *Sea Swallow* 36: 32-46.  
 Cheshire, N., et al. 1979. *Notornis* 26: 37-46.  
 Clark, G.S. 1989. *Notornis* 36: 51-2.  
 Cowan, A.N. 1979. *Aust. Bird Watcher* 8: 69-90.  
 Croxall, J.P. (Ed.) 1987. *Seabirds*.  
 Croxall, J.P., & P.A. Prince. 1987. Pp 347-68. In: Croxall 1987.  
 Croxall, J.P., et al. 1984. *ICBP Tech. Publ.* 2: 637-66.  
 Darby, M.M. 1970. *Notornis* 17: 28-55.  
 Dell, R.K. 1960. *Rec. Dominion Mus.* 3: 293-305.  
 Derenne, P., et al. 1976. *Com. natn. fr. Rech. Antarct.* 40: 107-48.  
 Derenne, P., et al. 1974. *Com. natn. fr. Rech. antarct.* 33: 57-87.  
 Despin, B. 1977. *Oiseau Rev. fr. Orn.* 47: 149-57.  
 Downes, M.C., et al. 1959. *ANARE Rep. Ser. B* 1: 1-135.  
 Duhamel, G. 1981. *Alauda* 49: 241-9.

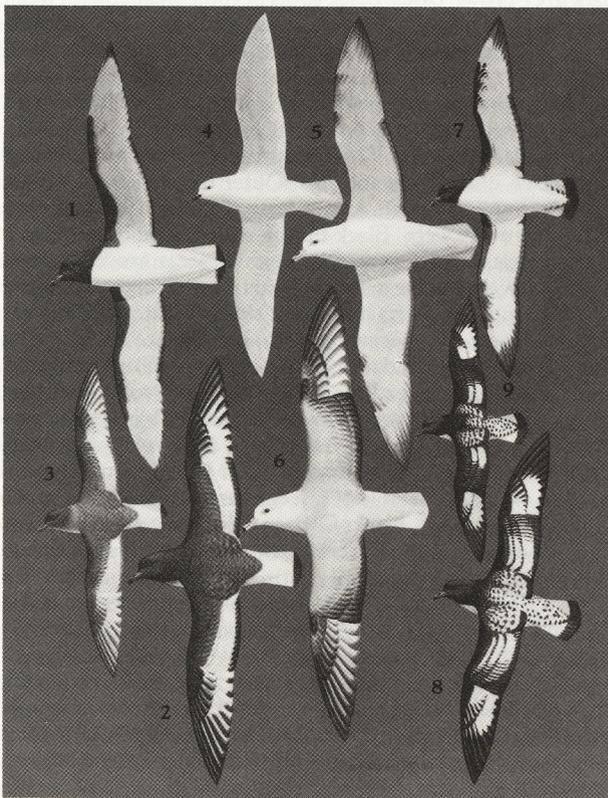


Plate 27

- Antarctic Petrel *Thalassoica antarctica*  
 1. Adult, ventral, fresh  
 2. Adult, dorsal, fresh  
 3. Adult, dorsal, worn
- Cape Petrel *Daption capense*  
 7. Adult, ventral  
 8. Adult, subspecies *capense*, dorsal  
 9. Adult, subspecies *australis*, dorsal

- Snow Petrel *Pagodroma nivea*  
 4. Adult, ventral

- Southern Fulmar *Fulmarus glacialisoides*  
 5. Adult, ventral  
 6. Adult, dorsal

- Enticott, J.W. 1986. *S. Afr. J. Antarct. Res.* 16: 25-8.  
 Falla, R.A. 1937. *Rep B.A.N.Z. Antarct. Res. Exped. Ser. B* 2: 1-288.  
 Fenwick, G.D. 1978. *NZ J. mar. freshwat. Res.* 12: 223-4.  
 Fleming, C.A. 1950. *Emu* 49: 169-88.  
 Flora, M.D. 1981. *Cormorant* 9: 3-7.  
 Gain, L. 1914. *Deuxieme Exped. antarct. fr.* 1908-10: 1-200.  
 Green, K. 1986. *Notornis* 33: 151-4.  
 Green, K., & G.W. Johnstone. 1986. *ANARE Res. Notes* 35: 1-54.  
 Griffiths, A.M. 1982. *Cormorant* 10: 9-13.  
 Hansen, L. 1978. *Dansk orn. Foren. Tidsskr.* 72: 179-88.  
 Harper, P.C. 1987. *Notornis* 34: 169-92.  
 Harper, P.C., et al. 1984. *ICBP Tech. Publ.* 2: 593-608.  
 Harper, P.C., et al. 1985. *Biomass Handbook* 24: 1-22.  
 Harris, M.P. 1973. *Condor* 75: 265-78.  
 Harrison, P. 1983. *Seabirds, An Identification Guide.*  
 Holdgate, M.W. (Ed.) 1970. *Antarctic Ecology*. 1.  
 Holgersen, H. 1945. *Scient. Results Norweg. Antarct. Exped.* 23: 1-100.  
 Holgersen, H. 1957. *Publ. Christensens Hvalfangstmus* 4: 1-80.  
 Horning, D.S., & C.J. Horning. 1974. *Notornis* 21: 13-24.  
 Hudson, R. 1966. *Br. Antarct. Surv. Bull.* 8: 63-73.  
 Humphrey, P.S., et al. 1970. *Birds of Isla Grande (Tierro del Fuego).*

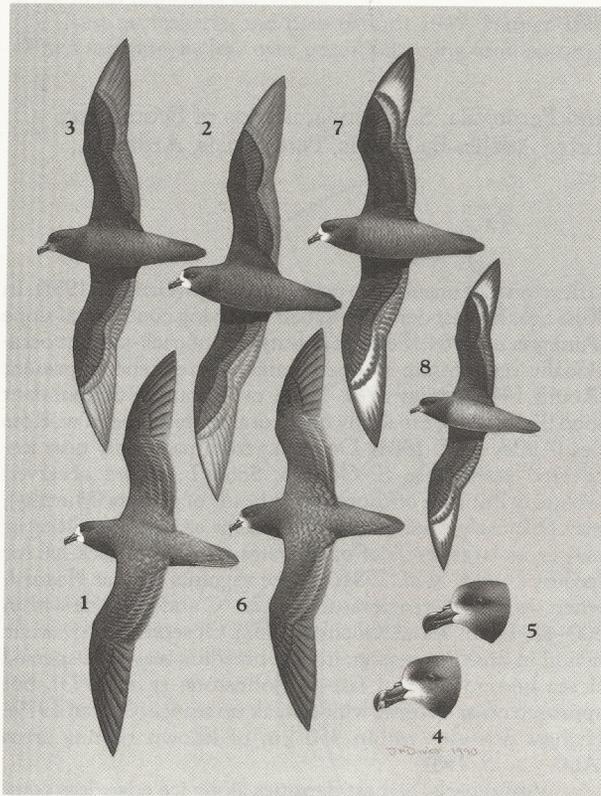


Plate 28

Great-winged Petrel *Pterodroma macroptera*

1. Adult, subspecies *gouldi*, dorsal
2. Adult, subspecies *gouldi*, ventral
3. Adult, subspecies *macroptera*, ventral
4. Adult, subspecies *gouldi*
5. Juvenile, subspecies *gouldi*

Providence Petrel *Pterodroma solandri*

6. Adult, dorsal, fresh
7. Adult, ventral, fresh
8. Adult, ventral, worn

- Hunt, G.L. Jr., & R.R. Veit. 1983. *Antarct. J. US* 18: 167-9.  
 Imber, M.J. 1983. *Notornis* 30: 283-98.  
 Isenmann, P. 1970. *Oiseau Revue fr. Orn.* 40 (No. Spec.): 135-141.  
 Jablonski, B. 1986. *Polish Polar Res.* 7: 217-60.  
 Jehl, J.R. 1973. *Auk* 90: 114-35.  
 Jenkins, J. 1981. *Aust. Seabird Grp Newsl.* 16: 3-16.  
 Johnstone, G.W., & K.R. Kerry. 1976. *Proc. Int. orn. Congr.* XVI: 725-738.  
 Johnstone, G.W., et al. 1973. *ANARE. Rep. B1*, 123: 1-62.  
 Jouventin, P., & J.P. Robin. 1984. *Emu* 84: 46-8.  
 Jouventin, P., et al. 1982a. *Com. natn. fr. Rech. Antarct.* 51: 427-36.  
 Jouventin, P., et al. 1982b. *Com. natn. fr. Rech. Antarct.* 51: 457-67.  
 Jouventin, P., et al. 1984. *ICBP Tech. Publ.* 2: 609-25.  
 Kamenev, V.M. 1969. *Sov. Antarct. Exped. Inf. Bull.* 7: 36-7.  
 King, W.B. 1967. *Seabirds of the Tropical Pacific.*  
 Kinsky, F.C. 1960-63. *9th-13th Annual Reports of the Banding Committee.* Dominion Mus., Wellington.  
 Lambert, K. 1971. *Beitr. Vogelk.* 17: 1-32.  
 Lindsey, T.R. 1986. *The Seabirds of Australia.*  
 Linkowski, T.B., & J.M. Rembiszewski. 1978. *Pol. Arch. Hydrobiol* 25: 717-27.  
 Liversidge, R., & G.M. Le Gras. 1981. *Proc. Symp. Birds Sea Shore:* 149-167.  
 Lucas, F.A. 1887. *Auk* 4: 4.  
 Mackworth-Praed, C.W., & C.H.B. Grant. 1962. *African Handbook of Birds.* 2(1).  
 Mathews, G. 1912. *Novit. Zool.* 18: 234.  
 McQuaid, C.D., & L.H. Ricketts. 1984. *Cormorant* 12: 14-28.  
 Milledge, D. 1977. *Corella* 1: 1-12.  
 Miskelly, C.M. 1984. *Notornis* 31: 209-23.  
 Mochizuki, H., & I. Kasuga. 1985. *Trans. Tokyo Univ. Fish.* 6: 155-65.  
 Montague, T.L. 1988. *Hydrobiologia* 165: 227-37.  
 Mougin, J-L. 1968. *Oiseau Revue fr. Orn.* 38 (No. spec.): 1-52.  
 Mougin, J-L. 1975. *Com. natn. fr. Rech. Antarct.* 36: 1-195.  
 Mougin, J-L. 1985. *Oiseau Revue fr. Orn.* 55: 313-49.  
 Nudelman, A.V. 1962. *Soviet Antarctic Expeditions 1959-1961.*  
 Obst, B.S. 1985. *Auk* 102: 540-9.  
 Ozawa, K. 1967. *Antarct. Rec.* 29: 1-36.  
 Ozawa, K., et al. 1968. *J. Tokyo Univ. Fish.* 9: 51-100.  
 Paessler, R. 1911. *J. Orn. Lpz.*, 59: 41-51.  
 Paessler, R. 1914. *J. Orn. Lpz.*, 62: 272-8.  
 Parmelee, D.F., et al. 1977. *Antarct. J. US* 12: 14-21.  
 Paulian, P. 1953. *Mem. Inst. Sci. Madagascar Ser. A* 8: 111-254.  
 Pinder, R. 1966. *Br. Antarct. Surv. Bull.* 8: 19-47.  
 Pitman, R.L. 1986. *Atlas of Seabird Distribution and Relative Abundance in the Eastern Tropical Pacific.* Natn. Mar. Fish. Serv., SW Fish. Center, Admin. Rep. LJ-86-02C.  
 Powlesland, R.G. 1986. *Notornis* 33: 171-84.  
 Prévost, J. 1953. *Alauda* 21: 205-22.  
 Prévost, J. 1964. *Oiseau Revue fr. Orn.* 34 (No. spec.): 91-112.  
 Pryor, M.E. 1968. Pp. 57-82. *In: Austin 1968.*  
 Rand, R.W. 1962. *Ostrich* 33: 48-51.  
 Reichenow, A. 1908. *Deutsche S'dpolar Exped., Band 9, Zool.* 1: 539-67.  
 Ridoux, V., & C. Offredo. 1989. *Polar Biol.* 9: 137-45.  
 Roberson, D. 1980. *Rare Birds of the West Coast of North America.*  
 Robertson, C.J.R., & J. Jenkins. 1981. *Aust. Seabird Grp Newsl.* 16: 17-27.  
 Robertson, C.J.R., & B.D. Bell. 1984. *ICBP Tech. Publ.* 2: 573-86.  
 Robertson, C.J.R., & G.F. van Tets. 1982. *Notornis* 29: 311-66.  
 Robertson, C.J.R., et al. 1980. *Natn. Mus. NZ Rec.* 1: 271-9.  
 Rootes, D.M. 1988. *Br. Antarct. Surv. Bull.* 80: 87-119.  
 Rounsevell, D.E., & N.P. Brothers. 1984. *ICBP Tech. Publ.* 2: 587-92.  
 Rumboll, M.A.E., & J.R. Jehl. 1977. *Trans. San Diego Soc. nat. Hist.* 19: 1-16.  
 Sagar, P.M. 1979. *Notornis* 26: 23-36.

- Sagar, P.M. 1986. *Notornis* 33: 259-63.
- Saunders, H. 1880. *Proc. zool. Soc. Lond.*: 161-65.
- Siegfried, W.R., et al. (Eds.). 1985. *Antarctic Nutrient Cycles and Food Webs*.
- Sinclair, J.C. 1978. *Bokmakierie* 30: 12-16.
- Stahl, J-C. 1987. TAAF-MR. *Rap. Camp. mer* 84-01: 175-90.
- Stahl, J-C., et al. 1985. Pp 478-486. In: Siegfried et al. 1985.
- Stallcup, R. 1976. *Western Birds* 7: 113-36.
- Starck, W. 1980. *Polish Polar Res.* 1: 183-96.
- Staub, F. 1976. *Birds of the Mascarenes and St Brandon*.
- Summerhayes, C.P., et al. 1974. *Ostrich* 45: 83-109.
- Sziji, L.J. 1967. *Auk* 84: 366-78.
- Thomas, T. 1986. *Oiseau Revue fr. Orn.* 56: 349-68.
- van Oordt, G.J., & J.P. Kruijt. 1954. *Ardea* 42: 245-80.
- Watson, G.E. 1975. *Birds of the Antarctic and Sub-Antarctic*.
- Watson, G.E., et al. 1971. *Antar. Map Folio Ser.* 14.
- Weimerskirch, H., et al. 1985. *Emu* 85: 22-33.
- Weimerskirch, H., et al. 1989. *Emu* 89: 15-29.
- Westerskov, K. 1960. *Birds of Campbell Island*. Wildl. Publ. No. 61. NZ Dept Internal Affairs.
- Whitlock, F.W., & H.M. Whittell. 1942. *Emu* 42: 36-43.
- Wilkins, G.H. 1923. *Ibis* (11)5: 474-511.
- Wilson, E.A. 1907. *Natn. Antarct. Exped. 1901-1904, nat. Hist.* 2, *Zool.*, 2, *Aves*: 1-121.
- Winterbottom, J.M. 1960. *Ostrich* 31: 176.
- Zink, R.M. 1981a. *Wilson Bull.* 93: 1-20.
- Zink, R.M. 1981b. *Gerfaut* 71: 59-74.



J. Davies 1992



Volume 1 (Part A), Plate 27

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 glacialisoides*

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

Cape Petrel *Daption capense*

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

© [Jeff Davies](#)