

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.

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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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Pterodroma brevirostris Kerguelen Petrel

Procellaria brevirostris Lesson, 1831, *Traité Orn.* 8: 611 — no locality. Type from Cape of Good Hope.

Named specifically because the bill is short and stubby.

OTHER ENGLISH NAMES Little Black or Short-billed Petrel.

MONOTYPIC

FIELD IDENTIFICATION Length 33–36 cm; wing-span 80–82 cm; weight 357 g. Medium-sized all-dark gadfly petrel of high latitudes in Southern Ocean; similar in size to Soft-plumaged Petrel *P. mollis*. Distinctive jizz of: large head with steep high forehead; thick neck; squat body that tapers to longish gently wedge-shaped tail (usually tightly folded, appearing pointed); bill, short, stubby and small in relation to big head; wings long and narrow with carpal joints held slightly forward. Flight also distinctive. Underwing with whitish leading-edge and silvery grey wing-tip. Appearance varies markedly with light conditions; in sunlight, whole plumage glossy and reflective and pale areas on underwing flash silvery (conspicuous and distinctive field character). Sexes alike. No seasonal plumage differences; plumage becomes browner with wear. Juveniles inseparable.

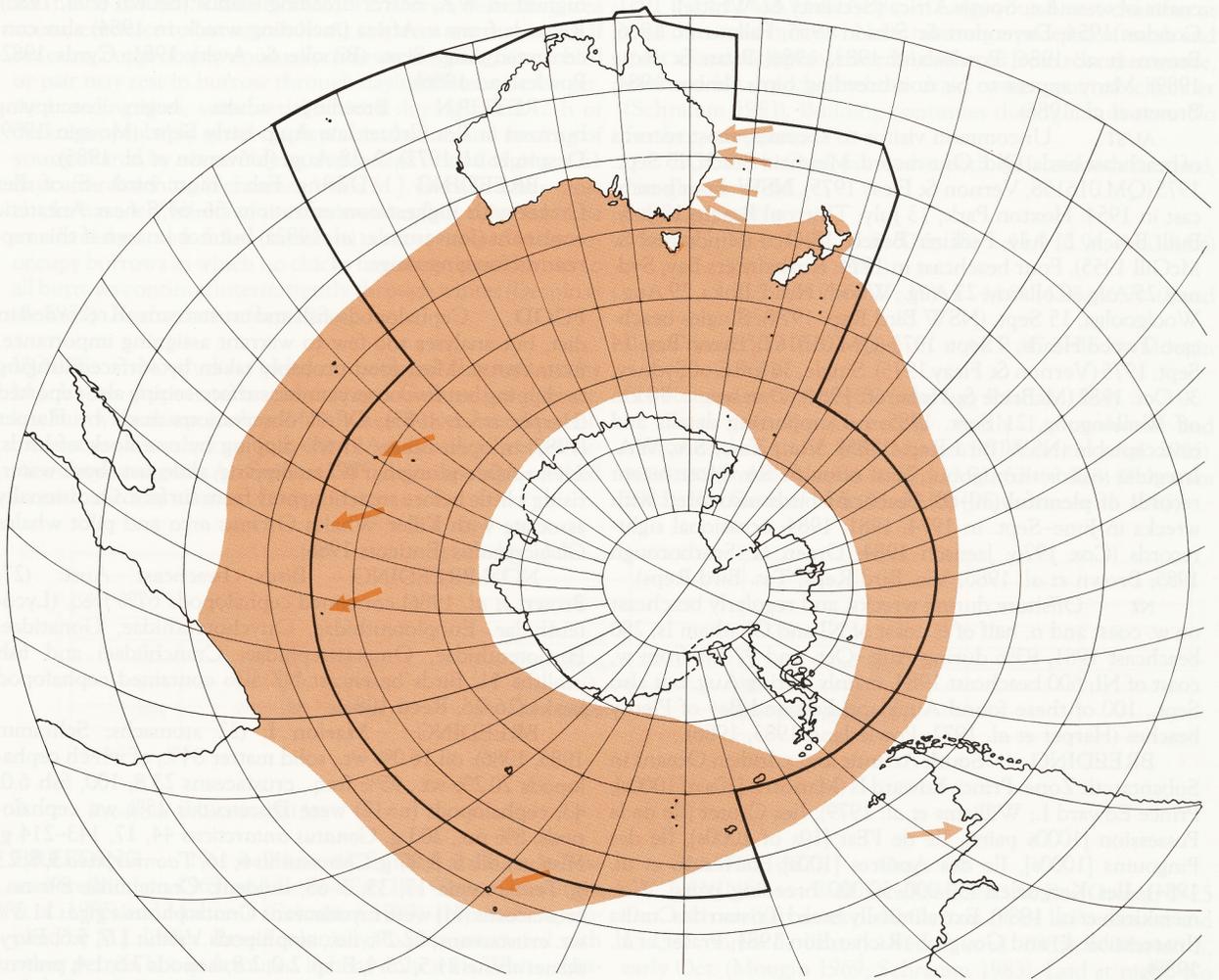
DESCRIPTION ADULT. Head and upperparts, rather uniform slate-grey; upperwing and tail slightly darker than body; slightly darker greyish-black patch round eye. Underbody, uniform slate-grey, slightly paler than upperparts. Underwing: marginal, lesser and median coverts, slate-grey with white fringes; fringes broadest on marginal coverts, forming conspicuous white leading-edge tapering from body to carpal joint. Primaries and greater primary coverts, silvery grey; secondaries and greater secondary coverts, duller silvery grey. General pattern of underwing: white leading-edge and silvery wing-tip contrasting strongly with dark-grey diagonal band formed by rest of underwing. Appearance alters in differing lights; in strong sunlight, plumage silvery grey with silvery or whitish patches, particularly on underwing where white leading-edge and wing-tip gleam silvery or even whitish (conspicuous and distinctive even at long range); sometimes, silvery of wing-tip extends inwards along secondaries and greater secondary coverts as tapering, fading line; head and neck may appear darker than rest of body briefly, giving hooded appearance, especially in side-on or ventral view. Plumage wears to brownish grey, chin and throat faintly paler than rest of underbody. Bill, black; short, stubby and strongly hooked with tubed nostrils prominent over basal quarter. Iris, brown. Legs and feet, brownish to purplish-grey.

SIMILAR SPECIES **Great-winged Petrel** *P. macroptera* noticeably larger and blackish brown (*q.v.*). **Dark-morph Soft-plumaged Petrel** similar in size and tone of plumage; differs markedly in shape, flight and pattern of underwing. (1) Smaller, more rounded head; wings appear slightly shorter and broader; carpals generally held farther forward, thus wing-shape more angular; primaries typically slightly spread in paddle-shape when arcing (in Kerguelen, usually only when circling high above sea). (2) Typical pendulum-motion progression of *Pterodroma*, appearing less dashing, with shallower peaks and slower, less flickering wing-beats; rarely prolonged gliding, soaring and tern-like

circling at great heights above sea (characteristic of Kerguelen). (3) Underwing appears wholly blackish except for broader, shorter and less conspicuous triangular white patch on inner leading-edge that tapers from base of wing to elbow (not carpal joint); silvery area confined to bases of primaries and greater primary coverts, contrasting less with dark lining. (4) Upperparts with distinct narrow black open M-mark across upperwings and rump; when worn, with distinct contrast between grey saddle and brownish black upperwings; on many, narrow dusky tip to tail contrasting with grey base. (5) Darkest individuals have head and underbody uniform slate-grey but, larger, more conspicuous black patch under eye, contrasting with grey cap; slightly paler individuals have uniform or heavily smudged grey belly, flanks, vent and under tail-coverts, with trace of dark-grey breast-band contrasting with paler chin and throat and rest of underbody; does not have dark-hooded appearance. **Providence Petrel** *P. solandri* also has frosty-grey plumage and dark-hooded appearance but differs by (1) being about one-third larger, with bigger chunkier bill, different jizz and lazier flight like that of Great-winged Petrel; (2) blackish open M-mark across upperwings; (3) prominent clear-cut pale face; (4) constant (not brief) dark-hooded appearance; (5) dark inner wing-lining on underwing, without pale leading-edge; (6) clear-cut whitish oval patch across basal half of primaries and greater primary coverts, divided by dark tips of latter.

Highly pelagic; rarely seen from land except when storm-driven; sometimes blown inland during gales. In strong winds, fast roller-coaster flight on switchback course, with long sweeping glides broken by brief bursts of rapid wing-beats; curious fast flickering wing-action, either in troughs of waves or at peak of arcs. Unlike other gadfly petrels, habitually tower up to 100 m, at times appearing to hang motionless while drifting slowly into wind; sustained drifting and soaring interspersed with slow tern-like circling high above sea, giving a few bat-like flickering wing-beats at start of each circling manoeuvre. In light winds, less vigorous arcing flight, interspersed with brief periods of rapid bat-like wing-beats and less drifting. Harper (1987) reported birds wheeling in bat-like fashion only inches above water while foraging. Feed mainly at night with some scavenging by day (Harper 1987; Sinclair 1978). Feed by dipping and surface-seizing; rarely dive. Usually solitary at sea, sometimes in small (five) groups, more rarely in larger flocks (Bierman & Voous 1950). Usually ignore ships but will occasionally fly over other procellariiforms feeding round trawlers. Strictly nocturnal at breeding colonies. Silent at sea; rather quiet over breeding colonies where flight-call is a wheezy *chee-chee-chay*.

HABITAT Marine, pelagic; in subantarctic and Antarctic waters. Birds breeding close to Antarctic Convergence



feed mainly in Antarctic waters; winter range extends into Subtropics in some areas (Jouventin *et al.* 1982a). In Antarctic Zone, occur S to belt of icebergs (Harper 1973), but do not penetrate pack-ice; in summer, observed where sea surface-temperatures between -2 and 2 °C, with most birds at 0 °C (Bierman & Voous 1950; Harper 1973). Mainly pelagic (Jouventin *et al.* 1982b) but at Iles Crozet may be excluded from areas with abundant food over continental shelf by competition with other petrels, particularly White-chinned *Procellaria aequinoctialis* (Stahl *et al.* 1985). Breed on subantarctic islands in Indian and Atlantic Oceans, burrowing in marshy ground on coastal plains and lava ridges (Schramm 1983); prefer wet soil and may concentrate in low-lying high-rainfall areas (Weimerskirch *et al.* 1989), but on Gough I., nest at 150–450 m asl (Swales 1965). In calm weather or when feeding, fly low over water, but may soar high in steady winds (Harper *et al.* 1972; Harper 1987). Settle on surface in rafts; one bird observed to dive, submerging completely (Bierman & Voous 1950) but usually feed from surface (Harper 1987).

DISTRIBUTION AND POPULATION Apparently circumpolar; subantarctic and Antarctic seas ranging from c. 33° S to 67° S; uncommon in South Pacific but occasionally seen near 60° S eastwards from 145° W; in some winters, numerous in Tasman Sea (Harper *et al.* 1972; M.J. Imber).

Periodically blown farther N in storms and wrecked on Aust. and NZ coasts, usually late winter-early spring.

Breeding birds generally remain near breeding islands from Sept.–Mar. but summer sightings range widely from as far N as 24° S on Brazilian coast to Antarctic pack-ice including: coasts of Brazil and Argentina; Weddell Sea Gyre; s. Indian Ocean from South Africa, S and E round Antarctic Continent almost as far as Balleny Is and well to E of Iles Kerguelen and Heard I. from c. 44° S 95° E and 53 – 56° S 85 – 92° E and near Ile St Paul; near Antarctic Convergence between 100° and 145° W (Paessler 1915; Falla 1937; Olrog 1958; Bierman & Voous 1950; Paulian 1953; Harper *et al.* 1972; Brooke & Avery 1981; Cyrus 1982). Some birds at breeding sites throughout most of year; so, to some extent sedentary (Mougin 1969; Jouventin *et al.* 1985). Towards end of breeding season reported E of S. Sandwich Is in Feb.–Mar.; near Convergence in Drake Passage in Feb. (Harper *et al.* 1972). Outside breeding season, subantarctic and Antarctic seas, ranging farther E than during breeding season but few records: between South Africa and Iles Crozet in June and July; near Antarctic Convergence between 100° and 145° W in Apr. and May (Rand 1963; Harper *et al.* 1972); according to Jouventin *et al.* (1982a) n. limit of distribution at sea shifts N to 33° S. Wrecks on coasts of Aust. and NZ usually occur May to Sept.; during large wreck of 1984, also found beachcast on

coasts of w. and e. South Africa (Serventy & Whittell 1951; Condon 1954; Davenport & Sibson 1955; Falla *et al.* 1966; Brown *et al.* 1986; Powlesland 1983, 1986; Ryan & Rose 1989). Many appear to be non-breeding birds (Imber 1984; Brown *et al.* 1986).

AUST. Uncommon visitor to s. coasts; most records of beachcast birds. **Qld.** One record, Mermaid Beach, 13 Sept. 1975 (QM 016158, Vernon & Fleay 1975). **NSW.** Four beachcast in 1954: Hoxton Park, 13 July; Thirroul Beach, 17 July; Bulli Beach, 21 July; Perkins' Beach, 18 Oct. (Hindwood & McGill 1955). Four beachcast in 1974: Rushcutters Bay, Sydney, 25 Aug.; Collaroy, 27 Aug.; Woody Head, Iluka, 29 Aug.; Woolgoolga, 15 Sept. (NSW Bird Rep. 1974). Singles beachcast: Tweed Heads, 9 Sept. 1975 (QM 016162); Byron Bay, 14 Sept. 1975 (Vernon & Fleay 1975). Single, 36 km E of Sydney, 30 Oct. 1982 (McBride & Hobcroft 1984). One seen c. 40 km off Wollongong, 21 Sept. 1985, no supporting details and unacceptable (NSW Bird Rep. 1985). **Vic., Tas., SA, WA.** Irregular visitor throughout, least often in SA. Most recent records of plentiful (30–60) beachcast birds associated with wrecks in June–Sept. in 1974, 1981, 1984; occasional sight-records (Cox 1976; Jaensch 1984; Green & Scarborough 1985; Brown *et al.* 1986; Vic. Bird Reps; Tas. Bird Reps).

NZ Offshore during wrecks, and regularly beachcast on w. coast and n. half of e. coast of NI and Chatham Is; 280 beachcast 1981, 93% during Aug.–Oct. and 97.5% from w. coast of NI; 600 beachcast 1984, mainly during Aug. but also Sept., 100 of these found Auckland East and Bay of Plenty beaches (Harper *et al.* 1972; Powlesland 1983, 1986).

BREEDING South Atlantic and s. Indian Oceans in Subantarctic Zone. Prince Edward Is (Marion I. [10s of 1000s], Prince Edward I.; Williams *et al.* 1979), Iles Crozet (Ile de la Possession [1000s pairs], Ile de l'Est [10s of 1000s], Ile des Pingouins [1000s], Ile des Apôtres [100s]; Jouventin *et al.* 1984), Iles Kerguelen (30 000–50 000 breeding pairs; Weimerskirch *et al.* 1989). Extraliminally breed Tristan da Cunha (Inaccessible I.) and Gough I. (Richardson 1984; Fraser *et al.* 1988).

Most populations substantial and secure but threatened by Black Rats *Rattus rattus* on Ile de la Possession; possibly exterminated by introduced cats, rats and dogs on Tristan da Cunha and introduced cats on Ile aux Cochons (Iles Crozet). Cats also at breeding colonies on Marion I. and Iles Kerguelen.

MOVEMENTS Migratory or dispersive; poorly understood. Particular weather systems may cause birds to drift or be blown into Aust. and NZ waters and probably explains the very large numbers found beachcast in some years (Brown *et al.* 1986).

DEPARTURE Young fledge Marion I. late Jan. (Schramm 1983), Iles Crozet 23 Jan.–18 Feb. (Mougin 1969; Jouventin *et al.* 1985), Gough I. late-Jan.–early Feb. (Swales 1965).

NON-BREEDING At Iles Crozet colonies remain occupied, apparently by non- and failed breeders, and visits continue intermittently throughout winter (Jouventin *et al.* 1984) though n. limit of distribution at sea shifts N to 33°S (Jouventin *et al.* 1982a). Wrecks on coasts of Aust. and NZ May–Sept., mainly Aug.–Sept. (Powlesland 1983) after breeding season has begun. Many young birds; in NZ, 80% birds beachcast were first-year (Reed 1981; Powlesland 1983; Imber 1984); in wreck in Vic. and WA in 1984, birds from various age groups, but 47.5% younger birds; proportion of adults

highest in WA, near breeding islands (Brown *et al.* 1986). Records from s. Africa (including wreck in 1984) also concentrated Aug.–Sept. (Brooke & Avery 1981; Cyrus 1982; Powlesland 1986).

RETURN Breeding adults begin occupying burrows at Iles Crozet late Aug.–early Sept. (Mougin 1969; Despin *et al.* 1972), 9–28 Aug. (Jouventin *et al.* 1985).

BREEDING During Feb., most birds S of Iles Crozet with highest concentrations 56–64°S near Antarctic continent (Jouventin *et al.* 1982a) but not known if this represents foraging range.

FOOD Cephalopods, fish and crustaceans all recorded in diet, but analyses too few to warrant assigning importance. **BEHAVIOUR.** Most food probably taken by surface-plunging or dipping but few observations; surface-seizing also reported (Harper *et al.* 1985). Of 41 observations made by Harper (1987) in open ocean, 97.6% dipping by one flock of birds, 2.4% surface-plunging. When dipping, glide just above water, rising a little before snatching prey from surface. Occasionally associate with Killer Whales *Orcinus orca* and pilot whales *Globicephalus* (Enticott 1986).

NON-BREEDING Birds beachcast Aust. (27; Brown *et al.* 1986) contained cephalopods 67% freq. (Lycoteuthidae, Enoploteuthidae, Onychoteuthidae, Gonatidae, Histiototeuthidae, Ommastrephidae, Cranchiidae) and fish otoliths 11. Birds beachcast NZ also contained cephalopod beaks (26/26; Reed 1981).

BREEDING **Marion I.** (22 stomachs; Schramm 1983, 1986): oil 16.0% wt., solid matter 84%, of which cephalopods 70.2% wt., 95% freq., crustaceans 23.8, 100, fish 6.0, 43; cephalopods (n=12) were *Discoteuthis* 25% wt. cephalopods, 8% no., 203 g, *Gonatus antarcticus* 44, 17, 143–214 g, *Histioteuthis* 5, 8, 37 g, *Chiroteuthis* 6, 16, *Taonius pavo* 3, 8, 23 g, *Teuthowenia* 17, 33, 3–68, unident. Cranchiidae 8% no.; crustaceans (71) were mysidaceans *Gnathophausia gigas* 11.2% wt. crustaceans, 22.2% no., amphipods *Vibilia* 1.7, 5.6, *Eurythenes obesus* 21.5, 25.4, *E. sp.* 2.0, 2.8, isopods 7.6, 1.4, prawns *Sergestes* 7.6, 5.6, shrimps *Acanthephyra* 5.4, 1.4, *Parapasiphae* 43.2, 49.3; fish incl. *Diaphus*.

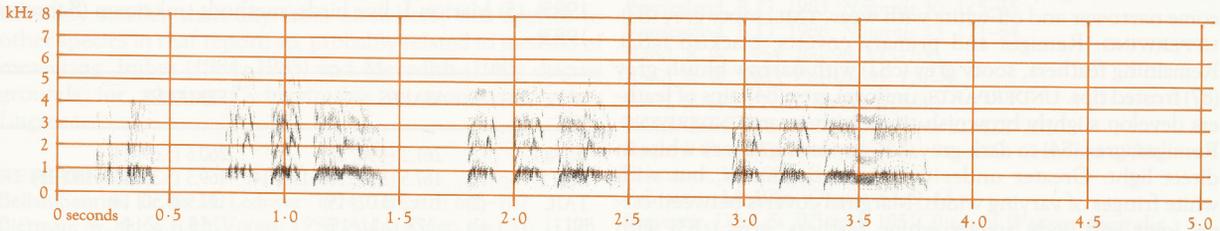
Iles Crozet: Ile de l'Est (three stomachs; Despin *et al.* 1972), cephalopods 100% freq., crustaceans 33; **Ile de la Possession**, (17 stomachs; Mougin 1969): cephalopods 89, crustaceans 11. Amphipod *Eurythenes obesus* also recorded in diet at Iles Crozet (Bellan-Santini & Ladoyer 1974).

INTAKE Mean size of meal Marion I. 73 g (19.0; 20–100; 22) (Schramm 1983), mean wt. stomach contents 11.1 g (Schramm 1986). At Iles Crozet, visited 31.4% nights (2.5; 29.1–34.1; 3 chicks) with 2.93 days between meals (0.26; 2.66–3.17; 157 weighings), chicks gaining 61.9 g (38.3; 1–168; 47) during 24-h period (Jouventin *et al.* 1985).

SOCIAL ORGANIZATION AND BEHAVIOUR Little information; based on information provided by M.J. Imber. Usually solitary at sea, sometimes in small groups of up to five birds, more rarely in larger flocks (Bierman & Voous 1950); gregarious when breeding. Probably monogamous but no systematic evidence. At Iles Kerguelen, displaying birds present at breeding areas, from beginning of Apr. to end of July (Weimerskirch *et al.* 1989). Return to breeding areas to copulate in late Aug.–early Sept., with pre-laying exodus in late Sept. (Mougin 1969). Incubate continuously; guard young for 1 to 2 days after hatching, then young usually unattended except when being fed. Breed in loose colonies; at Marion I.,

600 nests/10 km² (Schramm 1986). Territorial, defending area round entrance to burrow only. At sea, may rest on surface if sea calm, but probably unusually. During breeding, single bird or pair may rest in burrow through daylight hours or longer. At breeding sites, some aerial activity during first 1–2 h of darkness, probably aerial displays. Incubation and feeding of young shared by sexes. Young dependent until fledging c. 61 days after hatching (Schramm 1983; M.J. Imber). After most chicks have left, adults of uncertain status (but assumed to be non-breeders and failed breeders) almost immediately re-occupy burrows in which no chicks have been reared; visits to all burrows continue intermittently through winter (Despin *et al.* 1972). No further information.

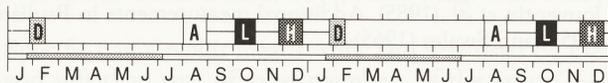
VOICE No studies; based on personal observations by M.J. Imber. Appear to be rather quiet. Calls rather distinct, low but with sharp quality. Mainly heard over breeding colonies soon after dark or from nest. Adult call, wheezy *chee-chee-chay* (sonagram A). Swales (1965) describes high-pitched scream used by alarmed birds.



A Recordist unknown; B1005

BREEDING Not well known. Studied at Ile de la Possession (Mougin 1969) and Ile de l'Est, Iles Crozet (Jouventin *et al.* 1985) and Marion I. (Schramm 1983). Information supplied by M.J. Imber. Breed colonially, loosely associated with other petrels but in favoured habitat only with White-chinned Petrel *Procellaria aequinoctialis* (Marion I. and Iles Kerguelen) and Salvin's Prion *Pachyptila salvini* (Marion I.); in water-logged or marshy tundra on oceanic islands, rarely on well-drained hillsides.

SEASON Broadly from Aug. to early Feb. Colonies never entirely deserted but numbers build up from early Aug. Pre-laying exodus by both sexes occurs about 4 weeks before laying starts. Eggs laid during Oct. Adults and young leave late Jan. to early Feb., with intermittent attendance at colonies onwards to Aug. by birds of unknown age or status.



SITE Burrows on flat or gently sloping tundra, in exposed or sheltered areas with entrances of burrows sheltered from prevailing winds and usually facing E. Burrows nearly always in wet ground or mires (Marion I.), with water inside and often running out of entrance; vary much in length, depth and shape and may have two chambers. Dimensions: length: 1.5 m (0.49; 0.8–2.8; 29); depth below surface, 35 cm (6; 25–50; 28); entrance, 11 cm (1.6; 8–14; 15) x 16.8 (2.3; 14–20) (Schramm 1983). Burrows sometimes shared with White-chinned Petrel and Salvin's Prion on Marion I. (van Zinderen Bakker 1971; Schramm 1983). No information on excavation of burrows or use from year to year.

NEST, MATERIALS Large round nest-chamber at end of curved burrow. Nest, mound or pedestal of earth and peat mixed with plant material collected from round entrance, surrounded by channel to drain water out of chamber (Schramm 1983). Building continues during incubation. No further information.

EGGS Oval, pointed at both ends; smooth textured, not glossy; white.

MEASUREMENTS:

Marion I. 57.4 (1.48; 55.5–60.5; 28) x 44.9 (0.94; 43.0–46.6) (Schramm 1983)

56.7 (54.7–60.2; 19) x 44.8 (43.6–46.7) (Rand 1954)

Iles Crozet 55.7 (53.2–62.4; 6) x 44.1 (42.3–45.9) (Mougin 1969)

Iles Kerguelen 59.6 x 46.0 (one egg; Paulian 1953).

Eggs from Iles Crozet, av. nearly 1 mm shorter and narrower than those from Marion I. (Jouventin *et al.* 1985).

WEIGHTS (fresh): Marion I.: 57.1 (3.91; 53–63.3; 4) (Schramm 1983); Iles Crozet: 55.5 (54–59; 8) (Jouventin *et al.* 1985).

CLUTCH-SIZE One.

LAYING Well synchronized. At Iles Crozet, 2–25 Oct. with median dates of 10 Oct. on Ile de la Possession and 15 Oct. on Ile de l'Est (Jouventin *et al.* 1985); at Marion I., early Oct. (Mougin 1969; Schramm 1983). Laid at night. No replacement laying nor second broods.

INCUBATION By both sexes, starting with female from laying: first shift (female) 2–9 days; second (male), av. 14.8 days (10–20); third (female), av. 13.2 days (11–17); fourth (male), 10.2 days (9–12); fifth (female), 2–9 days (Mougin 1969).

INCUBATION PERIOD. 49 days (46–51; 7; Mougin 1969; Schramm 1983). Eggshells trampled into nest.

NESTLING Semi-altricial, nidicolous. Downy when hatched; no details. Guarded by parents for 1–2 days after hatching. No further information on parental care. Fed by both parents by incomplete regurgitation. Size of meals 73 g (19; 20–100; 22); large increases in weight (100+ g) of chick probably or certainly result of two feeds per night; 31% of all feeds were thus double (Schramm 1983). **NESTLING PERIOD.** 61 days (1.1; 59–62; 4; Schramm 1983); c. 60 days (Mougin 1969); 61 and 62 days (n=2; Jouventin *et al.* 1985).

GROWTH Weight at hatching 52.4 g (45–58; 4); max. weight 410 (340–475; 3) (Jouventin *et al.* 1985); at fledging 302 (220–380; 10) or 92% of av. adult weight (Despin *et al.* 1972). Growth of tarsus and culmen reach asymptote when 40–45 days old; wing keeps growing till fledging; weight reaches max. (mean av. weight) at c. 35 days old and declines to c. 95% when almost fledged (Schramm 1983). See Jouventin *et al.* (1985) for details of increases of wing, tail, culmen.

FLEDGING TO MATURITY Chicks leave burrows at night, able to fly immediately and independent of

parents. No information on age at first pairing or breeding.

SUCCESS At Ile de la Possession, four of nine eggs hatched, no chicks fledged (Mougin 1969). At Marion I., 31 of 49 eggs hatched and 24 chicks fledged, for total success of 53% (Schramm 1983). No knowledge of longevity or survival. Most losses at Marion I. by desertion of eggs or abandonment of chicks; feral cats and skuas *Catharacta* spp major predators of adults, eggs and chicks (van Aarde 1980; Schramm 1983). Skuas cause losses at all colonies. Rats are serious threat to remnant population on Ile de la Possession (Mougin 1969).

PLUMAGES

ADULT (DEFINITIVE BASIC) Age of first breeding unknown. **HEAD AND NECK**, sooty grey (83) above, merging to brownish grey (brownish 84) below. Small pre-orbital patch, blackish (82). Feathers of forehead, chin and at base of bill have narrow off-white tips. All feathers have concealed white bases, occasionally exposed above pre-orbital patch. **UPPERPARTS**, sooty grey (dark 83), assuming slightly brownish tinge when worn. Feather-shafts, blackish (82). Feathers have narrow bluish-grey (87) frosted edges when fresh; these become narrower and off-white with wear. **TAIL**, sooty grey (83). **UPPERWING**. Remiges and primary coverts, blackish (c82). Remaining feathers, sooty grey (c82) with narrow bluish-grey (87) frosted tips. **UNDERPARTS**, uniform grey (84); tips of feathers develop slightly brownish tinge with wear. **UNDERWING**. Remiges, grey (84) to dark grey (84), appearing silvery white in direct light. Greater under wing-coverts, similar, but with white fringes of varying width. Marginal coverts between carpal joint and body appear white; feathers, grey (c83) with broad white fringes. All other under wing-coverts, dark grey (83) to blackish (82), with irregular white fringes.

DOWNY YOUNG 'Sooty brown' (Oliver); uniform grey (Despin *et al.* 1972).

JUVENILE As adult.

BARE PARTS Sources: Milon & Jouanin 1953; Elliott 1957; Swales 1965; NMNZ; photos in Lindsey (1986).

ADULT Iris, blackish brown (119). Bill, blackish (82), often with narrow white markings at base of unguis. Feet and legs, usually lead-grey (87) to blackish (82), palest on front of tarsus; sometimes with purplish (-) tinge. Middle toe may have small patch of flesh-pink (-) on underside. Feet, rarely flesh-pink (-) at Gough I. with some intermediate shades recorded. Claws, black (82-89).

JUVENILE Lack white markings on bill in first winter.

MOULTS Based on Brown *et al.* (1986), except where stated.

ADULT POST-BREEDING Pre-basic. Complete. No moult recorded at breeding grounds. Primary moult recorded as early as late Jan. in birds of unknown age (Bierman & Voous 1950; Elliott 1957); so, may begin soon after breeding season. However, primary moult not observed in birds at sea from Feb.-Apr. (Bierman & Voous 1950; Harper *et al.* 1972). Most adult beachcasts (aged on gonads) in Aust. and NZ from May to Sept. have completed primary moult (Brown *et al.* 1986; Imber 1984). Exceptions, WA beachcast in early June (HLW) with primary moult N⁵4¹2¹1⁰O², and two beachcasts completing primary moult in late May and Aug. (Imber 1984; Brown *et al.* 1986); these perhaps imply that starvation affects duration of moult. Body-moult recorded in three of ten adult beachcasts between May and Sept. (Brown *et al.* 1986). Moul-

condition similar in pre-breeders (in at least second year) beachcast in Aust. Primaries outwards; in captive birds p5 dropped before growth of p1 complete. p6-p10 replaced more slowly; preceding feathers about half to two-thirds grown before next feather shed. Wear suggests secondaries moult in several groups; s1-s5 and s6-s11 or 12 inwards; s19-21 moult before s16-s18. Tail apparently asymmetrical and irregular, outer feathers tend to be last to moult. Tail- and remex-moult concurrent, sometimes tail-moult completed after primaries.

POST-JUVENILE No information; juveniles beachcast in Aust. and NZ, May-Sept. have not begun moult (Imber 1984; Brown *et al.* 1986). Captive birds moulted primaries Sept. to Oct. perhaps in post-juvenile moult, but age unknown and timing of moult perhaps affected by captivity.

MEASUREMENTS (1) Throughout range, definitive skins (NMNZ). (2) Aust., fresh beachcasts; width of bill and depth at base (Brown *et al.* 1986). (3) Iles Kerguelen, skins (Mougin 1985). (4) Iles Crozet, live birds (Jouventin *et al.* 1985). (5) Marion I. live birds; methods unknown (Schramm 1983).

		MALES	FEMALES
WING	(2)	261.2 (4.96; 15)	260.6 (5.69; 14)
8TH P	(1)	167.5 (3.50; 162-174; 14)	169.5 (5.38; 163-180; 15)
TAIL	(2)	103.2 (5.02; 15)	102.9 (5.50; 14)
BILL	(2)	27.6 (1.12; 15)	26.8 (1.2; 14)
BILL D	(3)	12.1 (0.42; 15)	11.7 (0.46; 14)
BILL W	(2)	10.7 (0.34; 15)	10.3 (0.39; 13)
TARSUS	(2)	38.9 (1.61; 15)	38.4 (1.64; 14)
TOE	(2)	47.8 (1.38; 14)	47.7 (2.27; 14)
UNSEXED			
WING	(3)	258 (8; 246-272; 26)	
	(4)	259 (8; 231-275; 33)	
	(5)	257 (6.4; 239-272; 121)	
BILL	(3)	26.8 (1.4; 25.0-30.5; 26)	
	(4)	27.0 (1.4; 25.0-30.5; 26)	
	(5)	26.7 (1.47; 23.0-36.6; 118)	
TARSUS	(3)	38.4 (1.5; 34.0-41.2; 26)	
	(4)	38.5 (1.5; 35.5-41.0; 33)	
	(5)	39.5 (1.24; 36.5-42.0; 121)	

Information on growth of chicks in Schramm (1983), Jouventin *et al.* (1985). Additional measurements in Paulian (1953) and Swales (1965).

WEIGHTS (1) Iles Kerguelen, age unknown but chicks excluded (Mougin 1985). (2) Iles Crozet, age unknown but chicks excluded (Jouventin *et al.* 1985). (3) Marion I., adults, Apr. 1979-June 1980, Sept. 1980 (Schramm 1983). (4) Gough I., including 35 juveniles (Swales 1965). (5) Aust. beachcasts (Brown *et al.* 1986). No information on seasonal weight changes. Information on growth of chicks in Schramm (1983), Jouventin *et al.* (1985).

		UNSEXED
(1)		309 (21; 276-350; 14)
(2)		331 (40; 210-400; 29)

- (3) 357 (43.2; 255-451; 126)
 (4) 294 (220-365; 136)

	MALES	FEMALES
(5)	246 (31.9; 12)	230.3 (33.58; 12).

STRUCTURE Wing, long and narrow. Eleven primaries, p10 longest, p11 minute, p9 0-7, p8 9-22, p7 27-42, p6 42-68, p5 61-76, p4 83-110, p3 104-136, p2 125-158, p1 140-167. Twenty-one secondaries. Tail, rounded; 12 feathers, t1-t6 23. Head, large with steep forehead; large eyes contribute to somewhat owl-like appearance. In front of nostril tubes, bill, short and narrow; nostril tubes c. one-quarter length of bill. Maxillary unguis, large, strongly hooked; mandibular unguis, downcurved. Tarsus, rounded. Middle and outer toes about equal, inner c. 83%, hind toe (claw only) 10%.

GEOGRAPHICAL VARIATION None known. Measurements of tarsus from Gough I. (Swales 1965) considerably smaller than any from elsewhere; this applies to other species in that report; so, probably related to method of measuring. Imber (1984, 1985) and Meredith (1985) discuss grounds for placing *P. brevirostris* in monotypic genus *Lugensa*.

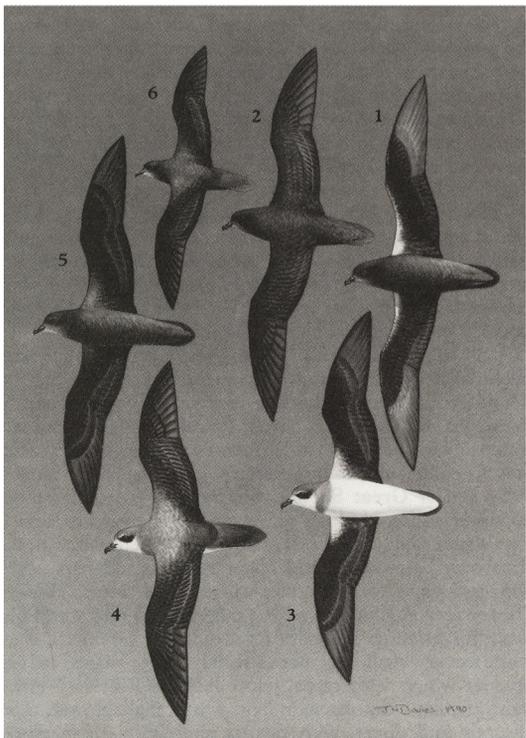
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Volume 1 (Part A), Plate 33

Kerguelen Petrel *Pterodroma brevirostris*

- 1. Adult, ventral
- 2. Adult, dorsal

Soft-plumaged Petrel *Pterodroma mollis*

- 3. Adult, light morph, ventral
- 4. Adult, light morph, dorsal, worn
- 5. Adult, dark morph, ventral
- 6. Adult, dark morph, dorsal

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