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 Diomedeidae. 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 longirostris Stejneger's Petrel

Aestrelata longirostris Stejneger, 1893, *Proc. US natn. Mus.* 16: 615–38 — Mutsu, northern Honshu, Japan.

Named for length of bill.

MONOTYPIC

FIELD IDENTIFICATION Length 26–31 cm; wingspan 53 cm. Small gadfly petrel of Cookilaria group. Grey above with darker crown, nape, upperwings and tail. Forehead and anterior crown, white, contrasting with blackish grey hindcrown and nape. Underparts, white; underwing, white with inconspicuous blackish diagonal bar from carpal joint across secondary coverts. Very similar to Pycroft's Petrel *P. pycrofti* and Gould's Petrel *P. leucoptera*. Sexes alike. No seasonal changes. Immatures similar to adults.

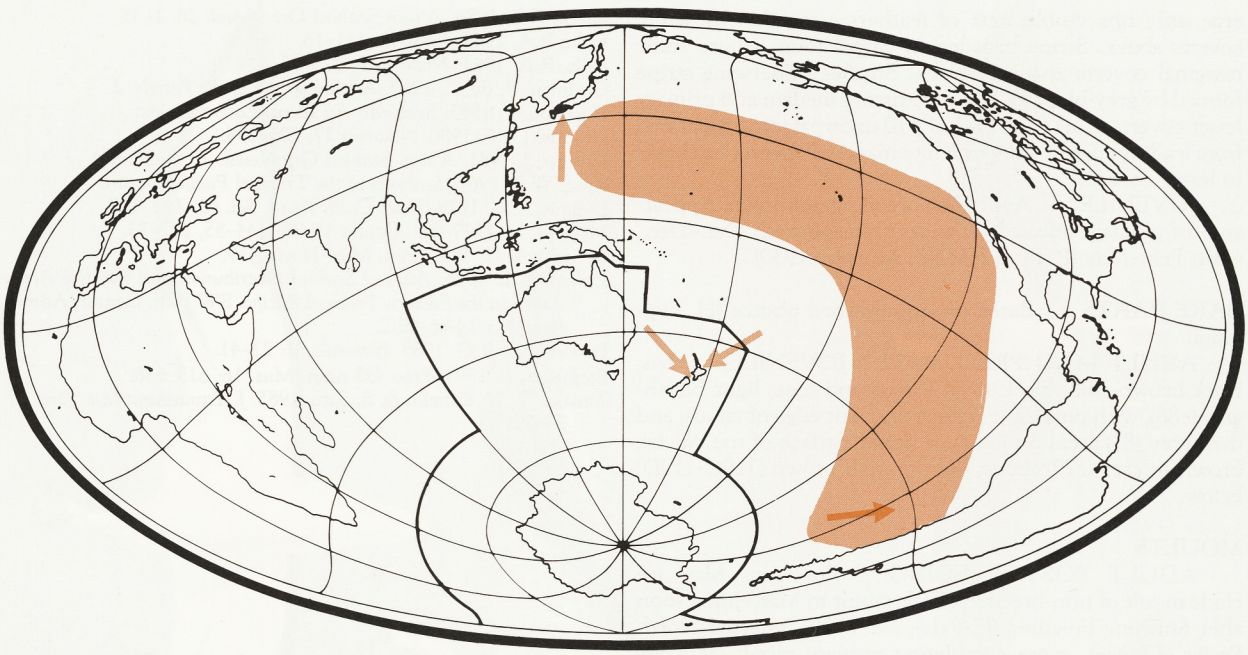
DESCRIPTION ADULT. Forehead, lores and forecrown, white, only slightly mottled along median line and on crown to level of eyes, as black-based centres to feathers hardly show. Crown and nape, blackish neutral-grey extending forward to join blackish suborbital patch and contrasting with medium neutral-grey back. Upperwing, brownish black; blackish outer primaries, greater coverts and rump form indistinct open M-mark from wing-tip to wing-tip. Inner webs of primaries, light grey fading to white at base and centre. Lower rump and upper tail-coverts, grey; tail, brownish black. Inner webs of outer rectrices vary somewhat but tend to be heavily mottled with grey. Underparts from chin and cheeks to under tail-coverts, white; grey feathers extend from mantle some distance onto sides of breast, to form conspicuous patch. Underwing, white except for narrow band of dark feathers along anterior edge of underwing near carpal flexure and extending onto secondary coverts as inconspicuous bar. Bill, black. Iris, brown. Legs and feet, pale blue, dark grey on outer toes, joints, and claws. IMMATURE. Similar to adult but mantle and back greyer, contrasting more with dark nape.

SIMILAR SPECIES Sea-range of Stejneger's Petrel overlaps with most Cookilaria petrels, but has not yet been reported from w. Tasman Sea. Stejneger's Petrel differs from all other Cookilaria petrels in having white extending high up forehead and forecrown; generally about 16 mm from base of bill, with further 7 mm of mottling. Most similar species, **Cook's** *P. cookii* and **Pycroft's Petrels**, show same underwing pattern and foot colour as Stejneger's Petrel. Identifying these species at sea is difficult. Differ mainly in head and back markings. Best feature for identifying Stejneger's Petrel is dark crown and nape, accentuated by extensive white forehead and contrasting paler grey back. Also look for long tail. Facial pattern of Pycroft's Petrel also differs in having poorly defined white stripe above eye, which otherwise surrounded by light grey feathers, except for conspicuous patch of dark below and in front of eye (in Stejneger's, eye entirely surrounded by blackish feathers, especially extensive below and behind eye). Cook's Petrel has longer bill and much paler crown and nape, not contrasting with mantle and back. M-mark across upperwing more prominent in Cook's Petrel. Other plumage differences include: white wedge on outer primary less defined in Stejneger's than in Cook's, but more defined than in Pycroft's, thus being intermediate between these extremes; inner webs of outer rectrices resemble Gould's Petrel *P.l. leucoptera* rather than Cook's and Pycroft's Petrels, latter having white inner webs peppered with grey. Mainly white underwing separates Stejneger's Petrel from **Gould's**, **Collared** *P. brevipes*, **Black-winged** *P. nigripennis*, **Chatham** *P. axillaris* and **Bonin** *P. hypoleuca* **Petrels**; latter four species also typically have bicoloured pink and black feet (cf blue in Stejneger's, Gould's, Cook's and Pycroft's Petrels). Crown and nape markings of Gould's Petrel resemble those of Stejneger's Petrel but former has blacker and more extensive crown and nape-patch almost encircling upper breast and with less white on forehead.

Behaviour at sea not described; flight said to be much as Cook's Petrel (Harrison 1983). Nocturnal at breeding colonies; in Jan.–Feb., birds return in evening, when first heard calling between 21:40–22:10, continuing till about 06:00. Only call reported, high-pitched, rapid *ti-ti-ti* similar to calls of Great-winged Petrels (Brooke 1987).

HABITAT Marine, pelagic; in subtropical and high-salinity tropical waters of s. Pacific Ocean (Ainley & Boekelheide 1983); in non-breeding season, migrate to subtropical North Pacific, where observed off Japan in vicinity of warm Kuroshio Current (Tanaka *et al.* 1985). Pelagic (King 1967).

Breed only Juan Fernandez Is off S. America, burrowing on slopes and ridges, 850–1100 m asl, under dense fern forest (*Dicksonia externa*); in mixed colonies with Juan Fernandez Petrels (Brooke 1987).



DISTRIBUTION AND POPULATION Breed se. Pacific Ocean on Isla Alejandro Selkirk, Juan Fernandez Grp; winter subtropical North Pacific Ocean. Accidental to NZ; no records Aust. Distribution not well known. During breeding season, populations concentrated round colonies but range not known. Non-breeding distribution North Pacific Ocean between Japan and w. USA, with most records in subtropical nw. Pacific, June to Nov. Specimens and sightings away from breeding colonies few: two before 1893, Mutsu, n. Honshu, Japan (Stejneger 1893); two before 1910, Bonin Is, Japan (Godman 1910); five collected, North Pacific, 600 miles E of Honshu, 1930 (Murphy 1930); one beachcast Kyoto, 20 Sept. 1972 (Yamashina Institute for Ornithology); one collected central North Pacific, June 1976 (Kanagawa Prefectural Museum). In ne. Pacific Ocean, five specimens collected 700 miles W California (Loomis 1918); no confirmed sightings e. tropical Pacific 1974–84 (Pitman 1986). Unverified sightings near Tonga, June–July (Jenkins 1980).

NZ Probably rare summer visitor, non-breeding birds. Seven records, all beachcast: one at Baring Head, Cook Str., 3 Dec. 1961; two at Ohope Beach, Bay of Plenty, 5 Jan. 1962; Wanganui, near Turakina, Nov. 1963; three on Ninety Mile Beach, Auckland West, Dec. 1983 (Falla 1962; Powlesland 1985; NZCL).

Breed Isla Alejandro Selkirk, Juan Fernandez Grp. Estimated population 131 000 pairs; predation by feral cats of concern (Brooke 1987); in mixed colonies with Juan Fernandez Petrels, cats preferentially take Stejneger's Petrels (Brooke 1987).

MOVEMENTS Trans-equatorial migrant to North Pacific from breeding grounds in Juan Fernandez Is. Dates of arrival and departure unknown but frequent observations near breeding colonies Oct.–Apr. (Harrison 1983; Brooke 1987) as far S as 49°S (Clark 1986) and present nw. Pacific E of Japan June–Nov. (Tanaka *et al.* 1985; K. Nakamura). Records from NZ Nov.–Jan. (Falla 1962; Jenkins 1981) probably reflect wide dispersal of non-breeders.

PLUMAGES

ADULT (Definitive basic). HEAD AND NECK. Forehead, lores, chin and throat, white. Feathers of forehead, dark grey (brownish 83) with broad white tips; wear of tips can make forehead look speckled dark grey. Crown, hindneck and eye-patch, brownish black (greyish 119), forming rather distinctive cap. Sides of foreneck, dark grey, forming small varying half collar; white triangular wedge in lower throat between foreneck and ear-coverts. UPPERPARTS. Mantle, back and most scapulars, dark grey (83); feathers, dark grey (83) merging to concealed white bases, broad grey (87) subterminal bands, and very narrow white tips, which are rapidly lost with wear. Wear of tips and subterminal bands reveals more dark grey (83), making contrast of cap slightly less striking. Longest scapulars and narrow band across rump, grey-black (82), forming part of open M-marking. Upper tail-coverts, grey (87), with narrow white tips, lost with wear. TAIL. Upperside, mostly grey-black, merging to grey (84) on outer tail feathers. Outermost tail feather (t6) has white inner edge, widest at base. Width of white inner edge apparently greater when feathers worn; t6 has white tips in at least some birds with fresh plumage. UPPERWING, black-brown (c19); outer primaries and greater coverts, blackish, forming part of open M-marking from wing-tip to wing-tip. In fresh plumage, light-grey (85) gloss found on secondaries, secondary coverts, outer edge of inner primaries and median coverts. Gloss becomes grey (84) with moderate wear, and eventually lost, feathers becoming black-brown (c19); grey gloss retained longest in secondary coverts. Mayaud (1949–50) describes the microstructural damage causing similar colour change in *P. leucoptera*. Primaries have broad white wedge on inner edge, extending to near tips; this usually concealed, and only visible part of inner web is blackish distal third. UNDERPARTS, white, save for grey (87) sides to uppermost breast, forming part of half-collar. UNDERWING, mostly white. Remiges have dark grey (83) to grey-black (82) tips. Narrow grey-black (82) underwing stripe near leading-edge of wing, from carpal joint to near humerus, formed by grey-black (82) secondary lesser cov-

erts; only tips visible, rest of feathers concealed by white coverts above. Stripe broadest at carpal joint, where some marginal coverts also grey-black. Smaller underwing stripe formed by grey-black (82) tips to primary median and primary lesser coverts, runs from base of p10 to carpal joint; separated from leading edge of wing by white marginal coverts and bases to lesser coverts.

JUVENILE Age of first breeding unknown. Appearance of plumage affected by wear; plumage fresh Oct.–Dec., worn Feb.–May (P. Pyle; NMNZ; Murphy 1930).

BARE PARTS Based on unpublished photos (H. Fujimora).

ADULT (AND PRESUMABLY JUVENILE) Iris, black-brown. Bill, black (89). Tarsus and toes, light bluish-grey (c88), with pinkish (c7) tinge on front edge of tarsus, and dark-grey (83) areas on joints of upper surface of toe. Webs, brownish grey (c79) above, light greyish brown (119C-119D) below.

MOULTS

ADULT POST-BREEDING Pre-basic. May include moult of non-breeders. Peak moult in Mar.–June, soon after finishing breeding (P. Pyle); five birds collected North Pacific, 17 Aug., were completing primary moult (Murphy 1930), still in body moult (Loomis 1918) and moulting outer tail-feathers (Falla 1942). Moult recorded as late as Nov. (NMNZ). Complete; primaries outwards; at least five primaries may grow at one time (photo by H. Fujimora). Adults collected in Juan Fernandez Grp 25 Nov. 1965 had new primaries.

POST-JUVENILE NZ beachcast on 5 June (NMNZ) with primary moult $N^{9}4^{1}$ may have been juvenile.

MEASUREMENTS Throughout range, juveniles excluded, skins (NMNZ). Other measurements in Loomis (1918), Murphy (1930), Brooke (1987).

	UNSEXED
WING	214.1 (8.07; 198–220; 7)
8TH P	148.3 (6.07; 142–159; 8)
TAIL	101.2 (3.77; 97–107; 5)
BILL	23.9 (1.18; 22.8–25.8; 5)
TARSUS	28.3 (1.43; 26.3–30.1; 5)
TOE	34.2 (2.29; 31.3–36.9; 4)

WEIGHTS One NZ beachcast 88 g. No other information.

STRUCTURE Wing, long and narrow. Eleven primaries, p10 usually longest, 0–1, p9 0–5, p8 8–13, p7 19–27, p6 34–42, p5 51–62, p4 72–81, p3 90–99, p2 109–115, p1 120–127. Fifteen secondaries, excluding tertials. Tail, strongly rounded; 12 feathers, t1-t6 21–25. Bill, short and slender, nostril tubes about quarter of length of bill. Tarsus, rounded. Outer toe *c.* 1 mm longer than middle, inner *c.* 6 shorter. Hind-toe consists of claw only.

RMO

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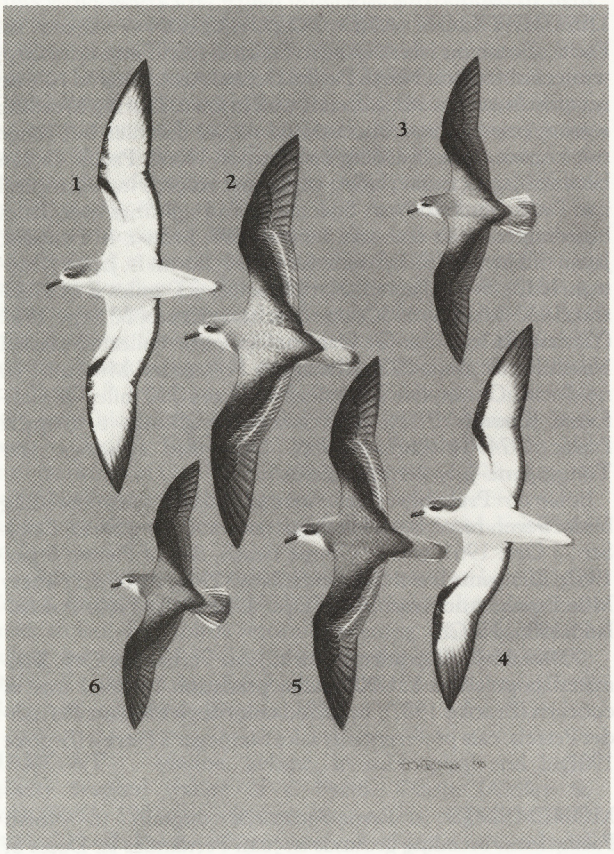
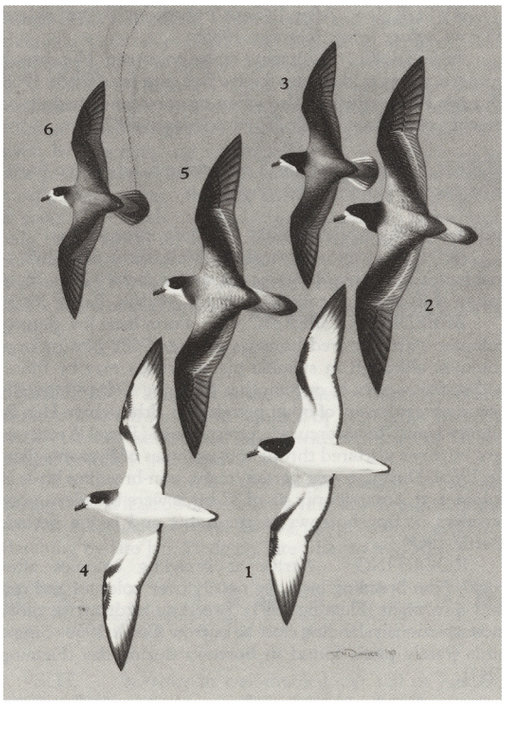


Plate 37

Cook's Petrel *Pterodroma cookii*
1. Adult, ventral, fresh
2. Adult, dorsal, fresh
3. Adult, dorsal, worn

Pycroft's Petrel *Pterodroma pycrofti*
4. Adult, ventral, fresh
5. Adult, dorsal, fresh
6. Adult, dorsal, worn



Volume 1 (Part A), Plate 38

Gould's Petrel *Pterodroma leucoptera* Subspecies *caledonicus*
1. Adult, ventral, fresh
2. Adult, dorsal, fresh
3. Adult, dorsal, worn

Stejneger's Petrel *Pterodroma longirostris*
4. Adult, ventral, fresh
5. Adult, dorsal, fresh
6. Adult, dorsal, worn