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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 Pelecaniformes. 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 fedges 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 pycrofti Pycroft's Petrel

COLOUR PLATE FACING PAGE 496

Pterodroma longirostris pycrofti Falla, 1933, Rec. Auck. Inst. Mus. 1: 176 — Taranga, Hen Island, New Zealand.

Named in honour of A.T. Pycroft (1875–1971) of Auckland Museum.

MONOTYPIC

FIELD IDENTIFICATION Length 28 cm; wingspan 53 cm. Small compact grey-and-white gadfly petrel of Cookialaria group. Virtually identical to Cook's Petrel *P. cookii*, but jizz subtly different: slightly smaller, with shorter wings, longer slightly more wedge-shaped tail and shorter more delicate bill; Pycroft's, Cook's and Stejneger's Petrel *P. longirostris* have similar pattern of underwing: mostly white with narrow dark-grey margins, widest at carpal joint, with narrow diagonal dark carpal-bar across inner wing-lining. Sexes alike; no seasonal variation. Juveniles inseparable.

DESCRIPTION ADULT. Forehead, grey, with white margins to feathers, giving scaled or freckled appearance; crown and nape, dusky grey, contrasting with slightly paler mantle and back; indistinct white supercilium. Dark-grey sub-

orbital patch from in front of eye to rear of ear-coverts. Grey of hindneck and mantle extends down onto sides of neck and upper breast forming dusky half-collar. Mantle, back and upper tail-coverts, medium-grey. Tail, grey with black tips; when spread, white inner webs of two outermost pairs of rectrices form white strip on either side. Upperwings, brownish black with indistinct open M-mark from wing-tip to wing-tip, joining across rump. Appearance of upperparts alters with wear, reducing contrast of dorsal pattern; may appear hooded with little or no contrast between head, hindneck and mantle; tail darkens to brownish black; upperwings become more uniform and M-mark less prominent. Underbody, white except for dusky half-collar. Underwing: remiges blackish, forming narrow dark trailing-edge and tip sharply demarcated from mostly white lining. Lining, white except for narrow dark leading-edge between carpal joint and base of outermost primary and narrow black diagonal carpal bar tapering inward from carpal joint, to point behind elbow. At distance, underwing appears white. Bill, black. Iris, dark brown. Legs and feet, pale violet-blue with dark grey on outer toes, joints and claws.

SIMILAR SPECIES Cook's Petrel closely similar and virtually indistinguishable at sea; with experience, subtle differences in size and shape may separate Cook's, which is slightly larger, with slightly longer wings, shorter tail and slightly longer bill. Much overlap in plumages: in fresh plumage, forehead whiter, crown paler, head and neck, uniform with mantle and back and upperwings, greyer; M-mark more prominent and clearly defined. When worn, plumages closely similar. Gould's and Stejneger's Petrels have striking contrast between blackish or dark-grey crown and nape (which form neat black cap), and white forehead. Black-winged Petrel *P. nigripennis*, Chatham Petrel *P. axillaris*, and Gould's Petrel *P. leucoptera* all have more black on underwings.

Extremely rare; pelagic distribution unknown. Said to be trans-equatorial migrant to North Pacific, but no published records outside NZ waters. Behaviour at sea unknown; assumed to be similar to Cook's and Pycroft's Petrels (Roberson & Bailey in press). Breed in small colonies off e. coast of n. NZ; at low densities, often with other petrels. Give noisy calls over breeding colonies, either chirping high-pitched zip-zip or strident low-pitched te-te; usually quiet on surface but call from burrows.

HABITAT Marine; rarely observed at sea and no knowledge, at present, of marine habitat.

Breed on offshore islands along e. coast NI, NZ; in valleys, and on saddles, sea cliffs and coastal slopes, up to 140 m asl; burrow in well-drained soft soil or humus, under mature *Metrosideros excelsa* forest. Birds may nest among Great-winged Petrels but excluded from areas where density of Fairy Prions or Buller's Shearwaters high (Bartle 1968).

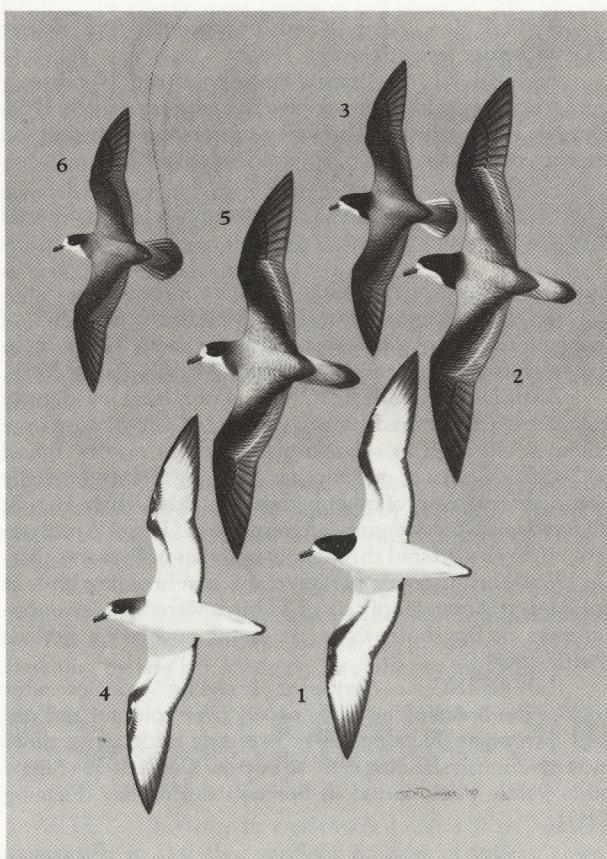


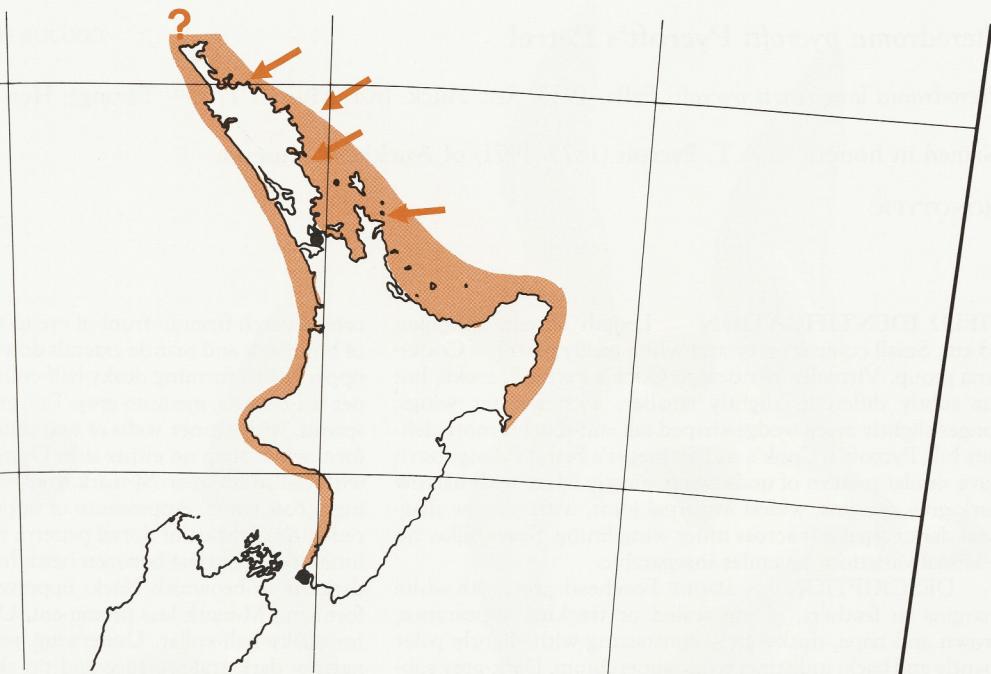
Plate 38

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



DISTRIBUTION AND POPULATION Distribution at sea unknown. Breeding restricted to islands off ne. coast of NI, NZ. Few beachcast specimens recorded; generally off ne. coasts of NI. Said to be transequatorial migrant; one record in North Pacific (Bartle *et al.* in press).

AUST. No confirmed records. One unconfirmed report, c. 320 km S of Lord Howe I. (34°03'S, 159°39'E), 29 Jan. 1977 (Harrison 1978).

NZ No reliable sight records. Few beachcasts, mostly between C. Maria van Dieman and Tauranga and to Wellington West region (Bartle 1968; Powlesland 1986). Since 1964, regular beach patrols have recovered 20 specimens, all on NI beaches, generally N of 37°S. Auckland West beaches, nine; Auckland East, seven; Bay of Plenty, two. Single also from East Coast and Wellington West (Powlesland 1987). Between 1960 and 1984, one specimen was recovered for every 2500 km of beach patrolled (Powlesland 1987). One collected, Kermadec Is, 1898 (AMNH 528249).

BREEDING From Bartle *et al.* (in press) unless stated: Stephenson I. (<10 pairs); Poor Knights Is (<10 pairs; Buddle 1941; Bartle 1968); Hen and Chickens Is (Hen I., 100 pairs [Skegg 1964; Bartle 1968]; Big Chicken I.; Marotiri [Skegg 1964; Merton & Atkinson 1964; Dunnet 1985]; Middle Chicken I. [Skegg 1964; Merton & Atkinson 1964]); Mercury Is (<300 pairs; Red Mercury); Korapuki (J.A. Bartle; Skegg 1963; Bartle 1968). Entire breeding population no more than 300 pairs of total population of <2000 birds (J.A. Bartle). Previously bred Norfolk I., extinct since c. 1800 (Bartle *et al.* in press).

Status, vulnerable. Only terrestrial predators are Tuatara *Sphenodon punctatus* and Polynesian Rats *Rattus exulans* (Bartle 1968).

MOVEMENTS No records away from NZ waters but may migrate to n. Pacific.

DEPARTURE Fledges Hen and Chickens Is, NZ, ≤23 Mar.-12 Apr. (Dunnet 1985).

NON-BREEDING Unknown.

RETURN After 29 Sept. but before 25 Oct., at least 38 days before laying (Dunnet 1985).

BREEDING Foraging range unknown. Non-breeders particularly evident at colonies Dec. and Jan. (Bartle 1968; Dunnet 1985), which is also when most birds washed up on beaches of e. coast of NI, NZ (Powlesland 1987).

FOOD Remains of small cephalopods have been found in stomachs. No other information.

SOCIAL ORGANIZATION Little information.

BONDS No information. Male takes first shift of incubation while female leaves colony for about 9 days. Incubation shift may last continuously for 14 days (Bartle 1968).

BREEDING DISPERSION Form local low-density colonies with scattered burrows (Bartle 1968). Not in large colonies, although in suitable places groups may be found within few metres of one another (Fleming 1941). Generally occur where density of other petrels low, although on Hen & Chicks Is and Red Mercury I., Great-winged Petrel *P. macroura* burrows scattered throughout colonies of Pycroft's (Bartle 1968). During laying period, many non-breeding birds at colonies; at Aorangi only six of 32 birds were breeders; non-breeders occupy burrows in pre-laying and laying periods (Bartle 1968).

ROOSTING Arrive at breeding colonies after 20:30. Non-breeding birds fly noisily over colonies and call well into night (Fleming 1941). Breeding birds arrive more inconspicuously, landing close to burrow (Bartle 1968). Single birds (rarely pairs) found in burrows during day (Fleming 1941).

SOCIAL BEHAVIOUR No information. Fleming (1941) speculated about evening mating flights where birds circled high above vegetation accompanied by continuous cry; Bartle (1968) observed unemployed birds flying over colony in high wide circles, calling loudly and almost continually. Paired birds observed following each other about, within 6 m of

freshly cleaned burrow. Accompanied by low crooning. When together, seen billing and pecking each other's heads (Fleming 1941).

VOICE Reasonably well known; detailed descriptions in Bartle (1968) on which account based; additional information in Sibson (1949). Usually silent at sea except when approaching breeding colonies at night; noisy at colonies during breeding season, mostly calling in flight over colonies and, less commonly, from ground (on surface and in burrows). Most common call, high-pitched *ti-ti-ti*... (Fleming 1941; Sibson 1949; Bartle 1968). Bartle (1968) describes seven calls, two flight calls and five given from ground. Most aerial calling by non-breeding birds; breeding birds not known to call in flight and usually silent on ground, though call from burrows. Strictly nocturnal at colonies, birds arriving c. 20:30; when flying to colonies, can be heard calling from some distance away; quieter over colonies; most birds leave before 02:00 and little calling heard after this time; usually leave colonies silently. Flight-call similar to that of Cook's Petrel but softer and less staccato (Sibson 1949). No information on individual or sexual differences; harsher and louder flight-call suggested to be call of female (Fleming 1941) though Bartle (1968) heard it from non-breeding males and females.

ADULT **FLIGHT-CALLS.** (1) High-pitched cicada-like *ti-ti-ti*..., or *zip-zip*; most common call given, c. 70% of calls heard. Birds call almost continuously and loudly in flight, including Courtship Flights. (2) Similar in structure and frequency to (1) but harsher and louder, sounding like *te-te-te*.... **GROUND-CALLS.** (3) Quiet shearwater-like crooning, sometimes uttered with growling or grunting (see below) or followed by grunting by other member of pair (Fleming 1941); given by breeding and non-breeding birds in burrows; at change-over during incubation and by single birds on surface, shortly after landing. (4) Single birds sometimes utter a growl or grunt. (5) A harsh strangled screech uttered by single birds; only heard twice. (6) Harsh series of squawks given from burrows when birds disturbed; often caused by observer walking over burrow. (7) Loud harsh shearwater-like growling cackle heard once from a group of five non-breeding birds on ground.

YOUNG No information.

BREEDING Poorly known. Studies by Bartle (1968) and Dunnet (1985). Information supplied by J.R. Starks. Breed in small colonies, sometimes mixed with burrows of Great-winged Petrels *P. macroptera*.

SEASON Broadly, Oct. to Apr. Return to colonies during Oct., at least 38 days before laying. Pre-laying exodus of both sexes for about 14 days. Laying, late in Nov. to early Dec. Hatching by late Jan. Fledging, late Mar. to mid-Apr.



SITE Burrows in well-drained soft soil or humus, occasionally in stiff clay; on floor or sides of valleys, steep slopes above shore at low elevations, mostly below 150 m asl. Most burrows in forest of pohutukawa *Metrosideros excelsa*, mahoe *Melicytus ramiflorus* or kanuka *Dysoxylon spectabile*. Leaf-litter hides entrances of burrows of breeding birds, which may be hard to find, but burrows of non-breeding birds often betrayed by freshly dug soil at entrance; sometimes pro-

tected by stones and large rocks. Burrows may wind among rocks and roots of trees (Fleming 1941). Dimensions: entrance, about 12x12 cm; length, average 75 cm (30–130); nest-chamber, about 45 x 30 x 15 cm (length, width, height) (Bartle 1968). Used year after year; new burrows not often found. At one burrow, male alone excavated, though female present at same time.

NEST, MATERIALS Claimed to be well built of leaves and grass (Fleming 1941) but only varying amounts of dead leaves and not well built seen by Bartle (1968).

EGGS Ovoid; smooth-shelled, mat; white. **MEASUREMENTS:** 48.3 (1.64; 46–52; 27) x 35.1 (1.48; 32–39); 48.9 (1.45; 45–50; 22) x 34.8 (1.67; 32–36). **WEIGHTS:** 31.9 (2.46; 25.5–35.5; 19).

CLUTCH-SIZE One.

LAYING Synchronized: 21 Nov.–10 Dec., mean 29 Nov. (Bartle 1968); 20 Nov. to 3 Dec., but some laid 6 Dec. or later (Dunnet 1985). Laid at night, soon after female returns; once between 22:15 and 01:00.

INCUBATION By both sexes. Females for short period after laying; then male for 10–14 days. If not relieved by male, female may sit for up to 5 days before leaving. Incubation may be intermittent, particularly by female; eggs may be deserted for several days and are liable to be knocked out of nest or deserted (Bartle 1968). **INCUBATION PERIOD.** About 45 days.

NESTLING Semi-altricial, nidicolous. Left alone in burrow a few days after hatching. Assumed to be fed by both parents, by incomplete regurgitation. Maximum weight about 250 g, 15 days before fledging; not fed for about a week before fledging; weight at fledging about 175 g (156–188) (Dunnet 1985). **NESTLING PERIOD.** About 80 days (77–84) (Dunnet 1985). Young independent at fledging.

SUCCESS Of 18 eggs, 13 (72%) hatched but generally loss of eggs high, by desertion or accidental removal from burrow. Of 12 burrows studied, six successfully reared a chick. Tuataras *Sphenodon punctatus* prey on eggs, young and perhaps adults or simply interfere with breeding by sharing burrows. No further information.

PLUMAGES

ADULT Age at first breeding unknown. **HEAD AND NECK.** In fresh plumage, hindcrown, dark brown (121), fringed grey (84); forecrown, fringed white; white fringes wider above eye, forming indistinct supercilium. Front of lores, cheeks and ventral side of neck, white. Rear of lores, in front of eye, grey-black (82). Feathers of hindneck and ear-coverts, dark brown (121), narrowly tipped grey (84); extend as narrow margin under eye. **UPPERPARTS.** Mantle and back, pale dark-brown (121), fringed grey (84); concealed bases of feathers, white, evident when feathers displaced. Fringes on upper mantle progressively widen towards lowermost mantle. Scapulars, black-brown (119) with rounded tips to webs. Rump, black-brown (119) with dark-brown (121) fringes. Upper tail-coverts, grey (84) with light-grey (85) fringes. **UNDERPARTS,** almost entirely white. At upper breast, incomplete collar; colour of feathers continuous with upper mantle, though fringes white and narrow. On lower flanks, feathers varyingly mottled or tipped brown-grey (79); rachis varies from entirely white to grey-black (82). Thighs, white and occasionally mottled grey (84). Under tail-coverts and axillaries, white; under tail-coverts, long, almost equal in length to tip of t1. Most of outer web, on t3–t6, grey (84) and varyingly speckled white near shafts, but not forming shaft-streak. Inner webs

similar but less speckled. T1-t3, grey (84), and pale dark-brown (121) on distal quarter; distal tip forms slight tail band. **UPPERWING.** Basal half of inner webs of remiges, dark brown (121) suffused with white; distal half merging to black-brown (119). Primaries, greater primary coverts and alula, black-brown (119). Marginal, lesser and median coverts, similar. Greater coverts, black-brown (119), narrowly fringed pale grey (86). Primaries extend 8–30 mm beyond tip of tail. Secondaries, black-brown (119) with light grey (85) shade; outer webs, edged white. Tertiaries and tertial coverts, black-brown (119). **UNDERWING.** All coverts, except at leading-edge of wing, white. Near humeral joint, marginal and lesser under wing-coverts, white and varyingly tipped dark brown (121). Near carpal joint, and extending to base of primaries, these feathers, black-brown (119). Most lesser upper wing-coverts, broadly fringed white; fringes narrow on marginal coverts near carpal joint, and most prominent here. In worn plumage, fringes on forecrown reduced, similarly on greater upper wing-coverts. Greater and median upper wing-coverts, dark brown (119A).

DOWNTY YOUNG Undescribed. Fleming (1941), describes downy young as having protoptile and mesoptile, both being dense, dark in colour and darker than in Cook's Petrel.

JUVENILE Probably indistinguishable from adult in fresh plumage.

BARE PARTS

ADULT Iris, dark brown (219). Bill, black (89). Legs and feet, light violet (170C); outer tarsus and toes, joints, and claws, dark grey (83).

DOWNTY YOUNG, JUVENILE Undescribed.

MOULTS Undescribed; occurs away from breeding grounds.

MEASUREMENTS (1) Adult skins (NMNZ).

	MALES	FEMALES
WING	(1) 213.3 (3.29; 209–217; 3)	219.5 (3.49; 214–226; 7)
8TH P	(1) 136.0 (7.25; 126–143; 3)	140.1 (3.40; 135–144; 8)
BILL	(1) 24.5 (0.33; 24.2–25; 3)	24.6 (0.66; 23.6–25.5; 7)
TARSUS	(1) 29.2 (1.22; 27.5–30.2; 3)	28.7 (1.10; 27–30.4; 7)
TAIL	(1) 89.0 (4.0; 85–93; 2)	94.3 (3.31; 89–100; 8)
TOE	(1) 35.8 (1.68; 34.1–38.1; 3)	36.2 (1.14; 34.2–37.6; 5)

Unsexed birds: (2) Live adults, Double I., Mercury Is, 1–5 Nov. 1988 (A.J.D. Tennyson).

	UNSEXED
WING	(2) 218.2 (4.75; 207–229; 30)
BILL	(2) 24.3 (0.84; 22.5–25.8; 30)
BILL D	(2) 10.0 (0.25; 9.6–10.6; 30)
BILL W	(2) 8.78 (0.40; 7.7–9.6; 30)
TARSUS	(2) 29.2 (0.79; 26.9–30.8; 30)
TAIL	(2) 94.7 (3.34; 88.3–102.5; 30)
TOE	(2) 35.8 (1.17; 33.6–37.7; 30)

Females slightly larger than males.

WEIGHTS (1) Adult skins, sexes combined (NMNZ). (2) Hen I., Dec.–Jan. 1962–63 (Bartle 1968). (3) Aorangi I., Nov.–Dec. 1964; (Bartle 1968).

(1)	152.7 (12.8 127.5–201.0; 30)
(2)	157.8 (11.2; 135–180; 27)
(3)	159.6 (19.2; 128–198; 53)
(2,3)	159.0 (16.8; 128–198; 80)

Label data taken from adult skins (NMNZ): females 166.1 (8.97; 157.8–181.2; 4). Bartle (1968) found that incubating adults lost 3–4 g/day, over 15 days. Weight loss linear. Similarly, Dunnet (1985), estimated 2–11 g/day with average of 5.6 g (3.8% of average initial weight of 148 g). For details of weights in non-breeders, see Dunnet (1985). For details of changes in chicks, see Dunnet (1985).

STRUCTURE Wing, short and narrow. Eleven primaries: p10 longest, p9 1–5 mm shorter, p8 8–17, p7 20–31, p6 37–48, p5 55–68, p4 73–87, p3 91–104, p2 108–120, p1 120–134, p11 minute. No emarginations. Tail, moderately long and square; 12 rectrices, t1 longest, t6 17–26 mm shorter. Bill, slender and short. Nasal tube c. 25% of length of bill. Legs and feet, slender. Outer and middle toes, approximately equal in length. Inner c. 80% of middle, hind c. 11.

SEXING, AGEING Adults can be sexed on cloaca during breeding season (Bartle 1968). Bartle (1968) records brood patches in breeding and non-breeding adults. Dunnet (1985) provides further details.

GEOGRAPHICAL VARIATION Treated as subspecies of *P. longirostris* by Peters.

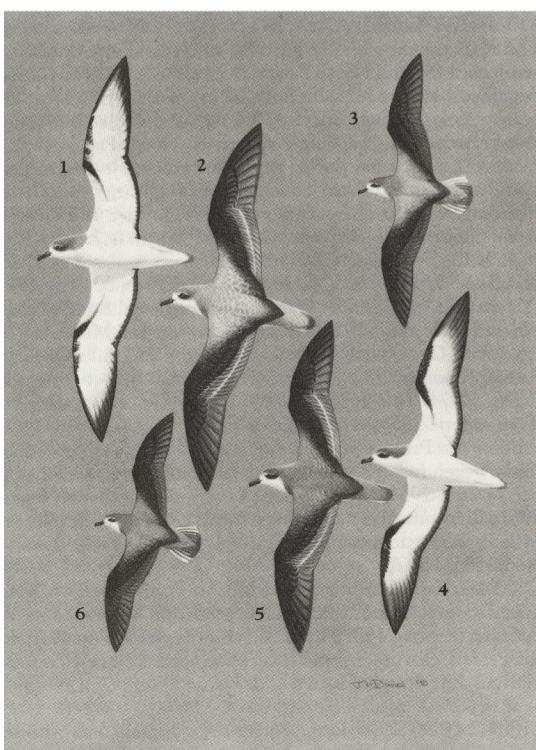
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Cook's Petrel *Pterodroma cookii*

- 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

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