

Order **PROCELLARIIFORMES**

A rather distinct group of some 80–100 species of pelagic seabirds, ranging in size from huge to tiny and in habits from aerial (feeding in flight) to aquatic (pursuit-diving for food), but otherwise with similar biology. About three-quarters of the species occur or have been recorded in our region. They are found throughout the oceans and most come ashore voluntarily only to breed. They are distinguished by their hooked bills, covered in horny plates with raised tubular nostrils (hence the name Tubinares). Their olfactory systems are unusually well developed (Bang 1966) and they have a distinctly musky odour, which suggest that they may locate one another and their breeding places by smell; they are attracted to biogenic oils at sea, also no doubt by smell. Probably they are most closely related to penguins and more remotely to other shorebirds and waterbirds such as Charadriiformes and Pelecaniiformes. Their diversity and abundance in the s. hemisphere suggest that the group originated there, though some important groups occurred in the northern hemisphere by middle Tertiary (Brodkorb 1963; Olson 1975).

Structurally, the wings may be long in aerial species and shorter in divers of the genera *Puffinus* and *Pelecanoides*, with 11 primaries, the outermost minute, and 10–40 secondaries in the Oceanitinae and great albatrosses respectively. The tail varies in length, being forked in *Oceanodroma*, forked to pointed in other forms, usually with 12 rectrices but up to 16 in fulmars. The tarsi are light and cylindrical in aerial forms; strong and laterally compressed with legs set far back in aquatic ones. The front toes are webbed; hind toe small or absent. The proventriculus is long and glandular; the gizzard small and twisted; and the small intestine often spiral in *Pterodroma*, presumably to aid absorption of the unusual lipids in their food. Chicks are helpless and covered in down, with two coats except in some Oceanitinae. Some larger species have a darker immature plumage, and the female is often darker than the male in the great albatrosses. The male is usually larger than the female, though smaller in the Oceanitinae and some other small species. Otherwise there is little difference in appearance with sex or age, except that young birds may have more pronounced pale or dark edges to the feathers. Many have simple counter-shaded markings that often appear to have given rise to uniformly dark or, less often, to pale derivatives; some species in most groups are dimorphic or polymorphic. The more complex groups have often developed distinctive markings of the extremities.

Breed more or less colonially on offshore islands, coastal cliffs, or on hills and deserts inland, where they perform complex vocal and aerial displays. The nest is a simple scrape or cup in a burrow or natural hole, sometimes under vegetation. The s. albatrosses build large cone-shaped nests in the open; may be lined with any debris available in the area. Smaller species visit it only at night, though larger ones and those breeding on remote islands may come to nests in the open by day. Parents incubate for spells of several days in turn and generally leave the chick alone soon after it hatches, only returning at long intervals to feed it by regurgitation. In consequence the chick is vulnerable to introduced predators and some species are now greatly reduced and at least two are now extinct. Some species also periodically liable to have unsuccessful breeding seasons. Many young or even old birds may be wrecked ashore and die when they meet bad weather or suffer shortage of food on migration or in the winter. Though it has been claimed that they are also vulnerable to all sorts of pollution, the evidence is weak (Bourne 1976). There is at present anxiety about the effect of some fishing methods, such as long-lining, which may be endangering species such as the great albatrosses.

All species feed at sea on a variety of fish, cephalopods and small marine invertebrates, either socially or alone; larger species may scavenge all sorts of offal or prey on other birds. Most, except perhaps *Pelecanoides*, can digest the complex lipids formed by some marine animals (Clarke & Prince 1976), and may eject them to soil the plumage of their enemies with lethal results (Swennen 1974). Some species can digest wax (Obst 1986). Many now take wastes from whaling and fishing operations (Fisher 1952). All have long life-cycles in proportion to their size; they disperse on fledging and then prospect for nest-sites for 2–12 years in their youth. They usually lay a single large white egg annually; though a successful breeding cycle may be completed in less than a year in at least one tropical species, *Puffinus lherminieri*, it may take 2 years in larger southern ones. Before laying, the birds court for weeks or months, then go to sea for feeding. Incubation lasts 6–8 weeks, and fledging 2–9 months. Once the fat chick fledges it fends for itself, even in species that immediately make a long migration, sometimes to the opposite hemisphere.

Tendency for failed breeders and non-breeders to begin moult before successful breeders. Five strategies of wing-moult in breeding adults: (1) In albatrosses, remiges replaced in staffelmauser interrupted while breeding; in nearly all other species, primaries moulted outwards; possibly simultaneously in some diving-petrels. (2) In most subantarctic and temperate species, moult begins soon after breeding and is completed shortly before next breeding season. (3) In most tropical species, moult aseasonal, between breeding attempts; resumption of breeding apparently depends on when moult completed. (4) In trans-equatorial migrants, wing-moult delayed until they reach non-breeding quarters, where it is completed; moult rapid but no satisfactory evidence for flightlessness. In

some species, body-moult also in winter quarters; in others, at breeding grounds. (5) In some species of high latitudes, rapid moult completed in summer when they breed; some begin moult long before breeding finished.

The history of the classification of the Order is very confused, as is seen by comparing Timmermann's (1965) discussion of their Mallophagan parasites with that by Klemm (1969) of their leg muscles and that by Harper (1978) of their proteins, but it is now widely agreed that the Order is best divided into four families: Diomedidae or large to huge aerial albatrosses; Procellariidae or medium-sized, mainly aerial but sometimes aquatic, petrels, shearwaters and prions; Hydrobatidae or small to tiny, aerial storm-petrels; and Pelecanoididae or small aquatic diving-petrels.

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Family PROCELLARIIDAE fulmars, petrels, prions, shearwaters

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

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

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

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

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

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

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

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

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

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Pterodroma cervicalis **White-necked Petrel**

COLOUR PLATE FACING PAGE 488

Oestrelata cervicalis Salvin, 1891, Ibis: 192 — Kermadec Islands.

Specifically named for the striking white nape (*cervix* = the back of the neck with the parts touching it).

OTHER ENGLISH NAMES White-naped, Black-capped or Sunday Island Petrel.

MONOTYPIC

FIELD IDENTIFICATION Length 43 cm; wingspan c. 100 cm; weight 380–545 g. Large, black-capped grey-and-white gadfly petrel with diagnostic white hindneck collar. Noticeably slender, streamlined form of (1) long, rather

prominent black bill; (2) small rather flat-crowned head; (3) slender cylindrical body tapering to long narrow gently wedge-shaped tail (usually held folded, appearing pointed); and (4) long narrow sharply-pointed wings, giving rather

straight-winged jizz; general impression of large elongated, straighter-winged version of *Cookilaria* gadfly petrel. Sexes alike. No seasonal variation. Juveniles inseparable.

DESCRIPTION ADULT. Crown, nape and sides of head to just below eye, black forming small black cap, sharply demarcated from white forehead, lores and cheeks; separated from grey mantle by diagnostic broad white hindneck collar. At long range, white forehead, cheeks and hindneck more striking than black cap, giving white-headed appearance. Mantle, back and scapulars, medium-grey with narrow greyish-white fringes giving scaled appearance when close. Grey of mantle extends down sides of neck to just below level of cap, forming narrow half-collar. Rump, blackish. Upper tail-coverts, medium-grey, sometimes with white bases showing during moult. Tail, uniform medium-grey; when spread, two outer feathers, and basal half of next, form white strip on either side. Upperwings, mostly medium-grey with silvery bloom; pronounced blackish M-mark from wing-tip to wing-tip, joining across rump. Grey coverts along inner forewing, fringed white, matching scaled saddle; median and greater secondary coverts, fringed white, showing in close view, as thin pale 'tramlines' down innerwing. Appearance of upperparts markedly altered through wear, reducing contrast of dorsal pattern and scaled appearance of saddle; tail darkens to brownish black; upperwings become more uniform brownish black and M-mark barely apparent but some grey tone always retained along innermost forewing. Underparts, white except for grey half-collar; narrow dark tip to tail. Underwing, white with (1) narrow black band from base of outermost primary to carpal joint, interrupted by white patches just distal of carpal; (2) narrow black diagonal bar tapering inward from carpal joint to point behind elbow; (3) narrow blackish trailing-edge to secondaries; (4) blackish tip of varying extent, usually covering distal half or more of primaries and shading evenly into white on bases; but sometimes only narrow black border round wing-tip. At distance, underwing appears white with narrow black leading- and trailing-edges. Bill, black; long and rather prominent, with strongly hooked nail and short nasal tubes raised over basal quarter. Tarsi and basal half of feet, pinkish flesh; terminal half of feet, black.

SIMILAR SPECIES Diagnostic broad white hindneck collar readily separates from all other species of *Pterodroma* in our region. Otherwise very similar *Juan Fernandez P. externa* and *Barau's P. barau* Petrels have grey hindneck uniform with grey of mantle; *Juan Fernandez* similar in size (*q.v.* for fuller discussion); *Barau's* usually smaller. Superficially similar *Great Shearwater Puffinus gravis* has much narrower collar, blackish cap extending forward to base of long slender bill, dusky belly patch, prominent white horse-shoe over base of tail and black spotting and bars across wing-pit; flight action, stiffer-winged and faster. *Buller's Shearwater Puffinus bulleri* has different jizz, flight and plumage; long slender bill, dark forehead, grey hindneck, clean white underwing lining, more strongly wedge-shaped tail and broader wings, with carpal joints held well forward giving more angular wing-shape; in light winds, flight slower, more leisurely and direct, with regular alternation of measured wing-beats and long glides keeping lower to surface; in strong winds, has less powerful arcing progression on more direct course.

Markedly pelagic but occasionally range into shelf-break waters; coastal sightings of storm-driven individuals rare; exceptionally sighted inland during cyclones. Flight at all times graceful and effortless, with few wing-beats; appear slower,

less vigorous and manoeuvrable than *Cookilaria* species. In light winds, maintain gentle roller-coaster progression low above water on direct or gently meandering course, interspersed with occasional higher arcs and periods of gentle banking, turning and short glides; following glide, give a few slow wing-beats before resuming arcing progression. When gliding, carpal joints held gently forward and outerwings gently angled back and bent downward; appear noticeably longer- and straighter-winged than *Cookilaria* species. In windier conditions, arcing becomes stronger and course more meandering, bird wheeling in broad arcs high above sea; wings then held more strongly flexed. Feed by dipping, aerial-pursuit and surface-seizing; often associate with cetaceans and join mixed-species feeding flocks, often in association with other gadfly petrels. Usually solitary at sea, although loose flocks of 20–30 birds recorded. Usually ignore ships but sometimes closely accompany for brief periods; occasionally attracted to smaller fishing vessels. Breed in dense colonies where they are nocturnal but a few fly over during day. Apparently silent at sea; noisy at colonies where main flight call is rapidly repeated *te-te-te*. . . or *ka-ka-ka*. . .; longer *kukooowika-ka-ka-ka* and variants also given in flight and from ground.

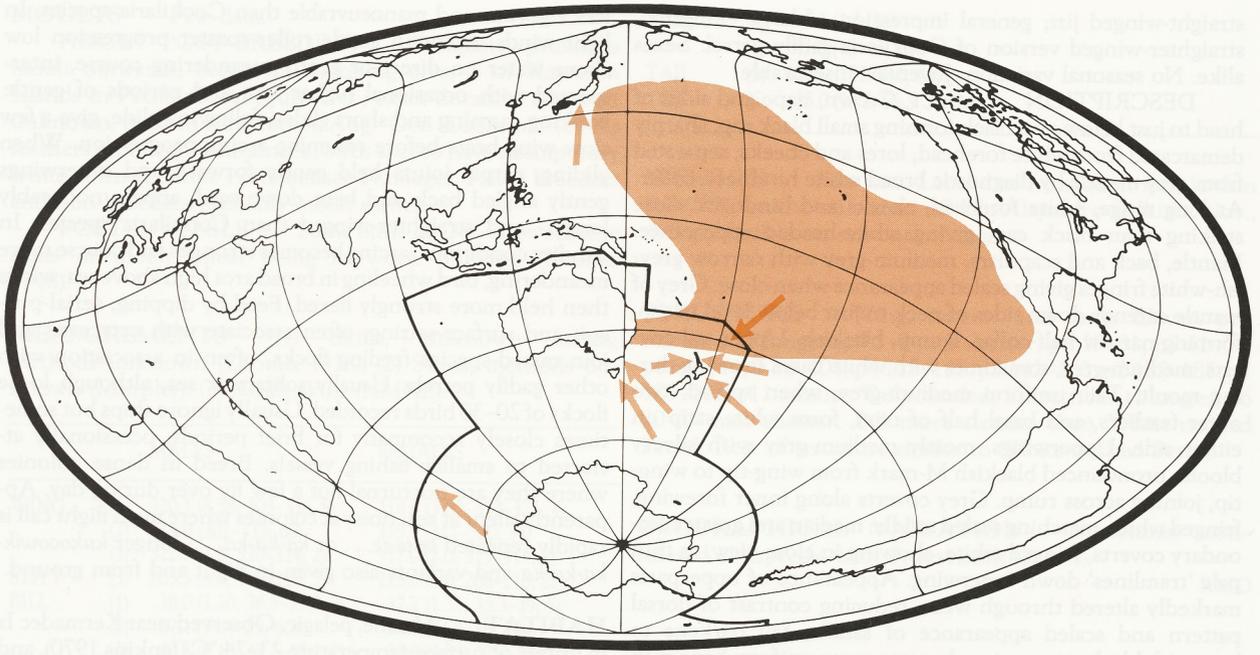
HABITAT Marine, pelagic. Observed near Kermadec Is in waters of surface-temperature 23–24 °C (Jenkins 1970), and in Tasman Sea over Gascoyne Seamount, where low surface-temperature (20.3 °C) indicated upwelling of cool water (Barton 1980). In waters SE of Japan, occurs in areas where surface-temperature 20.7–31.4 °C and especially abundant when between 27–30 °C (Tanaka & Inaba 1981). In tropical e. Pacific, associated with s. edge of North Equatorial Current at 10°N, over upwelling associated with current divergence (Pitman 1986). Vagrant record from near Iles Crozet (Stahl *et al.* 1984) suggests may occasionally wander into subantarctic waters. Pelagic throughout range (King 1967; Jenkins 1970). In Aust., observed over and beyond shelf-break waters; rarely seen from land. Occasionally found flying or exhausted inland after cyclone (Kinsky 1971; CSN 24; Smyth & Corben 1984; Qld Bird Rep. 1984).

Breed on Macauley I., Kermadecs Is, on gently sloping areas vegetated by sedges and low scrubs, mostly on higher slopes (M.J. Imber). In past, bred on Raoul I. (Kermadecs) on high-altitude ridges below 300 m asl (Sorensen 1964; Merton 1970; B.D. Bell). Fly in arcs high over sea surface (Harrison 1983), and glide close to water.

Increased number of sightings N of NZ in recent years; may indicate population increase following elimination of goats *Capra hircus* on Macauley I., which may have been trampling burrows and damaging habitat by eating vegetation that bound the friable soil (Jenkins 1980).

DISTRIBUTION AND POPULATION Ranges within Pacific Ocean: sw. Pacific Ocean during breeding season generally moving into n. hemisphere after breeding. Recorded once in Indian Ocean near Ile des Pingouins, Iles Crozet, on 8 Feb. 1982 (Stahl *et al.* 1984).

During breeding season, most abundant within c. 1000 km of Kermadec Is (M.J. Imber); not common Fijian (20–22°S, 176–177°E) and Tongan waters (15–22°S, 174–176°W); widespread S of these waters (Jenkins 1980, 1986); seen regularly N and NE of NI, NZ, occasionally S to East Cape; extends W into Tasman Sea, on e. coast of Aust. as far S. as Gascoyne Seamount (Harrison 1978; Barton 1980). During non-breeding season, found nw. Pacific Ocean, SE of Japan; two records



from Japan including specimen (Kuroda 1962; Tanaka & Inaba 1981; Brazil 1988). Recorded central Pacific between equator and Hawaiian Is; probably visitor all year (King 1967, 1970). Occasional observations e. tropical Pacific between 15°S-27°N and 154-95°W but dates not specified (Pitman 1986).

AUST. Although not reported before 1983, plainly a few birds occur well off coasts of Qld. and NSW, generally between Dec. and Apr. and seen occasionally nearer to, or from, land. Unfortunately almost all sightings have not been published or, if so, have not been supported by adequate details; exceptions are records off Sydney Heads, 26 Feb. 1983 (photo in Boles *et al.* 1985) and near Kempsey, 9 Apr. 1983 (roadkill; Boles *et al.* 1985). Other published but unauthenticated reports have been: **Qld:** Pt Lookout, Stradbroke I., 20 Feb. 1983 (first Aust. record), 19 Feb. 1984; off Pt Lookout, 11 Feb. 1984, 25 Jan. 1986; near Mudgeeraba, 9 Apr. 1984 (after cyclone) (Smyth & Corben 1984; Qld Bird Reps 1983, 1984, 1986). **NSW:** off Sydney Heads, 28 Jan. 1984; 40 km off Sydney Heads, 15 Dec. 1984; two, 140 km at sea between Port Stephens and Batemans Bay, 22 Dec. 1984; Ballina, 9 Feb. 1985; (NSW Bird Reps 1984, 1985). Off Wollongong, 10 Aug. 1985 (NSW Bird Rep. 1985).

NZ Four records, all NI: one storm-wrecked, Mamaku Ra., near Rotorua, 10 Apr. 1968 (Kinsky 1971); two blown inland by gales (alive), one near Gisborne, June 1977 (CSN 24) and one at Rawene Pen., Hokianga Harbour, 4 June 1982 (Brash 1982); one beachcast, Karikari Bay, 27 Jan. 1986 (Dowding 1987).

Breeding restricted to Macauley I., Kermadecs. Breeding population estimated to be 50 000 pairs in 1988 (Tennyson *et al.* 1989). Formerly bred Raoul I., Kermadec Is, where uncommon in 1887 (Cheeseman 1890), fewer than 500 pairs in 1908 (Iredale 1910) and one fresh beachcast found 1966-67 (Merton 1970); population probably destroyed by feral cats (Oliver; Sorensen 1964; Merton 1970; B.D. Bell).

POPULATION Before discovery of colony on Macauley I., species thought to be extinct. Status now stable,

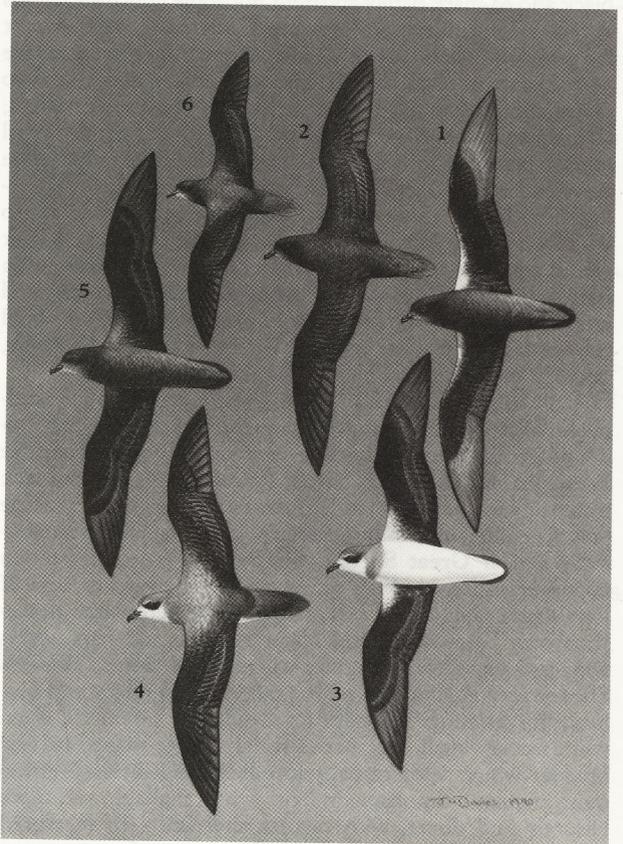


Plate 33

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

possibly increasing. Observations at sea suggest recent increase in population, perhaps as result of removal of goats (Jenkins 1980, 1986). Breeding range restricted to one island; population vulnerable.

MOVEMENTS Poorly known; trans-equatorial migrant from sw. Pacific where breeds on Macauley I. to n. Pacific. Little known of movements off Baja California and S of Mexico; records in Pitman (1986) undated.

DEPARTURE Young leave June (Oliver). Northward migration may pass E of Tonga in June and July (Jenkins 1980), but this is also when most Fijian records occur; migration probably takes place over broader front (Clunie *et al.* 1978; Lovegrove 1978; Jenkins 1986).

NON-BREEDING Move into n. Pacific. Considerable numbers migrate regularly to w. North Pacific Ocean from July to Nov.; not present N of 30°N until late July; often seen E of Mariana Is in Aug. and found scattered widely farther W between 25 and 35°N from Sept. to Nov. (Tanaka & Inaba 1981). In central Pacific recorded by King (1970) in all months except July–Sept. with lowest numbers Feb.–Apr.; according to King (1967), abundant from May to Nov.

RETURN Oct. (Oliver). No information on southward pathway.

BREEDING Disperse W into Tasman Sea where

small numbers found (Harrison 1978) as far as e. Aust., where recorded off Stradbroke I. (Smyth & Corben 1984), and offshore NSW as far S. as Gascoyne Seamount (Barton 1980). To the N, reported from Fijian waters Feb., Mar. and Dec. and from Tongan waters Mar. and Dec. Status of these birds in Aust. and Pacific waters, so far from breeding grounds, unknown; sightings from Tongan waters in Dec. may be foraging birds from Kermadecs (Jenkins 1980). King (1967) notes individuals present in central Pacific waters all year. E. tropical Pacific, recorded Feb.–Apr. from seas near Hawaii (Meeth & Meeth 1985, 1986).

FOOD Virtually unknown but includes cephalopods, remains having been found in stomachs of two nestlings (M.J. Imber). **BEHAVIOUR** Dipping, pattering and surface-seizing equally important (Prince & Morgan 1987) but no detailed descriptions. Recorded feeding in association with Great-winged Petrel *P. macroptera* and Flesh-footed Shearwater *Puffinus carneipes* (Ainley & Boekelheide 1983).

SOCIAL ORGANIZATION AND BEHAVIOUR

Little known. Typically solitary, though may form flocks (2–15) at food (Tanaka & Inaba 1981). Observed feeding or associating with Wedge-tailed Shearwaters *Puffinus pacificus*, Sooty Tern *Sterna fuscata*, White Noddy *Anous albus* and Common Noddy *A. stolidus*. No data on bonds, breeding associations or parental care. Breed colonially. Territorial, defending nest-site only. Resting at sea as for other species of *Pterodroma*, probably diurnal; possibly sleeping on the wing; sometimes sleeping or loafing on calm seas; at breeding sites, remain in burrows during day, emerging at night, when their distinctive call heard. Most of courtship, burrow preparation and mating occurs in Nov. after which birds leave colony for about 1 month (M.J. Imber). No further information on Social Behaviour.

VOICE Poorly known and no detailed studies. Based on tapes from Macauley I., Kermadec Is; information provided by M.J. Imber. Silent at sea; rather noisy at breeding colony, uttering several varying calls. Calls restricted to breeding season and to colony. No information on sexual or individual differences though sexual differences probable. The Long Call and second Flight Call appeared to cause nearby birds to respond with first Flight Call; this could be males calling (usually from ground) causing females in flight to respond (M.J. Imber). Long Call resembles main call of Dark-rumped Petrel *P. phaeopygia* (M.J. Imber).

ADULT **Long Call.** Varying call, rendered *kukooowik-ka-ha* or *kukooowik-ka-ka-ka* or *kukooowik-kee-kee*; endings vary but not known if associated with sexual differences; apparently given in flight and on ground and is probably the 'peculiar cry' referred to by Oliver. **Flight Call.** Two types noted, possibly given by different sexes. (1) Rather sibilant and not very loud *te-te-te-te-* was commonest call on tape; suggested to be call by females. (2) Louder and harsher *ka-ka-ka*; heard less often than (1) with fewer syllables per call than in former; suggested to be call by males.

YOUNG No information.

BREEDING Little known. No detailed studies. Information supplied by M.J. Imber. Breed colonially, among Wedge-tailed Shearwaters *Puffinus pacificus* and Black-winged Petrels *Pterodroma nigripennis*, latter using smaller burrows. Only on Macauley I., Kermadec Is; formerly on

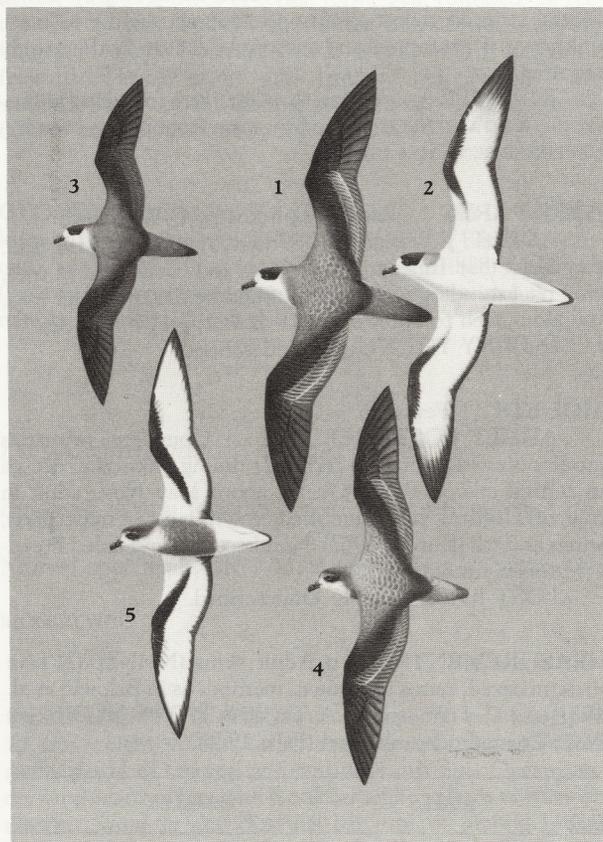
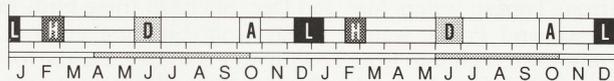


Plate 34

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|---|--|
| Barau's Petrel <i>Pterodroma baraui</i> | Mottled Petrel <i>Pterodroma inexpectata</i> |
| 1. Adult, dorsal, fresh | 4. Adult, dorsal, fresh |
| 2. Adult, ventral, fresh | 5. Adult, ventral, fresh |
| 3. Adult, dorsal, worn | |

Raoul I.

SEASON Breed from Oct. to June. No details of nesting cycle except that birds arrive in Oct.; laying, Dec-Jan.; hatching, late Feb.; fledgelings leave throughout June.



SITE In burrows; said formerly to be 'on upper slopes of Raoul I.'; in areas of sedge, grassland or low shrubs (M.J. Imber). No further information.

NEST, MATERIALS In chamber at end of burrow; details not known.

EGGS Oval; smooth-shelled; white.

MEASUREMENTS. Three eggs: 64, 65, 68 x 45, 47, 48.

CLUTCH-SIZE One. Single brooded. No replacement laying.

LAYING At night. At least from 26 Dec. to 2 Jan. and probably fairly well synchronized.

INCUBATION No information.

NESTLING Semi-altricial, nidicolous. Down, dove-grey; abdomen and central line on breast and throat, white. Period: probably 100-115 days (M.J. Imber). No further information on fledging to maturity or success. Feral cats probably wiped out former colony on Raoul I; no cats on Macauley I; Polynesian Rats *Rattus exulans*, which inhabit island, apparently vegetarian (M.J. Imber).

PLUMAGES

ADULT Age of first breeding unknown. **HEAD AND NECK.** In fresh-plumage: Forehead, white. Crown to hind-crown, dark brown (219); feathers at front of crown, fringed white giving scalloped appearance; when worn, fringes lost or narrow. Short white filoplumes on crown. Loops, white. Sub-orbital patch, dark brown (219); slight narrow white fringes on feathers in upper malar area give scalloped appearance; rest of malar area and ear-coverts, grey (84); concealed bases of feathers, white; some white feathers above and behind eye form indistinct supercilium. Lower nape and hindneck, white; white feathers, sometimes narrowly tipped grey (84); white feathers form collar, varying in width. Chin to base of fore-neck, white; some feathers on outer margins at base of fore-neck have mottled subterminal grey (84) webs, tipped white, giving appearance of partial collar; varying. **UPPERPARTS.** Mantle, grey (84) broadly fringed light grey (85). When worn, feathers become dark brown (219) and fringes lost or narrow; when fringes lost, tips, dark brown (119A). Back, dark brown (219). Lower back, rump and upper tail-coverts, grey (84), narrowly fringed light grey (85). Scapulars, black-brown (119); when wing outstretched, brown feathers form middle of M-shaped marking. **TAIL,** grey (84), with white tips on t3-5; inner webs basally white, extending distally towards outermost rectrices; t6 entirely white on inner web, outer web subterminally mottled grey (84); rachis, white (Loomis 1918). When worn, innermost rectrices, tipped dark brown (119A). **UPPERWING.** Primaries, black-brown (119) with suffused white basal inner margins of inner webs (see underwing), and exposed when wing spread. Secondaries and tertials, black-brown (119) with white inner webs extending to three quarters of length; secondaries, narrowly edged white on outer web; tertials, similar but edges narrower. Marginal coverts and alula, dark brown (219), narrowly fringed light grey (85); light-grey (85) fringes broader near humerus. Lesser coverts, dark

brown (219) with subterminal open pennaceous dark-brown (121) fringes, narrowly tipped light grey (85). Greater primary coverts, black-brown (119), narrowly tipped light grey (85). Lesser and greater primary coverts form part of M-shaped marking when wing spread and contrast with lighter surrounding feathers. Greater and median coverts, dark brown (219) with grey (84) shade, fringed light grey (85); when worn, fringes lost or narrow and grey (84) shade lost, feather tips becoming dark brown (119A). **UNDERPARTS,** white, including axillaries. **UNDERWING.** Primaries, pale black-brown (119) with suffused white inner margins of inner webs, extending for three quarters length of feather as moderately sharp wedge; outer margin of web, edged dark brown (121); white suffusion dull on p10. Secondaries, pale black-brown (119) narrowly edged white on outer web with white inner webs extending to three quarters of length of feather. Greater and median primary coverts, white, apart from outermost two feathers which are dark brown (219), narrowly tipped white or mottled white on inner webs; marginal and lesser primary coverts, dark brown (219) fringed white, forming narrow dark band from carpal joint along leading edge nearly to base of outermost primary. Dark band extends inward from carpal joint as tapering diagonal bar across innerwing lining finishing half way between carpal joint and posterior base of wing; rest of innerwing lining, white.

DOWNY YOUNG Covered in dove-grey down; central strip on throat, chest and abdomen, white (Oliver); unknown if proptile and mesoptile occur; further study required.

JUVENILE Similar to adult, but following differences. **HEAD AND NECK:** white fringes on front of cap, broader. **UPPERPARTS:** fringes broader.

BARE PARTS Based on photos by D.W. Eades.

ADULT, JUVENILE Iris, dark brown (219). Bill, grey-black (82). Inner margin of legs and basal third of toes, pink (7), extending to first joint of middle toe and inner toes, and along web to outer toe; rest of foot, grey-black (82).

DOWNY YOUNG Undescribed.

MOULTS Few data.

ADULT POST-BREEDING Complete; primaries moult outwards; duration and exact timing unknown; occurs in central and w. Pacific Ocean, about May-Nov.; adult in July, off Honshu, Japan, moulted crown, most of upperparts, wings and tail (Kuroda 1962). Non-breeders and failed breeders probably moult earlier.

POST-JUVENILE Undescribed.

MEASUREMENTS (1) Adult skins (NMNZ). (2) Live birds, unsexed, status unknown; methods as in Baldwin *et al.* (1931) (A.J.D. Tennyson, G.A. Taylor & P. Scofield). (3) Skins (NMNZ); methods unknown (Falla 1976).

	MALES	FEMALES
WING	(1) 315.9 (4.58; 309-322.5; 5)	310.3 (5.11; 303-319; 5)
8TH P	(1) 193.6 (5.85; 185-201; 5)	193.8 (3.62; 189-198; 6)
TAIL	(1) 136.5 (2.79; 132-139; 5)	131.2 (6.30; 124-142; 5)
BILL	(1) 36.4 (0.96; 35.7-38.1; 5)	35.6 (0.87; 34.5-37.1; 5)
TARSUS	(1) 40.7 (1.25; 39.4-42.9; 5)	39.1 (1.03; 37.4-40.0; 5)
TOE	(1) 53.1 (1.77; 51-56.3; 5)	50.9 (2.58; 47-53.3; 5)

UNSEXED

TAIL	(2)	129.3 (4.63; 121.4-139.7; 30)
	(3)	136.0 (132-142; 14)
WING	(2)	308.5 (5.28; 299-322; 30)
	(3)	312.0 (301-322.5; 14)
BILL	(2)	36.1 (0.85; 34.5-38.8; 30)
	(3)	36.4 (34.5-38.5; 14)
TARSUS	(2)	40.5 (1.26; 36.7-42.6; 30)
	(3)	42.0 (40-46; 14)
TOE	(2)	51.7 (1.30; 49.4-54.5; 30)
	(3)	52.0 (50.4-55.2; 14)

WEIGHTS At Kermadec Is, live unsexed birds, unknown status (23-26 Feb.): 445 (31.5; 380-545; 30) (A.J.D. Tennyson, G.A. Taylor & P. Scofield). Label data from adult skins (NMNZ), fat, Nov.: males 448.7 (30.89; 410-490; 4), females 436.2 (27.47; 405-480; 4). No data on seasonal changes.

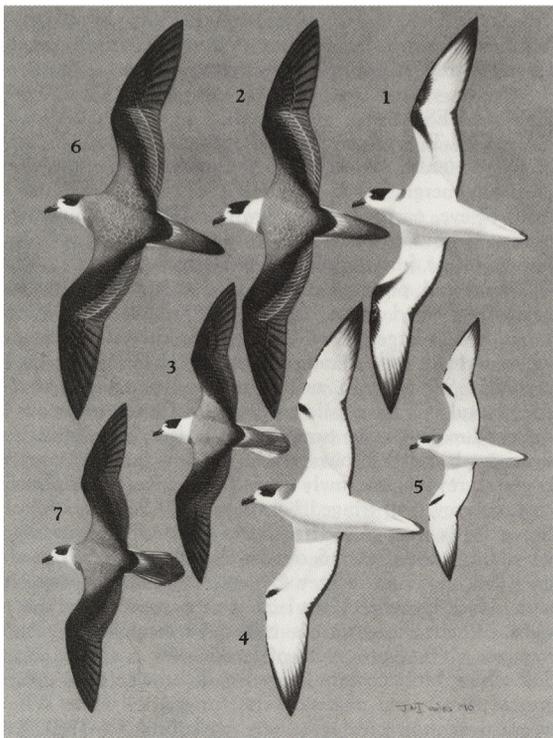
STRUCTURE Wing, narrow and long. Eleven primaries: p10 longest, p9 1-5 mm shorter, p8 12-19, p7 28-37, p6 47-64, p5 72-91, p4 100-110, p3 128-146, p2 152-169, p1 173-189, p11 minute. No emarginations. Twenty-two secondaries, including three of tertial form. Tail, rounded: 12 rectrices, t1 longest, t6 32-35 mm shorter. Bill, slender; maxillary unguis, hooked. Nostrils c. 25% of bill-length and point forward. Tarsus, short and laterally compressed. Feet, webbed. Outer and middle toes about equal in length, inner c. 86% of middle; hind, claw only, c. 11%.

GEOGRAPHICAL VARIATION No variation known, but specimens collected 48 km east of Banks I., Vanuatu, smaller and may represent an undescribed subspecies (Falla 1976). Sometimes considered conspecific with Juan-Fernandez Petrel *P. externa* (Imber 1985).

RMO

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Volume 1 (Part A), Plate 35

White-necked Petrel *Pterodroma cervicalis*

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

Juan Fernandez Petrel *Pterodroma externa*

- 4. Adult, ventral, fresh
- 5. Adult, ventral, fresh
- 6. Adult, dorsal, fresh
- 7. Adult, dorsal, worn

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