

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 neglecta Kermadec Petrel

COLOUR PLATE FACING PAGE 464

Procellaria neglecta Schlegel, 1863, *Mus. Hist. nat. Pays-Bas, Rev. Méth. Crit. Coe. 4, Procellaria*: 10 — Sunday Island = Raoul Island, Kermadec Group.

Specifically named 'forgotten' or 'overlooked' because three syntypes collected in July 1854 on Raoul I. by Verreaux had been labelled *Aestrelata diabolica* (a junior synonym of *Procellaria hasitata* [Kuhl 1820]) and were recognized as a different species by Schlegel only nine years later when he received the skins from Verreaux.

POLYTYPIC Nominate *neglecta* breeds subtropical South Pacific including Lord Howe I., Kermadec Is, Austral Pitcairn Grp; *juana* Mathews, 1935, breeds Juan Fernandez, San Ambrosia and San Felix Is.

FIELD IDENTIFICATION Length 38 cm; wingspan 92 cm; weight 509 g. Medium to large gadfly petrel of tropical and subtropical Pacific Ocean. Typical jizz of large *Pterodroma*: stubby bill, stocky bull-necked build, long pointed wings held well forward at carpals, outerwing swept back, short squarish tail. Much variation of plumage, greater than in any other gadfly petrel. In all plumages, pale patch on underwing at base of primaries, not extending onto secondaries or their coverts; whitish primary shafts show as diagnostic skua-like flash on upperwing (Phoenix, Herald and Providence Petrels all have dark shafts). Sexes alike. No seasonal variation. Juveniles inseparable.

DESCRIPTION **Pale morph.** ADULT. Head, mostly white or greyish-white with forehead, crown and nape freckled grey and brown. Upperwing, blackish brown; primaries, blackish with white shafts forming pale area in centre of outerwing. Back, pale ashy-brown, feathers with whitish margins; tail, blackish. Underparts, white, often with smudgy brown on sides of breast; under tail-coverts, white freckled with brown. Underwing, mainly dark greyish-brown but with conspicuous white patch at base of primaries formed by pale basal inner webs, for more than half length; lesser pale area inside this formed by outer greater-coverts, which are whitish with grey-brown tips; some pale feathers also on leading-edge of innerwing, along humerus. Iris, brown. Bill, black. Legs and feet, whitish pink with distal portion of webs and toes, black. **Dark morph.** Entirely blackish brown except for white freckling round base of bill and on cheeks. Wing markings, as for pale morph. Legs and feet, black. **Intermediate morph.** Continuous variation between extremes of pale and dark morphs; commonly with dark brown head and upperparts with some white on face, chin and above eye; upper breast and under tail-coverts, brown, rest of underparts, white. Other variations include varying amounts of greyish brown on underparts. Wing markings, as for pale morph. Legs and feet, usually as for pale morph, but may be bluish; although pale and intermediate birds usually have bicoloured feet and dark birds, black feet, any combination can occur (Oliver).

SIMILAR SPECIES Extreme variation of plumage of Kermadec Petrel can make identification at sea difficult, particularly as very similar Herald Petrel *P. arminjoniana* also polymorphic. **Herald Petrel** always has darker head and face (never so white as pale-morph Kermadec); palest Herald have mainly ashy-brown heads with whitish faces and throats and ill-defined dusky breast band; all have paler underwings, with white extending along secondaries and secondary coverts and not showing white skua-like flash on upperwing. **White-headed Petrel** *P. lessonii* differs from pale-morph Kermadec

by conspicuous black suborbital patch, paler upperwings and back, whitish tail and darker underwing (beware: rare pale examples can show whitish primary patch). **Phoenix Petrel** *P. alba* differs from intermediate-morph Kermadec in having mainly dark underwing without large white patches on under primaries, under tail-coverts white, primary shafts black. **Magenta Petrel** *P. magentae* has all-dark underwing, white under tail-coverts and longer, wedge-shaped tail. **Providence Petrel** *P. solandri* greyer than dark-morph Kermadec Petrel and has dark primary shafts. **Great-winged** *P. macroptera* and **Murphy's** *P. ultima* Petrels have wholly dark underwings. Kermadec can resemble all dark *Catharacta* and polymorphic *Stercorarius* skuas. **Catharacta** much bigger and bulkier with broad wings; flight more gull-like with less wheeling and banking. **Stercorarius** have more falcon-like jizz, often have protruding central tail-feathers; flight direct and powerful, with steady deep wingbeats and little soaring or banking.

Pelagic in subtropical and tropical Pacific Ocean, rarely reaching mainland Aust. and NZ. Flight more leisurely than most gadfly petrels, wheeling and banking in long unhurried glides interspersed with deep gull-like wing-beats. Flight and short squarish tail impart gull-like jizz in calm conditions. Solitary at sea; ignore ships. Silent at sea; noisy at breeding colonies; explosive *yuk-ker-a-oooo-wuk* in air and on ground.

HABITAT Marine, pelagic; in subtropical and tropical waters of South Pacific Ocean, dispersing to central North Pacific. Observations over waters of surface-temperature 24 °C near Kermadec Is (Jenkins 1970), 15–18 °C off Chile (Jehl 1973), and 15.6–24.7 °C in North Pacific Ocean (Gould 1983) indicate mainly subtropical distribution. Feed far from breeding islands (Holyoak & Thibault 1984). Breed on islands, atolls and rocky islets across subtropical South Pacific Ocean; on vegetated coastal slopes, cliffs or mountainous terrain inland; nest on ground or in rock crevices under ferns, shrubs or trees (Hindwood 1940; Merton 1970; Holyoak & Thibault 1984). Need for shade may be important factor in selection of nest-site (Merton 1970). Fly close to sea surface in arcs and glides (King 1967). Soar over cliffs at Mas Atierra, South America, to heights of 300 m or more (Murphy).

Introduced predators, especially cats and rats, prey on birds at breeding islands throughout range; breeding habitat degraded by goats and rabbits (Schlatter 1984).

DISTRIBUTION AND POPULATION Breed on islands in South Pacific Ocean, 25–35°S, from Lord Howe I. to Juan Fernandez Is. Pelagic distribution poorly known. Gen-

erally in subtropical seas between 20–35°S. Non-breeders migrate trans-equatorially and have been recorded as far N as 28°N in central Pacific and 21°N in e. Pacific (Gould & King 1967). Present round Kermadec Is throughout year. Vagrant to mainland NZ and e. coast of Aust.

Several sightings in e. Pacific, in offshore Mexican, Peruvian and Chilean waters, mostly 90–110°W (Murphy; Gould & King 1967; Pitman 1986). W of 120°W, mainly occur 5–20°N; occasionally recorded off Hawaii (Gould & King 1967; Pitman 1986). Throughout Polynesia; a few irregular records in Tongan waters (Jenkins 1980). Unconfirmed records from Japan (Sonoke 1982) and Philippines. Reports from Cheshire, UK, Apr. 1908 (Newstead & Coward 1908) and Pennsylvania, USA, Oct. 1959 (Heintzelman 1961) rejected (BWP; Palmer 1962). Old record from Bismarck Arch.

AUST. Rare visitor; no records in 1975–81 (Aust. Atlas). Qld. Six off Pt Lookout, 19 Aug. 1986, published without supporting details (Qld Bird Rep. 1986). NSW. Singles beachcast: Kingscliff, 27 Jan. 1974 (Rogers 1975); Tuggerah Beach, 16 Mar. 1968 (Holmes 1971); Steamers Beach, Jervis Bay, 20 June 1976 (Rogers 1977). Record off Wollongong, 7–21 Apr. unsubstantiated, not acceptable (Cooper 1989).

NZ Few mainland records. NI. Muriwai Beach, two beachcast specimens before 1955 (Oliver), one beachcast, Apr. 1981 (Powlesland 1983). Between Maunganui Bluff and Glink's Gully, one beachcast Mar. 1986 (Powlesland 1989). Cuvier I., intermittently sighted between 27 Jan. 1976 and 15 Jan. 1981 (Reed 1976; CSN 28, 29); reputed to have been seen there during previous two years; in 1976 seen to land; had made nest-scraps near Silver Gull *Larus novaehollandiae* colony but apparently failed to find mate (Reed 1976).

NORFOLK AND LORD HOWE IS Small breeding populations.

BREEDING, POPULATION Balls Pyramid, Lord Howe I.: <1974, 'a few pairs' (van Tets & Fullagar 1984).

Phillip I., Norfolk I.: pairs 1987, 1988 (Woods 1988).

Kermadec Is: Herald islets, 5000+ prs, mainly on North and South Meyer (Merton 1970); Macauley I.; Curtis I.;

Cheeseman I. (Robertson & Bell 1984). Total population: 5000–10 000 prs (M.J. Imber).

Extraliminally breed Pitcairn Is (Ducie, Oeno, Henderson Is; Oliver; Bourne & David 1983), Tuamotu Is (Garnett 1984), Austral Is (Rapa) (Garnett 1984; M.J. Imber), Easter I. (Schlatter 1984), Juan Fernandez Is (Mas-Atierra, Santa Clara) (Murphy; Schlatter 1984; M.J. Imber) and San Ambrosia I. (Jehl 1973).

Population on Raoul I., c. 500 000 birds in 1908 (Iredale 1914) now virtually extinct (Merton 1970); decline caused by introduced predators (cats and Brown Rats *Rattus norvegicus*) and harvesting of birds by humans (Merton 1970; M.J. Imber). No longer breed on Easter I. and populations on nearby islets threatened by egg-collecting and rats (M.J. Imber). Breeding birds and chicks on Juan Fernandez Grp possibly taken by cats and Coatis *Nasua* sp.

MOVEMENTS Migratory or dispersive from breeding islands, some birds moving to tropical North Pacific in non-breeding season.

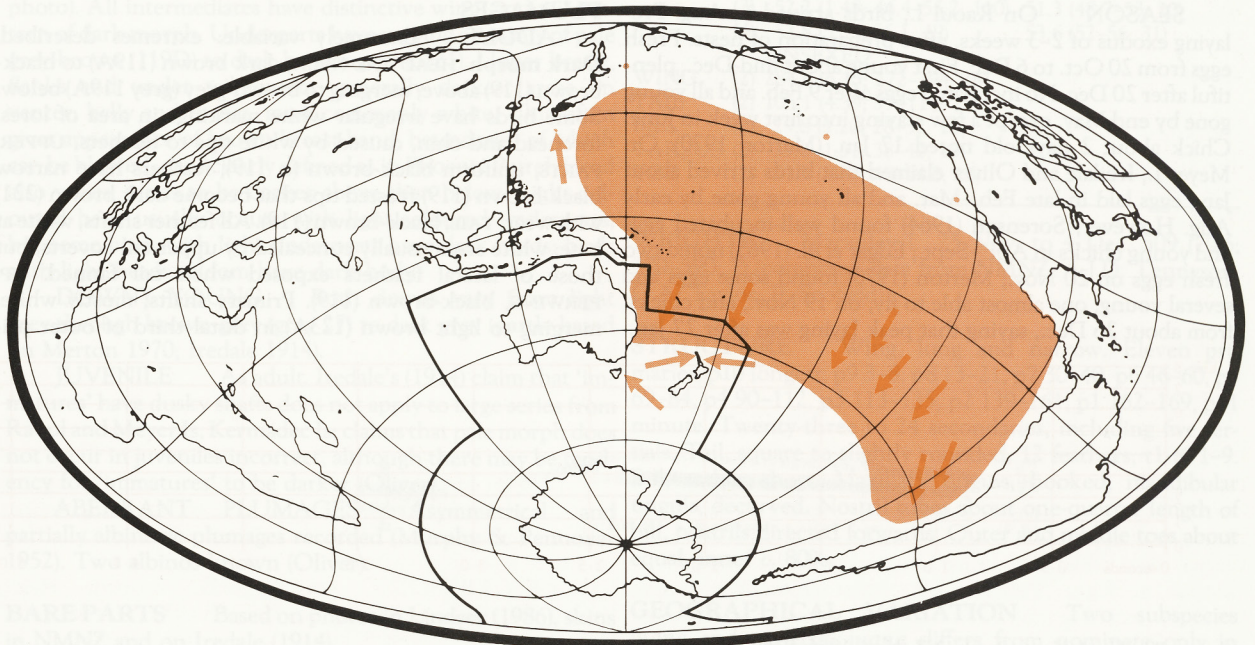
DEPARTURE In w. part of range most breeding now in summer, birds departing Lord Howe I. and Raoul I., Kermadec Is, Apr.–June (Hindwood 1940; Oliver) but those on Meyer I., Kermadec Is, winter breeders, leaving July–Oct. (Oliver; Falla *et al.* 1966) as probably were those on Norfolk I. (Hindwood 1940).

NON-BREEDING Poorly known. Thinly scattered throughout North Pacific N to 39°N in e. Pacific (Gould 1983) and up to 42°N in w. (Wahl 1978) with peak in abundance Nov.–Jan. (Gould & King 1967).

RETURN Arrive Lord Howe I. (Hindwood 1940) and Raoul I. (Oliver), Oct.–Dec.; Meyer I., late Feb.–early Apr. (Oliver; Falla *et al.* 1966).

BREEDING, NON-BREEDING In summer most records ≤400 km W of Raoul I. (Jenkins 1967) with report off Qld. in Aug. and beachcast birds, NSW, in Jan., Mar., June (see Distribution).

BANDING 29S177E 01 1+ U 92 8225 293.



FOOD Virtually unknown; young have contained cephalopods and crustaceans (Oliver). **BEHAVIOUR** Surface-seizing and dipping considered equally important, pattering less so (Prince & Morgan 1987); no detailed descriptions.

SOCIAL ORGANIZATION AND BEHAVIOUR

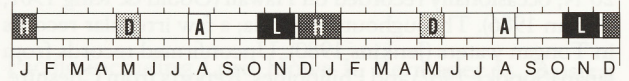
Little known. Solitary at sea. Breed colonially, at which time may mingle with other seabirds including storm-petrels and albatrosses at sea (Murphy). After establishing nest-sites, birds leave for 2 to 3 weeks before returning to lay (Oliver). Both parents incubate and feed young; young deserted 10–14 days before departing (Oliver). Nest in large colonies (Murphy); density can be high: c. 4000 nests/ha formerly recorded at Raoul I. (Cheeseman 1891). Territory restricted to nest-site only; if adjacent nests too close, both pairs vigorously bicker, sometimes to the exclusion of feeding young (Murphy). Pairs presumably rest on nest from shortly after sunset until one hour before sunrise; also possibly between 10:00 and 11:00, and 14:00 and 16:00 (Murphy; Johnson 1965; Ward 1969). As pairs arrive at breeding colonies, undescribed ‘courtship rituals’ performed before advancing to nest (Johnson 1965).

VOICE Little information. Call in flight and on ground at breeding sites, especially noticeable in evening when thousands may circle overhead (Oliver; M.J. Imber). Call characteristic and loud *yuk-ker-a-oooo-wuk*. Initial, rather resonant, hoot-like part of call ends with explosive, strongly accented final note. Terminal *wuk* may be repeated as many as three times or omitted altogether, incidence varying with time of year and perhaps location (Ward 1969). Sonagram A shows call with single, relatively weak, terminal *wuk*, typical of available recordings.

BREEDING Known only from observations made by Oliver and Iredale during visit to Raoul I. of 10 months in 1908 (Iredale 1914; Oliver) and by OSNZ Expedition of 2 months in 1966–67 (Merton 1970). Few other casual observations (Guthrie-Smith 1936; Sorensen 1964; Edgar *et al.* 1965). Information supplied by M.J. Imber. Breed colonially on surface in thick vegetation on scrubby slopes.

SEASON On Raoul I., birds arrived in Aug. Pre-laying exodus of 2–3 weeks, after preparation of nests. Fresh eggs from 20 Oct. to 6 Dec. First young about mid-Dec., plentiful after 20 Dec. No incubated eggs after 9 Feb. and all young gone by end May, except a few staying into first week in June. Chick about 2 days old noted 17 Jan. (Merton 1970). On Meyer I., Iredale and Oliver claimed that birds arrived about Jan., eggs laid in late Feb.–Mar. and all young gone by early Aug. However, Sorensen (1964) found well-incubated eggs and young chicks in Apr.–Sept.; Edgar *et al.* (1965) noted two fresh eggs on 20 Nov.; Merton (1970) found some eggs and several young, one almost able to fly, on 19 Nov., and chicks from about 26 Dec., saying that peak laying was after 27 Jan.

Guthrie-Smith reported incubated eggs and week-old chick on 14 Apr. It seems, then, that population on Meyer breeds generally about 3 months later than was the habit on Raoul, being essentially late-summer to autumn as opposed to spring–summer layer. Merton (1970) suggested that early spring–summer breeders on Meyer may be remnants of once-vast population on Raoul, but suspected that birds had always had protracted breeding season.



SITE On surface of ground in lush grass against rock-wall, partly hidden under clump of *Cyperis* on scrub-covered slope (Edgar *et al.* 1965); under ferns; under low understorey of ngaio and *Coprosma* on se. slopes, shading perhaps being factor in selection of sites (Merton 1970).

NEST, MATERIALS Shallow hollow on surface, scratched by bird, which went under log, fluffed out feathers, stood up and then lent forward on breast and scratched out soil backward using both feet at same time; thus formed hollow c. 20 cm across and 5 cm deep in half an hour; sticks and leaves than collected to build nest (R.S. Bell in Oliver).

EGGS White; otherwise undescribed. **MEASUREMENTS.** 64.3 (60.4–70.0; 24) x 46.6 (44.6–49.7) (M.J. Imber); 65.1 (63.0–67.9; 11) x 46.7 (43.7–50.3) (Murphy); from Kermadec Is, av. 64 (60–72; 96) x 46 (43–49) (HASB).

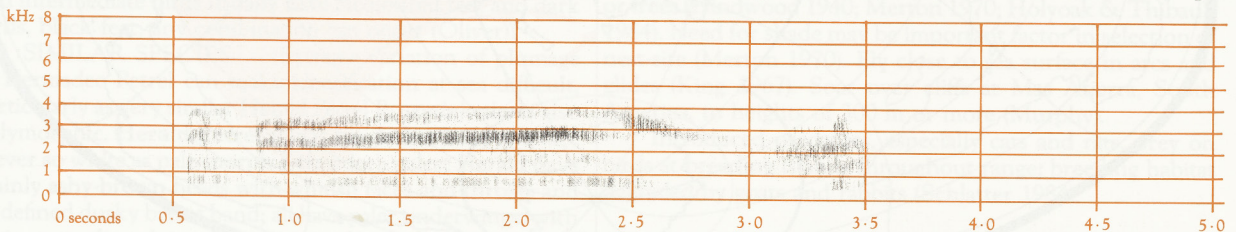
CLUTCH-SIZE One. Two eggs twice found in nest, product of two females (Merton 1970).

LAYING No information. **INCUBATION** No information. **INCUBATION PERIOD:** 50–52 days (Oliver).

NESTLING Semi-altricial, nidicolous. **NESTLING PERIOD.** Stay in nest where fed by parents for over three months (Oliver); estimated as 110–130 days from data given by Iredale for Raoul I. No information on parental care, growth and maturation of chicks or on breeding success.

PLUMAGES

ADULT Extremely variable: extremes described. **Dark morph.** **HEAD AND NECK,** dark brown (119A) to black-brown (119) above, merging to brown-grey (grey 119A) below. Some birds have irregular white markings in area of lores, forehead and chin, caused by white tips to feathers. **UPPER-PARTS,** uniform black-brown (c. 119); feathers have narrow black-brown (119) frosted tips that become dark brown (221) with wear. **TAIL,** black-brown (119). All feather shafts, white at base; white areas usually concealed by upper tail-coverts, but those of lateral feathers exposed when tail fanned. **UPPERWING,** black-brown (119). Primary shafts, mostly white, merging to light brown (123A) in distal third of outer pri-



A W. Ward; Kermadec Is, NZ, Nov. 1966; P26

maries and distal two-thirds of inner primaries. Primaries have white base to inner web, larger on outer feathers. **UNDERPARTS**, dark brown-grey, with dark greyish brown (greyish 121) axillaries and under tail-coverts. All feathers have concealed white bases, which can be exposed when plumage ruffled. **UNDERWING**, mostly dark grey-brown (dark greyish 121); all feathers have white bases; only those of primaries and greater primary coverts exposed. They form large white patch at base of primaries, and often smaller white crescent in front of this, separated by narrow dark dividing line.

Pale morph. **HEAD AND NECK.** Crown, mottled brown and white; feathers, brown (119B) to dark brown (119A) with narrow white tips and concealed white bases. Hindneck, similar, but tends to be paler; dark area of feathers brown (119B) to light grey-brown (27). In palest birds, head and neck look white; crown and hindneck feathers have dark-brown (21) shafts; crown feathers have light grey-brown (27) subterminal bands, visible only on close examination. **UPPERPARTS**, similar to dark-morph birds, but open pennaceous tips to feathers, light grey-brown (27), becoming whitish with wear. **TAIL, UPPERWING.** As dark-morph birds. **UNDERPARTS**, white; most birds have pale grey-brown (pale 119D) wash or mottling across upper breast. Under tail-coverts have light brownish grey (grey 27) tips. Axillaries range from light brownish grey (grey 27) to dark brown (c. 221), usually with white tips. **UNDERWING.** Remiges and greater under wing-coverts, as dark morph, but white bases to inner webs of primaries and primary wing-coverts larger, forming larger under wing-patches. Inner marginal coverts look white; feathers, white with narrow grey-brown (119C) subterminal bands and narrower white tips. Other wing-coverts, greyish brown (119B-119C), with narrow white tips and concealed white bases. White bases to primary median wing-coverts occasionally visible, forming third underwing stripe.

Intermediate morph. Continuous variation from pale to dark morph; some specimens superficially resemble Herald, Tahiti *P. rostrata*, Great-winged, White-headed (Murphy & Pennoyer 1952) and Phoenix (NMNZ) Petrels and even South Polar Skua *Catharacta maccormicki* (A.J.D. Tennyson photo). All intermediates have distinctive wing- and tail-pattern of dark morph. Underparts have varying amounts of pale grey-brown (119D) to dark brown-grey (c121). Upper breast, flanks and under tail-coverts, generally darkest areas on venter; belly and throat, most commonly white. This often gives appearance of brown breast band, boundaries of which can be blurred, or as clearly defined as in Phoenix Petrel. Head also varies; tends to be darker above than below. Light-coloured head usually occurs with light-coloured underparts, but some birds with light underparts have dark heads; birds with light heads seldom have dark body.

DOWNY YOUNG Both downs vary from light grey through brown-grey (grey 27) to dark grey (partly based on Merton 1970; Iredale 1914).

JUVENILE As adult. Iredale's (1914) claim that 'immatures' have dusky shafts does not apply to large series from Raoul and Meyer Is, Kermadec Is; claims that pale morph does not occur in juveniles incorrect, although there may be tendency for 'immatures' to be darker (Oliver).

ABERRANT PLUMAGES Asymmetrical and partially albinistic plumages recorded (Murphy & Pennoyer 1952). Two albinos known (Oliver).

BARE PARTS Based on photos in Lindsey (1986), skins in NMNZ and on Iredale (1914).

ADULT Iris, black-brown (119). Bill, black (82-89); adults usually have white markings at base of unguis, widest on mandibular unguis. Dark-morph birds usually have grey-black (82) legs and feet; pale-morph, usually pale pink with grey-black (82) distal half to two-thirds of webs and inner two toes; outer toe, grey-black (82) on top. However, pale-morph birds occasionally have dark legs.

DOWNY YOUNG In second down, bare parts similar to adult.

JUVENILE As adult.

MOULTS Presumably at sea, between breeding seasons. Birds collected at or near Kermadec Is in Nov. were completing wing- and tail-moult (Murphy & Pennoyer 1952).

MEASUREMENTS Nominat *neglecta*: (1) Kermadec Is, juveniles excluded, skins (NMNZ). (2) Herald Is and Kermadec Is, adults, live; minimum chord (Merton 1970). (3) Throughout range, skins; methods unknown (Murphy & Pennoyer 1952). Subspecies *juana*: (4) Juan Fernandez Is, skins; methods unknown (Murphy & Pennoyer 1952). Other measurements in Loomis (1918). No correlation between darkness of plumage and size.

	MALES	FEMALES
WING	(1) 287.4 (6.41; 276-296; 9) (3) 290.4 (6.59; 279-305; 49) (4) 298.9 (4.98; 290-307; 49)	290.0; (5.51; 280-299; 7) 289.5 (274-300; 20) 300.4 (290-309; 31)
8TH P	(1) 193.5 (10.2; 177-209; 11)	101.6 (4.67; 97-110; 5)
TAIL	(1) 102.2 (2.91; 98-106; 6) (3) 100.9 (3.14; 92.4-107; 110) (4) 105.8 (102-113.3; 49)	101.6 (4.67; 97-110; 5) 101.4 (97-107.3; 20) 106.1 (100.7-112; 31)
BILL	(1) 30.1 (1.00; 28.9-32.6; 10) (3) 30.6 (0.75; 28.5-32.5; 110) (4) 30.5 (0.87; 29.2-32.5; 49)	30.1 (1.28; 28.7-38.4; 8) 30.4 (28.8-31.8; 20) 30.8 (0.88; 29.3-32.8; 31)
TARSUS	(1) 39.4 (1.42; 37.5-41.2; 8) (3) 38.2 (1.12; 35.2-40.9; 110) (4) 40.3 (38.6-41.8; 49)	38.9 (1.19; 37.5-40.8; 5) 37.6 (33.2-39.4; 20) 40.4 (39.1-43.1; 31)
TOE	(1) 53.1 (2.15; 50.5-57; 5) (3) 52.2 (1.48; 46.4-55.2; 110) (4) 53.8 (51.4-56.1; 49)	51.1 (0.97; 49.9-52.6; 4) 51.3 (48.7-53; 20) 53.6 (52-56; 31)
	UNSEXED	
WING	(2) 284.8 (6.15; 272-294; 14)	
TAIL	(2) 105.1 (4.39; 99-114; 15)	
BILL	(2) 29.8 (1.20; 28-32; 16)	
TARSUS	(2) 39.6 (1.31; 38-42; 15)	
TOE	(2) 51.5 (1.86; 48-54.8; 16)	

WEIGHTS Macauley I., 25 Nov. to 4 Dec. 509 (70.6; 370-590; 7) (combined data from NMNZ; A.J.D. Tennyson; G.A. Taylor; P. Scofield).

STRUCTURE Wing, long and narrow. Eleven primaries, p10 longest, p9 3-8, p8 13-21, p7 30-40, p6 46-60, p5 69-84, p4 90-112, p3 113-135, p2 139-161, p1 162-169, p11 minute. Twenty-three to 24 secondaries, including five tertiaries. Tail, square to slightly rounded; 12 feathers; t1-t6 1-9. Bill, rather short. Maxillary unguis, hooked, mandibular unguis, decurved. Nostril tubes about one-quarter length of bill, nostrils directed forwards. Outer and middle toes about equal, inner c. 80%.

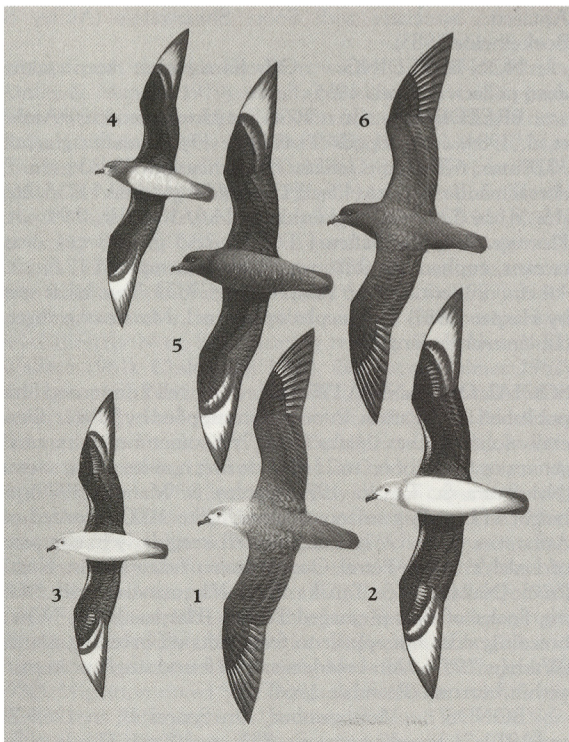
GEOGRAPHICAL VARIATION Two subspecies *juana* and *neglecta*; *juana* differs from nominate only in

slightly larger size (Murphy & Pennoyer 1952). Occasional hybridization with *P. alba* or *P. arminjoniana* suggested (Bourne & David 1983). Murphy & Pennoyer (1952) proposed increasing whiteness in plumage from E to W, palest pale-morph birds coming from Lord Howe and Kermadec Is, darkest dark-morph birds being *juana*. Proportions of each colour morph may vary with locality. In Kermadec Is, classified into three groups described above in Plumages; at Meyer I. (where most breeding supposed to occur in winter), 9% light morph, 13% dark morph, 78% intermediate (Merton 1970); at Raoul I. (where most breeding supposed to occur in summer), 17% light morph, 37% dark, 46% intermediate (Iredale 1914). Information for other populations in Murphy & Pennoyer (1952).

DIR

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Volume 1 (Part A), Plate 31

- Kermadec Petrel *Pterodroma neglecta*
 1. Adult, light morph, dorsal
 2. Adult, light morph, ventral
 3. Adult, white-headed light morph, ventral
 4. Adult, intermediate morph, ventral
 5. Adult, dark morph, ventral
 6. Adult, dark morph, dorsal

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