

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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Procellaria parkinsoni westlandica Falla, 1946, *Rec. Canterbury Mus.* 5: 11 — Barrytown, Westland, South Island, New Zealand.

Named geographically after type-locality.

OTHER ENGLISH NAMES Westland Black Petrel.

Perpetuation of **black petrel** as a potential group name is undesirable because it is inappropriate for the genus and has not been much used as such; if introduced, it would create clumsiness and difficulties with epithets in the names of other species.

MONOTYPIC

FIELD IDENTIFICATION Length 50–55 cm; wingspan 135–140 cm; weight 1.2 kg. Large, heavily built, uniformly sooty-black petrel with black legs and feet and robust cream-coloured or whitish bill, patterned and conspicuously tipped with black or greyish black. Second largest *Procellaria* petrel, only slightly smaller on average than White-chinned Petrel *P. aequinoctialis*; difference in size not discernible at sea. Sexes alike; no seasonal plumage differences. Juveniles separable at close range by bill colour and pattern.

DESCRIPTION ADULT. Entire body plumage, sooty-black, never with white chin-patch; in strong light, head may appear darker than rest of plumage. Upperwing, sooty-black as body; marginal, lesser and median under wing-coverts, same, forming solid dark lining contrasting with slightly paler, glossier greater coverts and remiges; when viewed in bright sunlight, paler greyish basal portions of latter two tracts form diffuse silvery highlight on underwing tip. Whole plumage wears to blackish brown, imparting same patchy dorsal aspect and barred ventral aspect as described for White-chin-

ned Petrel. Bill, sturdy, with tubed nostrils set prominently over basal third of upper mandible. Much of nostrils, latericorn and ramicorn, cream-coloured, with basal edge of nostrils, naricorn and sulcus, black (latter ending in triangle-shape above gonys). Culminicorn varies from dull black to greyish black. Pattern of unguis varies, as does their appearance according to light, best judged in even or subdued light: in close view, unguis appear uniform dull black in many, often with paler greyish area of varying extent over base of maxillary unguis; in others, unguis distinctly paler greyish-black, shading to black on distal half of ridge and tip of maxillary unguis; intermediates common. All dark areas contrast strongly with very pale side-plates. In strong light, greyish portions of unguis reflect light strongly, nearly match paleness of side-plates and seem to reduce apparent size of black tip, so that clear black then seems confined to distal ridge and hook of maxillary unguis. Legs and feet, black. **JUVENILE.** Plumage as freshly moulted adult. Bill as adult except side-plates paler, appearing ivory or whitish, never with

bluish-grey tinge of juvenile Black Petrel; nostrils, saddle of culmen and maxillary unguis, entirely deep black, blacker than adult, with mandibular unguis same or little paler, in all forming large black ridge and tip to bill, contrasting strongly with whitish or ivory side plates. Legs and feet, black.

SIMILAR SPECIES Most likely to be confused with **Black Petrel**, which has similar all-dark plumage and similar bill-pattern, but distinctly smaller (c. 20%), less bulky, with more slender neck and smaller, more compact bill, with yellowish tone on side plates in adults, and ivory with blue-grey tinge in juveniles (not much paler cream or ivory as in adult and juvenile Westland); see Black Petrel account for fuller distinctions. Also likely to be confused with all-dark forms of **White-chinned Petrel**; if present, white patch on chin and throat readily separates White-chinned; almost identical in size, structure and flight; unguis appear wholly pale as side plates and never show conspicuous black or greyish black bill-tip (dark tip conspicuous on Westland, except in strong light when unguis reflective, giving impression of paler bill-tip with black confined to very tip); side plates have yellowish or greenish-horn tinge, though side plates can appear whitish in strong light. Bill, larger, with more vertically expanded maxillary unguis imparting bulkier, more bulbous bill-tip profile. **Flesh-footed Shearwater** also has all-dark plumage and pale, dark-tipped bill but is about one-third smaller, and much less bulky, with finer head, more slender neck and body, without bull-necked and deep-gutted appearance of Westland; wings shorter and narrower, tail less strongly wedged, even gently rounded and tips of feet do not project beyond tail-tip; distinctly browner, with narrow pale fringes to scapulars giving scaled appearance over base of up-piercing (uniformly blackish on Westland); at once separated by flesh-coloured legs and feet, and smaller, more slender bill, pinkish-horn basally with darker, more contrasting blackish culmen saddle and sulcus. **Flesh-footed** flies somewhat faster, more manoeuvrably, less laboured and with faster, shallower wing-beats. Juvenile-plumaged **giant-petrels** *Macronectes* spp much larger (c. 40%) with different jizz and larger unpatterned bills.

Mostly in subtropical waters but known to range S into lower latitudes of Subantarctic Zone. During breeding season, distribution centred in NZ waters. More pelagic during non-breeding season but sometimes sighted in shelf-break and outer continental shelf waters. Rarely sighted from land except off w. coast of SI, NZ, where form large rafts (sometimes containing > 1000 birds) 1–2 km offshore from breeding area before dusk. Flight identical to White-chinned Petrel, in light winds appearing somewhat laboured, with periods of sustained gliding and relaxed shearwatering low to water, interspersed with few unhurried wing-beats; innerwings gently bowed forwards to carpals, outerwings swept back slightly and tapering to point. Flight actions more confident and powerful at higher wind-speeds, progressing in shearwater-like arcs (to 10 m or more; wings held strongly flexed) or stronger albatross-like soaring, wheeling and banking motions. Swim well, showing buoyant carriage, with wing-points extending beyond tail-tip. Feed nocturnally and diurnally by surface-seizing, surface-diving and pursuit-plunging. Usually solitary at sea during non-breeding season; more gregarious during breeding season when large numbers (up to 500) congregate round fishing trawlers and compete with other procellariiforms for offal. Regularly follow ships. Breed colonially in densely forested country, only near Punakaiki R., w. coast of SI, NZ. Birds arriving at colonies circle above for few minutes

before landing. At night, call noisily from ground and from burrows; some occasionally call from burrows during day. Variety of harsh calls and cackles, mostly *coo-roo-rah*. Usually silent at sea.

HABITAT Marine. In breeding season, found in mixed waters of NZ continental shelves N of Subtropical Convergence; disperse eastward into pelagic waters of central Pacific after breeding when few records in NZ waters (J.A. Bartle; R.L. Pitman). Feed on trawling grounds, attracted by offal (Bartle 1974). Gather in rafts 1–2 km offshore from breeding grounds at dusk, before flying inland to colonies (Best & Owen 1976; Baker & Coleman 1977).

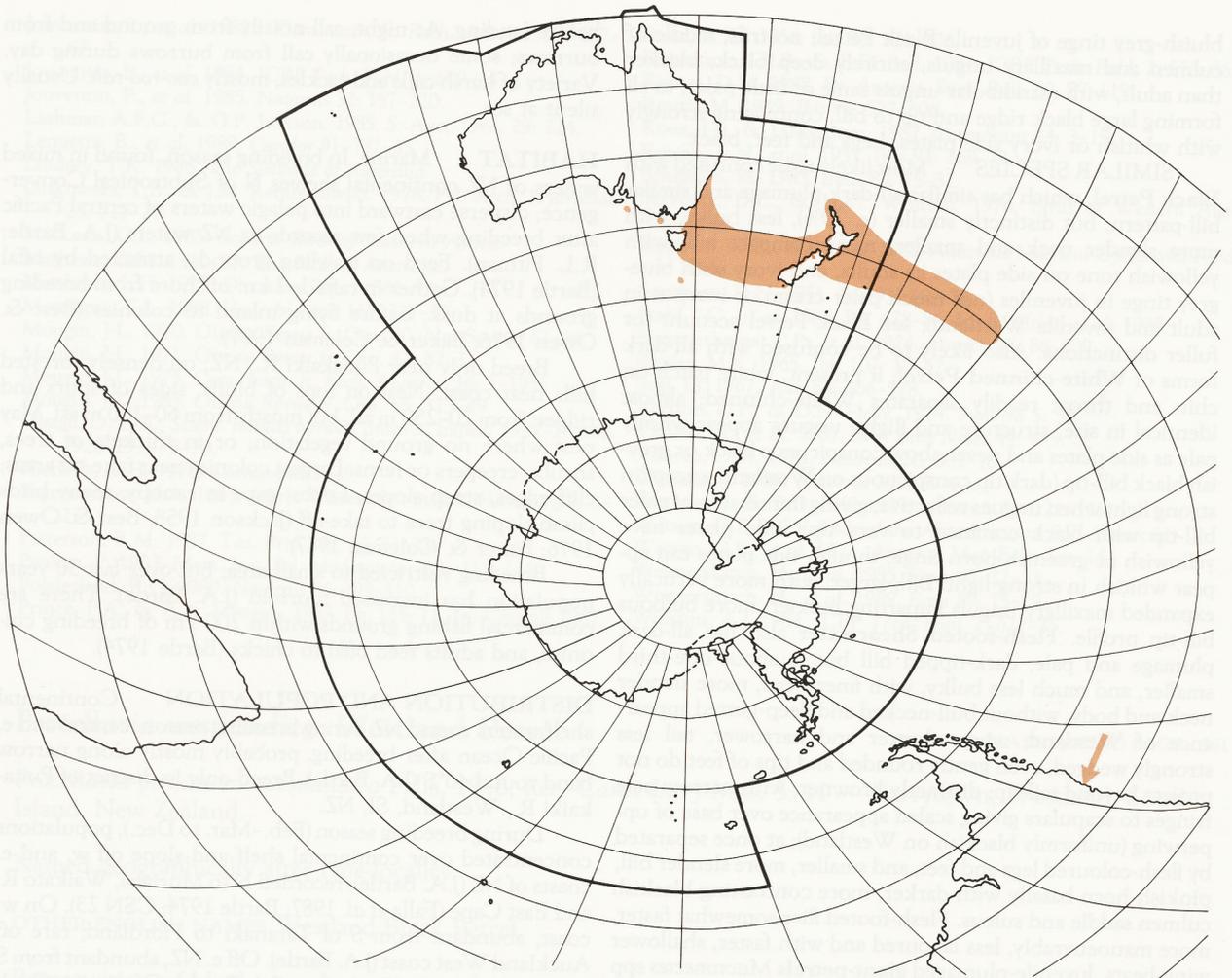
Breed only near Punakaiki R., NZ, on densely forested hills near coast. Nest on tops of bluffs, sides of spurs and ridges; from 20–250 m asl, but mostly from 60–100 m asl. May nest where no ground vegetation; or in thickets of trees, shrubs, creepers or ferns. Largest colonies near take-off areas; cliff edges, steep slopes, knobs, gaps in canopy; many birds climb sloping trees to take-off (Jackson 1958; Best & Owen 1976; Baker & Coleman 1977).

Breeding restricted to small area; but over last 30 years population has increased fourfold (J.A. Bartle). There are commercial fishing grounds within 200 km of breeding colonies, and adults feed offal to chicks (Bartle 1974).

DISTRIBUTION AND POPULATION Continental shelf waters round NZ during breeding season; central and e. Pacific Ocean after breeding, probably mostly along narrow band round 40°S (J.A. Bartle). Breed only in district of Punakaiki R., Westland, SI, NZ.

During breeding season (Feb.–Mar. to Dec.), populations concentrated over continental shelf and slope off w. and e. coasts of NZ (J.A. Bartle); recorded N to Muriwai, Waikato R. and East Cape (Falla *et al.* 1987; Bartle 1974; CSN 23). On w. coast, abundant from S of Taranaki to Fiordland; rare off Auckland West coast (J.A. Bartle). Off e. NZ, abundant from S of East Cape to N of Banks Pen. (J.A. Bartle). Often seen Cook Str., at e. approaches and from Tasman Bay to C. Campbell (Bartle 1974; CSN 22, 28–32); Cook Str. region (Wellington South, NI, and North Coast, SI) also had highest rates of recovery (beachcast birds/100 km) during regular beach patrols, 1960–86 (Powlesland 1989). During non-breeding season, apparent dispersal past Chatham Is (Clark 1989), E to central Pacific (J.A. Bartle) and possibly to S. American waters (recovery of two banded subadults in Chile). Birds rare in NZ coastal waters, Jan.–Feb. (J.A. Bartle). Rare in Tasman Sea beyond w. NZ shelf; extend N to c. 29°S in Tasman Sea in summer (Bartle 1974) with scattered records from Qld–NSW border to w. Tas. seas and probably to Great Aust. Bight.

AUST. Rare visitor, mostly in summer to se. Aust. waters; no confirmed records for SA, WA and NT (though unconfirmed sighting, single, off Robe, 2 Feb. 1989). **QLD.** One beachcast, Coolangatta, 1974 (Lindsey 1986); possible sighting, Pt Lookout, 15 July 1984 (Qld Bird Rep. 1984). **NSW.** Singles beachcast: Kingscliffe, 1 Jan. 1976 (Vernon 1977); Coffs Harbour, 14 Dec. 1976 (NSW Bird Rep. 1976); Cronulla, 12 Dec. 1958 (McGill 1959); Corrimal Beach, 2 Jan. 1956 (Gibson & Sefton 1956). Single sighted off Sydney Heads, 22 Jan. 1983 and possible sightings 27 Nov. 1982 and 6 Feb. 1983 (NSW Bird Repts 1982, 1983). **VIC.** Single beachcast, near Port Campbell, 15 Feb. 1989 (P.S. Lansley). **TAS.** Single, sighted, NW of King I., 17 Apr. 1984 (Bartram 1986); sightings, S of Tasman Pen., 1979: more than one on 1 and 25 Apr.,



singles 7 and 29 May (Carter 1980); singles, off se. Tas., 5 June 1985, 23 Sept. 1985, 15 Mar. 1986 (D.W. Eades); unconfirmed report, Seven Mile Beach, 1 Jan. 1989.

BREEDING Colonies found between Punakaiki R. and Lawson Ck catchment in Punakaiki region (Best & Owen 1976). Before 1958, reliably estimated 3000–6000 birds (Jackson 1958); in 1972, 6000–10 000 birds (Bartle 1974); in 1982, 1000–5000 breeding pairs (J.A. Bartle). Possibly now as many as 20 000 birds including breeding and non-breeding birds (J.A. Bartle).

Populations probably secure despite predation of eggs and chicks by mustelids and feral cats and modification of habitat by timber industry (Robertson & Bell 1984). Estimated that population may have increased fourfold in past 30 years, possibly because food (offal from trawlers) has increased (J.A. Bartle).

MOVEMENTS Migratory to eastern NZ waters and central Pacific to moult (J.A. Bartle; R.L. Pitman).

DEPARTURE Most young fledge late Nov. but fledging period ranges from early Nov. to late Jan; breeding birds leave NZ waters, Nov.–Dec. (J.A. Bartle; Baker & Coleman 1977; Jackson 1958).

NON-BREEDING Apparently migrates to e. NZ waters and central Pacific (E of Chatham Is) and off S. America (to Humboldt Current) (J.A. Bartle; R.L. Pitman). Subadults

may spend up to first 10 years in Humboldt Current (J.A. Bartle).

RETURN Arrival at breeding colonies varies; mid-Feb. to late Mar. (Jackson 1958; Bartle 1974; J.A. Bartle). Juveniles return to colonies aged 5–12 years (J.A. Bartle).

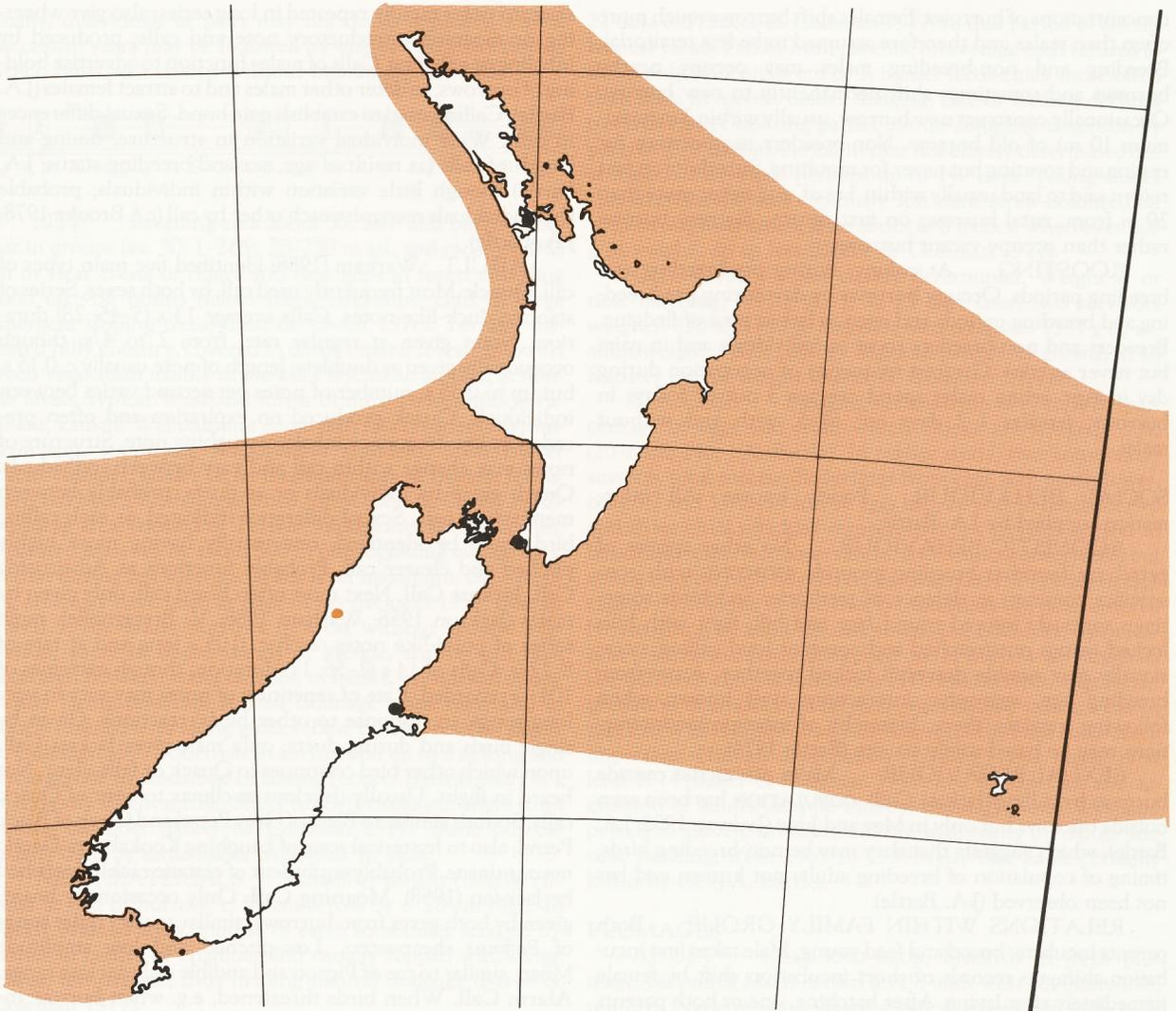
BREEDING Foraging range extends throughout cooler waters of NZ e. coast with birds passing through Cook Str. (Bartle 1974). Records from e. Aust. waters also occur throughout year but mostly in summer (McGill 1959; Gibson & Sefton 1956; Vernon 1977; Carter 1980, 1981; Blaber 1986; Bartram 1986; D.W. Eades); may be mostly juvenile and sub-adult birds; numbers considered insignificant (J.A. Bartle).

BANDING

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FOOD Mostly cephalopods and fish, occasionally crustaceans. **BEHAVIOUR.** Most food obtained by surface-seizing (6 of 6 observations; Ainley & Boekelheide 1983) and surface-diving, occasionally pursuit-plunging (Harper *et al.* 1985). Seen surface-seizing crustaceans at night near fishing boats (Bartle 1974) but also feed during day. Seen feeding in association with Royal Albatross *Diomedea epomophora*, Fairy Prion *Pachyptila turtur* and Great-winged Petrel *Pterodroma macroptera* (Ainley & Boekelheide 1983). Began taking offal from fishing boats in late 1950s (Bartle 1974) and now often



does so (Vooren 1977).

BREEDING At breeding colony (12 stomachs, 143 items; Imber 1976, with corrections by M.J. Imber) cephalopods 89.5% no., 100% freq. comprising *Abralia* 0.7% no., *Octopoteuthis* 0.7, *Moroteuthis ingens* 0.7, *Gonatus antarcticus* 2.1, *Histioteuthis* (incl. *H. atlantica*, *H. eltaninae*, *H. macrohista*, *H. meleagroteuthis*, *H. miranda*) 39.9, *Brachioteuthis* 0.7, *Nototodarus* spp 7.7, *Chiroteuthis* 10.5, *Taonius* sp. 2.1, *Teuthowenia pellucida* 20.3, unident. Cranchiidae 1.4, rest, fish 10.5% no., 41.7% freq. incl. *Argentina* 3.5% no., otolith length 0.41–0.52 cm, Gonostomatidae/Photichthyidae 0.7, 0.18 cm, Myctophidae 0.7, 0.21 cm, *Coelorinchus* 1.4, 0.43–0.52 cm, unident. Macrouridae 1.4, 0.60–0.89 cm, unident. fish 2.8. Regurgitated oil, dark straw-coloured with fishy odour (Baker & Coleman 1977).

SOCIAL ORGANIZATION Reasonably well known from studies since 1969 by J.A. Bartle, who supplied all information. Gregarious at sea; breeds colonially, only on SI, NZ. Outside breeding season, most reports of solitary birds.

BONDS Sustained or long-term monogamous. Sex-ratio on breeding grounds biased towards males, through greater mortality of females. Minimum age of first return to

colony, 5 years. Age of first pairing, 8–12 years; minimum age of first breeding, 12 years.

BREEDING DISPERSION Colonial; burrows scattered or clumped depending on terrain. **TERRITORIES.** Males highly territorial; females less so than males. Males arrive up to 3 months before laying and establish and defend territory of c. 1 m round burrow by singing in front of burrow and fighting, which occurs commonly (see Agonistic Behaviour); however, strange females sometimes accepted by territorial males even if both mated. Territory maintained and vigorously defended throughout incubation but not during later stages of fledging, when fledged chicks often enter and occupy burrows of other pairs. Exceptionally, burrows have common entrance and then result of conflict unknown. Many burrows occupied by solitary males. Non-breeding birds also territorial but never succeed in conflicts with established males. Burrows essentially permanent unless disturbed or destroyed when birds will shift; usual reason for shift is inadvertent opening of additional shafts into nest-chamber by extending length of burrow, or collapse of burrow by natural weathering or trampling by goats or humans. In about 100 pairings studied during 13 years, <10% of males have maintained same burrow without shifting; those that did not shift were outside dense

concentrations of burrows. Females shift burrows much more often than males and therefore assumed to be less territorial. Breeding and non-breeding males may occupy nearby burrows and sometimes shift permanently to new burrow. Occasionally construct new burrow, usually within 3 m (maximum 10 m) of old burrow. Non-breeders use burrows for resting and roosting but never for moulting. Subadults on first return said to land usually within 3 m of, and never more than 20 m from, natal burrow; on first return, dig new burrow rather than occupy vacant burrows.

ROOSTING At colony, during pre-breeding and breeding periods. Occupy burrows by day during pre-breeding and breeding periods and even as late as time of fledging. Breeders and non-breeders roost as individuals and in pairs but never as trios. Greatest frequency of occupation during day in Apr. when males spend average 3 out of 5 days in burrows, females 1-2 days out of 5, with and without males.

SOCIAL BEHAVIOUR Poorly known. All information supplied by J.A. Bartle.

AGONISTIC BEHAVIOUR No other species of petrel are found at breeding grounds. **FIGHTING** with conspecifics common in defence of territories and birds sometimes seriously injured round face and bill; fight with bills locked, wings outstretched and constant loud calling; occasionally may tumble downhill locked together. Away from breeding site, aggressive interactions well known when following trawlers; there, hierarchy of interspecific interactions may be based solely on size (Bartle 1974).

SEXUAL BEHAVIOUR Males **ADVERTISE** outside burrows by calling (Jackass Call). **COPULATION** has been seen outside burrows but only in May and June (Jackson 1958; J.A. Bartle), which suggests that they may be non-breeding birds; timing of copulation of breeding adults not known and has not been observed (J.A. Bartle).

RELATIONS WITHIN FAMILY GROUP Both parents incubate, brood and feed young. Male takes first incubation shift; no records of short incubation shift by female immediately after laying. After hatching, one or both parents stay with chick during day for up to 6 weeks (c.f. White-chinned Petrel). Feed chick nightly until fledging; feeding takes about 5-30 min, perhaps depending on age of chicks; adults may stay in burrow with chick after feeding but more often leave for sea soon after. Chick may be fed at any time after dark but most often within 2 h of dusk; fed more often by female toward end of period. Independent after fledging.

VOICE Detailed study by Warham (1988) and J.A. Bartle who supplied information. Silent at sea; noisy at breeding colonies where adults present Feb. to Dec. (J.A. Bartle). Warham (1988) recorded calls during May (laying) and Sept. (chick rearing); data from Warham (1988) unless indicated. Call during 2 h after sunset as birds land at colony, rapidly declining thereafter till birds begin displaying at entrances to burrows in morning before leaving colony (J.A. Bartle). Males call mostly from entrance to burrows and also in burrows when females are also present; sometimes call briefly from burrows during day; nearly always silent in flight (J.A. Bartle). Calls similar to those of other species of *Procellaria*, consisting of series of rapidly repeated staccato notes over wide range of frequencies; wheezy or moaning notes or calls similar to calls of shearwaters. Westland has most extensive repertoire of any *Procellaria*. Five main types of call, mainly consisting of short

staccato notes rapidly repeated in long series; also give wheezing or moaning introductory note and calls; produced by inhaling or exhaling. Calls of males function to advertise holding of burrows, to deter other males and to attract females (J.A. Bartle). Calling used to establish pair-bond. Sexual differences in calls. Wide individual variation in structure, timing and length of calls (as result of age, sex and breeding status; J.A. Bartle) though little variation within individuals; probable that individuals recognize each other by call (c.f. Brooke 1978; J.A. Bartle).

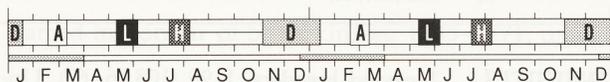
ADULT Warham (1988) identified five main types of call. **Quack**. Most frequently used call; by both sexes. Series of staccato duck-like notes. Calls average 13 s (5-45; 28) duration. Notes given at regular rate, from 2 to 4/s, though occasionally given as doublets; length of note usually c. 0.15 s, but up to 0.35 s; number of notes per second varies between individuals. Quack produced on expiration and often preceded by low-frequency inhalatory sighing note. Structure of notes may change within call and vary between individuals. Quack given by individuals or as duets, probably between members of pair. Sexual difference indicated, as each calling bird could be identified, one usually having more highly pitched and clearer call. Probably functions as Advertising Call. **Jackass Call**. Next most often heard call; only given by males (Jackson 1958; Warham 1988; V. Bretagnolle); rapid series of pulse-like notes, each c. 0.05 s long and at rate of 8-12/s. Calls of 14 s (2-56; 17) duration, though extremes of 104+ s recorded. Rate of repetition of notes may vary in very long songs, in response to other birds' reactions. Given by single birds and during duets; only male gives Jackass Call, upon which other bird continues to Quack or falls silent. Not heard in flight. Usually develops as climax to bout of Quack calls. Sounds similar to Bleat of Grey Petrel and Clack of Black Petrel; also to hysterical song of Laughing Kookaburra *Dacelo novaeguineae*. Probably equivalent of ecstatic cackle described by Jackson (1958). **Moaning Call**. Only occasionally heard; given by both sexes from burrows; similar to very quiet songs of *Puffinus* shearwaters. Low-pitched and low amplitude Moan, similar to *coo* of Pigeon and audible only at close range. **Alarm Call**. When birds threatened, e.g. when burrow invaded, they emit yells that range from strident squawks to high-pitched screams. **Aerial Call**. Occasionally, birds call in flight to and from, and over, colony (Warham 1988; Baker & Coleman 1977; Jackson 1958); possibly answered by birds on ground (Jackson 1958). Aerial Calls consist of short Quack or sometimes deeper repeated brief Croaks.

YOUNG Chicks have special feeding call: series of rapid low notes normally uttered only when adult enters nest chamber; given immediately before and sometimes while being fed.

BREEDING Reasonably well known. Breeding grounds discovered in 1946 (Falla 1946). Studied from 1969 to present by J.A. Bartle; studies also by Jackson (1958) and partial study by Baker & Coleman (1977). Information supplied by J.A. Bartle. Breed colonially during winter in forested hilly country.

SEASON Birds return to colony from mid-Feb. to late Mar. Laying well synchronized and constant from year to year, starting about 12 May, peaking about 23 May with few eggs laid in June. No pre-laying exodus, though females less often ashore in three weeks before laying (J.A. Bartle). Hatching mostly in last half July and fledging between 5 Nov. and 15 Jan., with peak about 20 Nov. Though breeding occurs an-

nually, individuals or pairs may not do so regularly; 1 or 2 successful years may be followed by one or two years during which birds visit colony without breeding (J.A. Bartle).



SITE Breeding area about 3.6 km² and burrows occur in groups (av. 30; 1–265), 20–250 m asl, and mostly (90%) on or near crests of ridges and near gaps in forest affording good take-off points (fallen trees, land-slips, cliffs or large emergent sloping trees) (Best & Owen 1976). Terrain, dissected hilly country, covered in dense coastal forest; at lowest levels vegetation mainly of kie-kie *Freycinetia banksii*; at middle levels, typical Westland forest of miro *Podocarpus ferrugineus*, kamahi *Weinmannia racemosa*, rata creepers *Metrosideros* spp, supplejack *Rhipogonum scandens*, bush lawyer *Rubus cissoides*, ladder ferns *Blechnum* spp; at highest levels, open red beech *Nothofagus fusca* forest (Best & Owen 1976). Breeding area, formed of Tertiary mudstones and siltstones, separated from sea by about 500 m of prograding coastal flats, so that during last interglacial sea-level maximum, the breeding area may have been at edge of sea (Jackson 1958; Best & Owen 1976). Many burrows in areas without ground vegetation; some in dense stands of kie-kie, shrubs and rata; excavated between roots of trees, in banks, on sides of spurs; mostly facing downhill so that drainage made easy; also in poorly drained sites along gullies (Best & Owen 1976; Baker & Coleman 1977). Burrows in surface soil up to 2 m long and 20 cm across; in sandstone or among roots of trees as short as 1 m and only 12 cm across. Short tunnels usually at angle from nesting chamber (Baker & Coleman 1977). Same burrow usually used by same males from year to year.

NEST, MATERIALS Chamber usually roughly circular at end of burrow, c. 55 cm across by c. 20 cm high. In poorly drained areas, mound of earth sometimes scraped together in centre of chamber and usually topped with twigs, leaves, fern-fronds, thus helping natural drainage (Baker & Coleman 1977).

EGGS Broad, ovate; not glossy; white.

MEASUREMENTS.

81.1 (0.42; 26) x 55.6 (0.24).

WEIGHTS.

At about 3 weeks incubation, c. 130 g; with loss of weight at rate of 7.6 g in 3 weeks, total loss during incubation c. 20 g and fresh eggs could weigh up to 150 g (Baker & Coleman 1977).

CLUTCH-SIZE One. No replacement laying or second broods.

LAYING Well-synchronized (see above); 87% of eggs laid in 3 weeks in May (Baker & Coleman 1977).

INCUBATION By both sexes in alternate shifts. Female leaves soon but not necessarily immediately after laying and male takes first stint. **INCUBATION PERIOD.** Not closely determined but minimum possible 51 days, max. 68+ days; three best estimates gave c. 57, c. 65, c. 63 days (Baker & Coleman 1977).

YOUNG Altricial, nidicolous. Hatched in down (undescribed). Mesoptile appears when 6–8 days old; at 4 weeks old feather shafts of teleoptile appear on wings and body; at about 8–9 weeks old, primaries, secondaries and contour feathers emergent. Attended by parents for about 2 weeks (Jackson 1958) but unattended chicks noted from 4 to

21 days old (Baker & Coleman 1977) so that period of attentiveness varies. Fed by both parents; on average each returns to do so only on 1 night out of 3; female feeds chick more often than male in month before fledging; rate of feeding declines towards end of nestling period but no complete desertion by parents (J.A. Bartle). Period in nest not closely determined but at least 120 days and perhaps up to 140 days. Young chicks characteristically and copiously spit dark straw-coloured oil with strong fishy smell; after about 6–8 weeks, when over 800 g in weight, do so less (Baker & Coleman 1977).

GROWTH Not closely determined. Weight at or near hatching, 98.3 g (8.33; 3); 23 days later, two survivors weighed 630 and 750 g. Heaviest bird weighed: 1384 g (cf av. adult weight, 1100–1200 g). Sigmoid pattern of growth in all features except weight (Baker & Coleman 1977).

SUCCESS Fledging success from 1977 to 1988 (percentage of eggs laid from which chicks are fledged), 37% (20–63%; 146; J.A. Bartle). In earlier study, two consecutive seasons, total success (fledgelings from eggs laid) much lower, only 5.7 and 3.0% (35 and 66 eggs laid, 26 and 36 hatched, two and three chicks fledged respectively) but samples subject to biases and imperfect observation, and results conservative but erring only on high side (Baker & Coleman 1977). Loss of eggs caused by collapse of burrows (5), infertility (2), dead embryo (4), smashing by adult (3), unknown (25); of chicks, by predation (2), infanticide (2), scratched out of burrow by subadults (2), fall over cliff (1) unknown (51). **PREDATION.** Significant predation of chicks by feral cats; predation by stoats, weasels, rats and Wekas *Gallirallus australis* occurs but not considered important. Human depredation ('birding') took place till at least 1974 (Baker & Coleman 1977; J.A. Bartle). Size and aggression of adults (despite burrow-nesting) allows Westland petrels to survive on mainland site with many predators and near housing; from 1969 to 1989, only one adult certainly killed by cat (J.A. Bartle).

PLUMAGES

ADULT HEAD AND NECK, blackish in fresh plumage, becoming black-brown (c119) with wear. **UPPERPARTS,** uniform black-brown. When fresh, feathers blackish with narrow grey (79) frosted tips, and concealed light-grey bases. Feathers become browner with age; when very worn, dark brown (221) with narrow brownish (239) tips. In autumn, differential wear makes head and neck seem slightly darker than rest of body. **TAIL,** blackish becoming blackish brown (221) with wear. **UPPERWING.** Most coverts as upperparts; some primary coverts of most birds with short off-white to buffish shaft-streaks. These shaft-streaks sometimes seen on innermost primaries. Remiges, black (82–89) when fresh with dark to blackish grey (83–82) inner webs. When worn, remiges, dark brown (221) with grey-brown inner webs. Shafts of outer primaries, brownish at base. **UNDERPARTS,** as upperparts, but frosted tips narrower. **UNDERWING,** similar to upperwing, but duller; coverts do not change colour with wear. Remiges and greater under wing-coverts show strong grey (c84) gloss especially at bases in strong direct light. Outer primaries have strong black (82–89) tegmen.

Some birds have small patches of white feathers on throat, rump or belly; retained through successive moults (J.A. Bartle).

JUVENILE At breeding grounds, and beachcast birds in first summer, as fresh adult. In about 1% of fledgelings, especially those last to depart colony with low weights, last-grown feathers brittle with short barbules practically ab-

sent on fringes. This is most severe on breast and belly, which often appear dark grey (c83), and also often on primaries and greater coverts. A few of these birds have dark greyish (c83) median and secondary coverts, and greyish (c83) to light-brown (119B-119C) breast and belly. This condition not caused by wear or parasites but believed due to nutrient imbalance in diet given to chicks (J.A. Bartle). These fledgelings are never progeny of experienced breeders and may have been fed mostly with offal from trawling (J.A. Bartle).

DOWNY YOUNG No data.

BARE PARTS

ADULT Naricorn, culminicorn and sulcus, black (c89). Ungues, black (89) to grey-black (82); base of maxillary unguis may have horn-grey patch of varying extent. Latericorn and ramicorn, cream-white to cream (54). Top of nostrils, ivory-grey (85). Opening of nostrils, usually black (89), sometimes whitish. Bill has rather flaky texture, increasing with age (J.A. Bartle). Iris, dark brown (219). Tarsus, feet and claws, blackish (82).

JUVENILE Bill, smooth; pattern similar to adult. Maxillary unguis, jet-black (89); horn grey patches at base absent before leaving breeding grounds. Tas. beachcast, Jan. (ANWC), believed to be juvenile on basis of smooth bill and deformed upper wing-coverts, had developed small horn-grey patch on sides of maxillary unguis. Similar markings also seen on juvenile (aged on feather deformity) beachcast Vic., Feb. (M.J. Carter). Mandibular unguis, blackish but noticeably paler than maxillary unguis.

MOULTS

ADULT POST-BREEDING Pre-basic. Flight feathers replaced between Dec. and Mar. Few breeding females completing outwards primary moult (moult score 49) collected in Apr. and May (NMNZ). Body-moult continues at breeding grounds in Apr. and May until June at latest, seeming to finish latest in females (J.A. Bartle).

POST-JUVENILE No information. Two juveniles with feather deformity, beachcast first summer, had not begun moult. Birds moulting flight-feathers at sea off w. SI in Sept., probably non-breeding sub adults (J.A. Bartle).

MEASUREMENTS (1) Skins (NMNZ). (2) Breeding adults, live; straightened chord recorded (Baker & Coleman 1977). (3) Non-breeding birds, live; straightened chord recorded (Baker & Coleman 1977).

BILL	(2)	50.4 (2.05; 67)
	(3)	49.3 (2.08; 30)
TARSUS	(2)	64.6 (1.72; 67)
	(3)	63.6 (1.97; 30)

WEIGHTS Unsexed breeders: 1199 (108.86; 67). Unsexed non-breeders: 1117 (78.3; 30) (Baker & Coleman 1977). Mean weight in Apr. varied from year to year: males 1171-1294 g (n=2192), females 1108-1244 g (n=739). Females heaviest in late Apr., males in early May and early June (J.A. Bartle). Although weights of males and females overlap, within a pair male usually heavier, especially in May (J.A. Bartle).

STRUCTURE Eleven primaries, p11 minute. Primaries 9 and 10 about equal in length; p10 up to 5 shorter, p9 up to 7 shorter; p8 11-22, p7 35-50, p6 60-78, p5 89-109, p4 107-141, p3 150-174, p2 176-204, p1 201-228. Tail, rounded; 12 feathers. Bill, shorter and deeper than *P. aequinoctialis*; nares about two-fifths of length. Nostrils point forwards and have rounded edges; line along culminicorn to top of maxillary unguis fairly straight. Middle and outer toes about equal in length; outer toe 1.5-3.7 longer; inner 5.1-12.2 shorter than middle. Hallux, small.

RECOGNITION From *P. aequinoctialis* on bill colour and shape. Closely similar to *P. parkinsoni*, from which differs in larger size (see Measurements). Bill of *westlandica* appears more robust, because line along culminicorn to dome of maxillary unguis fairly straight in *westlandica*, concave in *parkinsoni*. In *westlandica*, tip of maxillary unguis touches imaginary line drawn parallel to bottom of ramicorn and touching lower base of maxillary unguis. In *parkinsoni*, tip of maxillary unguis usually well below this imaginary line.

DIR

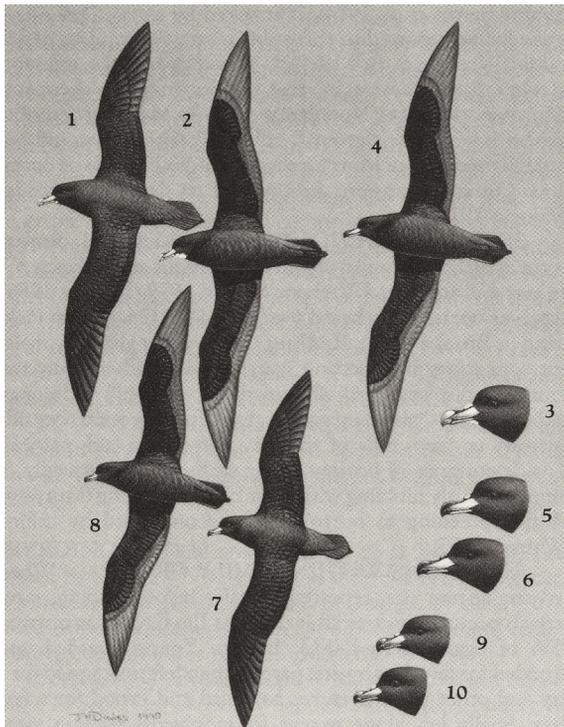
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	MALES	FEMALES
WING	(1) 385.6 (10.03; 364-400; 10)	381.5 (8.75; 362-396; 12)
8TH P	(1) 230.3 (6.47; 218-240; 10)	227.6 (7.03; 218-240; 14)
TAIL	(1) 122, 129	125.3 (124-126; 3)
BILL	(1) 48.4 (47.8-49.2; 3)	46.6 (124-126; 3)
TARSUS	(1) 63.4 (60.2-67.0; 3)	61.9 (57.9-66.9; 3)
TOE	(1) 79.2 (71.8-84.6; 3)	78.5 (76.6-82; 3)
UNSEXED		
WING	(2) 384 (9.82; 67)	
	(3) 386 (10.41; 30)	
TAIL	(2) 128 (5.73; 67)	
	(3) 125 (4.93; 30)	



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Volume 1 (Part A), Plate 42

White-chinned Petrel *Procellaria aequinoctialis*

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

Westland Petrel *Procellaria westlandica*

- 4. Adult, ventral, fresh
- 5. Adult
- 6. Juvenile

Black Petrel *Procellaria parkinsoni*

- 7. Adult, dorsal, fresh
- 8. Adult, ventral, fresh
- 9. Adult
- 10. Juvenile

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