

Order **PROCELLARIIFORMES**

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

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

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

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

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

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

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

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Family PROCELLARIIDAE fulmars, petrels, prions, shearwaters

The family Procellariidae represents the main radiation of medium-sized 'true petrels', characterized by having united nostrils with a median septum and the outer functional primary at least as long as the next. It tends to be dominant among the birds of the Southern Ocean, though in the n. hemisphere the Charadriiformes are more numerous. The giant-petrels *Macronectes* have also developed as large scavengers and predators, showing some convergence in appearance and behaviour with the 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 solandri Providence Petrel

COLOUR PLATE FACING PAGE 401

Procellaria solandri Gould, 1844, *Proc. zool. Soc. London*: 57 — no locality = Bass Strait *vide* Gould, 1844, *Ann. Mag. nat. Hist* 13: 363.

Named in honour of Dr D.C. Solander, FRS, 1733–1782, Swedish botanist, who accompanied Captain Cook in HMS Endeavour 1768–1771 and was attached to the British Museum from 1763 to 1782.

OTHER ENGLISH NAMES Bill Hill Muttonbird, Bird-of-Providence, Brown-headed or Solander's Petrel.

Providence Petrel and **Bird-of-Providence** commemorate survival of penal colony on Norfolk Island in 1790, when, faced with famine, the islanders ate the petrels, and in consequence of their survival named them 'birds of providence'. This and depredation of introduced pigs exterminated species on Island, where it had not been recorded since 1800. However, in 1985 discovered nesting on Philip I. nearby.

MONOTYPIC

FIELD IDENTIFICATION Length 40 cm; wingspan 95–105 cm; weight: 500 g. Large, heavily built, stout-billed gadfly petrel; mainly dark grey-brown with grey mantle, brown head with scaly white face, brown wings and tail; white patches on underside of primaries show in flight. Appear brown at long range but grey when closer. Flight slow and easy, typical gadfly petrel in strong winds. Resembles other large dark gadfly petrels, especially Great-winged Petrel *P. macroptera* and dark morphs of Kermadec *P. neglecta* and Herald *P. arminjoniana* Petrels. Sexes alike. No seasonal variation. Immatures similar to adults but may have white-edged feathers on back, and slimmer bills.

DESCRIPTION **ADULT.** Head, grey-brown; forehead, cheeks and chin, scaled with white; darker patch in front of eye. Upperwing, slate-grey tinged with brown; pri-

maries, blacker with white edge on basal half of inner webs. Mantle, mottled slate-grey contrasting with darker upperwings; back, dark grey; tail-feathers, slaty brown with pale bases. Throat and upper breast, slaty grey, contrasting with paler brown-grey underparts; bases of all body feathers, white. Underwing, dark grey with prominent cream-white patch formed by whitish bases of primaries and outer coverts; dark tips to coverts form narrow black line through underwing flash. Iris, brown. Bill, stout and black. Legs and feet, usually grey-black, occasionally patterned with pale grey-flesh on leg and inner webs.

SIMILAR SPECIES **Great-winged Petrel:** subspecies *gouldi* has similar pale face contrasting with dark plumage but darker generally and with totally dark underwing, except when light reflected from primaries. **Murphy's Petrel** *P.*

ultima also darker, with dark underwings and bicoloured pink and black feet. Dark morphs of **Kermadec** and **Herald Petrels** closely resemble Providence Petrel in having pale patches at base of primaries on underwing. **Kermadec Petrel** (dark morph), darker and browner in general; mantle does not contrast with upperwings, nor does head appear darker than underparts; has diagnostic pale primary shafts that show as skua-like patch on upperwing in good viewing conditions. **Herald Petrel**: all morphs have more white on underwing, extending as line along base of secondaries and secondary coverts towards body. Flight silhouette of Providence Petrel recalls **Wedge-tailed Shearwater** *Puffinus pacificus* but Providence Petrel has stubbier bill, thicker neck, narrower wings and shorter tail.

Pelagic but occasionally sighted offshore near continental shelf. On Lord Howe I., breeding colonies on forested mountain slopes. Flight slow and steady with prolonged glides and high banking turns in calm conditions. In higher winds, typical dashing gadfly flight. Solitary; do not follow ships. Silent at sea; over breeding colonies give loud, rapidly produced screeching *kir-rer-rer*, *kik-kik-kik*; on ground have deeper, trilling *ker-rer*, *kuk-kuk-kuk*, *ker-rer*.

HABITAT Marine, pelagic; in subtropical and tropical waters of sw. Pacific Ocean, some birds migrating to North Pacific and Bering Sea in non-breeding season. Preferences for water of different surface-temperatures in breeding range not known; warm waters of E. Aust. Current in Tasman Sea and edge of continental shelf off e. Aust. coast may be favoured feeding areas for breeding birds (Holmes 1977; Cheshire & Jenkins 1981). In n. hemisphere in non-breeding season, observed over seas of wide range of surface-temperatures, 3.5–28 °C, concentrating along convergences of warm and cold currents; some immature and non-breeding birds near Subarctic Front in breeding season (Kuroda 1955; Wahl 1978; Nakamura & Tanaka 1977; Tanaka 1986). Occur to edge of continental shelf, and rarely nearer shore (King 1967; Holmes 1977; Tanaka 1986).

On Lord Howe I. nest in burrows or rock crevices on forested, upper slopes and summits of mountains up to 600 m asl, with smaller numbers on grassy slopes at low altitudes (Hindwood 1940). On Norfolk I., nests on cliff tops of Philip I. (Hermes 1985; Hermes *et al.* 1986).

Glide low over calm seas; in windy conditions, soar in high arcs (Nakamura & Tanaka 1977). Occasionally rest on water (Kuroda 1955).

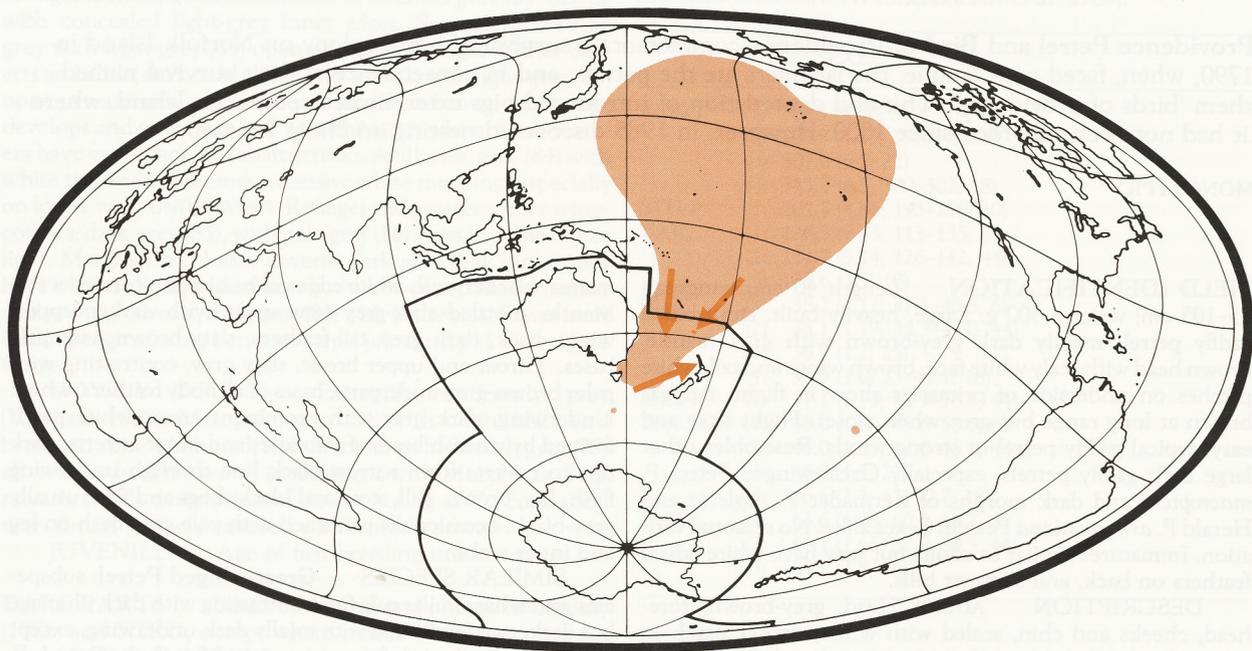
On Lord Howe I., there may have been more colonies at low altitudes before settlement.

DISTRIBUTION AND POPULATION Pelagic distribution, particularly during non-breeding season, poorly known. Mainly subtropical in sw. Pacific Ocean, including n. Tasman Sea, some birds migrating to North Pacific and Bering Sea. Tentative sight records in mid Pacific, off Hawaii, in Apr., Oct. and Nov. (King 1970).

During breeding season, found in waters off e. Aust. coast (Cheshire & Jenkins 1981); do not range widely E of breeding areas in s. hemisphere. Some juveniles and non-breeders present North Pacific, where reported from Japanese waters and near Ryuku Is (Kuroda 1955; King 1970; Nakamura & Tanaka 1977; Tanaka 1986); also Gulf of Alaska; up to 20°N in e. tropical Pacific; in Subantarctic Current, between 47°–56°N and 144°–180°W (56°N, 145°W, ne. most record) and n. California (Wahl 1978, 1982; Bailey *et al.* 1989).

In non-breeding season, observed in e. Aust. waters in most months, though rare or absent Dec–Feb.; in North Pacific, reported by Tanaka (1986) to be more widely spread W to E in non-breeding than in breeding season.

AUST. Once believed to be casual visitor to e. Aust. Observed in moderate numbers near edge of continental shelf about E. Aust. Current, between Fraser I. and se. Tas. from Mar. to Nov.; most often off n. NSW and se. Qld coast where regular from Apr. to Oct.; numbers decline southward, first record from Vic. waters being three observed 90 km S of Bemm R., 23 Apr. 1983 although later sightings indicate regu-



lar visitor to offshore water in e. Bass Str. from autumn to late spring. (Holmes 1977; Aust. CL; Tas. Bird Rep. 1979; Cheshire & Jenkins 1981; Harrison 1983; Aust. Atlas; NSW Bird Rep. 1983; Vic. Bird Rep. 1983).

NZ Accidental; two records of beachcast birds; Muriwai, Jan. 1921; W of Dargaville, 22 Sept. 1984 (Falla 1933; Miller 1986).

BREEDING At Lord Howe I., breeds on Mt Lidgibird and Mt Gower; in 1975, estimated 27 000 breeding pairs on Mt Gower with estimated total population of 96 000 (P.J. Fullagar).

Exterminated on Norfolk I. by convicts and by introduced pests such as pigs and goats between 1790 and 1800; discovered breeding on nearby Philip I. in 1985; estimated at least 20 birds and at least four nesting burrows (Hermes 1985; Hermes *et al.* 1986).

MOVEMENTS Trans-equatorial migrant to ne. Pacific though movements poorly understood because some records in n. hemisphere coincide with winter breeding season at Lord Howe I. and recorded from e. Aust. waters in all months except Jan. (McGill 1955; Holmes 1977; Tas. Bird Rep. 1979; Gosper 1981; Mochizuki & Kasuga 1985; Qld Bird Rep. 1986; Smyth & Corben 1984; D.W. Eades)

DEPARTURE Leave Lord Howe I. late Oct.-early Nov. (Hindwood 1940; McKean & Hindwood 1965; P.J. Fullagar). Most birds have left Aust. waters by Dec. although a few remain in waters off e. Tas. in that month (D.W. Eades) as far S as Subtropical Convergence (M. Carter; N.G. Cheshire).

NON-BREEDING Away from breeding areas little known. Most appear to move into w. North Pacific; in n. hemisphere, more widely spread from W to E in non-breeding than in breeding season (Tanaka 1986).

RETURN Arrive Lord Howe I. late Feb.-Mar. (Hindwood 1940; McKean & Hindwood 1965; P.J. Fullagar). Although recorded Tas. in Feb. (Mochizuki & Kasuga 1985), most move into e. Aust. waters during Mar. with considerable numbers being sighted off e. Tas. late Mar.

BREEDING Highest densities off continental shelf of mainland Aust. and Tas. Mar.-Nov. (NSW Bird Rep. 1983; D.W. Eades). Some birds remain in North Pacific, being mainly concentrated along Polar front; May to Aug., in warmer currents off Japan but also reported July-Aug. between 47-56°N and 144-180°W and in very low numbers up to 20°N in e. tropical Pacific from May-Nov. (Kuroda 1955; Nakamura & Tanaka 1977; Wahl 1978, 1982; Tanaka 1986).

FOOD Fish, cephalopods, crustaceans and offal all reported but essentially unknown. **BEHAVIOUR.** No descrip-

tions of feeding but have been seen feeding near Humpback Whale *Megaptera novaeangliae* (Tarrant 1989) and near fishing boats with Buller's Shearwaters *Puffinus bulleri* (Kuroda 1955). Observed feeding at night (J. McKean). Sometimes in flocks of up to 50 (Nakamura & Tanaka 1977).

NON-BREEDING Recorded taking swordfish offal in North Pacific (Kuroda 1955).

BREEDING Regurgitations at feeding colonies have contained small fish, cephalopods, crustaceans and offal (HASB; P.J. Fullagar).

SOCIAL ORGANIZATION, SOCIAL BEHAVIOUR

No detailed information. At sea, singly or in flocks. Sometimes feed in flocks of up to 50 (Nakamura & Tanaka 1977). Seen in thousands during breeding season. Breed in densely spaced colonies and vigorously defend area close round burrow from other birds. During breeding, some birds roost on ground at night and depart just before dawn. At Lord Howe I., tame; can be called in by loud shouting. From Mar. to Aug., **COURTSHIP** chases in pairs occur over colonies in which groups of calling birds wheel and dive in upcurrents round mountaintops; activity increases from mid-morning to peak numbers in late afternoon (P.J. Fullagar). Both male and female incubate. After hatching, activity during day-time over colony diminishes, possibly because unemployed birds leave. Adults return at night, only briefly, to feed chicks.

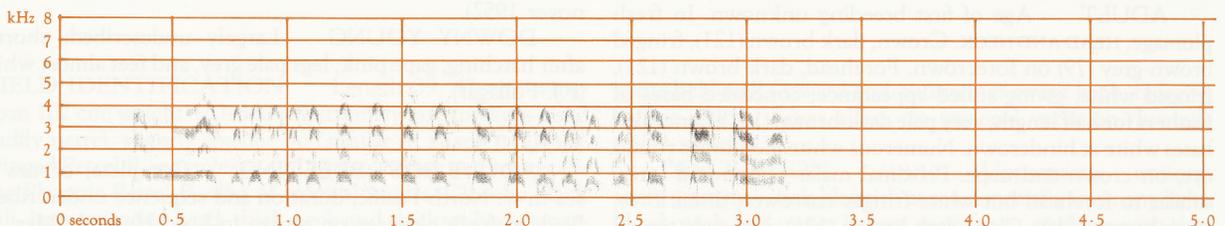
VOICE No detailed study. Information based on observations by P.J. Fullagar. Noisy at colonies from Mar. to Aug. Loud calling accompanies courtship chases on the wing and territorial disputes on ground. Birds easily incited to call and gather at any point of disturbance, including shouting (Hindwood 1940). Sexual differences in call and individual variation not known.

ADULT When flying, produce loud screeching rapidly repeated *kir-rer-rer*, *kik-kik-kik*. On ground at breeding colony, utter higher pitched warbling *ker-rer*, *kuk-kuk-kuk*, *ker-rer* (sonagram A).

Young. Calls typical of petrel chicks; soft peeping.

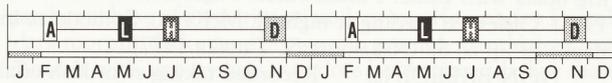
BREEDING No detailed study for whole nesting cycle; observations on Lord Howe I. by P.J. Fullagar, and on Philip I., Norfolk I. by N. Hermes. Breed colonially, in dense concentrations on Lord Howe I., in small colony on Philip I.

SEASON Winter breeder (Feb.-Nov.). Birds return 13-18 Feb. to select and occupy sites, plentiful by mid-Mar. Pre-laying exodus confidently supposed by P.J. Fullagar, supported by data from Lt. R. Clark's diaries (1790; see Whitley 1934). Laying mid- to late May (P.J. Fullagar; also Whitley 1934; Bell diaries). Hatching starts mid-July; most chicks



A P.J. Fullagar; Lord Howe I., NSW, Aug. 1971; P26

fledged by Nov. Report of chicks in Apr. (HASB) clearly erroneous.



SITE Burrows throughout cool subtropical montane mossy forest on upper slopes of Mts Lidgbird and Gower, Lord Howe I., with few colonies on lower slopes, where once there may have been more nesting before settlement; from near sea level (at two places out of reach of pigs) to summit of Mt Gower. On precipitous eroded cliffs with sparse vegetation on Philip I. (P.J. Fullagar; N. Hermes). Maximum density of burrows: 13/25 m², average 4.8 ± 4.5/25 m².

NEST, MATERIALS In chamber at end of burrow 1–1.8 m long; rarely in natural cavities or under overhangs, often with substantial pile of dry leaves of *Dracophyllum fitzgeraldii* and shredded palm *Howea* fronds in lowland burrows; often inundated and muddy (P.J. Fullagar). Excavated soil often surrounds entrance in crescentic mound. Occupied burrows may be plugged with dry leaves and debris. Role of sexes in selection and excavation of burrows, use of burrows by same birds in successive years, not recorded.

EGGS Elliptical; unglossed, roughly and sparsely pitted; white, becoming stained.

MEASUREMENTS: 66 (62–73; 18) x 49 (47–51) (HASB); 65 (62–68.4; 8) x 48 (46.6–50.7) (P.J. Fullagar).

WEIGHTS: 81, 84, 87 g.

CLUTCH-SIZE One. No replacement laying.

LAYING Synchronized in last part of May but not exactly recorded.

INCUBATION About 8 weeks. By both sexes. First shift probably usually by male: in seven burrows on 22 May, five had male on fresh egg, one had female without egg and one had pair without egg (P.J. Fullagar).

NESTLING Altricial, nidicolous. Hatched with uniform dark ash-grey protoptile. Gape, pink. Legs, pale grey. Feet, white. Fledging from early Nov. No information on parental care.

GROWTH Weights of known-age chicks not recorded but approximately: in late July–early Aug., 2–3 weeks old, av. 304 (227–454; 22); 14–20 Sept., 9–10 weeks, av. 616 (425–794; 18); 30 Sept.–8 Oct., about full grown, av. 750 (539–907; 34); thus chicks reach about 150% of adult av. of 493 (425–567; 47) (P.J. Fullagar).

SUCCESS No detailed knowledge; of 22 chicks less than 14 days old in late July–early Aug., at least 17 survived to early Oct. (P.J. Fullagar). Lord Howe Island Woodhen *Tricholimnas sylvestris* may take eggs but probably only those laid on surface by inexperienced birds.

PLUMAGES

ADULT Age of first breeding unknown. In fresh plumage: **HEAD AND NECK.** Crown, dark brown (121), fringed brown-grey (79) on forecrown. Forehead, dark brown (121), fringed white, giving scaled appearance; concealed bases of feathers for half length, very pale dark-brown (121); concealed bases white at hindcrown. Numerous white filoplumes round eye, on crown and nape. Proximal malar region and lores, similar to forehead but white fringes narrower; distal lores, black-brown (119). Chin, dark brown (121), narrowly tipped white. When worn, white fringes on head lost or narrow. Throat, brown-grey (79) with dark-brown (121) shade; con-

cealed bases of feathers for three-quarters length, white. Sides of neck, hindneck and rest of foreneck, dark brown (121). **UPPERPARTS.** Mantle, back, rump and scapulars, grey (84); when worn, feathers dark brown (121). Outer margins of mantle, back, rump and scapular feathers, narrowly tipped white; white tips broader on mantle; when worn, white tips largely lost or narrow. Scapulars have moderately pointed webs; webs of larger lowermost scapulars, more rounded. Upper tail-coverts, dark brown (121). **TAIL.** Dark brown (121); rachis, brown (219B) on upperside, pink-buff (121D) on underside. **UPPERWING.** Marginal coverts, dark brown (121), narrowly fringed dark brown (119A). Lesser, median and greater coverts, grey (84), tipped white. Remiges and alula, black-brown (119); rachis, dull-white at base, merging to brown (119B) and then most being grey-black (82); inner webs of remiges, dull white. Greater primary coverts, black-brown (119), narrowly tipped white. When worn, white tips on coverts largely lost or narrow. **UNDERPARTS.** All feathers have concealed white bases for three-quarters length with dark tip. Upper breast feathers tipped dark brown (121); rachis, white. Rest of underparts have broad subterminal pale dark-brown (121) tips, narrowly tipped white; white tips fewer on abdomen; rachis, white. Flank-feathers, moderately long; rachis, dark olive-brown (129). Sub-terminal tips of under tail-coverts, dark brown (121), tipped white. With extreme feather wear, concealed white bases sometimes exposed. Axillaries, dark brown (121) tipped white. **UNDERWING.** Greater primary coverts and greater coverts, glossy brown-grey (79) with white bases. Rest of coverts, dark brown (121). When wing spread, large white patch, formed by white bases of primaries and greater primary coverts visible.

DOWNY YOUNG Down, dark grey; unknown if two stages occur.

JUVENILE Largely indistinguishable from adult; may have broader white tips to feathers of mantle. When juveniles in fresh plumage at breeding colony, adults have lost most white feather-tips on upperparts. Murphy & Pennoyer (1952) state that fledgelings distinguished on more slender bill, but no precise details given.

ABERRANT PLUMAGES Exposed white bases of feathers on underparts reported by Boles (1988), giving appearance of Phoenix Petrel *P. alba*, possibly caused by attack of specimen by insects and not extreme feather-wear; breeding burrows, damp on Lord Howe I., where birds are winter breeders (P.J. Fullagar).

BARE PARTS Based on photos in NZRD and Lindsey (1986), except where stated.

ADULT, JUVENILE Iris, black-brown (119). Bill and nostrils, grey-black (82). Legs and feet, black-brown (119), grey-black (82) on outer margins of tarsus and distal webs; apparently tarsus and webs varying, from black, and even yellow, on tarsus and proximal parts of toes (Murphy & Pennoyer 1952).

DOWNY YOUNG Largely undescribed; shortly after hatching, gape pink, legs pale grey, and feet almost white (P.J. Fullagar).

MOULTS

ADULT POST-BREEDING Complete; occurs at sea in w. North Pacific; duration and sequence undescribed. Birds in fresh plumage on return to Lord Howe I., Mar.

POST-JUVENILE Undescribed. Murphy & Pennoyer (1952) state that chicks have been collected in Apr.–

Oct.; clearly in error.

MEASUREMENTS (1) Skins; unknown status; methods unknown (Murphy & Pennoyer 1952); (2) Lord Howe I., adults, skins (ANWC; AM).

	MALES	FEMALES
WING	(1) 306.1 (5.45; 296-317; 25) (2) 304.8 (4.05; 297-310; 6)	302.1 (7.59; 284-316; 58) * 314.7 (5.89; 302-323; 7) *
8TH P	(2) 175.2 (8.07; 165-185; 4)	186.0 (5.38; 179-193; 4)
TAIL	(1) 127.0 (3.46; 121.8-134.5; 25) (2) 126.3 (5.43; 120-135; 6)	126.1 (3.31; 120.2-134.2; 58) 135.2 (5.03; 127-144; 7) *
BILL	(1) 34.6 (1.05; 32.7-37.1; 25) (2) 36.2 (1.81; 33.5-38.3; 6)	34.3 (1.18; 30.1-36.2; 58) 35.4 (0.82; 34.4-36.9; 7)
TARSUS	(1) 42.6 (1.09; 40.9-44.7; 25) (2) 43.6 (0.89; 42.1-45.0; 6)	41.8 (1.04; 39.1-44.6; 58) * 43.1 (1.98; 38.7-45.0; 7)
TOE	(1) 57.2 (1.36; 55-60.5; 25) (2) 56.3 (2.64; 52-59.2; 4)	56.3 (1.83; 50.7-60.0; 58) * 59.1 (1.35; 57.6-61.1; 4)

WEIGHTS Lord Howe I., Apr.-Sept., adult skins, label data (ANWC, AM): males 517.6 (64.32; 443-600; 3); females 423.5 (9.50; 414, 433; 2). No data on seasonal changes.

STRUCTURE Wing, long and pointed. Eleven primaries: p10 longest, p9 3-8 mm shorter, p8 13-21, p7 31-42, p6 52-66, p5 78-90, p4 104-116, p3 132-140, p2 160-164, p1 (185 n=1). No emarginations. Twenty secondaries, including four of tertial form. Tail almost square; 12 rectrices, occasionally 14; t1 longest, t6 30-34 mm shorter. Bill, laterally slender; deep at base. Maxillary unguis hooked. Nasal tubes c. 38% of length of bill; nasal tubes project forwards; septum sub-terminal. Tarsus short and slightly laterally compressed. Feet webbed. Outer toe and middle toes about equal. Inner toe c. 82% of middle, hind toe, claw only.

GEOGRAPHICAL VARIATION Monotypic. Not closely related to *P. macroptera*, *P. lessonii*, *P. incerta* nor *P. magentae* as suggested by Peters.

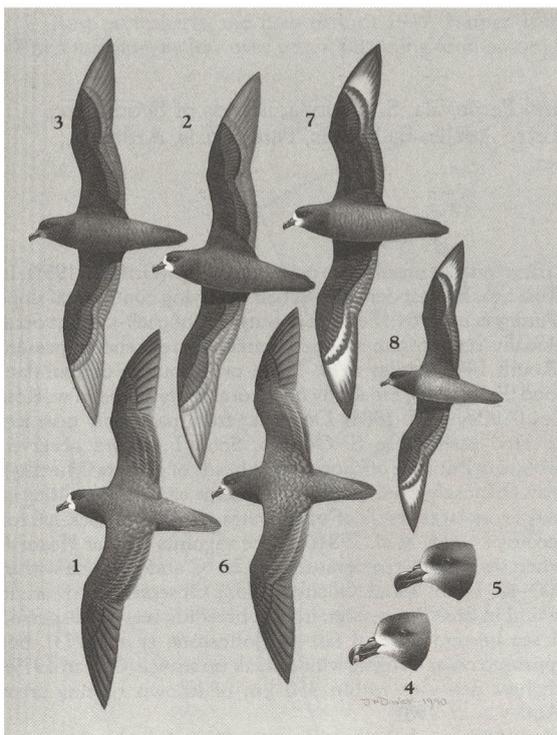
RMO

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Volume 1 (Part A), Plate 28

Great-winged Petrel *Pterodroma macroptera*

- 1. Adult, subspecies *gouldi*, dorsal
- 2. Adult, subspecies *gouldi*, ventral
- 3. Adult, subspecies *macroptera*, ventral
- 4. Adult, subspecies *gouldi*
- 5. Juvenile, subspecies *gouldi*

Providence Petrel *Pterodroma solandri*

- 6. Adult, dorsal, fresh
- 7. Adult, ventral, fresh
- 8. Adult, ventral, worn

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