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.

References

Bang, B.G. 1966. *Acta anat.* 65: 305–415.
Bourne, W.R.P. 1976. Pp 403–502. **In**: Johnston 1976.
Brodkorb, P. 1963. *Bull. Flor. St. Mus. biol. Sci.* 7: 179–293.
Clarke, A., & P.A. Prince. 1976. *J. Exp. mar. Biol. Ecol.* 23: 15–30.
Fisher, J. 1952. *The Fulmar.*
Harper, P.C. 1978. *NZ J. Zool.* 5: 509–549.
Johnston, R. (Ed.). 1976. *Marine Pollution.*
Klemm, R.D. 1969. *S. Ill. Univ. Monogr. Sci. Ser.* 2.
Obst, B.S. 1986. *Wilson Bull.* 98: 189–95.
Olson, S.L. 1975. *Smithson. Contr. Paleobiol.* 23.
Swennen, C. 1974. *Ardea* 62: 111–117.
Timmermann, G. 1965. *Abh. Verh. naturwiss.* Vereins Hamburg NF 8, Suppl. 1–249.

Family PROCELLARIIDAE fulmars, petrels, prions, shearwaters

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

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

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

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

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

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

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

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

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

REFERENCES

Brodkorb, P. 1963. *Bull. Flor. St. Mus. biol. Sci.* 7: 179–293.

Cox, J.B. 1980. *Rec. S. Aust. Mus.* 10: 91–121.

Fleming, C.A. 1941. *Emu* 41: 134–55.

Harper, P.C. 1980. *Notornis* 27: 235–86.

Imber, M.J. 1985. *Ibis* 127: 197–229.

Kuroda, N. 1954. *On the classification and phylogeny of the order Tubinares, particularly the shearwaters (Puffinus), with special consideration on their osteology and habit differentiation.* Tokyo.

Murphy, R.C., & J.M. Pennoyer. 1952. *Am. Mus. Novit.* 1580.

Olson, S.L. 1975. *Smithson. Contr. Paleobiol.* 23.

Voous, K.H. 1949. *Ardea* 37: 113–22.

Pterodroma mollis Soft-plumaged Petrel

COLOUR PLATE FACING PAGE 472

Procellaria mollis Gould, 1844, *Ann. Mag. Nat. Hist.*, 13: 363 — South Atlantic Ocean, latitude 20°-40°S.

Specific name *mollis* means 'soft' and was used by Gould because 'the under plumage . . . is much more dense and soft than that of most members of the group' — something that was not confirmed by recent check of skins of this species against those of *P. lessonii* and *brevirostris* (B. Gillies; A.R. McEvey).

OTHER ENGLISH NAME Soft-plumaged Fulmar.

POLYTYPIC Nominate *mollis* Gough I. and Tristan da Cunha Grp, South Atlantic Ocean; *dubia* Clancey *et al.*, 1981, Prince Edward Is, Iles Crozet and Kerguelen and Antipodes Is; but taxonomy complicated; see Geographical Variation.

FIELD IDENTIFICATION Length 32–37 cm; wingspan 83–95 cm; weight 279–312 g. Medium-sized gadfly petrel. Combination of grey upperparts, breast-band and underwing, and white underparts, separates from all other gadfly petrels.

Sexes alike. No seasonal variation. Juveniles resemble adults.

DESCRIPTION ADULT. Forehead, freckled white, grey and dusky black, with scaly appearance; crown, dark slate-grey, occasionally with brown wash; indistinct short white supercilium. Black patch before, below and round eye merges posteriorly into grey nape. Chin and throat, white; sides of face, white, sometimes lightly barred with grey or dusky black. Upperwing, dark grey-brown; sooty black primaries and broad black band across upper secondary coverts form varying open M-mark from wing-tip to wing-tip. Hindneck and upperparts, dark slate grey, fringed paler in fresh plumage. Tail, grey; outer rectrices, white freckled with grey. Underparts, white, with narrow dark-grey band partially or completely across breast; undertail, white. Underwing, dusky grey with darker narrow leading-edge and paler central stripe. In dull light, underwing appears completely dark; when reflecting light, pattern can resemble that of Mottled Petrel *P. inexpectata*, although pale areas never so extensive. Iris, brown. Bill, stout and black. Legs, flesh coloured, with white or pink tinge; feet, flesh-pink, with outer toes and webs black-brown; front of webs may also be tipped with brown-black. Dark morph varies in colour from completely brown-grey with faint trace of breast-band to birds with heavily streaked underparts and dark wide breast-band.

SIMILAR SPECIES **White-headed Petrel** *P. lessonii* (*q.v.* for comparison); larger, paler but has sub-orbital patch isolated on mainly pale head; back, wings and uppertail also paler. **Mottled Petrel**; similar size, structure and flight, but has dark abdomen and strikingly patterned white underwing with pronounced black carpal bar. **Magenta Petrel** *P. magentae* can appear similar; has more pronounced hood, without white on chin, face and throat; upperparts more uniformly dark (*q.v.* for more details). **Grey Petrel** *Procellaria cinerea* much larger and has darker head, dark under tail-coverts and larger paler bill. Rare dark-morph closely resembles Kerguelen Petrel *P. brevirostris* (*q.v.* for differences).

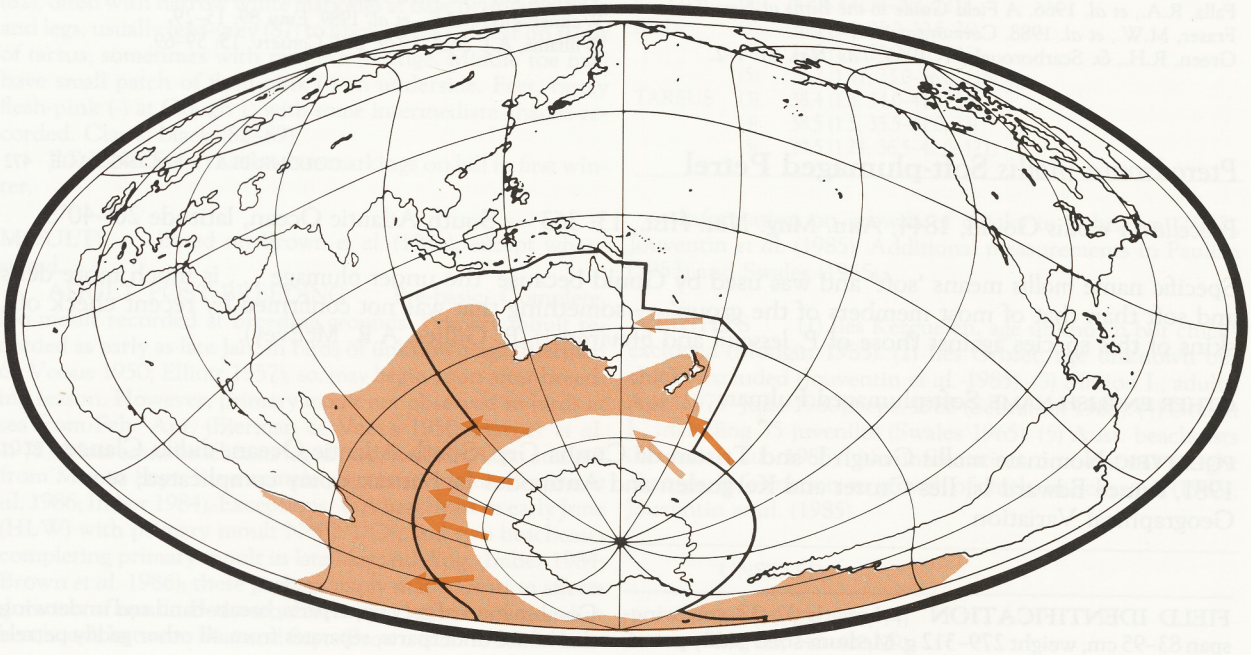
Breed in colonies among tall coastal vegetation of ferns and tussock grasses. Highly pelagic, preferring open ocean between 30–50°S where water relatively warm. Seldom seen inshore, but frequently occur as beach wrecks, especially about w. Aust. coast. Rapid flight with quick wing-beats interspersed with long glides on angled wings. Fly in great arcs with zig-zagging progression, but rarely fly high or float in air. Pick up food from water surface, sometimes alighting in wake of ship to feed on disturbed zooplankton. Usually seen singly at sea, but loose flocks of up to a thousand reported (Harrison 1983). Occasionally follow ships in small numbers. Silent at sea and on ground. Flight-call over colonies, mournful, low-pitched moan, occasionally wavering and often ending in higher pitched *whik*. Typical *Pterodroma* jizz of stout black bill, thick-set build and vigorous flight.

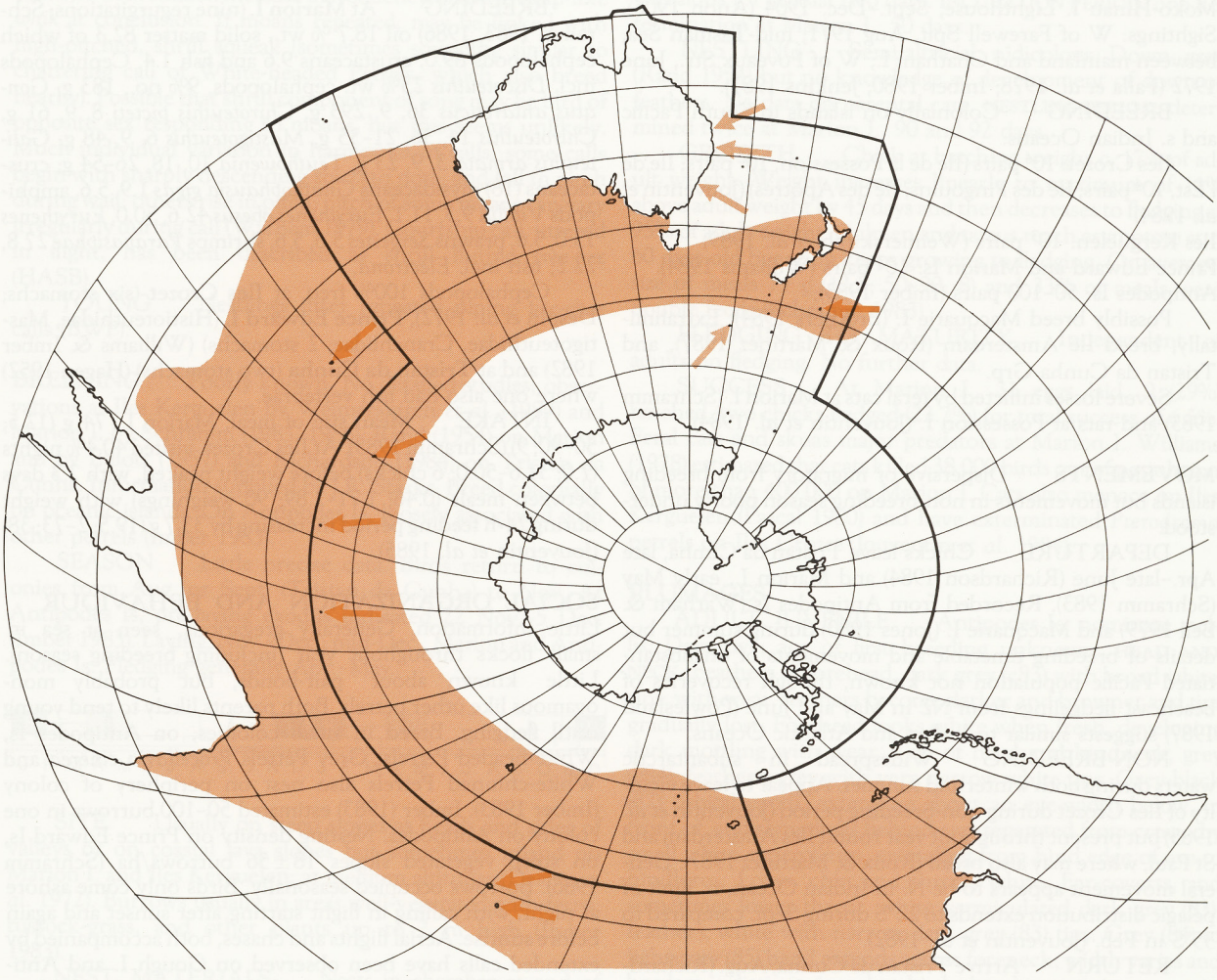
HABITAT Marine; pelagic; in subantarctic, Antarctic and subtropical waters. Mainly subantarctic, but tolerate wide range of sea surface-temperatures (0–20 °C) (Bierman & Voous 1950); in Weddell Sea, attracted to waters of iceberg belt, surface-temperature 0.7–1.0 °C, where food abundant (Harper 1973), but birds breeding at Iles Crozet forage mainly to N of islands over subtropical waters (Jouventin *et al.* 1982). At Iles Crozet, may be excluded from areas of high food-concentrations over continental shelf by competition with other species of petrels, particularly White-chinned Petrels *Procellaria aequinoctialis* (Stahl *et al.* 1985).

Breed on islands in NZ region, and in Indian and South and North Atlantic Oceans; burrow among tussock grass and ferns on slopes and valleys; mainly coastal but occasionally inland (Imber 1983; Schramm 1983; Weimerskirch *et al.* 1989). Distribution within breeding islands may be determined by location of feeding areas (Weimerskirch *et al.* 1989).

Fly in high arcs broken by gliding or close to sea surface (Bierman & Voous 1950).

DISTRIBUTION AND POPULATION Generally





found over temperate and subantarctic waters in South Atlantic, s. Indian and w. South Pacific Oceans (Harper 1973). In South Atlantic, abundant from 30 to 60°S from e. coast of South America to South Africa (Murphy; Watson *et al.* 1971). In s. Indian Ocean, most numerous between 30 and 50°S from South African to w. Aust. coasts (Alexander 1921; Watson *et al.*1971); in Feb., recorded from 35 to 52°S in transect from Réunion via Iles Crozet to near Antarctica (Jouventin *et. al.* 1982). Possibly common in seas S of Aust., rarely S of Antarctic Convergence. Report of common occurrence between Antarctic Convergence and pack-ice (Johnstone & Kerry 1977) incorrect, probably arising from confusion with White-headed Petrels (Nakamura 1982). Regular and common winter visitor to South Africa, Namibia (Brown *et al.* 1982), Argentina, Uruguay and Brazil (Johnson 1965). Occasional visitor to Mozambique (often beachcast).

AUST. **Qld**. One derelict (alive), Maryborough, 20 July 1984 (Qld Bird Rep. 1984). **NSW**. One, Byron Bay, 10 July 1985; two unconfirmed records at sea off Wollongong (NSW Bird Rep. 1985). **Vic**. Single birds beachcast Discovery Bay, 9 and 16 Aug. 1959 (Learmonth 1961); Sealer's Cove, Wilson's Promontory, early 1963 (Wheeler 1967); two unconfirmed records at sea off Portland. **Tas**. One, 20 km E of Hippolytes, 31 Mar. 1980 (Tas. Bird Rep. 1980; Aust. Atlas). Sightings from edge of continental shelf off se., s. and w. coasts, Dec.–Jan., Apr., May and Sept. (Carter 1980; D.W. Eades; Tas. Bird Rep. 1985). **SA**. Beachcast: one Kingston SE, 14 Sept. 1978 (Aust. Atlas); one Salt Creek (alive), 12 Sept. 1980 (Parker & May 1982); one Aldinga Beach, 27 Sept. 1981 (Parker & May 1982; Aust. Atlas). Sight records: in Feb., Aug. and Nov., since 1974, in Great Aust. Bight, off Port MacDonnell and Robe (Cox 1976; Cheshire 1986; D.W. Eades). **WA**. Eleven beachcast since 1919 between Mar. and Aug., eight being in July and Aug. (Alexander 1920, 1921; Serventy 1927, 1937; Whitlock 1939; Whittell 1942; Serventy & White 1943; Roberts 1982; K. Bartram). Also many sightings between Geraldton and NW Cape (Pocklington 1967); W of Rottnest I. (Alexander 1921); w. region of Great Aust. Bight (Ferguson 1921); off Albany (K. Bartram). Increased records in recent years clearly result of increase in activity of observers, especially on sea-going trips (D.W. Eades). Even if records have not always been made with adequate details, plain that species is regular and quite common visitor to s. Aust. seas; more common in W than in S and SE.

NZ Rare; number of sightings at sea increasing (Falla *et al.* 1978). Beachcast: Bay of Plenty, Nov. 1971 (Hellyer *et al.* 1973); Raukaka Beach, Auckland, Dec. 1974 (Veitch 1976); Hukuwai Bay, 13 Nov. 1984 (CSN 33); Hutt Valley, May 1971 and June 1978 (Kinsky 1971; NZCL); Petone Beach, 24 June 1978 and two on 22 May 1983 (CSN 25, 31; Veitch 1980); one,

Moko-Hinau I. Lighthouse, Sept.–Dec. 1904 (Anon 1906). Sightings: W of Farewell Spit, Aug 1971; mid-Tasman Sea; between mainland and Chatham I.; W of Foveaux Str., June 1972 (Falla *et al.* 1978; Imber 1980; Jenkins 1981).

BREEDING Colonially on islands in South Pacific and s. Indian Oceans.

Iles Crozet: 10^4 pairs (Ile de la Possession, 10^2 pairs; Ile de l'Est, 10^4 pairs; Ile des Pingouins; Ile des Apôtres) (Jouventin *et al.* 1984)
Iles Kerguelen: 10^3 pairs (Weimerskirch *et al.* 1989)
Prince Edward and Marion Is: 10^3 pairs (Williams 1984).
Antipodes Is: 50–100 pairs (Imber 1983);

Possibly breed Macquarie I. (Brothers 1984). Extralimitally, breed Ile Amsterdam (Roux & Martinez 1987), and Tristan da Cunha Grp.

Severe losses inflicted by feral cats at Marion I. (Schramm 1983) and rats at Possession I. (Jouventin *et al.* 1984).

MOVEMENTS Dispersive or migratory from breeding islands but movements in non-breeding season poorly understood.

DEPARTURE Chicks leave Tristan da Cunha, late Apr.–late June (Richardson 1984) and Marion I., early May (Schramm 1983). Recorded from Antipodes Is (Warham & Bell 1979) and Macquarie I. (Jones 1980) during summer but details of breeding timetable and movements of unsubstantiated Pacific population not known, though recoveries of beachcast fledgelings from NZ in May and June (Powlesland 1987) suggests similar to Indian and Atlantic Oceans.

NON-BREEDING Widespread in subantarctic waters during both winter and summer. Appear to leave vicinity of Iles Crozet during non-breeding period (Jouventin *et al.* 1985) but present throughout year round Iles Amsterdam and St Paul, where may also breed (Roux & Martinez 1987). General movement appears to be N: in Indian Ocean, n. limit of pelagic distribution extends to 22°S during Sept. compared to 35°S in Feb. (Jouventin *et al.* 1982).

RETURN Arrive Tristan da Cunha, Aug. (Richardson 1984), Iles Crozet before 20 Sept. 1981 (Jouventin *et al.* 1985).

BREEDING Female with egg in oviduct found beachcast, Bay of Plenty, NZ (Hellyer *et al.* 1973), possibly from Antipodes Is. Round Iles Crozet, most birds during Feb. concentrated to N of islands up to 35°S (Jouventin *et al.* 1982).

FOOD Food regurgitated by chicks, mostly cephalopods, some fish and crustaceans. BEHAVIOUR. Food apparently taken by surface-seizing (Harper *et al.* 1985) but few descriptions (Griffiths 1982). Occasionally follow cetaceans including pilot whales *Globicephalus* and Southern Right Whale Dolphins *Lissodelphis peronii* (Enticott 1986).

BREEDING At **Marion I.** (nine regurgitations; Schramm 1983, 1986) oil 18.7 % wt., solid matter 82.3 of which cephalopods 89.0, crustaceans 9.6 and fish 1.4. Cephalopods incl. *Discoteuthis* 23% wt. cephalopods, 9% no., 183 g, *Gonatus antarcticus* 36, 9, 293 g, *Chiroteuthis picteti* 8, 9, 61 g, *Chiroteuthis* 14, 36, 21–35 g, *Mastigoteuthis* 6, 9, 48 g, *Galiteuthis armata* 3, 9, 23 g, *Teuthowenia* 10, 18, 26–54 g; crustaceans (18) mysidaceans *Gnathophausia gigas* 1.9, 5.6, amphipods *Vibilia* 9.3, 11.1, *Eurythenes obesus* 42.6, 50.0, *Eurythenes* 13.0, 5.6, prawns *Sergestes* 5.6, 5.6, shrimps *Parapasiphae* 27.8, 22.2; fish incl. *Electrona*.

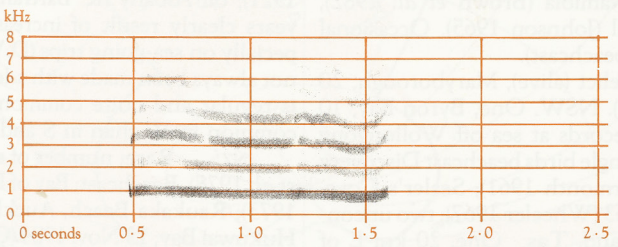
Cephalopods 100% freq. at **Iles Crozet** (six stomachs; Despin *et al.* 1972), **Prince Edward I.** (Histioteuthidae, Mastigoteuthidae, Cranchiidae; 2 stomachs) (Williams & Imber 1982) and at **Tristan da Cunha** (two stomachs) (Hagen 1952) where one also had fish vertebrae.

INTAKE Mean size of meal, Marion I., 74 g (12.5; 50–90; 9) (Schramm 1983). At Iles Crozet, visited 40.4% nights (7.0; 31.6–50.0; 6 chicks) before weight peaked, with 2.3 days between meals (0.46; 1.71–2.89; 90 weighings) with weight during 24-h feeding period increasing by 33.7 g (19.5; 2–73; 38) (Jouventin *et al.* 1985).

SOCIAL ORGANIZATION AND BEHAVIOUR

Little information. Generally gregarious, seen at sea in small flocks throughout year (including breeding season). Little known about pair-bonds, but probably monogamous like other petrels. Both parents likely to tend young until fledging. Breed in small colonies; on Antipodes Is, White-headed Petrels, Grey Petrels *Procellaria cinerea* and White-chinned Petrels also nest on periphery of colony (Imber 1983). Imber (1983) estimated 50–100 burrows in one colony on Antipodes. Nesting density on Prince Edward Is, on steep vegetated slopes 18 ± 56 burrows/ha (Schramm 1986). Burrows occupied seasonally. Birds only come ashore at night, with calling in flight starting after sunset and again before sunrise. Aerial flights and chases, both accompanied by extended calls have been observed on Gough I. and Antipodes Is (HASB). Courtship in full progress at Gough I. in early Nov. (Imber 1983). Each pair appears to spend at least two consecutive days in burrow before pre-laying exodus, male perhaps returning alone for a few days before his departure (Imber 1983). Details on behaviour within burrow unrecorded.

VOICE Although usually silent at sea, heard calling over breeding colonies. Never heard calling from ground. **Flight Call** (apparently uttered during aerial chases) distinctive, and unlike songs of other species of petrel that breed in vicinity; low-pitched musical wail, of between one and two s duration, usually repeated several times (see sonagram A); pitch of moan may rise and fall irregularly, resulting in call wavering. Most



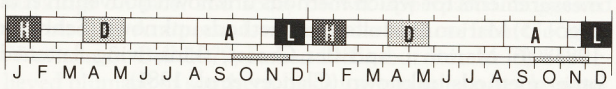
A Recordist unknown; B1005

calls end with sudden increase in frequency, causing whip-like *whik* at conclusion. If moans repeated, may be linked with high-pitched, shrill squeak (sometimes sounding similar to chattering call of White-headed Petrels, which also breed nearby). Possible that shrill component of song may be bird of opposite sex responding to moans, but this seems unlikely. Much individual variation in harmonics of calls: some calls begin with sharply descending staccato note, and fall in pitch during wail; others rise in pitch; pitch of some moans can vary irregularly during call (Warham 1979). Courtship call, uttered in flight, has been described as shrill fluting *tree-pee* (HASB).

YOUNG Nestlings utter repeated piping *pee-chee* calls (BWP).

BREEDING Poorly known. No detailed studies; observations at Iles Kerguelen by Weimerskirch *et al.* (1989) and Marion I. by Schramm (1983, 1986); Rand (1954) on Marion and by Elliott (1957) and Richardson (1984) on Tristan da Cunha. Information supplied by J.R. Starks. Breed colonially on oceanic islands. On Antipodes Is, loosely associated with other petrels (Imber 1983).

SEASON Little precise data. Birds return to colonies from Aug. or Sept. (Tristan da Cunha) to Nov. At Antipodes Is, pre-laying exodus indicated 22 Nov.–5 Dec. (Imber 1983). Laying, Nov.–Dec.; mid-Dec., Marion and Antipodes Is. Fledging generally Apr.–May.



SITE Usually on steep slopes at heads and sides of valleys or on coastal lava slopes but sometimes inland on Marion I. and Iles Kerguelen; at medium altitudes (Despin *et al.* 1972). Burrows usually in areas well-vegetated with ferns, tussock-grass, and other plants up to 2 m high (Imber 1983).

NEST, MATERIALS Nests in chamber at end of single sloping burrow (Schramm 1983) curved and with drainage channel round nest and down side of burrow (Rand 1954; Imber 1983). On Marion I., av. length of burrow 148.5 cm (56.1; 60–280; 69); entrance 9.8 cm (1.2; 8–12; 16) high x 16.5 (2.4; 14–20) wide. Depth of burrow below ground, 41.6 cm (9.7; 25–55; 67); 15.5 cm (2.2; 10–20; 19) high x 30.8 (4.7; 20–40; 19) wide. On Antipodes Is, length of burrows 1–1.5 m (Imber 1983). Density on Marion I., 10 burrows per hectare. Chamber lined with grasses and plant material, collected near entrance (Schramm 1983; Imber 1983; Rand 1954). No information on excavation of burrows, building.

EGGS Elliptical, ovate, inclined to oval; somewhat rough-textured with limy nodules at smaller end, dull or slightly glossy; white (Campbell).

MEASUREMENTS: Marion I., 59.7 (2.4: 55.8–65.1; 22) × 43.0 (1.29; 40.3–45.8); Iles Kerguelen, 59.3 (2.7; 10) x 43.3 (1.1).

WEIGHTS (fresh): Marion I., 54.4 (3.92; 50.0–59.5; 3); 52, 53 (n=2 (Rand 1954).

CLUTCH-SIZE One. On Marion I., one burrow, attended by at least three birds, had two eggs (Schramm 1983).

LAYING Roughly in Nov. and Dec. (above). Synchronization or otherwise unknown.

INCUBATION Role of sexes, shifts of incubation, etc., not known. At Marion I., one egg was deserted on two occasions for at least two days. INCUBATION PERIOD: one determination at Marion I., 50 days.

NESTLING Semi-altricial, nidicolous. Down, grey (Rand 1954) but no knowledge of development of down or feathers. No data on parental care. NESTLING PERIOD: determined twice at Marion I., 90 and 92 days.

GROWTH Chick at hatching weighs *c.* 17% of adult weight. Weight increases linearly to maximum of 11% above adult weight by 45 days and then decreases to fledging at 95% of adult weight. Culmen and tarsus reach asymptote at *c.* 60 days old but wing keeps growing to fledging. On average, size of meals 74 g (12.5; 50–90; 8) and 33% of meals were double feeds (Schramm 1983).

FLEDGING TO MATURITY Independent of adults on fledging. No further data.

SUCCESS At Marion I., 31 eggs laid, 9 (29%) hatched, two chicks fledged (22.2%) for total success of 6.5%. Feral cats and skuas major predators at Marion I. Williams (1978) estimated that cats killed 38 000 birds out of population of more than 400 000 on Marion I. Cats also menace on Iles Kerguelen (Pascal 1980) and have exterminated *Pterodroma* petrels on Iles Crozet (Jouventin *et al.* 1984).

PLUMAGES

ADULT, JUVENILE Antipodes Is, nominate *mollis*. Definitive; age of first breeding unknown. HEAD AND NECK. Feathers of forehead, dark grey (c83) with broad white tips; with wear, feathers become darker and browner and tips gradually lost. Forehead looks white when fresh, developing dark mottling with wear. Top of head and hindneck, grey (c84); feathers, grey with very narrow white tips. Grey-black (82) orbital patch, extending about an eye-width below, in front of, and sometimes behind eye, separated from crown by small white supercilium, extending from hind edge of eye to hindlores. Lores, chin and throat, white. Ear-coverts, and sometimes lower throat, white vermiculated dark grey (83); feathers, white with narrow dark-grey (83) tips. Grey (84) to light-grey (85) band extends across foreneck; width varies and borders indistinct; in palest birds, barely meets in centre; in darkest, centre of band is about half-width of white throat. Band appears narrower and darker when bill pointed downwards. UPPERPARTS. When fresh, grey (84); feathers, grey (84) with pale-grey (86) open pennaceous tips. When worn, grey tinge and pale tips lost; feathers become dark brownish grey (greyish 21). All feathers have concealed white bases. TAIL, grey (84) above, pale grey (86) below with white mottling near base of most feathers concealed by tail-coverts; in one bird collected at Antipodes I., t6 had heavy white vermiculation on grey inner web, most intense at tip which looked largely white. In beachcast NZ juvenile, t6 white with heavy grey mottling on outer web, some grey mottling near base of t5 (Kinsky 1971). UPPERWING. Marginal coverts, brown-black (19) with light-grey (85) open pennaceous tips; appear grey (84) in fresh plumage when grey (84–85) tips broader. When fresh, secondary and median coverts, light grey (85), with concealed grey (84) inner web, and narrow white fringes widest near tip of outer web. With wear, white fringes become narrower, and feathers lose grey gloss, becoming dark brown (c121). Lesser, humeral and primary coverts, dark grey (83) with frosted grey (84) edges of uniform width; with wear become dark brown (c121). Primaries, black-brown (c119) with paler concealed inner edges; inner primaries have grey (84) tinge near shafts. Secondaries, grey (84), becoming black-brown with wear. Secondary coverts retain grey gloss

for longer than other upperwing feathers. UNDERPARTS, white. Flank feathers have grey-black (82) shafts and varying amount of grey (83–84) mottling; in some birds mottling practically absent, in others forms indistinct bars, giving flanks speckled appearance. Axillaries, grey (84), mottled white near tip. UNDERWING. Inner marginal coverts, white with irregular dark-grey (83) markings near shaft on outer web; form white leading-edge between body and point one-third or less of distance between humerus-ulna joint and carpal joint. Lesser and median coverts have varying blotchy white tips, wider in median coverts. Greater under wing-coverts, light grey (85–86), with blotchy white, less reflective tips. Remiges, mostly grey (84), but darker (83) near wing tip, merging to pale grey (c86) at base; pale-grey area not entirely covered by under wing-coverts.

RARE DARK PHASE OR MORPH. Small number of birds from South Atlantic with varying dark streaking on underparts (Elliott 1954; Bourne 1957) may imply continuous variation from light to dark phase. Moulting beachcast (WAM) differs from light morph in following characters. HEAD AND NECK. Chin, throat and lores, finely mottled dark grey and white. No white supercilium; crown and ear-coverts, brown-grey. UPPERPARTS. Dark grey (brownish 83). UNDERPARTS, grey (84), colour as breast of Mottled Petrel; feathers have grey (84) tips and concealed white bases; dark tips slightly broader in foreneck and uppermost breast, forming slightly darker band. TAIL, grey (84) below. Severe wear of outer edge of t6 suggests it may have been paler. UPPERWING. New primaries have black-brown (119) shafts; shafts of old primaries, brown (223A). Greater coverts, albinistic. UNDERWING, as for *P.m. dubia*, but innermost marginal coverts, grey-black (c82). Some birds slightly lighter, with upperparts as pale-phase birds (D.W. Eades). Some birds darker (Elliott 1954; Swales 1965; Schramm 1983). Bourne (1957) examined two skins almost identical to Kerguelen Petrel; differed in dark primary shafts, pale bases to feathers of underparts, and white fringes to chin. Colour of feet, biometrics, skeletal differences and extent of white on leading-edge of wing are useful identification characters.

DOWNY YOUNG Protoptile, dark grey above, somewhat lighter below. Mesoptile, lighter grey (Watson 1975); in Tristan da Cunha Hagen (1952) described mesoptile as 'nearly uniform dark leaden grey with a slightly brownish tinge'; down short round base of bill, long elsewhere.

BARE PARTS Based on photos in Lindsey (1986), NZRD and label data (NMNZ).

ADULT, JUVENILE Iris, dark brown (c20). Bill, black (89); adults of unknown status have varying pale-grey or white marking at base of maxillary unguis (juveniles lack this). Claws, distal two-thirds of toes and webs, top of outer toe and, sometimes, patch on front of tarsus, greyish black (c82). Rest of tarsus and foot, pale pink (c7); sometimes pale-pink streak in outer web (Elliott 1954).

DOWNY YOUNG Large chicks, losing mesoptile, similar to adults (Hagen 1952; Elliott 1957). Hagen mentioned 'orange' corner of bill, Elliott mentioned 'greyish' distal two-thirds of webs.

MOULTS

ADULT POST-BREEDING Pre-basic; may include moult of non-breeders. At Antipodes I., completed just before breeding season. In late Nov. and early Dec., all birds examined in final stages of moult; most had not completed moult of upper wing-coverts or growth of p10; one was in tail-moult and another had not shed p10 (Imber 1983). Small gonads and solitary occurrence (possibly unpaired), suggest they were non-breeders (J.A. Bartle). Birds of unknown status collected mid-late Feb. had slightly worn primaries, save for female with primary moult $N^{9}4^{1}$ (NMNZ). No information for birds of known breeding status. In Indian Ocean on a voyage from 25 Mar. and 13 Apr. between *c.* 32–42°S, wing-moult was recorded for 256 birds seen clearly (D.W. Eades); 24.6% not in primary moult; 17.2% growing varying number of inner primaries p1-p5; 30.5% growing varying number of outer primaries p6-p10; extent of moult not determined for 27.7%. Histogram of remaining outer primaries suggests two categories of birds moulting at slightly different times. In Indian Ocean, do not breed and moult concurrently (J.A. Bartle; J-C. Stahl), so these birds presumably non-breeding, perhaps including some failed breeders. Two sub-adults from Iles Kerguelen in early Feb. in heavy body-moult (NMNZ), with worn primaries. Some birds seen by D.W. Eades, and one photograhed off Portland, Vic., in Mar. or Apr. (M.J. Carter) growing five inner primaries at one time.

MEASUREMENTS (1) Antipodes I., juveniles excluded, skins; flattened chord (Warham & Bell 1979). (2) Antipodes I., juveniles excluded, skins (NMNZ). (3) Iles Kerguelen, live birds; methods unknown (Weimerskirsch *et al.* 1989). (4) Iles Crozet, live birds; possibly including <11 measurements for which methods unknown (Jouventin *et al.* 1985). (5) Marion I., adults, live; methods unknown (Schramm 1983). (6) Marion I. and Iles Crozet, skins; wing flattened, other methods unknown (Clancey *et al.* 1981).

	UNSEXED
WING	(1) 255.8 (3.9; 6)
	(3) 253.5 (10; 235–276; 14)
	(4) 253 (5; 238–265; 76)
	(5) 250 (0.61; 233–263; 90)
	(6) 248.2 (5.1; 239–259; 18)
TAIL	(1) 114.9 (4.0; 7)
	(6) 107.9 (1.01; 105–111; 18)
BILL	(1) 28.7 (0.9; 8)
	(3) 28.4 (1.5; 25.4–31.8; 14)
	(4) 28.5 (1.0; 26.0–31.8; 14)
	(5) 28.3 (1.31; 23.7–30.7; 85)
	(6) 28.3 (1.00; 27–30; 18)
TARSUS	(1) 33.9 (0.7; 8)
	(3) 36.3 (1.5; 34.3–39.2; 14)
	(4) 35.8 (1.0; 33.5–38.0; 76)
	(5) 36.5 (1.58; 34.0–42.5; 85)
	(6) 34.1 (1.01; 32.5–36; 18)
TOE	(1) 48.0 (1.0; 8)

No significant differences between sexes. Adult size not always reached before fledging (Jouventin *et al.* 1985). Measurements from South Atlantic in Swales (1965), Clancey *et al.* (1981), Fraser *et al.* (1988).

WEIGHTS No information on seasonal changes. At Antipodes I. in Feb., 279.6 (29.7; 256.6–343; 7) (NMNZ); at Iles Kerguelen, 294.3 (38.8; 222–350; 14) (Weimerskisch *et al.* 1989); at Iles Crozet 302 (23; 245–360; 72) (Jouventin *et al.* 1985); at Marion I. 312 (34.7; 250–380; 85) (Schramm 1983). NZ beachcast, juvenile male, 176.

STRUCTURE Antipodes Is, nominate *mollis*. Wing, long and narrow. Eleven primaries, p11 minute, p10 longest, p9 0–4; p8 7–19; p7 21–38; p6 41–59; p5 61–82; p4 84–102; p3 111–123; p2 127–142; p1 148–157. About 16 secondaries, excluding tertials. Tail, wedge-shaped; 12 feathers, t6 26–29 shorter than t1. Bill, rather short; bill depth, similar to *P. brevirostris*, but bill looks more gracile because maxillary unguis relatively shorter. Bill, narrow, but does not taper as abruptly in front of nostrils as in *P. brevirostris*. Nostril-tubes about one-quarter of length of bill, nostrils point forwards; separated from maxillary unguis by short culminicorn. Tarsus, rounded. Middle and outer toes, about equal, inner *c.* 80%, hind toe consists of claw only.

GEOGRAPHICAL VARIATION Peters recognized three subspecies: *mollis* (breeding Tristan da Cunha Grp, Prince Edward Is, Iles Crozet and Antipodes Is), *feae* (breeding Cape Verde Is and Desertas Is, off Madeira); *madeira* (Madeira). Since then, *feae* and *madeira* given specific status (Bourne 1983; Zino & Zino 1986). Both lack complete breast band of s. hemisphere birds.

Taxonomy of s. hemisphere birds somewhat controversial. Clancey *et al.* (1981) recognized two subspecies: *mollis* from Tristan da Cunha Grp (distinguished by narrow breast band, paler dorsal plumage and whiter outer tail-feathers) and *dubia* from Prince Edward Is, Iles Crozet and Kerguelen and Antipodes Is (darker, with broad dark breast-band, heavier markings on face, and sooty brown upperparts). Suggested that birds on Antipodes Is most similar to those from Gough I. (Warham & Bell 1979; Imber 1983), but Bourne (1983) believed plumage of southern birds too variable to be classified. Birds breeding Antipodes Is, pale mantled *mollis*, not *dubia* as claimed by Clancey *et al.* (1981) and Harrison (1983).

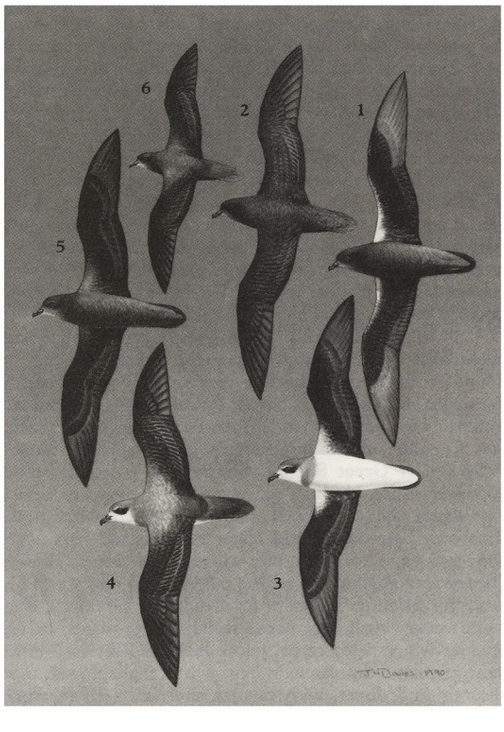
Some characters used by Clancey *et al.* (1981) to separate *mollis* and *dubia* alter with wear. Subspecies *mollis* has 'neutral grey' crown and upperparts (Clancey *et al.* 1981; using Ridgeway's colour chart), equivalent to grey (84) crown and upperparts found in skins in fresh plumage from Antipodes, and in new feathers from four *dubia* skins from Iles Kerguelen (MV, NMNZ). Subspecies *dubia* has 'fuscous' (Ridgeway) hindneck and mantle, which was found in worn birds from Antipodes and Iles Kerguelen. Clancey *et al.* (1981) reported *dubia* had relatively 'reduced' white scaling to forehead; *dubia* also said to have darker wings, with less grey on median and greater coverts; upperwing darkens with wear in Antipodes Is (see plumages). Most *mollis* skins examined by Clancey *et al.* (1981) were collected at Gough in Oct. and Nov., when plumage of birds from Antipodes Is fairly fresh. Following characters probably not affected by wear, however, have not been described in sufficient detail to allow identification of beachcast birds without large comparative series of both *mollis* and *dubia*. Race *dubia* said to have darker tertials, long scapulars and breast band; more extensive black mask and mottling on lores and sides of neck, wider breast band. Much variation in both subspecies (R.K. Brooke). Colour of outer tail feathers regarded as most useful character in separating *mollis* and *dubia*; in *mollis* from Gough I., outer tail feathers largely white (R.K. Brooke). In three pale-phase *dubia* examined (MV), t1 to t4 grey (84) above, light grey (85) below, merging to concealed white bases. T5 similar, but with fine white speckling near base of inner web. On upperside, t6 has grey (84) outer web. Inner web, grey (84) near shaft, but most of inner web has varying white vermiculation, distal third dominated by grey, basal third by white, area between transitional. Birds seen at sea in s. Indian Ocean and off Wollongong seemed to have white t6 (D.W. Eades); some birds have no white vermiculation on t6 (Clancey *et al.* 1981). Underside of t6 similar, but darker vermiculations are pale grey (86). Undertail of *dubia* can look paler when reflecting direct light; t6 can appear almost completely white. Underwing may be paler in *mollis*. No detailed description available for *mollis* from Gough I.; photographs of limited use because reflection can change appearance substantially. In four *dubia* examined (two from Iles Kerguelen, two from Macquarie I.), median, lesser and outer marginal coverts, blackish grey (dark 83), with narrow light-grey (85) tips and grey-black (82) shafts; these feathers non-reflective. In diffuse dull light, remiges and greater under wing-coverts, dark grey (83) with concealed pale-grey (86) bases. When reflecting direct light, these feathers can look pale grey (86), merging to silvery white near base. Skins examined from Antipodes I. had paler underwings (see Plumages); however, these specimens had fresher underwings than those of other *dubia* examined; unknown if appearance of underwing affected by wear.

DIR

REFERENCES

Alexander, W.B. 1920. *Emu* 20: 14–24.
Alexander, W.B. 1921. *Emu* 21: 261–72.
Anon. 1906. *Emu* 5: 107–10.
Bierman, W.H., & K.H. Voous. 1950. *Ardea* 37 (Extra no.): 1–123.
Bourne, W.R.P. 1957. *Ibis* 99: 182–90.
Bourne, W.R.P. 1983. *Sea Swallow* 32: 65–71.
Brothers, N.P. 1984. *Aust. Wildl. Res.* 11: 113–31.
Brown, L.H., *et al.* 1982. *The Birds of Africa. 1.*
Carter, M.J. 1980. *Tas. Bird Report* 9.
Cheshire, N. 1986. *S. Aust. Orn.* 30: 15–18.
Clancey, P.A., *et al.* 1981. *Durban Mus. Novit.* 12: 203–13.
Cox, J.B. 1976. *S. Aust. Orn.* 27: 28–82.
Despin, B., *et al.* 1972. *Com. nat. fr. Rech. Antarct.* 31: 1–112.
Elliott, H.F.I. 1954. *Bull. Br. Orn. Club.* 74: 21–4.
Elliott, H.F.I. 1957. *Ibis* 99: 545–86.
Enticott, J.W. 1986. *S. Afr. J. Antarct. Res.* 16: 25–8.
Falla, R.A., *et al.* 1978. *The New Guide to the Birds of New Zealand.*
Fraser, M.W., *et al.* 1988. *Cormorant* 16: 7–33.
Ferguson, E.W. 1921. *Emu* 21: 104–14.
Griffiths. A.M. 1982. *Cormorant* 10: 9–14.
Hagen, Y. 1952. *Results Norw. Scient. Exped. Tristan da Cunha 1937–1938.* 20.
Harper, P.C. 1973. *Notornis*: 20: 193–201.
Harper, P.C., *et al.* 1985. *BIOMASS Handbook* 24.
Harrison, P. 1983. *Seabirds: An Identification Guide.*
Hellyer, N.R., *et al.* 1973. *Notornis* 20: 71–2.
Imber, M.J. 1980. *Notornis* 27: 203–204.
Imber, M.J. 1983. *Notornis* 30: 283–98.
Jenkins, J. 1981. *A'sian Seabird Grp Newsl.* 16: 3–16.
Johnson, A.W. 1965. *The Birds of Chile and Adjacent Regions of Argentina, Bolivia and Peru.*
Johnstone, G.W., & K.R. Kerry. 1977. *Proc. Int. orn. Congr. XVI*: 725–38.
Jones, E. 1980. *Notornis* 27: 11–20.
Jouventin, P., *et al.* 1982. *Com. nat. fr. Rech. Antarct.* 51: 427–36.
Jouventin, P., *et al.* 1984. *ICBP Tech. Publ.* 2: 609–25.
Jouventin, P., *et al.* 1985. *Notornis* 32: 157–220.
Kinsky, F.C. 1971. *Notornis* 18: 215–16.
Learmonth, N.F. 1961. *Emu* 61: 196.
Lindsey, T.R. 1986. *The Seabirds of Australia.*
Nakamura, K. 1982. *Trans. Tokyo Univ. Fish.* 5: 203–11.
Parker, S.A., & I.A. May. 1982. *S. Aust. Orn.* 28: 213–16.
Pascal, M. 1980. *Mammalia* 44: 161–82.

Pocklington, R. 1967. *Emu* 67: 133–8.
Powlesland, R.G. 1987. *Notornis* 34: 237–52.
Rand, R.W. 1954. *Ibis* 96: 173–206.
Richardson, M.E. 1984. *Cormorant* 12: 123–201.
Roberts, G. 1982. *A'sian Seabird Grp Newsl.* 17: 3–5.
Roux, J-P., & J. Martinez. 1987. *Cormorant* 14: 3–19.
Schramm, M. 1983. *Emu* 83: 75–81.
Schramm, M. 1986. *Ostrich* 57: 9–15.
Serventy, D.L. 1927. *Emu* 26: 269–72.
Serventy, D.L. 1937. *Emu* 37: 56–60.
Serventy, V.N., & S.R. White. 1943. *Emu* 43: 81–95.
Siegfried, W.R., *et al.* (Eds). 1985. *Antarctic Nutrient Cycles and Food Webs.*
Stahl, J-C., *et al.* 1985. Pp 478–86. **In**: Siegfried *et al.* 1985.
Swales, M.K. 1965. *Ibis* 107: 17–42, 215–29.
Veitch, C.R. 1976. *Notornis* 23: 168–78.
Veitch, C.R. 1980. *Notornis* 27: 115–24.
Warham, J. 1979. *Notornis*: 26: 357–60.
Warham, J., & B.D. Bell. 1979. *Notornis* 26: 121–69.
Watson, G.E. 1975. *Birds of the Antarctic and Sub-Antarctic.*
Watson, G.E., *et al.* 1971. *Antarctic Map Folio Ser.* 14.
Weimerskirch, H., *et al.* 1989. *Emu* 89: 15–29.
Wheeler, W.R. 1967. *A Handlist of the Birds of Victoria.*
Whitlock, F.L. 1939. *Emu* 39: 47–56.
Whittell, H.M. 1942. *Emu* 42: 36–43.
Williams, A.J. 1978. *S. Afr. J. Antarct. Res.* 8: 49–52.
Williams, A.J. 1984. *ICBP Tech. Publ.* 2: 627–35.
Williams, A.J., & M.J. Imber. 1982. *S. Afr. J. Antarct. Sci.* 12: 40–6.
Zino, P.A., & F. Zino. 1984. *Bolm. Mus. Mar. Funchal.* 38: 141–65.



Volume 1 (Part A), Plate 33

Kerguelen Petrel *Pterodroma brevirostris*
1. Adult, ventral
2. Adult, dorsal

Soft-plumaged Petrel *Pterodroma mollis*
3. Adult, light morph, ventral
4. Adult, light morph, dorsal, worn
5. Adult, dark morph, ventral
6. Adult, dark morph, dorsal