

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 HYDROBATIDAE (OCEANITIDAE) storm-petrels

Storm-petrels are the smallest seabirds, distinguished by having prominent united nostrils with a single opening, wings with a longer second functional primary, and often with a white rump, varying in closely related forms and assumed to serve as an important interspecific recognition-signal. They feed by picking small animals from the surface and fall into two groups.

(1) The sub-family Oceanitinae consists of seven fairly distinct species in five genera, of which five species occur in our region. Characterized by short wings with only ten secondaries, more or less square tails, elongated skulls, and tarsi longer than the toes. They progress by hopping and fluttering over the surface. Some species are said to have only one coat of nestling down. Adults are all polymorphic to some extent. Six species are usually white below; only one has an entirely black breast (Murphy & Snyder 1952). Most breed in the s. hemisphere and only the normally dark-breasted species, Wilson's Storm-Petrel *Oceanites oceanicus*, migrates far N of the equator, where an ancestor might have given rise to the second group (Palmer 1962).

(2) The sub-family Hydrobatinae consists of some 14 fairly closely related species in three genera; in our region only two of these species (in *Oceanodroma*) have been recorded, as accidentals. This group is characterized by having longer wings than the other, wedge-shaped or more usually forked tails, short skulls and bills, tarsi usually about equal in length to the toes, and a swooping flight, walking but not hopping along the surface. They have two coats of nestling down. Adults are usually dark and not polymorphic, though one species is grey and another southern one is white below. Most breed in the north but some breed, or migrate a short distance, south of the equator.

In general, plumage is black or grey above; the rump and underparts may be grey or white. Wing with 11 primaries, p9 longest, p11 minute; 10-11 secondaries, rather short, diastataxic. Tail quite long, forked, square or rounded; 12 feathers. Bill rather small, strongly hooked; nostrils fused with single opening, often upwards. Tarsus, rounded; three forward toes, webbed; hind toe, rudimentary; claws, sharp; flattened in some. Oil-gland feathered. Peculiar musky odour. Sexes similar and juveniles like adults.

Cosmopolitan in all oceans; strictly pelagic, coming to shore only to breed and then usually by night. Very little knowledge of distribution, behaviour and requirements of most species when at sea, because birds are so hard to find and identify. On land, crouch on tarsi and move with shuffling gait. Flight erratic, usually close to surface, characterized by bouncing, fluttering, swooping and skimming progress. Feed mostly on planktonic crustaceans, molluscs and small fish; some species habitually follow ships, scavenging in wake; obtain food mostly by flight-feeding while hovering, pattering or walking on water; seldom dive. Gregarious or solitary at sea. Long-term monogamous pair-bond, probably maintained only at nest-sites by reason of fidelity to site. Little knowledge of social behaviour but birds evidently not specialized for visual displays; sexual communications probably by tactile (allopreening), olfactory and vocal means. Churring or purring calls are a notable feature of breeding colonies. Nest colonially in holes or burrows. Eggs, ovate, mat, white. Clutch-size, invariably one. Single-brooded and probably no replacement laying or very seldom. Incubation by both sexes in alternate shifts of up to 6 days; single median brood-patch. Incubation period, 40-50 days. Eggshells usually left in nest. Young, semi-altricial, nidicolous; hatched in down. Guarded and brooded for 5-7 days before being left alone during day and fed at night, by incomplete regurgitation. Nestling period, 59-73 days; not deserted by parents in last days in nest. Maturity attained in some species at 4-5 years of age.

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Oceanites nereis Grey-backed Storm-Petrel

COLOUR PLATE FACING PAGE 680

Thalassidroma nereis Gould, 1841, *Proc. zool. Soc., London* (1840): 178 — Bass Strait.

The specific name after Νηρηΐς daughter of Nereus, an ancient sea-god, and so a nereid or nymph of the sea.

MONOTYPIC

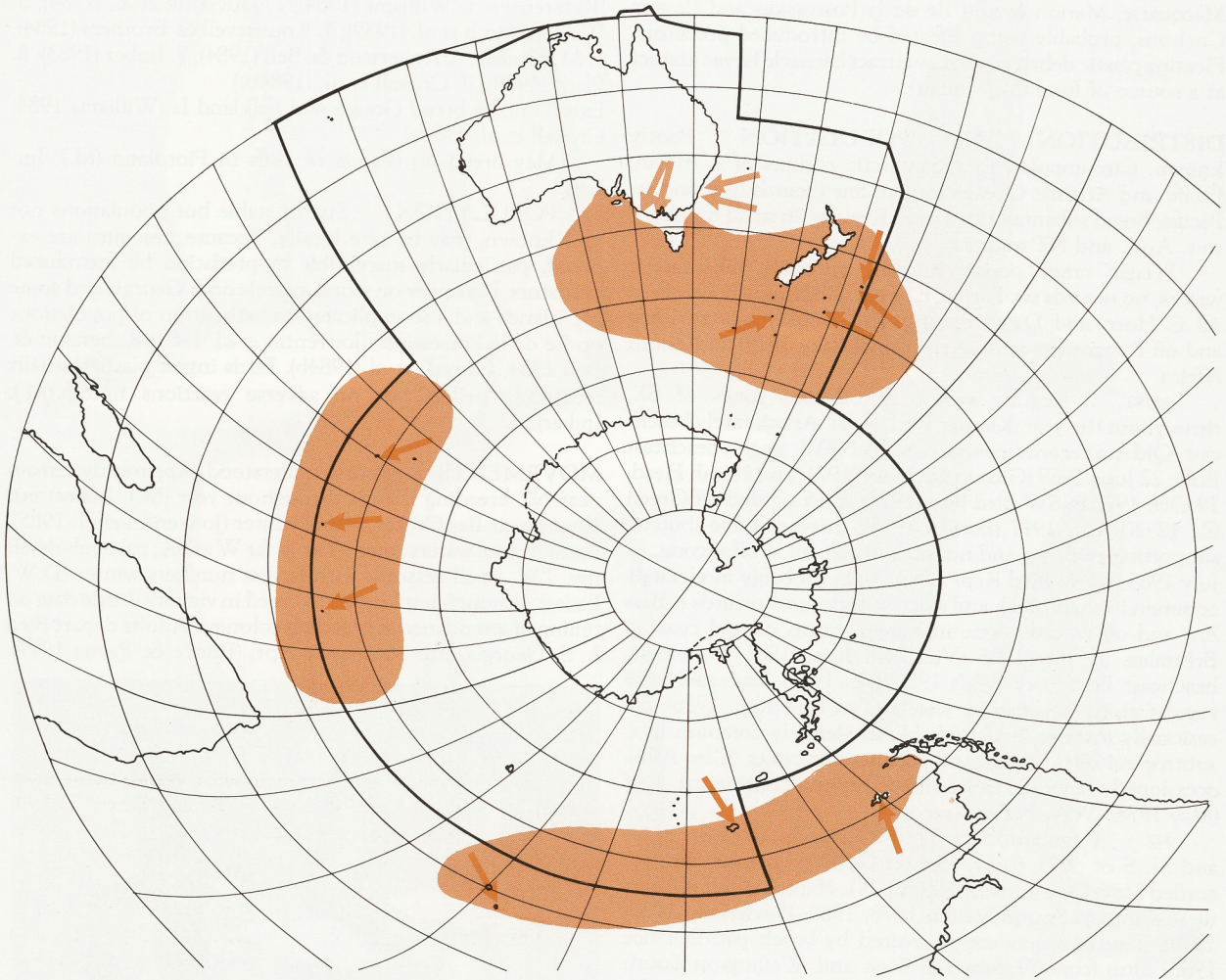
FIELD IDENTIFICATION Length: 16–19 cm; wing-span: 39 cm; weight: 34 g. Smallest storm-petrel of Southern Ocean, occurring N to about 35°S. Slightly smaller, with narrower and shorter wings than Wilson's Storm-Petrel *Oceanites oceanicus*; much smaller than White-faced *Pelagodroma marina* and *Fregetta* storm-petrels, with which it may be confused at distance. At sea, appears as tiny, fast-flying storm-petrel; small and slender-bodied, with square-cut tail, proportionately short innerwing and well-rounded outerwing. Ashy-grey above (including rump, upper tail-coverts) with contrasting blackish hood and leading-edge to wing; tail, ashy-grey, narrowly tipped blackish; shows conspicuous paler silvery-grey panels on proximal upperwing. White below with contrasting blackish hood and undertail; underwing white with narrow blackish margins. Feet project noticeably beyond tail-tip in travelling flight. Travelling flight fast and direct, fluttering low to sea with continuous bat-like wingbeats; when feeding, flight erratic and more varied. Sexes alike. No seasonal variation. Juveniles inseparable.

DESCRIPTION ADULT. Head, neck and upper breast, greyish black, forming blackish hood sharply demarcated from white lower-breast and belly; hood merges evenly into ashy-grey mantle. Mantle, scapulars, back, rump and upper tail-coverts, ashy grey, palest on latter two tracts; upper-tail, ashy grey with narrow blackish terminal band. On upperwing, all marginal coverts, lesser inner wing-coverts, primary coverts and outer primaries blackish, collectively forming dark leading-edge. Remaining primaries, blackish, overlain with pronounced silvery-grey bloom when fresh. Secondaries, blackish. Median and greater secondary coverts, ashy grey, forming pronounced pale panels on proximal upperwing; narrow white fringes to greater coverts form pale rear border to each panel, extending outwards onto tips of inner greater primary coverts. In fresh plumage, mantle, scapulars, rump, upper tail-coverts, median and greater secondary coverts narrowly fringed white and overlain with pronounced silvery-grey bloom, imparting frosty aspect to dorsum and emphasizing pale panels on upperwing. White fringing and silvery bloom to upperparts reduced with wear, dorsum then appearing duller ashy grey, without frosty aspect of fresh-plumaged birds; pale panels on upperwing duller but still distinct; remiges and remaining blackish areas of dorsum wear and fade to brownish-black. Underbody behind dark hood, white apart from blackish undertail; some show a few scattered grey mottlings over white of flanks and under tail-coverts, visible only with optimum view. Underwing lining, white apart from narrow blackish leading margin running from base of wing outwards to base of outermost primary. Leading primary and tips of rest, greyish-black; form narrow dusky border round underwing tip, enclosing extensive paler silvery-grey basal portions of primaries exposed beyond lining. Blackish secondaries form narrow dark trailing-edge to innerwing. Bill, black, tiny, strongly down-curved at tip, with tubed nostrils prominent and angled upwards over base of

upper mandible. Feet and long legs, black; tips of feet project noticeably beyond tip of tail in travelling flight; held dangled when feeding or foraging.

SIMILAR SPECIES Combination of small size, blackish hood contrasting with white underbody and with ashy- or paler frosty-grey upperparts (lacking white patch on upper tail-coverts of many other storm-petrels) plus fast, bat-like, continuously fluttering flight should prevent confusion with other storm-petrels. **White-faced Storm-Petrel**, which frequently occurs with Grey-backed, shares white underparts but readily separable by much larger size and clear white forehead, supercilium and throat forming diagnostic patterned face; also by distinctly browner (grey-brown) upperparts with clear grey confined to upper tail-coverts, leaving whole of uppertail black (uppertail grey with narrow blackish terminal band on Grey-backed). Travelling flight of White-faced more weaving and prion-like, with periods of fluttering broken by short glides and much banking; foraging and feeding flight also differs from that of Grey-backed in stronger bounding and skipping movements higher off surface of sea. Confusion also possible (especially at distance) with **White-bellied *Fregetta grallaria*** and **Black-bellied *F. tropica* Storm-Petrels**, particularly with fresh-plumaged light morphs of White-bellied Storm-Petrel, which show pronounced white scaling and subtle greyish cast to otherwise black mantle, back and scapulars in combination with pale panel on proximal upperwing. Both *Fregetta* spp are, however, considerably larger and fatter-bodied, with much darker black or blackish dorsal aspect; on underwing, show wholly dark primaries forming larger dark wing-tip (paler silvery-grey with narrow dusky border on Grey-backed). Moreover, white-bellied morphs of *Fregetta* show conspicuous white patch on upper tail-coverts, providing ready separation from Grey-backed, which have uppertail coverts uniform-grey with rest of dorsum. Bounding, skipping and pattering flight actions of Grey-backed when feeding recall those of *Fregetta* and White-faced but travelling flight distinctive: fast, bat-like, continuous fluttering action (without glides) unmatched by *Pelagodroma* or *Fregetta*, which have flutter-and-glide action between sustained bouts of skipping and bounding across surface. Note characteristic upswept wings of *Fregetta* during glides.

Primarily found in subantarctic waters, Subtropical Convergence Zone and higher latitudes of Subtropical Zone; also in Antarctic Zone. During breeding season, sometimes forage in continental shelf-waters round breeding islands. At other times, prefer shelf-break and pelagic waters, only occasionally venturing more than short distance into outer shelf-waters. Travelling flight, fast and direct, covering more ground than larger species; continuous flapping produces fast, bat-like fluttering flight low over waves. Feeding flight slower and more varied; in light winds, skip across surface, using one or both feet to kick off water. In higher winds, strongly bound to and fro in wave troughs, suddenly breaking off to rise into wind and tightly circle round to retrace path inside trough. When



pattering, maintain more or less stationary position while facing into wind, with legs dangled and feet touching surface; reach forward to pick items deftly from surface; in strong wind, sometimes blown backwards many metres. Feed by aerial- and contact-dipping, also by pattering, usually in wave-troughs; more rarely by shallow plunging. Usually seen singly or in small loose groups but sometimes form larger parties (>50) when feeding. Frequently follow ships and strongly attracted to fishing trawlers where sometimes form large groups that readily follow in wake; often forage round groups of procellariiforms feeding on natural food or waste from trawls; round breeding islands, parties reported hovering over rafts of kelp. Rarely seen resting on surface but sometimes gather in tight rafts; do not dive. Solitary or gregarious at sea and at breeding colonies. Breed colonially on well-vegetated islands in subantarctic and Antarctic zones; also in Subtropical Zone at Chatham and Gough Is. On land, walk awkwardly, often using wings for balance; sit when stationary. Silent at sea. Largely silent at breeding colonies where crepuscular and nocturnal. Main call, given from ground or nest, is subdued, low, regularly repeated wheezy chirp.

HABITAT Marine; mainly in Subantarctic Zone of three major oceans; in Aust. and NZ region, occurs N to Subtropical Convergence (Norris 1965; May 1978); range extends

S of Antarctic Convergence at S. Georgia (breeding site). In breeding season, range contracts towards breeding islands; birds observed in s. Tasman Sea and round Tas., W to Kangaroo I. but not in Aust. sector of Southern Ocean in summer (Johnstone & Kerry 1976; D.W. Eades). At Iles Crozet, in breeding season forage over continental shelf and in pelagic zone, but not shoreward of kelp (*Macrocystis*) zone (Jouventin *et al.* 1982, 1985). In non-breeding season, most observations over shelf-break and slope and, occasionally, shelf waters; few records in pelagic waters and use of this habitat not described; in Aust., winter observations in shelf-break and slope waters (Klapste 1981) and recorded over waters of 160 m (s. NSW; Barton 1978) and 180 m depth (SA; May 1978).

Circumpolar breeding distribution on subantarctic and Antarctic rocky or vegetated islands. Nest below 350 m asl; on Antipodes I. and Pyramid Rock (Chatham Is), under coastal grassland and heath; tussock (*Poa litorosa*), ferns (*Polystichum*) or succulents (*Cotula renwicki*) (Fleming 1939; Imber 1983). On Pyramid Rock, choose flatter parts of rock stack (Fleming 1939). In S. Georgia, also use rock crevices (Murphy).

Fly and feed at lowest levels, immediately above surface.

Tussock grassland on some breeding islands destroyed by grazing by introduced stock and rabbits or by fire. Breeding not now known at Chatham I. itself nor on Campbell,

Macquarie, Marion Is and Ile de la Possession and Ile aux Cochons, probably being affected by introduced predators. Floating plastic debris at sea may attract barnacle larvae and act as a source of food (M.J. Imber).

DISTRIBUTION AND POPULATION Poorly known. Circumpolar, in subantarctic regions of s. Indian, Pacific and Atlantic Oceans though few records in s. and se. Pacific. Breed subantarctic islands. Regular, in small numbers, to s. Aust. and NZ waters.

Pelagic range poorly known; primarily subantarctic waters; no records sw. Pacific, E of NZ. Occasionally observed off C. Horn and Diego Ramirez Is, Chile (Johnson 1965) and off Patagonian coast, Argentina (Blake 1977) and South Africa.

AUST. Regular visitor to offshore zones of SE, throughout the year (Klapste 1981; Aust. Atlas); rarely beachcast. **Qld:** no records (*contra* HASB). **NSW:** singles beachcast Bulli, 22 June 1969 (Gibson & Sefton 1971) and Norah Head, 29 Oct. 1972 (NSW Bird Rep. 1972); c. 15 sighted off Green C., 12–20 Apr. 1977 (Barton 1978); three possible (but no supporting evidence and not acceptable), off Wollongong, 27 July 1985 (NSW Bird Rep. 1985). **Vic.:** probably moderately common in shelf-break and slope waters; most records e. Bass Str. and off w. coast; one inshore sighting, central coast at Breamlea, 31 July 1985 (Vic. Bird Reps 1981–85); single, beachcast, Port Fairy, 8 July 1976 (Isles 1977). **Tas.:** said to be regular visitor to offshore waters (Tas. Bird Rep. 1986); occasionally inshore. **SA:** probably moderately common in s. subtropical deep waters and subantarctic zones (Cox 1976); occasionally recorded in hundreds beyond continental shelf (May 1978). **WA, NT:** no records.

NZ Regular to seas S of NZ; straggles to coasts of NI and SI, S of 36°S, from Hauraki Gulf to Foveaux Str.; recorded May–Dec. (Oliver; NZCL). **NI:** Hauraki Gulf (Oliver) to Wellington South (Veitch 1978, 1980; Powlesland 1987, 1989). Twelve specimens recovered by beach patrols since 1960: nine from Wellington West and Wellington South beaches, also Auckland West and Wairarapa coasts. **SI:** between 1960 and 1986, singles beachcast Westland and Canterbury North. Live birds occasionally recovered in S (sometimes inland) including Mt Aspiring (CSN 25), Manapouri (CSN 28), Alexandra (CSN 20), Doubtful Sound (Cooper 1980; Hawke 1989) and L. Howden (Morrison 1983).

BREEDING Subantarctic islands in Indian, Pacific and Atlantic Oceans.

Prince Edward Is: 100 pairs (1)

Iles Crozet: 100s pairs (2)

Ile de l'Est: 100s

Ile des Apôtres and Ile des Pingouins: possible sites; Ile de la Possession: exterminated (2)

Iles Kerguelen: 3000–5000 pairs (3)

Macquarie I.: estimated 100 pairs but breeding not confirmed (4)

Campbell Is: probably on nearby stacks and islands (5)

Auckland Is: probably widespread (6)

Antipodes Is: probably all islands (6,7)

Chatham Is: total 10 000–12 000 birds (5)

Houruakopara I.: 200–300 pairs

Rabbit I.: c. 100 pairs

Mangere, South East, Star Keys, Pyramid and probably other islets and stacks (5,8)

S. Georgia (9)

[References: 1. Williams (1984); 2. Jouventin *et al.* (1984); 3. Weimerskirch *et al.* (1989); 4. Rounsevell & Brothers (1984); 5. M.J. Imber; 6. Robertson & Bell (1984); 7. Imber (1983); 8. Plant (1989); 9. Croxall *et al.* (1984b)]

Extraliminally breed Gough and Falkland Is (Williams 1984; Croxall *et al.* 1984a).

May breed on islands or cliffs in Fiordland (M.J. Imber).

POPULATION Status, stable but populations not well known; may be rare locally. Because nest-sites are exposed, particularly susceptible to predation by introduced predators. Rats prey on storm-petrels on S. Georgia and some NZ islands and also implicated in extirpation of populations on Ile de la Possession (Jouventin *et al.* 1984; Robertson & Bell 1984; Croxall *et al.* 1984b). Birds ingest plastic (usually feedstock) pellets but no adverse reactions noted (M.J. Imber).

MOVEMENTS Poorly understood. Apparently remain near NZ breeding islands throughout year (M.J. Imber) but absent near Iles Crozet during winter (Jouventin *et al.* 1985); occur in cool waters round Tas. as far W as SA, particularly off nw. Tas., in all seasons, with largest numbers winter (D.W. Eades), although not known to breed in vicinity. Little data on timing of attendance at breeding colonies. Adults depart Bird I., S. Georgia, late Mar.–early Apr. (Prince & Payne 1979);

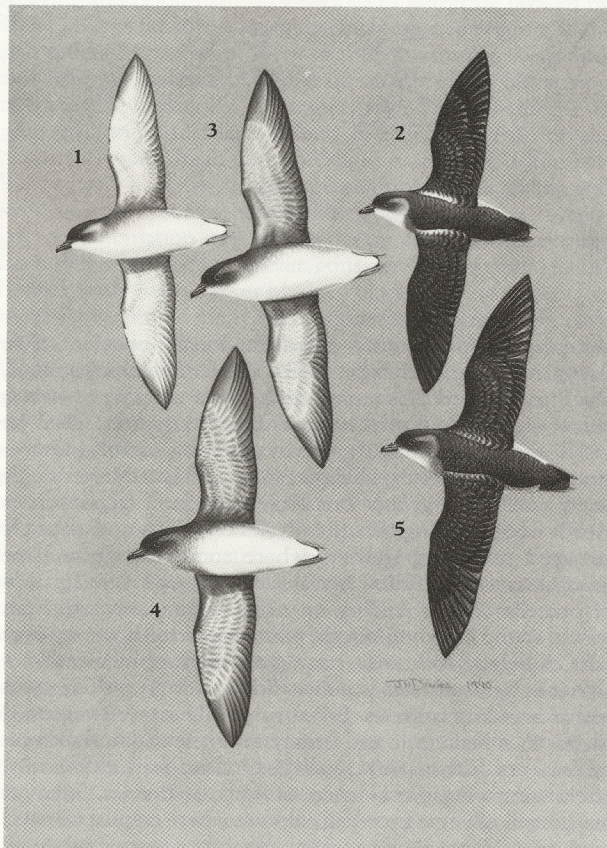


Plate 53

South Georgian Diving-Petrel

Pelecanoides georgicus

1. Adult, ventral

2. Adult, dorsal

Common Diving-Petrel

Pelecanoides urinatrix

3. Adult, pale form, ventral

4. Adult, dark form, ventral

5. Adult, dorsal

young fledged from Iles Crozet, 1–13 Feb. 1971 (Jouventin *et al.* 1985) and do so from Chatham Is, Jan.–Mar. (M.J. Imber). Present Chatham Is all year (M.J. Imber). Return Iles Crozet, 17 Oct. 1981 (Jouventin *et al.* 1985) and Bird I., Nov. (Prince & Payne 1979). No long-distance banding recoveries.

FOOD Main food, immature barnacles with a few other crustacea and, occasionally, small fish. **BEHAVIOUR.** Food collected mainly by pattering and aerial-dipping, which is performed with characteristic swinging motion, feet hopping across water surface and wings held just above horizontal (Beck & Brown 1971; Klapste 1981); occasionally shallow plunges (Harper *et al.* 1985). Off Tas., pattering 75% observations, aerial-dipping 25% (D.W. Eades).

BREEDING At Chatham Is, (27 birds, 8144 items; Imber 1981) imm. barnacles *Lepas australis* (1.7–5.4 mm) 85.5% wt., 98.2% no., with balance euphausiids *Nyctiphanes australis* 7.3, 0.8, 8.0–14.0 mm, amphipods *Cylopus macropis* 0.1, <0.1, 8.5 mm, *C. magellanicus* 5.0, 0.8, 6.0–9.5, *Hyperia spinigera* 1.4, <0.1, 11.0–14.0, *Themisto gaudichaudii* 0.3, <0.1, 7.0–8.0 and isopods *Idotea metallica* 0.1, <0.1 4.0–5.0 and one unidentified fish 0.3, <0.1, 12.

Another sample from Chatham Is, also mostly imm. *Lepas australis* with some euphausiids *Nematoscelis megalops*, *Nyctiphanes australis* and amphipods *Themisto gaudichaudii* (Plant 1989).

Similarly, collections from Marion I. (three birds; Imber 1981) or offshore (one bird; Grindley & Lane 1979), at Bolsons I., Antipodes Is (one bird; Imber 1981, 1983) and from s. NZ (one bird; Richdale 1943) contained only imm. *Lepas australis*. Immature barnacles scarce in surface plankton, so feeding apparently highly selective.

INTAKE Chicks fed every 1.6 days (0.6; 1–3; 23) and gain 1.74 g/day (Plant 1989).

SOCIAL ORGANIZATION Not well known; information supplied by M.J. Imber. Solitary or gregarious throughout year, except during breeding season when in pairs. Feed solitarily or in small flocks. Nocturnal at breeding colonies, arriving 2–3 h after sunset (Woods 1970).

BONDS Assumed monogamous, probably sustained or long-term. No information on timing or age of pair-formation. Co-operative breeding not recorded, but not impossible at nests where more than one egg laid (M.J. Imber); at Chatham Is, a single egg was incubated by three birds (Plant 1989). Both parents incubate and tend young until fledging.

BREEDING DISPERSION Loosely colonial; no data on distances between nests. Once, 23 burrows counted in 100 m traverse (Woods 1970). Territorial, defending nest-site only.

ROOSTING Sleep when incubating and probably at other times at nest. At other times, probably roost at sea. Some doubt about ability to spend long time on surface of sea without suffering adverse effects, and therefore may sleep on wing (M.J. Imber). Roost solitarily.

SOCIAL BEHAVIOUR No detailed studies; information supplied by M.J. Imber, A.R. Plant. Difficult to observe and behaviour inconspicuous. Rarely form flocks; usually observed singly or as pairs.

AGONISTIC BEHAVIOUR Not known; will quite often spit oil, more so than other storm-petrels such as White-faced Storm-Petrel. No further information.

SEXUAL BEHAVIOUR Birds call from nest or on

ground; possibly involved in pair-formation and mate-attraction; flying birds, hearing call, especially from nest site, hover above calling bird, sometimes landing. Calling seems restricted to Aug.–Nov. period of pair-formation. No other courtship or greeting displays observed, but allopreening probable. No information on copulation.

RELATIONS WITHIN FAMILY GROUP Both parents incubate in shifts 1.9 days (1.1; 1–5; 30), each shift nearly always followed by period of desertion of 2.7 days (1.2; 1–7; 26); thus, eggs deserted for about 50% of egg-period (Plant 1989). Brood- and guard-periods brief (Despin *et al.* 1972; M.J. Imber); at Chatham Is, chick brooded during day for maximum 4 days after hatching (Plant 1989). Parental care intermittent during incubation; chick fed often, at Chatham Is, every 1.3 days (0.6; 1–3; 23) and so grows rapidly (Despin *et al.* 1972; Plant 1989). Young independent after fledging. No information on communication between parents and young or period of desertion (if any).

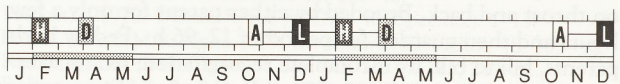
VOICE No detailed studies; information supplied by M.J. Imber. Generally silent and little variety in calls; only one low, rather harsh call known; similar to main call of Wilson's Storm-Petrel and somewhat like a cricket or grasshopper (M.J. Imber). Birds call only from ground. Calling seems restricted to Aug.–Nov. when pairs formed. Sexual differences, individual differences, geographical variation have not been investigated.

ADULT A low, regularly repeated wheezy chirp (M.J. Imber) or a quiet wheezy croak (Woods 1970); on Falkland Is, repeated a little more quickly than one per second. Appears to function in mate-attraction; flying birds hearing call, especially from nest-site, hover above calling bird, sometimes landing. No further information.

YOUNG Very quiet; not heard by M.J. Imber. Quietness may be adaptation to avoid predation by skuas, as nests virtually in open (M.J. Imber).

BREEDING Poorly known. Field studies in Chatham Is by Plant (1989) and M.J. Imber; in Iles Crozet by Jouventin *et al.* (1985). Information supplied by M.J. Imber. Breed colonially on subantarctic islands, usually in tussock-grassland in some places associated with other storm-petrels but not in competition with them.

SEASON Broadly from Aug. to Apr. In Chatham Is, birds never entirely absent, visiting nesting grounds at night virtually throughout year; laying from 20 Sept. at earliest to late Dec.; fledging early Jan. to early Apr. In Iles Crozet, birds almost absent in winter; returned 17 Oct.; visited nesting grounds during 60-day pre-laying period in cycles of 16.5 ± 0.7 days with pre-laying exodus in last 14 days; laying 15–29 Dec.; hatching between 1 and 13 Feb. and fledging end Mar. and early Apr. Despin *et al.* (1972) suggested later laying at colonies in higher latitudes than in lower but very few data.



(Iles Crozet)

SITE Colonies mostly coastally on larger islands, preferably in tussock-grassland or under low forest; also among ferns and bracken, New Zealand flax *Phormium* spp, creepers *Muehlenbeckia*, *Cotula*, *Anistome* and brambles *Rubus* sp. In Chatham Is, generally under dead flax leaves or in

fissures between bases of live leaves and rhizomes. Usually on flat or sloping ground but on Gough I. on steep to vertical cliffs. Nests mostly on or above ground, unlike other storm-petrels, well covered by vegetation and often hard to find. In Falkland Is, nests c. 30 cm inside skirt of dead leaves of tussock *Poa flabellata* (Woods 1970).

NEST, MATERIALS In Chatham Is, holes or tunnels in vegetation 0–50 cm long and 7 cm in diameter. Nest chamber without real lining except perhaps some grass stems or fibres of flax, probably pulled from leaves by the birds. Sites traditionally used from year to year. Roles of sexes in choosing and preparing sites or building not known.

EGGS Elongate ellipsoid, short elliptical or occasionally (2/41) pyriform; smooth-textured, not glossy; white with light scattering of reddish-brown spots, usually concentrated at one end.

MEASUREMENTS:

Chatham Is 30.8 (28.4–33.0; 29) x 23.0 (21.3–24.4) (Fleming 1939; M.J. Imber).
31.2 (1.0; 29.2–33.0; 9) x 23.2 (0.6; 22.0–23.9) (Plant 1989).

Iles Crozet 33.2 (1.9; 31.6–37.5; 8) x 24.3 (1.1; 22.7–25.7) (Jouventin *et al.* 1985).

WEIGHT:

Chatham Is 8.8 (7.7–9.7; 13) or ratio of egg: adult weight 29% at laying and relatively heavier than egg of kiwi (Fleming 1939; M.J. Imber).

8.4 (0.9; 6.8–9.9; 18) (Plant 1989) egg: ad. wt 25.9%.

Iles Crozet 9.0 (0.7; 8.5–10.0; 8) (Jouventin *et al.* 1985) egg: ad wt 28.1%.

CLUTCH-SIZE One.

LAYING In Chatham Is, apparently not synchronized (20 Sept. to end Dec.), with evidence for two peaks of laying: early Oct. and late Nov. (M.J. Imber). In Iles Crozet, well synchronized (15–29 Dec.). Egg laid at night. Sometimes two, rarely three, females lay in same nest. No second brood nor replacement laying.

INCUBATION During incubation adults often leave egg unattended, specially when under observation and being handled, which ought to be done circumspectly (Plant 1989; M.J. Imber). Thus, **INCUBATION PERIOD** varies much and no adequate determinations; estimated at c. 45 days (Despin *et al.* 1972). Both sexes incubate in alternate shifts; at Iles Crozet, shifts averaged 1.5 days (1–3; 4), followed by desertion for 3 days (2.0; 1–5; 3) (Jouventin *et al.* 1985); at Chatham Is, 1.9 days (1.1; 1–5; 30), followed by desertion of 2.7 days (1.2; 1–7; 26) in all but one instance, thus giving an extended incubation period (Plant 1989). At Chatham Is, one egg was incubated by three birds in shifts over 20 days' observation. Eggshells trampled in nest. No further information.

NESTLING Semi-altricial, nidicolous. Hatched with greyish-black or smoky-grey protoptile, later dark grey (? mesoptile). Eyes fully open by second day. Quills appear when 9–13 days old; when 12–14 days old, feather tracts discernible on throat and back. Brooded by either parent for only a few hours and then guarded for period of 12–96 h. Fed by both parents, bill to bill, by incomplete regurgitation; fed on average every 1.6 days (0.6; 1–3; 23) with size of meal increasing with age (Plant 1989). No further information.

GROWTH Weight at hatching not known but chick grows rapidly to equal adult weight by 17 days old, at Chatham Is; maximum weight more than 50 g (Despin *et al.* 1972). Average daily rate of growth 1.74 g/day; daily increase in weight 12.6% (Plant 1989).

FLEDGING TO MATURITY Fledgelings leave at

night, able to fly right away and totally independent of parents. No knowledge of age at first pairing or breeding.

SUCCESS No information. In Chatham Is, skuas *Catharacta* and Swamp Harriers *Circus approximans* take adults and young. Prions and penguins probably interfere with nests by trampling and breaking eggs, in places leaving bare ground, unsuitable for nesting of Storm-Petrels, and so affecting extent of colony. Introduction of grazing animals and predators to breeding islands has caused extinctions.

PLUMAGES Age of first breeding unknown.

ADULT In fresh plumage: **HEAD AND NECK**, black-brown (119), slightly darker round eye; paler on chin, throat and foreneck. When worn, forehead, dark brown (119A). **UPPERPARTS**. Dark-grey (83) mantle merges to grey (84) at back; slight white fringing on mantle. Larger scapulars, dark grey (83), broadly fringed white; smaller scapulars with narrower fringes. Rump and upper tail-coverts, light grey (85); upper tail-coverts, broadly fringed white, lateral upper tail-coverts variably fringed grey (84). When worn, fringes on upperparts, narrow and concealed white bases of feathers on mantle and rump often exposed. **Tail**, light grey (85) with broad (10–16 mm) terminal black-brown (119) band. **UPPERWING**. Remiges, greater primary coverts, alula, lesser and marginal coverts, black-brown (119); inner webs of primaries slightly paler. Primaries extend 18–20 mm beyond tip of tail when wing closed. Greater and median coverts, grey (84), broadly fringed white. Inner secondaries and primaries (p1-p5), narrowly tipped white. When worn, fringes on upper wing-coverts and white tips on primaries and secondaries, largely lost. **UNDERPARTS**, mostly white; breast, black-brown (119) with sharp demarcation at lower margins. Some feathers on flanks, thighs and under tail-coverts irregularly mottled light grey (85). Under tail-coverts almost reach tail tip. Axillaries, white. **UNDERWING**. All coverts white, apart from black-brown (119) marginal coverts.

DOWNY YOUNG First down: in skins, brown-grey (79); live birds, black-brown (c119) (M.J. Imber) or smoky-grey; ventrally, two bands of whitish-grey down from base of legs, broadening and uniting on breast (Plant 1989). Fluffy all over; down c. 2 cm long, thicker on head and back. Crown covered in down; throat, cheek and face from bill to behind eye, bare (Plant 1989). Unknown if second down stage occurs. Quills emerge: first scapulars (9 days old), then secondaries and coverts (10–11 days old), primaries and coverts (12–13 days old) and feather tracts on breast and back (12–14 days old) (Plant 1989).

JUVENILE Similar to adult, differences described here only. Some feathers at posterior of lores, tipped white. White fringes on mantle and scapulars broader when in fresh plumage. Distinguished from fresh plumaged adult by shape of outer primary; pointed in juvenile, rounded in adult.

BARE PARTS Based on photos in Lindsey (1986), NZRD, and unpublished (A.J.D. Tennyson) except where stated.

ADULT, JUVENILE Iris, dark brown (221). Bill, legs and feet, grey-black (82).

DOWNY YOUNG Bill, black. Claws, black; legs, toes and webs, whitish-flesh to 8 days old; becoming greyer from 8–14 days old; after 14 days old, black (Plant 1989).

MOULTS Based on skins at NMNZ except where stated.

ADULT POST-BREEDING Complete; in breeding birds, Feb.–May (Swales 1965). Moulting may occur at breeding locality (Swales 1965; Warham & Bell 1979). Primaries moult outwards; two adjacent primaries growing at same time; duration unknown. Tail moult begins when primaries nearly finished, body moult occurs at this time. **Post-juvenile.** No data.

MEASUREMENTS (1) Houruakopara I., Chatham Is, live adults (sexed by cloacal inspection); methods unknown (M.J. Imber). (2) Iles Crozet, live birds, unsexed; standard methods (Jouventin *et al.* 1985). (3) Iles Kerguelen, live birds, unsexed; methods unknown (Weimerskirch *et al.* 1989). (4) Main I. and Mangere I., Chatham Is, live birds, unsexed, unknown status; methods as in Baldwin *et al.* [1931]; WING=flattened chord (A.J.D. Tennyson). (5) Auckland, Campbell and Antipodes Is, adult skins, juveniles excluded (NMNZ); Skins from Antipodes Is taken offshore; no evidence of breeding (Warham & Bell 1979).

	MALES	FEMALES
WING	(1) 129.5 (2.52; 124–134; 19) (5) 127.4 (3.60; 124–138; 17)	134.9 (3.11; 127–139; 16) 133.2 (3.69; 126–140; 27)
STH P	(5) 96.6 (3.19; 92–104; 9)	102.1 (2.29; 98–105; 7)
BILL	(1) 12.7 (0.44; 11.9–13.4; 19) (5) 13.0 (0.53; 12.2–14.3; 17)	13.0 (0.33; 12.4–13.6; 16) 12.9 (0.36; 12.3–14.1; 24)
TARSUS	(1) 31.8 (1.07; 29.9–34.1; 19) (5) 31.7 (1.53; 27.4–34.5; 17)	32.3 (0.88; 30.7–33.5; 16) 33.4 (1.39; 30.2–35.6; 25)
TAIL	(1) 63.4 (1.89; 60–67; 19) (5) 62.9 (2.14; 60–66.5; 16)	66.0 (2.37; 62–70; 16) 67.0 (3.03; 61–71; 25)
TOE	(1) 26.4 (1.36; 23.3–29.6; 19) (5) 26.7 (1.03; 25.4–29; 11)	26.6 (1.30; 24.1–28.7; 16) 27.6 (1.23; 25.4–29.9; 18)
	UNSEXED	
WING	(2) 127.0 (6; 116–134; 18) (3) 126.8 (3.8; 118–135; 41) (4) 130.4 (4.36; 123–138)	
BILL	(2) 13.6 (0.7; 12.5–15.0; 18) (3) 13.1 (0.9; 11.6–15.4; 41) (4) 12.7 (0.38; 11.8–13.5; 15)	
BILLD	(4) 5.1 (0.25; 4.7–5.8; 14)	
BILLW	(4) 4.8 (0.23; 4.4–5.3; 14)	
TARSUS	(2) 32.6 (1.4; 30–34; 18) (3) 31.9 (1.3; 29.1–34.1; 41)	
TAIL	(4) 63.5 (4.49; 55.4–72.4; 14)	
TOE	(4) 27.2 (1.31; 24.6–29.2; 15)	

Additional measurements in Murphy, Swales (1965), Prevost (1970), Despin *et al.* (1972), Warham & Bell (1979) and Clancey (1981). For some details of growth rates in chicks, see Breeding.

WEIGHTS Adult live birds: Houruakopara I., Chatham Is, Oct.–Nov. 1981 (M.J. Imber): males 34.0 (2.87; 29–40; 13); females 34.0 (2.87; 28–39.5; 11). At Iles Crozet, unsexed birds: 32.0 (5.0; 25–42; 16) (Jouventin *et al.* 1985). At Iles Kerguelen, unsexed birds: 38.2 (3.5; 31–44; 38) (Weimerskirch *et al.* 1989). Label data from adult skins at (NMNZ), from Auckland, Campbell and Antipodes Is: males 32.4 (5.69; 20.6–41; 12); females 32.6 (2.44; 26.8–36; 14). Additional weights in Swales (1965) and Warham & Bell (1979). No data on seasonal weight changes. For details of weight changes in chicks, see Jouventin *et al.* (1985).

STRUCTURE Wing short and narrow. Eleven primaries: p9 longest, p10 2–12 mm shorter, p8 1–3, p7 7–12, p6

16–23, p5 25–33, p4 34–45, p3 43–57, p2 52–66, p1 60–74, p11 minute. No emarginations. Tail, short and square; 12 rectrices: t1 usually longest, t6 0–3 mm shorter. Bill short and narrow; nasal tube 50% of bill length. Nostril tube upturned distally. Tip of p10 pointed in juveniles; rounded in adults. Tarsi, scutellate. Legs thin, feet narrow, toes webbed. Claws flattened and spade-shaped; sharp when pre-breeding, blunt when worn. Outer toe longest, middle almost equal, inner c. 87% of middle, hind reduced, claw only.

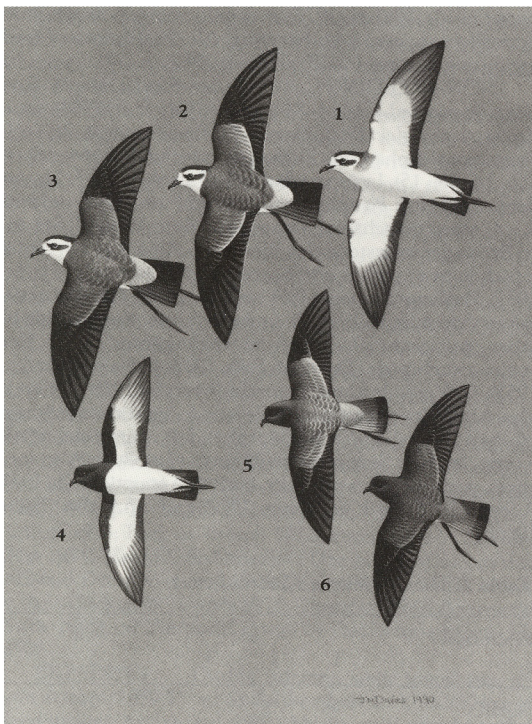
SEXING, AGEING Sexes distinguished on measurements (see above). Juveniles distinguished by pointed tip to p10 (rounded in adults), and broader white fringing on upperparts when in fresh plumage.

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Volume 1 (Part A), Plate 51

White-faced Storm-Petrel *Pelagodroma marina* Subspecies *dulciae*

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

Grey-backed Storm-Petrel *Oceanites nereis*

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

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