

Order PROCELLARIIFORMES

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

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

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

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

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

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

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

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Family PROCELLARIIDAE fulmars, petrels, prions, shearwaters

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

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

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

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

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

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

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

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

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

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Pachyptila salvini **Salvin's Prion**

COLOUR PLATE FACING PAGE 529

Prion vittatus salvini Mathews, 1912, *Birds, Aust.* 2: 212 — Iles Crozet, Marion Island, etc.; restricted to Marion Island by Mathews, 1934, *Novit. zool.* 39: 172.

Named in honour of O. Salvin, 1855–98, Curator of Ornithology, Cambridge University, 1874–82.

OTHER ENGLISH NAMES Lesser Broad-billed, Medium-billed or Marion Island Prion as well as those under *P. vittata* above.

Salvin's is the simplest and most appropriate name. Retention of **Lesser Broad-billed** is incorrect because recent work has shown *salvini* to be very different from Broad-billed Prion *P. vittata* and more closely related to Antarctic Prion *P. desolata* (P.C. Harper).

POLYTYPIC Nominate *salvini* breeds Marion and Prince Edward Is and Iles Crozet; *macgillivrayi* (Mathews, 1912), breeds Iles St Paul and Amsterdam.

FIELD IDENTIFICATION Length 28 cm; wingspan 57 cm. Medium-sized prion of Indian Ocean; virtually identical to Antarctic Prion *P. desolata* in shape, size, flight, appearance and habits and the two are inseparable at sea; on average,

bill longer and slightly broader than Antarctic Prion. For discussion, see Antarctic Prion.

HABITAT Marine, in subantarctic and adjacent Antarctic and subtropical waters. Pelagic range poorly known, because specific identification is difficult to impossible at sea. In breeding season, forage over continental shelf and slope off breeding islands (Iles Crozet; Jouventin *et al.* 1985). Outside breeding season, occur off coasts of Aust., NZ and South Africa, in plankton-rich upwelling zones (Harper 1980). In winter, normally absent from near Marion I., but congregate in inshore waters (from 0.5 to several kilometres from shore) ahead of strong cold-fronts (air pressure <1000 mb); depart when front arrives (Mendelsohn 1981).

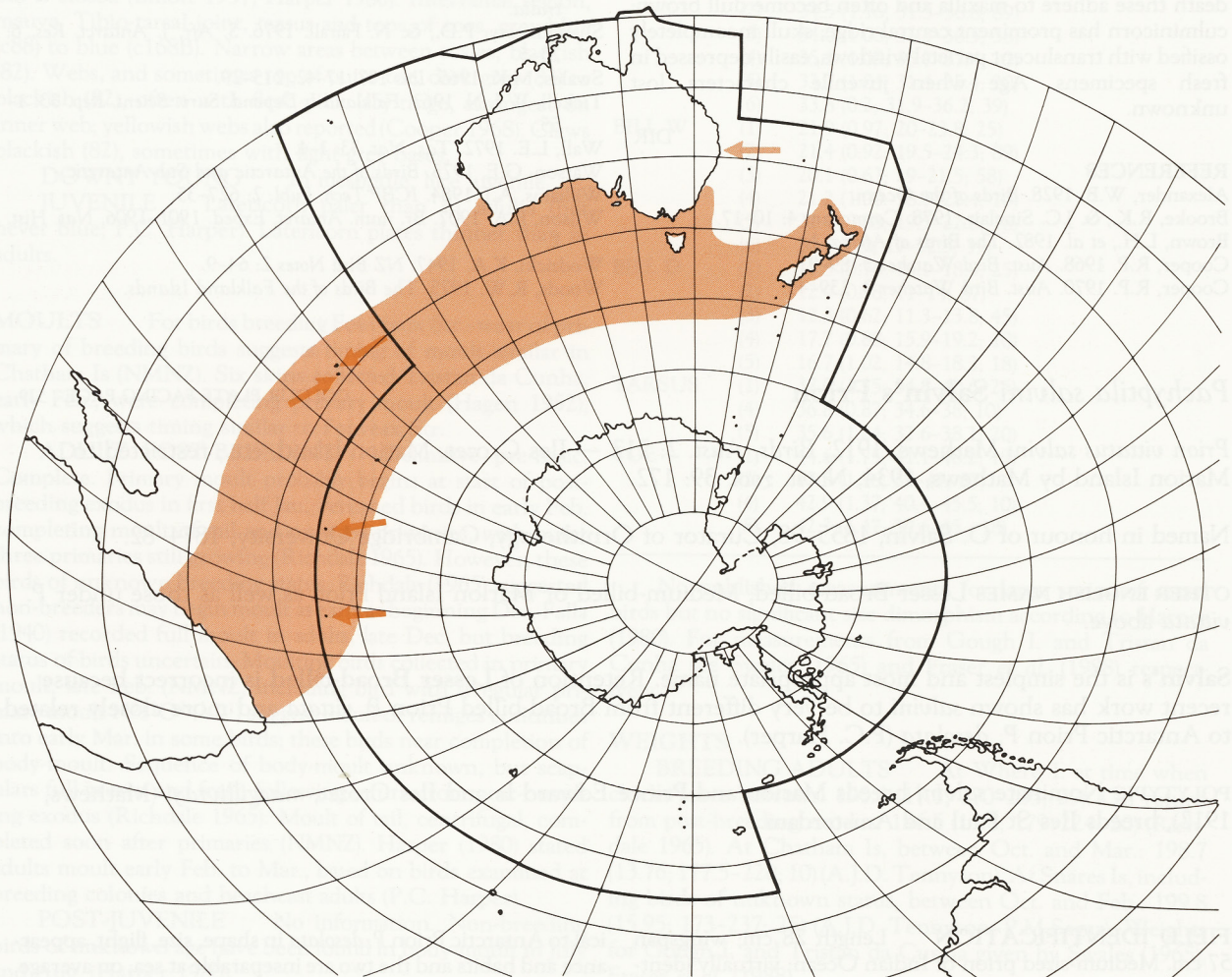
Breed on subantarctic Indian Ocean islands; in burrows in vegetated slopes (*Azorella*, *Acaena*, *Cotula*, *Poa*, *Rumex*) or in rock crevices and caves; nest from sea-level to above 200 m asl (Rand 1954; Derenne & Mougou 1976).

Introduced predators such as Brown Rats *Rattus rattus* have reduced numbers and limited breeding on some islands (e.g. Ile de la Possession, Iles Crozet).

DISTRIBUTION AND POPULATION S. Indian Ocean, from Africa to e. Aust., and extending into Tasman Sea. Breed Prince Edward, Marion Is and Iles Crozet in s.

Indian Ocean and Iles Amsterdam and St Paul farther N. Pelagic distribution poorly understood; s. Indian, Southern and sw. Pacific Oceans from se. African coast to NZ waters; mainly subantarctic waters, extending N to subtropical seas during non-breeding season. Not recorded South Atlantic; probably extends no farther into sw. Pacific than NZ (Harper 1980). Regular visitor to se. African coast, from Cape of Good Hope to Natal and Mozambique Channel (McLachlan & Liversidge 1978). No records South America (Harper 1980).

AUST. Regularly beachcast in winter (June–Oct.) in sw. and s. Aust.; uncommon e. coast. **Qld.** Singles: near Brisbane, July 1954 (McKean & Vernon 1971); N. Stradbroke I., Aug (year unrecorded) (Roberts 1979); Fraser I., July 1985 (Qld Bird Rep. 1985). **NSW.** Occasional beachcast specimens, N to Sydney (Morris *et al.* 1981). Wrecks after cyclones in July recorded on NSW coast in 1904, 1948, 1954 (Hindwood & McGill 1955). **Vic.** Beachcast birds from entire coast: Lakes Entrance (Hitchcock 1952) to Portland (Learmonth 1957). Most frequent on central and w. coasts and W of Wilson's Prom. (Vic. Atlas; Vic. Bird Repts 1984, 1985). **Tas.** Common winter visitor, mainly beachcast on w. coast (Green 1977; Tas. Bird Repts 1979, 1981). **SA.** Regular and common beachcast, June–Oct. (Cox 1976; Parker *et al.* 1979), along shores of Gulf St Vincent, The Coorong and w. coast (Condon 1969). **WA.**



Often beachcast along sw. coast (Serventy 1948).

NZ Moderately common as beachcast (mostly juveniles) in winter. More abundant NI. NI. Highest rate of recovery of beachcasts between 1960 and 1986 on Auckland West coast (16.3%), but figures distorted by wrecks, notably in 1970 and 1974 (Powlesland 1989). Large numbers may be blown ashore onto w. coast (Falla *et al.* 1981). Recovered all coasts except Wairarapa, but few on entire e. coast. SI. Beachcast birds found in small numbers on all coasts.

BREEDING Restricted to Indian Ocean.

Prince Edward Is: hundreds of thousands (Harper 1980; Williams 1984)

Iles Crozet (Jouventin *et al.* 1984)

Ile de la Possession: hundreds of thousands

Ile de l'Est: millions

Ile aux Cochons: 4 million

Ile des Pingouins: thousands

Ile des Apôtres: tens of thousands.

Extralimally, breed La Roche Quille, Ile St Paul (a few pairs; Tollu 1984) and Ile Amsterdam (a few pairs; Roux *et al.* 1986).

POPULATION Nominate *salvini* has large world population and is secure; predation by Black Rats *Rattus rattus* has reduced numbers and restricted breeding on Ile de la Possession (Jouventin *et al.* 1984); on Marion I., feral cats have a significant effect on breeding success (van Rensburg & Bester 1988). Populations of *P.s. macgillivrayi* have declined and subspecies threatened by deforestation and introduction of Brown Rats *R. norvegicus* and feral cats to Ile Amsterdam (Jouventin *et al.* 1984).

MOVEMENTS Dispersive or migratory; apparently moves E-W between breeding islands in s. Indian Ocean and A'asia.

DEPARTURE Marion I., 25 Feb.-9 Mar. (Berruti & Hunter 1986); Ile aux Cochons, Iles Crozet, mean 23 Mar. (6 days; 13 Mar.-4 Apr.; 39) (Derenne & Mougin 1976).

NON-BREEDING A few may remain Marion I. in non-breeding season (Mendelsohn 1981) but not recorded at Iles Crozet during non-breeding period (Jouventin *et al.* 1985). Adults recorded often off WA but immatures predominate se. Aust. and NZ. At least some birds occur off South Africa in Apr. (Bierman & Voous 1950). No evidence of circumpolar distribution with no records from South America or polar Pacific. Emaciated immatures often beachcast NZ after storms late May-July (Harper 1980) with notable wrecks 1970 and 1974 (Powlesland 1989). Beachcast birds have sex-ratio biased 2:1 in favour of males but source of bias unknown (Harper 1980).

RETURN Arrive breeding islands, late Sept. (Harper 1980). Population of adults on Iles Crozet cycles after return, with intervals of 7.4 days (2.4; 5.4-12.0), ending with pre-laying exodus of about 15 days (Jouventin *et al.* 1985).

BANDING

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46S051E 03 P U 03 9323 135 NZNBS

FOOD Mostly crustaceans, particularly amphipods and euphausiids, and small fish with some cephalopods. **BEHAVIOUR.** Recorded surface-seizing, surface-filtering, hydroplaning, rarely surface-diving, shallow-plunging and pursuit-plunging (Harper *et al.* 1985).

NON-BREEDING One bird shot at sea contained euphausiids and pteropods (Bierman & Voous 1950) and one

taken by Falla (1937) had the remains of a cephalopod in its mouth. Cephalopod beaks common in gizzards of storm-killed birds in A'asia (Harper 1980). Of 663 gizzards from immature birds examined between 1958 and 1977, 20.4% contained plastic pellets (Harper & Fowler 1987).

BREEDING Summarized Table 1. At Marion I. (39 regurgitations; Gartshore *et al.* 1988) euphausiids incl. *Euphausia valleritini* 11.1% wt., 4.9% no., 23.1% freq., amphipods *Hyperietta* 2.6, 67.4, 46.2, *Themisto gaudichaudii* 29.4, 20.5, 79.5, *Cylopus* 0.1, 0.1, 5.1, *Vibilia propinqua* 2.7, 0.2, 5.1, unident. Lysianassidae 0.2, <0.1, 7.7, unident. Gammaridea <0.1, <0.1, 2.6; fish incl. *Electrona carlesbergi* 5.8 cm, 8.3 cm, *Protomyctophum tenisoni* 5.5 cm (0.9; 4.1-6.9; 6); cephalopods were Onychoteuthidae 1.5 g (2.0; 0.4-4.5; 4), 2.1 cm (1.7; 0.8-4.6; 4); oil occurred in 35.9% samples and weighed 0.8 g (1.3; <0.1-3.8; 14). In samples from birds killed by skuas (23; Gartshore *et al.* 1988) cephalopods 87% freq., fish 87% freq. incl. Melamphaidae.

Other records. At Marion I., one stomach contained 65 euphausiids, 11 amphipods and remains of one fish (Grindley & Lane 1979); at Iles Crozet (four stomachs; Mougin 1975) crustaceans 75% freq., cephalopods 25%.

Table 1. Diet at Marion I. (from Gartshore *et al.* 1988).

	%wt.	%no.	%freq.
CRUSTACEANS	44.2	99.7	97.4
Ostracods	0.4	1.0	2.6
Euphausiids	11.2	10.4	53.8
Amphipods	32.6	88.2	92.3
FISH	41.9	0.1	51.3
CEPHALOPODS	13.9	0.2	33.3

INTAKE At Iles Crozet, chicks visited 49.5% of nights (5.8; 41.4-57.1; 10 chicks) with interval between meals 1.75 days (0.25; 1.45-2.13; 270 weighings) and an increase in weight of 16.4 g per 24 h feeding period (13.2; 0-53; 133) (Jouventin *et al.* 1985).

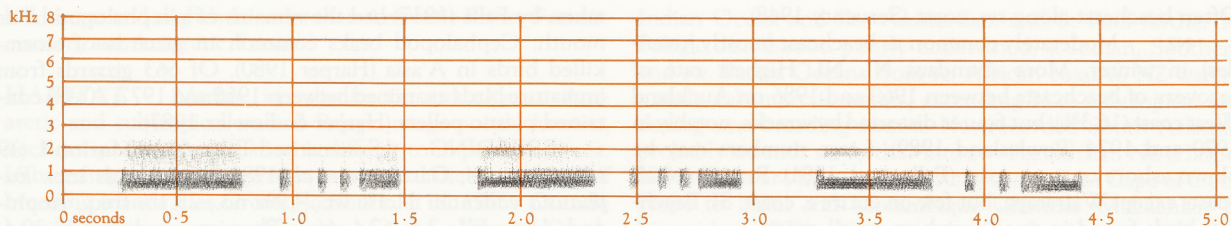
SOCIAL ORGANIZATION Little known.

BONDS On Iles Crozet, of 149 paired birds, 132 (88.6%) were faithful to one partner during courtship; 15 (10.1%) courted two successively; two (1.3%) courted three (Jouventin *et al.* 1985). Daily observation of 58 burrows showed that 202 birds visited them during pre-laying period, of which only 43 pairs laid in them (thus non-breeding proportion of visitors 57.4%). Of the 202 birds, 182 (90%) visited only one burrow, 18 (9%) visited two burrows and two (1%) visited three burrows, each. Each of the 58 burrows was visited on average by 3.86 (2.01; 1-10) birds; burrows in which eggs eventually laid visited by 4.32 (2.01; 2-10) birds and those that remained empty by 3.0 (1.75; 1-7) birds, the difference being significant.

BREEDING DISPERSION In colonies in excess of 1 million birds (Harper 1980) where nests rarely isolated: two or three often situated in a connecting system of radiating burrows (Rand 1954). During breeding season may congregate in flocks offshore (Rand 1954).

ROOSTING On Iles Crozet, all birds return to colony within 1 h after sunset (Jouventin *et al.* 1985).

SOCIAL BEHAVIOUR No information.



A Recordist unknown; B1005

VOICE No detailed studies. Roux *et al.* (1986) give some notes. Information here based on notes supplied by G.F. van Tets from Marion I., Aug. 1987. No information on level of noisiness, variety of calls, period of calling, sexual, individual or geographical variation. Adult said to utter a four-syllable *ka-kakadu* resembling rhythm of 'what have to do', emphasis on first and last syllables (sonagram A). No information on calls of young.

BREEDING Fairly well known. Studies at Iles Crozet by Despin *et al.* (1972), Derenne & Mougouin (1976) and Jouventin *et al.* (1985) and at Marion I. by Berruti & Hunter (1986). Information supplied by J.R. Starks. Breed colonially in burrows and rock crevices.

SEASON Broadly Sept. to Apr. At Iles Crozet, birds return late Sept. and pair on arrival; pre-laying period of at least 69 days, including pre-laying exodus roughly between 10 and 20 Nov.; laying period of 3 weeks in late Nov.-early Dec.; hatching last half of Jan. to early Feb.; departure of fledgelings last half Mar. to early Apr. Colonies deserted after first week Apr. At Marion I.: laying in last half Nov.; hatching first half Jan.; departure of fledgelings late Feb. to 9 Mar.



(Iles Crozet)

SITE In Iles Crozet, where not restricted by predators, burrows in all suitable places from sea-level to high slopes near summits of islands; in peaty soil in areas vegetated by *Acaena*, *Azorella* and *Cotula*; in rock crevices; in black-lava areas dominated by *Blechnum*, *Acaena* and *Azorella* on Marion I. (Adams 1982) and even under sealers' huts and in caves (Rand 1954). Burrows often grouped in twos or threes in radiating and interconnected system. Length of burrow, 60 cm (93-135), ending in nest-chamber, 30 cm (20-45) x 15 (12-18) (Harper 1980) and on Marion I., 14.7 cm (2.4; 12-25; 10) x 11.1 (1.3; 8-15). On Ile aux Cochons, about 4 x 10⁶ birds occupy burrows over c. 40-70 km² area of island. No information on excavation of burrows.

NEST, MATERIALS Constructed of leaves and twigs in chamber (Harper 1980). No information on building.

EGGS Oval; smooth-textured, not glossy; white, becoming stained.

MEASUREMENTS:

Iles Crozet: 49.2 (1.5; 45.7-52.4; 65) x 35.7 (1.1; 33.5-38.7); Marion I.: 50.3 (47.2-52.6; 16) x 35.9 (33.3-37.7) (Rand 1954);

Marion I.: 50.0 (1.6; 46.9-53.8; 24) x 35.9 (1.7; 30.8-40.8) (Berruti & Hunter 1986).

WEIGHTS:

Iles Crozet: 36.1 (1.1; 34-38; 15) or 21.2% of average adult weight.

Marion I.: 32 (27-36; 12) (Rand 1954); 34.7 (3.2; 31-41; 9) (Berruti & Hunter 1986).

CLUTCH-SIZE One. No replacement laying. On Iles Crozet, in 53 observed burrows, two birds laid in succession in three burrows and three birds did so in another three.

LAYING Well synchronized. At Iles Crozet, mean 29 Nov. (5 days; 18 Nov.-10 Dec.; 62). At Marion I., mean 21 Nov. (13-27 Nov.). At Iles Crozet, 96% of females returned to burrow on night of laying, 2% returned the night before and 2% returned 2 nights before laying.

INCUBATION By both parents in alternate shifts. Number of shifts eight, starting with female; mean lengths of shifts 6.5 days (2.4; 0.5-11; 43) with male taking somewhat greater share, 7.6 days (2.8; 3-11; 20) v. 5.5 (2.5; 0.5-9; 23). Periodically egg deserted during incubation; total length of desertions 4.8 days (2.5; 1-8; 6); mean length of desertions 1.9 days (1.1; 1-5; 15). **INCUBATION PERIOD:** total time 49.6 days (3.4; 46-55; 6); actual time of incubation 44.8 days (1.7; 43-47; 6) (Jouventin *et al.* 1985). At Marion I., total period 49 days (3.16; 45-52; 4). At Iles Crozet, hatching 23 Jan. (6; 14 Jan.-10 Feb.; 52), 15 Jan. (5; 7-25 Jan.; 15) and 4-18 Jan. in different seasons.

YOUNG Semi-altricial, nidicolous. Hatched with dark-grey proptile, replaced by longer smoky grey mesoptile. Quickly attain thermoregulation and are usually left alone by parents a few hours after hatching. Fed by both parents by incomplete regurgitation. For whole nestling period, chicks fed on average of 49% of nights (5.8; 41.4-57.1; 10) at intervals of 1.75 days (0.25; 1.45-2.18; 10) with increase of weight per 24 h when chicks fed 18 g (14.0; 0-53; 133). Visits more frequent while chicks gain weight, 54.4% of nights (9.7; 41.5-71.8; 272); c. 38.6% (10; 25-50; 37) while losing weight (Jouventin *et al.* 1985). **NESTLING PERIOD:** at Iles Crozet: 59.7 days (2.7; 54-65; 34); at Marion I.: 52-63 days. Departure from Iles Crozet, 23 Mar. (5; 13 Mar.-4 Apr.; 39).

GROWTH Weight at hatching 25 g (3.7; 21-32; 8) or 16% average adult weight. Reach maximum weight, at 44 days old (11; 25-61; 17), of 186 g (29; 140-270; 17) or 117% of average adult weight, and lose weight to 154 g (22; 115-200; 17) or 97% of average adult weight at departure (Jouventin *et al.* 1985). Details of growth of wings, tarsus and culmen in Berruti & Hunter (1986).

FLEDGING TO MATURITY Independent of parents at fledging. Mortality of fledgelings at sea may be 75% (Mougouin 1975). Among beachcast birds in NZ (wrecks), 98% were emaciated fledgelings 2-4 months after fledging (Harper 1980; Harper & Fowler 1987). No further information.

SUCCESS No adequate data; four of nine eggs

hatched, and 11 or 15 chicks fledged at Marion I., where chicks hatched were killed by skuas *Catharacta*; skuas and Dominican Gulls *Larus dominicanus* excavate burrows and take chicks (Sinclair 1980). Black Rats *Rattus norvegicus* have restricted breeding on Ile de la Possession to rock crevices above 200 m asl (Harper 1980).

PLUMAGES

ADULT Definitive basic. Age of first breeding unknown. Closely similar to Broad-billed Prion *P. vittata* in definitive basic plumage; differences described below. **HEAD AND NECK.** Feathers of crown and central forehead, dark grey (83) merging to light grey (85); bases with broad light bluish-grey fringes; when fresh these fringes wider than in Broad-billed Prion. Dark grey (83) mottling develops, especially near forehead, as tips wear, but mottling usually less heavy than in Broad-billed Prion. In area of ear-coverts, sub-orbital stripe, medium grey (84) to dark grey (83). Distal half of lores, usually white, occasionally with traces of grey (84) mottling in worn birds; feathers, white with dark grey (83) bases. **TAIL**, light grey (85) with blackish (82) tip broadest on t1 (c. 20 mm) and narrowing outwards; t4 has smudge of blackish on tip; t5 and t6, wholly grey. **UPPERWING.** Primaries 1-6 occasionally fringed with white.

DOWNY YOUNG Protoptile, dark grey (-). Mesoptile, longer, smoky grey (-) (P.C. Harper).

JUVENILE Differs from adult: **HEAD AND NECK.** Feathers in distal half of lores usually have narrower white tips than adult; this area generally has fine dark-grey (83) mottling. **UPPERPARTS.** White tips of longest scapulars tend to be broader. **UPPERWING.** Lesser, median and outer marginal coverts, dark grey (83) with blackish (82) shafts and blue-grey (bluish 85) tip of c. 2 mm. Primaries 1-6 usually fringed white.

BARE PARTS

ADULT, JUVENILE Iris, dark brown. Nares, nari-corn, culminicorn and sulcus, dark grey (83) to blackish (82). Ungues, light blue-grey (c88) with blackish (82) tips. Latericorn and ramicorn, light grey (85) to light blue-grey (88); often a small area of latericorn just below nares, dark grey (83). Latericorn discolours to blackish soon after death (Cox 1980). A live bird photographed at Iles Crozet (J.C. Stahl) had blackish (82) latericorn, with blue-grey (88) strip where latericorn curved over maxilla. Scales of tarsus and toes, grey-blue (c88) to blue (-); webs, flesh-pink. Yellowish grey (-) and whitish (-) webs also reported. Claws, blackish (82), often with light-grey (85) bases.

DOWNY YOUNG No information.

MOULTS

ADULT POST-BREEDING Definitive pre-basic. Primaries outwards; one to two adjacent primaries may grow at one time (n=11 beachcasts; MV, NMNZ). Tail, centrifugal in two skins, beginning when primary-moult nearly complete and finishing after primaries complete. Lesser coverts are last body feathers to be replaced, after primary-moult complete (Harper 1980; NMNZ). No other information on sequences of secondary and body-moult. Adult post-breeding moult said to begin in last weeks of breeding season; completed by May or June. Beachcast birds in Aust. (MV) moulting in June and July (n=9; moult scores 20-49); age of these birds uncertain, but not juveniles.

POST-JUVENILE Juveniles beachcast in first win-

ter have not begun primary-moult. No other information.

A male of unknown age collected Ile St. Paul on 20 Oct. had completed primary moult, had old tail-feathers, and had fresh body plumage save for some old feathers on head (Mayaud 1949-50).

MEASUREMENTS (1) Iles Crozet, adults, skins (Mus. Hist. nat., Paris; J.A. Bartle). (2) NZ, freshly beachcast; birds aged as 'immatures' on gonads or bill, precise ages unknown (NMNZ).

	MALES	FEMALES
WING	(1) 186.1 (4.85; 177-194; 10) (2) 184.5 (4.76; 176-194; 28)	189.3 (2.10; 187-194; 10) 182.3 (3.74; 176-192; 20)
TAIL	(2) 88.1 (3.85; 79.6-97.6; 28)	88.1 (1.81; 84-91; 19)
BILL	(1) 29.9 (0.91; 28.6-31.8; 10) (2) 30.1 (1.20; 27.6-32.8; 27)	29.1 (0.53; 28.2-30; 10) 29.1 (1.24; 27.1-32; 20)
BILL W	(1) 14.9 (0.41; 14.2-15.7; 10) (2) 15.7 (0.80; 13.4-17.4; 28)	14.7 (0.67; 13.5-15.9; 10) 15.4 (0.66; 14.2-17; 20)
TARSUS	(1) 33.2 (1.29; 31.4-34.9; 10) (2) 33.5 (0.96; 31.5-35.5; 28)	33.3 (1.00; 32.2-35.4; 10) 32.4 (1.28; 30.1-35; 20)
TOE	(1) 38.7 (2.08; 36.3-42.2; 5) (2) 41.4 (1.77; 38.8-45.8; 28)	38.5 (1.27; 37.0-40.4; 5) 39.5 (1.72; 36.8-43.5; 20)

(3) Iles Crozet, adults, live (Jouventin *et al.* 1985). (4) Vic., juveniles excluded, beachcast, skins (MV). (5) Vic., juveniles, beachcast (MV). *P.v. macgillivrayi*. (6) Skins; bill-width method unknown (Roux *et al.* 1986).

	UNSEXED
WING	(3) 193.2 (5.2; 152) (6) 201 (5; 196-210; 10)
8th P	(4) 127.9 (4.37; 123-136; 13) (5) 123.8 (5.11; 116-131; 7)
BILL	(3) 30.2 (2.5; 153) (6) 31.1 (1.1; 29.5-32.5; 11)
BILL W	(3) 17.0 (0.77; 152) (6) 17.3 (1.2; 15.7-19.2; 11)
TARSUS	(3) 33.9 (1.14; 152)

Measurements of Marion I. birds given by Berruti & Hunter (1986) similar to those from Iles Crozet. In adults, percentage of bill shrinkage 6 (1.5; 4-8; 7); of immatures 8 (4.2; 1-23; 8) (Kinsky & Harper 1968). Information on growth of chicks in Derenne & Mouglin (1976), Jouventin *et al.* (1985) and Berruti & Hunter (1986).

WEIGHTS Free-flying birds at breeding grounds; age and dates unknown: (1) Marion I.: 168.1 (17.8; 115-210; 325) (Berruti & Hunter 1986); (2) Ile de l'Est, Iles Crozet: 170 (11; 140-200; 63) (Jouventin *et al.* 1985); Ile aux Cochons, Iles Crozet: 159 (13; 130-210; 85) (Jouventin *et al.* 1985).

NZ beachcast 'immatures', aged on gonads or bill, precise ages unknown: males 95.7 (7.03; 86-116.2; 21), females 92.6 (8.16; 79.5-102; 14) (NMNZ).

Gain of weight by chicks given in Derenne & Mouglin (1976), Jouventin *et al.* (1985), Berruti & Hunter (1986). At Iles Crozet, maximum weight 186 (29; 140-270; 17) reached at 44 days old (11; 25-61; 17). Fledging weight: 154 (22; 115-200; 17) (Jouventin *et al.* 1985).

STRUCTURE Eleven primaries; p11 minute, p9 lon-

gest, p10 0-3 shorter, p8 6-8, p7 17-22, p6 29-36, p5 42-51, p4 57-70, p3 72-84, p2 79-91, p1 94-107. Eighteen secondaries, about four of tertial form. Tail strongly rounded; 12 feathers; t1-t6 14-19. Bill-width about half bill-length; convex mandibular rami surround bare distensible gular-pouch. Comblike lamellae run inside tomia of upper mandible, starting at base but not extending to unguis; visible when bill closed. Nostril tubes about one-fifth bill-length, nares separated by narrow septum. Maxillary unguis narrower than culminicorn, c. 30% of bill-length. Maxillary unguis hooked; mandibular unguis downcurved. Tarsus and toes, scutellate; outer and middle toe equal in length, inner toe c. 80%.

AGEING Based on Harper (1980). Ossification of skull and presence of ridge on culminicorn are guide to age, as in other prions. Bill often warps while drying, producing surface irregularities in maxilla. These distort thin latericorns of juveniles, but not thick latericorns of adults. Unknown when this character lost. In winter, moult condition also a guide.

RECOGNITION From *P. vittata* on measurements, and colour of bill. Adult *P. salvini* have longer, broader bill than *P. desolata* (see Measurements). Unless birds can be aged (weak ossification of bones of skull), separation of immature *P. salvini* and adult *P. desolata* extremely difficult since measurements of bill overlap. Mandibular rami, convex in all *P. salvini*, straight or sometimes convex in *P. desolata*. *P. salvini* usually have barred lateral under tail-coverts; usually not recorded in *P. desolata* (except Heard I. birds) (P.C. Harper).

GEOGRAPHICAL VARIATION Two subspecies: *salvini* and *macgillivrayi*. Subspecies *macgillivrayi* previously considered subspecies of *P. vittata*. Subspecies *macgillivrayi* differs from nominate by broad, strongly compressed bill (length 31.1 mm [29.5-32.5]; width 17.3 mm [15.7-19.2]) and slightly longer wing (201 mm [196-210]).

DIR

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Antarctic Prion *Pachyptila desolata*

- 1. Adult, ventral
- 2. Adult, dorsal, fresh
- 3. Adult, dorsal, worn
- 4. Adult, head

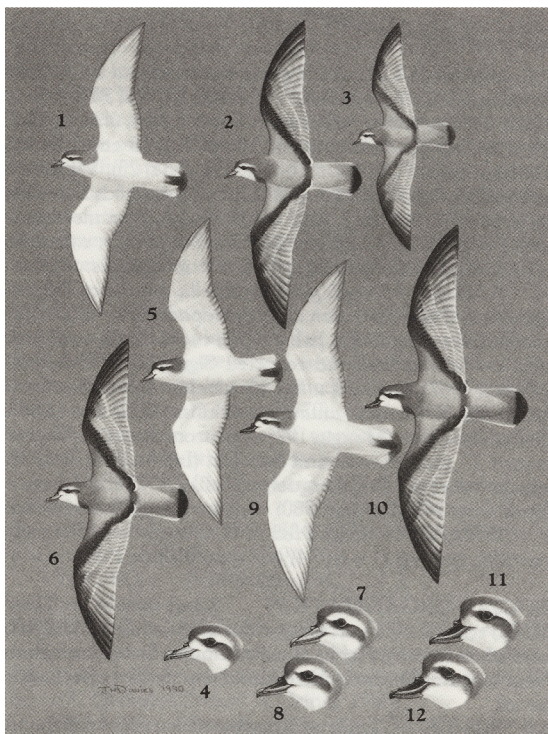
Salvin's Prion *Pachyptila salvini*

- 5. Adult, ventral
- 6. Adult, dorsal
- 7. Adult, head, light bill
- 8. Adult, head, dark bill

Broad-billed Prion *Pachyptila vittata*

- 9. Adult, ventral
- 10. Adult, dorsal
- 11. Adult, head, light bill
- 12. Adult, head, dark bill

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