

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 vittata Broad-billed Prion

COLOUR PLATE FACING PAGE 529

Procellaria vittata G. Forster, 1777, *Obs. Voy. Wld. 'Resolution'* 1: 91, 98, note — lat. 47°10'S, Anchor Island, Dusky Sound, New Zealand; breeding.

The generic name is compounded of the Greek παχύς (thick) and πτίλον (feather, plumage, especially down) and refers to the thick downy plumage of these birds. The specific *vittata* is Latin, meaning 'bound with a fillet or chaplet' referring to the M-mark across wings and rump: '. . . the blue petrel, so called from having a bluish-grey colour and a band of blackish feathers across the whole back' (Forster 1777).

OTHER ENGLISH NAMES Blue or Broad-billed Dove-Petrel, Long-billed Prion, Icebird or Whalebird.

The name *prion* is a direct transcription of the Greek πρίων, a saw, and refers to the lamellae on inside of bill, showing externally. It is clearly a more simple, elegant and descriptive name than others that have been used. Qualifying epithets in English are not easy to decide because the species are so similar and for three, including *vittata*, depend on measurements of the bill, rather unsatisfactorily so.

MONOTYPIC The prion on Iles St Paul and Amsterdam (formerly *P. vittata macgillivrayi* (Mathews, 1912) now confirmed as subspecies of Salvin's Prion *P. salvini* (Roux *et al.* 1986).

FIELD IDENTIFICATION Length 28 cm; wingspan 61 cm; weight 170–235 g. Largest prion; huge, broad, glossy iron-grey bill, high forehead, sombre facial pattern and prominent blue-grey half-collar impart appearance of large dark head compared with other prions. Usually confined to seas within or just N of Subtropical Convergence. Sexes alike. Juveniles inseparable.

DESCRIPTION ADULT. Forehead, crown and nape, bluish-grey, slightly darker than grey of hindneck and saddle; greyish-black sub-orbital patch extends from in front of eye to rear of ear-coverts; blue-black barring or freckling prominent over lores and on upper cheeks below sub-orbital patch. Short white supercilium immediately above and behind eye. Blue-grey of hindneck extends down sides of neck and upper breast, forming conspicuous half-collar; complete on some. Facial pattern, dark crown and pronounced collar give generally dark-headed appearance; forehead and crown darker when worn, contrasting more with hindneck and saddle. Upperparts, rich blue-grey except for: broad well-defined black open M-mark from wing-tip to wing-tip, joining across rump, becoming noticeably brownish with wear; fine white trailing-edge to secondaries; scapulars, narrowly tipped white; narrow black terminal tail-band not extending onto outer two rectrices. On upperwing, area behind M-mark, especially remiges, appears paler than blue-grey of inner forewing and translucent when backlit. Underparts, white except for blue-grey half-collar, faint blue wash on flanks, blackish streak on centre of undertail and faint greyish trailing-edge to underwing. Massive bill, unique; broad and deep at base; glossy iron-grey (appearing blackish at sea) with bluish ramicorn visible only when close. Iris, dark brown. Feet, lilac-blue; webs, cream.

SIMILAR SPECIES Easiest prion to identify: stands out by large size, huge blackish bill, large head with steep forehead profile, dark-headed appearance, pronounced collar and narrow tail-band; flight slower with more gliding than other prions; does not bank so steeply with wing-tips approaching vertical as smaller species. **Salvin's *P. salvini*** and **Antarctic *P. desolata*** Prions differ by smaller size, smaller, mostly bluish (not blackish) bill and usually whiter lores and longer supercilium giving paler face. **Slender-billed Prion *P. belcheri*** smaller, with more slender build, smaller head and much finer bluish bill; paler, less bluish grey above with paler, less well-defined M-marking, narrower tail-band; much longer broader white supercilium and usually clean white lores, giving much whiter face. **Fairy *P. turtur*** and **Fulmar *P. crassirostris*** Prions much smaller and more slender, with smaller head; wings tend to be held straighter; bill, much smaller and shorter, bluish; facial pattern, paler and less distinct; forehead and crown, paler, uniform with rest of upperparts; lack pronounced collar; tail-band broader.

Mainly occur in or just N of Subtropical Convergence Zone. Flight like other prions but slower and less erratic, with more gliding. Size of head emphasized by massive bill and steep forehead; neck held tucked into body and wings held forward emphasizing length of tail; long cylindrical body. Feed mostly by hydroplaning and surface-plunging, surface-seizing, surface-filtering and surface-diving. Gregarious when foraging and feeding. Not known to follow ships. Breed on well-

vegetated islands near Subtropical Convergence. Strictly nocturnal at breeding colonies. Silent at sea; utter variety of calls at breeding colonies.

HABITAT Marine; mainly in subtropical waters, occasionally reaching subantarctic and tropical waters outside breeding season; pelagic range poorly known because specific identification difficult at sea. Some birds stay near breeding islands all year (Richdale 1965). Probably feed in pelagic waters during breeding season; generally absent from inshore waters round Whero I. (Richdale 1965) and at Chatham Is, closely linked to copepod prey *Calanus tonsus* of mainly pelagic occurrence (Imber 1981); sometimes enter inshore waters during rough weather (Whero I.; Richdale 1965).

Breed on islands near Subtropical Convergence; in NZ region, nest under firm banks, in dry rocky soil, in cavities in sea-facing cliffs, or in crevices; burrows may be placed among sedge or *Muehlenbeckia* (Oliver; Richdale 1965; Sagar 1977).

Feed from surface or just below, rarely diving (Harper 1987).

DISTRIBUTION AND POPULATION Breed on islands in or adjacent to Subtropical Convergence. Breed NZ region and South Atlantic Ocean (Harper 1980).

In NZ, birds present about breeding colonies all year; widely distributed in zone of Subtropical Convergence; some evidence of dispersion or migration by part of population to e. Tasman Sea in first two months after breeding (Harper 1980). In S. Atlantic, birds either resident round breeding colonies during winter, or move N to Atlantic and Indian Ocean coasts of s. Africa (Maclean 1985) to c. 10°S (Harrison 1987). Extraliminally, common non-breeding winter visitor to s. Africa, from Mozambique to Namibia (Maclean 1985), but less common than Antarctic Prion (Brown *et al.* 1982). Occasionally reported off Madagascar and Réunion (Alexander 1928; Oliver). Doubtful occurrence off Brazilian coast (date unrecorded) (Murphy). Three records for Falkland Is (Woods 1975).

AUST. Rare; all beachcast specimens. **Qld:** single, Stradbroke I., 14 Aug 1961 (Hines 1962). **NSW:** two, Sydney, 8–10 July 1904 (Hindwood 1948); singles, Cronulla, July 1948, Aug. 1954, Jan. 1971; four, Sydney to Ulladulla, July 1954; (Morris *et al.* 1981; Morris 1973); four, Newcastle to Nadgee, July 1973 (NSW Bird Rep. 1973). **Vic.:** two, Phillip I., July 1966; single, Oberon Bay, Wilson's Promontory, 6 Aug. 1967 (Cooper 1968); single, Norman Beach, Wilson's Promontory, 6 July 1969 (Cooper 1970); single, Thirteenth Beach, June 1984 (Vic. Bird Rep. 1984). **Tas.:** single, Coles Bay, Sept. 1961 (Wall 1972); single, Orford, July 1971; single Roaring Beach, South Arm, July 1974; three, Seven Mile Beach, July 1974; single, Calverts Beach, South Arm, July 1974; single, Swan I., June 1975; single, Friendly Beaches, July 1975; single, Marshall Bay, 1981 (Tas. Bird Reps 1971, 1974, 1975, 1981). **SA:** single, Cowandilla, 16 July 1964; single, Middleton, 11 July 1970; single, Aldinga, 20 July 1973 (Cox 1976). **WA:** few beachcast specimens (Serventy & Whittell 1976), including several 'Broad-billed'-type prions in sw. WA in 1984 (Jaensch 1984).

NZ Common and widespread along Subtropical Convergence but apparently not S of it. More abundant SI, being near breeding colonies. NI. Beachcast specimens recovered on all coasts. Highest rate of recovery between 1960 and 1986 on Wellington West coast, with 19.5 birds/100 km (distorted by wreck in 1974); Auckland West (4.8/100 km) next highest. Least frequent along e. and ne. coasts (Powlesland 1989) though Harper (1980) reports frequent storm-driven birds in Bay of Plenty. SI. Less common on n. coast than s. and se. coasts. Highest recovery at Southland (19.4/100 km) and Canterbury South coast (8.7/100 km) but relative scarcity on Otago coast unexplained (Powlesland 1989).

Wrecks occurred NZ in 1961 (1385 birds collected) and 1974. Greater incidence on w. coast NI suggests dispersal into Tasman Sea after breeding (Harper 1980), or sw. gales blowing birds from zone of Subtropical Convergence into Tasman Sea, as happened in 1961 (Powlesland 1989). Of 1175 beachcast birds collected in 1974, 80% were found on Wellington West beaches (Powlesland 1989).

BREEDING Stewart I. (Oliver); mainland and islets in Foveaux Str. (Oliver; Richdale 1965; Powlesland 1989); Dusky Sound (Oliver); Breaksea Sound; Chalky Inlet (Gaze 1988); Snares Is ('small numbers'; Harper 1980) and dead chicks and an old egg, Toru I., Snares Is, 1986 (A.J.D. Tennyson); Chatham Is (millions; Fleming 1939). Extraliminally, on

Tristan da Cunha and Gough Is (Williams 1984). Prions breeding Iles St Paul and Amsterdam now considered subspecies of Salvin's Prion (Roux *et al.* 1986).

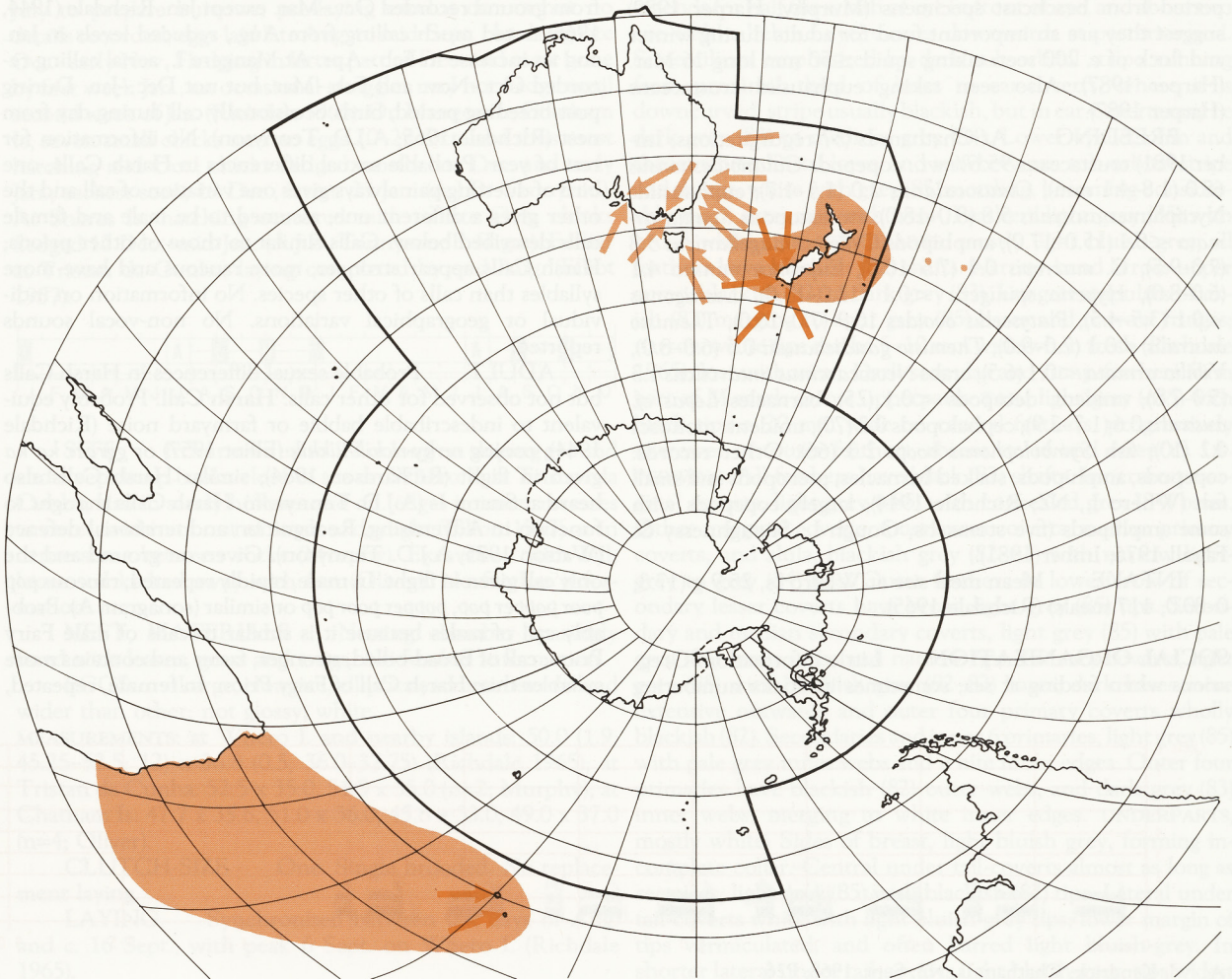
No estimates of total population. Not threatened, though some populations should be watched. At NZ breeding colonies, introduced Wekas *Gallirallus australis*, cats and rats *Rattus* spp prey on prions. On Tristan da Cunha, predation by introduced mammals has caused populations to decline. Still abundant on Gough I.

MOVEMENTS Dispersive or migratory but some birds near breeding islands throughout year (Elliot 1957; Richdale 1965; Swales 1965).

DEPARTURE Most chicks fledge Whero I., NZ, 17.4 Dec. (5.3 days; 7 Dec.-2 Jan.; 37 chicks); last chicks probably fledge in second week of Feb. and birds are not seen ashore again for another 4-5 weeks (Richdale 1965). At Gough I., one chick fledged 9 Dec. (Swales 1965).

NON-BREEDING Records of beachcast birds show birds from Foveaux Str. move N and W into Tasman Sea (Harper 1980). Also recorded during July 1400 kms ne. of Chathams (Fleming 1950). Non-breeding winter visitor to waters off C. Province, South Africa (Brooke & Sinclair 1978).

RETURN At breeding islands in large numbers during July (Richdale 1944) although flocks, with equal ratio of



males and females (Wodzicki 1947), often beachcast after late winter gales. During Aug. along both e. and w. coasts of NZ (Harper 1980) with major wrecks 1961 and 1974 when gales had apparently blown them N from Subtropical Convergence (Powlesland 1989). No information on foraging range.

FOOD Little information, the few reports suggest crustaceans in summer and small squid in winter. **BEHAVIOUR.** Most food taken by hydroplaning, and surface-filtering, also surface-seizing, surface-diving and dipping (Harper *et al.* 1985), surface-plunging (Harper 1987); hydroplaning 51.5% observations, surface-plunging about 41.1% (estimated size of flock 200), surface-seizing 4.5%, surface-filtering 2.9% (487 observations; Harper 1987). Small items of food obtained by hydroplaning, birds scurrying rapidly forward with beak partly open and head moving from side to side. Water drawn into enlarged mouth cavity and expelled by upward movement of broad tongue and distensible interramal pouch with small items of food retained by palatal lamellae and swallowed (Harper 1987) in manner similar to balleen whales (Murphy). Take individual euphausiids by picking them from surface, or, if food small, by filtering them while sitting on the surface. Larger prey, including squid at night, caught by surface-seizing, or surface-diving for 4–5 s, rowing under water with partly open wings (Harper 1987).

NON-BREEDING Remains of cephalopods reported from beachcast specimens (Murphy; Harper 1980) suggest they are an important food for adults during winter and flock of c. 200 seen taking squid ≤ 50 mm long 16 Mar. (Harper 1987). Also seen taking euphausiid crustaceans (Harper 1987).

BREEDING At Chatham Is (57 regurgitations; Imber 1981) crustaceans 95.6% wt.: copepods *Calanoides tonsus* 68.0 (1.8–4.1 mm), *Clausocalanus* 2.0 (1.3–1.7); euphausiids *Nyctiphanes australis* 5.8 (8.0–18.0); stomatopods *Squilla armata* <0.1 (15.0–17.0); amphipods *Cylopus magellanicus* 3.8 (7.0–9.5), *C. macropis* 0.4 (7.5–10.0), *Eupronoe minuta* 4.1 (6.0–8.0), *Hyperia spinigera* <0.1 (12.0–13.0), *Lestrigonus* <0.1 (3.5–4.5), *Platyscelus ovoides* 10.9 (7.0–16.0), *Themisto australis* <0.1 (7.0–9.0), *Themisto gaudichaudii* 0.5 (6.0–8.0), *Vibilia armata* <0.1 (6.5); crabs *Nectocarcinus antarcticus* 1.3 (5.0–7.0); unident. decapods <0.1 (25), barnacles *Lepas cf. australis* 0.6 (1.7–2.9); cephalopods 0.2 (70), unident. molluscs 0.2 (10); fish *Symbolophorus boops* 2.3 (66). Other records: copepods, amphipods, stalked barnacles, pteropods and small fish (Whero I., NZ; Richdale 1944); largely copepods with some amphipods (five stomachs, Gough I.; Shaughnessy & Fairall 1976; Imber 1981).

INTAKE Mean meal size at Whero Is, 25.9 g (17.3; 0–80.0; 117 meals) (Richdale 1965).

SOCIAL ORGANIZATION Little information. Gregarious when feeding at sea, sometimes in flocks numbering

many hundreds, and when breeding. Large flocks in Tasman Sea in Feb. (Harper 1980).

BONDS Monogamous. Both parents incubate and tend young until after fledging.

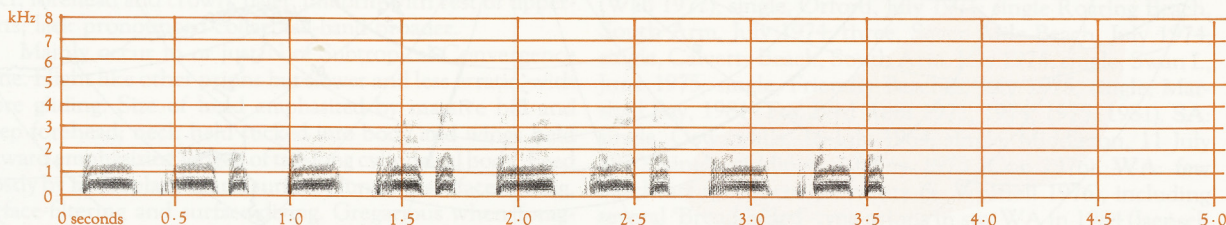
BREEDING DISPERSION Sometimes nest in dense colonies, among rocks or in burrows (A.J.D. Tennyson). Burrows dug into sloping ground or steep, damp banks, close to sea. Densities of nests not recorded.

ROOSTING No information.

SOCIAL BEHAVIOUR Little known; some information in Richdale (1965). Rarely seen near breeding grounds during day, except occasionally in stormy weather; occasionally stay in burrows during day. On Stewart I., birds do not return to nest until 22:00, often midnight, during chick-rearing period. Not easily disturbed when incubating, pecking at hand when egg extracted; will remain in nest after removal of egg (Oliver). No further information.

VOICE No detailed studies; information supplied by A.J.D. Tennyson from observations at Mangere I., Chatham Is, unless indicated otherwise. Silent at sea. Noisy at breeding colonies at night; birds utter persistent raucous cooing calls at colonies, mainly from nest-sites and also in flight. Flight call differs in being soft croaking version. Harsh Calls are the normal calls given on ground and the only aerial calls. Calling from ground recorded Oct.–Mar. except Jan. Richdale (1944, 1965) noted much calling from Aug., reduced levels in Jan. and an increase in Feb.–Apr. At Mangere I., aerial calling recorded Oct.–Nov. and Feb.–Mar. but not Dec.–Jan. During post-breeding period, birds occasionally call during day from nest (Richdale 1965; A.J.D. Tennyson). No information for rest of year. Probable sexual differences in Harsh Calls; one bird of duetting pair always gives one variation of call and the other gives a different one; assumed to be male and female calls described below. Calls similar to those of other prions; Harsh Calls appear stronger, more raucous and have more syllables than calls of other species. No information on individual or geographical variations. No non-vocal sounds reported.

ADULT Probable sexual differences in Harsh Calls but not observed for other calls. **Harsh Call.** Probably equivalent to indescribable babble or farmyard noise (Richdale 1944); cooing *rerky-rickik-kikkik* (Elliot 1957) or *ggrarr ka ka* given in flight (Richardson 1984); similar Harsh Calls also heard at Snares Is (A.J.D. Tennyson). Harsh Calls thought to function in Advertising, Recognition and territorial defence (Watson 1975; A.J.D. Tennyson). Given on ground and the only call given in flight. In male, rapidly repeated, raucous *pop pop popper pop*, *popper pop pop* or similar (sonagram A). Probably call of males because it is similar to calls of male Fairy Prion; call of Broad-billed, stronger, faster and contains more syllables than Harsh Call of Fairy Prion. In female, repeated,



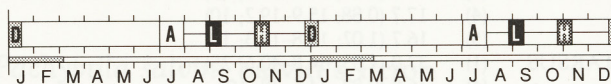
A J. Kendrick; Chatham Is, NZ, Sept. 1968; P26

slurred *err errr* or *eh-eh-eh err errr*. Probably call of female because similar to Harsh Call of female Fairy Prion; calls of Broad-billed stronger and usually contains more short syllables. **Rattle Call.** Rapidly repeated *per-per-per-per*. . . heard once (28 Oct.) from duetting bird that also uttered Harsh Call of assumed male. Very similar call given by Fairy Prion was suggested to be a copulation call. Given after hatching period but no observations were made before hatching period. **Distress Call.** Shrill *pihihihi*. . . sometimes given by birds being handled and considered to be a distress call. Fairy prions gave a very similar call in same circumstances.

YOUNG All ages beg with a short whistling *peeea* while tapping adult's bill with their own. Chicks occasionally give squeakier version of adult Distress Call; probably same as Richdale's (1965) description of 'very harsh cries which soon subsided to canary-like calls' when handled. Harsh Calls also given by chicks (Richdale 1965; A.J.D. Tennyson) but tend to be slower, with fewer syllables and squeakier than Harsh Calls of adults, and can be difficult to distinguish from calls of Fairy Prions.

BREEDING Poorly known. Only study by Richdale (1965) on Whero I., NZ. Information supplied by P.C. Harper and A.J.D. Tennyson. Breed colonially, often in vast numbers, e.g. Gough I. (Swales 1965).

SEASON Early nester. Return to NZ colonies in July to prepare burrows; pre-laying exodus occurs but no details recorded; eggs laid late Aug. to mid-Sept. Hatching late Oct.-early Nov. Fledging in latter part of Dec. and most gone by first week Jan.; an occasional straggler may not fledge until second week of Jan. (Richdale 1965). On Mangere I., Chatham Is, seven small chicks and no eggs 20-29 Oct. and thus most hatching mid-Oct.; chicks fledged mostly late Dec. and early Jan., earliest seen, 19 Dec., latest, 23 Jan. (A.J.D. Tennyson). At Snares Is, hatching occurred mid- to late Oct.; chicks fledged 12 Dec.-mid-Jan. (A.J.D. Tennyson; P. Sagar). Earlier at Tristan da Cunha; laying completed by end Aug. (Elliott 1957).



SITE In burrows up to 1.2 m long on sloping ground and steep damp banks close to sea on Whero I.; at Tristan da Cunha, also in sandy hollows and on ledges in inner recesses or caves, within or out of reach of daylight (Elliott 1957) or in depressions between rocks (Murphy). Excavation with bill; loose soil kicked away with feet (Oliver). No further information.

NEST, MATERIALS Nesting chamber sparingly lined with leaves, grass and twigs. No further information.

EGGS Large, elongate, elliptical, sometimes one end wider than other; not glossy; white.

MEASUREMENTS: at Whero I. and nearby islands: 50.0 (1.9; 45.25-52.5; 12) x 36.8 (0.5; 36.0-37.75) (Richdale 1965); at Tristan da Cunha: 52.5 x 35.0, 51.5 x 35.0 (n=2; Murphy); at Chatham Is: 47.7 x 35.6, 51.0 x 36.0, 45.8 x 33.0, 49.0 x 37.0 (n=4; Oliver).

CLUTCH-SIZE One. Single brooded. No replacement laying.

LAYING Synchronized between last days of Aug. and c. 16 Sept., with peak 6 Sept. on Whero I. (Richdale 1965).

INCUBATION Period not known (Richdale 1965). No further information.

NESTLING Semi-altricial, nidicolous. Hatched with dark grey protoptile; replaced by smoky grey teleoptile, lighter below; lamellae of bill not developed (Oliver). See Richdale (1965) for weights and measurements of 24 chicks to last day before fledging. Increase in weight similar to that of other *Pachyptila* spp (Tickell 1962; Harper 1976). Richdale (1965) suspected that chicks not fed on 29.5% of nights during nestling period but methods of weighing probably at fault and this needs confirmation (Harper 1976). No proof of any starvation period before fledging. **NESTLING PERIOD:** estimated c. 50 days (Richdale 1965). No further information.

FLEDGING TO MATURITY Fledglings (n=37) on Whero I. left 7-30 Dec. in one season, 78% between 10 and 21 Dec.; all had gone by 7 Jan.; always left about midnight, irrespective of weather. Heavy predation, especially of fledglings by skuas *Catharacta* spp (Richdale 1965).

PLUMAGES

ADULT Definitive basic. **HEAD AND NECK.** Crown and central forehead light bluish-grey when fresh; dark grey mottling, particularly near forehead, becomes more extensive with wear. Feathers, dark grey (83) merging to light grey (85) bases, with broad light bluish-grey fringes, and blackish (82) shafts. Hindneck, light bluish grey. Small white supercilium extends for half the width of eye in front of eye, and about two eye-widths behind eye; curves downwards at posterior end. Supercilium emphasized by dark sub-orbital stripe running from proximal third of lores to ear-coverts, where it is downcurved; stripe usually blackish, but in ear-coverts may be dark grey (83) to medium grey (84). Lower eyelid, chin and throat white. Distal lores, and area between sub-orbital stripe and throat, white with grey (85) mottling, becoming considerably more extensive with wear. Feathers light grey (85) with broad white tips. **UPPERPARTS,** mostly light bluish-grey; all feathers have blackish (82) shafts. Narrow band across upper rump, blackish (82) to dark grey (83). Longest scapulars blackish (82) merging to light grey (85) bases and narrow fringes; narrow white tips can be 5-10 mm wide when fresh (Richdale 1965), lost with wear. Dark scapular and rump-feathers form part of M-mark across upperparts. **TAIL,** light grey (c85) with black tips c. 20 mm wide on central feathers, progressively narrower on outer feathers, absent on t6 and often t5. **UPPERWING.** All feathers have black (82) shafts. Innermost marginal coverts, light grey (c85) with concealed grey (84) bases. Other marginal coverts, most lesser coverts, median primary coverts, and alula, blackish grey (82-83) with narrow light-grey to grey (84) tips. Outer feathers in lowest row of secondary lesser coverts have broad light grey (85) tips. Secondary and median secondary coverts, light grey (85) with pale grey (86) inner webs and narrow tips. Primary coverts, light grey (85) with blackish grey (82-83) bases; dark bases more extensive outwards and outer four primary coverts wholly blackish (82). Secondaries and inner 6 primaries, light grey (85) with pale grey inner webs and white inner edges. Outer four primaries have blackish (82) outer webs, and dark grey (83) inner webs, merging to white inner edges. **UNDERPARTS,** mostly white. Sides of breast, light bluish grey, forming incomplete collar. Central under tail-coverts almost as long as rectrices; light grey (85) with blackish (82) tips. Lateral under tail-coverts white with light bluish-grey tips; lower margin of tips vermiculated, and often barred light bluish-grey. In shorter lateral under tail-coverts light bluish-grey, tips widest

on outer web. **UNDERWING.** Coverts white, save for black (82) outer webs to outermost primary under wing-coverts. Remiges, white with pale greyish tint; outermost primaries have grey (85) tegmen and tips.

DOWNY YOUNG Protoptile, medium grey (brownish 84), with slightly browner breast and belly. Mesoptile, medium grey (c84), sometimes with white on belly.

JUVENILE Similar to adult. Crown said to get darker with age (Harper 1980). White tips to longest scapulars tend to be longer than in adult. Lesser, median and outer marginal coverts, dark grey (83) with large grey-black (82) smudge near end of feather and light blue-grey (bluish 85) tip c. 2 mm. More of dark grey base of feather exposed than in adults, making M-mark appear smaller and paler.

BARE PARTS Based on Elliott (1957), Cooper (1968), Harper (1980), labels on skins (NMNZ) and photos in Lindsey (1986), NZRD, and unpublished (NZDOC library; A.J.D. Tennyson).

ADULT Iris, blackish brown (c19). Nares, unguis, culminicorn and sulcus, black (89 to 82). Maxillary unguis, occasionally grey-blue (88) on proximal sides. Latericorn, blackish, often with grey-blue (c88) strip where latericorn curves over maxilla. Ramicorn, grey-blue (c88) at base, merging to light grey (85) at tip. Lamellae, yellowish, visible when bill is closed (Elliott 1957; Harper 1980). Interramal region, mauve. Tibio-tarsal joint, tarsus and tops of toes, grey-blue (c88) to blue (c168B). Narrow areas between scales, blackish (82). Webs, and sometimes top of outer toe, dark grey (83) to blackish (82), often with flesh-pink (c5) tinge, strongest on inner web; yellowish webs also reported (Cooper 1968). Claws blackish (82), sometimes with light-grey bases.

DOWNY YOUNG In mesoptile, like juvenile.

JUVENILE Latericorn paler than in adults (but never blue; P.C. Harper). Latericorn plates thinner than in adults.

MOULTS For birds breeding Fouveaux Str.: wear of primary of breeding birds suggests timing of moult similar in Chatham Is (NMNZ). Six skins collected Tristan da Cunha, early Feb., were completing primary moult (Hagen 1952), which suggests timing similar to Fouveaux Str.

ADULT POST-BREEDING Definitive pre-basic. Complete. Primary moult probably begins at start of post-breeding exodus in first half Jan.; returned birds in early Feb. completing moult of tail and outward primaries, with outer three primaries still growing (Richdale 1965). However, these birds of unknown breeding status; Richdale (1965) suggested non-breeders may begin moult as early as beginning Dec. Falla (1940) recorded full moult in adults, late Dec. but breeding status of birds uncertain. Moulting birds collected in primary moult, late Feb. (NMNZ, including bird with irregular primary moult N⁶1¹O¹4¹O¹) suggest moult of remiges continues into early Mar. in some birds; these birds near completion of body-moult. Sequence of body-moult unknown, but scapulars full grown and fresh following return from post-breeding exodus (Richdale 1965). Moult of tail, centrifugal, completed soon after primaries (NMNZ). Harper (1980) stated adults moult early Feb. to Mar., based on birds examined at breeding colonies and beachcast adults (P.C. Harper).

POST-JUVENILE No information. Non-breeding birds of unknown age have been found in body-moult in July and Aug. (Harper 1980).

MEASUREMENTS (1) Snares Is, live birds in definitive plumage, unknown status; natural chord (A.J.D. Tennyson; P.M. Sagar). (2) Whero I., live adults; methods unknown (Richdale 1965). (3) Whero I., live juveniles before leaving breeding grounds; methods unknown (Richdale 1965). (4) Chatham Is, live breeders; natural chord (A.J.D. Tennyson). (5) Chatham Is, live and recently dead definitives of unknown status. (6) Chatham Is, dried; methods unknown (Harper 1980). (7) Chatham Is, skins, juveniles excluded (NMNZ). (8) Chatham Is, skins, juveniles (NMNZ).

UNSEXED	
WING	(1) 211.8 (3.97; 205-211; 14)
	(2) 213.9 (5.54; 195-225; 87)
	(3) 203.2 (8.4; 181-207; 54)
	(4) 212.7 (3.30; 209-217; 3)
	(5) 211.0 (6.04; 195-219; 17)
	(6) 205.6 (0.9; 195-220; 37)
8TH P	(7) 141.3 (4.03; 137-148; 8)
	(8) 134.5 (4.51; 128-138; 4)
	(9) 134.5 (4.51; 128-138; 4)
TAIL	(1) 103.6 (2.96; 99.1-111.1; 12)
	(2) 107.2 (3.71; 99-115; 42)
	(4) 103.4 (2.79; 101.3-108.7; 5)
	(5) 102.7 (4.52; 92.3-110.1; 13)
	(6) 99.0 (1.0; 90-104; 16)
	(7) 99.0 (1.0; 90-104; 16)
BILL L	(1) 34.6 (1.22; 32.5-36.7; 25)
	(2) 34.5 (1.16; 31.5-36.8; 89)
	(3) 34.0 (1.08; 31.3-36.5; 58)
	(4) 35.1 (1.09; 33.7-37.4; 10)
	(5) 33.7 (1.04; 31.4-35.4; 20)
	(6) 33.8 (0.2; 31.9-36.2; 39)
BILL W	(1) 21.9 (0.97; 20-23.8; 25)
	(2) 21.4 (0.92; 19.5-24.3; 89)
	(3) 20.1 (0.63; 19-21.5; 58)
	(4) 21.2 (1.00; 18.7-22.4; 10)
	(5) 21.1 (0.88; 19.5-22.8; 18)
	(6) 20.7 (0.9; 19-22.5; 39)
BILL D	(1) 17.5 (0.76; 16.1-18.9; 25)
	(2) 12.9 (0.78; 11-14; 87)
	(3) 12.3 (0.62; 11.3-13.8; 45)
	(4) 17.7 (0.88; 15.9-19.2; 10)
	(5) 16.7 (1.02; 14.8-18.3; 18)
	(6) 16.7 (1.02; 14.8-18.3; 18)
TARSUS	(1) 37.0 (1.35; 34.8-40.6; 25)
	(4) 36.8 (0.87; 34.6-38; 10)
	(5) 35.6 (1.24; 32.6-38.1; 20)
	(1) 44.6 (1.75; 41.1-48.2; 19)
	(2) 43.5 (1.76; 39-47; 87)
	(4) 42.9 (1.37; 40.4-45.5; 10)
TOE	(5) 42.3 (1.47; 39.6-45; 18)
	(5) 42.3 (1.47; 39.6-45; 18)

No published measurements for large series of sexed birds but no significant size dimorphism according to Harper (1980). For measurements from Gough I. and Tristan da Cunha see Swales (1965) and Fraser *et al.* (1988) respectively.

WEIGHTS

BREEDING ADULTS At Whero I. at time when chicks leave burrows: 190.4 (17.1; 170-235; 29). On return from post-breeding exodus: 196.5 (13.8; 179-224; 20) (Richdale 1965). At Chatham Is, between Oct. and Mar.: 198.7 (13.76; 177.5-220; 10) (A.J.D. Tennyson). At Snares Is, including birds of unknown status, between Oct. and Feb.: 199.8 (15.95; 173-237; 25) (A.J.D. Tennyson, P.M. Sagar). Weights for Gough I. and Tristan da Cunha given by Swales (1965), Fraser *et al.* (1988).

CHICKS Based on Richdale (1965) at Whero I. On leaving burrow: 174.5 (17.5; 144–217; 32); 16 to 13 days before departure: 221 (170–330; 59). Unknown when maximum weight attained; weights decrease gradually between 24 and 9 days before departure, and then more rapidly until departure.

STRUCTURE Eleven primaries, p9 or p10 longest; p11 minute, p10 0–2, p9 0–1, p8 4–10, p7 15–23, p6 29–37, p5 41–51, p4 61–67, p3 71–82, p2 84–97, p1 96–108. Eighteen secondaries, about four of tertial form. Tail, strongly rounded; t1–t6 13–15. Bill width, about two-thirds length. Mandibular rami convex, enclosing large distensible unfeathered gular pouch (for illustration of distended pouch see Wilson 1907; Murphy). Comb-like lamellae run inside tomia of upper mandible, from base of bill to base of maxillary unguis; visible when bill closed. Nostril tubes about one-fifth length of bill; nares separated by narrow septum. Maxillary unguis narrow, about one-third length of bill; hooked. Mandibular unguis slightly downcurved. Tarsus and toes, scutellate; outer and middle toes about equal in length, inner toe c. 80%.

AGEING (Based on Harper 1980). Adults have thick keratinized latericorns, which retain glossy appearance after death; culminicorn, flat or slightly convex; skull fully ossified. Juveniles have soft thin latericorn plates; when drying after death these adhere to maxilla and often become dull brown; culminicorn has prominent central ridge; skull incompletely ossified with translucent parietal windows, easily depressed in fresh specimens. Age when juvenile characters lost unknown.

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DIR



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Antarctic Prion *Pachyptila desolata*

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

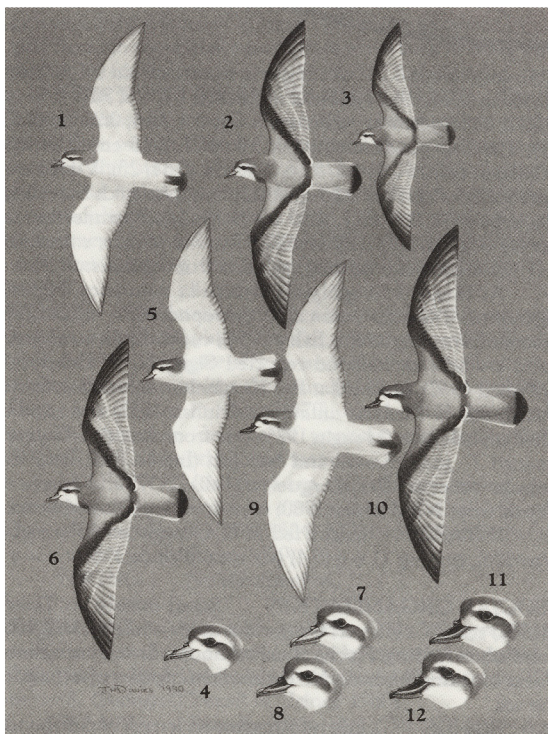
Salvin's Prion *Pachyptila salvini*

- 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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