THE FIELD IDENTIFICATION AND DISTRIBUTION OF THE PRIONS (genus Pachyptila), WITH PARTICULAR REFERENCE TO THE IDENTIFICATION OF STORM-CAST MATERIAL

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ABSTRACT

This paper examines the field identification, distribution, and taxonomy of the six species of *Pachyptila*. Particular attention is given to the identification of storm-cast material. The data include observations of prions at sea, on their breeding grounds, and 10 086 specimens examined over a 21-year period from 1958 to 1979.

The validity of the six recognised species of *Pachyptila* is reaffirmed, and one subspecies each of the Fairy Prion *(Pachyptila turtur)* and the Fulmar Prion *(Pachyptila crassirostris)* is retained.

The need for further ecological data, better food analyses, and carefully defined behavioural studies is stressed. The value of biochemical genetics for elucidating the speciation mechanisms of *Pachyptila* emphasises the preliminary nature of the present findings.

INTRODUCTION

Almost 40 years have passed since Falla (1940) and Fleming (1941) reviewed genus *Pachyptila*. This paper is intended to bring up to date the taxonomic status of the prions and their distribution, and to present a guide to their identification at sea. During the last 21 years I have examined 10 086 specimens of *Pachyptila* (839 birds from breeding localities (Fig. 1) and 9247 beached specimens). Despite this harvest of material, the obvious lack of data in some of what follows will ensure that the prions remain a topic for continued research.

Prions are not easy to identify. This is particularly true of storm-cast birds because immatures of larger-billed species look deceptively like adults of smaller-billed ones. Moreover, a 1-13% shrinkage in some bill dimensions (Kinsky & Harper 1968) can significantly alter the appearance and profile of a prion's beak. Hence, a freshly measured immature *salvini* can take on the appearance of an adult *desolata* after the specimen has dried. Geographic variation in the bill structure of *turtur* has resulted in its confusion with the rare *crassirostris*, a species now known to be sexually dimorphic in the critical bill characters (see below).

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In recognition of these difficulties, I have given particular attention to the identification of storm-cast prions. My main concern in any taxonomic decision on the *Pachyptila* subspecies has been whether or not a beach specimen can be correctly identified to subspecific level. The information at present available on some species' variability is, in my opinion, highly dubious and of little practical help in dividing the species into their named subspecies. To add to the confusion, some species appear to have a surfeit of vernacular names often quite unrelated to their supposed specific ones. The prion *Pachyptila salvini,* variously called the Marion Island, Medium-billed, Salvin's, and Lesser Broad-billed Prion, is a good example. It is understandable that some perplexed authors (e.g. Watson 1975) have recently considered *salvini* to be a subspecies of the Broad-billed Prion *(P. vittata).*

Sketches of prion bills are not uncommon in the literature, but all too often the illustrations are of immature birds whose shrunken bill appearance is often unlike that of a typical adult and/or fresh material. For example, see plate 43 in Mathews (1938). Sometimes the sketches are too small and lack a scale (as in Falla *et el.* 1979, 'The new guide to the birds of New Zealand'). In the hope that they will be more helpful, the sketches below have been taken from living or fresh specimens, and a 30 mm scale is given where appropriate. A description of a prion's headparts, as illustrated by an Antarctic Prion, is shown in Figure 2. To standardise dimensions as much as possible, I have remeasured *Pachyptila* in several collections held in New Zealand and elsewhere. This has been especially useful in dealing with the *desolata* subspecies, as discussed by Tickell (1962).

BROAD-BILLED PRION

Pachyptila vittata (Forster, 1777)

Material examined: 1280 beach specimens and museum skins from New Zealand; 48 skins of adults and fledglings from breeding localities.

Observations: Seen off the Chatham Islands, **Eltanin** cruise 23; Tasman Sea, cruise 28.

DESCRIPTION OF ADULT

The Broad-billed Prion is the largest *Pachyptila* in body size, with a distinctively bowed and very broad bill measuring no less than 31 mm in length, and 17-23 mm at its widest point. The bill unguis is small and often ridged, and the culminicorn is broad and black. The large latericorns are glossy iron-grey (*not blue*) and the mandibular rami are violet blue. The pale lemon-yellow palatal lamellae are well developed, and clearly visible when the bill is closed. Beneath the cream-coloured tongue, which is large and fleshy, is a distensible pouch lying between the rami. The action of the pouch is well shown in Edward Wilson's colour painting of *vittata* (figures in Roberts 1967).

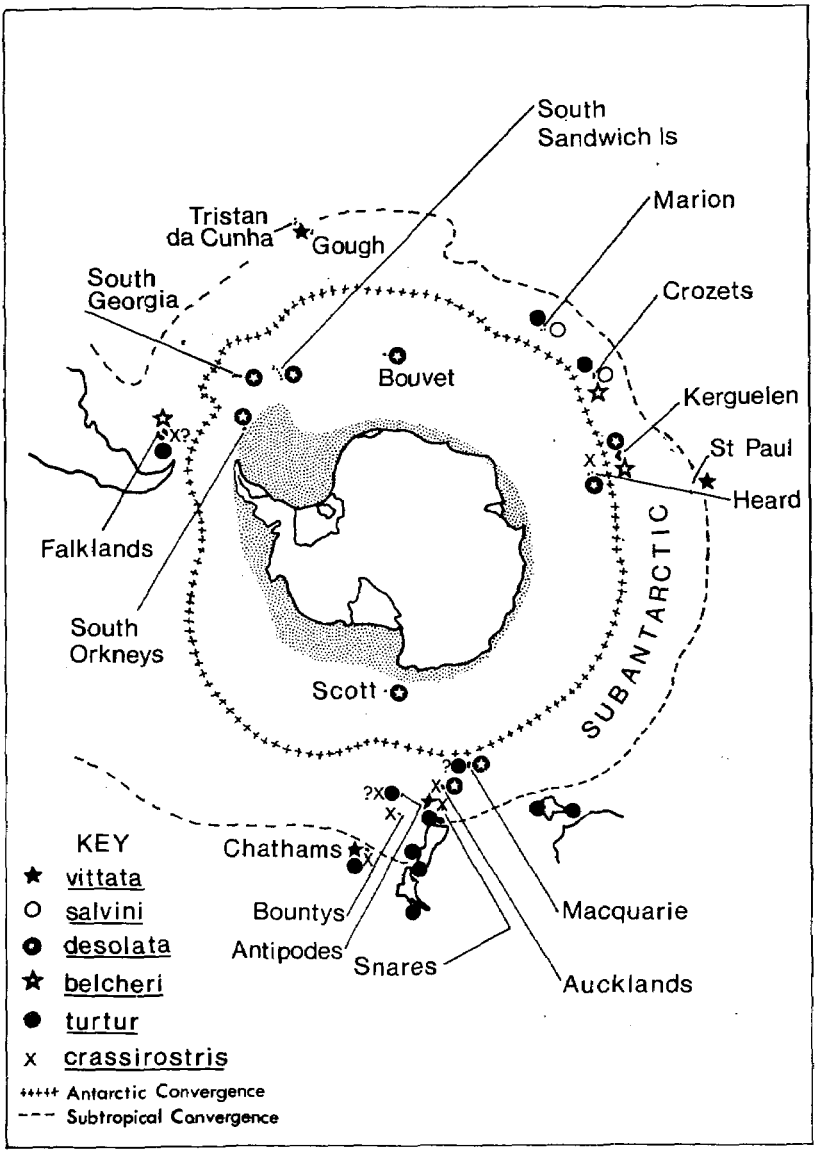

FIGURE 1 — Map of breeding localities of **Pachyptila** prions.

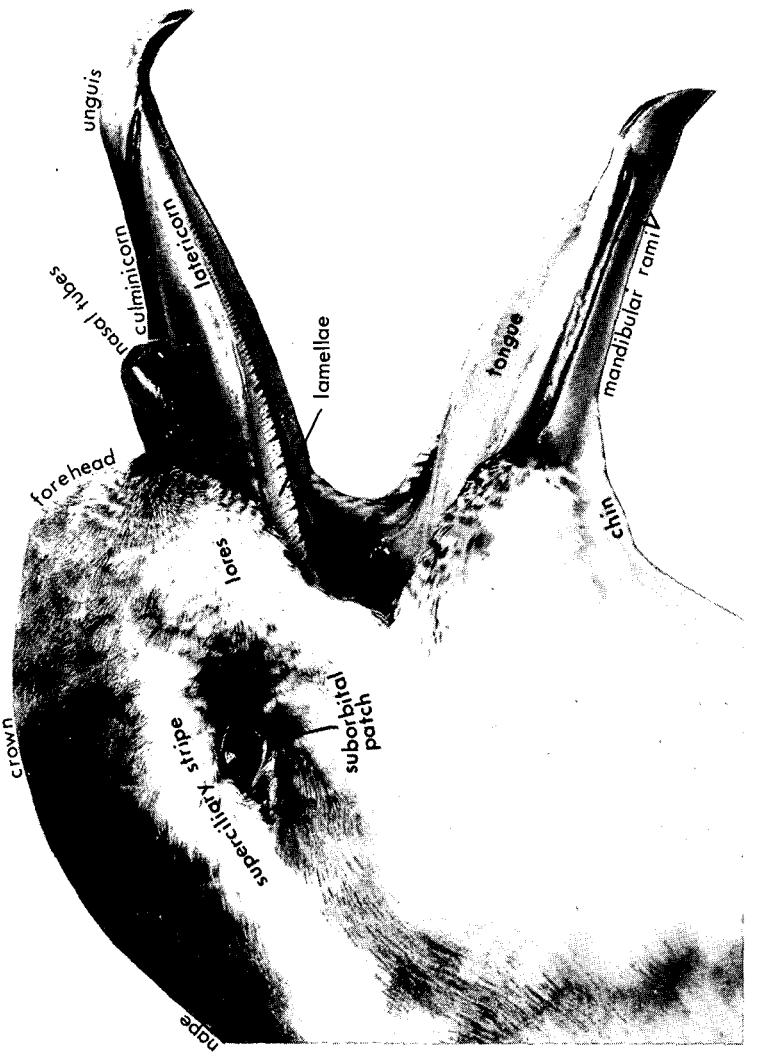

FIGURE 2 — Description of **Pachyptila** headparts illustrated by an Antarctic Prion, **Pachyptila desolata.**

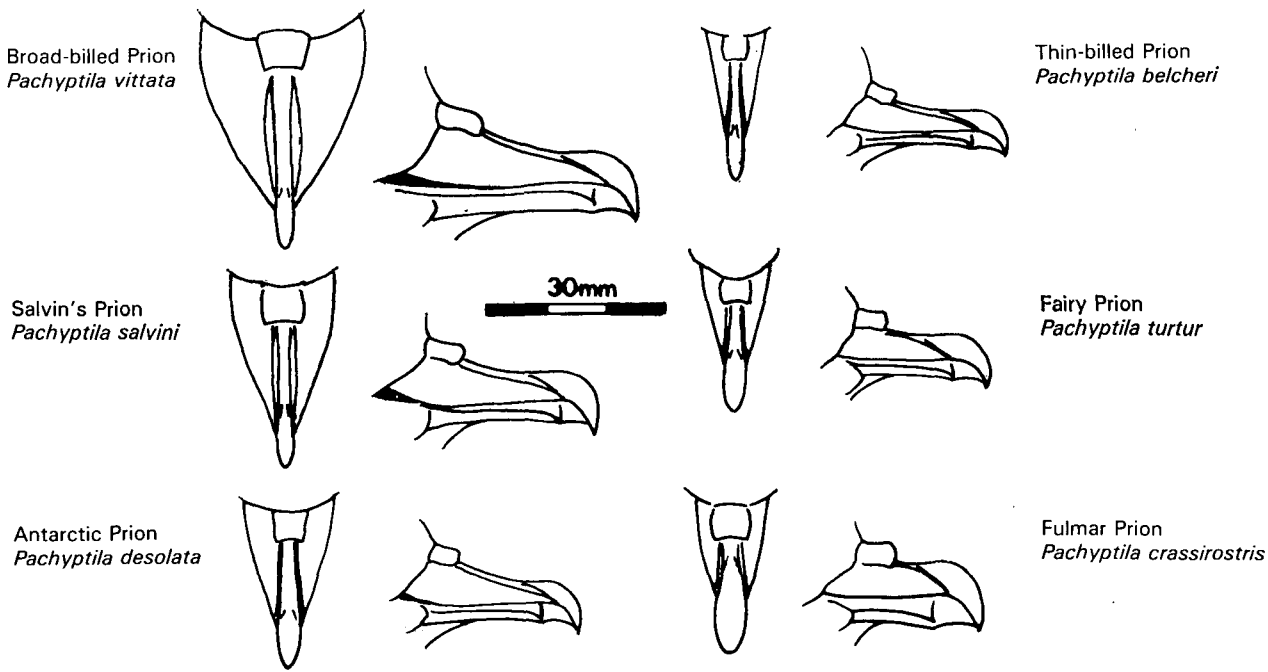

FIGURE 3 — Adult bill profiles of the six species of **Pachyptila.**

TABLE 1 — Breeding localities of **Pachyptila** Prions

	Latitude (° and'S)		Longitude (° and'E or W)		Reference*
	Pachyptila vittata				
Tristan da Cunha	37	15	12	30W	Elliott 1957
Gough I.	40	20	10	00W	Swales 1965
The Snares	48	01	166	35E	Sagar 1977
Stewart I.	47	00	167	50E	Richdale 1965
Chathams Is	44	00	167	50E	Fleming 1939
St Paul I.	38	43	77	30E	Jouanin 1953
	Pachyptila salvini				
Marion I.	46	52	37	51E	Rand 1954
Crozets: East,	46	26	52	10E	Despin et al 1972
Possession I.	46	25	52	00E	Despin et al 1972
Hog I.	46	06	50	14E	Derenne & Mougin 1976
	Pachyptila desolata				
Kerguelen I.	49	15	69	10E	Falla 1937
Heard I.	53	06	73	20E	Falla 1937
Macquarie I.	54	37	158	54E	Law & Burstall 1956
Auckland Is	50	40	166	30E	Falla 1940
South Orkneys (Signy)	60	43	45	38W	Tickell 1962
South Georgia I.	54	15	36	45W	Murphy 1936
South Sandwich Is (Leskov)	56	40	28	10W	Vaughn 1967
(Bellingshausen)	59	25	27	03W	Vaughn 1967
Scott I.	57	24	179	55W	Harper 1972
	Pachyptila belcheri				
Kerguelen I.	49	15	69	10E	Falla 1937
Falkland Is	51	45	59	00W	Cawkell & Hamilton 1961
Crozets (East I.)	46	25	52	12E	Despin et al 1972

TABLE 1 (continued)

	Latitude (° and 'S)		Longitude (° and 'E or W)		Reference*
			Pachyptila turtur		
Marion I.	46	52	37	51E	Prevost 1970 Despin et al 1972
Crozets (Hog I.)	46	06	50	14E	Derenne & Mougin 1976
Bass Strait Is	39	20	145	30E	Condon 1975
Tasmania					Condon 1975
Macquarie I.	54	37	158	54E	Carrick 1957
The Snares	48	01	166	35E	Oliver 1955
Stewart I.	47	00	167	50E	Richdale 1965
Antipodes Is	49	40	178	47E	Oliver 1955
Antipodes Is	49	40	178	47E	Oliver 1955
Chatham Is	44	00	176	30W	Oliver 1955
New Zealand offshore islands					Harper 1976
Beauchene I.(Falklands)					Strange 1968
			Pachyptila crassirostris		
Heard I.					Downes et al. 1959
Auckland Is					Falla et al. 1979
Bounty I.					Oliver 1955
Chatham Is					Fleming 1939
The Snares (Western chain)					Fleming & Baker 1973

* See Watson et al 1971 for additional data.

The facial pattern is dark, with blue-black or fuscous barring or freckling prominent over the lores and below the eye. The short white superciliary is restricted to the area immediately above and behind the eye and is often lightly barred with blue. The fuscous suborbital stripe is broad and boldly underscores the dark-brown eye. The crown feathers have dark centres and black shafts which make the crown generally dark when the feathers are worn.

The dorsal plumage is a rich blue, and a prominent half collar extends ventrally over the neck. The open 'M' marking across the

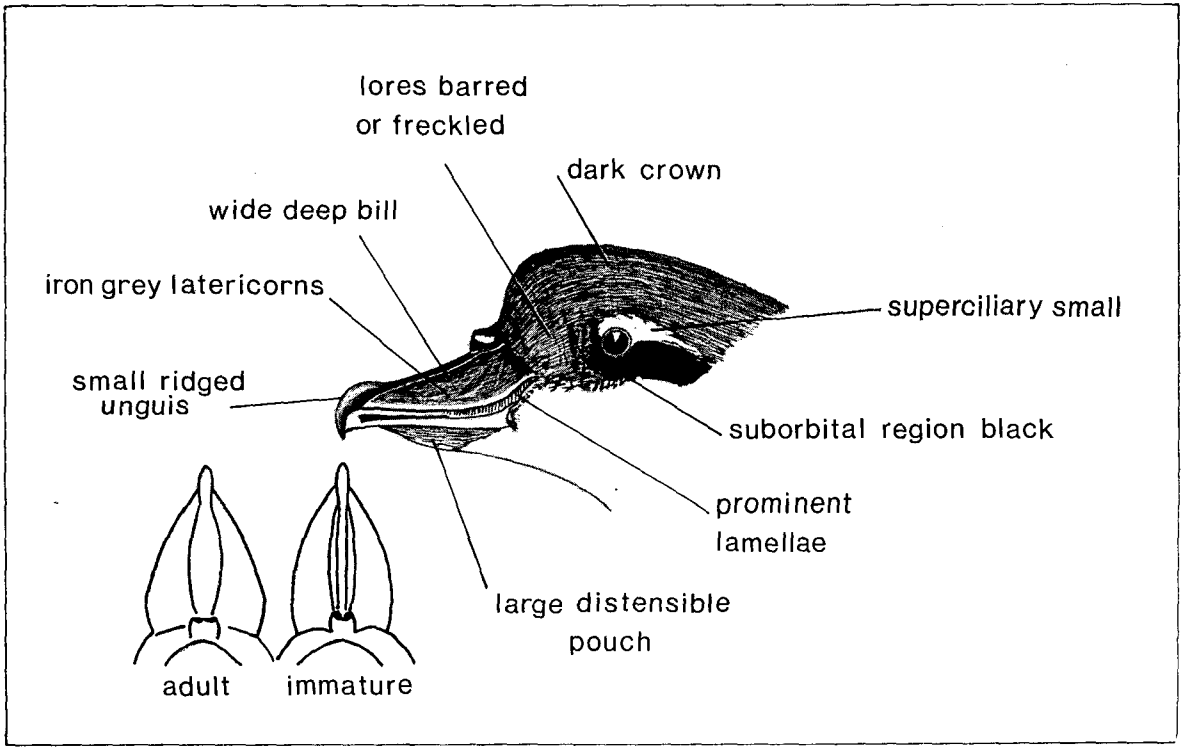

FIGURE 4 — Broad-billed Prion headparts and bill profiles of adult and immature birds.

wings is black, broad, and well defined. The rectrices are black for 28-33 mm (average 29.9) at the tip. Undersurface white, under-tail coverts barred with dark blue apically. Feet cobalt blue, webs variably grey or cream, claws bluish black.

IMMATURES

Broad-billed Prions in their first (juvenile) plumage can be distinguished by their smaller dimensions and the conspicuous white edging to their inner primaries (1-6). The pale smoky tone of the plumage is also characteristic.

The bill is weak (see Fig. 4), with a narrow unguis and a prominent culminar ridge. During the drying of prepared skins, the soft thin latericorn plates laminate themselves to the maxilla beneath and often lose their gloss to become dull brown. The cranial bones are poorly ossified and thin with translucent 'parietal windows' that are easily depressed by finger pressure in fresh specimens. The gonads are small and inactive.

In subsequent plumage changes, the crown and wings darken and the keratinised bill plates thicken as the adult bill contour is attained. Radiating latericorn ridges and retention of the glossy appearance of the bill is typical of adult specimens. In adults the culminicorn is flat or slightly convex, with the black epidermal skin tightly stretched across it. The skull is well ossified and lacks the resilience found in younger birds.

FIELD CHARACTERS

The Broad-billed Prion is one of the easiest *Pachyptila* to identify, both at sea and in the hand. Field observers should note its large size, long cylindrical body shape, and prominent wing markings. The tail bar is small. The head size is emphasised by the massive bill and high forehead, while the neck, when tucked into the body, appears short and thickset. The head has a distinctively dark pattern, and the neck collar is conspicuous. The wings are usually held forward accentuating the length of the tail. Flight behaviour is slower than the smaller species of prions, with much gliding. This species does not usually bank as steeply, with the wing-tips approaching the vertical, as smaller prions do. Broad-billed Prions often gather into large flocks when feeding.

DISTRIBUTION

P. vittata is a common resident prion in New Zealand, and both young and old birds occur in storm-cast material. Being a species usually confined to the subtropical zone of surface water, Broad-billed Prions breed on islands situated in or adjacent to the Subtropical Convergence. St Paul Island, a short distance south of the Subtropical Convergence, appears to be the only exception.

Although the species is sedentary with birds present about their

breeding grounds all months of the year, a notable fall-off in numbers is conspicuous in the first two months following the breeding season (Richdale 1965). Evidence from beach records (pers. obs.) indicate that Foveaux Strait birds move north and west in February and March, dispersing into the eastern Tasman Sea. I have seen them flocking with *turtur* in mid-Tasman during February 1967. In a voyage from Wellington to Panama in 1948, Fleming saw many prions he presumed to be this species in subtropical waters (surface temp. c. 13.9 °C), and collected two *vittata* some 1400 km north-east of the Chathams (38°S 161°30'W) on 3 July. No prions were seen the following day (Fleming 1950). Storm-driven birds are often reported from the Bay of Plenty and north-eastern coasts of the North Island during July, and adults with enlarged gonads returning south down the west coast of the North Island often fall victim to westerly gales that cast them ashore fom June to early August. Such flocks appear to be composed of an even ratio of males to females — 16 males to 16 females in late August 1946 (Wodzicki 1947), and 137 males to 133 females in various months and years (Harper, unpubl. data).

TABLE 2 — Dimensions (mm) of Pachyptila vittata. Numbers of birds are given in brackets. Chatham Is material dried; rest fresh.

	GOUGH I. (Swales 1965)	CHATHAM Is (this study)	STEWART I. (Richdale 1965)
Bill Length			
Mean & S.E.	(84) 35.5 ± 0.2	(39) 33.8 ± 0.2	(89) 34.5 ± 0.1
Range	32-38	31.9-36.2	31.5-36.8
Bill Width			
Mean & S.E.	(129) 21.6 ± 0.1	(39) 20.7 ± 0.1	(89) 21.4 ± 0.1
Range	18-25	19-22.5	19.5-24.3
Wing Length			
Mean & S.E.	(128) 209.8	(37) 205.6 ± 0.9	(87) 213.9 ± 0.6
Range	191-229	195-220	195-225
Tail Length			
Mean & S.E.	(127) 106 ± 0.3	(16) 99.0 ± 1.0	(42) 107.2 ± 0.6
Range	94-120	90-104	99-115

BREEDING CYCLE

Table 1 gives the localities where *vittata* breeds. Most populations are impressively large — an estimated 10 million birds at Gough (Swales 1965). Large numbers also occur at the Chathams (Fleming 1939) and on islands in Foveaux Strait (Richdale 1965). Before being overrun with rats, Tristan da Cunha was also a breeding ground of several species of petrel, the most abundant of which was *vittata.*

The reproductive cycle begins with the return of large numbers of birds in July (Richdale 1965). Burrows about a metre long are often dug in sloping ground or steep damp banks close to the sea. Inner recesses of sea caves or caverns may also be used as nest sites. Leaves and twigs are used sparingly to construct the nest. Eggs are laid in late August-early September and hatch some 45 days later. After about 53 days at the nest the fledglings depart in mid-December, and the season is normally finished by the first week in January.

MOULT

The adults begin moulting in early February, and feather replacement is completed by early March.

Non-breeding birds have been found in body moult in July and August (pers. obs.).

FOOD AND FEEDING

Broad-billed Prions gather their food from the sea's surface. They rarely dive. The birds scurry forward rapidly, moving their heads from side to side with their beaks partly open, taking water and food into their mouth. The water is rapidly expelled by upward movement of the tongue and collapse of the distensible gular pouch, and the food is gathered by the large fleshy tongue and quickly swallowed. Larger items such as cephalopods are seized directly from the water (pers. obs.).

Food items include crustaceans (mainly copepods), stalked barnacles, pteropods, and small fishes (Richdale 1944). Cephalopod remains taken from storm-killed birds suggest that these animals are an important winter food item.

EGGS

Clutch one; egg white.

Length 45.25-52.5 mm (mean 50.0 $\pm$1.9; n = 12); width 36.00-37.75 mm (mean 36.8 $\pm$0.5) (Foveaux Strait islets — Richdale 1965). Two eggs from Tristan da Cunha measure 52.5 x 35 mm and 51.5 x 35 mm (Murphy 1936). Four from the Chathams measure 47.7 x 35.6, 51 x 36, 45.8 x 33, and 49 x 37 mm (Oliver 1955).

STATUS

The widely distributed breeding populations of this species in the South Atlantic and around New Zealand show close agreement in

morphology, reproductive schedule, and nesting habitat. There is little appreciable variation in the measurements (Table 2), and specimens I have examined appear to be remarkably similar for both New Zealand and Gough Island populations.

In a somewhat arbitrary view of the subspeciation of *Pachyptila,* Mathews (1912: 211) differentiated the *vittata* nesting at St Paul and Amsterdam islands (Indian Ocean) from his subspecies *gouldi* (now recognised as immatures of the nominate race) because of its " bill being slightly shorter and wider." No further information was supplied to justify his " *Prion vittatus macgillivrayi,* subsp. n.", of which few specimens exist in collections. I have been able to examine three adult birds with the following dimensions:

Bill	Wing	Tail	Tarsus	Toe
No. 1267, Paris Museum, 20 Oct 1874, adult ♂				
32.6 x 19.4	209	100	36	41.7
No. 114, Paris Museum, 1875, unsexed				
32.4 x 19.2	202	95	38	45
Holotype, BM 81.5.1.531, British Museum (Natural History), Jan 1853				
31 x 18	194	91	34	37

These dimensions are slightly smaller than those obtained from dried specimens or live birds sampled from other populations (Table 2). The holotype is an immature bird.

Serventy, Serventy & Warham (1971) give data for 15 specimens of *P. v. macgillivrayi* which show a bill of slightly smaller dimensions than that of the Gough Island and New Zealand material (Table 2). This discrepancy is, however, probably the difference between fresh and dried material, rather than the criterion for a valid subspecific distinction. Further data are required. Because no other phenotypic or ecological differences between *macgillivrayi* and the nominate race are at present available, and in view of Mathews' inadequate original description, I believe taxonomy would best be served by absorbing the subspecific name *macgillivrayi* into synonymy with *Pachyptila vittata vittata* Forster, 1777.

Segonzac (1972), in reviewing the breeding status of *vittata* at St Paul Island, reports that this prion has suffered severely from rat and cat predation. Although a few flying adults were seen by Segonzac, no trace of breeding was found in February 1970. A similar situation apparently exists at Amsterdam Island, where Jouanin & Paulian (1960) found only rat-chewed prion bones. Segonzac comments that the numbers of *vittata* in the air might indicate the presence of nesting birds in small numbers in isolated areas free from mammalian predators. February is a period of low activity at the breeding grounds in other populations, so numbers may not be as drastically reduced as the observations suggest. Further data would be valuable.

The Broad-billed Prion is unique among *Pachyptila* species in having an iron-grey bill with violet-blue mandibular rami. This curious character is, however, also present in the Blue Petrel *(Halobaena caerulea)* and in family Pelecanoididae, the diving petrels. That such a colour pattern should appear in three such distant procellariiform groups is intriguing (the Blue Petrel is only distantly related to *Pachyptila* — Harper 1978) and suggests convergence or, more plausibly, an ancestral combination of genes common to all three groups.

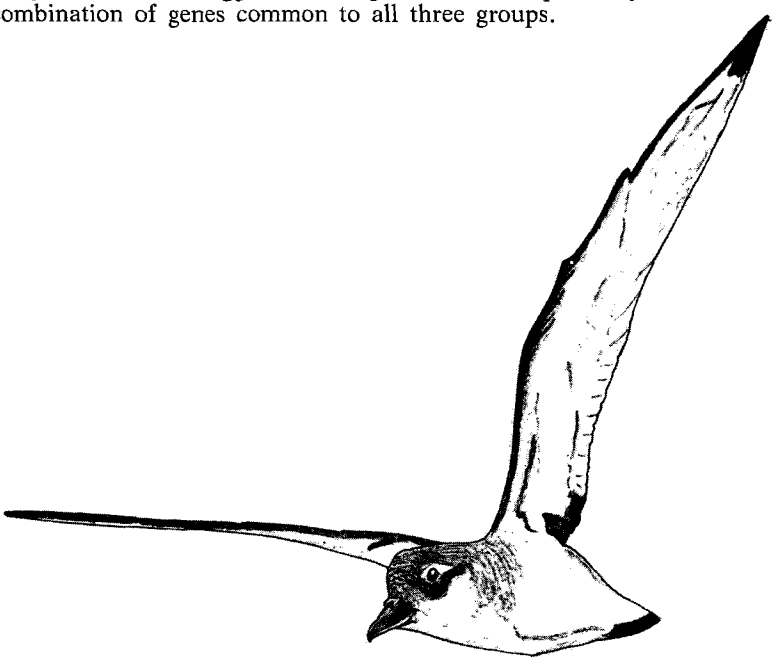

FIGURE 5 — A Broad-billed Prion in flight off the Chatham Islands, cruise 23, 1966 (adapted from photograph).

SALVIN'S PRION

Pachyptila salvini (Mathews, 1912)

Material examined: 3015 beach specimens; 12 skins from breeding localities.

DESCRIPTION OF ADULT

This species can be distinguished from *vittata* by its smaller dimensions, by its paler plumage (particularly the crown and lores), and by having a blue bill — not a steel-grey one. Bill width at the gape ranges from 12.5 mm to 20.5 mm. The palatal lamellae are smaller than those of *vittata* but are clearly visible anterior to the gape with the beak closed. Viewed from above, the free edges of the

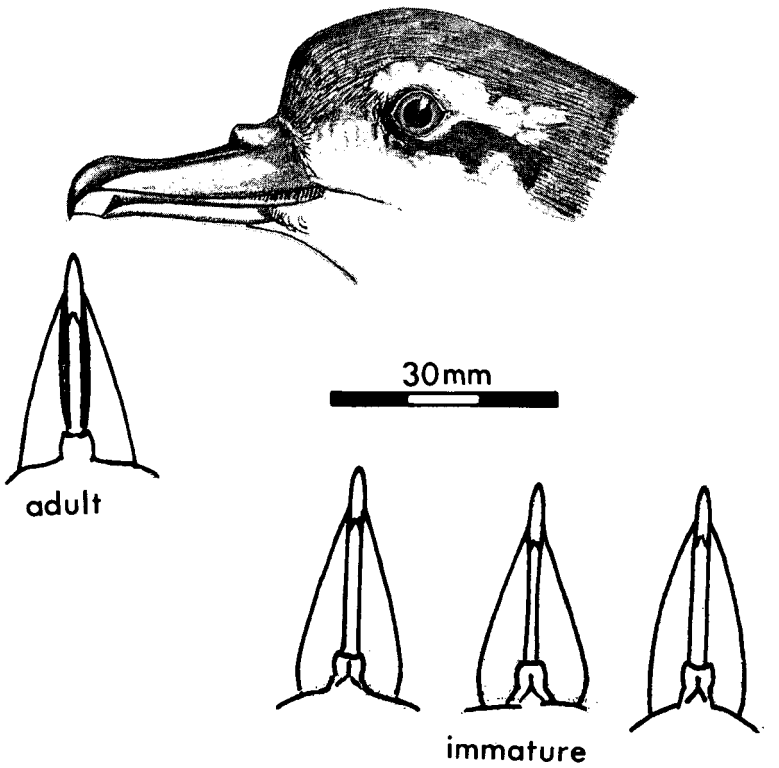

FIGURE 6 — (a) Headparts of Salvin's Prion, **Pachyptila salvini.**

latericorn plates are bowed outward, that is, not straight as in most adult *desolata* (see Fig. 7). The unguis is generally small and rounded in adults, and a distensible pouch lies between the mandibular rami.

The crown of fresh-plumaged adults is usually pale, only slightly darker than the mantle. With wear, however, the pale extremities of the dark central regions of the crown feathers are worn away to produce a dark crown before the body moult. The lores are usually white but sometimes are fully shaded with bluish grey. The superciliary is small (as in *vittata*), and a well-defined suborbital stripe of bluish black underscores the eye.

The open 'M' across the wings is dusky black, as in *vittata,* and the terminal black marking over the tail is mainly on the centre feathers (width 23-30 mm). The rest of the upper surface is rich blue, and the dark-blue neck collar is conspicuous.

Underparts white. Feet lilac blue, webs pale pink or yellowish cream, sometimes veined with brown; claws bluish black.

IMMATURES

Immature birds show a wide variety of plumage and bill characters. Most have smoky blue lores and crown and pale upperparts. Immatures lack the dark pigment of the adults in the wings and tail, and often primaries 1-6 are fringed with white. The broad white barring of the scapulars is emphasised also.

The immature bill structure is weak, with a high culminar ridge, thin latericorn plates, and a ridged unguis. Frequently the bill warps with drying, and surface irregularities of the maxilla appear beneath the soft latericorns.

FIGURE 6 — (b) Adult Salvin's Prion, Marion Island.
Photo: Ian Sinclair

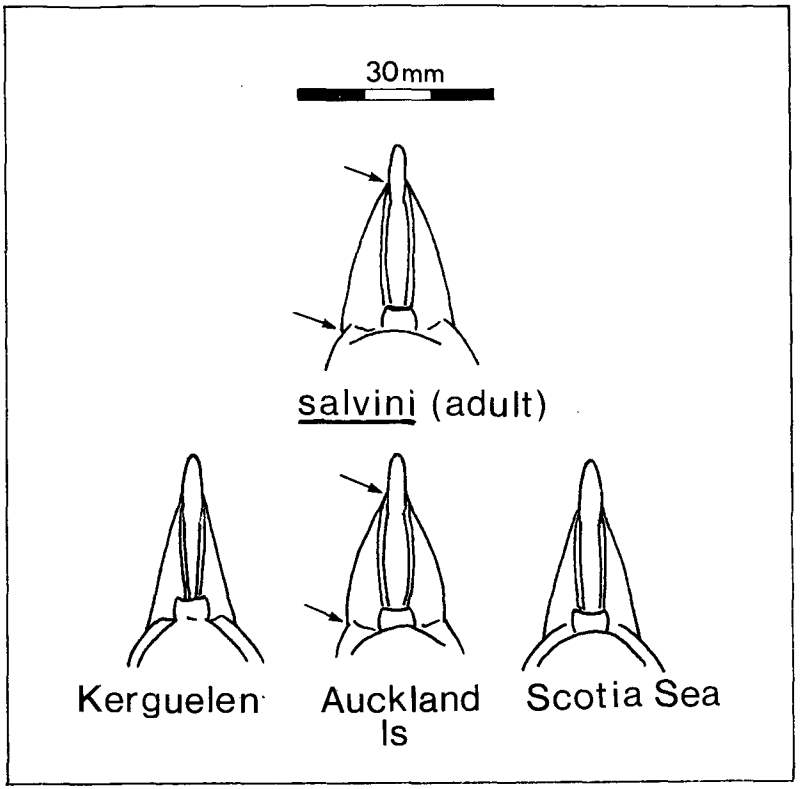

FIGURE 7 — A typical adult **salvini** bill compared with typical examples from three **desolata** populations. Auckland Island **desolata** show the closest resemblance to **salvini**. Note, however, the smaller overall size, larger unguis, and shorter length of the outside edge of the latericorns of **desolata** (that is, the distance between the arrows shown).

The teleoptyle plumage is replaced by a slightly darker one. The white edging of the primaries disappears or is much reduced, and the facial feathers darken below the eye. The lores whiten and lose their smoky appearance. Dark feathers sometimes appear in the crown, and the bill form approaches that of the adult, although the culminar ridge is still raised and epidermal shrinking is present across it.

COMPARISON OF *salvini* AND *desolata*

Because fresh specimens of *salvini* look very like adult *desolata,* the two have often been confused. Indeed, the two species are often inseparable on the plumage characters alone.

The important distinction is in bill shape and size. In adult *salvini* the bill is on average significantly larger ($P > 99\%$) in both length and width than that of *desolata* (Tables 3 & 5). An unidentified bird with a (dry) bill 30 mm or longer by 16 mm or wider will very likely be *salvini*. The bowed contour of the latericorns and the ever-present lamellae are additional distinguishing features.

Immature *salvini* bill dimensions fall well within the range for adult *desolata* (compare Tables 3 and 5), and so species identification at this level is distinctly more challenging. Any indication of immaturity should be looked for in the birds being examined: conspicuous signs of bill shrinkage; lack of cranial ossification; small gonads; shrivelling of foot tissue when dried; and the plumage characters noted above. Once a specimen has been skinned or left to dry, immature *salvini* and adult *desolata* can be distinguished much more easily.

FIELD CHARACTERS

I have not identified Salvin's Prions at sea. From collecting and examining many storm-driven birds, however, my impression is that *salvini* is similar to *desolata* in general appearance and flight pattern (Fig. 8). The lores are darker than in New Zealand populations of the Antarctic Prion, and the blue-grey upper surface is a shade darker in adult *salvini,* but not in immature birds.

DISTRIBUTION

The breeding range of Salvin's Prion is unique among the *Pachyptila* in that it is restricted to the islands of the Indian Ocean. It breeds by the million at Marion Island and at East and Hog islands in the Crozet Archipelago. Large numbers previously existed at Possession Island, but predation by the black rat *(Rattus rattus)* has limited breeding *salvini* to rock crevices above 200 m, above the vegetation cover. After the breeding cycle finishes in early April, Salvin's Prions desert Marion Island and the Crozet Archipelago for their winter feeding grounds. Where these are is largely conjectural, perhaps in the plankton-rich zones of upwelling about the southern coasts of South Africa and west-southwest of Australia. Adult *salvini,* common in West Australian prion wrecks, are rare in New Zealand, where almost all the *salvini* are fledglings not long out of their nests (two to four months). Howell (1974) found such a bird storm-wrecked near Dargaville, New Zealand, on 30 June, 116 days after it was banded (FL 13456) as a chick on Hog Island on 6 March 1974.

New Zealand birds are severely emaciated (body weights down about 41% on the departure weight of 157 $\pm$5.6 g given below: a sample of 40 weighed an average of 92.3 $\pm$0.9, range 78-105 g). These figures are typical of many thousands of *salvini* which come ashore from late May to July in New Zealand and suggest the birds have not eaten for the last 10 days or so of their ill-fated 6000 km journey. Mougin (1975) suggested that the mortality of fledglings at sea is 75% of the number which leaves the breeding islands. Mortality

TABLE 3 — Dimensions (mm) of **Pachyptila salvini**. (Fresh material in all cases. Numbers of birds given in brackets.)

	MARION I. (Rand 1954)	EAST I. (Derenne & Mougin 1976)	HOG I.	POSSESSION I. (Despin et al, 1972)	NEW ZEALAND (beach specimens)
BILL LENGTH					
Mean & S.E.	(23) 30.6	(39) 31.6±0.22	(89) 30.2±0.11	(11) 30,5	(39) 29.9±0.2
Range	28-33	29-34	27.5-32.2	29-32	26.6-32.2
BILL WIDTH					
Mean & S.E.	(23) 16.4	(25) 18.4±0.3	(89) 16.9±0.08	(11) 18.4	(39) 15.1±0.2
Range	14.6-17.6	15.5-20.5	15.2-18.5	15.5-20.5	12.5-17.7
WING LENGTH					
Mean & S.E.	(23) 192.0	(39) 191.0±0.8	(89) 192.0±0.5	(11) 189.0	(37) 184.8±1.1
Range	185-202	182-202	184-207	184-194	174-201
TAIL LENGTH					
Mean & S.E.	(12) 91.0	no data	no data	no data	(36) 89.5±0.9
	87-96				80-104
WEIGHT (g)					
Mean & S.E.	(18) 154	(31) 156±2.6	(85) 159±1.4	(8) 162	(40) 92.3±0.9
Range	133-182	125-195	130-210	145-177	78-105

data from Australasia suggest the younger birds either disperse more widely than the adults or are more susceptible to the prevailing westerly storms sweeping towards New Zealand. The consistent predominance of males over females (almost exactly 2: 1, n = 330) of *salvini* in New Zealand is interesting (see Discussion). I have no evidence of Salvin's Prions frequenting the Tasman Sea-New Zealand region during summer and have not seen them in the Pacific south of 45°S (Harper 1972). I doubt whether this species reaches the Pacific east of New Zealand. No specimens to my knowledge have been taken from either side of South America.

The vast numbers of unidentified *Pachyptila* reported by several observers south of South Africa in summer (January-March; Falla 1937, Van Oordt & Kruijt 1954) may, as they suggest, be *vittata.* But they may well be non-breeding *salvini.* Winter observations in the region would also be valuable. Bierman & Voous (1950) collected an adult female *salvini* on 18 April 1947 at 37°10'S 19°15'E in 16°C waters of the continental slopes of South Africa.

BREEDING CYCLE

On Marion, East and Hog Islands, where the prion populations are not curtailed by heavy predation, *salvini* nest in all suitable habitats from sea level to the higher slopes near the summit where the vegetation gives way to bare volcanic rock. On Hog Island, Derenne & Mougin (1976) estimated *salvini* to occupy about 40 of the island's 70 km², with a population of some 4 million birds. The birds nest in burrows of diverse form and in rock crevices, often under vegetation *(Acaena ascendens, Azorella selago,* and *Cotula plumosa, Poa,* and *Rumex).* The birds return to the islands in late September. Burrows typically average 60 cm (range 93-135) in length with a spacious nest chamber, 30 cm (20-45) by 15 cm (12-18). The nest itself is constructed of leaves and twigs. Eggs are laid in early to mid November, and their average weight of 32 g is about 20.6% of the female's body weight. The incubation period is approximately 55 days. On East Island (Despin *et al.* 1972) during 1971, most chicks hatched during the period 4-18 January; on Hog Island in 1974, the first hatchings were seen on 14 January, the last on 10 February: 96% occurred in late January, less than 4% in February. Young *salvini* remain in their nests an average of 60 days (range 54-65). Fledglings leave their nests from early March to 3-4 April, the times of departure varying between colonies. The average for Hog Island is about 23 March, and the island is deserted after the first week of April. Departure weights of 17 fledglings was 157 ±5.6 g (range 115-204: Hog I.).

MOULT

Data from adult *salvini* examined in Australia and New Zealand indicate a post-nuptial moult. The lesser wing-coverts are the last feathers to be replaced, and adults in Australasian waters are typically in new plumage except for the worn wing-covert feathers and the

FIGURE 8 — Salvin's Prions photographed at sea off Marion Island.
Photos: Ian Sinclair

occasional short outer primary. Because of these plumage changes, adult *salvini* can often be distinguished from fresh-plumaged immatures.

FOOD AND FEEDING

The prominent lamellae and the distensible gular pouch strongly suggest that *salvini* is able to capture its food by sifting, like *vittata.* Observations are needed to confirm this.

Specimens shot at sea show that *salvini* eats euphausiids, pteropods (Bierman & Voous 1950), and cephalopods (Falla 1937). Squid beaks and pumice gastroliths are common in the stomachs of storm-killed Australasian birds.

EGGS

Clutch one: egg white.

TABLE 4 — Egg data for **Pachyptila salvini.**

	Number	Mean	Range	
Length (mm)	16	50.3	47.2 - 52.6	Marion I. (Rand 1954)
Width (mm)	16	35.9	33.3 - 37.7	
Weight (g)	12	32.0	27 - 36	
Length (mm)	36	48.6 ± 0.40	42.1 - 52.6	East I. (Despin et al. 1972)
Width (mm)	36	35.2 ± 0.27	30.5 - 38.9	
Weight (g)	4	30.0	29.5 - 35.5	
Length (mm)	45	48.5 ± 0.30	43.1 - 52.3	Hog I. (Derenne & Mougin 1976)
Width (mm)	45	35.3 ± 0.20	28.9 - 37.4	
Weight (g)		No data.		

STATUS

There are no satisfactorily described subspecies of *Pachyptila salvini.* A small-billed form hitherto thought to be breeding at the Crozet archipelago *(P. salvini crozeti)* has been shown by Despin *et al.* (1972) not to differ from the nominate form. Although Derenne & Mougin (1976) found the *salvini* of Hog Island to be smaller in the bill width than those of neighbouring East Island (16.9 ±0.08 and 18.4 ±0.26 respectively), the two populations look alike in all other respects. Philopatric behaviour in prions enhances the likelihood of small dissimilarities in morphology and plumage pattern between popu-

lations (Table 3), and so from present information concerning *salvini* there seems to be no reason for any subspecific recognition.

By contrast, however, Watson (1975) has recently considered *salvini* to be a subspecies of the Broad-billed Prion *(P. vittata)*. This view is surprising, considering the adaptations peculiar to *vittata,* such as size, shape, and colour of bill, reproductive schedule, sedentary behaviour, and distributional ecology. Indeed, few *Pachyptila* species are more clearly differentiated from each other than *vittata* and *salvini.*

Salvin's Prion has been given too many vernacular names in the literature, such as Lesser Broad-billed, Medium-billed, Marion Island, and Salvin's Prion. One name only is desirable. I disagree with Schodde *et al.* (1978) that the name Lesser Broad-billed Prion should be adopted because the facts do not support the close relationship this name implies. I recommend Salvin's Prion as a succinct and unambiguous name, more in keeping with Fleming's (1941) view of a neotenous pattern of development from shorter billed to wider billed species.

ANTARCTIC PRION

Pachyptila desolata (Gmelin, 1789)

Material examined: 813 beach specimens and museum skins; 163 skins representing all breeding localities.

Observations: Many sightings at sea — **Eltanin** cruises 16, 20-23, and 26-28.

DESCRIPTION OF ADULT

The Antarctic Prion is similar in appearance to Salvin's Prion. It has, however, a smaller bill, typically 26.5 mm long and 14 mm wide, whereas that of *P. salvini* is typically 30.5 mm by 18 mm.

The latericorns are chiefly straight-sided in *desolata* and not bowed as in *salvini,* except for the birds from the Auckland Islands — see Fig. 7. The unguis is larger and more rounded, and so the latericorn plates do not extend as far forward as in *salvini* (Fig. 7). The closed mandibles generally conceal the small palatal lamellae, but in some populations, particularly those of the Scotia Sea region, small lamellae are visible where the latericorns slope upward immediately before reaching the gape.

The open-M marking across the wings is moderately broad, and the terminal area to the central rectrices is well pigmented with black, as in *salvini.*

Underparts white. Feet pale blue, webs yellowish cream. Claws bluish black.

IMMATURES

Immature birds have the pale teleoptyle plumage typical of the genus. The bill is weak, and in the Kerguelen form can appear deceptively like that of an adult *belcheri.* The high culminar ridge

contributing to the greater depth of the bill and the soft latericorns, however, readily distinguish *desolata,* particularly if the bird is skinned and the bill is allowed to dry. The shrivelled bill and feet of a dried immature specimen of *desolata* are quite unlike those of an adult *belcheri,* be it freshly dead or fully dried.

FIELD CHARACTERS

At sea Antarctic Prion looks a medium-sized *Pachyptila* with a conspicuous beak, dark crown and dark eye patch, a rather small superciliary stripe and a conspicuous collar of dark bluish grey extending over the thick-set neck. The open-M wing-marking is distinct and the tail appears long in relation to the headparts (see Harper 1972 and Harper & Kinsky 1978: 40).

The lores in South Atlantic and Heard Island birds are often freckled with sooty black feathers. This freckling and the well-marked suborbital black patch underscoring the eye give these populations of *desolata* a facial pattern much more sombre than the smaller species. Australasian populations of freshly moulted *desolata* have paler heads; for these, pay particular attention to the bill size and tail length. Their plumage darkens with wear; the open M across the wings turns noticeably brownish only in cases of extreme wear.

The black terminal barring of the central rectrices in *desolata* is more pronounced than in *belcheri,* but much less so than the black tail bar of the Fairy or Fulmar Prions.

Antarctic and Salvin's Prions cannot usually be distinguished at sea. Their differing zones of water habitat and the limited distribution of *salvini* might help a shipboard observer clarify his *Pachyptila* spp: however, only unusually close observations or collections of specimens can confirm the distinction between them.

DISTRIBUTION

The Antarctic Prion is abundant in the South Atlantic and southern Indian Oceans and well distributed in the colder waters of Australasia. It is rare in the central Pacific. It breeds on at least nine widely distributed islands about Antarctica (see Table 1 and Fig. 1). *P. desolata* were described by Falla (1937) as nesting at Cape Denison in 1913 (three eggs collected by McLean, 12 December) but from recent observations they apparently no longer do so. In general, the pack ice is the southern limit to the range of *desolata* at sea (Vanhoffen, *in* Murphy 1936; Harper, pers. obs.).

BREEDING CYCLE

Tickell (1962) has produced an excellent breeding-biology study of the Antarctic Prion at the South Orkney Islands. Although the populations of *desolata* are widely separated, their breeding times are similar. The birds return to their breeding stations in late October and re-occupy burrows from early November. Eggs are laid at the

close of December, and the fledglings leave from mid-March to early April. Post-nuptial dispersal begins in early May. The earliest records of fledgling *desolata* on New Zealand shores are in mid-March. Southerly gales drive fledglings ashore on the New Zealand mainland only hours after their first flight from their burrows.

MOULT

Adult *desolata* replace their worn plumage on completion of breeding. Body moult occurs in late March, with the flight feathers being replaced in April and May (Tickell 1962; pers. obs.). Non-breeding birds moult in mid-winter, which helps sort them out from a collection of storm-driven immature *salvini*, the brown faded plumage of *desolata* contrasting strongly with the pale fresh plumage of young *salvini*.

FOOD AND FEEDING

This species has a varied diet. Scotia Sea populations of *desolata* eat crustaceans, in summer, and large numbers of *Euphausia superba* are taken by day (Harper 1972). The stomachs of five *desolata* examined by Ealey (1954) at Heard Island yielded large numbers of the amphipod *Hyperiella antarctica*, with smaller numbers of *H. spinigera* and the pteropod *Clio sulcata*. Ealey considered that the surface amphipod *Euthemisto antarctica* is probably eaten in large quantities by Heard Island *desolata*, and Paulian (1953) found large numbers of *Euthemisto* in a specimen at Kerguelen. Both Falla (1937) and Downes *et al.* (1959) reported prions feeding close inshore at Heard Island. Although feeding mostly from the surface, birds were seen to dive freely with their wings half spread and to disappear from view momentarily beneath the water. Murphy (1936), observing this species offshore from South Georgia, noted "each one would dive out of sight, to emerge quickly a meter or less ahead. They stayed below the surface not more than a fraction of a second except, perhaps, when they shot through the crest of a wave." Cephalopod remains, found in the stomachs of Kerguelen birds (Falla 1937), are also quite frequent in storm-killed birds from New Zealand shores.

EGGS

Clutch one: egg white.

50.5 x 35 mm (Falla 1937) (Kerguelen). Two eggs from Macquarie measure 50.0 x 35 mm and 50.2 x 36 mm (Falla 1937); and three from Cape Denison measure 43.4 x 32.2 mm, 44.2 x 33.0 mm, and 45.9 x 34 mm (McLean, *in* Falla 1937). Length 44.0-52.0 mm (mean 47.1 $\pm$1.77; n = 42); width 31.0-36.5 mm (mean 34.6 $\pm$1.28; n = 42); weight 19.0-36.0 (mean 32.8 $\pm$2.19; n = 23) (Tickell 1962) (Signy I, South Orkneys).

STATUS

The breeding populations of the Antarctic Prion vary geographically in bill profile and facial pattern. These variations are subtle and

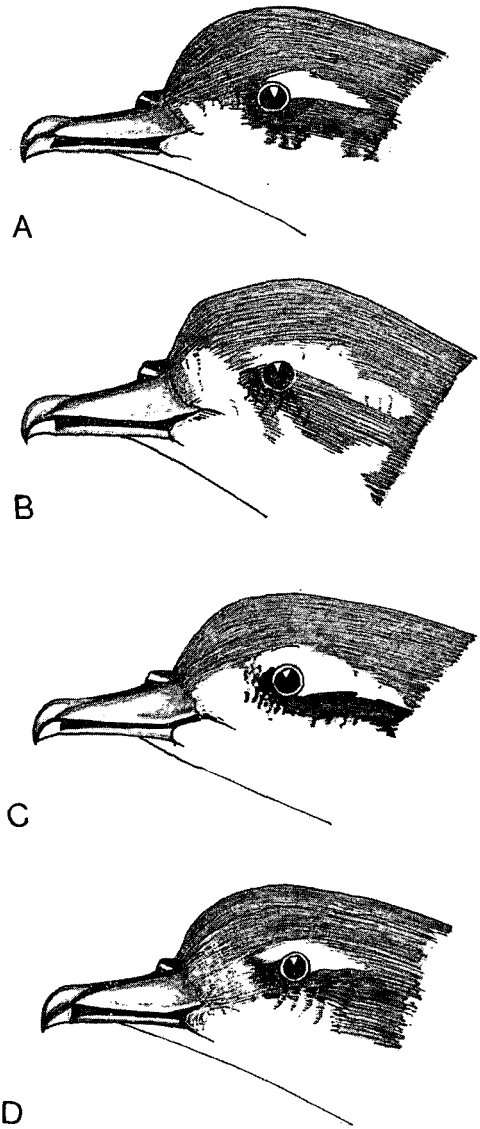

FIGURE 9 — Antarctic Prion, **Pachyptila desolata**, representative examples, drawn to scale.

(a) Adult, Kerguelen Island
(b) Adult, Auckland Islands
(c) Adult, Macquarie Island
(d) Adult, South Atlantic

TABLE 5 — Dimensions (mm) of **Pachyptila desolata.** All dried material.

LOCALITY	AUCKLAND IS	KERGUELEN	MACQUARIE	HEARD	SCOTIA SEA
Number of Specimens	41	40	26	22	18
BILL LENGTH					
Mean & S.E.	26.8 ± 0.1	26.5 ± 0.2	27.2 ± 0.2	27.7 ± 0.2	27.4 ± 0.2
Range	25 - 28.7	25 - 29	25.6 - 28.5	26.7 - 29.8	26.4 - 28.8
BILL WIDTH					
Mean & S.E.	14.1 ± 0.1	13.1 ± 0.1	14.0 ± 0.5	14.3 ± 0.1	14.0 ± 0.2
Range	13.3 - 16	12 - 14.5	12.7 - 14.8	13.4 - 15.2	13.3 - 15.7
WING					
Mean & S. E.	180.8 ± 0.7	185.4 ± 0.7	186.5 ± 1.0	188.7 ± 0.8	191.2 ± 0.9
Range	171 - 197	179 - 197	177 - 200	182 - 195	185 - 199
TAIL					
Mean & S.E.	86.0 ± 0.6	89.4 ± 0.8	89.6 ± 0.9	91.5 ± 0.9	92.2 ± 0.9
Range	79 - 92	82.7 - 100	82 - 96	87 - 100	85 - 98.4

are shown in Figure 9, which is based on a study of live birds and museum material. Tickell (1962) accepts three subspecies: *P. d. desolata, P. d. banksi,* and *P. d. alter.*

The Kerguelen Island population (the nominate subspecies, *P. d. desolata*) has the narrowest bill (Table 5). This feature is regarded by Tickell as a valid subspecific character. The depth of the bill — the distance between the culminicorn and rami with the bill closed (see Fig. 9) — is notably shallow. The lamellae are not visible at the gape, as they are in the other populations. The bill of immature Kerguelen birds is so narrow that it has a similar profile to that of adult *belcheri.*

Kerguelen *desolata* are intermediate in facial pattern between birds from the Australasian region and those from the Scotia Sea. The lores are often tinted with pale blue, with darker barring in front of and below the eye. The suborbital and ear-covert area is dark blue (sometimes fuscous), and the superciliary stripe is moderately distinct (see Fig. 9). The crown feathers are uniformly a shade darker than the upper surface, which is slightly darker than in Auckland Island birds but paler than in Scotia Sea birds. The dark feathering about the gape in Scotia Sea birds is generally not present in Kerguelen or Australasian birds. The remaining contour plumage pattern and the soft-part coloration are the same in all populations.

Kerguelen *desolata* range east of their breeding grounds and are regularly storm driven on to west Australian beaches in winter (Serventy & Whittell 1967; pers. obs.). Further east they are uncommon (South Australia and Victoria) or rare (New Zealand, Harper 1972).

Australasian *desolata* (*P. d. macquariensis* Mathews, 1912, a name that has priority over *P. d. alter,* according to Condon 1975) have predominantly white lores and a comparatively large superciliary stripe. The effect of the latter is partly masked in Auckland Island birds by the consistently pale crown and suborbital patch. Macquarie birds have a conspicuous suborbital stripe which accents the white lores and cheeks (Fig. 9; also Fig. 60 in Serventy *et al.* 1971). Their plumage is slightly darker than in Auckland Island birds, particularly on the crown. Referring to this subspecies as *alter* (Mathews 1912), Tickell remarks, " This sub-species is tenable solely on the grounds of its short tail." The tail measurements supplied to Tickell by the late Sir Robert Falla were in error, however, and were consistently some 10-12 mm short (R. A. Falla, pers. comm.; pers. obs.).

The bill of Auckland I. birds is broad and the latericorn edges have a distinctly bowed appearance, as in *salvini,* when viewed from above (Fig. 7). Macquarie I. birds have on average less deep bills and vary more in bill width; in bill structure Macquarie I. birds are intermediate between the Auckland Island and Kerguelen populations.

Immature Australasian *desolata* are notable for their white lores

and pale plumage. They occur regularly on southern beaches of New Zealand and Australia from late March through the winter months.

Scotia Sea and Heard Island birds (*P. d. banski* Smith, 1840) are often the darkest of the *desolata* populations. In adults the lores are often mottled with sooty feathers in the form of vertical barring in front of the eye. The black suborbital ear-covert marking is pronounced, particularly in Heard Island birds, being either boldly barred or a broad black stripe. The crown is generally dark also, particularly in the Scotia Sea populations. There is often dark feathering about the gape.

The bill is broad and deep, with the tumescent nature of the plates particularly evident in Heard Island specimens, and the small lamellae are often visible near the gape.

Immatures are paler than adults, and although their bills shrink in the usual way, they cannot be confused with adult *belcheri.*

Examples of *P. d. banksi* are rare from Australasian beaches; the occasional bird blown to New Zealand shores is probably from Heard Island.

Kinsky & Harper (1968) drew attention to the shrinkage of *Pachyptila* bills when museum skins dry. When dealing with the currently recognised *desolata* subspecies, shrinkage is sufficient to change significantly the bill and tail measurements between fresh and dried material. For example, 18 specimens of Antarctic Prion I collected in the Scotia Sea in 1966 were remeasured 6 years later with the results shown in Table 6.

TABLE 6 — Shrinkage of 18 Antarctic Prion specimens.

	n	Bill length	Bill width	Wing length	Tail length
Fresh	18	28.06 ± 0.2	14.61 + 0.15	190.61 ± 1.1	96.64 ± 0.71
Dried	18	27.38 ± 0.2	14.00 ± 0.15	191.17 ± 1.1	92.17 ± 0.91
		(P < 97%)	(P < 99%)	(NS)	(P < 99%)

These data show that the difference in bill width caused by shrinkage is comparable with the difference between the nominal subspecies (e.g. between the Kerguelen *P. d. desolata* and the Macquarie Island *P. d. macquariensis*). Note also the highly significant change in the tail measurements. Australasian and Scotia Sea/Heard Island *desolata* also cannot be distinguished by their bill dimensions (Table 5). Although the wing and tail dimensions of Auckland Island birds average slightly smaller than those of other *desolata* populations, these are too weak to be regarded as a valid subspecific distinction.

To be both convenient and useful, named subspecies should differ from each other in easily observable characteristics. As is well known, the degree of intergradation between the *desolata* populations can frustrate attempts to assign a beach specimen to a particular subspecies. The reality of this problem is clearly demonstrated in Table 5.

I am therefore extremely reluctant to retain any of the three subspecies of *desolata* now recognised, particularly when so many workers experience difficulty at the species let alone the subspecific level (between *desolata* and *salvini,* for example). Antarctic Prions with narrow bills that are cast ashore are quite likely to be from Kerguelen Islands, but some individuals I collected in the Scotia Sea are identical to Kerguelen birds in nearly every respect. In Australasia, where *P. d. banksi* is rare and the prevailing winds bring many Indian Ocean petrels ashore, one can expect Kerguelen *desolata* to become storm victims, particularly on the west coast of Australia (Harper 1972). In South America, however, the situation could be much more complicated.

In view of this uncertainty, and for the sake of practicality, I suggest that *Pachyptila desolata* be recognised only as showing some interesting geographical variation. If, however, my observations on phenotypic variation can be shown to be of practical use in discriminating birds from different populations, I would be happy to accept any or all of the three nominal subspecies of *desolata* as valid.

THIN-BILLED PRION

Pachyptila belcheri (Mathews, 1912)

Material examined: 427 beach specimens from New Zealand, Australia and South America; 85 skins from Kerguelen and the Falklands.

Observations: Many sightings in the South Pacific; **Eltanin** cruises 20, 21, 23 & 27; South Atlantic; cruise 22.

DESCRIPTION OF ADULT

P. belcheri is one of the smaller species with a narrow bill, a conspicuous facial pattern, and a pastel-blue upper surface appreciably paler than that of other *Pachyptila.*

The maxillary latericorns are straight sided and the unguis is only weakly developed. Bill lamellae are absent. Between the unguis and the nasal tubes, the culminicorn measures no less than 8.3 mm, usually about 9.2 mm. This is a useful point for distinguishing *belcheri* from *turtur* (mean 5.1 mm; range 4.2-6.0 mm).

The white lores and white superciliary stripe are conspicuous, and the suborbital patch is small and diffusely pigmented with dark blue or black. The crown of Kerguelen birds is often pale, whereas 60% of 71 Falkland birds examined showed a variable amount of dark crown feathering.

The open-M marking across the wings is narrow and ill defined, and the central tail feathers are more narrowly tipped black than in other *Pachyptila*. Body upperparts are pastel blue and have no prominent half-collar over the neck.

Underparts white; feet lavendar blue, webs creamy yellow.

TABLE 7 — Dimensions (mm) of **Pachyptila belcheri.**

	KERGUELEN I. (adult birds)	FALKLAND I. (adult birds)	NEW ZEALAND (immature beach specimens)
BILL LENGTH			
Mean & S.E.	(14) 25.2 ± 0.2	(71) 25.0 ± 0.1	(45) 24.6 ± 0.1
Range	24.6 - 27	23.4 - 27.6	23 - 26
BILL WIDTH			
Mean & S.E.	(14) 11.1 ± 0.1	(71) 10.3 ± 0.1	(45) 10.4 ± 0.1
Range	10.5 - 12	9 - 11.5	9.3 - 11.5
WING LENGTH			
Mean & S.E.	(14) 181.1 ± 1.1	(71) 183.1 ± 0.4	(45) 177.3 ± 0.7
Range	175 - 187	175 - 191	166 - 190
TAIL LENGTH			
Mean & S.E.	(14) 89.3 ± 1.3	(71) 87.0 ± 0.4	(45) 82.2 ± 0.7
Range	82 - 95	81 - 96	74 - 93

The Kerguelen and Falklands material is dried; New Zealand material is fresh - some shrinkage will occur (see text).

IMMATURES

Immature *belcheri* are paler overall than the adults. After death, the bill width shrinks about 8.4%. For example, 20 fresh birds gave a mean and S.E. of 10.4 ± 0.1 mm (range 9.3-11.5); the same birds after drying, 9.5 ± 0.1 mm (range 8 to 11 mm).

FIELD CHARACTERS

The white facial appearance, pale plumage, poorly defined wing markings, and small black tail-bar distinguish this species (Fig. 11 and Harper 1972: Fig. 3).

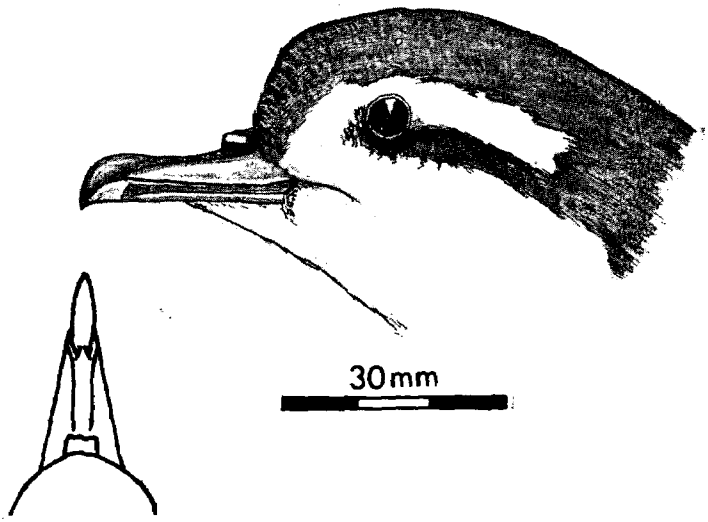

FIGURE 10 — Headparts of the Thin-billed Prion, **Pachyptila belcheri.**

DISTRIBUTION

The Thin-billed Prion breeds at Kerguelen and East Islands (Indian Ocean) and at the Falklands (South Atlantic). Although its breeding distribution is confined to high-subantarctic islands, it is common in Antarctic waters, especially in the Pacific and Indian Oceans.

After the summer breeding cycle, Thin-billed Prions migrate eastward (and probably westward) from Kerguelen in March. Adults are cast ashore on west Australian beaches from May to September, while younger birds travel further east. Immatures have been reported from the Kermadecs, Java, and Campbell Island, and are commonly wrecked in winter on the beaches of the New Zealand mainland.

Falkland Island birds migrate westward into polar waters of the South Pacific, where they remain as the most abundant prion. They do not appear to disperse far enough to the west to reach New Zealand (Harper 1972: Fig. 11).

BREEDING CYCLE

At the Kerguelen Archipelago, where the landform is mountainous and deeply dissected with fiords, *belcheri* is an abundant breeder. Falla (1937) found many deeply tunnelled earth burrows in the more sheltered areas, such as Bossiere Arm in Royal Sound. At the Falklands, *belcheri* breeds on several of the outlying islands without mammalian predators (Cawkell & Hamilton 1961). Burrows occur in peat and sand and under rocks or clumps of tussock grass. Dried

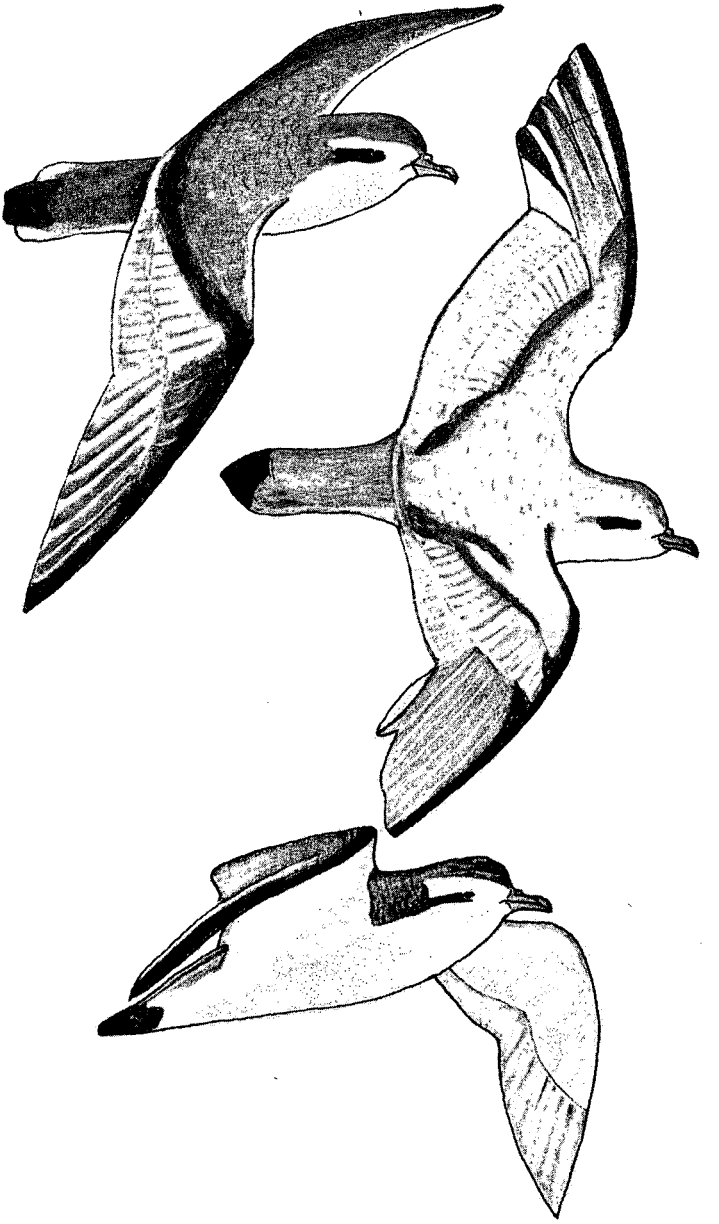

FIGURE 11 — Thin-billed Prions in flight (adapted from photographs), Pacific, 1966.

grass and feathers support the egg in a nesting chamber, which occasionally may be 3 m from the burrow's entrance.

Falkland *belcheri* nest at low altitudes (under 190 m). On East Island, Despin *et al.* (1972) found a *belcheri* colony comprising only a few nests on a volcanic plateau approximately 300 m above the sea.

Fragmentary data from these three populations suggest a similar reproductive timetable. Birds arrive at the islands toward the end of September, and eggs are laid about 10 November. Hatching occurs in the first two weeks of January, and the main exodus of fledglings takes place from mid-February to early March. The earliest New Zealand record of a fledgling, probably from Kerguelen or East Island, is 21 May. As noted by Despin *et al.* (1972), the breeding schedule of *belcheri* coincides with that of *P. salvini*, a fact which might explain why *belcheri* is so rare on East Island, where *salvini* is vastly abundant, and perhaps why *salvini* does not breed at Kerguelen, where *belcheri* predominates.

MOULT

Sub-mature birds of the Falkland populations moult in South Pacific Antarctic waters in December (Harper 1972). Adults begin moulting in March and are in new plumage by May.

FOOD AND FEEDING

Food consists of amphipods, pteropods, small fishes, and squid, all taken at night (see Harper 1972).

EGGS

Clutch one; egg white, ovoid.

50 x 36 mm, 49.5 x 35.5 mm, 46 x 34 mm, 47.7 x 34.2 mm Kerguelen (Falla 1937).

46.0 x 33 mm, 51.1 x 36.2 mm East I. (Despin *et al.* 1972).

STATUS

There are no subspecies of *belcheri*. Of 71 birds examined from the Falkland Islands, 58 were darker on the crown and about the eye than the Kerguelen birds examined. This darkening results in a heightened contrast between the white superciliary stripe and the surrounding facial features. Such colour differences between Atlantic and Indian Ocean *belcheri* is also apparent in like populations of *desolata*.

Kerguelen *belcheri* have a slightly shorter bill, with less variance about the mean. Falkland birds are more variable — the largest bill measured was 27.6 x 11.5 mm and the smallest 23.4 x 10.5 mm. Both birds were adult males with enlarged testes taken by Rollo Beck off the Falkland Islands on 10 September 1915. The smaller bill is like that of some *turtur*, but the distance between the unguis and the nasal tubes, the diagnostic facial pattern, and the small black tail bar readily distinguish the bird from *turtur*.

FAIRY PRION

Pachyptila turtur (Kuhl, 1820)

Material examined: 3710 beach specimens and 471 birds representing all breeding localities except Hog Island.

Observations: **Eltanin** cruises 16, 20, 23, 26-28; many observations in New Zealand.

DESCRIPTION OF ADULT

One of the smaller *Pachyptila,* the Fairy Prion is conspicuous for its short rather robust bill, lack of any head pattern, and prominent wing and tail markings. The blue bill is 20-25 mm long by 10-12 mm wide. The distance between the nasal tubes and the moderately developed unguis is 4.2-6.0 mm (mean 5.1) — much shorter than the 8.3 mm of the smallest-billed example of *belcheri,* but not as short as the 2-4 mm of the very robust-billed Fulmar Prion. The small latericorns are usually straight sided, occasionally slightly convex; the maxilla lacks lamellae. The iris is sepia brown.

The facial appearance of the Fairy Prion is indistinct. The whiteness of the lores is shadowed by blue pigment or darker mottling in front of the eye. Often the lores are entirely washed with pale blue pigment. The superciliary is small and diffuse, often shaded behind the eye with grey. The crown is chiefly bluish grey like the mantle feathers, although the larger-billed populations have variable darkening of the crown and the smaller-billed birds of cooler waters are consistently much paler.

The open-M marking across the wings is broad, dark, and distinctive, and remains so despite wear and fading. The black tail-bar is 35-45 mm wide (mean 40 mm) on the central rectrices (Fig. 13), 25% broader than that of the other species. The Fairy Prion and Fulmar Prion *(P. crassirostris)* are the only two to have the tips of the long uppertail coverts consistently smudged with black.

IMMATURES

Immature *turtur* are paler than the adults and have weaker bills that shrink on drying. Fledglings storm-wrecked on their first flight occasionally have their wing coverts, tails, and crowns extremely worn from the birds' movement in their rock crevices before they leave the breeding grounds. The webs of the feet in young birds are a darker grey than those of the adults.

FIELD CHARACTERS

Identification characters are the well-marked wing and tail patterns, which, unlike *belcheri,* contrast strongly with the pale indistinct facial pattern. The small bill is readily discernible at close range. The buoyant flight and the body profile of *turtur* are reminiscent of *belcheri.*

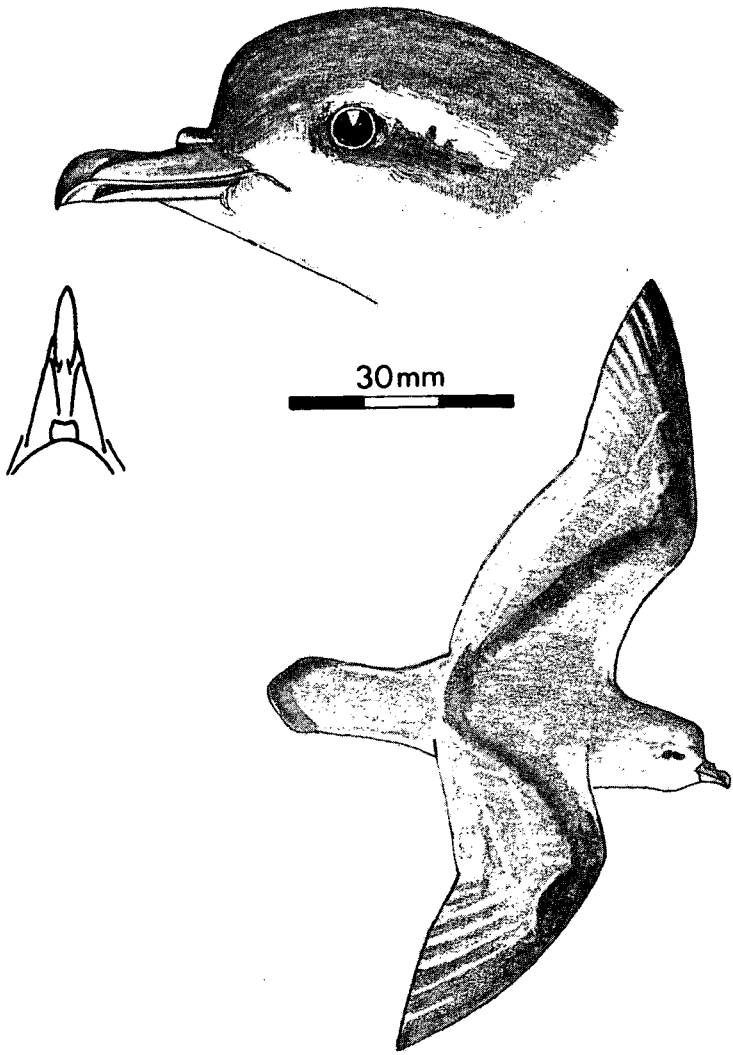

FIGURE 12 — Fairy Prion, **Pachyptila turtur**; headparts and bird in flight (adapted from photograph).

DISTRIBUTION

The Fairy Prion is circumpolar in its distribution. Centres of abundance are the subtropical waters of the Indian Ocean, about New Zealand, and off the south-eastern coasts of Australia. It is common in the Tasman Sea in summer, and probably frequents all these subtropical waters during its winter absence from the breeding grounds. An adult banded at Stephens Island (Cook Strait) in September 1966 was recovered in the feeding roost of a Peregrine Falcon *(Falco peregrinus)* 300 km south of Sydney at Montagu I. on 1 December 1967 (Robertson 1968).

I have seen examples of the small southern subspecies *(subantarctica)* during the *Eltanin's* 1967 summer voyage over the Campbell Plateau. The majority were near the Antipodes Islands and further south-west in waters adjacent to Macquarie, in January and February. However, beyond the vicinity of these islands they were rarely encountered.

Ten specimens of the Subantarctic Fairy Prion from New Zealand's west coast beaches suggest that some northward dispersal

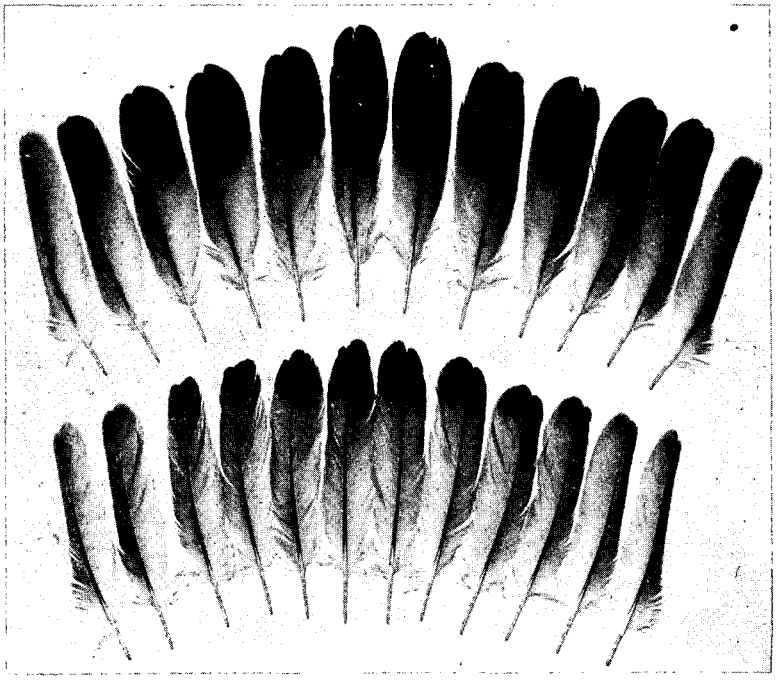

FIGURE 13 — Tail feathers of **turtur** (above) and **belcheri** (below). Note the characteristically darker tips to the rectrices of **turtur** (and **crassirostris**) as compared to **belcheri** (and **vittata, salvini, desolata**). An excellent identification aid both at sea and for birds in the hand.

occurs in winter, but the extent of this subspecies' winter distribution is unknown. Beach patrollers in Australasia should carefully check their hauls of storm-driven Fairy Prions for examples of this distinctively short-billed and pale subspecies (see below).

BREEDING CYCLE

Many offshore islands about the New Zealand and southern Australian coasts are breeding localities for the Fairy Prion (Kinsky 1970, Condon 1975). The species breeds either in burrows 0.5-1 m long or in rock crevices and caves. Most populations are large. On Hog Island, for example, Fairy Prions nest in dozens of millions (Derenne & Mougin 1976).

A seasonal cline in the timing of the breeding season occurs in New Zealand. At the northernmost breeding station, the Poor Knights Islands (35°30'S 174°44'E), eggs are laid in mid-October. Hatching occurs during the last days of November, and the fledglings depart in early January (Harper 1976). At Whero (46°55'S 168°12'E), eggs are laid from 3 November to 5 December (mean 16 November), and hatching occurs some 45 days later — 18 December to 19 January (mean 31 December). Departure dates, according to Richdale (1965), are from 6 February to 10 March (mean of 1941 season, 16 February; of 1949 season, 20 February).

Strange's (1968) mention of several young downy chicks on 5 January 1967 at Beauchene I. (Falklands) and observations from the Crozets (Derenne & Mougin 1976) suggest a breeding schedule similar to that of *turtur* on Whero, but confirmation is needed.

A chick which hatched on 31 December 1944 was recovered by Richdale breeding in a burrow 42.4 m from its natal burrow on 5 January 1950. I have recovered a chick breeding within 15 m of its burrow of birth 4 years later in 1977 (Poor Knights). No further recoveries by Richdale at Whero or by myself at the Poor Knights suggests a high mortality of fledglings during the 4-5 years before they first breed. Wrecks of large numbers of fledgling *turtur* are common in New Zealand during the windy weeks of late January to mid-February when the inexperienced prions are trying to find food.

MOULT

Feather replacement begins with a body moult before the adults leave the breeding grounds in January and February, and is completed with renewal of the primaries and rectrices by the end of June. New plumage and a down-covered brood patch are attained by most birds in July; slight wear becomes evident in August. I saw Subantarctic Fairy Prions in wing moult near the Antipodes on 3 January 1967. These were probably non-breeding birds undergoing an early moult, in a similar manner to *belcheri* in mid-Pacific (see Harper 1972). Birds in full moult are rarely seen on New Zealand beaches in winter; but an adult male in full tail moult was collected from Palliser Bay beach on 23 March 1974 and another was collected in mid-Tasman on 1 June

1963 (National Museum No. DM 10057). This bird was a submature female.

FOOD AND FEEDING

Fairy Prions use a dipping or surface-pursuit flight behaviour to catch their food, chiefly planktonic crustaceans. Stomach contents of Poor Knights *turtur* during the October-January breeding season show a predominance of *Nyctiphanes australis* and *Parathemisto gracilipes* (Harper 1976). Squid beaks occur in the stomachs of storm-killed birds. The winter diet is more varied; cephalopod beaks occur in the gizzards of storm-driven birds.

EGGS

Clutch one; egg white, dull.

TABLE 8 — Egg data for **Pachyptila turtur.**

	Number	Mean ± S.E.	Range	
Length (mm)	55	43.86 ± 0.2	38.5 - 45.9	Poor Knights
Width (mm)	55	31.41 ± 0.1	27.8 - 33.2	Is (Harper
Weight (g)	23	22.21 ± 0.3	18.5 - 25.0	1976)
Length (mm)	15	44.7 ± 0.6	41.5 - 48.0	Motunau I.
Width (mm)	15	32.4 ± 0.3	30.0 - 34.0	(Taylor 1967)
Length (mm)	100	45.1 ± 0.2	40.5 - 48.5	Whero I.
Width (mm)	100	32.6 ± 0.1	29.0 - 34.5	(Richdale
Weight (g)	56	24.2 ± 0.4	18.3 - 29.3	1965)

STATUS

Because New Zealand *turtur* have a latitudinal breeding range exceeding 1200 km, it is perhaps inevitable that earlier workers should have made ecogeographical differences in bill morphology into subspecific features. Mathews and his co-workers recognised at least nine subspecies — see Condon (1975) for the list of synonyms. Such differences in bill size in *turtur* agree well with Allen's well-known rule to the effect that, in warm-blooded animals, protruding body parts tend to be shorter relative to body size in races that live in cold

TABLE 9 — Dimensions (mm) of **Pachyptila turtur.** (Numbers of birds in brackets.)

	POOR KNIGHTS	COOK STRAIT	MOTUNAU	CHATHAMS	*WHERO (Richdale 1965)	(Derenne & Mougin 1976)	subantarctica +
BILL LENGTH							
Mean & S.E.	(29) 23.2±0.1	(23) 22.7±0.2	(13) 22.8±0.2	(6) 22.0±0.5	(100) 22.1±0.1	(27) 22.1±0.25	(18) 20.9±0.1
Range	22.5-25.2	21.1-24.9	21.0-24.2	20.4-23.5	20-24	(27) 20-26	19.8-21.9
BILL WIDTH							
Mean and S.E.	11.7±0.1	11.3±0.1	11.5±0.1	11.3±0.3	10.9±0.1	(18) 11.4±0.21	10.4±0.1
Range	11-12.5	10.4-12.2	11-12.2	10.7-12.3	10-12	10.5-12.2	10-11.5
WING LENGTH							
Mean and S.E.	181.3±1.5	179.7±1.1	183.7±1.1	185.6±2.1	182.5±0.3	(27) 179±0.9	178.6±1.2
Range	171-190	170-191	176-189	179-194	175-191	168-185	169-184
TAIL LENGTH							
Mean & S.E.	89.6±0.9	85.8±1.1	86.5±0.6	91.5±1.4	91.7±0.3	N.D.	88.9±1.5
Range	82-94	78-94	84.5-90	87-95	86-98		80-99
WEIGHT (g)							
Mean & S.E.	(see Harper 1976)				131.8±1.4	(24) 132±1.7	
Range	96-166				92-162	120-155	

* Fresh material; others dried. Allow for shrinkage when comparing the data.

\+ Material from the Snares, Antipodes, Campbell, Big South Cape Islands.

climates than in those living in warm climates (e.g. Dobzhansky *et al.* 1977).

Unlike *crassirostris,* Fairy Prions are apparently not sexually dimorphic. Table 10 shows a random sample of storm-killed *turtur* taken from New Zealand over various months and years.

On the material available, I suggest that a single subspecies of *Pachyptila turtur* be retained — namely, Oliver's (1955) *subantarctica,* which he called Subantarctic Fairy Prion. Hence:

Pachyptila turtur turtur — Fairy Prion
Breeding on many New Zealand offshore islands from the Poor Knights to Foveaux Strait; also at the Chathams, islands in Bass Strait (Condon 1975), and at the Falkland Islands (Strange 1968).

Pachyptila turtur subantarctica — Subantarctic Fairy Prion
Breeding Antipodes (type locality; see Fig. 14), Big South Cape, and The Snares; also possibly on outliers of Macquarie.

Oliver's description of this race includes the much smaller bill (see Table 9), and that it is " identical " in colour to *P. t. turtur* of New Zealand. Were that so, I would have been diffident about recognising its status. However, in addition to its small beak *subantarctica* has consistently paler plumage than populations of *turtur* nesting north of the Subtropical Convergence, making it easy to identify in the hand. It normally lacks dark feathering on the forehead and crown and is very pale about the face. Its dark wing and tail markings are thus emphasised as in *crassirostris,* which it closely resembles in plumage, although the bill profiles are completely different.

In discussing *turtur* at the Antipodes Islands, Warham & Bell (1979) state: " Oliver (1955) referred to a bird taken at the island on 31 July 1924 which he made the type of subspecies *subantarctica* on account of its small and deep bill, and he also stated that those brought back in 1950 were similar. It appears, however, that the smaller, shorter bill of this bird was that of a shrunken juvenile and that *subantarctica* is not a valid subspecies (R. A. Falla, pers. comm.)."

This statement requires clarification. The Antipodes holotype (AV3244) collected on 31 July 1924 is at present held at the Canterbury Museum where I have had the opportunity to examine it. The bird is an adult male. Oliver's (1930) original subspecific designation of *P. t. fallai* for the Subantarctic Fairy Prion, is based on an Otago beach specimen (AV209.22). This bird is a juvenile of the nominate race. Hence, *P. turtur fallai* belongs in synonomy with *P. turtur turtur,* while the name *P. t. subantarctica* remains valid.

Two birds collected at the Antipodes on 23 November 1978 are unusual in that both have conspicuous white superciliary stripes exactly as *belcheri.* In other morphological features they agree with typical *turtur subantarctica.* I shall mention here a curious specimen of *desolata* collected by R. A. Falla from the beach of Campbell Island.

TABLE 10 — Dimensions (mm) of beach specimens of **Pachyptila turtur** in New Zealand (fresh material).

	BILL LENGTH	BILL WIDTH	WING LENGTH	TAIL LENGTH
69 females	22.80±0.1	11.55±0.7	180.8±0.7	88.9±0.5
50 females	22.63±0.1	11.23±0.7	180.8±0.7	89.9±0.6

No significant variation ($P < 95\%$) exists between the above data.

This bird is also notable for a conspicuous eye stripe and a bill morphology intermediate between *desolata* and *belcheri*.

These disconcerting specimens suggest that either some interbreeding and/or hybridisation between species of *Pachyptila* occasionally occurs, or that a particular phenotype usually belonging to another species can appear from a genetic hiccup. Hence, dominant or alternative allelic genotypes, which are expressed normally as a conspicuous

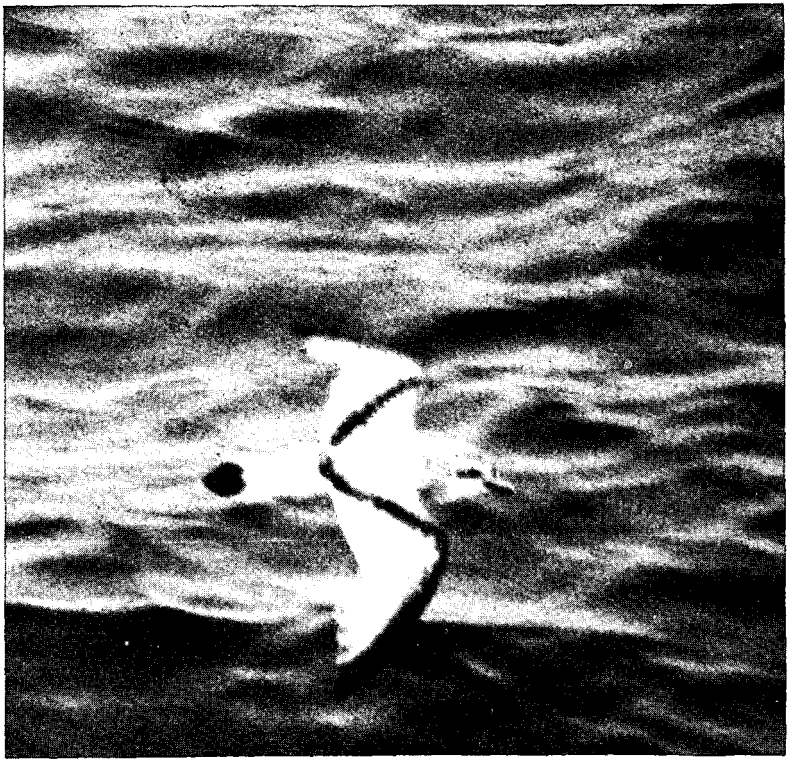

FIGURE 14 — A Subantarctic Fairy Prion (**P. turtur subantarctica**) photographed off the Antipodes Islands, 3 February 1967.

facial pattern in *belcheri* and the opposite in *turtur*, are switched by genetic error. One or both of these alternatives together probably occur within the enormous number of matings that take place in *Pachyptila* each breeding season.

FULMAR PRION

Pachyptila crassirostris (Mathews, 1912)

Material examined: 60 skins from breeding localities; 2 beached adults from Lyall Bay and Petone (Wellington); skeletal material from the Chatham Islands.

Observations: Subtropical waters near Stewart Island (**Eltanin** cruises 16 and 27); near the Chatham Islands, cruise 23.

DESCRIPTION OF ADULT

The Fulmar Prion closely resembles the much more abundant Fairy Prion in size, body proportions, and general coloration. However, it has a very stout bill which is strongly tumescent in both width and depth to an extent not approached by even the largest *turtur* (Fig. 15). The conspicuous maxillary unguis is strongly developed in both sexes, and it terminates at an average of 3.4 mm (range 2.0-4.0) from the nasal tubes (cf. 5.1 mm, range 4.2-6.0 in *turtur*). The bill is also characteristically wider (Tables 9 and 11). Fulmar Prions are unique among the *Pachyptila* in being sexually dimorphic in bill structure. The female has a consistently smaller beak (Fig. 15).

The head pattern of *crassirostris* is the palest and least distinct of any *Pachyptila*. The superciliary is barely apparent, and the usual *Pachyptila* suborbital patch of dark feathering is represented by only a trace of dark shading in front of the eye.

The open-M marking across the wings and the broad band of black pigment terminating the tail feathers are particularly conspicuous. The flanks are often barred with blue.

Feet wedgewood blue, webs pale flesh; claws dusky brown.

IMMATURES

The bill plates of young *crassirostris* do not shrink on drying to the same extent as in other species of *Pachyptila*. Epidermal shrinkage of the bill and feet are useful external indicators of a young specimen.

FIELD CHARACTERS

The black tail bar is the most conspicuous feature of *crassirostris* at sea; it is the broadest of all in prions. Conspicuous also is the Fulmar Prion's well-defined wing pattern and contrasting lack of any head pattern.

On the wing, *crassirostris* is particularly agile with a very fast looping flight pattern. I observed this peculiar characteristic both near Stewart Island in early 1965 and again off the Chathams in 1967.

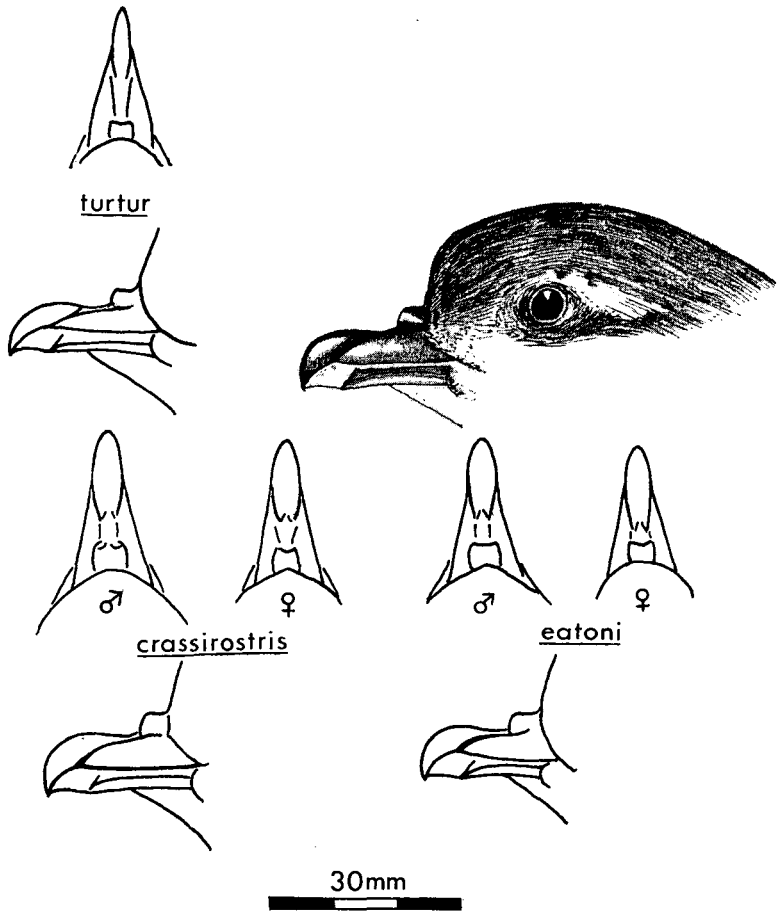

FIGURE 15 — Headparts and bill profiles of the Fulmar Prion. A bill of **turtur** is shown for comparison.

In exceptional circumstances the stocky bill can be discerned with binoculars.

DISTRIBUTION

The nominate race of *crassirostris* breeds in the New Zealand region only, at the Chatham Islands, The Snares, and Bounty Islands. The smaller subspecies, *eatoni,* nests in the lava cliffs of Heard Island and in small numbers at the Auckland Islands. Mathews & Hallstrom (1943) gave measurements of a pair of birds from the Antipodes

Islands, but recent visits have failed to confirm that this species is a breeding resident. It may breed in the rock crevices of Bollon's Island (R. A. Falla, pers. comm.). The status of the Fulmar Prion at the Falkland Islands also requires clarification.

Like its larger subtropical relative *vittata,* the Fulmar Prion appears to be sedentary about its breeding grounds throughout the year. Some local movement of birds in winter along the Subtropical Convergence appears likely, but this requires confirmation. The conspicuous lack of storm-driven birds from the prevailing westerly winds in New Zealand suggests that few, if any, Fulmar Prions enter the Tasman Sea from New Zealand breeding stations.

BREEDING CYCLE

Fulmar Prions lay their eggs in crevices with ready access to the sea or in the innumerable cracks and crannies afforded them by

TABLE 11 — Dimensions (mm) of **Pachyptila crassirostris.**

	CHATHAMS		BOUNTYS	
BILL LENGTH	11 males	23.52 ± 0.3 *	12 males	22.9 ± 0.2 *
	10 females	22.50 ± 0.4	11 females	22.16 ± 0.3
UNGUIS	10 males	5.47 ± 0.06	18 males	5.02 ± 0.07
WIDTH	10 females	5.31 ± 0.08	17 females	4.86 ± 0.06
BILL WIDTH	11 males	12.65 ± 0.2 *	12 males	11.42 ± 0.1
	10 females	12.23 ± 0.1 *	10 females	11.41 ± 0.1
WING	11 males	192.9 ± 1.4	12 males	185.8 ± 1.5
	10 females	192.6 ± 2.0	11 females	184.8 ± 0.9
TAIL	11 males	97.7 ± 0.7 *	8 males	88.9 + 1.2
	10 females	97.7 ± 1.8	9 females	90.7 ± 1.4

* $P < 95\%$

lava cliffs or steep screes. On Pyramid Rock (Chathams), Fleming (1939) found holes excavated by Fulmar Prions beneath nests of the Chatham Island Mollymawk *(Diomedea cauta eremita).* On The Snares and Bounty Islands, Fulmar Prions are unusual in visiting their nest crevices during the day (Fleming & Baker 1973), a marked contrast with *Pachyptila* species nesting in soil burrows in areas of high predation pressure. A facility of *crassirostris* for quick entry to and departure from their concealed nest sites, together with a lack of places where an avian predator could perch nearby, might be factors

explaining this daytime activity. Fulmar Prions sometimes rise as a flock to mob skuas flying over the prions' nesting crevices.

Data on the reproductive schedule are sparse. Eggs appear to be laid in early November at Heard Island (Downes *et al.* 1959), where hatching occurs from late December to early January. Fledged chicks leave their nests in mid-February. Cursory observations in the New Zealand region suggest a similar schedule.

FOOD AND FEEDING

Ealey's (1954) detailed stomach-content analysis of 38 Heard Island *eatoni* led him to suggest that " there is a seasonal variation in the diet of this species, which probably depends on the availability of different plankton species. Remains of the pteropod *Clio sulcata* Pfeffer can easily be identified by the presence of chitinous hook sacs which they do not digest. *C. sulcata* formed the main part of the stomach contents of Fulmar Prions during June and July but were not found after August. *Euthemista* and occasional *Hyperia spinigera, Vibillia armata* Bovallius and *Hyperiella antarctica* Bovallius were eaten during this period also. During September all Fulmar Prions taken contained large numbers of *H. antarctica* and an occasional example of the other amphipods mentioned. No further material was available until the following January and February, when the stomachs were distended with *Euthemisto.* In June and July, when 80 large animals could be found in a single stomach, the prions had apparently been feeding on breeding swarms, but in January and February as many as 500 or 600 smaller individuals could be extracted from one bird. These latter were probably maturing juveniles. Other organisms, occasionally eaten by these birds, are the amphipod *Tryphosella barbatipes* (Stebbing) and the mysid *Boreomysis rostrata* (Illig.). Remains of a small fish were found in one bird." The undigested state of the food taken from birds returning to their roost sites at dusk, as compared to the near empty stomachs of birds at dawn, suggested to Ealey that " for the part of the year they were studied, Fulmar Prions feed only during the day."

STATUS

Three subspecies are at present recognised: *crassirostris* (Mathews 1912), *eatoni* (Mathews 1912), and *pyramidalis* (Fleming 1939).

In describing *pyramidalis* from the Chathams, (the holotype, AU 14082, is an adult male), Fleming expressed his concern at the small number of specimens available to him in 1939 (two skins and nine heads) but remarked " I feel sure further material will establish the distinction made " (Fleming 1939). In the intervening 40 years the number of Chatham Islands skins has grown to 21, enabling a tentative reassessment to be made.

A comparison between 21 *pyramidalis* from the Chathams and 21 *crassirostris* from the Bounty Islands shows no substantive difference

TABLE 12 — Dimensions (mm) of **Pachyptila crassirostris** subspecies.

	P. c. crassirostris[1]		P. c. eatoni	
BILL LENGTH	20 males	23.4 ± 0.2 *	6 males	20.8 ± 0.2
		22.2 - 24.7		20.4 - 21.6
	20 females	22.2 ± 0.2 *	3 females	19.8 ± 0.4
		20.4 - 23.9		19 - 20.3
WIDTH OF UNGUIS	18 males	5.38 ± 0.06 *	6 males	5.06 ± 0.05
		5 - 5.7		4.9 - 5.2
	17 females	5.17 ± 0.07	3 females	4.76 ± 0.09
		4.8 - 5.7		4.6 - 4.9
BILL WIDTH	20 males	12.1 ± 0.2 *	6 males	10.7 ± 0.05
		10.8 - 14.7		10.5 - 10.8
	20 females	11.9 ± 0.2 *	3 females	10.2 ± 0.13
		10.5 - 13.4		9.9 - 10.3
WING	21 males	191.6 ± 1.2 *	6 males	180.0 ± 1.9
		180 - 201		175 - 187
	19 females	189.5 ± 1.4 *	3 females	179.5 ± 0.3
		181 - 203		179 - 180
TAIL	20 males	94.7 ± 1.2 *	5 males	91.2 ± 1.1
		81 - 102		90.4 - 94.5
	18 females	94.7 ± 1.4	3 females	91.3 ± 0.3
		88 - 107		91 - 92

[1] data from Chathams, Bounty and Snares Islands

* $p < 95\%$

in plumage pattern or coloration. Dimensions do differ, however (Table 11). The situation may be summarised as follows.

1. In both populations the males have longer bills than the females ($P < 95\%$). Males in both populations have, on average, a wider unguis than the females. The bill of Chatham I. birds is significantly wider ($P < 95\%$) than that of Bounty Island birds.
2. The differences between the sexes are as significant as the differences between the two populations.

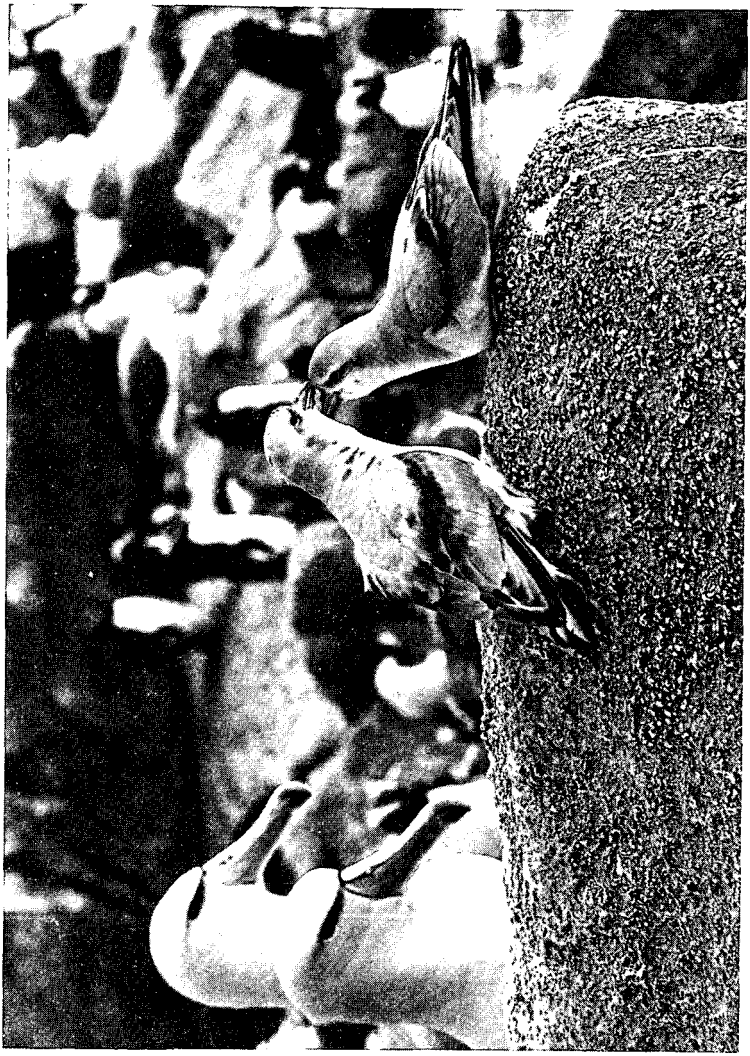

FIGURE 16 — Fulmar Prions at the Bounty Islands. Photo: Evening Post

Although the Bounty Island birds have narrower bills than their equivalents at the Chathams, the present information does not support the retention of *pyramidalis* as a tenable subspecies. If it were retained we would have little alternative but to recognise several subspecies in *Pachyptila turtur* also. This proposition is clearly unacceptable. I therefore recommend that Fleming's subspecies *pyramidalis* be absorbed into synonymy.

In Table 12 three populations of *P. crassirostris* (Chatham Islands, n = 20; Bounty Islands, n = 21; The Snares, n = 2) are compared dimensionally with nine specimens of *P. c. eatoni* from the Auckland Islands. Here, a clear distinction is apparent, despite the limited amount of material — *eatoni* is a smaller bird in all dimensions. It is likely that Heard Island birds are consistent with *eatoni* (Falla 1937), but more information is required to confirm this.

COMPARISON OF *crassirostris* AND *turtur*

These two species can be readily distinguished using the following criteria:

1. *P. crassirostris* has a much more robust bill (Fig. 15).
2. The distance of the culminicorn (between the unguis and nasal tubes) is 2-4 mm (average 3.4) in *crassirostris* and 4.2-6 mm (average 5.1 mm) in *turtur*.
3. The unguis width at its widest point is over 4.6 mm in *crassirostris* (range 4.6-5.7) and less than 4.4 (range 3.3-4.4) in *turtur*.
4. The black tail bar is more conspicuous on *crassirostris* than *turtur:* the second innermost tail feather is consistently shaded with black over much of the distal part of the outer web in *crassirostris,* whereas only a small black terminal smudge on the outer web is apparent in *turtur*.
5. *P. crassirostris* is sexually dimorphic in bill structure; *turtur* is not sexually dimorphic in any single characteristic measurement (Tables 10 and 12).

DISCUSSION

Much remains a mystery with prions. The consensus view, however, now follows Murphy (1936), Falla (1940), and Fleming (1941) in recognising six species of *Pachyptila.* This taxonomic decision is based on both morphological and ecological differences which appear sound, given the present somewhat patchy nature of the data.

Identifying young prions into their respective species is a daunting task for many. Deciphering prions can be achieved, however, given practice and clues for what to look for. Two points bear repeating. Age groups occurring within a mixed bag of storm-killed *Pachyptila* can be separated by the careful scrutiny of a specimen for any signs of immaturity. This is essential for a correct identification.

TABLE 13 — Summary of taxonomic proposals for **Pachyptila**

Broad-billed Prion	**Pachyptila vittata** (Forster 1777)	No subspecies
Salvin's Prion	**Pachyptila salvini** (Mathews 1912)	No subspecies
Antarctic Prion	**Pachyptila desolata** (Gmelin 1789)	No subspecies
Thin-billed Prion	**Pachyptila belcheri** (Mathews 1912)	No subspecies
Fairy Prion	**Pachyptila turtur** (Kuhl 1820)	1 subspecies **subantarctica** (Oliver 1955)
Fulmar Prion	**Pachyptila crassirostris** (Mathews 1912)	1 subspecies **eatoni** (Mathews 1912)

Regarding the distribution of prions, it is important to realise that, while breeding adult birds nest on islands confined to a particular water zone, fledglings and submature birds are not thus confined. Like the young of other marine bird species, immature prions appear to be much more widespread in their distribution than are adults. This is well documented by wrecks of prions in Australia and New Zealand (e.g. Harper 1972).

I find the ' exploratory migration model ' of Baker (1978, 1980) a distinctly more plausible hypothesis than the current fuzzy notion of ' dispersal.' Putting Baker's model into the present framework, it seems likely that during the period from the fledglings' departure from their nests until the survivors return some 4 to 5 years later (in the case of *P. turtur*, Richdale 1965, pers. obs.), the young prions explore a variety of marine habitats assessing their relative suitability for their own particular requirements. In so doing they cross marine barriers such as convergences which may normally restrict adult birds. Hence the adults do not accompany the young birds throughout the exploratory migration phase of their life cycle. The net result is " an adult home range crystallising out from the pre-reproductive area of familiarity," which may differ from those of past generations. In a changing environment, the flexibility of this arrangement in evolutionary terms is an obvious advantage to a species using it.

Sexing storm-killed *Pachyptila* can generate interesting information. Table 14 details preliminary results from 4930 sexed prions in New Zealand. Both the *salvini* and *belcheri* data are from immature birds; the age structure of the remaining three species is mixed.

Males predominate in all five species, particularly in *salvini*, and prominently also in both *turtur* and *belcheri*. The abundance of fledgling males in the Indian Ocean migrants suggests at least three

hypotheses: (1) young males predominate in the exploratory migration phase of the life cycle, (2) young females have a more restricted distribution because of their higher reproductive investment in perpetuating the existing populations, or (3) females suffer a higher mortality at sea than do males. Consideration of these and other hypotheses clearly highlights the importance of seabird collections from beaches. We could learn a great deal about the evolutionary mechanisms in the Procellariiformes from such an inquiry.

I am doubtful whether a more refined method of measuring prions (for example, multimorphic analyses) will tell us more about prions than we already know. Comparisons made strictly on like with like (breeding females with breeding females, one-year-old males with one-year-old females, etc.) may provide more useful information. The pitfalls of the existing prion measurements are, I trust, very evident in this paper. Plumage description likewise appears to have run its full cycle.

Further and more refined ecological data on the *Pachyptila*, such as sonagrams, better food analyses and carefully defined behavioural studies, will be of great value for future studies.

New techniques of biochemical research, such as the comparative analysis of plasma proteins in the Procellariiformes (Harper 1978) offer great potential for unravelling the speciation mechanisms of *Pachyptila*. I am at present using differences found while using the vertical slab electrophoresis technique (P A G E) as a basis for a newer, more refined approach: that of analytical electrofocusing. I hope very shortly to offer some clear-cut genetic solutions to the challenge prions present, in addition to expanding some of the points raised in this paper.

TABLE 14 — Sex ratios of storm-killed prions in New Zealand.

	Number	Males	Females	Approximate ratio
vittata	702	371	331	1:1
salvini	332	220	112	2:1
desolata	861	437	424	1:1
belcheri	1385	787	598	4:3
turtur	1650	1000	650	5:3
	4930	2815	2115	

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yet to come. My thanks to my colleagues at the National Museum and other institutions for their long-standing assistance and the loan of *Pachyptila* material.

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SHORT NOTE

PARADISE SHELDUCKS STANDING ON LIPS OF WATERFALLS

On 15 January 1980, in brilliantly fine weather, my family and I twice saw Paradise Shelducks perching on the lips of falls on the Aniwaniwa River at Waikaremoana. On the first occasion we saw a drake on one of the main Aniwaniwa Falls, while later in the day we saw a duck on the edge of the Papakorito Falls, some distance further upstream. Possibly the birds found the lip area of the falls favourable places for feeding because of the growth of algae on the flat and constantly wet rocks there — although we did not see them feeding. Alternatively, the birds may simply have been occupying ideal vantage points for watching the downstream parts of the river.

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