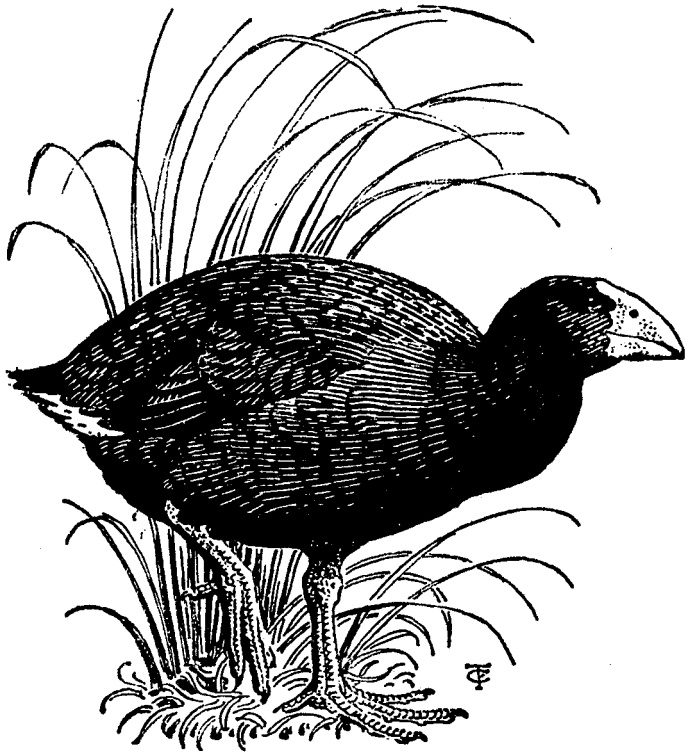
NOTORNIS

Journal of the Ornithological Society of New Zealand



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A biology of birds, by B. D. Heather. $1.50

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Reports and bulletins (1939-1942) $2.00

OSNZ Library catalogue (1976 ed) 17 pp. $0.55

Banding reports, Nos 8-14, 55c each.

Kermadec Expedition, 1964, by A. T. Edgar. $0.50

Guide to Identification of Shearwaters and Petrels in New Zealand waters (Auckland Museum), J. P. Croxall $0.55

From P. C. Harper, Dept of Extension Studies, University of Canterbury, Christchurch:

Southern albatrosses and petrels: an identification guide, by P. C. Harper & F. C. Kinsky, 1978 edition $5.00

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Bird distribution in N.Z. A provisional atlas. $6.00

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SEABIRD RECORDS FROM TONGA — AN ACCOUNT BASED ON THE LITERATURE AND RECENT OBSERVATIONS

By J. A. F. JENKINS

ABSTRACT

The previous sparse literature on Tongan seabirds is reviewed and is expanded by records made on 60 voyages through the area here described as Tongan waters.

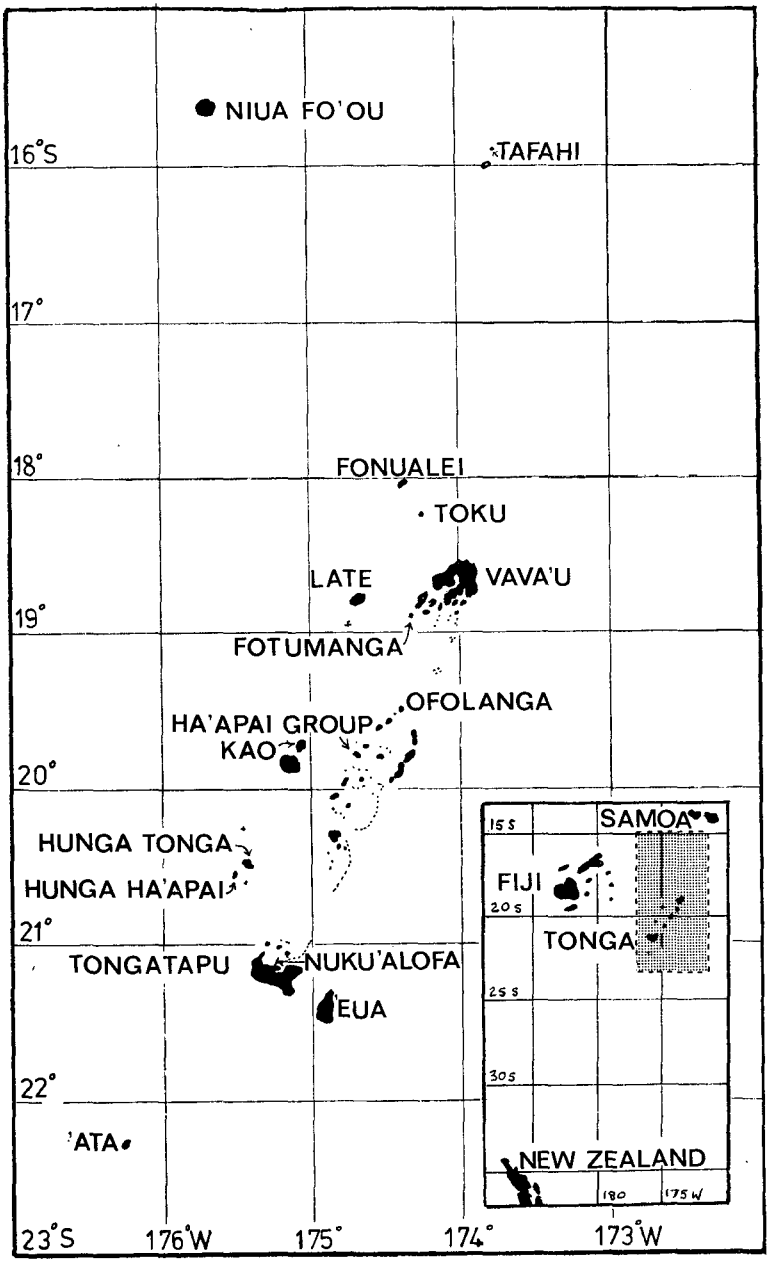
Of the 37 species thought to occur, 5 are passage migrants; breeding has been confirmed in 8 species and could occur in a further 8; 8 species are thought to be visitant; and the status of another 8 requires confirmation.

INTRODUCTION

Few places in the world can have had as little systematic bird study as Tonga, and this is especially true of the seabirds. The scattered literature that exists is difficult to find and when traced often contains little of interest. This paper reviews such literature as could be found and incorporates it with recent observations made on 60 voyages through Tongan waters.

In this paper Tongan waters are defined as that sea area bounded by 15° and 24° South latitude, and 172° and 176° West longitude. This area abuts the sea area defined as Fijian waters by Clunie *et al.* (1978). The *Pacific Islands Pilot* (1969) contains a full description of the islands of Tonga and the meteorology of the area .

Since 1973 I have made 60 voyages through Tongan waters, three to seven in each month of the year. The 18 voyages made before


NIUA FO'OU
16°S
TAFAHI
17°
18°
FONUALEI
TOKU
LATE
VAVA'U
19°
FOTUMANGA
OFOLANGA
HA'APAI GROUP
KAO
20°
HUNGA TONGA
HUNGA HA'APAI
21°
TONGATAPU
NUKU'ALOFA
'EUA
22°
'ATA
23°S
176°W
175°
174°
173°W
SAMOA
15 S
FIJI
20 S
TONGA
25 S
30 S
NEW ZEALAND
180
175 W

1973 were partly summarised in a previous paper (Jenkins 1973). The more recent 60 voyages have usually consisted of a transect through the north of the area when the ship was going from Fiji to Samoa, followed by a further transect from Samoa to Tonga, and a final transect from Tonga to New Zealand. Five voyages have been made from Fiji to Tonga and then north to Samoa before returning to Tonga and New Zealand.

To avoid endless repetition of latitudes and longitudes, positions are recorded using the "square" system adopted by the Australasian Seabird Group. That is, the basic degrees only are used. Throughout the paper positions are given as, say, 20/175W, which means that the sighting occurred in 20°S latitude and 175°W longitude. Since all latitudes used in this paper are south, the indicator S has been omitted. The area defined as Tongan waters includes 45 squares, of which 26 have been visited, most of them regularly.

My observations are mostly those made since 1973. Before 1973 different tracks were followed, and only two voyages were made to the south of Tongatapu. However, where relevant, important records made before 1973 have been included.

Since all records from the south of Tongatapu have been made on voyages coming from north to south, they are more likely to show the true northerly limits of the southern ship-following species than are northbound voyages.

For nomenclature of the albatrosses and petrels I have followed Harper & Kinsky (1978).

HISTORY

The literature on Tongan birds can conveniently be divided into three phases; the records of the early explorers starting with Cook's voyages; the largely German research of the late 19th century; and the modern studies starting with the work of the Whitney South Sea Expedition.

Early explorers

The first recorded visit of Europeans to Tongatapu was that of Abel Tasman in 1643, but the first birds were not recorded until some 130 years later during the visits of Captain Cook. The Forsters on Cook's second voyage described 15 species from Tonga, including three seabird species. The second voyage ships were in Tonga in 1773. During Cook's third voyage a specimen of *Sterna bergii* was collected (Medway 1979). Hombron & Jacquinot, the natural scientists of the French South Pole Expedition under the command of Dumont d'Urville in the ships *Astrolabe* and *Zelee,* were the first naturalists to visit Vava'u. They recorded one new species of landbird but no new seabirds (Hartlaub, 1854).

Titian Peale with the United States Exploring Expedition commanded by Charles Wilkes, collected 9 species in Tonga. All were

TABLE 1 — Seabirds recorded up to 1859.

Species	FORSTER (1844)	ANDERSON (1777)*	GRAY (1859)
Phaethon aethereus	-	-	X
Phaethon rubricauda	-	-	X
Sula leucogaster	X	-	-
Sula sula	-	-	X
Sterna bergii	-	X	-
Sterna dougallii	-	-	X
Gygis alba	X	X	X
Anous stolidus	X	X ?	X

* in Beaglehole (1967)

already known and the only seabird was *Gygis alba* (Hartlaub 1852). G. R. Gray (1859) provided what is in effect a summary of the knowledge of Tongan seabirds to that time, and Table 1 sets out the knowledge at the end of the first phase of exploration.

19th century collecting

The second or German-dominated phase of Tongan seabird exploration opened with the publication of Finsch & Hartlaub's *Beitrage zur Fauna Centralpolynesiens* in 1867. The book does not add to the eight seabird species known at the end of the first phase. In 1869 Finsch & Hartlaub described a collection of birds obtained from Tonga by the Museum Godeffroy, though there were no seabirds in this collection.

Dr Eduard Graffe (1870), when collecting in Tonga, recorded some habits of *Gygis alba.* From descriptions given by local people he suggested the presence of *Sterna bergii* and a species of *Anous.* This was probably *A. minutus,* which is frequently seen close inshore and could have been more familiar to the local people than *A. stolidus.* He also reported being told of a tropicbird which he assumed was *P. aethereus* but which was more probably *P. lepturus.* Graffe's report of the *Teiko,* which he said " breeds in burrows and is therefore probably a *Puffinus* or *Thalasedroma* species," is the first mention of a shearwater or petrel from Tonga. It is interesting to note that Carlson (1974) stated that the present Tongan name of Audubon's Shearwater *(Puffinus lherminieri)* is *Teiko.* A bird which from local descriptions Graffe thought could have been a *Diomedea* was subsequently identified by Finsch (1877) as *Sula leucogaster.*

In 1870 Finsch & Hartlaub published *Zur Ornithologie der Tonga-inseln* which set out the then current knowledge of Tongan birds, where and when they were first recorded, and a description of 18 species collected by Graffe for J. C. Godeffroy of Hamburg. They cast doubt on species added to the Tongan list by Latham and Gray, of which they said: " In addition Latham lists four other species allegedly from Tonga, and G. R. Gray in his admirable ' List of the Birds of the tropical islands of the Pacific (1859)' added another eight, which reached the British Museum not always accompanied by the vital collector's verification. The total number of birds from Tonga amounts to 33, six of which, however, must be considered as not having been completely proven." Seabirds considered not proven were Latham's *Sterna bergii* which had, in fact, been collected in Tonga in 1777, Gray's *Phaethon rubricauda* and *Sula sula,* both of which occur in Tonga, *Phaethon aethereus,* which was subsequently reported only by Layard (1876), and *Sterna dougallii,* which has not been reported from Tonga since.

The only Tongan seabirds recorded by the *Gazelle* Expedition (Cabanis & Reichenow 1876) were *Gygis alba* from the Ha'apai Group, and a bird recorded as *Anous melanogenys* = *Anous minutus.*

While E. L. Layard (1876) was British Consul in Fiji, he recorded birds in Fiji, Samoa and Tonga, greatly adding to the ornithological knowledge of the South-west Pacific. His work in Fiji is briefly described by Heather (1977). Layard added two new species to the Tongan list, *Phaethon lepturus* and *Fregata minor,* though he added to the confusion on the early status of the tropicbirds in Tonga by reporting seeing three species, *P. aethereus, P. rubricauda* and *P. lepturus.* His are the first reports of *P. lepturus* and the last of *P. aethereus,* which had been added to the Tongan list by Gray. Layard noted that although *Sterna dougallii* had been reported by Finsch & Hartlaub, who were in fact repeating Gray's statement, he did not see it.

In July 1874 HMS *Challenger* visited Tongatapu and 30 bird specimens of 9 species were collected. However, none of these were seabirds (Finsch 1881). Moseley (1879) in a book on the voyage does not comment on Tongan seabirds.

HMS *Curacao* visited both Tongatapu and Vava'u in July, 1865 (Brenchley 1873). Birds collected during the voyage through many island groups other than Tonga were described by G. R. Gray in an appendix to Brenchley's book, though none of the specimens described is from Tonga. It appears that Gray did not describe all the specimens obtained as he stated in the appendix " .... it is therefore proposed to notice only those birds that are new or especially rare to science ...." Only a portion of Brenchley's collection reached the British Museum. The principal part, consisting of many things other than birds, was presented to the museum at Maidstone. It would seem that no new seabirds were recorded during this visit.

This phase of the exploration ended with the publication by Finsch (1877) of notes on a collection of birds from 'Eua. The specimens described had been sent from Tonga to the Museum Godeffroy by Hubner, one of the museum's collectors. Seabirds included *Phaethon lepturus, Sula leucogaster, Sterna bergii, Gygis alba,* and one new record, that of *Procelsterna cerulea.*

Finsch's own observations of the birds of the Pacific are contained in his " Ornithological letters from the Pacific " (1880, 1881a, 1883). He did not visit Tonga.

Table 2 summarises the knowledge of Tongan seabirds at the end of the 19th century. It shows 11 species confirmed, 2 about which there was already some doubt, and an unidentified shearwater or petrel.

TABLE 2 — Seabirds recorded up to 1900.

Species	F & H (1867)	Gräffe (1870)	F & H (1870)	Layard (1876)	Finsch (1877)
Puffinus ?	-	X	-	-	-
Phaethon aethereus ?	X	X ?	-	X	-
Phaethon rubricauda	X	-	-	X	-
Phaethon lepturus	-	-	-	X	X
Sula leucogaster	X	-	-	X	X
Sula sula	X	X	-	-	X
Fregata minor	-	-	-	X	-
Sterna bergii	X	X ?	-	X	X
Sterna dougallii ?	X	-	-	-	-
Sterna anaethetus	-	-	-	X	-
Gygis alba	X	X	X	X	X
Anous stolidus	X	-	-	X	X
Anous minutus	-	X ?	-	X	-
Procelsterna cerulea	-	-	-	-	X

The 20th century

Nicoll (1904, 1908) described many seabirds in the South-west Pacific, but though he visited Samoa and Fiji, he did not visit Tonga.

The modern phase of Tongan exploration began with the visit of the Whitney South Sea Expedition in 1925, when for the first time systematic work was done on some of the seabirds. The first Procellariiformes were recorded when *Pterodroma arminjoniana heraldica* was found breeding and a specimen of *Puffinus lherminieri* was collected. New records since the Whitney Expedition are in the form of short notes (Davidson 1931, Jenkins 1967, Cheshire 1974), reports of visits to the area (Fry 1966, Jenkins 1973, Dhondt 1976), or papers on species where Tongan populations play a part (Murphy 1951, 1952, Jenkins 1979).

Mayr (1933) said very little about seabirds and hardly anything about Tonga. In his 1941 paper he said of Tongan birds in general " The total native landbird fauna comprises 18 species, with only five species of Passerines, all the others being widespread and strong flying non-passeres," and " There is on Tonga not one endemic genus and only one endemic species."

An unpublished paper by Carlson (1974), written when he was a Peace Corps Volunteer, was intended as a text book for Tongan schools (F. Clunie, pers. comm.). It contains a full list of bird names in the Tongan language. Carlson gave some very interesting observations of landbirds and of seabirds seen from the land. He also confirmed the breeding of four seabird species. Since he spent little time off-shore, he apparently based his comments on pelagic birds on his own interpretation of previous records, and so the paper is misleading in this respect.

Neither a recent visit to 'Ata to conduct archaeological and geological studies (Anderson 1979), nor that to Fonualei (A. John Halunen, pers. comm.) was accompanied by an ornithologist. Both parties strived to record the birds seen but were hampered by lack of knowledge of Pacific seabirds. Halunen, a United Nations Development Programme marine geologist, landed on Fonualei " .... to collect additional round volcanic stones for precious coral tangle-net dredges." He took the opportunity to walk to the crater rim to note the volcanic activity, and though on the island only about 4 hours, found four species of seabirds breeding.

A further important source of Tongan seabird records which I have been unable to review is contained in the Journals of the Whitney South Sea Expedition. These Journals are kept at the American Museum of Natural History, and extracts have been published in various papers on South Pacific seabirds. Where such extracts have been found they are included in this paper.

Table 3 sets out, as far as it has been possible to trace previous records, the current knowledge of Tongan seabirds. Where Jenkins without a date is given as the authority the record appears in this paper. The table summarises 37 species now recorded from Tongan waters.

DIOMEDEIDAE

I have found only two mentions of albatrosses in the literature. Graffe (1870) was told of a bird with the Tongan name of *gutulei,* which from the description he surmised was a *Diomedea,* but when a specimen was obtained later from 'Eua (Finsch 1877) it was found to be *Sula leucogaster.* Carlson (1974) gave the Tongan name of *katafa* as meaning albatross and stated without evidence that the Royal *(D. epomophora),* Wandering *(D. exulans),* and Black-browed *(D. melanophrys)* are vagrant, appearing rarely.

TABLE 3 — Seabird records up to 1979.

Species	First Recorded	Visitant	Passage Migrant	Breeding Status
Diomedea exulans	Jenkins	Jenkins	-	-
Macronectes sp.	Jenkins 1967	Jenkins	-	-
Daption capense	Jenkins	Jenkins	-	-
Pterodroma e.cervicalis	Jenkins	Jenkins	Jenkins	-
Pterodroma alba	Beck ? 1925	Status uncertain	-	-
Pterodroma rostrata	Jenkins	Status uncertain	-	-
Pterodroma a.heraldica	Beck 1925	-	-	Confirmed Murphy 1952
Pterodroma nigripennis	Jenkins 1973	Jenkins	-	-
Pterodroma leucoptera	Jenkins	Jenkins	-	-
Pterodroma longirostris	Jenkins	Jenkins	-	-
Pterodroma brevipes	Jenkins	Jenkins ?	-	-
Puffinus pacificus	Davidson 1931	-	-	Confirmed Davidson 1931
Puffinus bulleri	Cheshire 1974	-	Jenkins	-
Puffinus griseus	Jenkins	-	Jenkins	-
Puffinus tenuirostris	Jenkins	-	Jenkins	-
Puffinus lherminieri	Murphy 1928	-	-	Suspected Jenkins
Phaethon rubricauda	Gray 1859	-	-	Probable Anderson 1979
Phaethon lepturus	Layard 1867	-	-	Confirmed Carlson 1974
Sula leucogaster	Forster F & H 1870	-	-	Probable Jenkins

TABLE 3 (continued)

Species	First Recorded	Visitant	Passage Migrant	Breeding Status
Sula dactylatra	Jenkins 1973	-	-	Probable Anderson 1979
Sula sula	Forster 1844	-	-	Probable Carlson 1974
Fregata minor	Layard ? 1876	-	-	Probable Anderson 1979
Fregata ariel	Beck 1925	-	-	Probable Sibley & Clapp 1967
Stercorarius S. maccormicki	Jenkins	-	-	-
Stercorarius pomarinus	Jenkins	-	-	-
Stercorarius parasiticus	Jenkins	-	-	-
Sterna bergii	Anderson 1777	-	-	Suspected Jenkins
Sterna fuscata	Whitney Exp. 1925	-	-	Confirmed Whitney Exp. 1925
Sterna anaethetus	Layard 1876	-	-	-
Sterna lunata	Mayr 1945	Status unknown	-	-
Sterna sumatrana	Layard 1876	-	-	Confirmed Carlson 1974
Gygis alba	Forster 1844	-	-	Confirmed Carlson 1974
Anous stolidus	Forster F & h 1870	-	-	Confirmed Finsch 1877
Anous minutus	Layard 1876	-	-	Confirmed Carlson 1974
Procelsterna cerulea	Finsch 1877	-	-	-

In this study the Southern Royal Albatross has not been recorded near the area, but a Northern Royal *(D. e. sanfordi)* was seen once just south of Tongan waters at 24/177W on 15 May 1974.

Observations show that the Wandering Albatross is an irregular winter straggler to southern Tongan waters between July and November.

The sightings were:
In 23 S: one on 11/9/74; one on 11/9/76
In 24 S: one on 31/7/75; one on 9/7/76; two on 28/7/76; two on 17/8/74; two on 2/10/76; two on 20/11/76

All sightings were recorded using a modification of the plumage keys developed by Gibson (1967), the brownness of the inner upperwing being noted on a scale of 1 (all brown) to 5 (all white). All the birds recorded had innerwings that were wholly or almost wholly brown, the plumages generally conforming to Gibson's Figure 3 types A, B, C. This could suggest that they were young birds or birds from the Antipodes Islands (Warham & Bell 1979), the nearest breeding colony. Antipodes Islands birds are known to breed in this brownish plumage.

The nearest sighting of a Black-browed Mollymawk to Tongan waters was that of a subadult at 26/178W on 28 April 1976.

Wandering Albatrosses and Black-browed Mollymawks have been recorded in the Fiji Islands considerably to the north of the sightings here (Clunie *et al.* 1978). This may merely reflect the fact that more ships go to Fiji from the south than to Tonga, providing more opportunities for these birds to be drawn further north.

PROCELLARIIFORMES

GIANT PETREL *Macronectes* sp.

One bird, apparently the first record, was seen on 10 August 1967 in the Ha'apai Group (Jenkins 1967). I have since seen one at the entrance to Nuku'alofa Harbour on 30 July 1975 and another just south of Tongan waters at 24/177W on 31 July 1975. All three birds had dark almost black plumage and very light bills, suggesting that they were the young of the year dispersing from the breeding colonies. The Giant Petrel seems to be an irregular visitor to Tonga during the winter. Their northerly spread into the South-west Pacific during the winter has been shown by Jenkins *et al.* (1977).

CAPE PIGEON *Daption capense*

Cheshire *et al.* (1979) described the spread of the Cape Pigeon to the north of New Zealand during the southern winter but did not record Tongan sightings separately. The records in Table 4 are probably the first for Tonga and include birds seen close to the south of Tongan waters.

These sightings show that the Cape Pigeon occurs irregularly, especially in the south of the area, between July and September.

TABLE 4 — Cape Pigeon records.

Date	Number of birds	Position	Date	Number of birds	Position
July			September		
9.7.76	2	22/176W	1.9.74	1	15/172W
15.7.70	5	23/176W	11.9.76	2	24/177W
30.7.73	2	22/176W	21.9.78	1	15/172W
August					
12.8.73	2	24/177W			

WHITE-NAPED PETREL *Pterodroma externa cervicalis*

Since this petrel migrates to the Central Pacific during the non-breeding season (King 1970), it was expected in Tongan waters on passage. There seem to be no previous records, and of the few here, those seen in December in the south of the area could well be foraging from the Kermadecs. This may indicate that the main migration track of this species is to the east of Tonga. My first record for Tonga was on 26 December 1973 when two were seen just north of Vava'u; all records are included in Table 5.

South of Tongan waters the birds are widespread in summer, and sightings between New Zealand and the Pacific Islands have increased noticeably in recent years. It may be no coincidence that

TABLE 5 — White-naped Petrel records.

Date	Number of birds	Position	Date	Number of birds	Position
March			November		
6.3.75	1	22/176W	17.11.76	1	16/172W
24.3.75	1	22/176W			
June			December		
11.6.78	2	19/174W	7.12.74	1	15/174W
11.6.78	2	21/175W	11.12.74	2	19/174W
12.6.78	1	22/175W	20.12.74	2	20/175W
21.6.78	1	15/173W	26.12.73	2	18/174W
July					
13.7.75	2	20/175W			

this increase has occurred since the goats were cleared from Macauley Island in the Kermadecs in 1966 (Williams & Rudge 1969), which could now be the main breeding island.

PHOENIX PETREL *P. alba* and TAHITI PETREL *P. rostrata*

Eggs thought to be those of *P. alba* were collected on Hunga Tonga by Beck in July 1925 (Murphy 1952). W. R. P. Bourne (pers. comm.) doubts the identity of the eggs and has suggested that they are those of *P. a. heraldica,* which Beck found breeding on the island.

During this study I have found it very difficult to separate *alba* and *rostrata* as the white throat of the former is rarely visible at sea. Therefore I have recorded them as *rostrata/alba* except whenever the underwing was seen clearly enough to note either the presence or absence of the thin white line shown by Murphy (1952). Birds without this white line and therefore thought to be *rostrata* were mostly darker brown than *alba* and they appeared to be bulkier, as noted by Harper & Kinsky (1978). Generally *rostrata* has a very dark head, back and upper-wing, with a clear-cut division on the lower throat between the dark brown of the neck and the white of the belly. In *alba* the brown is less dark and the division on the lower throat less clear-cut. I have not been able to compare a range of skins of these birds, and so the separation in the following sightings is based on the above comments on field observations.

January:	1 *rostrata* at 20/175W on 7/1/79
March:	1 *rostrata/alba* at 21/175W on 24/3/75
April:	1 *rostrata* at 18/174W on 19/3/78
	1 *rostrata* at 21/175W on 16/4/79
	1 *alba* at 15/171W on 27/4/79
May:	1 *rostrata* at 21/175W on 30/5/74
June:	1 *alba* at 22/175W on 26/6/78
July:	1 *alba* at 21/175W on 10/7/78
	1 *rostrata* at 20/175W on 29/7/79
	1 *rostrata* at 19/174W on 26/7/76
	2 *rostrata* at 20/175W on 8/7/76
	1 *alba* at 20/175W on 8/7/76
	1 *alba* at 21/175W on 8/7/76
September:	1 *rostrata* at 22/176W on 1/9/74
October:	1 *rostrata/alba* at 18/174W on 31/10/77
December:	1 *rostrata/alba* at 20/175W on 29/12/74
	2 *rostrata/alba* at 21/175W on 29/12/74

Most of these sightings have been in the south of the area; other than that they form no obvious pattern. It is perhaps surprising that they seem to be present throughout the year.

MOTTLED PETREL *Pterodroma inexpectata*

This trans-equatorial migrant breeds on islands south of New Zealand and migrates as far north as the Bering Sea (Kinsky 1970).

TABLE 6 — Mottled Petrel records.

Date	Number of birds	Position	Date	Number of birds	Position
March					
16.3.78	1	14/171W	22.10.79	1	20/176E
			22.10.79	1	20/176E
April					
23.3.79	1	20/176E	22.10.79	1	20/176E
23.3.79	1	21/176E	25.10.79	1	14/171W
27.3.78	1	19/177E	25.10.79	1	14/171W
May			28.10.77	1	13/171W
10.5.79	2	16/179W	29.10.77	1	13/172W
October			30.10.77	1	18/174W
3.10.79	1	15/175W	30.10.77	1	18/174W
			30.10.79	2	19/174W

I have found no previous records for Tonga, and so the two seen at 18/174W on 30/10/77 may be the first. Table 6 is a full list of sightings about Fiji, Samoa and Tonga, and includes the first for Fiji (Clunie *et al.* 1978) and for Samoa.

From these few sightings the northerly migration appears to be more prolonged than the southerly migration, although in both Mottled Petrels seem to move in ones and twos rather than in flocks. King (1970) noted that in the Central Pacific " usually only one bird was seen at a time, and never more than two together." He also recorded that the southerly migration peak occurred in October.

One observation of possible significance was made well to the south of Tonga at 25/178W on 15 May 1979 of two separate Mottled Petrels flying northwards with migrating Sooty Shearwaters *(P. griseus)*.

KERMADEC PETREL *Pterodroma neglecta*

Kermadec Petrels have often been seen between Tonga and New Zealand, presumably birds foraging from the Kermadec Islands. They do not appear to visit Tonga regularly and I have found no previous records of them in Tongan waters.

Since Kermadec Petrels could be confused with other similar species known to occur in the area, I have tried to exclude the others by recording as Kermadec Petrels only birds seen to have white quills in the upperwing. Records are: March 1975 one at 20/175W; May 1975 three at 18/174W; August 1978 two at 22/176W; October 1979 one at 22/175W; December 1973 two at 22/176W.

TRINIDADE PETREL *Pterodroma arminjoniana heraldica*

Breeding in Tonga was proved at Hunga Tonga, Hunga Ha'apai when Beck and his fellow workers collected " young in the nest " on 24 July 1925 (Murphy 1952). This reference has been used in all books on the area, but I have found no fresh record of *heraldica* until one was caught aboard ship in Tongan waters on 16 July 1966 (Jenkins 1973). This bird was identified by W. R. P. Bourne from photographs and measurements. It was in an intermediate colour phase, which seems rare in Tonga where most of the birds seen are in the light phase. Murphy (1952) said that all 18 specimens collected by Beck and now in the Smithsonian Institution are of the light phase, though he warned that care must be taken with phases when the number of specimens is limited.

Carlson (1974) reported breeding on Fukave Island off Tongatapu. He stated that this colony was only 5-10 years old, having resulted from conservation measures taken by the owners of the island. He also claimed that the birds breed from December to February, which is contrary to other observations and requires confirmation.

My records for 1975 and 1976 are given in Turbott (1977). These and sightings since show that *heraldica* is in Tongan waters in relatively small numbers in the southern winter. They are usually seen in ones and twos with 15 the highest number seen together, this in a mixed feeding flock. All my sightings were between 5 March and 25 September with the exception of two single birds seen just north of 'Ata on 24 December 1979.

These records suggest that *heraldica* is a winter breeder in Tonga, arriving as the Wedge-tailed Shearwater *(P. pacificus)* is leaving the area, using the vacated Wedge-tailed breeding islands of Hunga Tonga and Hunga Ha'apai and moving away as the Wedge-tails return. King (1970) found that in the Central Pacific it " occurred fairly regularly but never in large numbers. It was seen most consistently between October and February — peak numbers were in December." King's birds may have been the Tongan population on migration, but many other Pacific populations could be the source of these Central Pacific sightings.

It would be unusual if the Tongan population were winter breeders as W. R. P. Bourne (pers. comm.) noted " Quite definitely at most sites *P. arminjoniana* seems to breed all the year round. The Whitney material indicates it for the Pacific, Murphy concludes it does so on S. Trindade in the Atlantic in ' Oceanic birds of South America,' and a series of published and unpublished recent observations indicate it does so on Round Island off Mauritius (in sharp contrast to the well defined southern summer breeding of the Wedge-tailed Shearwaters). There is no doubt about it." See *Postscript.*

BLACK-WINGED PETREL *Pterodroma nigripennis*

First recorded in Tongan waters when one was caught aboard ship in the Ha'apai Group on 28 November 1967 (Jenkins 1973). Records since then show that it is not uncommon in the southern summer, when it has been seen between 22 October and 11 June. The small numbers seen about Tonga compared with the much larger numbers seen between Tonga and New Zealand suggest wandering from the Kermadecs rather than a Tongan population. Recently one was seen inside Nuku'alofa Harbour less than a mile from the wharf.

Note: The following three **Pterodroma** species are notoriously difficult to identify at sea. A further complication in Tongan waters is the extreme variability of **brevipes**. The records of **leucoptera, longirostris** and **brevipes** should accordingly be regarded as tentative only.

GOULD'S PETREL *Pterodroma leucoptera*

There do not appear to be any previous records of Gould's Petrel in Tongan waters. Two birds thought to be of this species were seen in 1973, four in 1974, three in 1978, and seven in 1979. Sightings have been made in January, March, April, May, July and December. On 27 April 1979 one landed aboard ship at 16/172W, which I banded and released. Later the identification was confirmed by G. van Tets from photographs and measurements, although the same data suggested to W. R. P. Bourne that "it probably belongs to a local population of *brevipes*, but there is still much work to be done on that group."

STEJNEGER'S PETREL *Pterodroma longirostris*

Petrels thought to be of this species have been seen on three occasions. On 6 July 1976 two were seen that had white foreheads, black caps contrasting with grey backs, and upperwings that showed blackish M markings. On 25 June 1978 one was noted that had a black cap contrasting with a grey back, a white forehead and no sign of a collar. One seen on 20 July 1978 had a very active flight with constant flipping from side to side.

Though not recorded from Tonga previously, this petrel, which breeds at the Juan Fernandez Islands, ranges widely through the Pacific during the non-breeding season.

COLLARED PETREL *Pterodroma brevipes*

Petrels thought to be *brevipes* have been seen on eight occasions: January 1979 one at 19/174W; February 1974 four seen together with Black-winged Petrels at 22/176W; June 1978 one at 19/174W, one at 22/175W, three at 22/176W; September 1978 three at 15/172W; November 1976 two at 16/172W and two at 20/175W. I have found no previous records for Tongan waters, although the Collared Petrel is known to occur in Fiji.

WEDGE-TAILED SHEARWATER *Puffinus pacificus*

During its breeding season this is the most common shearwater in Tongan waters. Observations have shown that it is almost absent from the area during July-September, returning in large numbers by mid-October (Jenkins 1979). There is little in the literature about the breeding sites, although a small colony was recorded by Davidson (1931). Halunen (pers. comm.) found shearwaters which he thought were adult Wedge-tails on the ground during a daytime visit to Fonualei in January 1980. Carlson (1974) said " This bird is also readily seduced by wailing sounds and radio music and in Niuafo'ou and 'Eua, where the bird is known as ' manu'uli,' the people use this trait to their advantage by calling down birds only to whack them out of the air with long sticks to procure themselves a meal." See *Postscript.*

BULLER'S SHEARWATER *Puffinus bulleri*

Common in New Zealand waters, where it breeds at Poor Knights Islands from September to May (Jenkins 1974), after which it migrates to the North Pacific (Falla *et al.* 1979). The few records for Fiji, Samoa and Tonga suggest that the migration path both in and out of New Zealand waters lies well to the east of Tonga.

This large distinctive shearwater was recorded in Tongan waters apparently for the first time on 23 May 1972 when three birds were seen to the west of Vava'u (Cheshire 1974). During this study two birds were seen at 15/173W on 7 May 1975, and one at 20/175W on 14 May 1979. Buller's Shearwater is apparently an uncommon passage migrant through the area, and it has been seen only on its northward migration flight.

SOOTY SHEARWATER *Puffinus griseus*
SHORT-TAILED SHEARWATER *Puffinus tenuirostris*

The difficulty in separating these species when only one or two birds are seen is well known, and many observations were recorded as Sooty/Short-tailed, possible Sooty, etc. However, on many occasions large numbers allowed positive identification.

Both species occur in northern Tongan waters during September-November. Short-tails greatly predominate as their southerly migration path seems to pass close to the north of Samoa and through the Fiji Islands. Few are seen during the northerly migration, which appears to pass to the west of Fiji. King (1970) recorded the southerly migration flight of *tenuirostris* through the Central Pacific but did not see the northerly flight.

Sooty Shearwaters are fewer in northern Tongan waters during September-November as their southerly migration path probably passes well to the south-east of Tonga. They can be seen in large numbers during May as their northerly path appears to pass close to Tonga and just to the east of the Samoas. Both northerly and southerly migration flights were recorded in the Central Pacific by King (1970).

I have found no previous records of these shearwaters in Tongan waters.

AUDUBON'S SHEARWATER *Puffinus lherminieri*

First recorded by Murphy (1928) who reported a male collected 5 miles east of Fotu Manga. King (1967), in a list of Tongan seabirds, suggested that it is a non-breeding migrant. Jenkins (1973) reported a bird which landed aboard ship 7 miles north of Ofolanga Island, and a further sight record north of the Vava'u Group. Carlson (1974) reported birds on various Ha'apai Islands but could not find evidence of breeding.

Since 1973 this small, comparatively sedentary shearwater has been seen in Tongan waters each month, mostly near the Ha'apai Group and near 'Ata. Because the range at sea is usually within 100 miles of the breeding islands (King 1967) it probably breeds at both places.

HYDROBATIDEA

During this study only one storm petrel has been seen in the area. It appeared briefly on 3 March 1975 at 16/172W. It was noted as a large all-dark storm petrel with a white rump which suggests that it could have been either Wilson's *(O. oceanicus)* or Leach's *(O. leucorhoa)*.

PHAETHONTIDAE

[RED-BILLED TROPICBIRD] *Phaethon aethereus*

Gray (1859) described a skin of this species in the collection of the British Museum as being from Tonga. This is apparently the basis of its being recorded as a Tongan bird by Finsch & Hartlaub (1867), although in their Tongan paper of 1870 they cast doubt on the record and marked it " according to Gray." Graffe (1870) said " The *Tavaki* or *Lariki (P. aethereus)* seldom comes to Tongatapu but is common on the rocky islands of Honga or Hoga Hapai." The twin islands of Hunga Tonga and Hunga Ha'apai are now known to be a breeding place of the White-tailed Tropicbird *(P. lepturus)*, and it seems that Graffe did not see either bird but was reporting what he had been told by local people. The present Tongan name for the White-tailed Tropicbird is *tavake* (Carlson 1974).

The only naturalist who has reported seeing this bird in Tonga is Layard (1876). He reported three species of tropicbird *aethereus, lepturus* and *rubricauda* as being present.

It has not been seen during this study and King (1967) and W. R. P. Bourne (pers. comm.) seriously doubt the authenticity of the early records. Until further evidence is obtained it should be dismissed from the Tongan list.

RED-TAILED TROPICBIRD *Phaethon rubricauda*

Gray (1859) recorded this bird from " Tonga Islands (Pylstaarts or La Sola Island)." This is the southernmost island of Tonga and is now known as 'Ata. Finsch & Hartlaub said that it occurred in Tonga in their book of 1867, but cast doubt on it in 1870, marking it " according to Gray." Layard (1876) reported seeing the Red-tailed Tropicbird in Tonga.

More recently Mayr (1945) and King (1967) referred to it as a breeding bird but offered no evidence. Carlson (1974) noted that it was less common than the White-tailed and implied that it may breed on some of the rarely visited islands. Anderson (1979) thought that it might breed on 'Ata where he saw small groups of 2-12 roosting (pers. comm.).

Up to now there is no evidence that it breeds in Tonga although the two records from 'Ata, over 200 years apart, suggest breeding there.

The few sightings at sea show that it is uncommon in Tongan waters, and since 1973 I have seen it only eight times. Records are: 1/3/74 one at 15/176W; 12/5/75 one at 22/176W; 12/6/78 one at 20/175W; 10/7/78 one at 21/175W; 27/8/78 one at 22/176W; 31/8/74 one at 20/175W; 8/9/76 one at 17/173W; 25/10/76 one at 15/174W. Five of these sightings are in the south of the area and so are close to 'Ata.

Red-tailed Tropicbirds are rarely seen in Fijian waters and breeding there has yet to be proved. Tarburton (1978) found the White-tailed breeding at widely separated sites in Fiji, but did not mention even seeing the Red-tailed.

The few Red-tailed Tropicbirds seen in Fijian and Tongan waters could come from 'Ata, if it is indeed a breeding island, or from the known breeding stations at the Kermadecs, Norfolk or Lord Howe. That these birds are capable of such wanderings is shown by the recovery at Gunners Quion Island, north of Mauritius, of a bird banded off Sumatra some 2700 n. miles distant (Jenkins & Robertson 1969).

WHITE-TAILED TROPICBIRD *Phaethon lepturus*

The White-tailed is the common tropicbird of Tonga, although it seems to have been misidentified by the early explorers. It was first noted by Layard (1876) as *P. candidus,* and he obtained an egg thought to be of this species from 'Eua. This record was repeated by Finsch (1877) who referred to the bird as *P. flavirostris.* The next recorded sighting was, apparently, that of Fry (1966) who saw it at Vava'u. King (1967) gave it as a breeding species for Tonga, as did Carlson (1974) who stated that it occurs on all the islands of Tonga, confirming breeding at Tafahi.

During this study, White-tailed Tropicbirds were seen in every square visited, throughout the year with little variation in numbers. Over 90% of observations were of single birds, six being the highest

number seen together. They have not been recorded in the mixed feeding flocks frequently met with in the area. Indeed, on many occasions they were seen to fly past such flocks, apparently ignoring the opportunity to feed. From this and other observations, the main food taken during the day seems to be flying fish, and the birds are often seen diving down to attack fish which are in the air. By day they are regularly seen resting on the sea surface, even in quite rough weather.

SULIDAE

Gray's (1859) Tongan records of boobies seem to be based on Forster's observations and note only one species *Sula (piscatrix) piscator* = *S. sula* as occurring there. His many references to *S. fiber* = *S. leucogaster* and a long list of islands where it was known to occur do not include Tonga. Finsch & Hartlaub (1870) said that *Dysporus sula* = *S. leucogaster* was recorded in Tonga by Forster, and suggested the presence of *Dysporus piscator* = *S. sula* (1867, 1870). Both species were reported by Layard (1876) without comment. A specimen of *Dysporus sula* = *S. leucogaster* was obtained from 'Eua and described by Finsch (1877).

The next reference to boobies in Tonga appears to be that of King (1967) who gave the Brown Booby as breeding and the Red-footed as visitant. Jenkins (1973) reported seeing all three species of South-west Pacific boobies off Vava'u. Carlson (1974) noted Red-footed Boobies breeding at Tafahi and suggested that the Brown Booby may breed at Vava'u. Dhondt ,1976) saw an adult and two immature Red-footed at Vava'u. A. John Halunen (pers. comm.) on a visit to Fonualei in January 1980 recorded "boobies" with young in white fluffy down.

BROWN BOOBY *Sula leucogaster*

These are seen in relatively high numbers between Late and Vava'u and about 'Ata, and since they are present all year, they probably breed at Late, Fonualei and at 'Ata. See *Postscript.*

At sea they are frequently seen sitting on floating logs and other debris, and this habit probably explains why they regularly settle on the buoys and reef markers at harbour entrances.

BLUE-FACED BOOBY *Sula dactylatra*

By far the rarest booby in Tongan waters, the Blue-faced was noticed, apparently for the first time in Tonga, off Vava'u in 1967 (Jenkins 1973). Since then small numbers of both adults and sub-adults have been regularly seen near 'Ata. Sea observations suggest that if breeding does occur in Tonga it would be at 'Ata. Anderson (1979) thought he saw Blue-faced breeding at 'Ata, and he said (pers. comm.) "... Masked Boobies living on the cliff edge at the south of the island. This colony of between 30 and 50 individuals had shallow holes in the soil which I took to be nests. Elsewhere around

the cliff edge small groups (2-4 individuals) of boobies under the foliage and some also seem to be occupving holes and crevices under boulders on the north side about 5 m above sea level."

It is hard to understand why Anderson did not find other species of booby at 'Ata, as both Red-footed and Brown Boobies are seen offshore in much greater numbers and more often than Blue-faced.

Blue-faced Boobies have been recorded in Tongan waters in all months except January, August and October, which suggests that they are present throughout the year.

RED-FOOTED BOOBY *Sula sula*

By far the most numerous booby in Tonga, it is present throughout the year with no obvious peaks. Jenkins (1973) suggested that Late was a breeding island, and further observations support this. The numbers of birds regularly seen near 'Ata suggest that it also is a breeding island. See *Postscript*.

FREGATIDEA

GREATER FRIGATEBIRD *Fregata minor*
LESSER FRIGATEBIRD *Fregata ariel*

Layard (1876) reported *Tachypetes aquilus* = *Fregata minor*, although from the text he seemed to be referring to frigatebirds in general. The first specific reference is that of the Whitney South Sea Expedition. Speaking of *ariel*, they recorded "half a dozen found roosting" and collected a female "with gonads enlarged" at Fatumanga on 8 August 1925 (Sibley & Clapp 1967). King (1967) said that *ariel* may breed but did not mention *minor* in relation to Tonga. Jenkins (1973) said that no frigatebirds had been seen in Tonga. Carlson (1974) said that the status of *minor* was not known and, without evidence, said that *ariel* is much more common in Tonga. Dhondt's (1976) report of an adult female *minor* over Nuku'alofa may be the first definite published sighting of this species from Tonga. Anderson (1979) said that at 'Ata *minor* was commonly seen and that it may breed.

Since 1973 both species have been seen in Tongan waters. To avoid misidentification and the confusion that was noted between these two species in Fiji (Clunie *et al.* 1978), only birds that were seen well and that were clearly adult were allocated to species. Distant birds, immatures and birds which appeared subadult were recorded as ? species. Records are: *ariel* definitely on 20 occasions for a total of 24 birds; *minor* definitely on 7 occasions for a total of 8 birds; ? species on 23 occasions for a total of 109 birds. The large number of ? species includes an observation of about 60 birds seen flying over Fonualei on 29 September 1976.

Both species therefore occur in Tonga, and these observations suggest that *ariel* is more often seen than *minor*. Confirmation is

needed for the probable breeding sites at Fonualei and 'Ata. See *Postscript.*

STERCORARIIDAE

I have found no previous records of skuas, and my own few sightings indicate that they are rare in Tongan waters.

ANTARCTIC SKUA *Stercorarius maccormicki*

A large skua much lighter in overall colour than the Southern Great Skua *(S. skua lonnbergi)* was seen on 7 December 1974 at 15/173W; it was noticeably straw coloured about the neck. Two other birds thought to be of this species have been seen closer to Samoa.

POMARINE SKUA *Stercorarius pomarinus*

One bird was seen on 7 December 1973 and one on 27 December 1973, both near 'Ata at 22/176W; one on 26 October 1977 at 18/173W.

ARCTIC SKUA *Stercorarius parasiticus*

One on 14 May 1979 at 20/175W.

STERNIDAE

The records of the commoner terns and noddies are so numerous that a fuller analysis of their distribution in Tongan waters is in preparation.

CRESTED TERN *Sterna bergii*

The confusion that existed concerning the first record of the Crested Tern from Tonga has been cleared by Medway (1979), who showed that it was first described from Tonga by William Anderson, the surgeon of the *Resolution* during Cook's third voyage, under the name *Sterna crestata.* There is a drawing in the British Museum (Webber folio 121) inscribed " J. Webber del 1777 Friendly Isles " (Lysaght 1959) and Medway (pers. comm.) notes that " A specimen of the Crested Tern from the ' Friendly Islds ' was taken back to England and went into the collection of Sir Joseph Banks. It may have been one and the same bird as that described by Anderson and drawn by Webber."

Finsch & Hartlaub listed the species as present in Tonga in their 1867 book but not in their paper of 1870. It was seen in Tonga by Layard (1876), and Finsch (1877) described a specimen from 'Eua. Mayr (1945) said that it occurs in Tonga. King (1967) said that it may breed. Jenkins (1973) reported small numbers at Nuku'alofa and at Ha'apai. Carlson (1974) noted some behaviour patterns. Dhondt (1976) said it is " regularly seen in small numbers over lagoons and reefs in Tongatapu and Vava'u."

This large tern is rarely seen offshore and my sightings have mostly been in Nuku'alofa Harbour where two or three are always

present. Though it must breed in Tonga, the actual sites have yet to be found. In Fiji, although it is common and much more critical bird study has been done, breeding was not confirmed until 1975 (Clunie *et al.* 1978).

[ROSEATE TERN] *Sterna dougallii*

Gray (1859) recorded it as *S. gracilis* from the " Tonga Islands." Finsch & Hartlaub repeated this in their 1867 book, but in their paper of 1870 they omitted it from the Tongan list marking it " according to Gray," thus casting doubt on Gray's specimen. Layard (1876), who noted that Finsch & Hartlaub gave it as occurring in Tongatapu, apparently did not see it. Gray's doubtful record persists in the literature with suitable warnings that it was unlikely to occur, but the Roseate Tern has not been reported from Tonga since. There is little evidence that it has ever occurred there, and so it should not be on the Tongan list.

SOOTY TERN *Sterna fuscata*

A common bird in Tongan waters, although I have found no early records of its being seen there. The first reports appear to be those of the Whitney South Sea Expedition, and Ashmole (1963) listed Sooty Tern specimens taken by the Whitney Expedition. The labels noted " nesting " 15 August 1925 on Fonualei, 1 August 1925 on Tokulu, 24 July 1925 on Hunga Ha'apai (many nesting on this last). Mayr (1945) said that Sooty Terns occur in Tonga, and King (1967) said that it may breed. Carlson (1974) suggested incorrectly that " It doesn't appear to be as abundant in Tonga as elsewhere." A. John Halunen (pers. comm.), during his short visit to Fonualei on the morning of 31 January 1980, noted " Near the top of the volcano was a very large colony of Sooty Terns. There were many eggs concentrated near the very top, in and near the vent area. Young birds, many of them just able to fly, were concentrated just below the top. It appeared that the young, shortly after hatching, moved down the volcano perhaps 100-200 feet, possibly because of the very large number of individuals incubating eggs in the vent area." Halunen also said that while it had been impossible to get any real idea of numbers, he would guess that the total may have been 100 000+. See *Postscript*.

It is interesting to note the breeding dates on Fonualei, 15 August in 1925 and 31 January in 1980.

Sooty Terns have been seen in almost all squares visited, although they are not present all year and the records need further analysis. The highest numbers have been seen near Fonualei and Toku and I commented on this in a previous paper (Jenkins 1973).

BROWN-WINGED TERN *Sterna anaethetus*
GREY-BACKED TERN *Sterna lunata*

I rather doubt my ability to separate these terns from Sooties at sea when, and if, they flock together in mixed feeding flocks.

The Brown-winged Tern seems to have been first recorded by Layard (1876) as *S. payana*. Mayr (1945) said that the species was reported from Tonga. King (1967) reported it as " visitant — may breed." Carlson (1974) seemed to repeat King's comment without adding to it. During this study only 10 observations have been made totalling 15 birds thought to be of this species, all close to land.

The Grey-backed Tern was first reported in the literature by Mayr (1945), who said it was common in Tonga. King (1967) reported it as " visitant — may breed." Carlson (1974) said that it was known to breed in Tonga. It has not been seen during this study, but this may reflect my inability to identify it.

BLACK-NAPED TERN *Sterna sumatrana*

First recorded in Tonga by Layard (1876) as *S. melanauchen*. Mayr (1945) said that it occurred in Tonga, but the next actual sighting appears to be that of Fry (1966) who saw " three pairs " at the entrance to Vava'u. King (1967) described it as " visitant — may breed." Carlson (1974) gave the first breeding record and commented " . . . but in any case there are probably few colonies of this bird in Tonga. Throughout the Islands I have found only one, possibly two, small breeding colonies in Ha'apai during April. All the nests I observed were placed on rock ledges on a cliff and comprised of small pebbles surrounding a bare rock area where the eggs were laid. The eggs which were laid two to a nest, with a few nests having only one egg, were small, ovate, and pointed at one end with a white base colour covered by blotches of brown, rust and dark grey." Dhondt (1976) recorded three Black-naped Terns at Vava'u. See *Postscript*.

My five records, which were made at or near Nuku'alofa wharf, were 26 August 1978 one probably immature as it had greyish brown marks at the fore-end of the upperwing; 11 September 1978 one adult; 26 September 1978 one which appeared immature; 15 April 1979 one adult; 8 October 1979 one adult.

WHITE TERN *Gygis alba*

First recorded by Forster (1844) as *Sterna candida* during Cook's second voyage. The localities given were Tongatapu and 'Eua, and the second voyage ships were at these islands in October 1773. It was also recorded at Tongatapu by Peale during the American Exploring Expedition (Hartlaub 1852). Forster's observations seem to be the source of the record in Finsch & Hartlaub's 1867 book. In their 1870 paper they repeated this record and added that it had been seen in Tonga by Graffe, although they omitted Peale's record. Graffe (1870) noted the birds in the forests of Tongatapu. Layard (1876) collected specimens at 'Eua and Tongatapu, and Finsch (1877) described a specimen from 'Eua. Fry (1966) reported it as common in Vava'u, and King (1967) gave it as a breeding species. Carlson (1974) said " The White Tern undoubtedly frequents every island in Tonga and probably breeds on most, if not all, of them." Carlson also said " The

main breeding season seems to be in December and January, although no doubt spreads over a few more months." Dhondt (1976) recorded White Terns at Tongatapu.

During this study White Terns have been seen throughout the year and in 22 of the 26 squares visited.

BROWN NODDY *Anous stolidus*

Finsch & Hartlaub (1870) noted that this bird had been found in Tonga by Forster, apparently the source of the record in their 1867 book. The journal of William Anderson contains a mention of " common noddy's " *(sic)* met with in Tonga in 1777 (Beaglehole 1967). This could have been *A. stolidus* if it was appreciated then that two species of noddies occurred there. Layard (1876) saw it, and Finsch (1877) described three specimens collected by Hubner at 'Eua, about which Finsch said " according to Mr Hubner this species breeds on the rocks on the east side of 'Eua." King (1967) recorded it as a breeding species. Jenkins (1973) said it was frequently seen.

Carlson (1974) in an interesting note on noddies in Tonga said " These birds may possibly breed in small numbers throughout the year, but the general breeding season of these two species, as well as most of the seabirds in Tonga, is during the months of December, January, and extending on until the birds are ready to leave the nest. Their breeding sites are mainly restricted to small uninhabited islands or the more secluded areas of those larger islands which are inhabited. Both birds build their nests in trees. The Black Noddy prefers branches of broad-leafed trees or clumps of leaves of pandanus trees, while the Brown Noddy is more commonly found nesting at the base of a coconut leaf or on ledges of rocky cliffs. The nests themselves are well constructed, composed of leaves, and small sticks and twigs, and normally only one egg is laid in each nest . . . Many times both species will breed together on the same island . . ." Dhondt (1976) recorded Brown Noddies in Tongatapu and Vava'u. Halunen (pers. comm.) found that at Fonualei on 31 January 1980 Brown Noddies had young which " ranged in development from totally in fluffy down to plumage complete enough to begin flying." See *Postscript.*

They have been seen throughout the year in 17 of the 26 squares visited during this study, usually further out to sea than the Black Noddy.

BLACK NODDY *Anous minutus*

The first record appears to be that of Layard (1876) who reported it as *Anous leucocapillus,* and said that he had seen the Brown Noddy at sea off the islands and that the Black Noddy was common even in the harbour at Nuku'alofa, an observation that is true today. Fry (1966) recorded the Black Noddy and almost certain breeding because he saw empty nests and immature birds at Vava'u on 26 June 1966. King (1967) recorded it as a possible breeder. Jenkins (1973)

said it was common throughout the Tongan Islands. Carlson (1974) recorded breeding in his note on Tongan noddies. Dhondt (1976) recorded it as "fishing much closer to the coast than the Brown Noddy." See *Postscript.*

In this study it has been recorded throughout the year in 10 of the 26 squares visited and almost always close to land.

GREY TERNLET *Procelsterna cerulea*

Finsch (1877) described two specimens of what he called *Anous albivittatus* = *P. cerulea* from 'Eua and said that it was a new species for Tonga. Mayr (1945) reported it as present in Tonga. Oliver (1955) reported it as breeding in Tonga. King (pers. comm.) noted that "... Oliver's mention of Blue-grey Noddies breeding in Tonga was the source of the listing in my identification manual." In 1973 I reported birds seen near Vava'u which could have been of this species, an observation about which I now have considerable doubt. Carlson (1974) said that its status in Tonga was unknown.

Grey Ternlets have been definitely seen three times during this study. Two of the sightings were near 'Ata where there were four birds on 27 December 1973 and two on 24 December 1979. One bird was seen near Tafahi at 15/173W on 1 March 1978. These appear to be the first records since Finsch (1877). Evidently these ternlets are rare in Tongan waters.

BREEDING ISLANDS

There are known breeding sites in the remoter parts of the inhabited islands, and there are probably several hundred small islets and stacks which could provide sites for small seabird colonies. It is, however, likely to be the larger more distant offshore islands, offering a variety of habitats, that are most important to the survival of the seabird population.

The islands of Kao and Late are uninhabited, although they are visited to collect copra. Both are high, well wooded, and appear to be suitable breeding islands. From observations made at sea it appears that Late could have a large colony of Red-footed Boobies and fewer Brown Boobies. Tofua is thinly populated but birds could breed on its high steep slopes without disturbance.

Sea observations and what little there is in the literature suggest that the most important breeding islands are Fonualei, the twin islands of Hunga Tonga and Hunga Ha'apai, and 'Ata.

Fonualei

This volcanic island rises to a well-defined peak about 182 m high. It suffered a major eruption in 1847. In January 1980 Halunen (pers. comm.) found that "Around the present crater were cracks several inches across from which steam and other gases were being expelled. Sulphur was being deposited near the exhalations. The

floor of the most recent vent was quiet. Some vegetation is growing in the vent area." Referring to Fonualei, the *Pacific Island Pilot* (1969) noted " . . . but no inhabitants are permitted by the Tongan Government to reside there on account of its liability to eruption. The island is visited occasionally by islanders from Vava'u."

Seabirds known to breed on the island include Wedge-tailed Shearwater, " Boobies," probably Red-footed and Brown, Sooty Tern and Brown Noddy. Those thought to breed include Audubon's Shearwater, White Tern, and possibly both Greater and Lesser Frigatebird.

Hunga Tonga and Hunga Ha'apai

The uninhabited islands of Hunga Tonga (149 m above sea level) and Hunga Ha'apai (121 m) lie about one n. mile apart. Both are rocky and steep, with sheer cliffs and thin vegetation.

Seabirds known to breed are Trinidade (Herald) Petrel, Wedge-tailed Shearwater and White-tailed Tropicbirds. Audubon's Shearwater and White Tern probably breed there, and there has been a suggestion that the Phoenix Petrel breeds there also.

'Ata

'Ata was named Pylstaert* by Abel Tasman who, in 1643, was the first European to sight the island. It is well wooded, about 289 m high, and off the southern end has two large stacks, 121 m and 91 m high. These stacks appear to be ideal seabird breeding sites. The *Pacific Islands Pilot* (1969) recorded " The island has been uninhabited since 1865 when the islanders were taken off and re-established on 'Eua Island, in the Tongatapu Group, on the orders of the then King of Tonga, to prevent further depredations by 'blackbirders'." Anderson (1979) described the archaeology of the island.

Seabirds which may breed are Audubon's Shearwater, Red-tailed Tropicbird, Brown, Red-footed and Blue-faced Booby, Greater Frigatebird, Brown Noddy and White Tern.

CONCLUSION

There has never been a full survey of either landbirds or seabirds in Tonga. Little has been published to indicate population numbers, and there is nothing to show whether species known to occur are increasing or decreasing. There is no information on what non-avian predators are present — it has yet to be established what species of rats occur on the various islands.

At present there is no Tongan Wildlife Service. If and when

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* The name Pylstaert is used on the British Admiralty chart. However, the correct Dutch is **Pijlstaert**. The name was given "*because there were* so many **Pijlsteerten.**" **Pijlstaert** literally means arrow-tailed and is used to denote the fledged end of the arrow. If it referred to birds it is difficult to know what species was meant.

such a service is formed, even with outside assistance, time will be needed to ensure the availability of trained personnel before the primary task of surveying hundreds of islands can begin.

Fortunately there are large uninhabited offshore islands where seabird breeding apparently continues unhindered. If one or more of these islands could be declared sanctuaries immediately, the areas concerned would remain undisturbed, in spite of the increasing human population and the need of more land for agriculture, until facilities are available for systematic bird study to begin. Four islands in particular appear to deserve consideration on present information — Fonualei, Hunga Tonga, Hunga Ha'apai and 'Ata.

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Speculation and opinion in this paper are my own.

POSTSCRIPT

Since this paper was prepared I have received the following important notes on Tongan seabirds from David Todd, who was in Tonga for about 14 months during 1978-1980 studying the Niuafo'ou Megapode *(Megapodius pritchardii)* and was able to visit many of the islands of Tonga.

P. a heraldica

Todd saw these birds in " hundreds " flying close to Hunga Tonga and Hunga Ha'apai in August 1979. In February 1979 he saw " large numbers around the small islands to the north of the eastern end of Tongatapu, and between Tongatapu and 'Eua. Two were seen flying high over the southern tip of 'Eua during the day. On 31 March 1979 there were many near Fonualei . . ." It is interesting to note that Fakave, the island where Carlson (1974) suggested that summer breeding occurred, is one of the small islands to the north of the eastern end of Tongatapu. These observations correct my statement that the bird occurs " in relatively small numbers " and indicate summer breeding.

P. pacificus

On 31 March 1979 Todd noted " one almost fledged young was found in one of the many burrows on Fonualei."

Sula leucogaster

He saw them on or near all the islands visited and added " In August 1978 a few were seen on the cliffs at Hufangalupe, Tongatapu. Over 100 were seen around the Hungas during the same month. In February 1979 more than 30 were on the cliffs in the south of 'Eua. On 31 March 1979 more than 50 moulting adults and fledged young were seen on one boulder beach on Fonualei."

Sula sula

Todd saw them throughout Tonga except around Tongatapu and 'Eua. He recorded that " In August 1978 many were in the trees on the two Hungas. It was not possible to land to confirm breeding. On 31 March 1979 they were seen building nests in the trees on Fonualei and Toku."

Fregata sp.

He recorded frigatebirds " throughout Tonga and in cases where I could identify the species, more proved to be *F. minor* than *F. ariel.* On 31 March 1979 male Greater Frigatebirds were seen displaying on Fonualei."

Sterna fuscata

Todd saw " thousands " circling above Hunga Ha'apai on 21 August 1978 and above Fonualei on 31 March 1979.

Sterna anaethetus

Birds thought to be of this species were occasionally seen off Tongatapu and Vava'u in February, March, and May. However Todd said that he could not be sure that the birds were not *lunata.*

Sterna sumatrana

Seen off Tongatapu and Vava'u, and on 17 May 1980 Todd saw an adult feeding a fledged young bird on Onevai Beach off Nuku'alofa.

Anous stolidus

He saw a nest with an egg at Hufangalupe in August 1978, and nests with eggs and young at all stages of development were found at Toku on 31 March 1979.

Anous minutus

Recently fledged young were seen on Toku 31 March 1979.

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SHORT NOTE

NORTHWARD MIGRATION OF SHORT-TAILED SHEARWATERS IN THE TASMAN SEA

On 25 April 1980, the *Union Rotorua,* bound from Sydney to Auckland, encountered migrating Short-tailed Shearwaters *(Puffinus tenuirostris)*. The ship's course was 092° with a speed of 18 knots. From 14.55 to 14.58 hours in position 33°48'S 158°29'E (357 miles east from Sydney Heads), the ship passed across a dense stream of migrating Short-tailed Shearwaters flying very fast at about 40-50 knots, 3-15 m above sea surface. During the 3 minutes at 14.55-1458 hours, birds were counted crossing the bow at a rate of about 1000 per minute. This density of birds extended along their track to the limit of binocular vision. From 14.58 to 1520 hours birds crossing the bow averaged 50 per minute, and thereafter until darkness only occasional small flocks were seen.

All the birds were flying on a course of about 030°, aided by a favourable 25-knot wind from 165°. Their course from the position at 1455 hours would take them about 20 miles south-east from Balls Pyramid, Lord Howe Group, and thence to the south-east corner of New Caledonia.

NEIL CHESHIRE, *140 Glamorgan Drive, Torbay, Auckland 10.*

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

By PETER C. HARPER

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).

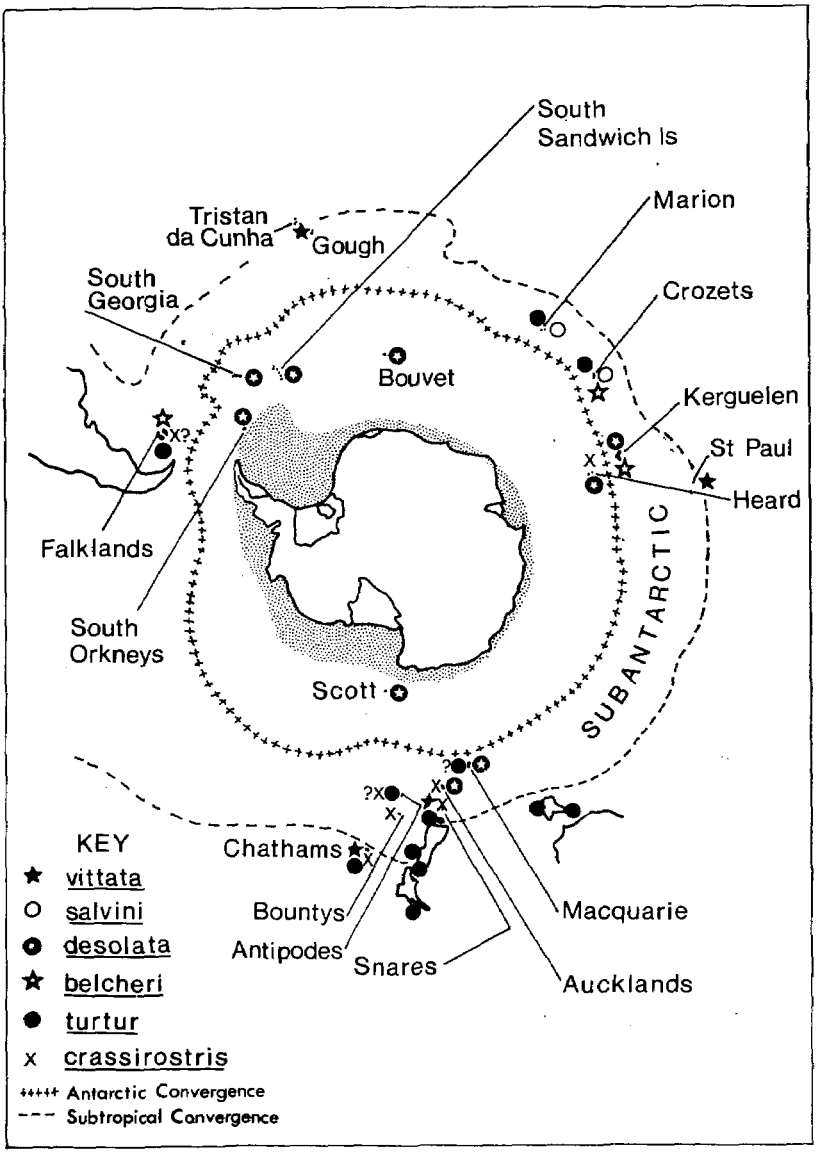

FIGURE 1 — Map of breeding localities of **Pachyptila** prions.

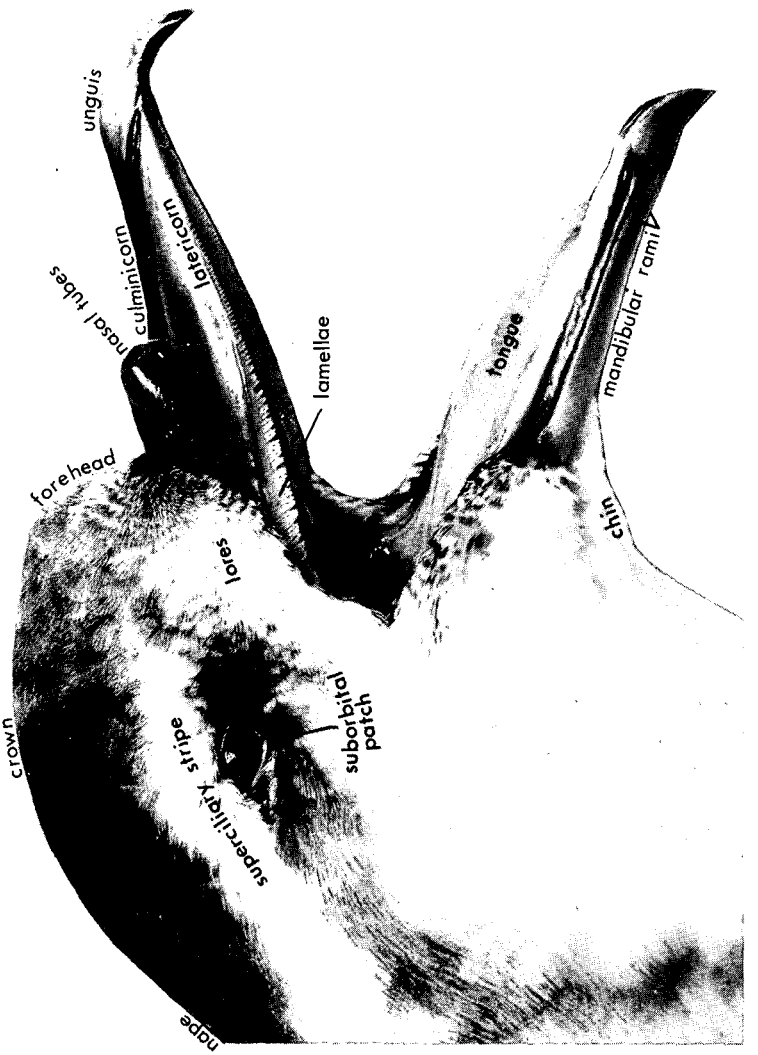

FIGURE 2 — Description of **Pachyptila** headparts illustrated by an Antarctic Prion, **Pachyptila desolata.**

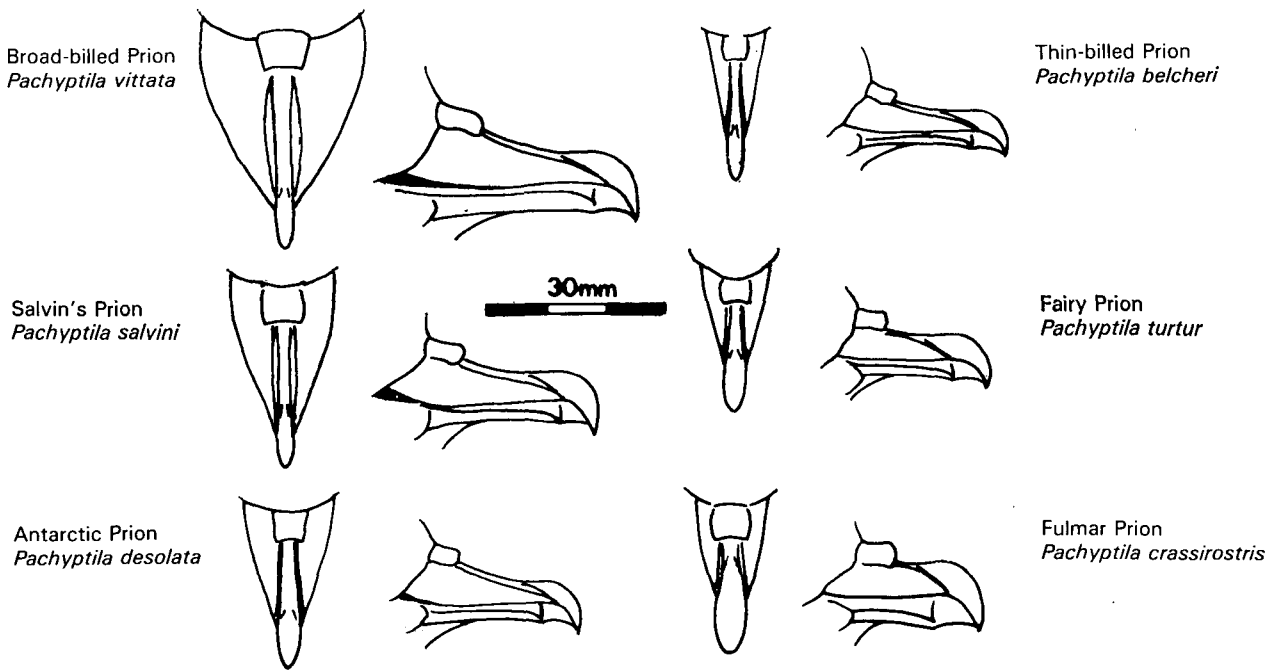

FIGURE 3 — Adult bill profiles of the six species of **Pachyptila.**

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

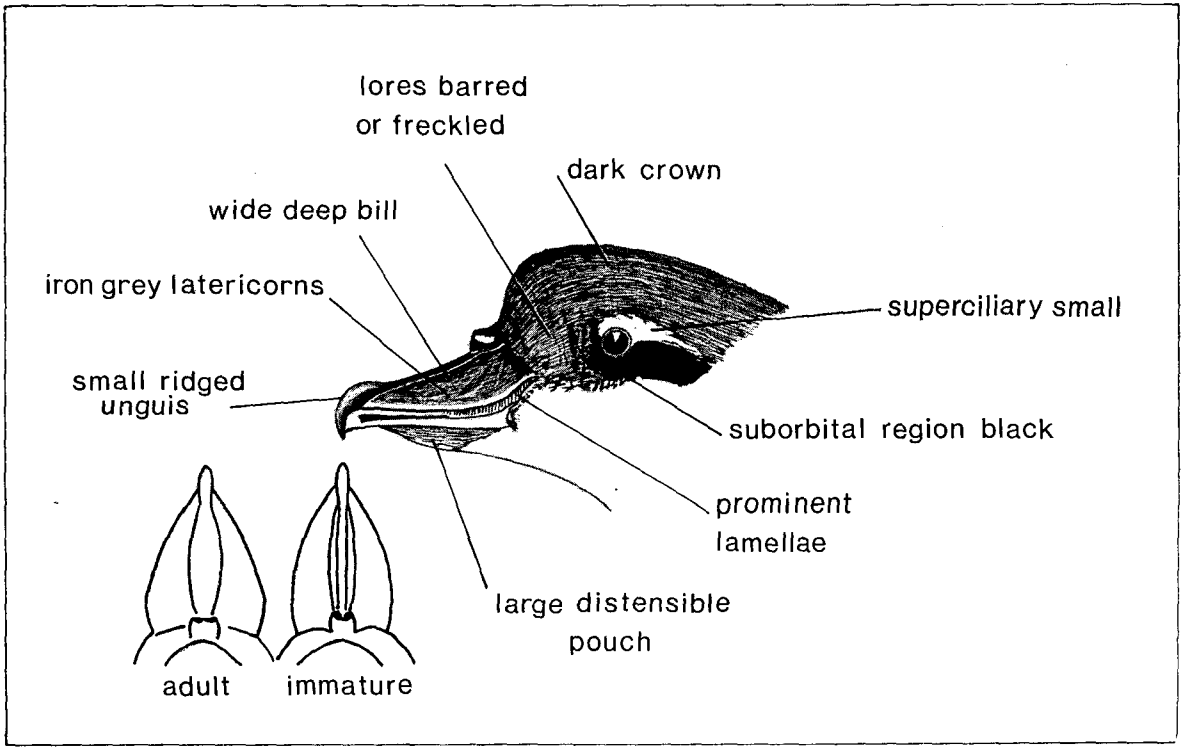

FIGURE 4 — Broad-billed Prion headparts and bill profiles of adult and immature birds.

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.

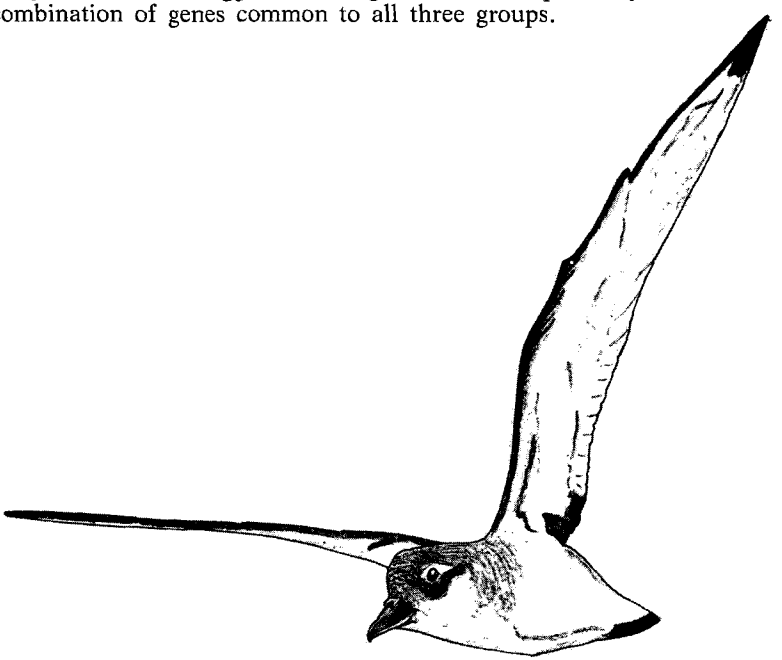

FIGURE 5 — A Broad-billed Prion in flight off the Chatham Islands, cruise 23, 1966 (adapted from photograph).

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

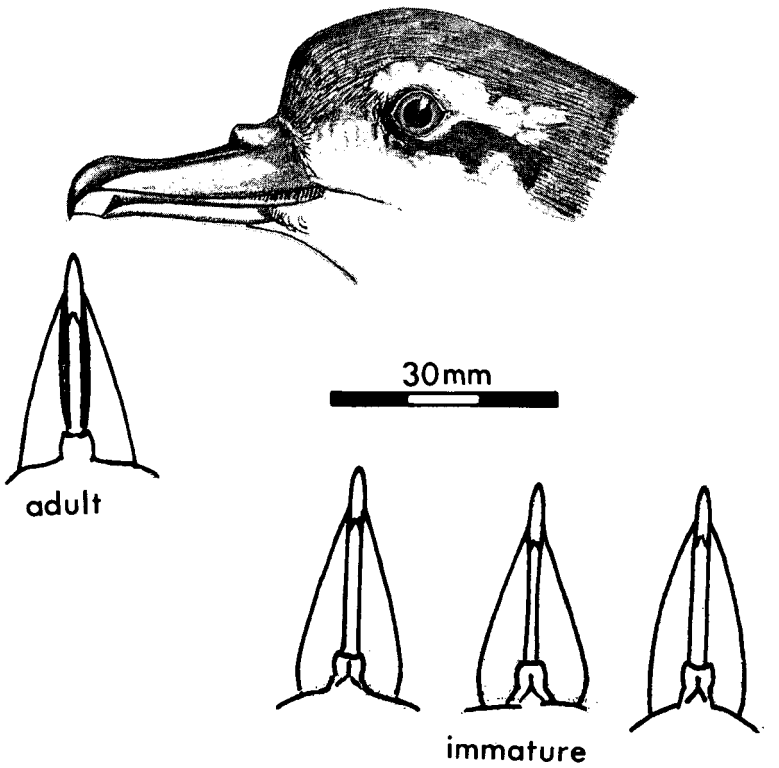

FIGURE 6 — (a) Headparts of Salvin's Prion, **Pachyptila salvini.**

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

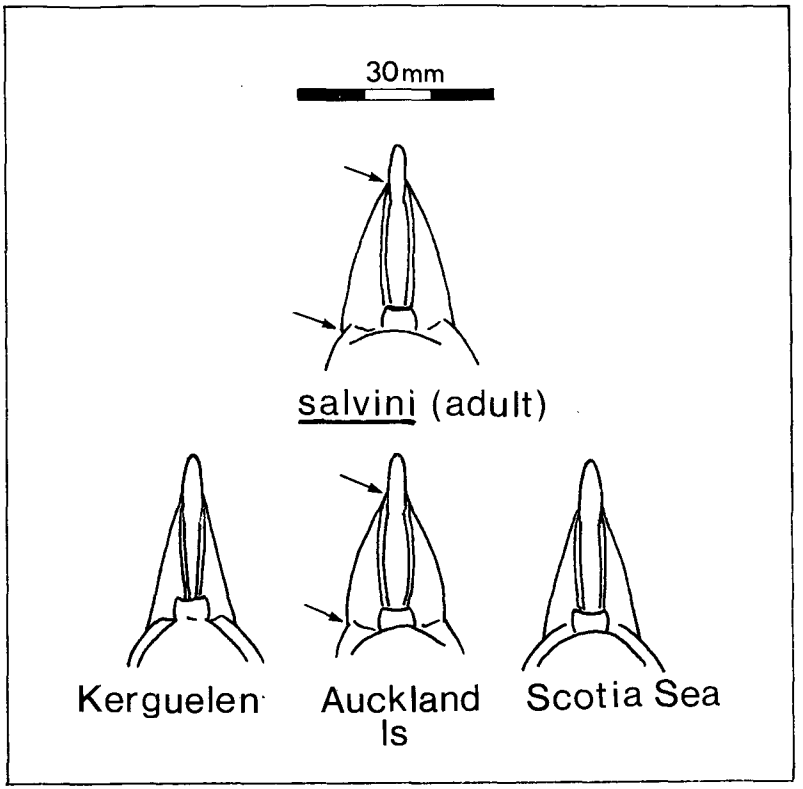

FIGURE 7 — A typical adult **salvini** bill compared with typical examples from three **desolata** populations. Auckland Island **desolata** show the closest resemblance to **salvini**. Note, however, the smaller overall size, larger unguis, and shorter length of the outside edge of the latericorns of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

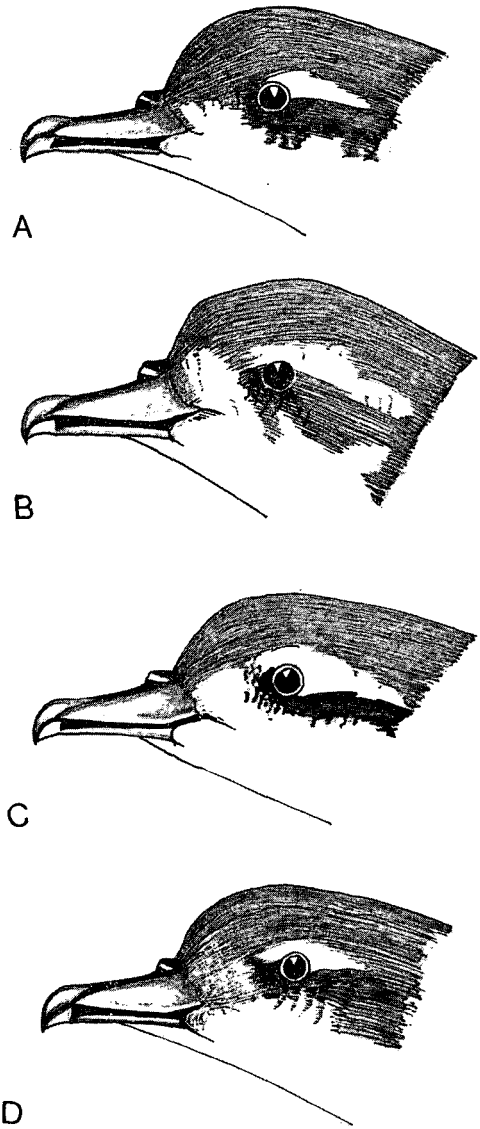

FIGURE 9 — Antarctic Prion, **Pachyptila desolata**, representative examples, drawn to scale.

(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).

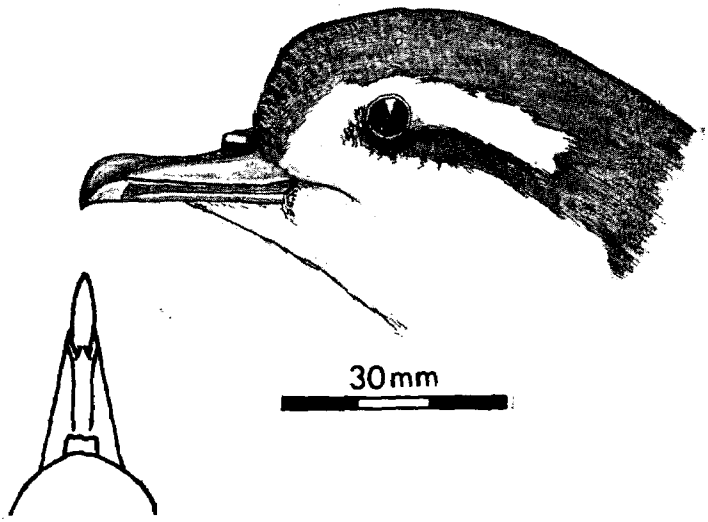

FIGURE 10 — Headparts of the Thin-billed Prion, **Pachyptila belcheri.**

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

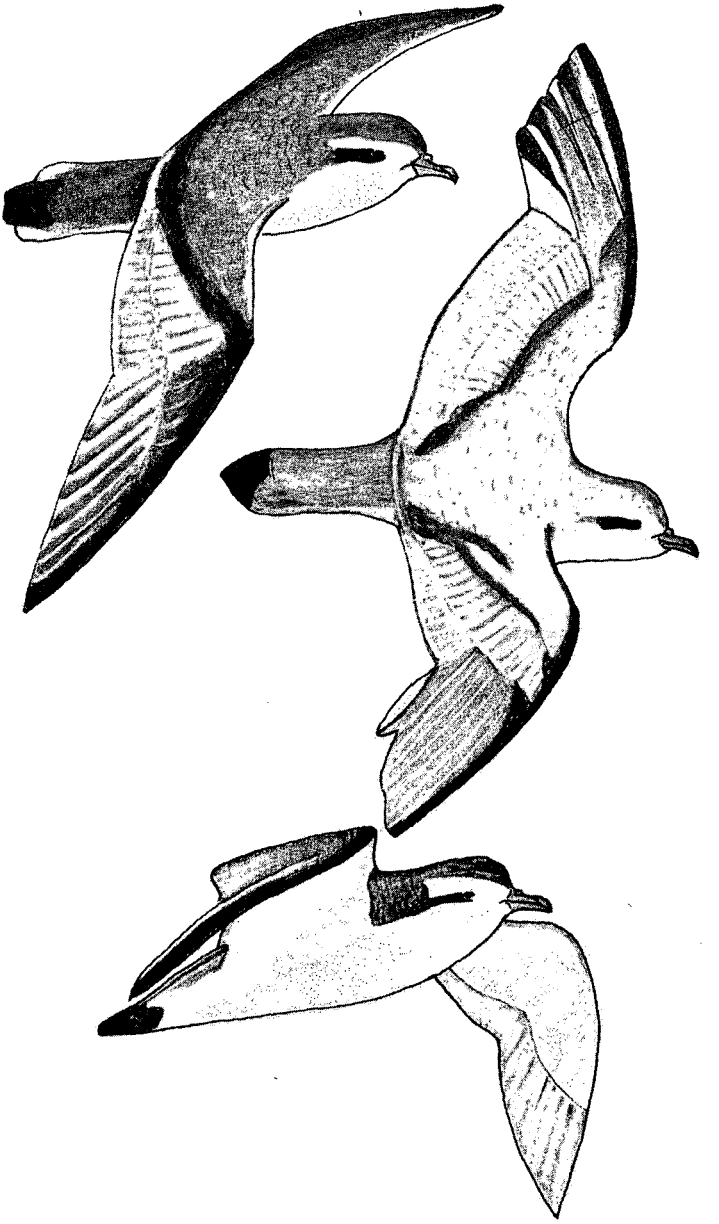

FIGURE 11 — Thin-billed Prions in flight (adapted from photographs), Pacific, 1966.

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.*

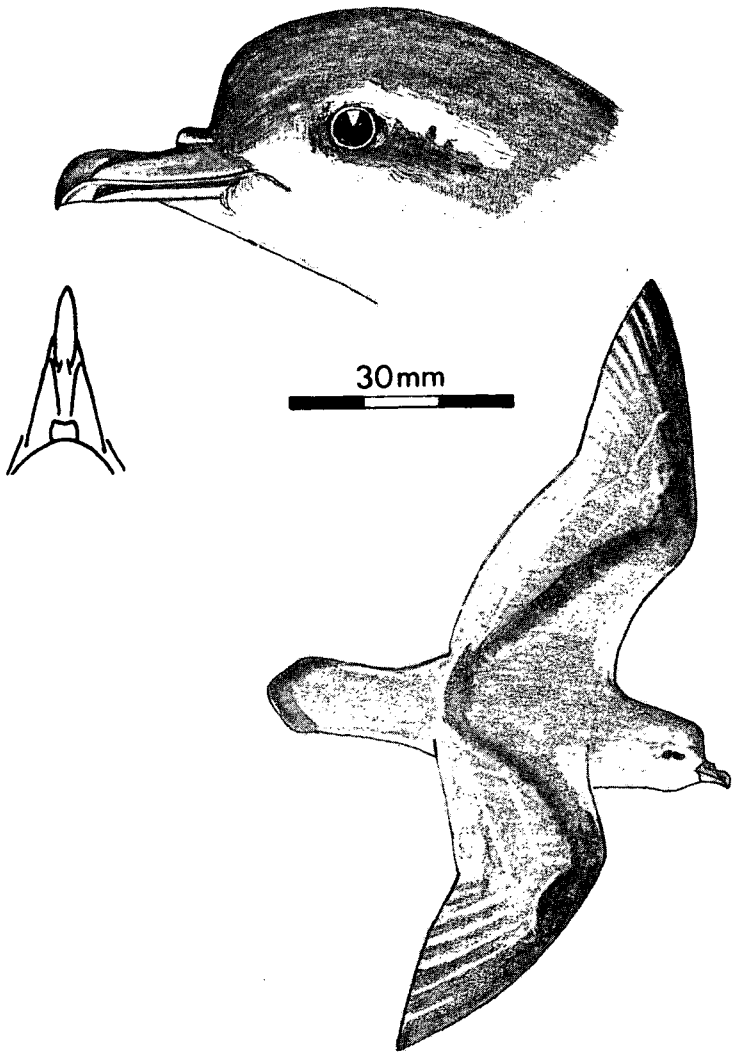

FIGURE 12 — Fairy Prion, **Pachyptila turtur**; headparts and bird in flight (adapted from photograph).

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

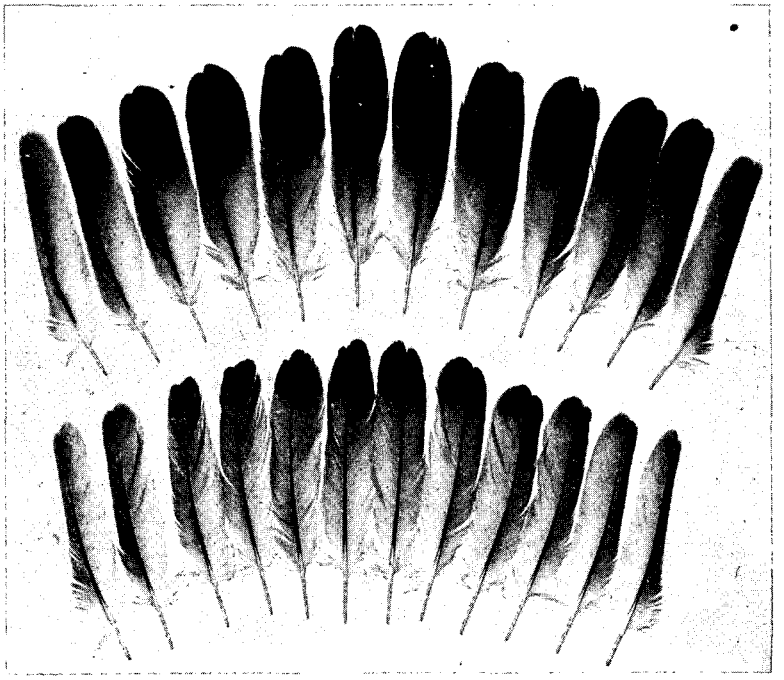

FIGURE 13 — Tail feathers of **turtur** (above) and **belcheri** (below). Note the characteristically darker tips to the rectrices of **turtur** (and **crassirostris**) as compared to **belcheri** (and **vittata, salvini, desolata**). An excellent identification aid both at sea and for birds in the hand.

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

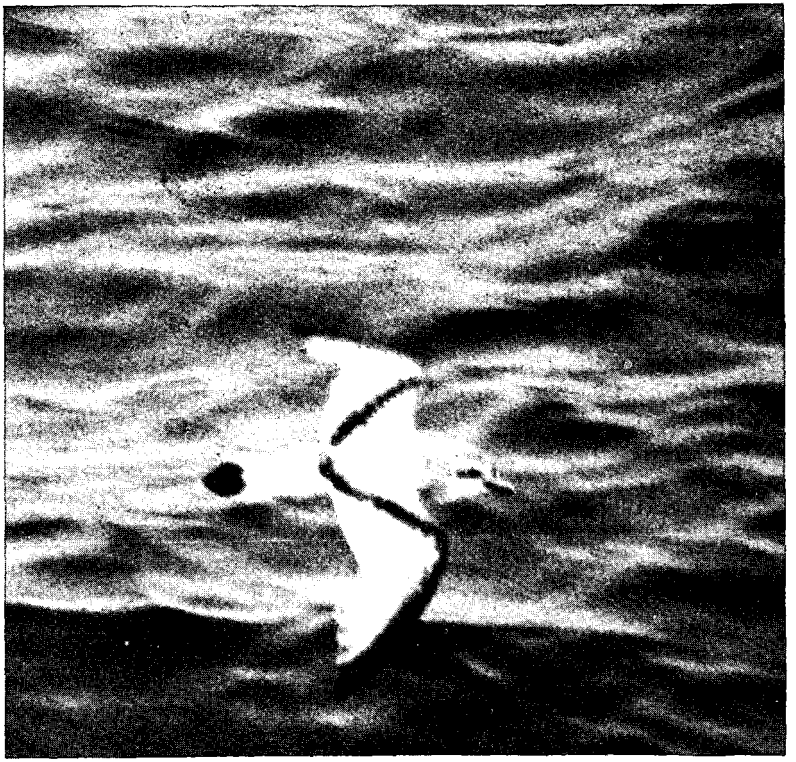

FIGURE 14 — A Subantarctic Fairy Prion (**P. turtur subantarctica**) photographed off the Antipodes Islands, 3 February 1967.

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.

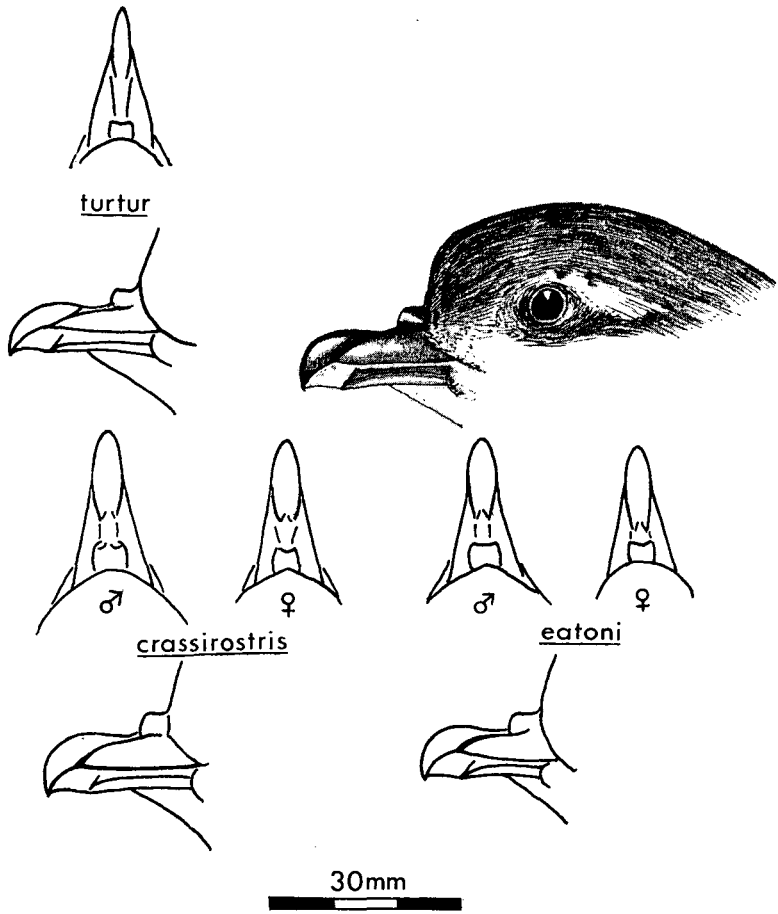

FIGURE 15 — Headparts and bill profiles of the Fulmar Prion. A bill of **turtur** is shown for comparison.

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.

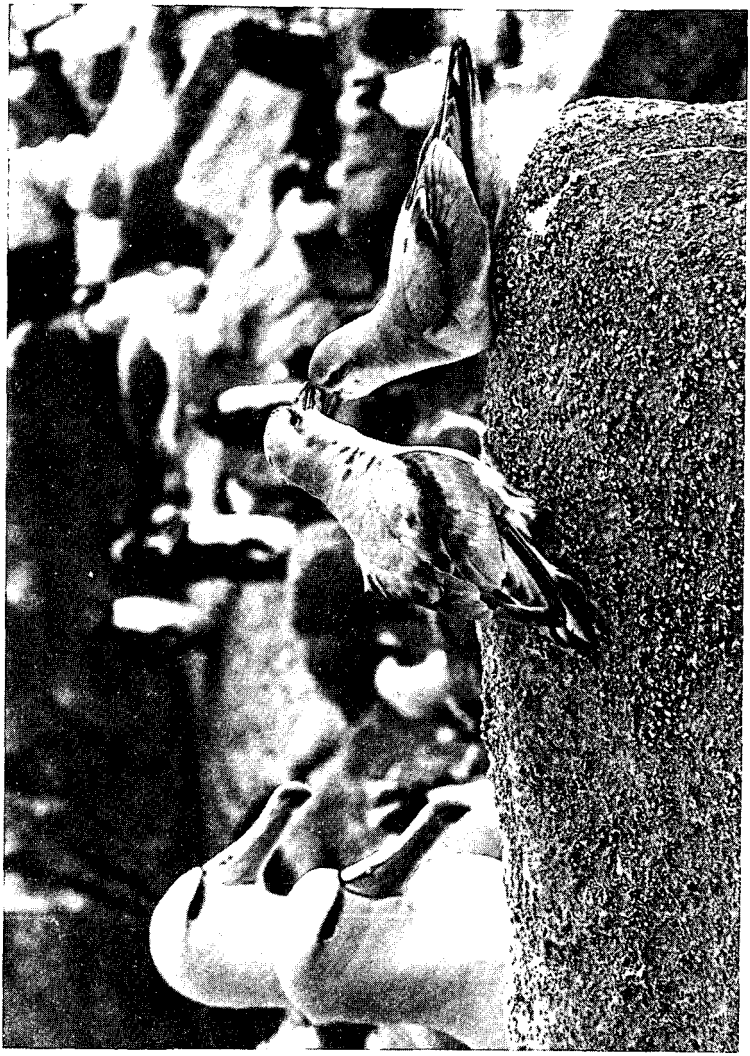

FIGURE 16 — Fulmar Prions at the Bounty Islands. Photo: Evening Post

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	

ACKNOWLEDGEMENTS

I respectfully dedicate this contribution to the memory of Robert Alexander Falla (1901-1979). To everyone who unloaded sack-loads of prions at my door over the past 21 years I extend my sincere gratitude. I have not answered all their questions here, but more is

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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SEX DETERMINATION OF THE PUKEKO OR PURPLE SWAMPHEN

By JOHN L. CRAIG, BRIAN H. McARDLE and PAUL D. WETTIN

The Pukeko or Purple Swamphen *(Porphyrio porphyrio melanotus)* has monomorphic plumage, which makes sexing of the living bird difficult. A method of sexing using body measurements has been proposed (Williams & Miers 1958), but it uses measurements and cut-off values which are not fully reliable. While cut-off values may vary geographically, the reliability of the different measurements should not. This paper uses multivariate techniques to investigate the reliability of combinations of measurements for sexing swamphens and outlines the problems with the existing method.

METHODS

During a 3-year study on Pukeko in the Manawatu, New Zealand, by JLC, 133 birds were captured and many subsequently recaptured. Four head measurements (Fig. 1) and weight were taken at all first captures and many of the recaptures. The subsequent behaviour and/or death of these individually tagged birds allowed sex to be assigned for most. The five measurements taken at all captures and in all months of all definitely sexed individuals with adult characteristics (i.e. red culmen, shield and legs) were used in an attempt to determine which measures, or sets of measures, best distinguish the sexes. A 2-group Discriminant Function Analysis was performed using the BMD statistical package (Dixon 1974), and discriminant functions were calculated for every combination of these measures (see Table 1). To determine the sex of an individual, a linear combination of the variables is calculated and compared with a cut-off value — i.e. an individual is classified as a male if

$$\sum_{i=1}^{5} a_i V_i > C$$

where a_i is the coefficient of the discriminate function; V_i is the i^{th} variable and C is the appropriate cut-off value. Otherwise the individual is a female. To rank these sets of measures according to their ability to discriminate between the sexes, the probability of misclassifying an individual was calculated for each set. This ranking is only approximate because the assumptions underlying the statistic are probably not met (Rao 1952).

The same measurements (excluding depth) for a small number of birds sexed by observations of behaviour were available from a similar

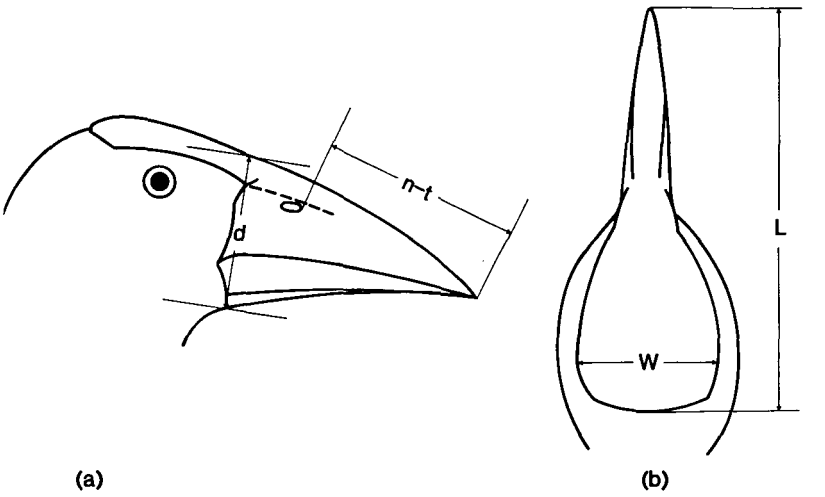

FIGURE 1 — (a) Side view of head measurements. n-t = nares to tip.. d = bill depth.
(b) Top view of head measurements. L = culmen + shield length. w = shield width.

study carried out (by PDW) at Longneck Lagoon in New South Wales. These birds were sexed using the functions produced from the Manawatu sample.

RESULTS AND DISCUSSION

Use of the Discriminant Function Analysis on the Manawatu sample, which included birds of all ages that were indistinguishable from adults and which included measurements taken in all seasons, allowed ranking of the different combinations of these variables as reliable indicators of sex (Table 1). Table 1 also contains the coefficients of the discriminant functions and the suggested cut-off points (assuming equal sex ratio). This analysis showed that use of all characters was the most reliable method of sexing, but this is not easily applied in the field. The single most reliable variable was *nares to tip* (8.8% error). The least reliable was shield width (27.2% error). Williams & Miers (1958), using an unweighted combination of culmen and shield length and weight, found an error rate of 6.6%. Using the same two characters, from our data a weighted combination of culmen plus shield length and weight gives a 7.4% error. Real cut-off measurements for a single character can be obtained by dividing the 'cut-off value' (Table 1) by the coefficient of discriminant function for that character.

When the coefficients and cut-off values obtained with the Manawatu sample are applied to the limited data from New South Wales, nares to tip was the only single character that allowed correct sexing of this rather small sample. Weight or any combination using

TABLE 1 — Combination of variables ranked according to reliability as predictors of sex. (The coefficients of discriminant function and the cut-off values are included for comparison.)

Variables Incorporated	Estimated % error	Coefficients of Discriminant Function for Variables					Cut-off Value
		1	2	3	4	5	
1 2 3 4 5	2.5	.0083	-.00816	.015	.0094	.00017	1.258
1 2 3 5	3.0	.011	-.01	.016		.0002	1.156
1 2 3 4	3.4	.0081	-.0056	.014	.012		1.195
1 3 4 5	3.5	.0029		.011	.014	.00012	1.053
2 3 4 5	3.7		-.0019	.015	.015	.00017	1.019
1 2 4 5	3.9	.0084	-.0053		.011	.00016	.940
3 4 5	3.9			.013	.016	.00014	.996
1 3 4	4.1	.004		.011	.015		1.052
1 4 5	4.6	.0045			.014	.00012	.852
1 2 3	4.7	.011	-.0078	.016			1.05
3 4	5.0			.015	.018		.966
2 3 4	5.0		.00039	.014	.018		.962
1 2 5	5.1	.011	-.0076			.00019	.788
1 2 4	5.1	.0082	-.0032		.013		.897
1 4	5.4	.0057			.015		.846
1 3 5	5.6	.0047		.011		.00014	.770
2 4 5	5.8		.0096		.017	.00016	.695
4 5	5.9				.017	.00017	.684
1 3	7.0	.0062		.012			.771
1 5	7.4	.0064				.00014	.581
3 5	7.5			.015		.00019	.627
2 4	7.6		.0029		.019		.657
1 2	7.6	.012	-.0055				.696
4	8.8				.020		.603
1	9.6	.0079					.554
2 3	12.6		.0064	.017			.573
3	12.7			.018			.518
2 5	14.0		.00092			.00021	.227
5	14.2					.00023	.217
2	27.2		.0037				.096

Variable 1 = Culmen + shield length; 2 = Culmen width; 3 = Depth, 4 = Nares to Tip; 5 = Weight.

this character were of little or no use, as none of the males or females at Longneck Lagoon reached Williams & Miers' cut-off weight of 950 g.

The published method devised by Williams & Miers (1958) relies on the combined measurements of culmen plus shield length (Fig. 1) and body weight. Adult males were considered to exceed 950 g with a culmen and shield length exceeding 70 mm. Owing to limitations imposed by sampling during the non-breeding season, and from two localities only, Williams & Miers were unable to account for seasonal, age or geographical variations. They suspected that such differences may introduce complications, and this study attempts to determine which variables are the most stable with season and age.

Weight is the least reliable measurement for sexing pukeko. Seasonal variations in weight were common, especially for breeding females (cf. Anderson 1975). More serious was the geographic variability. At Longneck Lagoon few males reached the 950 g cut-off weight determined by Williams & Miers from their New Zealand samples. This is also known to occur in other areas in New South Wales (B. Gilligan, pers. comm.). The extent to which geographical variation affects the other variables is unknown but could be significant.

Culmen plus shield length is also subject to seasonal variation. The shield characteristically swells with the onset of breeding and regresses later in the year. Such changes are well documented for other gallinules (see Gullion 1951, Anderson 1975). This measurement also correlates with social status (Craig 1974). Furthermore, young of the year from 4-5 months can have a fully red shield and legs, thus being indistinguishable from adults, but still have a small culmen plus shield length and hence appear to be female. Even yearlings (up to 18 months old) retained in their natal territory and socially prevented from breeding have a juvenile-sized shield and hence fall within the female range.

Three other measurements were used in our studies. Shield width suffered from all the limitations mentioned above. The remaining two measurements, nares to tip of the beak (N-T) and depth, had a number of advantages: (i) both have hard end-points which ensure minimal operator error; (ii) neither varies seasonally; and (iii) both reach adult size by the time the shield has become red and so juveniles need not be separated out by eye colour or other characteristics. It is not surprising, then, that these latter two measurements (nares to tip, and depth) had the lowest error when two measurements were used.

CONCLUSIONS

We recommend the use of the measurements *nares to tip* and *bill depth* for sexing *Porphyrio p. melanotus*. These measurements have fixed end-points allowing accurate reproduction. They also allow sex determination at the earliest age and do not vary seasonally. However, in any study, the more independent measurements used, the greater the accuracy that can be obtained. It should be stressed that

homosexual and reverse copulations do occur, making short-term observations insufficient for accurate sexing.

Though the variables *nares to tip* and *bill depth* are remarkably stable over age and seasons, it seems unlikely that they will have the same absolute values for all populations. It is also doubtful that any simple set of cut-off points could be generally applicable, and we recommend that other workers derive their own cut-off values for the reliable measurements.

ACKNOWLEDGEMENTS

We wish to thank Geoff Tunnicliffe for first drawing attention to the *nares to tip* measurements and Graham Hardy and Ian McLean for comments on the manuscript.

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SHORT NOTES

SOME RED-CAPPED DOTTEREL RECORDS

The Red-capped Dotterel *(Charadrius alexandrinus ruficapillus)* has a curiously inconclusive history in New Zealand. Apart from an isolated record of an adult male collected near Waikanae in December 1878, its history is limited to that of, apparently, a single female that bred with a Banded Dotterel *(C. bicinctus)* in 1947 and 1950, successfully raising at least one hybrid young (Oliver 1955, *New Zealand birds)*. It presumably bred also in the intervening years. This occurred on the Ashley River bed in northern Canterbury. On the ocean beach near the mouth of the Ashley River and, on one occasion at the mouth of the nearby Waipara River, an adult female was seen repeatedly in October-December 1955 but not in February-May 1956 (W. C. Clark & B. D. Heather 1957 *in* Class. Summ. Notes, *Notornis* 7 (3): 80).

More recent reports, as yet unpublished, of dotterels seen in the Ashley River area that were Red-capped, hybrids, or both suggest that a small population may still persist. I therefore wish to put on record several recent sightings of my own in case they will contribute to a better understanding of the species' status in New Zealand, once the situation in Canterbury is better known.

On 2 February 1963, at Lake Tuakitoto, South Otago, D. V. Merton and I saw a small neat dotterel, grey above, clean white below, which showed a faint reddish tinge on crown and nape and had sharply defined grey shoulder patches. Much smaller than nearby immature Banded Dotterels. We guessed it to be an immature female.

On 13 March 1966, a party consisting of D. V. Merton, Miss M. C. R. McIntyre, D. Bettesworth, R. Buskell, Miss S. Fogarty, and I saw at Miranda, Firth of Thames, a bird that was apparently a juvenile Red-capped. It was much smaller than the c.145 Banded Dotterel and single Mongolian Dotterel *(C. mongolus)* it was with. It was clean grey and white, with no trace of buff. Its face was conspicuously white, and its shoulder patches were disc-shaped, pointed, and clearly defined. On 25 February 1968 I saw another very small dotterel at Miranda that had a very fine bill, but no further description was taken. On 22 March 1968, R. B. Sibson (pers. comm.) saw a Red-capped Dotterel at Kidd's Bay, Karaka, feeding in a puddle with a stint and a Banded Dotterel. Its nape was rufous but not its crown. Its legs were black.

On 13 January 1970, I saw two birds among the Banded Dotterels at Karaka, Manukau Harbour. Both were small and with tiny bills compared with the Bandeds. One had a white face, a slightly rufous crown, and the typical well-defined part band or shoulder patch. The other was presumably a hybrid, rather slate-grey overall above, with no shoulder patch, but with a faint lower-breast band like that of many Banded Dotterels at this time of year.

On 11 February 1975 I noted one in a field with Banded Dotterels at Karaka, but a description was not kept.

To complete the record, on 7 December 1975 a single bird was seen at Karaka on the mud. It had no rufous markings (B. Brown 1976, *Notornis* 23 (4): 336).

One wonders whether these birds were stragglers from Australia or, among Banded Dotterels, from Canterbury.

H. R. McKENZIE

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ACQUISITION OF A SPECIMEN OF THE NEW CALEDONIAN KAGU (CAGOU)

The Kagu, or Cagou (*Rhynochetos jubatus* Verreaux & Des Murs, 1860) is to New Caledonia what the kiwi is to New Zealand: a national emblem, endemic, at least partly nocturnal, almost flightless and a threatened species facing extinction as a result of reduction of its forest habitat and decimation by fire and introduced mammals since the arrival of European Man.

It is a kiwi-sized light blue-grey bird with a crude but prominent crest, strong beak and legs, and a piercing stare. Because of its small numbers, threatened status and occupation of montane forest areas,

its habits are poorly known. So are its relationships and origin. It is placed in a monotypic family and suborder within the Gruiformes and is thought to be most closely related to the tropical finfoots (Heliornithidae) and the sun bittern (Eurypygidae).

The Kagu has recently begun to warrant greater interest on the part of New Zealand ornithologists with the claim (Olson & Zusi, *in* Olson 1977) that our extinct *Aptornis* should be removed from the Rallidae and afforded a family of its own and that its closest affinity appears to be with *Rhynochetos*. A full discussion of this opinion has not yet been published, but already it is gaining acceptance. Stevens (1980, p. 253, 308), for example, cites the kagu as a remnant of the original Gondwana fauna (although more advanced than the kiwi, moa and other such ratite remnants) with an affinity with *Aptornis* dating back " a very long time."

To permit direct osteological comparison and because no kagu skeleton was held in a New Zealand institution, an approach was made to the Chef du Service des Eaux et Forets of the New Caledonian Direction Territoriale des Services Ruraux to obtain a skeleton. Some months later I was informed that a bird had died in captivity and that the skeleton would be despatched after necessary preparation and documentation. The specimen arrived in June 1980 and was found to be the complete carcase. Because of preservation in formalin the skin and plumage could not be saved during extraction of the skeleton, but the internal organs have been retained.

The skeleton has been disarticulated and cleaned and is lodged in the collections of the University of Auckland Geology Department under the acquisition number V13. The gut, heart and trachea have been placed in the keeping of the Auckland Institute and Museum and registered there as acquisition number AV1359.1. The remains are available for study and loan to interested workers.

The carcase was accompanied by an official " Fiche de Renseignements " which showed that the bird had been captured in August 1976 at about 9 months old and judged to be male because it " appears to have paired with female No. 23 which produced an egg in 1979." It was brought to the Noumea Parc Forestier in February 1980 and the same day " died perhaps of a broken heart at the departure of its owner." It would thus have been a little over four years old. At death it had an overall length of 53 cm, a wingspread of 77 cm and weighed 860 grams; other details are given on the information sheet.

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Photo: C. R. Veitch, Wildlife Service

PLATE IV — Chatham Island Tit, South East Island, September 1976.

Photo: C. R. Veitch, Wildlife Service

PLATE V — Spur-winged Plover, Cass River, November 1977. The chick hatched 2 days before the others.

PLATE VI — Roseate Spoonbills at Manawatu Estuary. Note the pale "eyebrow" mark, which is yellow and a feature of adults.
Photo: M. D. Dennison

THE PRIONS COLLECTED BY R. H. BECK OFF THE ANTIPODES ISLANDS AND THE BREEDING SEASON OF THE LITTLE SHEARWATER

In their recent interesting account of the birds of the Antipodes Islands Warham & Bell (1979) remark that the Whitney South Sea Expedition collected four prions nearby on 15 February 1926. Dr Warham informs me that they obtained the information from R. H. Beck's diary, and during my last visit to New York I searched the collection in the American Museum of Natural History for the specimens. They shed interesting light on the reliability of data as well as the avifauna of the Antipodes Islands.

While I failed to locate any birds with that date, I eventually found four specimens which could be the birds in question (Table 1), although like the Little Shearwaters *(Puffinus assimilis)* taken at the same time, the location is given as 49°S 179°W as reported by Murphy (1927), whereas the Antipodes Islands which were supposedly in sight at the time are usually thought to lie in 179°E. This is not the only time labelling problems have occurred with longitude in this collection, as they also occur with the Flesh-footed, Buller's and Hutton's Shearwaters *(Puffinus carneipes, P. bulleri* and *P. huttoni)* at the Chatham Islands (Bourne 1967). Similar problems arise with the date.

The serial numbers of the Little Shearwaters said to have been collected at the same place on 16 February are 211019 and 211648-52. I conclude that all these birds were probably part of a mixed bag collected in the vicinity of the Antipodes Islands which were labelled erratically under the pressure of processing them in cramped conditions at sea, and as with a great many other older specimens from the subantarctic islands of New Zealand, it is necessary to exercise caution over the dates and localities. Bearing this in mind, it still seems likely that the birds that Beck shot before breakfast off Antipodes Island on 16 February 1926 (Warham & Johns 1979) included the first Antarctic Prion *(Pachyptila desolata)* for the area. I find the wing and tail a little short and the culmen and tarsus rather long compared to other populations (see also Despin *et al.* 1972), but there is also much room for scepticism over races of prions.

Since Warham & Bell assume that Little Shearwaters must

TABLE 1 — Prions said to have been collected at 49°S 179°W by the Whitney South Sea Expedition. (Measurements in mm.)

Serial No.	Date	Identity	Sex	Wing	Tail	Culmen Length	Culmen width	Tarsus	Toe
211790	1 Feb.1926	P.turtur	f.	181	90	20	10	33	37
334605	"	"	m.	179	88	21.5	10.5	32	38
334606	"	"	f.	171	85	20	10	30	37
334610	16 Feb.1926	P.desolata	f.	186	84	28	13	34	36

breed in the winter in the Antipodes Islands, as they do further north, it may also be worth pointing out that M. J. Imber has recently found eggs in November on Gough Island. Few of the specimens from the subantarctic islands of New Zealand shed much light on the breeding dates there, except that nearly all the specimens from the Chatham Islands appear to be fledging juveniles with incompletely grown flight-feathers, and the two in the Canterbury Museum that have dates were collected by Hawkins on South East Island in May 1892 and on 13 October 1893. This suggests a prolonged breeding-season with at least some birds nesting in the summer there.

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COMMUNAL ROOSTING IN THE FANTAIL

In September 1978 Mr I. C. Duxbury, a farmer from Pigeon Bay, Banks Peninsula, described to me some observations he made there on the winter roosting behaviour of South Island Fantails *(Rhipidura fuliginosa fuliginosa)*.

On cold 1970 winter evenings he observed Fantails entering the northern doorway of a shed. Because of the scarcity of shelter on his property he assumed that the birds were seeking shelter. One blustery night he found at least seven Fantails huddled together inside a 125 mm diameter loop of 14-gauge wire. The loop was strung from a roof support about 2 m above the floor. The postures of the Fantails were consistent with those adopted by birds exposed to the cold: withdrawn heads, fluffed-out plumage, and crouched low so that the legs were concealed by the under-body feathers.

The huddling together of the Fantails would further reduce heat loss, a function which has been ascribed to this behaviour in other species (see Landsborough Thomson, 1964, *A New Dictionary of Birds*, p. 710).

The configuration of the loop provided limited horizonal roosting space. Most Fantails, therefore, were forced to spread themselves up the sides of the loop, and so their distribution on the wire resembled a "U".

One possible advantage of this communal pattern of roosting is the support the uppermost birds would get from those beneath. Fantails perched on the sides of the loop, in particular, therefore, would need less energy to maintain their grip than if they had roosted alone

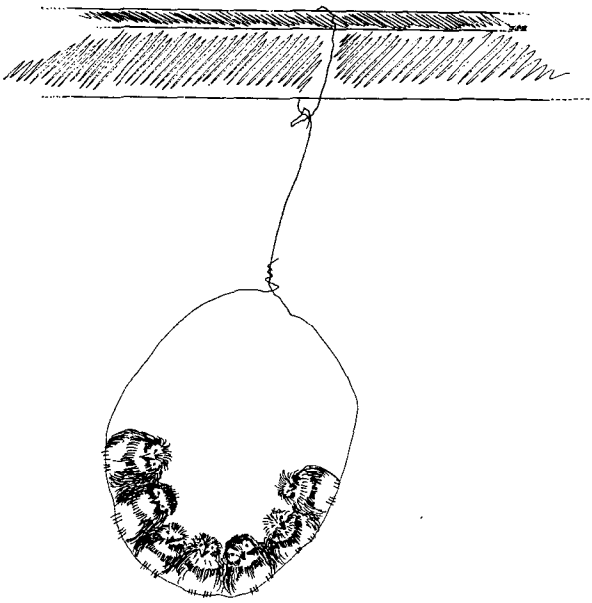

FIGURE 1 — An artist's impression of the wire loop used by Fantails as a communal roost. Sketch: J. Bruce

on a vertical perch. The amount of energy conserved by this mode of roosting could be significant throughout a winter's night.

In a more exposed situation, the duplication of this pattern of roosting would give stability to birds on a perch subject to buffeting by the wind. The interlocking of the fluffed feathers between huddled neighbours, the increased strength provided by the compounded grip arising from the communal roosting, and the weight distribution of the birds would produce an overall consolidating effect. These factors combined, therefore, would protect the birds from being jolted or blown off their perch.

The consistent pattern in which the Fantails distributed themselves on the wire loop and the blustery conditions which apparently elicited this behaviour suggest that their mode of roosting may be more than just an atypical response to an unusual situation.

If other observers locate Fantails on communal winter roosts such as the one described here, it would be interesting to know whether my provisional interpretation of Mr Duxbury's observations is valid because, as far as I am aware, this roosting behaviour has not previously been reported in Fantails.

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A DUNLIN AT KARAKA SHELLBANKS

On 23 June 1979 I was at Karaka shellbanks, Manukau Harbour. As the tide fell steadily small flocks of Knots *(Calidris canutus)* fed 20-30 m from the banks. Among these was a distinctly different and smaller bird in bright breeding plumage. The head was pale, wings and back were bright orange-rufous, and on the belly was an obvious black patch. The bill, longer than that of a Knot, was slightly decurved at the tip and deep at the base. The legs were black . There was no doubt in my mind that this was a Dunlin *(Calidris alpina)*. Nearby Knots tended to chase it a little, although this did not make it leave. The bird was seen occasionally by various members until September.

More detailed study showed the crown to have chestnut streaks on it extending part-way down the hind neck where they faded. There was a white eye-stripe. Throat and upper chest were also white. Faint streaking down the side of the neck and lower breast was visible only at close range. The edge of the folded wing showed fawn. Feathers of the large wing-coverts were orange rufous, brown centred, and edged whitish. This pattern was repeated on the lesser coverts. Here, due to the feather size, the patterning was less obvious. Sides of rump

FIGURE 1 — Dunlin in breeding plumage.

Photo: A. Habraken

FIGURE 2 — Dunlin (back) and Wrybill (front).
Photo: J. A. Brown

were white. In flight, a dark stripe extended down the centre of the back and tail. Under-wings were white. The black belly patch started low in the breast, was squared off below and just in front of the fore-wing, then extended to just behind the legs. Here, on both sides it tapered off to a point. The fore section between the legs appeared smudgy and came to a rounded point. The feathers around the upper tibia were clearly seen to be white, most evident when the bird was feeding and walking.

On 28 June I heard the bird call as it flew, *trrree* or *trrrii,* with a slight roll and stopping abruptly. This was the only call heard. The Dunlin usually roosted in among the Knots but tended to feed with the wintering Wrybill *(Anarhynchus frontalis)* flocks. Its method of feeding in very soft mud was similar to that of Red-necked Stints *(C. ruficollis)* but had an even quicker " sewing-machine " action. It was often seen to feed in soft mud or on surfaces which held a thin film of water. It was also seen on sandy half-exposed shell and around the edges of tidal pools. I believe this to be the first Dunlin to be recorded in full breeding plumage in New Zealand.

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BLACK SWAN

On 14 March 1980, in position 40°52'S 176°30'E, which is some 13 miles off Castle Point, a Black Swan *(Cygnus atratus)* was sighted flying out from the coast. It circled the ship once and then headed off in a south-easterly direction — towards the Chatham Islands?

JOHN JENKINS

★

GIZZARD STRUCTURE OF THE PACIFIC PIGEON, *Ducula pacifica*

An error regarding the structure of the gizzard of the Pacific Pigeon *(Ducula pacifica)* has been widely disseminated as a citation (Wood 1924) in the text *Fundamentals of Ornithology* (Van Tyne & Berger 1959: 239). The purpose of this note is to correct that error.

Since the 1800s it has been known that the gizzard of Peale's Pigeon *(Ducula latrans)* of Fiji is peculiarly adapted for processing hard fruit. The interior of the gizzard is typically lined with 23 conical corneous projections about 4 mm high which have " about the density of ox-horn " (Garrod 1878: 103). Garrod noted that a similar adaptation had been described in the Giant Pigeon, *Phaenorhina (Ducula) goliath,* of New Caledonia, a species which is now generally considered a geographical representative of Peale's Pigeon (Amadon 1943: 13; Goodwin 1970: 386, 387).

Wild Fiji nutmegs (*Myristica* sp.) form a major portion of the diet of Peale's Pigeon. Garrod (1878: 104) was informed that the Pacific Pigeon in Samoa also " feeds on nutmegs, from which it is highly probable that in that species the gizzard epithelium is modified in a manner similar to that of the Fiji or New Caledonia species."

In 1923, Wood (1924: 434) attempted to verify Garrod's suggestion. During his visit of about seven months in Fiji, he dissected 21 pigeons which he thought to be Pacific Pigeons, finding the " intestinal tract much the same as that partially described by Garrod " in the Peale's Pigeon. However the pigeons he dissected were in fact Peale's Pigeons rather than Pacific Pigeons. Wood himself later recognized and acknowledged his mistake (Wood 1926: 117), although this retraction was not cited by Van Tyne & Berger *(loc. cit.)*. Meanwhile the true structure of the gizzard of the Pacific Pigeon has evidently remained unknown.

In November 1977, on Wakaya Island in the Fiji Group, I dissected the gizzard of a mature male Pacific Pigeon and found that it did not have any trace of the horny projections of Peale's Pigeon as described and figured by both Garrod and Wood. Instead, the gizzard was lined on opposite ends with bulbous uncornified muscle masses. A section of thin wall on either side of the gizzard separated the two muscular areas.

The differences between the gizzards of the Pacific Pigeon and Peale's Pigeon lend support to their placement in different subgroups within the genus *Ducula* (Goodwin 1970: 285, 286).

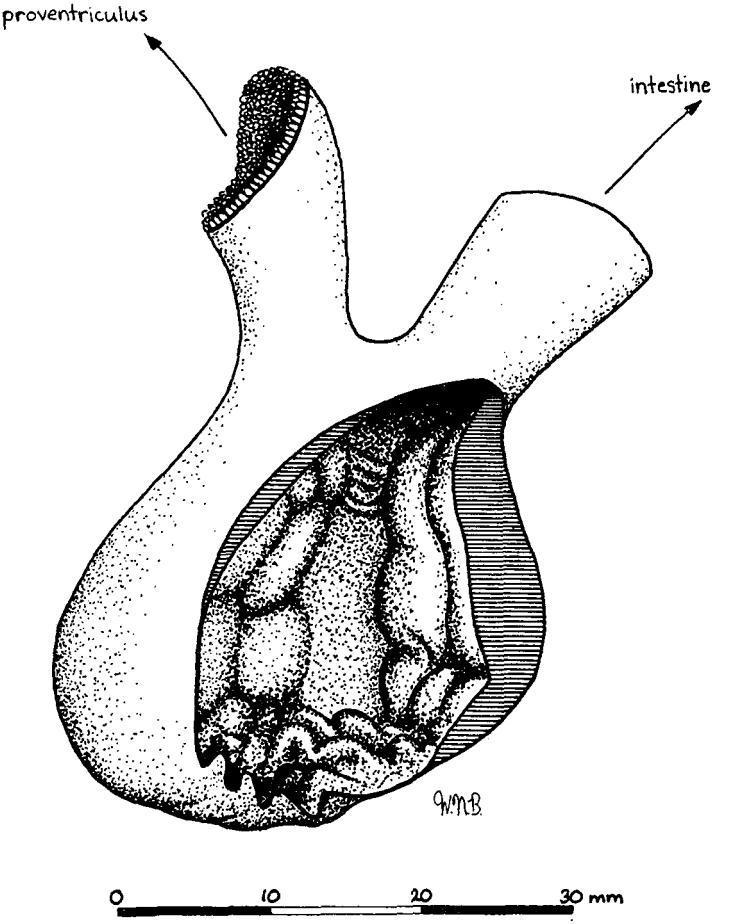

FIGURE 1 — Gizzard of an adult male Pacific Pigeon from Wakaya Island, with a one-quarter section cut away to show the interior.

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REVIEWS

The new guide to the birds of New Zealand, by R. A. Falla, R. B. Sibson & E. G. Turbott. 1979. Pp. 247, 48 col. plates, many b/w ills. Collins. $13.95.

The "Field Guide" continues to improve with each revision. In the latest (3rd) edition, the text has been reset (though by no means completely revised), and a new set of colour plates has been provided, covering nearly all the species. To say that the plates are an improvement is not to make an artistic judgment, but rather that the style is better suited to a field guide. I found it irritating, however, that the birds on individual plates are often not to the same scale; the inclusion of overall length in centimetres is not an adequate substitute. Another criticism is that species which need to be compared (and are usually compared in the text) are frequently illustrated on different plates. Whether this was the decision of the publisher or the artist I am unable to say. While the sequence of orders and families follows current systematic practice, the same cannot be said of the sequence of species within families. The sequence of species within the Charadriidae, for instance, is decidedly idiosyncratic, and does not even have the merit of grouping species which are easily confused in the field. Neither the above criticisms, nor those which follow should deter anyone from buying this book. In these days of inflation, the retail price of $13.95 is very good value indeed.

The text, as one would expect, is remarkably free from inaccuracies, but it suffers occasionally from inadequate treatment. The artist has portrayed very few of the species inaccurately, or misleadingly, but the omission of juvenile or non-breeding plumages in certain cases is a pity. Most of the deficiencies in treatment relate to species which will rarely be seen by the great majority, but it is when such species *are* seen that a good field guide is most needed.

Grebes: This group is inadequately dealt with, though reasonably accurately as far as it goes. The text incorrectly continues to state that the Crested Grebe has a distinct winter plumage. It is now known that Australian populations do not. Neither text nor illustrations mention the juvenile plumage of the Dabchick or the winter plumages of Hoary-headed or Australian Little Grebes, quite a serious omission.

Herons & Egrets: Both text and illustrations describe the wrong subspecies of Cattle Egret so far as breeding dress is concerned; in the race *coromandus* the whole head and neck are suffused with orange-buff. (Homer would also appear to have nodded — for once — in using the feminine form *coromanda*!) The identification of the Plumed Egret may also be rather more difficult than implied by the text. The relatively shorter neck makes the overall length markedly shorter than that of the White Heron, but the difference in body size between a small *alba* and a large *intermedia* is less conspicuous.

Rails: Most recent authorities treat the Black-tailed Native Hen as a moorhen *(Gallinula)*. This species is one of the least accurately

portrayed of all those illustrated. Undoubtedly the artist had not seen the species in the field, but there are surely good photographs available. The 'bantam-like' appearance (mentioned in the text) is caused mainly by the long and broad tail, carried above the back constantly, and the long and rather pointed wings project beyond the vent.

Cuckoos: The Fan-tailed Cuckoo appears to have been based on a juvenile specimen or illustration. The colours are correct for an adult except for the tail, which should be darker and with the centre feathers longer. The shorter square tail is also a field character of the Brush Cuckoo *(C. variolosus)*.

Swifts: The wings of a flying swift should surely look curved and sickle-like, rather than angled at the carpal joint. As shown, they look too much like swallows with longer wings.

Passerines: The Black-faced Cuckoo-shrike should show at least the head of a juvenile; most of the New Zealand occurrences of this species have been juveniles. The colour on the breast of the female Satin Flycatcher is too dark and extends too far on the breast; separation of this species from the Leaden Flycatcher in the field is not easy. The illustration of a female Goldfinch is apparently based on an aberrant specimen and should be ignored. The Rook appears to have too small a bill, the white on the throat is surely too extensive and intense, and the thighs are insufficiently " shaggy."

Of the fourteen species featured in the above comments, seven are most unlikely to be seen by more than a fortunate few. Of the remaining seven, only the Rook can be said to be poorly portrayed, while the three smaller grebe species will undoubtedly cause trouble when seen out of breeding plumage. All in all, a very fine production on which both authors and artist must be congratulated.

D. H. BRATHWAITE

Seabirds: In this latest edition of the " Field Guide " the text has been reset and almost every bird illustrated. The plates are new and generally superior to the old ones, the " jizz," proportions and stances mostly well caught. These plates and the black and white diagrams should be a big help in field identification.

The following comments are restricted to the substantial part of the work covering seabirds.

The revision of the text seems rather uneven, being strongest in bringing the distributions up to date, with some comments as late as 1977, and including new birds like the Christmas Island Shearwater and the Taiko. Otherwise, the text is often quite out-dated, and at times identical with that of the 1966 edition, even for species on which more work has been published in the last ten than in the previous hundred years !

The nomenclature is also often dated. The Cape Pigeon, of course, remains *Daption capensis*, the two giant petrels, *Macronectes halli* and *giganteus,* are still regarded as subspecies (although it is noted

that both breed on the same island!), and yet the three *cauta* mollymawks remain as full species. Stranger still is the retention of *atratus* for the Erect-crested Penguin, despite the written support in Bull. zool. Nomenclature in 1974 by the late Sir Robert Falla of a proposal to suppress *atratus* and to use *sclateri,* a proposal adopted officially by ICZN back in 1975.

Neither of these criticisms will lead to misidentifications as such, but if a *new guide* is to have any text, then this too ought surely to be new and reflect current practice.

It seems a pity that Chloe Talbot Kelly's plate of penguin heads was discarded, for she got some of the characters just right, whereas in Elaine Power's plate 3 the birds are all grey-backed, their eyes and bills all coloured alike (they aren't), the Erect-crested Penguin lacking the velvety jet-black of head and nape so typical of the species and excellently shown by Talbot Kelly. And so on. In my opinion, it was also a mistake to drop the sketches of penguin under-flippers rather than to improve them. At least they drew attention to the quite diagnostic under-flipper of the Erect-crested Penguin, which enables the most battered, headless corpse to be identified if a flipper is still intact — a fact also unnoted in the text.

In a book of this nature some errors seem inevitable, but more have persisted here than there should with three people to vet facts and figures. A few examples should suffice. The Wandering Albatross incubation period is given as 66 days (p. 29) whereas Dr Tickell published the correct figure of 78 days back in 1968. Giant Petrels are said to breed on the Snares: that they don't was published in *Notornis* in 1967. The eyes of the Royal Penguin are not bright geranium red as stated; that is the colour of the adult Rockhopper's irides and a useful recognition character shown in Talbot Kelly's 1966 plate but not in today's 1979 one !

Wandering Albatrosses have been getting a rough deal from artists recently. There are very strange portrayals in Tuck's " Guide to the Seabirds of Britain and the World " and in the " Birds of the Western Palearctic ": you might have expected we could do better. Not so. On plate 4 we have a most peculiar Wanderer with a white trailing edge to a blotchy upperwing, whereas in truth the trailing edge remains dark even in old birds. Two other representations of this species labelled immature could be breeders from Antipodes Island, but the existence of large numbers of dark-plumaged adults is not mentioned in the text. Such birds are common in our seas and across the Tasman where NZ-banded birds have been caught off SE Australia.

Wandering Albatross bill colours are seldom accurately shown in paintings — they are pink with horn-coloured tips in life — but in the present work perhaps more confusing is the excessively yellow bill of the Black-browed Mollymawk (plate 5). All the *Procellaria* bills on plate 10 are also poorly shown, the most inaccurate being that of the Grey Petrel, which has been given a bright yellow beak: in life it is greyish black with the side plates the grey-green of old-fashioned dried peas — as noted nearly 50 years ago by Robert Murphy.

On plate 13 we have clear paintings of the storm petrels that should help a lot with their identification. Unfortunately the wings

have been given rather pointed tips. This is a common artist's fault — presumably because they don't know the birds in flight themselves — and hence they draw the outermost primary the longest, which it's not.

A useful innovation is a diagram naming the bill plates of petrels, a figure that follows von Boetticher in his "Albatrosse und anderer Sturmvogel" (1955) and "The Handbook of Australian Sea-birds" (1971). A diagram that is retained from earlier editions of the bills of prions could well have been redrawn as it still shows very narrow-billed *vittata* and *salvini* that would have been better labelled *salvini* and *desolata*.

The content of the work is well organised on lines familiar to users of earlier editions. There are useful end-paper maps and the book is well printed and bound in Collins' admirably tough style designed to stand up to the battering of field use. The book will enable most New Zealand birds to be identified if properly seen: it is mainly with the "difficult" ones that users will encounter frustrations.

JOHN WARHAM

Birds of a feather, edited by Atholl Anderson. 1979. NZ Archaeological Association Monograph II. BAR International Series 62.

This book consists of 17 osteological and archaeological papers written and published in honour of Ron Scarlett. The papers are written, in collaboration or individually, by 22 authors, including Scarlett himself, who apparently collaborated in one paper and wrote another on request without knowing where they were to be published.

The ornithologist with an interest in our extinct birds, or even in the past distribution of our living species and their exploitation by the Maoris will find 7 anthropological papers of little interest but the remaining 10 of much interest. Scarlett (Avifauna and Man), B. F. Leach (Maximising minimum numbers: avian remains from the Wash-pool midden site), J. M. Davidson (Archaic middens of the Coromandel Range: a review), E. W. Dawson (Some osteological contemplation on Maori and Kakapo in early Wellington) and D. G. Sutton (Island and coastal fowling strategies of the prehistoric Moriori) bring together some interesting analyses of human middens, while G. F. van Tets analyses the avifaunal composition of skua middens on some Australasian sub-antarctic islands. For the taxonomist, J. C. Yaldwyn has shed further light on the types (and validity) of some of the moa species and genera described by W. R. B. Oliver. G. E. Hamel (The breeding ecology of moas) has written a thought-provoking hypothesis that is a timely reminder that moas were once living creatures and that our studies of their bones should aim at giving us a greater understanding of them as birds.

I find this book of great interest, but it is decidedly of more interest to the archaeologist than to an ornithologist whose interest in birds is mainly in living species.

D. H. BRATHWAITE

Catalogo dei tipi di uccelli del Musco Civico di Storia Naturale di Genova, by G. Arbocco, L. Capocaccia, & C. Violani. 1979. Ann. Mus. Civ. St. Nat. Genova 82: 184-265.

The collections of the Genoa Museum of Natural History are rich in type specimens of subspecies and species, mostly from the Oriental and Australian regions. 317 types are listed, of which 249 are said to be still valid. Most were described by Salvadori, Sharpe, or Sclater; the majority are from New Guinea; most of the rest are from the Indonesian islands. Although not of direct interest to New Zealanders, it is a scholarly work of taxonomic importance to lands in our region; it is also a reminder of the amount of material in early journals and in the collections and archives of European museums. Would that more such catalogues were available to help us in the south to trace types and other early specimens with their often valuable collector's notes. Copy in OSNZ library.

B. D. HEATHER

LETTER

The Editor, 29 July 1980

Sir,

WHITE NELLIES

In his interesting article in *Notornis* 27: 176-178, R. B. Sibson refers to my 1962 paper on giant petrels — " From studies subsequently made by Warham (1962), we now know that there is a high frequency of white-phase birds in the breeding colonies on Macquarie, nearly 7% on the west side of the island and more than 15% on the east."

I don't know where these figures came from but Mr Sibson got his wires crossed somewhere as the data are not from my 1962 paper. There, on page 156, I stated that of 557 birds on the colonies 44 or 8% were white, that in November 1952 32 of 305 adults banded (10%) were white, and that in 1959 20 white birds were counted among 200 (10%). I made no comparisons between the proportions on the west and east sides of the island because, in my time, all but one of the colonies were on the west side and about 2700 of the 2846 chicks I ringed were from that coast. Hence any differences in proportions would probably have been ascribed to chance.

JOHN WARHAM