Rec. West. Aust. Mus. 1988, 14(2): 237-247

Observations on the marine distribution of Tropicbirds, Sooty and Bridled Terns, and Gadfly Petrels from the eastern Indian Ocean

J.N. Dunlop*, N.G. Cheshire† and R.D. Wooller*

Abstract

Observations of pelagic birds were made in the eastern Indian Ocean during a cruise on *R.V. Franklin* during October 1987. The Christmas Island form of the White-tailed Tropicbird *Phaethon lepturus fulvus* was observed up to 1300 km ESE of their breeding station, in water close to the shelf edge. White-tailed Tropicbirds generally occupied water masses of lower salinity than Red-tailed Tropicbirds *Phaethon rubricauda* and, as a consequence, the two species were not recorded in close proximity. Both species foraged solitarily. The relatively high salinities in the marine habitat of *P. rubricauda* may explain its penetration of the sub-tropics as a breeding species. A short-lived breeding episode at Rottnest Island apparently followed a period of relatively low sea surface salinity, approaching the range recorded for this species at sea. Such oceanographic events, associated with the strength of the Leeuwin Current, may underly the range extension of *P. rubricauda* into south-western Australia.

Observations of *Bulweria bulwerii, Pterodroma baraui* and *P. rostrata* recorded during the cruise suggest that these gadfly petrels are seasonal visitors to the tropical, eastern Indian Ocean.

Sooty Terns *Sterna fuscata* did not occupy water masses where the sea surface temperature was much below 23°C and apparently preferred active warm current areas, such as the South Equatorial Current. Bridled Terns *S. anaethetus* frequented the higher salinity waters which occur across the continental shelf over a wide latitudinal range.

Introduction

The distribution of marine birds off the western coast of Australia, and the factors governing their occurrence, are little known. This coast is unusual because it is influenced by a 'through flow' of water from the western Pacific Ocean. This throughflow, as well as contributing to the South Equatorial Current, is thought to give rise to the Leeuwin Current in which warm, low salinity, surface waters flow southwards seasonally along the continental shelf (Pearce and Cresswell 1985).

The Leeuwin Current has been implicated in the southwards expansion of breeding ranges in several seabird species on this coast (Dunlop and Wooller 1985) but the distributions of seabirds away from their breeding colonies is

* Biological Sciences, Murdoch University, Western Australia 6150.
† 4 Willora Road, Eden Hills, South Australia 5050.

poorly documented. During an investigation of the Pacific throughflow during 1987, the opportunity was taken to survey seabirds in this area. The general relationships between seabird assemblages and the marine environments traversed have been reported elsewhere (Dunlop *et al.* 1989). This paper deals specifically with three groups, the tropicbirds (*Phaethon* spp.), terns (*Sterna* spp.) and gadfly petrels (*Pterodroma* and *Bulweria* spp.).

Methods

All observations were made on Cruise 9 of the CSIRO oceanographic vessel *R. V. Franklin* from 2 until 22 October 1987. Departing Fremantle, the course went northwards along the continental shelf to the Montebello Islands and Rankin Bank, and then in a north-westerly direction across oceanic waters to Christmas Island (312 km south-east of Java Head and 1400 km from the north-west Australian coast). Eight days were spent working in Christmas Island waters, traversing areas to the south-east, east, north-east, west and south-west of the Island. The vessel then returned in an east-south-easterly direction across the North Australian Basin and the continental shelf to Broome.

Throughout the cruise the vessel's thermosalinograph monitored sea temperature and salinity 4 m below the surface. The location of the ship was obtained using the GPS Satellite Navigation System. Current vectors were regularly available from an acoustic Doppler current profiler and, at intervals off north-western Australia, from conductivity/temperature/depth sampling. All observations were of birds passing within 300 m of the vessel and the identifications were made with the aid of binoculars.

Results and Discussion

Tropicbirds

The eastern Indian Ocean has breeding populations of both the White-tailed Tropicbird *Phaethon lepturus* and Red-tailed Tropicbird *P. rubricauda*. All breeding colonies of *Phaethon lepturus* are, within the tropics, on atolls such as North Keeling Island in the Cocos/Keeling group (Figure 1), Christmas Island and the Ashmore/Cartier group (Stokes *et al.* 1984, Dunlop 1988). Except for Christmas Island, with an estimated 12000 breeding pairs, these populations are small (Dunlop 1988).

The largest colony of Red-tailed Tropicbirds in the region also occurs on Christmas Island. A few isolated nests of this species have also been recorded from North Keeling, the Ashmore/Cartier group and the Rowley Shoals (Stokes *et al.* 1984, Dunlop 1988, Berry 1986). However, unlike the White-tailed Tropicbirds, Red-tailed Tropicbirds have also nested on subtropical, continental islands including the Houtman Abrolhos, Rottnest Island and Sugarloaf Rock, near Cape Naturaliste. The species no longer nests at the Abrolhos and there was only a

transient breeding episode on Rottnest, but the small colony at Sugarloaf Rock survives (Tarburton 1977, Storr *et al.* 1986).

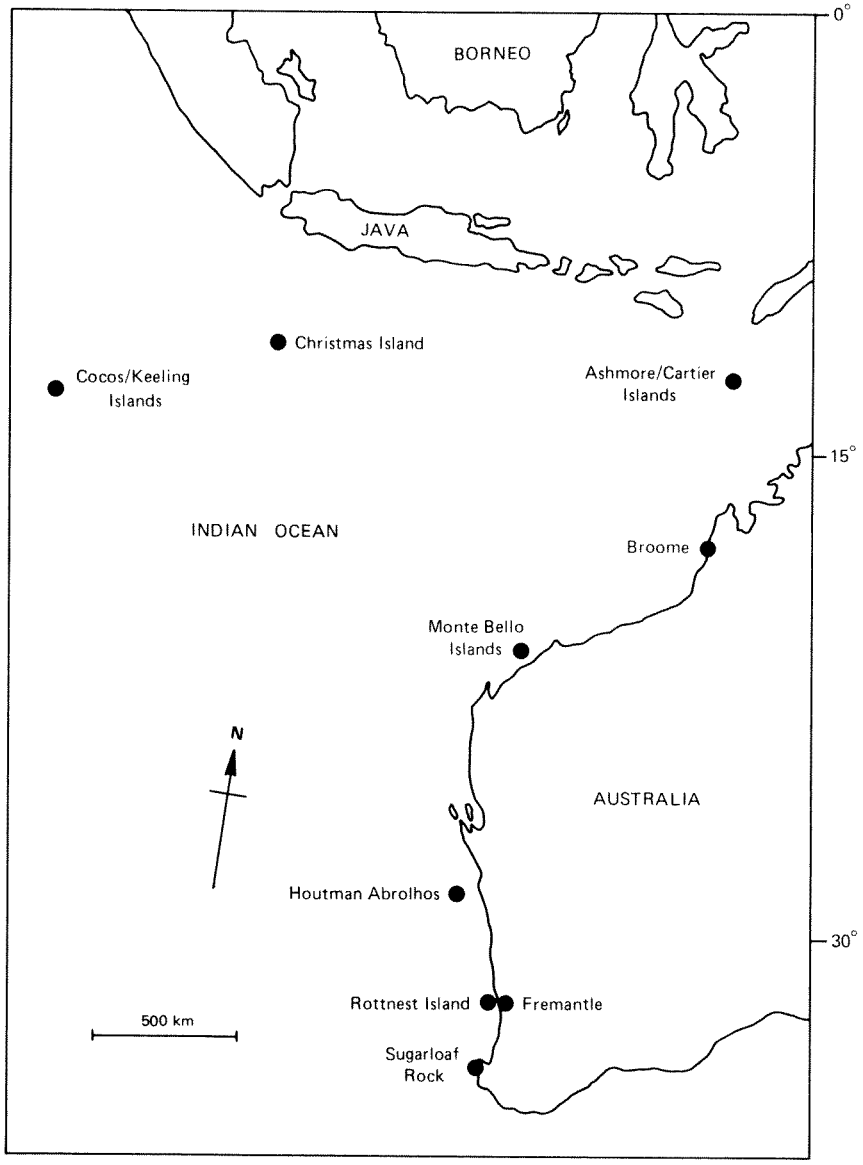

Figure 1 The location of tropicbird breeding colonies mentioned in the text, and other named features.

White-tailed Tropicbirds from the Christmas Island population show a very distinctive, apricot plumage suffusion, giving rise to the name Golden Bosunbird. Largely because of this coloration, Christmas Island birds are regarded as a separate subspecies *P. lepturus fulvus*. However, there is considerable variation in the extent and intensity of the apricot wash and about 7 per cent of breeding adults show no trace of it. Thus, whilst all golden birds observed at sea can be identified as from the Christmas Island population, it cannot be assumed that pure white individuals are not.

All but two of the 31 White-tailed Tropicbirds observed at sea had the rich, apricot plumage suffusion characteristic of the Christmas Island population. A white specimen recorded close to Christmas Island was also assumed to be from this population but a second white bird, observed 1185 km to the east-south-east, may well have come from a different source (Figure 2).

The tropicbirds were never observed feeding in association with other seabirds or in flocks. All of the six Red-tailed Tropicbirds sighted were solitary. Golden Bosunbirds were observed in twos, either in flight or sitting on the water, but all individuals of this species actively fishing (plunge-diving) were alone. Plunge-diving was recorded in a Golden Bosunbird only 3.7 km from Christmas Island; the closest feeding Red-tailed Tropicbird observed was 120 km from this colony.

The readily-identified Christmas Island *(fulvus)* form of the White-tailed Tropicbird, although more abundant near the Island, was recorded at extreme distances of 357, 907 and 1339 km (Figure 2). Pocklington (1967), from observations in July, recorded the Golden Bosunbird in oceanic waters off north-western Australia more than 1460 km from Christmas Island (Figure 2). In the same waters, Pocklington (1967) also encountered, all-white *P. lepturus* and one specimen with the rosy plumage suffusion known in the Ascension Island race (Stonehouse 1962). In June 1986, a single specimen of the Golden Bosunbird was observed well to the north-east of Christmas Island at 2°18′N, 89°57′E (Chapman and Cheshire 1987) and apricot-plumaged birds have also been sighted to the south-west, over the Cocos/Keeling Islands (Gibson-Hill 1947).

Red-tailed Tropicbirds from Christmas Island cannot be distinguished at sea from those of other populations. However, the population there vastly outnumbers any other colony in the region, which seldom exceed a few isolated nests. It is probable, therefore, that most of the sightings were of Christmas Island birds, even at a distance of 1593 km (Figure 2). Interestingly, Pocklington (1967) did not record this species off north-western Australia in July.

White-tailed and Red-tailed Tropicbirds were never sighted together. Tropicbirds were recorded in 16 one degree blocks (for each of which there were at least 3 h observations), *P. lepturus* in 11 and *P. rubricauda* in 5, but never in the same one. This segregated marine distribution is probably achieved, in part, by habitat selection. White-tailed Tropicbirds preferred water masses with lower sea surface salinity (34.38 ± 0.07 ppt) than Red-tailed Tropicbirds (34.49 ± 0.12 ppt), a significant difference ($t = 2.979$, $df = 24$, $p < 0.01$). However, some

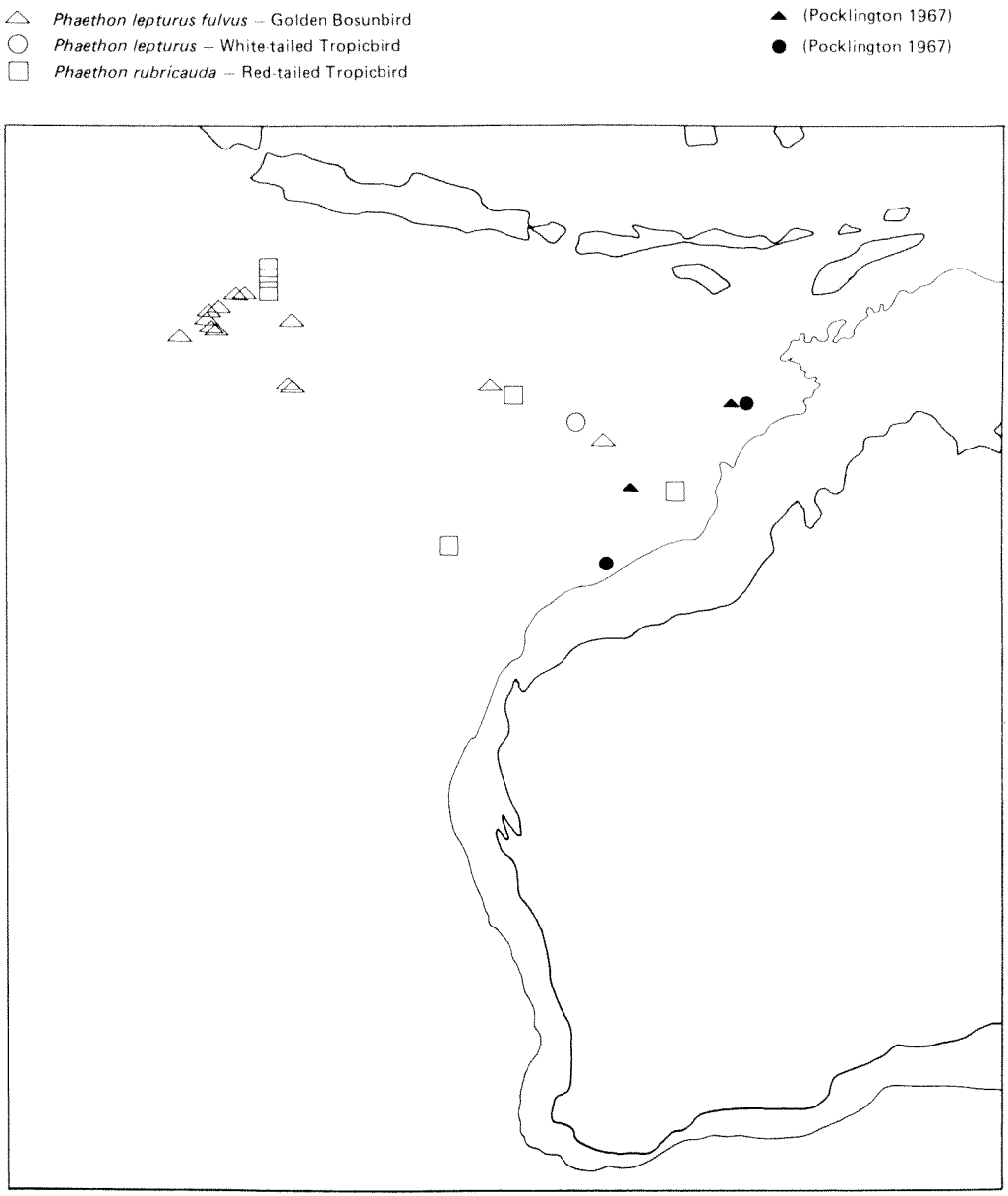

Figure 2 The localities at which *Phaethon lepturus fulvus, P. lepturus* and *P. rubricauda* were recorded during the present survey. Also presented are the localities at which *P. lepturus* and *P. lepturus fulvus* were noted by Pocklington (1967). Each symbol indicates an independent sighting of one, or a number, of individuals.

overlap does occur in the water masses occupied, which suggests that some form of avoidance or agonistic behaviour may take place.

The tendency for White-tailed Tropicbirds to occupy low salinity marine habitats, whilst the Red-tailed Tropicbirds inhabit relatively high salinity ones, may explain some of the observed differences in distribution. In the eastern Indian Ocean, White-tailed Tropicbirds are apparently confined to low, and very low, salinity tropical waters. In contrast, Red-tailed Tropicbirds have expanded their breeding range southwards beyond 32°S (Dunlop and Wooller 1985) into relatively high salinity, subtropical waters.

Sea surface salinity may have been a factor in the history of the Red-tailed Tropicbird on Rottnest Island (Figure 1). Between 1951 and 1957, and again from 1971 to 1984, sea surface temperature and salinity were measured at a Rottnest 50 m station (Cresswell *et al.*, in prep.). The tropicbirds first appeared over the Island in 1957 (three individuals) and nesting was attempted in 1958 and 1959 (Tarburton 1977). Unfortunately, there are no oceanographic data for 1957, but 1956 showed the lowest salinities recorded from the 18 years of sampling, and 1953 and 1955 were also low points. The minimum surface salinity in 1956 was about 34.8 ppt, close to the maximum value for water over which Red-tailed Tropicbirds were observed during the survey (34.7 ppt). It is worth noting that no tropicbirds have been seen close to Rottnest Island in recent years and that, between 1977 and 1984, annual minimal salinities were above 35.4 ppt, and as high as 35.9 ppt.

The colonisation of south-western Australian waters by a number of tropical seabird species populations, therefore, may have followed similar oceanographic events, principally fluctuations in the warm Leeuwin Current.

Sooty and Bridled Terns

At sea, the closely related Sooty Terns *Sterna fuscata* and Bridled Terns *Sterna anaethetus* are sometimes difficult to distinguish. However, a two-toned contrast between the black head and nape and the grey mantle and brown wings is usually evident in Bridled Terns, and differs from the uniform black dorsum of Sooty Terns. Other characteristics which assist in identifying Bridled Terns at sea are their lighter, more reactive, flight patterns and the grey clouding of their white underparts.

In October, Sooty Terns are present on their southern-most breeding grounds in the Houtman Abrolhos (Storr *et al.* 1986). Here they have access to the warm, low salinity stream of the Leeuwin Current. Ashmole (1963), analysing the breeding distribution of *S. fuscata,* found that it did not occupy waters cooler than 23°C. The course of the research cruise passed inside the Abrolhos on the inner continental shelf, where sea surface temperatures were below 20°C. The first Sooty Terns were encountered at 23°52′S, where sea-surface temperature was 22.6°C, and again at 23°28′S and 22.8°C (Figure 3). All other observations of the species were in waters warmer than 23°C. It was also significant that no

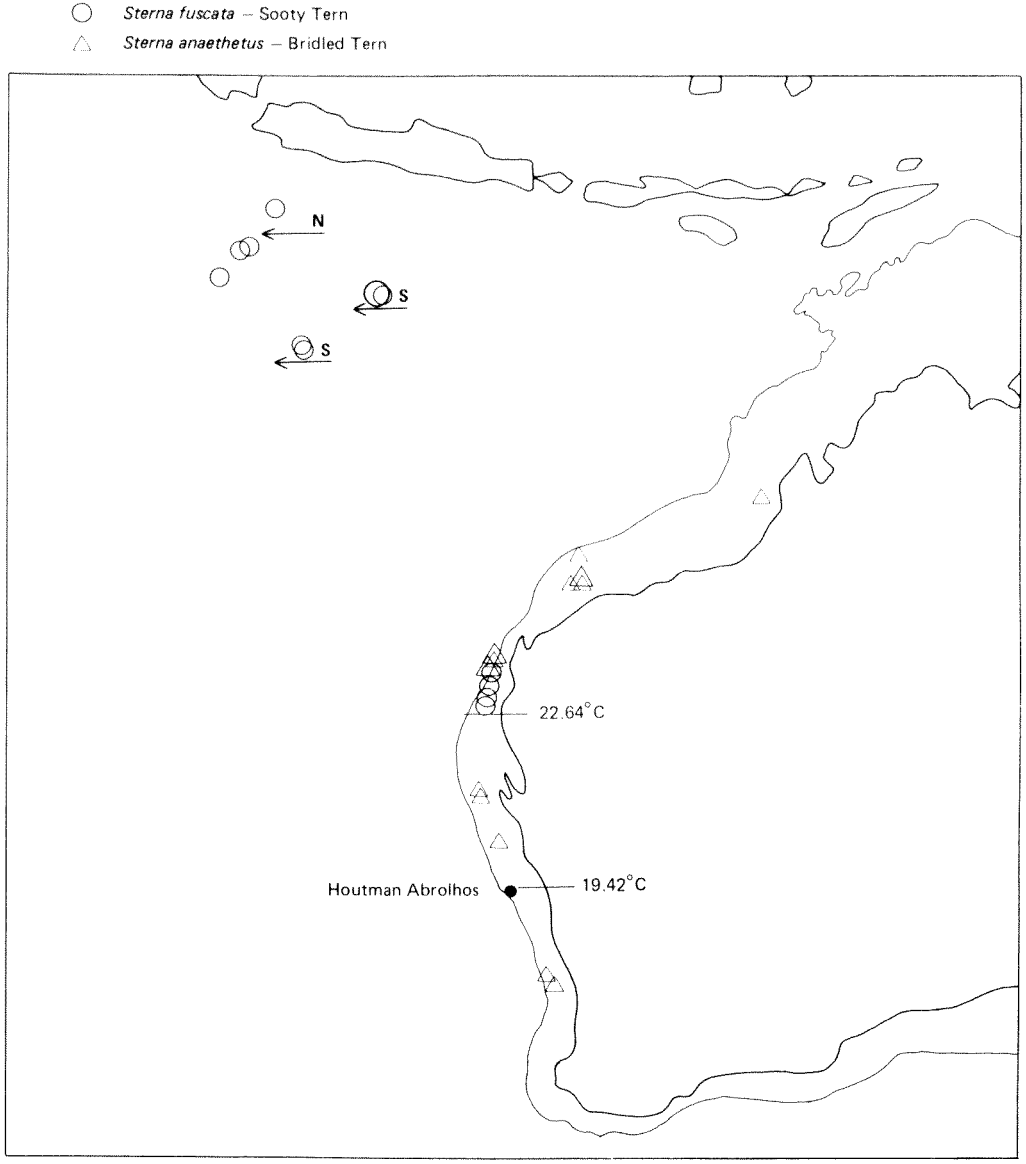

Figure 3 The localities at which the tropical terns *Sterna fuscata* and *S. anaethetus* were recorded, in relation to the continental shelf, northern and southern boundaries of the South Equatorial Current (arrows) and sea surface temperatures. Small symbols indicate less than 10 individuals and larger symbols 10-99 individuals.

Sooty Terns were present over the warm, low salinity waters off north-western Australia but were common over the South Equatorial Current (Figure 1). This

suggests that temperature and salinity factors alone do not explain the distribution of *S. fuscata* and that active, warm, low salinity current streams, such as the Leeuwin or South Equatorial Currents, may also be important habitat components.

Almost without exception, Bridled Terns occupy their many breeding colonies along the south-western and mid-western Australian coastline between mid-October and early April. A migration to equatorial latitudes apparently takes place during the intervening period (R.E. Johnstone pers. comm.). These birds have been observed to arrive at their breeding grounds in Western Australia suddenly, and in large numbers, between 10 and 14 October. However, at sea, over the continental shelf adjacent to their colonies, between 2 and 6 October, they were dispersed as solitary birds or small parties. There was no evidence of the mass movements which coincide with the exodus from these colonies in early April, and which have been observed off western Sri Lanka (De Silva 1987).

During the pre-breeding period, Bridled Terns occupied a wide sea temperature range, feeding over water at least as cool as 19.3°C. They were also restricted to relatively saline waters (34.8 - 35.5 ppt) over the continental shelf. The influence of the lower salinity Leeuwin Current on the extra-limital distribution of this species is as yet unclear. It is possible that, whilst breeding, Bridled Terns feed over the warm core or filaments of this current, as they do at Gulf Stream frontal eddies (Haney 1986).

Gadfly Petrels

Gadfly Petrels (genera *Pterodroma* and *Bulweria*) are poorly represented in the eastern Indian Ocean. Until recently, the only known breeding species from the region was the Great-winged Petrel *Pterodroma macroptera* which nests on some continental islands off southern Western Australia (Serventy *et al.* 1971, Harrison 1983). However, during 1986, Stokes and Goh (1987) recorded Herald Petrels *Pterodroma arminjoniana* from North Keeling Atoll in the Cocos/Keeling Islands. The behaviour of these birds suggested that breeding occurred on the atoll.

Barau's Petrel *Pterodroma baraui* was observed at two separate localities close to Christmas Island (Figure 4). Both records were of solitary individuals, seen simultaneously, by two observers. The first bird was tentatively identified as *P. baraui* and this was later confirmed by the second observation. These records follow other recent sightings in the seas to the west of the Cocos/Keeling Islands and Christmas Island (Chapman and Cheshire 1987). Together, they suggest that the relatively productive waters of the South Equatorial Current may be an important refuge for this little known, and possibly rare, species (Feare 1984).

Tahiti Petrels *Pterodroma rostrata* were recorded close to the edge of the continental shelf between 16°39′ and 16°50′S latitude (Figure 4). There were two sightings within an hour, the first of two birds and the second of a solitary individual. These records follow another sighting further south on the Western

△ *Bulweria bulwerii* – Bulwers Petrel
○ *Pterodroma baraui* – Barau's Petrel
□ *Pterodroma rostrata* – Tahiti Petrel

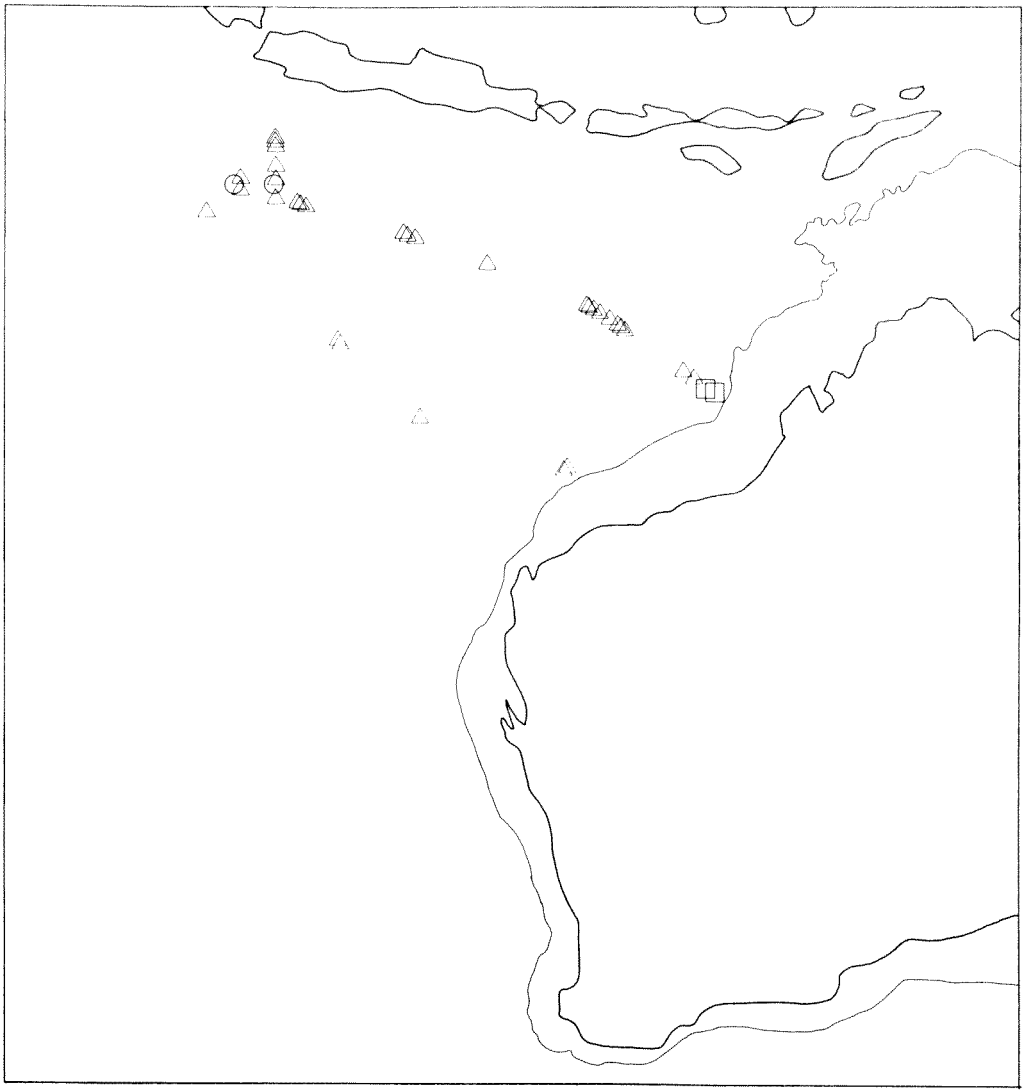

Figure 4 The localities at which the Gadfly Petrels *Bulweria bulwerii, Pterodroma baraui* and *Pterodroma rostrata* were recorded. Each symbol indicates an independent sighting involving one or a number of individuals.

Australian coastline earlier in the year. As far as is known, this gadfly petrel nests in the tropical Pacific Ocean at New Caledonia, the Marquesas and Society Islands (Harrison 1983) and in the eastern Coral Sea (Stokes and Corben 1985).

Bulwer's Petrel *Bulweria bulwerii* was common and widespread in tropical, oceanic waters off north-western Australia during October 1987 (Figure 4). Sightings were usually of solitary individuals, occasionally of twos. With the exception of the ubiquitous Wedge-tailed Shearwaters *Puffinus pacificus*, Bulwer's Petrels were the only seabirds recorded with any regularity over the vast expanses of warm, low salinity water between the Australian coastline and the edge of the South Equatorial Current. Nevertheless, there is only one published record of the occurrence of this gadfly petrel in the region (Harrison 1979).

The present records of *P. rostrata* and *Bulweria bulwerii* add to a growing list of pelagic species from the Pacific utilising the waters off Western Australia. This list also includes species such as Streaked Shearwaters *Calonectris leucomelas* (Storr *et al.* 1986, McKean 1980) and Matsudaira's Storm-petrels *Oceanodroma matsudairae* (Pocklington 1967, Stokes *et al.* 1987). The marine continuity between the eastern Indian Ocean and the tropical, western Pacific apparently facilitates this interchange of pelagic bird faunas. This would be especially so if, as has been suggested (Pearce and Cresswell 1985), there is also some continuity in 'water types' due to a westward 'throughflow' via the Indonesian archipelago.

Acknowledgements

This survey was undertaken as part of a consultancy to the Australian National Parks and Wildlife Service under its Research and Surveys program (Project 8687/10:103/9), with additional support from a Murdoch University Special Research Grant. We thank Tony Stokes for a number of useful comments and George Cresswell, Janice Peterson and Tim Osborn for their enthusiastic support on the *R. V. Franklin*.

References

Ashmole, N.P. (1963). The biology of the Wideawake or Sooty Tern *Sterna fuscata* on Ascension Island. *Ibis* 103b: 340.

Berry, P.F. (1986). Faunal surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef, north-western Australia. VIII Insects, reptiles, birds and seagrasses. *Rec. West. Aust. Mus.* Suppl. (25): 105-106.

Chapman, S.E. and Cheshire, N.G. (1987). Notes on seabird reports received 1986. *Sea Swallow* 36: 32-46.

Cresswell, G.R., Boland, F.M., Peterson, L.L. and Wells, G.S. (in prep.). Currents on the continental shelf of Western Australia.

De Silva, R.I. (1987). Observations on the mass migration of Bridled Terns *Sterna anaethetus* off the coast of Colombo. *Ibis* 129: 88-91.

Dunlop, J.N. (1988). The status and biology of the Golden Bosunbird *Phaethon lepturus fulvus*. Report to the Australian National Parks and Wildlife Service.

Dunlop, J.N. and Wooller, R.D. (1986). Range extensions and the breeding seasons of seabirds in south-western Australia. *Rec. West. Aust. Mus.* 12: 389-394.

Dunlop, J.N., Wooller, R.D. and Cheshire, N.G. (1989). A study of the distribution and abundance of marine birds in the eastern Indian Ocean. *Aust. J. mar. Freshwat. Res.* 39.

Feare, C.J. (1984). Seabird status and conservation in the tropical Indian Ocean. *ICPB Technical Publication* 2: 457-471.

Gibson-Hill, C.A. (1947). Notes on the birds of Christmas Island. *Bulletin of the Raffles Museum* 18: 87-165.

Haney, J.C. (1986). Seabird segregation at Gulf Stream frontal eddies. *Mar. Ecol. Prog. Ser.* 28: 279-285.

Harrison, P. (1983). *Seabirds. An Identification Guide.* A.H. and A.W. Reed Ltd, Wellington.

McKean, J.L. (1980). Oceanic ornithological survey between Derby, W.A. and Darwin, N.T. *Northern Territory Naturalist* 3: 8-13.

Pearce, A. and Cresswell, G. (1985). Ocean circulation off Western Australia and the Leeuwin Current. CSIRO Division of Oceanography Information Service Sheet Number 16-3.

Pocklington, R. (1967). Birds seen at sea off N.W. Australia July 23-30, 1965. *Emu* 67: 133-137.

Serventy, D.L., Serventy, V. and Warham, J. (1971). *The Handbook of Australian Seabirds.* A.H. and A.W. Reed, Sydney.

Stokes, T. and Goh, P. (1987). Records of Herald Petrels and the Christmas Frigatebird from North Keeling Island, Indian Ocean. *Australian Bird Watcher* 12: 132-133.

Stokes, T., Sheils, W. and Dunn, K. (1984). Birds of the Cocos (Keeling) Islands, Indian Ocean. *Emu* 84: 23-28.

Stokes, T., Merton, D., Hicks, J. and Tranter, J. (1987). Additional records of birds from Christmas Island, Indian Ocean. *Australian Bird Watcher* 12: 1-7.

Stonehouse, B. (1963). The tropic-birds (genus *Phaethon*) of Ascension Island. *Ibis* 103b: 124-173.

Storr, G.M., Johnstone, R.E. and Griffin, P. (1986). Birds of the Houtman Abrolhos, Western Australia. *Rec. West. Aust. Mus.* Suppl. (24): 5-42.

Tarburton, M.K. (1977). Nesting of the Red-tailed Tropicbird at Sugarloaf Rock, W.A. *Emu* 77: 122-126.

Received 22 February 1988 Accepted 5 July 1988 Published 23 December 1988

SHORT COMMUNICATIONS