

Kermadec petrels (*Pterodroma neglecta*) at Ilha da Trindade, South Atlantic Ocean and in the North Atlantic

M. J. IMBER

Science & Technical Centre, Department of Conservation, PO Box 10-420, Wellington, New Zealand.
mimber@doc.govt.nz

Abstract Kermadec petrels (*Pterodroma neglecta*) are shown to be resident in the Atlantic Ocean, breeding at Ilha da Trindade, off Brazil, South Atlantic Ocean and migrating to the North Atlantic. Previously mistaken for Trindade petrels (*Pterodroma arminjoniana*) at Ilha da Trindade, they were identified by the whitish shafts and largely white inner webs of their primaries and, at the colony, by their distinctive call. Records of five non-breeding Kermadec petrels in the North Atlantic Ocean include the first Atlantic specimen from western United Kingdom in 1908. All of eight identifications of Kermadec petrels from Atlantic waters were dark phase birds, like those identified from the Indian Ocean, though, in the Pacific Ocean, the species is polymorphic. Trindade petrels from Ilha da Trindade are mostly the light phase (59%, $n = 71$), outnumber Kermadec petrels there by about 20:1 in collections, and disperse into the North Atlantic Ocean. As 70% ($n = 43$) of these two species combined observed at sea in the North Atlantic were dark phase, about 49% of North Atlantic records may have been Kermadec petrels. As they are in Pacific waters, Kermadec petrels may be more migratory and reach higher latitudes than do Trindade petrels. The *Halipeurus* feather louse hosted by Kermadec petrels in the Pacific Ocean has been identified from both petrels in Atlantic waters, but that hosted by Trindade petrels elsewhere has not been reported from Atlantic waters, possibly indicating earliest colonisation by Kermadec petrels. The morphometrics of Trindade petrels in the Atlantic Ocean cannot be established accurately until the generally larger Kermadec petrels are excluded from data sets.

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INTRODUCTION

The surface-nesting gadfly petrels *Pterodroma* spp., sometimes placed in the subgenus *Hallstroma*, have challenged ornithologists' identification abilities and remain one of the more taxonomically unstable groupings within this genus. The species-groupings or species *arminjoniana* (including *heraldica*, but excluding monomorphic *alba* and *atrata* here) and *neglecta* (including *juana*) have confused many ornithologists because they often nest together, are similarly polymorphic in plumages, and are of similar size. They also breed almost or entirely throughout the year, but in different proportions at different times according to species.

The Trindade petrel (*Pterodroma arminjoniana* (Giglioli and Salvadori, 1869)) was described (as *Aestrelata arminjoniana*) from collections made at Ilha da Trindade, off Brazil (20°30'S, 29°22'W), South Atlantic Ocean by the 'Magenta' expedition on 23 January 1868 (Giglioli & Salvadori 1869: 62-63). It was based on two skins, both light phase (typically dark-collared) with blackish primary shafts, thus distinguishing it from the Kermadec

petrel (*Pterodroma neglecta* (Schlegel, 1863)), which has whitish primary shafts (Giglioli & Salvadori 1869). From 1863 to 2000 Kermadec petrels were considered to breed only in the Pacific Ocean, between latitudes 25°-35°S (Marchant & Higgins 1990). Giglioli & Salvadori (1869: 65-66) also described *Aestrelata trinitatis*, which became generally accepted as the dark phase of the Trindade petrel (e.g. Murphy 1936). In this dark phase, based on two specimens, Giglioli & Salvadori described the primary shafts as similar to those of *P. arminjoniana*. Described 19 years later, the similar but apparently smaller Herald petrel (*Pterodroma (arminjoniana) heraldica* Salvin, 1888) breeds across the South Pacific Ocean between c.8° and 27°S (Marchant & Higgins 1990). Presently *arminjoniana* (including the Round Island population in the Indian Ocean (Murphy & Pennoyer 1952)) and *heraldica* tend to be treated as full species (e.g. BirdLife International 2000).

Further petrel collections at Ilha da Trindade were made by (among others) British Antarctic Expeditions on 13 September 1901 (Wilson 1904) and on 28 July 1910; by the 'Valhalla' expedition on 3-5 January 1906 (Nicoll 1906); from the whaler 'Daisy' on 8 April 1913 (Murphy 1915); and around late December 1975 by S.L. Olson (specimens in the USNM). All were identified as *P. arminjoniana* or its

synonyms and no Kermadec petrels have previously been identified from this island. The petrel population on Ilha da Trindade in the mid-1990s, estimated as 2000-5000 individuals, was assumed to be entirely *P. arminjoniana* (BirdLife International 2000).

The first record of one of these petrels in the North Atlantic was a Trindade petrel (pers. obs.) captured on a yacht in December 1905 at 21° 51' N, 43° 35' W (Lowe 1911). A Kermadec petrel was blown inland to Cheshire, western England in April 1908 (Newstead & Coward 1908). As this species was considered restricted to the Pacific Ocean, the record is presently rejected and the species is not on the British list (BOU 1998). The first Atlantic-seaboard North American record was of a dark phase *P. arminjoniana* blown inland to New York State in August 1933 (Allen 1934). A filmed sighting in Pennsylvania, U.S.A. in October 1959 after a hurricane (Heintzelman 1961) was identified as a dark phase Kermadec petrel by experts but remained controversial (Gochfeld *et al.* 1988) and was not accepted officially until 1998 (AOU 1998). A dark phase Trindade petrel was collected at sea in 1978 (Lee 1979), and another was seen ashore among nesting terns in Puerto Rico, West Indies in July 1986 (Gochfeld *et al.* 1988). Since regular pelagic trips to observe seabirds off eastern U.S.A., particularly off Cape Hatteras, North Carolina, began around 1991 (Brinkley 1996) there have been many sightings identified as Trindade (Herald) petrels (Brinkley 1996; Patteson 2003; Tove 2003).

During 1992-93 Giovannini da Silva studied petrels on Ilha da Trindade for his Master's thesis (Silva 1995). He considered all his study subjects to be *P. arminjoniana*. The calls he reported were referred to in Brooke *et al.* (2000), who gave evidence for two petrel species (a *P. arminjoniana* form and Kermadec petrel) on Round Island, Indian Ocean. Until then, Kermadec petrels had been considered restricted to Pacific waters, whereas the breeding range of Trindade/Herald petrels had been known to span South Atlantic, Indian and South Pacific Oceans since 1869, 1952 and 1888 respectively (Murphy & Pennoyer 1952). A television film about the natural history of Ilha da Trindade (TCFIT *et al.* 2001) includes a c.2 min. segment on Trindade petrels and their calls.

This paper re-examines the identification of the *Pterodroma* petrels of Ilha da Trindade and of these petrels seen in north Atlantic waters.

METHODS

Specimens and source material

Specimens and other relevant material were sourced or examined from several institutions which are abbreviated as follows:

AMNH - American Museum of Natural History, New York, U.S.A.; BMNH - Natural History Museum, Tring and London, U.K.; GMC - Grosvenor Museum, Chester, U.K.; MONZ - Museum of New Zealand, Wellington, New Zealand; MRSN - Museo Regionale di Scienze Naturali, Torino, Italy; NCSM - North Carolina State Museum, Raleigh, U.S.A.; USNM - United States National Museum, Washington D.C., U.S.A.

Other abbreviations used in this paper are: AOU - American Ornithologists' Union; BOU - British Ornithologists' Union; RCM - Robert Cushman Murphy; TCFIT - Twentieth Century Fox International Television.

Vocalisations

Trindade petrels' calls at Ilha da Trindade were described by Silva (1995), and can be heard on film (TCFIT *et al.* 2001). For Round Island birds' calls I listened to the 1987 recording by D.V. Merton (Brooke *et al.* 2000) and studied those described by Gardner *et al.* (1985). For Pacific Ocean colonies I heard these petrels at Rarotonga, Cook Islands in 1986, had access to recordings made by J. Jolly on Henderson Island, Pitcairn group in 1991, and studied the description by Marchant & Higgins (1990). There is a sonagram of the main call in Brooke *et al.* (2000).

For Kermadec petrels, recordings were made at Kermadec Islands in 1966 by W.V. Ward (NZ Department of Conservation sound library), and at Round Island in 1987 by D.V. Merton. There are sonagrams in Marchant & Higgins (1990) and Brooke *et al.* (2000). Oliver (1955) and Ward (1969) described the characteristic call, as heard at Kermadec Islands.

Plumage

The plumage features which I compared were the colour of the primaries' shafts and inner webs, and the colour phases of birds. In his original 1863 description Schlegel reported the whitish primary shafts of Kermadec petrels (Giglioli & Salvadori 1869), subsequently confirmed by Newstead & Coward (1908), Murphy & Pennoyer (1952), Marchant & Higgins (1990) and Brooke *et al.* (2000). Some of these authors also noted the conspicuous underwing patch formed by the white basal two-thirds of the primaries' inner webs. In contrast, Trindade petrels have primaries with dark shafts and darker inner webs distally, but have a whitish stripe tapering inwards across the posterior underwing, formed by white bases to primary coverts, greater coverts and secondaries (Giglioli & Salvadori 1869; Murphy 1915; Marchant & Higgins 1990).

Both species are polymorphic. In Trindade petrels there are dark and light phases, the latter nearly always with a collar of dark feathers

encircling the lower neck, but few intermediates between the two (Giglioli & Salvadori 1869; Murphy & Pennoyer 1952; Marchant & Higgins 1990). Kermadec petrels can show a wide range of plumages from the dark phase to a light phase in which the head and under surface of the body are mostly white, but collared birds are uncommon (Murphy & Pennoyer 1952; Oliver 1955; Marchant & Higgins 1990).

I studied 46 skins and one spirit specimen of petrels from Ilha da Trindade, and obtained information on three others at AMNH, and 16 at USNM. Plumage descriptions and data on colour phases are given by Giglioli & Salvadori (1869), Nicoll (1906), Murphy (1915, 1936), Lee (1979), Brinkley (1996), TCFIT *et al.* (2001) and Tove (2003). I examined 43 skins of Kermadec petrel at MONZ for details of primary shafts colour and plumage phases.

Intestines

Helicoidal structure of the upper intestines of *Pterodroma* has been studied extensively (Imber 1985). Some species have untwisted intestines while others have twisted intestines, with the number of twists and proportions of left and right twists varying greatly between subgenera, but only slightly between species within subgenera. A Kermadec petrel had 82 helicoidal twists, 58% left-handed (LH). A Herald petrel had only 34 twists (56% LH) and a closely-related Phoenix petrel (*P. alba*) 39 (69% LH). Samples were small but, in two gadfly petrels where 15-21 intestines were examined, the number of helicoidal twists varied only ± 9 around the mean for that species (Imber 1985). Thus Kermadec petrels are always likely to have 70-90 twists, and Herald petrels 25-45, with Trindade petrels unlikely to differ from the latter.

I examined the intestines of one spirit specimen from Ilha da Trindade.

Feather lice (Insecta: Phthiraptera)

Several genera of lice regularly parasitise Trindade and Kermadec petrels. Both petrels carry the same species of the genera *Ancistrona* Westwood, 1874 and *Trabeculus* Rudow, 1866, but usually different species of the genus *Halipeurus* Thompson, 1936. *Halipeurus kermadecensis* (Johnston & Harrison, 1912) has been reported from many Kermadec petrels in the Pacific Ocean (Johnston & Harrison 1912; Pilgrim & Palma 1982; R.L. Palma pers. comm.), and *H. heraldicus* Timmermann, 1960 from numerous Herald petrels in the Pacific Ocean (Timmermann 1960; R.L. Palma pers. comm.) and Trindade petrels at Round Island, Indian Ocean (Vinson 1976; R.L. Palma pers. comm.).

Lice from petrels collected on Ilha da Trindade were obtained from three skins by ruffling feathers to dislodge lice, and one spirit specimen by

washing with water over a fine sieve (B. Zonfrillo, R.L. Palma pers. comms.). They were preserved on slides and identified at MONZ by R.L. Palma (pers. comm.). Seven lice were also identified by Timmermann (1960) from at least three BMNH skins from Ilha da Trindade, though he did not specify the skins' registration numbers.

RESULTS

Vocalisations at Ilha da Trindade

Three types of vocalisation by Ilha da Trindade petrels were described by Silva (1995). The first ['Vocalização básica'] is very recognisable as the common, repetitive chatter of Trindade/Herald petrels from Round Island to the Pitcairn group (sonagram in Brooke *et al.* 2000), and well recorded on film (TCFIT *et al.* 2001). It is uttered in flight and on the ground. The second ['Canto'] is the only other well-formed Trindade petrel call reported in the literature, and is 'a drawn out, low pitched growl lasting 20-30 s' (Gardner *et al.* 1985), or 15-45 sec (Silva 1995). It also can be heard on the film (TCFIT *et al.* 2001). It may be given only on the ground, apparently by the male where a pair is courting at a nest site (Silva 1995) and allopreening (TCFIT *et al.* 2001).

The third call ['Chamado'] has no equivalent in any description of Trindade/Herald petrel calls from anywhere. Initially I did not recognise this call, partly through the wording and/or translation and partly through the phonetics Silva (1995) used, when referred to in Brooke *et al.* (2000). This is clearly the call of Kermadec petrels. Silva's (1995) phonetics are given in Fig. 1a above sonagrams of a Round Island Kermadec petrel's call (Fig. 1b) and 3 calls from Meyer Islands, Kermadec group (Fig. 1c-e). The translated description is: '— which comprises a nasal and sonorous "haác" or "huéc", as well as a disyllabic "urreeennn – quíc" or "eeenn – nhác", of which the first note is ascendant and quite prolonged, and passes into the second which is short and acute' (Silva 1995).

The report by Silva (1995) is apparently the first and only detailing of this call in the Ilha da Trindade literature (Murphy 1915, 1936; Brinkley 1996). He states that this call was related to territorial defence, and given by adults attending eggs or chicks, as well as by birds near nests, thus indicating breeding by these Kermadec petrels. He implies that it was mainly uttered on the ground during his observations, as it was at Round Island (Brooke *et al.* 2000) and, particularly from late incubation onwards, at Kermadec Islands (Ward 1969). Also, the repeated, terminal 'wuk's ('quíc' or 'nhác' in Silva's phonetics) of the call (Ward 1969; Brooke *et al.* 2000), usually uttered early in the season and often by flying birds at Kermadec

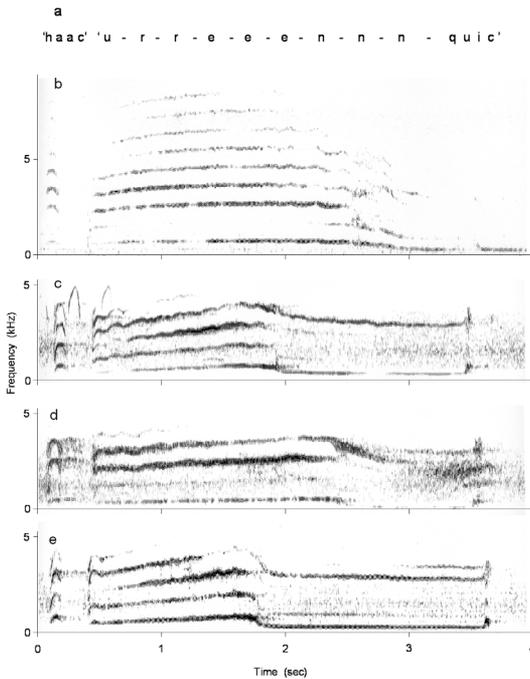


Figure 1 Calls of Kermadec petrels rendered phonetically (a) and by sonograms (b-e); (a) Ilha da Trindade, 1992-93 (Silva 1995), (b) Round Island, 1987 (D.V. Merton recording), (c-e) Three calls, apparently by the same bird (Ward 1969), at Meyer Islets, Kermadec Islands, 1966 (W.V. Ward recording).

Islands (Oliver 1955; Ward 1969), were apparently omitted from calls everywhere later in the breeding season.

Kermadec petrel primary shafts colour

The Kermadec petrel skins in MONZ comprised nine dark, 12 intermediate and 22 light phase birds, all from Kermadec Islands. All adults had whitish (dull white or off-white) shafts of the primaries (except the outer 10-20% of each shaft which was dark), and this whiteness tended to be more conspicuous dorsally. However, in full-grown fledglings (one dark, three intermediate and one light phase) the shafts were less pale beyond the coverts (a brownish-white or very pale tan), such that they might be discernible with difficulty at sea.

Petrels at Ilha da Trindade

Among the material and literature examined from Ilha da Trindade I identified three Kermadec petrels (Table 1) and 71 Trindade petrels (Table 2). The Kermadec petrel from Ilha da Trindade, spirit specimen USNM 503731 (Table 1), had primaries with whitish shafts and mainly white inner webs,

intestines (Imber 1985: as *P. arminjoniana* in table 2) like those of a Kermadec petrel from the Pacific Ocean, and 19 *Halipeurus kermadecensis* lice (R.L. Palma pers. comm.). The two AMNH skins (Murphy 1915: RCM 1979 = AMNH 132502, RCM 1981 = AMNH 269660) were identified by the same details of the primaries (P. Capainolo pers. comm.). Murphy (1915: 343) referred only in general terms to 'concealed portions of the feathers are pure white, including the shafts' for *A. trinitatis* adult; not specifying the primaries, nor whether there were one or two 'adults' among his three *trinitatis* skins.

If these data (Tables 1 and 2) are representative of the island's petrel population, then less than 5% of the Ilha da Trindade petrel population were Kermadec petrels. All three Kermadec petrels identified were dark phase birds. However, 59% of Trindade petrels were light phase, including the few intermediate phases (except dark intermediates) among these light phase birds (3 dark, 0 light cf. 29 dark, 42 light: $\chi^2 = 4.1$, $df = 1$, $P < 0.05$). The overall proportion of light phase petrels at Ilha da Trindade, both species combined, was 57% ($n = 74$).

Petrels in the North Atlantic Ocean

Five Kermadec petrels from the North Atlantic Ocean were identified, or tentatively identified (Table 1). These included the first Atlantic record (Newstead & Coward 1908). The plumage description of this male, particularly underwing, primaries and their shafts, is consistent with Kermadec petrel. Conversions of measurements from imperial - wing (282 mm), tail (102 mm), tarsus (38 mm), mid-toe (53 mm), weight (454 g) - are within the ranges for male Kermadec petrels (Murphy & Penroyer 1952; Marchant & Higgins 1990). However, culmen (43 mm) is clearly an error; recalculating from Newstead's photograph by comparing the culmen profile (and allowing for the head being turned towards the camera) with that of the tarsus gave 29-29.5 mm, also consistent with Kermadec petrel.

The first Atlantic-seaboard U.S.A. record was the Heintzelman (1961) sighting with film, identifiable by its extensive white area on the primaries underneath, pale-based rectrices, tail shape and consensus (R.C. Murphy, G.E. Watson).

Three of the North Atlantic "records" of Kermadec petrels (Table 1) were sightings from pelagic, seabird observation trips off eastern U.S.A. in the last 12 years (Brinkley 1996; Patteson 2003; Tove 2003). Birds seen have often been very well photographed and these images put on the internet (Patteson 2003). One of the sightings (M. Tove *in* Brinkley 1996) reported 'pale feather shafts in all nine primaries', characteristic of Kermadec petrels.

Table 1 Confirmed and possible records of Kermadec petrels (*Pterodroma neglecta*) from Ilha da Trindade, South Atlantic Ocean and the North Atlantic, arranged by locality then chronologically.* Originally identified as *P. arminjoniana* † tentative identification here

Locality	Date	Colour phase	Type of record	Reference
Ilha da Trindade	8 April 1913	Dark	Skin: RCM 1979	Murphy 1915;
	8 April 1913	Dark	AMNH 132502 *	P. Capainolo pers.comm.
	28 Dec 1975	Dark	Skin: RCM 1981 AMNH 269660 *	Murphy 1915; P. Capainolo pers.comm.
			Spirit specimen: USNM 503731 *	pers. obs.; J. Dean pers. comm.
North Atlantic: Cheshire, U.K.	1 April 1908	Dark	Mounted skin: GMC ?no.	Newstead & Coward 1908
Pennsylvania, U.S.A.	3 Oct 1959	Dark	Sighting + film	Heintzelman 1961
Off N. Carolina	29 May 1994	Dark	Sighting *	M. Tove <i>in</i> Brinkley 1996
Off N. Carolina	25 May 2001	Dark	Sighting/photo †*	Patteson 2003
Off N. Carolina	26 May 2002	Dark	0525n1 copy.JPG Sighting/photo †*	Patteson 2003
			020526hepe.jpg	

Table 2 Records of Trindade petrels (*Pterodroma arminjoniana*) from Ilha da Trindade and the North Atlantic, arranged by locality then chronologically.

‡ type specimens † seen by MJI

Locality	Date	Colour phase		Type of record	References
		Dark	Light		
Ilha da Trindade	23 Jan 1868	2	2 ‡	Skins: MRSN †	Giglioli & Salvadori 1869
	13 Sept 1901	4	1	Skins: BMNH †	Wilson 1904
	3-5 Jan 1906	8	11		Nicoll 1906
	28 July 1910	3	10		pers. obs.
	ca.1880,1950	0	2		pers. obs.
	28 July 1910	1	1	Skins: MONZ †	pers. obs.
	8 April 1913	2	5	Skins + 1 spirit: AMNH (RCM)	Murphy 1915
				1974-78, 80, 82	
	8 April 1913	0	1	Photo: (plate 24)	Murphy 1915
	19 Dec 1975- -31 Jan 1976 ca. 2000	8 1	8 1	Skins: USNM Film	J. Dean pers. comm. TCFIT <i>et al.</i> 2001
North Atlantic:- 21°51'N, 43°35'W	31 Dec 1905	0	1	Skin: BMNH †	Lowe 1911
Ithaca, New York, U.S.A.	24 Aug 1933	1	0	Skin: USNM 348070	Allen 1934; Lee 1979
Off N. Carolina	20 Aug 1978	1	0	Skin: NCSM	Lee 1979
Puerto Rico, West Indies	12 July 1986	1	0	Sighting + photographs	Gochfeld <i>et al.</i> 1988
Off N. Carolina	31 May 2002	1	0	Sighting/ photo 020531hepe.jpg	Patteson 2003
Off N. Carolina	Aug 2002?	1	1	Sightings/photos trpe2-2.jpg Hepe1-scn.jpg	Patteson 2003
Off N. Carolina	23 May 2003	0	1	Sighting/ photo hepe052303	Patteson 2003
Off N. Carolina	31 May 2003	1	1	Sightings/photos hepedm053103 hepelm053103	Patteson 2003

The two others (Patteson 2003) I tentatively identified mainly by the underwing pattern, but *0525n1copy.JPG* may also be showing pale primary shafts or inner webs, and a paler face; *020526hepe.jpg*, which was in moult, shows a white primary inner web where the next inner primary has been shed but pale shafts are not visible, however.

The first record of Trindade petrel from the North Atlantic Ocean was that of Lowe (1911: 223), followed by that of Allen (1934) (Table 2). The Gochfeld *et al.* (1988) sighting was well described and illustrated. The seven sightings at sea from recent years (Patteson 2003) comprised both dark and light phase birds (Table 2). All three light phase birds had typical Trindade petrel underwings, although *hepelm053103* was unusually pale-headed and short-tailed. The four dark phase birds appeared to be Trindade rather than Kermadec petrels, based on underwing pattern and impression of tail length.

All five Kermadec petrels identified from the North Atlantic were of the dark phase. Among Trindade petrels from the North Atlantic the ratio was 6 dark:4 light (Table 2) but this depends on the veracity of some dark phase identifications. Considering only at-sea observations, and including Brinkley's (1996) data, 70% ($n = 43$) of North Atlantic Ocean records, both species combined, were of dark phase birds.

Feather lice (Insecta: Phthiraptera)

Halipeurus lice, held in MONZ and BMNH, from at least seven birds collected at Ilha da Trindade were all identified as *H. kermadecensis*. I was able to confirm the identity of all of these hosts: one Kermadec petrel (USNM 503731) and at least six Trindade petrels in the BMNH collection (where there are no Kermadec petrels from Ilha da Trindade). Thus *H. heraldicus* may be absent at Ilha da Trindade, and both petrels in the Atlantic host *H. kermadecensis*.

DISCUSSION

Petrels at Ilha da Trindade

The relegation of the Kermadec petrel call to third place by Silva (1995), and the absence of previous reports of this call at Ilha da Trindade, indicates that this species is rarer than the Trindade petrel there. This concurs with evidence in this paper that possibly less than 5% of that island's petrel population are Kermadec petrels. This figure is less than that indicated at Round Island (at similar latitude in the Indian Ocean) where, depending on time of year, <10-28% of the petrel population were Kermadec petrels by call ratios (Brooke *et al.* 2000). As these species breed almost throughout the year but each with different peaks of egg-laying, the proportions of the two species within the island

population will vary seasonally. Kermadec petrels on Raoul I., Kermadec Islands had a laying peak in November (Oliver 1955) (but this formerly huge colony is now extinct), whereas on nearby Meyer Islets the laying peak was February/March (Oliver 1955; Veitch & Harper 1998). Trindade petrels had a laying peak in July-October at Round Island (Gardner *et al.* 1985), and Herald petrels laid almost evenly throughout the year at Pitcairn Islands (Brooke & Rowe 1996). I have not studied information from Ilha da Trindade (Silva 1995), as it was not among the sections of his thesis that I obtained.

Evidently the population of Kermadec petrels at Ilha da Trindade is heavily biased towards, or exclusively, the dark phase. The same may apply at Round Island, where 70% of the petrel population is dark-phased (Gardner *et al.* 1985), as were the two Kermadec petrels identified there by Brooke *et al.* (2000). However, the two species have not so far been separated into respective colour phase proportions there. Elsewhere, Murphy & Pennoyer (1952) found the highest proportion of the dark phase at Juan Fernandez Islands (43%). Thus, the predominantly dark-phased Trindade population of Kermadec petrels may be the result of founder effect from an already largely dark Indian Ocean population, assuming colonisation of Ilha da Trindade by westward dispersal south of Africa, as did Murphy & Pennoyer (1952: 35) for *P. arminjoniana*.

Wilson (1904) and Nicoll (1906) observed that dark phase birds at Ilha da Trindade seemed more abundant at higher altitudes. This could have been because Kermadec petrels prefer cooler conditions for breeding as well as at sea, and were more prevalent among those seen breeding at higher altitudes by Wilson and Nicoll. This may also partly explain the apparent paucity of Kermadec petrels among specimens collected there; most collecting may have been done at the more accessible lower altitudes, or even from around the various expeditions' ships while inshore.

Petrels in the North Atlantic Ocean

Records of undifferentiated Trindade/Kermadec petrels from the North Atlantic Ocean are predominantly of dark phase birds - 72% (Brinkley 1996), roughly 80% (Tove 2003) and 70% (this paper). This raises the question as to how a breeding population of only 43% dark phase petrels generates 70% dark phase migrants north of the equator. Kermadec petrels migrate transequatorially in the Pacific Ocean to 42°N (Marchant & Higgins 1990); one banded at Kermadec Islands was recovered seven years later in the Philippine Islands in the non-breeding season (R.O. Cossee pers. comm.). On the other

hand, Herald petrels are considered only to disperse across the tropics, though apparently reaching 39°N in the Pacific (Marchant & Higgins 1990). The higher proportion of dark phase birds in the North Atlantic Ocean can be explained by a higher proportion of Kermadec petrels migrating there. If 70% of all these petrels are dark phase in the North Atlantic Ocean, virtually all Kermadec petrels are dark but only 41% of Trindade petrels are, it follows that 49% of all petrels of these two species occurring in north Atlantic waters could be Kermadec petrels. It seems unlikely that dark phase Trindade petrels would be more dispersive than those of the light phase.

Brinkley (1996) wrote of these petrels: 'the paler morphs resemble nothing else that is likely to be seen off the coast of North Carolina, - - - - . The dark morph is the trickster - - -: it can resemble - - - - dark morph jaegers/skuas (*Stercorarius* spp.) far more than one might believe.' In the Pacific Ocean, Spear & Ainley (1993) reported Kermadec petrels to be mimics of jaegers and small skuas both in appearance and flight, and to utilise this at times in kleptoparasitic feeding behaviour. Although North Atlantic comparisons have been with small, dark jaegers, and Spear & Ainley's with pomarine jaegers (*Stercorarius pomarinus*) and South Polar skuas (*Catharacta maccormicki*) in the Pacific, the similarities are obvious. The observations in North Atlantic waters of such likenesses between dark petrels of this group and jaegers support the conclusion that many of these dark petrels may be Kermadec petrels.

Kermadec petrels range into cooler seas than do Trindade petrels, being mainly subtropical as opposed to the more tropical Trindade petrels (Murphy & Pennoyer 1952). They reach the subtropical convergence at 44°S east of New Zealand but Trindade petrels have not been recorded off New Zealand (Marchant & Higgins 1990). It is likely that Kermadec petrels also range further north in the Atlantic, and the early records from U.K. and Pennsylvania, U.S.A. are consistent with this idea.

Feather lice

The apparent dominance or exclusiveness of the louse *Halipeurus kermadecensis* on these Ilha da Trindade petrels may have occurred if the Kermadec petrel, one of its regular hosts, colonised Ilha da Trindade first, because Africa presents less of a barrier to this subtropical species than to the tropical Trindade petrel. When the latter arrived, its louse (*H. heraldicus*), present at Round Island, may have suffered competitive exclusion by *H. kermadecensis*. Exchange of lice between the two hosts is possible at Ilha da Trindade, as the petrels probably share and compete for limited nest sites.

Also, colonising Trindade petrels may have lacked *Halipeurus*, a phenomenon known as 'missing the boat' (Paterson *et al.* 1999). However, further collecting of lice from Trindade petrels is needed to ascertain the apparent absence of *H. heraldicus*. The probable dominance of *H. kermadecensis* does mean that lice should not be used as an adjunct to the identification of these petrels in the Atlantic.

Status of *Pterodroma arminjoniana*

Investigations of the taxonomic status of Trindade petrels in the Atlantic and Indian Oceans may have been compromised by the inclusion of a minority of data from the somewhat larger Kermadec petrel. Only when morphometrics are obtained from correctly identified Trindade petrels from Ilha da Trindade and Round Island will their relationship to Herald petrels be confidently assessable. The impression from the few specimens seen side-by-side in MONZ was that Trindade petrels were noticeably larger and, from recordings, that their calls were lower-pitched, compared to those of Herald petrels.

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