

Notes on the biology and morphology of Audubon's Shearwaters *Puffinus lherminieri* (Procellariiformes: Procellariidae) from Fernando de Noronha, northeast Brazil

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RESUMO: Observações sobre a biologia e morfologia da pardela-de-asa-larga *Puffinus lherminieri* (Procellariiformes: Procellariidae) de Fernando de Noronha, nordeste do Brasil. *Puffinus lherminieri* nidifica em pequeno número em duas ilhotas do arquipélago de Fernando de Noronha, nordeste do Brasil, onde pode ser um colonizador recente. Ninhos com ovos foram encontrados em agosto-setembro, ninhegos em setembro-outubro e filhotes com penas em outubro, mas parece haver grande variação interanual na fenologia reprodutiva. As aves visitam as colônias durante a noite e vocalizam mesmo fora da temporada reprodutiva. As análises morfométricas concordam com estudos genéticos ao reunir as aves brasileiras com as do Caribe. As mesmas análises também permitem distinguir todos os táxons atlânticos do grupo *lherminieri-assimilis* e concorda com análises genéticas ao mostrar a semelhança entre *P. baroli* e *P. boydi* do Atlântico Norte.

PALAVRAS-CHAVE: análise morfométrica, Brasil, biologia reprodutiva, Fernando de Noronha, *Puffinus lherminieri*.

ABSTRACT: Audubon's Shearwaters nest in small numbers on two islets of the Fernando de Noronha group, off northeast Brazil, where they may be recent colonizers. Nests with eggs have been found in August-September, downy chicks in September-October and full-grown chicks in October, but there seems to be great annual variation in breeding phenology. Birds visit the nesting colonies after dark and call even outside the nesting period. Morphometric analyses agree with genetic ones in lumping the Brazilian birds with Caribbean populations. The same analyses also allow discrimination of all Atlantic small-shearwater taxa and concur with genetic analysis showing the similarity between North Atlantic *Puffinus baroli* and *P. boydi*.

KEY-WORDS: Audubon's Shearwater, Brazil, breeding biology, Fernando de Noronha, morphometric analyses, *Puffinus lherminieri*.

The shearwaters of the *Puffinus assimilis-lherminieri* complex form a yet poorly known assemblage of small-sized seabirds widespread in tropical and temperate seas, with around 20 described taxa (Jouanin and Mougouin 1979, Harrison 1985, Shirihai *et al.* 1995, Warham 1990, 1996). The validity and assignment of some to one or another species is problematical, as well as species' limits (Murphy 1927, Austin 1996, Shirihai *et al.* 1995, Hazevoet 1996, Bretagnolle *et al.* 2000). Austin *et al.* (2004) presented the first phylogenetic analysis of the group based on molecular (mitochondrial DNA) data, suggesting 14 "lower-level" and five "higher level" taxa can be recognized. The lower-level taxa equal to subspecies under the Biological Species Concept.

Five extant taxa in the *assimilis-lherminieri* complex have been described from the Atlantic Ocean: nominate *lherminieri* and *P. l. loyemilleri* from the Caribbean,

P. l. boydi from Cape Verde (sometimes assigned to *assimilis*), *P. a. baroli* from the Azores, Canaries and Madeira, and *P. a. elegans* from Tristan da Cunha and Gough (Jouanin and Mougouin 1979, Sinclair *et al.* 1982, Warham 1990, Shirihai *et al.* 1995). Austin *et al.*'s (2004) molecular analysis suggest all Atlantic taxa, except *elegans*, are in the same clade; *elegans* being part of the *assimilis* lineage.

Nevertheless, while recent treatments (*e.g.*, Onley and Scofield 2007) have restricted the name *P. assimilis* to populations nesting in the sub-tropical and sub-Antarctic Indian Ocean and off Australia and New Zealand, and considered *P. baroli* and *P. elegans* (this including populations nesting in the south-Atlantic and sub-Antarctic New Zealand) as full species, *boydi* has been included in *lherminieri*, a view at odds with the molecular data. Despite this, no morphological analysis has been made to test if there is congruence between morphology and the molecular data.

Audubon's Shearwater *P. lherminieri* has only recently been recorded in Brazil from shelf waters (Olmos 1997) and as a breeder in the Itatiaia Islands, State of Espírito Santo (20°21'S, 40°16'W) on the southeastern coast (Efe and Musso 2001).

In March 1989 one shearwater identified as a Little Shearwater *P. assimilis* was captured at its nest on Morro do Leão Islet, Fernando de Noronha Archipelago, a group of 17 oceanic islands and islets about 354 km from the Brazilian mainland, covering a total area of 26 km² (c. 03°54'S, 32°25'W; Antas *et al.* 1990, Silva e Silva 2008). Later, two further records of birds in apparent nest burrows were made on nearby Morro da Viuvinha Islet (Schulz-Neto 1995). No specimens were collected for identification (A. Schulz-Neto, *pers. comm.*) but Schulz-Neto (1995) shows a colour photograph of one bird with blue feet and flesh-colored webs and some white above the eyes and, based on those records, *P. assimilis* entered the list of Brazilian birds (Sick 1997).

Soto and Filippini (2003) reviewed the Brazilian records of *P. lherminieri*, providing the first published measurements for the Fernando de Noronha birds, and found no differences between these and those from Espírito Santo (Efe and Musso 2001). They confirmed the presence of small nesting colonies on two islets, Morro da Viuvinha and Morro do Leão, with less than ten nesting pairs overall. They hypothesized that the shearwaters of Fernando de Noronha actually belonged to the small *loyemilleri* form of Audubon's Shearwater based on the morphology and colour of the birds.

The small population size and the fact that Fernando de Noronha is overrun by introduced predators (cats, dogs, black rats, brown rats and mice; Silva e Silva 2008) have raised concerns about the species' survival, and it is now considered as "Critically Endangered" in Brazil (Machado *et al.* 2005). Here we provide information on morphology, voice and natural history of the shearwater population of Fernando de Noronha and comment on its status and conservation.

METHODS

General data on Audubon's Shearwaters and other birds on Fernando de Noronha were gathered during eight trips made between 1999 and 2008: 17-26 October 1999, 9-18 August 2000, 3-20 March 2002, 3-15 February and 31 August-15 September 2003 (the latter with F. O.), 22 November-11 December 2004, 3-18 October 2005 and 18 February-11 March 2008. Several satellite islands of Fernando de Noronha were visited in search of nesting shearwaters. Observations were made with binoculars (Cannon 10 × 30 IS and Swarovski 8.5 × 42 EL) and photographic documentation obtained with professional equipment. Shearwaters were caught by hand at nest holes,

measured with callipers and ringed with metal rings supplied by the Centro Nacional de Pesquisa para a Conservação de Aves Silvestres (Cemave). Birds found dead were collected, frozen and sent to the Museu de Zoologia da Universidade de São Paulo (MZUSP, São Paulo). Calling shearwaters were recorded with Marantz PMD660 and Sony TCM 450DV recorders equipped with a Sennheiser ME66 directional microphone. A sample is available in the website of xeno-canto America (www.xeno-canto.org).

We compared morphological characters of the shearwater specimens from Fernando de Noronha (three museum study-skins and three live birds) with samples of the *lherminieri-assimilis* complex from the Caribbean (*lherminieri*), Cape Verde (*boydi*), Madeira, Porto Santo and Canaries (*baroli*) and Gough (*elegans*). See Appendix for museum specimen data. One Atlantic taxon not available for inclusion in the analysis (*P. lherminieri loyemilleri* from islands off Panama) was compared to the Brazilian birds from published measurements and morphological characters (Wetmore 1959, Sinclair *et al.* 1982). Two birds in the American Museum of Natural History (AMNH, New York) identified as *loyemilleri*, collected in Tobago, were included in the *lherminieri* sample because birds from those islands agree both genetically and in measurements with the latter (Austin *et al.* 2004).



FIGURE 1: Audubon's Shearwaters *Puffinus lherminieri* adult and chick on nest among boulders on Morro da Viuvinha islet, Fernando de Noronha, northeast Brazil (Photo: R. S. S.).

TABLE 1: Morphometric data (mean and \pm SD) of specimens of the *Puffinus assimilis-lherminieri* complex used in the discriminant analysis.

Measurements	<i>lherminieri</i> ¹ n = 24	<i>boydi</i> n = 12	<i>baroli</i> n = 8	<i>elegans</i> n = 6	<i>lherminieri</i> ² n = 6
Wing chord	201.3 \pm 26.5	181.6 \pm 11.4	177.9 \pm 5.8	183.0 \pm 8.0	204.2 \pm 7.5
Tail length	94.3 \pm 12.7	82.6 \pm 7.6	75.5 \pm 7.8	82.6 \pm 3.1	98.6 \pm 4.5
Tarsus length	38.3 \pm 3.4	34.8 \pm 4.0	36.4 \pm 2.8	40.6 \pm 0.8	38.1 \pm 1.2
Middle toe	40.7 \pm 4.7	38.1 \pm 3.5	38.1 \pm 3.5	47.3 \pm 1.5	40.7 \pm 2.0
Bill length	28.6 \pm 4.6	25.2 \pm 4.7	25.7 \pm 1.2	25.6 \pm 0.8	28.5 \pm 1.5
Base of bill to nostril	6.2 \pm 1.8	5.6 \pm 1.6	6.9 \pm 1.0	7.1 \pm 0.7	6.9 \pm 0.5
Bill width at base	8.5 \pm 1.8	7.2 \pm 1.0	6.7 \pm 0.7	8.7 \pm 0.5	8.4 \pm 0.6
Bill height at base	9.6 \pm 1.8	7.8 \pm 1.6	7.6 \pm 0.8	8.9 \pm 0.4	8.4 \pm 0.6
Smaller bill height	6.7 \pm 1.5	5.2 \pm 1.3	5.1 \pm 0.8	5.9 \pm 0.3	7.0 \pm 0.7
Lower jaw	30.0 \pm 4.2	25.8 \pm 2.9	26.5 \pm 2.0	25.6 \pm 1.0	30.1 \pm 1.1
Unguis length	14.2 \pm 3.4	25.8 \pm 2.9	11.6 \pm 1.7	15.4 \pm 0.7	13.2 \pm 1.0
Bill height at unguis	6.9 \pm 1.1	5.7 \pm 0.9	5.6 \pm 0.6	6.5 \pm 0.3	6.9 \pm 0.2

¹ Specimens from the Caribbean.

² Specimens from Fernando de Noronha Archipelago in north-eastern Brazil.

Morphological variables were compared among groups using Analysis of Variance, with *post-hoc* tests to check for between group differences. Additionally, a forward stepwise discriminant function analysis (DFA) was performed on log-transformed data to determine the effectiveness of 12 morphological variables (Table 1) in assessing the similarity of the sampled specimens. Variables were chosen following the suggestion of Shirihai *et al.* (1995) that bill structure should be considered besides standard measurements (Table 1).

Only adult birds were included in the analyses; we excluded obvious newly-fledged young. We pooled both sexes for the analyses due to small sample sizes and lack of significant differences between the sexes during preliminary analyses. All analyses were performed using the SAS 8.2 and SPSS 13.0 statistical software packages.

RESULTS

Breeding Biology

On 13 August 2000 R. S. S. found shearwaters nesting on Morro do Leão Island (03°52'27"S, 32°26'09"W), and on 17 August, they were also found to be nesting at Morro da Viuvinha Island (03°52'19"S, 32°26'17"W). The birds nest in natural cavities among boulders (Figure 1), perhaps scraping some to make them more comfortable. At Morro do Leão most nests are in a sort of cave made by several large collapsed boulders at the water's edge. No nesting material is used.

In September 2003 six nests with attending adults were found at Morro da Viuvinha; one had a young chick, the others eggs. Two eggs measured 54.41 \times 38.4 mm (38 g) and 49.37 \times 37.06 (36 g). In late November 2004, two adult shearwaters were found in the same spot.

Another visit in the beginning of October 2005, also in Morro da Viuvinha, found 10 active nests, all with adults and their downy chick, with a total of 30 birds (20 adults and 10 chicks). Another five adults were seen in a spot above the colony but the presence of active nests could not be confirmed. A night search starting in the late afternoon of 8 October and going until the following morning found 15 *P. lherminieri*, 13 adults and two well-grown young, all being ringed.

The birds arrived in the nesting colony only after sunset, from 18h40 onwards, and quickly went to their nests. They called intensely throughout the night, even in flight, vocal activity diminishing a little during the hours before dawn. At first light, around 05h00, most adults left the colony, but a few remained in the nests.

Three of the ringed birds were recaptured, two in the same month of October 2005, and another in August 2006, all of them in the same spot where first captured. The apparent fidelity to the nest site seen in Fernando de Noronha is known from other localities where the species breeds, including, in Brazil, the islands off Espírito Santo (Efe and Musso 2001).

From late February to early March 2008 night visits to Morro da Viuvinha Island recorded at least two individuals arriving in silence at 19h00 and starting to call soon thereafter, but no active nest. In fact, one could stand on Leão Beach facing the island and hear the calling shearwaters up to around midnight, even from the Projeto Tartarugas Marinhas (Tamar) shelter built above the beach.

Morphological Analysis

The shearwaters from Fernando de Noronha have dark-brownish rather than blackish upperparts. The

remiges are mostly dark-brown with greyish inner vanes, while the underwing coverts are white to greyish-white. The crown extends just below the eye and is sharply demarcated against the white throat. The underparts are white except for the brown undertail coverts and pectoral patches forming an interrupted breast band. Live birds have pinkish-blue tarsi and toes with pinkish webs. The outer toe and side of the leg are darker blue (Figure 2). The bill is bluish-grey with darker unguis and cutting edge. Three live birds caught at their nests in Morro da Viuvinha islet in September 2004 weighed 215, 269 and 239 g.

The Analysis of Variance (ANOVA) revealed significant differences among groups for all variables (all $P < 0.001$) except the minimum height of the bill measured between the nostrils and the unguis, but *post-hoc* univariate analysis failed to find significant differences



FIGURE 2: Adult *Puffinus lherminieri* moving to its nest on Morro da Viuvinha islet, Fernando de Noronha, northeast Brazil (Photo: R. S. S.).

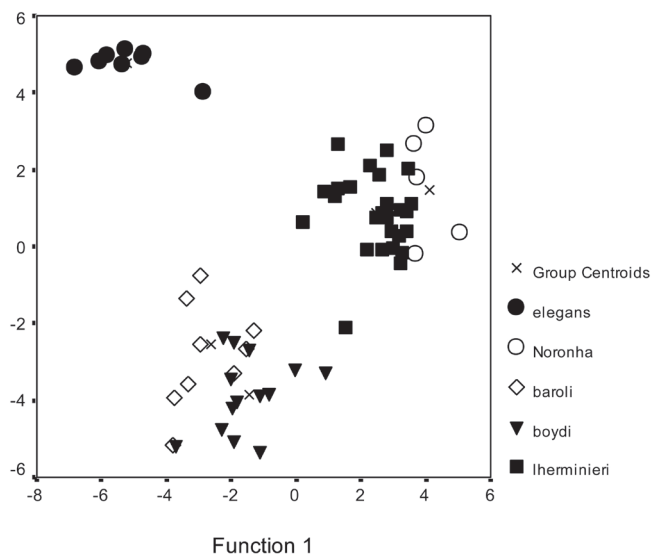


FIGURE 3: Discriminant function analysis on morphological measures of five groups of the *Puffinus assimilis-lherminieri* group.

TABLE 2: Standardized weights of discriminant function roots based on forward stepwise analysis of 12 morphological measurements for seven taxa of the *Puffinus assimilis-lherminieri* complex. Only seven variables were included in the final model.

Variable	Root 1	Root 2	Root 3	Root 4
Tail	0.654	0.167	-0.415	-0.552
Tarsus	-0.057	0.633	0.581	0.184
Toe	-0.493	0.401	-0.348	-0.410
Base-Nostril	-0.208	0.597	0.614	-0.241
Lower bill	0.639	-0.353	0.371	0.386
Unguis Length	-0.457	0.096	-0.549	0.708
Unguis height	0.567	0.608	0.104	-0.700
Eigenvalue	9.829	8.290	1.434	0.272
Canonical correlation	0.953	0.945	0.768	0.463
% of variance	49.6	41.8	7.2	1.4
Cumulative %	49.6	91.4	98.6	100.0

between the Noronha birds and Caribbean *lherminieri* in all measurements (Tukey HSD tests, all $P > 0.1$). Interestingly, there were no significant differences between *baroli* and *boydi* in wing (Kruskall-Wallis test, $P > 0.05$) and tail lengths (Tukey HSD test, $P > 0.1$).

The discriminant analysis shows significant Mahalanobis distances among all groups, but distances between Fernando de Noronha birds and Caribbean *Puffinus lherminieri* were smallest. This analysis also grouped these samples (Figure 3), making a group of long-tailed, long-winged and long-toed shearwaters with longer unguis and jaw, and thicker bills. North Atlantic birds make a group of smaller birds with shorter wings and tail (Table 1). The discriminant function is heavily loaded by tail and tarsus length (Table 2) and correctly classified 80% of the Fernando de Noronha birds (20% were lumped with Caribbean *lherminieri*), and 96% of the Caribbean *lherminieri* (4% were lumped with Fernando de Noronha birds). For other taxa, 100% of *baroli* and *elegans*, and 97% of *boydi* were correctly identified by the function.

Measurements and coloration set the Brazilian birds apart from *Puffinus [assimilis] elegans*. Like *P. assimilis*, *P. elegans* has a mostly white underwing and white undertail coverts, and its upperparts are greyish when fresh, giving the birds a silvery appearance that slowly fades away as feathers worn out. Also, the upperwing coverts show white edges. While wing length of Gough Island birds ranges from 180-199 mm (Sinclair *et al.* 1982; see Table 1), values for Fernando de Noronha shearwaters range from 204-210 mm. Gough birds also have much shorter tails (53-63 mm) than the Brazilian ones (87-95 mm).

Wings and tails of *P. lherminieri loyemilleri* are 185-193 mm and 80.7-87.7 mm for males, and 185-195 mm and 82.8-88.5 for females (Wetmore 1959). All Fernando de Noronha birds have wings longer than 200 mm, the collected male with wing and tail lengths of 204 and 87 mm, and the female 210 and 95 mm. Considered as smaller than nominate *lherminieri*, *P. l. loyemilleri*

remains to be properly characterized, as published information shows extensive overlap with nominate *lherminieri* in all measurements but wing (Wetmore 1959). Molecular data from a single specimen (Austin *et al.* 2004) suggest it is not a valid taxon but this requires further analysis, as this evidence may not suffice to lump *loyemilleri* with *lherminieri* (see below).

DISCUSSION

So far, *Puffinus lherminieri* has been found to nest in only two islets in the whole Fernando de Noronha archipelago. Nevertheless, other islands, such as Frade and Cabeluda, seem to have ideal conditions for nesting shearwaters but, because access is difficult, they have not been adequately surveyed. It would be important to carry out a throughout survey of the occurrence of *P. lherminieri* in different sites of the archipelago using call playback. Especially during the nesting season, it would be easy to pinpoint colonies from their calls while doing night surveys. The same methodology might also reveal other species of Procellariiformes nesting in the archipelago.

We found the annual breeding cycle of shearwaters in Fernando de Noronha extends from August to November-December. Nests with eggs well into hatching were found from mid-August to September, small downy chicks in September-October, well-grown young in October and adults and probable late departing youngsters found in the colonies in February-March. Fernando de Noronha has a marked, although variable, dry season from September-February, when the birds seem to nest.

Other researchers found nesting shearwaters, which helps to bracket their nesting period and to suggest interannual variations. Nests with eggs were also found in August 1990 and September 2000 (Soto and Filippini 2003). Interestingly, during the same month seven fledged young were found in several beaches (Soto and Filippini 2003), raising the possibility of the presence of a subpopulation nesting during the rainy season.

In November 1991, two nests were found at Morro da Viuvinha Island, one with one adult on an egg, and another with an adult and a downy young. In November 1992, the species was again found nesting at the same spot, but only one adult was found (Schulz-Neto 2004). This suggests nesting in 1991 was delayed.

The shearwaters nesting in Fernando de Noronha have coloration and morphometrics that are very similar to Caribbean *Puffinus lherminieri*. Only the colour of the feet (flesh-colored in *lherminieri*, light-blue with pinkish webs in Fernando de Noronha) seems to differ but the validity of this character may be questioned, as it seems to vary widely among individuals in several small shearwater species (M. Imber *in litt.* 2009). The colour of undertail coverts, usually considered to be diagnostic

of *P. lherminieri*, is actually variable. Of three handled in September 2003, one had white coverts, a condition also found elsewhere (Lee and Haney 1996).

The discriminant analysis, although able to tell Fernando de Noronha birds apart from all other shearwaters, put them together with Audubon's Shearwaters from the Caribbean. The morphological data also agree in considering the North Atlantic taxa as closer to *lherminieri* than to *assimilis*, and to be closely-related, although distinctive. Our analyses do not support the treatment of Onley and Scofield (2007), who lumped *boydi* with *lherminieri*. Rather, *boydi* is morphologically closer to *baroli*.

The results validate the use of a set of variables describing bill morphology in differentiating shearwater taxa, and show that discriminant analysis is a very useful tool to aid the identification of closely-related taxa such as *baroli* and *boydi* even without including plumage characters. Validating molecular data suggesting all Atlantic taxa, except *loyemilleri*, can be considered, at the least, phylogenetic species. In addition, morphological data are coherent with molecular ones showing the Fernando de Noronha birds share the same genotype with Caribbean shearwaters, pointing to a common ancestry and/or gene flow among the populations (Austin *et al.* 2004).

Regarding molecular data, care must be taken about equating a lack of detectable sequence divergence in a small portion of mitochondrial DNA (mtDNA) as evidence against subspecific or, in some cases, even specific, designation. Because the sequence variation examined in mtDNA reflects selectively neutral mutations accumulated over long periods of time, these changes are not likely to reflect divergent traits that have suffered strong selection over shorter periods of time. That means mtDNA does not constitute a definite test for subspecific and, for some taxa, even specific status, and it would be unwise to alter the status of a taxon based largely or exclusively on small amounts of sequence data. The lack of significant mtDNA divergence between some procellariiform sister taxa reported by Penhallurick and Wink (2004) suggests that, in some albatrosses and petrels, morphology (and ecology) indicative of reduced gene flow may change faster than mtDNA. Morphological, ecological, behavioral and parasitological data should be used to corroborate results from molecular analyses. In the case of Fernando de Noronha birds, the morphology validates the close relationship with Caribbean *lherminieri*.

In the western Atlantic, Audubon's Shearwaters are known to breed as far south as Tobago, where a population apparently intermediate between *loyemilleri* and *lherminieri* nests (Collins 1969, Blake 1977). Prior to the late 1980s, none of the researchers working in the Fernando de Noronha archipelago found nesting shearwaters (Ridley 1888, 1890, Murphy 1936, Oren 1982, 1984, Nacinovic and Teixeira 1989) and some pointed specifically to their absence (Olson 1982). It is possible the nesting

colonies there represent either a relict population that managed to go unnoticed through the islands' history or a recent range extension of Caribbean *lherminieri* into the South Atlantic. The absence of shearwaters from both the historical and paleontological records (Olson 1982) favours the second hypothesis.

Besides Fernando de Noronha, Audubon's Shearwaters have recently been found nesting only in one island in south-eastern Brazil (Efe and Musso 2001). Nevertheless, their nocturnal and burrowing habits make nesting shearwaters generally inconspicuous, even for ornithologists aware of their possible presence. The observations of possible Audubon's Shearwaters over the Brazilian shelf as far south as Lat. 26°S (Olmos 1997) suggests this species may be more widespread in the South Atlantic than currently thought.

Austin *et al.* (2004) stated that "morphological similarities and differences are poor indicators of relationships within the small *Puffinus* shearwaters. That is exemplified by the failure of all previous taxonomic treatments to reflect phylogeny, by the conflicting placement of *boydi* in either the *assimilis* group or the *lherminieri* group and of *baroli* in the *assimilis* group when both are sister taxa and closely related to *lherminieri*, and by the sheer number of conflicting taxonomic arrangements that have been proposed". Our results show relatively simple quantitative morphological analyses can be used to validate, and strengthen, molecular data.

Most of the Fernando de Noronha archipelago, including the islets where shearwaters are known to nest, is included in a national park created in 1988, the remaining being an "Environmental Protection Area". Nevertheless, management has failed to deal with the issue of introduced species (especially rats, cats, and tegu lizards) that restrict smaller ground-nesting seabirds to offshore islets. One of the known nesting sites for petrels, Morro da Viuvinha, is very close to the main island of the archipelago and within reaching distance by swimming rats, being under continuous threat (Silva e Silva 2008). Previous work elsewhere in the world have proved an eradication campaign targeting all introduced predators would be quite feasible in a relatively small archipelago such as Fernando de Noronha (see examples in Howald *et al.* 2007 and Hughes *et al.* 2008) and would benefit not only nesting petrels but other seabirds and the endemic land fauna and flora (Silva e Silva 2008).

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APPENDIX

List of specimens used for morphological analysis. The following abbreviations are used: MZUSP = Museu de Zoologia da Universidade de São Paulo, São Paulo; AMNH = American Museum of Natural History, New York; m = male; and f = female.

Fernando de Noronha specimens: MZUSP 75185 ?; MZUSP 75186 m; MZUSP 75187 f.

Puffinus lherminieri lherminieri: AMNH 788348 f, 788349 f (Little Tobago), AMNH 749052 f, 749058 m (St. Thomas), 749056 f (Barbados), 325297 m, 325978 f, 32599 f (Grenadines), 55155 f, 108862 f (Guadeloupe), 349275 f, 783743 m (Bermuda), 24458 m, 26848 m, 26849, 26850 m, 749057 m, 76542 f, 76543 f, 76544 f, 79393 f, 349286 f, 527878 m, 527879 m, 527880, 527881 m, 527888 m, 527889 f (Bahamas).

Puffinus [lherminieri] boydi: AMNH 265402 m, 265403 m, 265404 m, 265405 m, 265406 m, 265408 f, 265409 f, 265410 f, 265411 f, 265413 f, 197721 m, 197726 f, 197727 f (Razo, Cape Verde Islands), 527894 f, 197727 f (Rombos, Cape Verde Islands).

Puffinus [assimilis] baroli: AMNH 407682 f, 527860 m, 527861 m (Porto Santo, Madeira), 527871 m (Gran Canaria, Canary Islands), 527874 m, 52875 f, 527876 m (Tenerife, Canary Islands), 527876 m (Graciosa, Canary Islands).

Puffinus [assimilis] elegans: 32797 f, 32798 f, 32799 f, 32800 m, 32801 f, 32082 m, 32803 m, 32804 m, 32805 ?, 32806 m (Gough Island).