

Sooty Terns *Onychoprion fuscatus* on Ascension Island in the south Atlantic are a reproductively isolated population

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RESUMO: Os trinta-réis-das-rocas *Onychoprion fuscatus* da Ilha de Ascensão constituem uma população reprodutiva isolada. O tamanho de uma população é determinado pelo equilíbrio entre nascimentos e mortes, e entre imigração e emigração. Para investigar a dinâmica populacional de *Onychoprion fuscatus* da Ilha de Ascensão no Atlântico Sul, este estudo concentrou-se na imigração, através da medição das proporções de recrutas filopátricos e imigrantes para população reprodutora. A colônia de *Onychoprion fuscatus* de Ascensão cresceu 7% após a erradicação de gatos ferais *Felis silvestris* em 2003. Entre 1975 e 2002 potenciais recrutas para a população reprodutora foram anilhados quando ainda no ninho em Ascensão e outras colônias do Atlântico. Buscas por esses indivíduos, mas como adultos reprodutores, em Ascensão iniciaram-se em junho de 2002 e entenderam-se até dezembro 2008. Dos 600 ninhos anilhados em Ascensão, 36 (6%) foram recrutados para população reprodutora e dos 9.482 anilhados em outras colônias, apenas um (0,01%) foi encontrado reproduzindo em Ascensão. Uma investigação extra sobre a morfometria de *Onychoprion fuscatus* mostrou que as aves de Ascensão diferem significativamente daquelas de colônias vizinhas no Atlântico, sugerindo que as aves de Ascensão constituam uma subespécie ainda não identificada. Conclui-se, que a imigração para a população reprodutora em Ascensão é mínima e que essa é reprodutivamente isolada.

PALAVRAS-CHAVE: ilha de Ascensão, *Onychoprion fuscatus*, filopátrido, dinâmica populacional, isolamento reprodutivo, anilhamento.

ABSTRACT: Population size is determined by the balance of births and deaths, and of immigration and emigration. In order to investigate population dynamics of the Sooty Tern *Onychoprion fuscatus* population on Ascension Island in the south Atlantic, we focussed on the key component of immigration by measuring the proportions of philopatric and immigrant recruits to the breeding population. The Sooty Tern colony had expanded by 7% following the eradication of Feral Cats *Felis silvestris* in 2003. Between 1975 and 2002 potential recruits to the breeding colony were ringed as chicks on Ascension Island and in colonies elsewhere in the Atlantic. Searches for these birds as adults breeding on Ascension commenced in June 2002 and continued until December 2008. Of the 600 chicks ringed on Ascension, 36 (or 6%) were recruited into the breeding population and of the 9,482 ringed in other colonies, only one (0.01%) was found breeding on Ascension Island. A further investigation of morphometric measurements revealed that Sooty Terns on Ascension were significantly different from those from neighbouring colonies. The sample of birds from Ascension was drawn from a different population and is possibly of a previously unidentified, sub-species. We conclude that immigration to the breeding population on Ascension is minimal and that they are a reproductively isolated population.

KEY-WORDS: Ascension Island, *Onychoprion fuscatus*, philopatric, population dynamics, reproductive isolation, ringing.

We studied the population dynamics and, specifically, the recruitment of Sooty Terns *Onychoprion fuscatus* breeding on the British Overseas Territory of Ascension Island in the middle of the Atlantic Ocean (07°57'S, 14°24'W; 9,700 ha). The island is geographically isolated being 1,400 km from the nearest island and 2,300 km from South America. It holds important breeding colonies of seabirds including the endemic Ascension Frigatebird *Fregata aquila* and is an 'Important Bird Area' (Sanders 2006). Feral Cats *Felis silvestris* were eradicated

on Ascension Island in 2003 to facilitate the restoration of seabird colonies (Hughes *et al.* 2008). The eradication programme resulted in some successes with Masked Boobies *Sula dactylatra* and Brown Noddies *Anous tenuirostris* returning to nest on the main island in 2004 (Sanders 2006). The recruits that re-established on the main island colonies were most likely birds that had occupied cat-free offshore stacks (B. J. H. *pers. obs.*). Between 1996 and 2008 the large colony of Sooty Terns breeding on the main island expanded by 26,000 birds to 420,000 birds

(or by 7% based on average breeding population sizes for 14 seasons; Hughes *et al.* 2008). The source of these recruits is the subject of this paper. We ask the question: Has Sooty Tern population growth on Ascension Island been achieved by immigration from other colonies or is the island's population isolated?

Natal dispersal of Sooty Terns is common (Schreiber *et al.* 2002) and inter-colony movements of over 1,000 km have been reported in the Indian Ocean (Feare and Lesperance 2002) and in the Caribbean Sea (Norton 1986). Therefore, although Ascension is geographically isolated (Figure 1), immigration from other colonies may occur. St. Helena Island lies 1,400 km SE and has a population of < 500 Sooty Terns. The species is also found on Atol das Rocas, Brazil (03°51'S, 33°49'W; 36 ha; at a distance of 2,200 km from Ascension with a population of \approx 140,000 Sooty Terns), on Tinhosa Grande, São Tomé and Príncipe, Gulf of Guinea (01°21'N, 07°18'E; 21 ha; at distance of 2,600 km with a population of \approx 200,000 Sooty Terns) and in the Caribbean where large colonies breed on the Dry Tortugas and on > 50 other islands (Schreiber *et al.* 2002) (Figure 1). The nearest Caribbean colony to Ascension is Saba Cay, St.

Thomas, U.S. Virgin Islands (18°19'N, 65°00'W; 30 ha; at a distance of 6,300 km with a population of \approx 40,000 Sooty Terns). Juveniles on migration from the Caribbean to their nursery in the Gulf of Guinea travel 4,000 km eastwards along the southern inter-tropical convergence zone (Figure 1) passing within < 1,000 km of Ascension (Robertson 1969). Thus, Sooty Terns travel great distances and juveniles from any of these colonies could be considered as providing possible recruits to the Ascension Island colony.

In order to investigate the source of recruits to the increasing population on Ascension, we carried out intensive searches for birds returning as adults to breed. Here, we report the results of our ring recovery programme. Morphometric measurements of Sooty Terns were recorded to establish whether there is variation in body size between Ascension and other colonies.

MATERIAL AND METHODS

We based our ring recovery programme on Ascension Island on 10,082 Sooty Tern chicks that were ringed

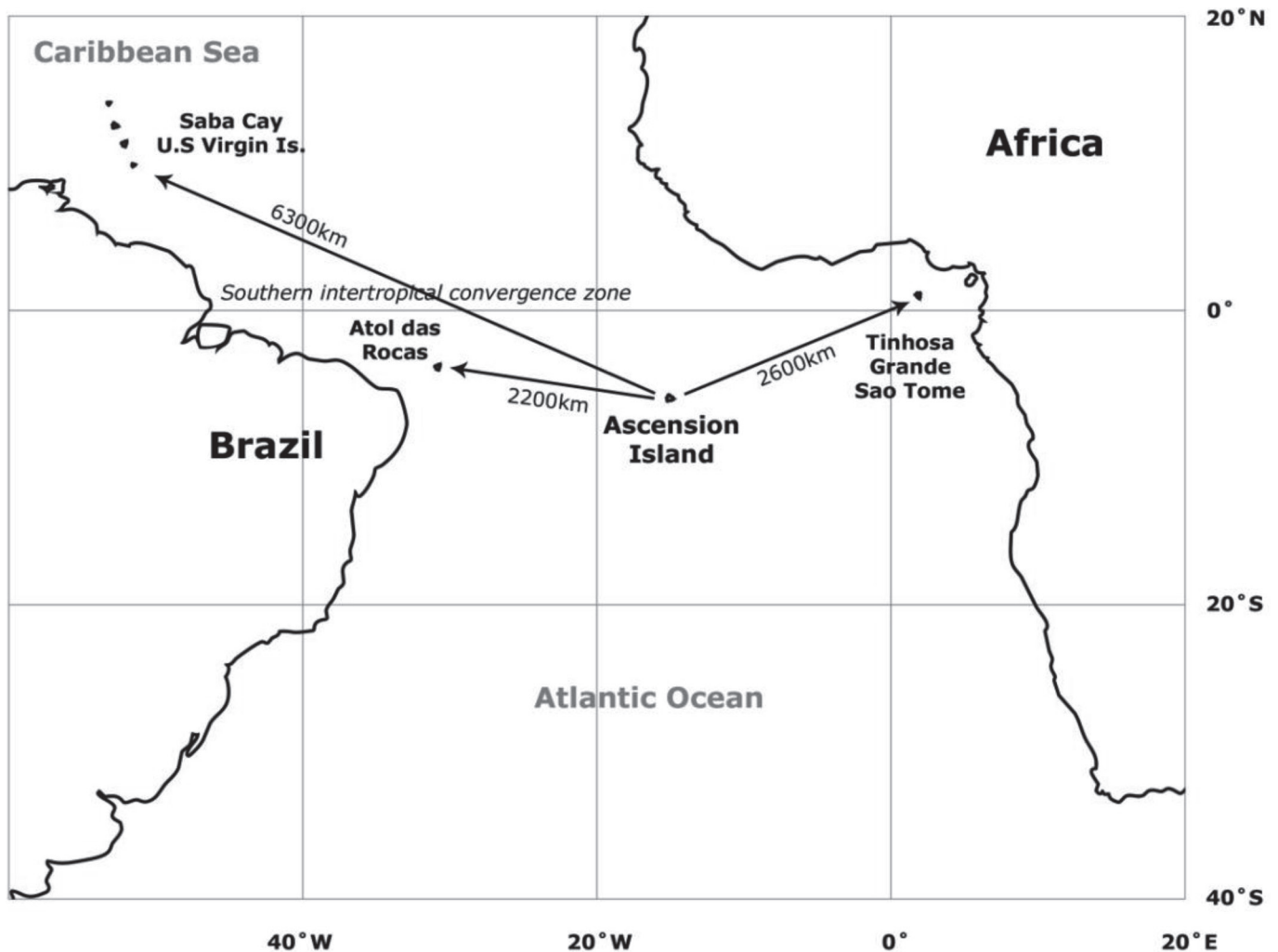


FIGURE 1: Location of Ascension Island and distances to other large Sooty Tern *Onychoprion fuscatus* colonies in the Atlantic Ocean.

in the four Atlantic colonies between 1975 and 2002. On Ascension 600 have been ringed, on Atol das Rocas 5,558, on Saba Cay 3,900 and on Tinhosa Grande 24. Ascension Sooty Terns breed in two sub-colonies that are 3 km apart at Mars Bay and Waterside in the south-west corner of the island (Figure 2). Re-trapping of recruits took place during nine breeding seasons from June 2002 to December 2008. (Note that in some years two breeding seasons occur as a result of sub-annual periodicity; see Hughes *et al.* 2008 for further details). Recruits ringed as chicks (age 7-35 days) were re-captured with a long-handled net while incubating eggs and their natal colony identified from details provided on their rings.

In addition to ringing chicks, some 17,000 incubating Sooty Terns were ringed. From this cohort > 1,800 were randomly selected and standard morphometric measurements were taken. They included body mass (to nearest 1 g with a spring balance), wing length (to nearest 1 mm with a stopped ruler; see Redfern and Clark

2001 for further details), and culmen (to nearest 0.1 mm with a digital calliper; see Reynolds *et al.* 2008 for further details).

A literature search provided comparative biometric measurements and breeding periodicities of Sooty Terns at other Atlantic colonies. We used Z-tests to compare morphometric measurements of Ascension Island Sooty Terns with conspecifics from other Atlantic colonies.

RESULTS

Across nine seasons of the study period 374.5 hours of re-trapping effort resulted in the re-capture of 38 birds that were ringed as chicks (Table 1). Thirty-six of the re-captured adults were from the cohort of 600 chicks ringed on Ascension. Of the 9,482 chicks ringed elsewhere in the Atlantic, one immigrant was re-captured twice on Ascension Island (Table 1). The first evidence

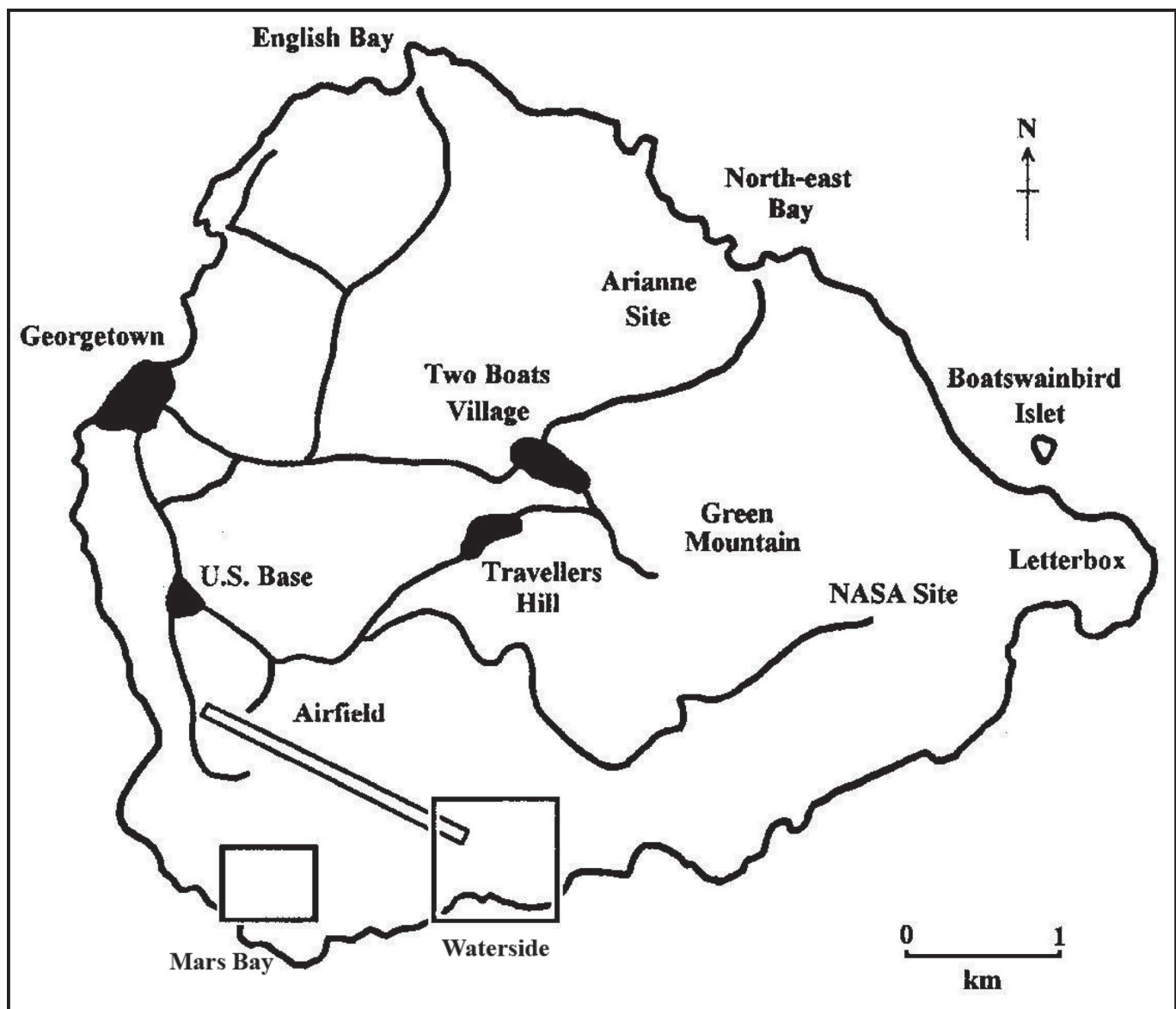


FIGURE 2: Locations of the Sooty Tern *Onychoprion fuscatus* colonies at Mars Bay and at Waterside on Ascension Island in the south Atlantic.

TABLE 1: Results from re-trapping of Sooty Terns *Onychoprion fuscatus* on Ascension Island across nine seasons from June 2002 to December 2008. Results document hours of focused re-trapping effort, numbers of birds ringed as chicks and recaptured as incubating adults, numbers recaptured in their natal sub-colony, numbers recaptured in the adjacent sub-colony and immigrants. Note: The one immigrant was recaptured in 2003 (Hughes and Wearn 2006) and, again, in 2008.

Date	Re-trap effort (hours)	Numbers of re-trapped adult birds that were:		
		Ringed as chicks	Philopatric	Immigrants
Jun 2002	≈ 10	1	1	0
Apr 2003	19	2	1	1
Feb 2004	64	4	4	0
Nov 2004	32	1	1	0
Oct 2005	18	3	3	0
Aug 2006	55.75	7	7	0
May 2007	53.25	11	11	0
Feb 2008	70.5	6	5	1
Dec 2008	52	3	3	0
Total	374.5	38	36 (97%)	1 (3%)

that mixing of populations occurs was gathered on 24 April 2003 when a Sooty Tern wearing a Brazilian CE-MAVE ('Centro de Pesquisas para a Conservação de Aves Silvestres') ring number H25617 and ringed on 31 January 1993 was re-trapped (Hughes and Wearn 2006). The bird was re-trapped for a second time six seasons later on 13 February 2008. Both times the bird was recaptured while incubating at Mars Bay. The distance between the respective nest sites occupied on Ascension in 2003 and in 2008 was 0.3 km.

Morphometric measurements of Ascension Island Sooty Terns revealed body masses of 190.1 ± 19.0 g (\pm SD) (range 162-318 g, $n = 531$), wing lengths of 292.60 ± 7.95 mm (range 202-318 mm, $n = 1,845$) and culmens of 43.50 ± 2.00 mm (range 34.8-52.5 mm, $n = 986$) (Table 2). Mean body mass, wing and culmen lengths of Sooty Terns on Ascension were significantly larger ($Z = 8.10, 5.23, 7.86$ respectively, all $P_s = 0.01$) than birds on Tinhosa Grande (Monteiro *et al.* 1997)

(Table 2). Body masses and wing lengths were also significantly larger ($Z = 5.61, 4.11$ respectively, all $P_s = 0.01$) than those on Atol das Rocas (Schulz-Neto 1998) and wing lengths were significantly longer ($Z = 3.92, P = 0.01$) than Sooty Terns from the Caribbean (Schreiber *et al.* 2002; Table 2). The mean body mass of Sooty Terns on Ascension was 29% larger than that of birds on Tinhosa Grande.

DISCUSSION

The age range of Sooty Terns re-trapped in the breeding colony was 5.5-27.5 years (B. J. H. unpubl. data). Thus, most chicks that were ringed between 1975 and 2002 were old enough to be in the breeding colony yet young enough not to have exceeded their life expectancy during the 2002-2008 re-trap period. The recapture of just one immigrant from a population of 9,482 chicks ringed in the Atlantic colonies outside Ascension suggests that the increase in the Sooty Tern population on Ascension is due to local recruitment. Lower predatory pressures resulting from the removal of Feral Cats may have improved survivorship thereby improving recruitment in recent years.

If survivorship has improved then emigration is a possibility that needs investigating. The one immigrant we found had travelled 2,200 km from its natal colony on Atol das Rocas, off north-east Brazil (Hughes and Wearn 2006). Searches for Sooty Terns at the Atol das Rocas Biological Reserve would provide welcome insight into emigration from Ascension.

The differences in morphometric measurements of various sub-species in the Atlantic, Pacific and Indian Oceans (Schreiber *et al.* 2002) are very similar in magnitude to the differences within a single sub-species found in the four Atlantic colonies. Thus, there are significant morphometric differences and breeding cycle differences between Ascension Sooty Terns and the various forms

TABLE 2: Linear measurements (mm) and body masses (g) (mean \pm SD; $n =$ sample size, and range), and breeding season descriptions of Sooty Terns *Onychoprion fuscatus* from four islands in the Atlantic Ocean. Means with the symbol '*' are significantly different ($\alpha = 0.01$) from those on Ascension Island.

Measurements	Tinhosa Grande, São Tomé	Atol das Rocas, Brazil	U.S. Virgin Is., Caribbean	Ascension Island
Body mass	155.0* \pm 22.9 ($n = 29$; 122-216)	176.3* \pm 16.4 ($n = 50$)	184.0 \pm 15.8 ($n = 50$)	190.1 \pm 19.0 ($n = 531$; 162-318)
Wing length	283.9* \pm 8.9 ($n = 29$; 262-300)	288.8* \pm 6.4 ($n = 50$)	289.0* \pm 6.5 ($n = 50$)	292.60 \pm 7.95 ($n = 1845$; 202-318)
Culmen	41.00* \pm 1.65 ($n = 28$; 38.1-44.2)	43.2 \pm 1.8 ($n = 50$)	44.0 \pm 1.8 ($n = 50$)	43.50 \pm 2.00 ($n = 986$; 34.8-52.5)
No. of juveniles ringed	24 (1996-1997)	5,558 (1991-1994)	3,900 (1976-1980)	600 (1975-2002)
Breeding season	Cycle unknown: peaks Dec-Jan and May-Jun	Year-round: peak in Jan-Feb	Annual cycle: peak in Apr-Aug	Sub-annual cycle: every 9.6 months
References	Monteiro <i>et al.</i> (1997); Jones and Tye (2006)	Schulz-Neto (1998)	Norton (1986)	

breeding elsewhere in the Atlantic. This indicates that the sample of birds on Ascension Island was probably drawn from a different population and is possibly a different and hitherto unidentified sub-species.

Future research might investigate whether there are significant differences in mitochondrial DNA between Ascension birds and those nesting elsewhere in the Atlantic. Blood samples from Ascension birds have been collected for comparison with similar samples from other colonies. Analysis of these samples is ongoing and we await the results to confirm our initial conclusions that population growth is the result only of local recruitment and that Ascension Island Sooty Terns are a reproductively isolated population.

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REFERENCES

- Feare, C. J. and Lesperance, C. (2002).** Intra- and inter-colony movements of breeding adult Sooty Terns in Seychelles. *Waterbirds*, 25:52-55.
- Hughes B. J.; Martin, G. R. and Reynolds, S. J. (2008).** Cats and seabirds: Effects of feral Domestic Cat (*Felis silvestris catus*) eradication on the population of Sooty Terns (*Onychoprion fuscatus*) on Ascension Island, South Atlantic. *Ibis*, 150(Suppl. 1):121-129.
- Hughes, B. J. and Wearn, C. (2006).** Re-trapping Adult Sooty Terns *Sterna fuscata* on Ascension Island. *Osprey*, 6:22.
- Jones, P. and Tye, A. (2006).** *The birds of São Tomé and Príncipe with Annobon*. Oxford, UK: British Ornithologists' Union.
- Monteiro, L. R.; Covas, R.; Melo, M. P.; Monteiro, P. R.; Jesus, P.; Pina, N.; Sacramento, A. and Vera Cruz, J. (1997).** *Seabirds of São Tomé e Príncipe: the taxonomic status of the Madeiran Storm Petrel (Oceanodroma castro) and conservation of the whole community*. University dos Azores progress report. www.horta.uac.pt/port/pesquisa/marine_ecology_11.html (accessed in: 18/05/2010).
- Norton, R. L. (1986).** Recoveries of Sooty Terns (*Sterna fuscata*) on Saba Cay, St Thomas, U.S. Virgin Islands. *J. Field Ornithol.*, 57:226-228.
- Redfern, C. P. F. and Clark, J. A. (2001).** *Ringers' manual*. Thetford, UK: British Trust for Ornithology.
- Reynolds, S. J.; Martin, G. R.; Wallace, L. L.; Wearn, C. P. and Hughes, B. J. (2008).** Sexing Sooty Terns on Ascension Island from morphometric measurements. *J. Zool., London*, 274:2-8.
- Robertson, J. W. B. (1969).** Transatlantic migration of juvenile Sooty Terns. *Nature*, 222:632-634.
- Sanders, S. M. (2006).** *Important bird areas in the United Kingdom Overseas Territories*. Sandy, UK: Royal Society for the Protection of Birds.
- Schreiber, E. A.; Feare, C. J.; Harrington, B. A.; Murray Jr., B. G.; Robertson Jr., W. B.; Robertson, M. J. and Woolfenden, G. E. (2002).** Sooty Tern (*Sterna fuscata*). In: A. Poole and F. Gill (eds.) *The birds of North America* No 665. Philadelphia, PA: The Birds of North America, Inc.
- Schulz-Neto, A. (1998).** Aspects of seabird biology at Atol das Rocas Biological Reserve, Rio Grande do Norte, Brazil. *Hornero*, 15:17-28.