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Report of seabird observations in the Indian sector of the Southern Ocean during the austral summers of 2005 - 2008

Short Communication

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Seabirds are the major top predators in the Southern Ocean ecosystem, because of their extensive prey-biomass consumption (Croxall 1984). They have been used as good indicators of ecological changes resulting from variations in the marine environment of the Southern Ocean (Reid et Croxall 2001, Croxall et al. 2002). Therefore, the surveys of seabird ecologies are considered as crucial information for understanding the marine ecosystem. The basic information required in animal ecology surveys is data on distribution and habitat. In the Southern Ocean, many studies about the distribution and habitat of seabirds have been performed by visual observation (Cline et al. 1969, Ainley et Jacobs 1981, Griffiths 1983, Ainley et al. 1984, Abrams 1985, Ainley et al. 1993, Pakhomov et McQuaid 1996, Woehler 1996, Raymond et Woehler 2003, Hyrenbach et al. 2007, Thiebot et Weimerskirch 2013). These studies clearly indicate that variable environmental factors decided the distribution of seabirds since their distribution was found to be affected by marine physical environment and prey environment. However, few simple and descriptive reports have focused on the distribution of seabirds according to their type. Determining the detailed distribution of seabirds by observational surveys is difficult across all seasons because of the temporal and spatial limitations of ship surveys. Obtaining observational data for seabirds across various areas at different seasons is necessary to accurately predict their distribution. The aim of this study was to characterize the distribution of seabirds in the Indian sector of the Southern Ocean.

The survey was conducted using the training and research vessel TRV *Umitaka Maru* in the Indian sector of the Southern Ocean in January 2005, January 2006, and between December 2007 and January 2008. Many previous studies have performed observation surveys to determine the numbers of seabirds present within a 300 m radius (Ainley et al. 1993, Woehler 1996, Hyrenbach et al. 2006). However, in this study, we performed

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15-min. scan surveys every hour from sunrise to sunset within a distance of 400 m with 180° forward vision to ensure best visibility in order to obtain the information of seabird distribution over a wider range. The observations were conducted by two to four persons when the vessel speed was higher than 4 knots. The observational data for three seasons were pooled. These data included monitoring of the presence or absence of each species of the observed seabirds in various areas of the ocean, which included sections of 1° in latitude and 10° in longitude.

The observations were carried out 658 times during the three seasons from 50 to 68° S and from 24 to –97° E (Table 1). The observed ocean areas were divided into 45 sections (Table 1), and 25 species of seabirds were observed. However, some individuals could not be identified to the species level.

Latitude (S)	Longitude (E)							
	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
-50	10							16
-51	12							19
-52	6							10
-53	11						4	17
-54	10						13	4
-55	15						14	
-56	13						20	
-57	6						14	
-58	9					4	8	
-59	12					20		
-60		11				18		
-61		12				13		
-62		11			14	7		
-63		9		11	27			
-64		11	11	40	33			
-65		36	23	5	1			
-66		56	20					
-67		16						
-68		6						

Table 1. Number of observations at each ocean area (42 sections).

Data for the Antarctic Prion *Pachyptila desolata*, Slender-billed Prion *Pachyptila belcheri*, and Blue Petrel *Halobaena caerulea* were pooled in one group (Prion group). Sooty Shearwater *Puffinus griseus* and Short-tailed Shearwater *Puffinus tenuirostris* were collected under the same genus (*Puffinus* genus). Sooty Albatross *Phoebetria fusca* and Light-mantled Sooty Albatross *Phoebetria palpebrata* were pooled as the same genus (*Phoebetria* genus). Two species of giant petrel (Northern Giant Petrel *Macronectes halli* and Southern Giant Petrel *Macronectes giganteus*) and two species of tern (Antarctic Tern *Sterna vittata* and Arctic Tern *Sterna paradisaea*) were collected as *Macronectes* genus and *Sterna* genus, respectively. The observation data for South Georgian Petrel *Pelecanoides georgicus* were excluded from the analysis because of large errors arising from the observational abilities of each researcher. Distribution data for seabirds were collected for 11 species, four genera, and one group (Prion sp. plus Blue Petrel). The presence or absence data for these species in the 45 sections studied are shown in Table 2. The three Albatross species—Wandering Albatross *Diomedea exulans*, Black-browed Albatross *Diomedea melanophrys*, and Grey-headed Albatross *Diomedea chrysostoma*—were observed mainly in the low-latitude area. Cape Petrel *Daption capense*, White-chinned Petrel *Procellaria aequinoctialis*, Wilson's Storm Petrel *Oceanites oceanicus*, Grey-backed Storm Petrel *Oceanites nereis, Puffinus* genus, *Phoebetria* genus, and Prion group were observed across wide latitudes.

Latitude (S)	WA	BBA	GHA	SA and LMSA	SGP and NGP
	Longitude (E)				
50	21-30(10), 91-100(19)	91-100(6)	21-30(10)	21-30(10), 91-100(13)	
51	21-30(17), 91-100(5)		91-100(5)	21-30(8), 91-100(5)	
52	21-30(17), 91-100(10)			91-100(10)	
53	21-30(18)		91-100(6)	91-100(6)	21-30(9)
54	21-30(10)			21-30(10), 81-90(8)	
55	21-30(13)		81-90(7)	81-90(14)	81-90(7)
56	21-30(15)	21-30(8), 81-90(10)		21-30(8), 81-90(5)	21-30(8)
57	21-30(17), 81-90(7)	81-90(7)		81-90(7)	81-90(7)
58	21-30(11)	81-90(13)	81-90(13)	21-30(11), 81-90(25)	81-90(25)
59	21-30(8), 71-80(5)			71-80(15)	21-30(8), 71-80(5)
60				31-40(18), 71-80(17)	71-80(6)
61				31-40(8), 71-80(8)	
62				31-40(18), 61-70(14), 71-80(14)	61-70(7)
63				31-40(11), 51-60(9), 61-70(19)	51-60(9), 61-70(11)
64				31-40(9), 51-60(8), 61-70(6)	31-40(9), 51-60(5), 61-70(3)
65				31-40(6), 41-50(9), 61-70(100)	31-40(6), 41-50(4), 51-60(20)
66	31-40(4), 41-50(2)			31-40(7), 41-50(5)	31-40(7), 41-50(15)
67				31-40(13)	31-40(19)
68					

Latitude (S)	SF	APT	CPT	SPT	PR sp. and BPT
				Longitude (E)	
50			21-30(10)		21-30(20), 91-100(13)
51					21-30(17), 91-100(16)
52					21-30(17), 91-100(20)
53					21-30(27), 91-100(12)
54			81-90(8)		21-30(20), 81-90(16), 91-100(25)
55	21-30(7)				21-30(20), 81-90(14)
56					21-30(23), 81-90(10)
57	81-90(7)				21-30(17), 81-90(7)
58					21-30(22), 71-80(25), 81-90(25)
59			71-80(5)		21-30(25), 71-80(15)
60			31-40(9), 71-80(11)		21-30(18), 71-80(11)
61			31-40(8)		21-30(17), 71-80(15)
62		31-40(27), 61-70(7)	71-80(14)		31-40(18), 61-70(14), 71-80(14)
63	31-40(11), 61-70(4)	31-40(22), 51-70(9)	31-40(22), 51-60(9), 61-70(7)	31-40(11), 61-70(7)	31-40(11), 51-60(9), 61-70(11)
64	61-70(6)	31-40(18), 41-50(18), 51-60(8),61-70(6)	31-40(9), 41-50(9), 51-60(8),61-70(2)	31-40(9), 51-60(3), 61-70(3)	31-40(18), 51-60(3), 61-70(6)
65	31-40(3), 41-50(13)	31-40(13), 41-50(13), 51-60(20),61-70(100)	31-40(8), 41-50(9), 51-60(20)	31-40(11), 51-60(20)	31-40(8), 61-70(100)
66	31-40(2), 41-50(10)	31-40(11), 41-50(10)	31-40(7), 41-50(5)	31-40(9), 41-50(5)	31-40(5), 41-50(10)
67	31-40(13)	31-40(19)	31-40(19)	31-40(19)	
68					

Latitude (S)	WCPT	SW sp.	WSP	GBSP	GS	ART and ANT
50	21-30(10), 91-100(19)	21-30(10), 91-100(6)	21-30(20), 91-100(13)	21-30(20), 91-100(6)		
51	21-30(17), 91-100(11)	21-30(8), 91-100(5)	21-30(17)	21-30(17)		
52	21-30(33), 91-100(10)	21-30(33)	21-30(17)	21-30(17)		
53	21-30(9), 91-100(12)	21-30(9), 81-90(25), 91-100(6)	81-90(25), 91-100(6)		91-100(6)	
54	21-30(10), 81-90(8), 91-100(25)	81-90(8)	81-90(15), 91-100(25)	81-90(15), 91-100(25)		
55	21-30(13), 81-90(14)		81-90(14)	81-90(14)		
56	21-30(23), 81-90(10)	21-30(15), 81-90(10)				
57	81-90(14)	81-90(14)	21-30(17), 81-90(7)	21-30(17), 81-90(7)		
58	21-30(22), 71-80(25), 81-90(25)		81-90(13)	81-90(13)		
59	21-30(8), 71-80(15)	21-30(17), 71-80(5)	71-80(5)	71-80(5)	21-30(8), 71-80(5)	
60	31-40(18), 71-80(6)		31-40(9)	71-80(6)		
61	71-80(15)	31-40(8), 71-80(8)			71-80(8)	
62	31-40(9), 61-70(14), 71-80(14)	31-40(18), 61-70(7)	31-40(9), 61-70(7), 71-80(14)	31-40(9), 61-70(7), 71-80(14)	31-40(9)	
63	31-40(11), 51-60(9), 61-70(11)	31-40(11), 61-70(7)	51-60(9), 61-70(4)	51-60(9), 61-70(4)	51-60(9)	
64	31-40(9), 41-50(9), 51-60(5)	31-40(9)	51-60(3), 61-70(6)	51-60(3), 61-70(6)	41-50(9)	51-60(3)
65	31-40(11), 41-50(4), 61-70(100)	41-50(4), 61-70(100)	31-40(8), 41-50(4)	31-40(6)	31-40(6), 41-50(4)	41-50(4)
66	31-40(7), 41-50(5)	41-50(10)	31-40(11), 41-50(5)	31-40(5)	31-40(7)	31-40(2)
67		31-40(13)	31-40(19)		31-40(19)	31-40(13)
68			31-40(17)			

Table 2. Presence or absence data for 11 species, four genera, and one group of seabirds.

Wilson's Storm Petrel was observed at the highest latitude area of 68° S. Southern Fulmar *Fulmarus glacialoides*, Antarctic Petrel *Thalassoica antarctica*, Snow Petrel *Pagodroma nivea*, Great Skua *Catharacta skua*, and *Sterna* genus were mostly observed in high-latitude areas.

In this study, some individuals could not be identified to the species level because the observations were conducted at a farther distance (*e.g.*, Prion group, *Puffinus* genus, *Phoebetria* genus, *Macronectes* genus, and *Sterna* genus). Therefore, the quality of observation data was not better than that of observation data of other previous studies. In some studies, distribution of seabirds was investigated to divide seabird assemblages according to trophic structure (Abrams 1983, Abrams 1985, Pakhomov et McQuaid 1996, Thiebot et Weimerskirch 2013). For example, Abram (1985) attempted to divide Blue Petrel and Prion sp. into zooplankton-feeder group, Sooty Albatross and Light-mantled Sooty Albatross into cephalopod-feeder group, Antarctic Tern and Arctic Tern into fish-feeder group, and Southern Giant Petrel and Northern Giant Petrel into mixed-feeder group. Thus, obtaining information about the distribution of seabirds according to their trophic structure would be useful if seabird observation could not be conducted up to the species level. Conversely, some studies attempted to divide seabird assemblages into groups on the basis of their physical features such as pack-ice assemblage and open-water assemblage (Ainley et al. 1993, Thiebot et Weimerskirch 2013). The information obtained in our study could not contribute to studies such as analyzing to divided seabird assemblages into groups on the basis of their physical features. This is because many studies have found that seabirds of the same trophic structure are distributed across different oceanographic regions (*e.g.*, Southern Giant Petrel and Northern Giant Petrel).

Few ecological studies have used visual observation method for studying the distribution of seabirds in the Indian sector of the Southern Ocean (Abrams 1985, Woehler 1996, Raymond et Woehler 2003, Woehler et al. 2010, Thiebot et Weimers-kirch 2013). Especially, Woehler et al. (2010) carried out an important study about seabird ecology to explain the relationships among abiotic and biotic oceanographic parameters and the observed seabird community in an area similar to our study area. Although our study showed data regarding only the presence or absence of each species of the observed seabirds in various areas, this is one of the few studies in which direct observation survey was used to determine the distribution of seabirds in the Indian sector of the Southern Ocean.

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