Observations of seabirds in Peruvian and Chilean waters during the 1998 El Niño

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Se realizaron observaciones de aves marinas durante un crucero oceanográfico a lo largo de la costa oeste de Sudamérica en enero de 1998, durante el pico del último ENSO. Se registraron 54 especies, siendo las más abundantes las pardelas *Puffinus griseus* y *P. bulleri*, los paíños *Oceanodroma markhami*, *O. hornby*, la gaviota *Creagrus furcatus* y el piquero *Sula variegata*. Varias de las especies que nidifican en las Islas Galápagos se encontraron bien dentro de aguas chilenas; se presenta una nueva extensión en la distribución del albatros *Phoebastria irrorata*. Se encontraron hasta 100 gaviotines *Sterna lorata* por dia entre 25 y 250 km de la costa, reposando en materia flotante; esto puede representar un componente antes no documentado del ciclo de vida de esta especie.

Introduction

In January 1998, at the height of the recent El Niño event, we participated in an oceanographic cruise from Callao, Peru (12°S) to Valparaiso, Chile (33°S), aboard the Scripps Institution of Oceanography's research vessel, *Melville*, which was engaged in geophysical and marine biological studies of the Peru–Chile Trench floor. The cruise track was 70–200 km offshore (mean c.100 km from the coast; Fig. 1), and traversed much of the (normal) Peruvian upwelling region, and in January 1998, the southern portion of an area exhibiting positive sea surface temperature (SST) anomalies of 2–5°C (NOAA climate data) (Fig. 2). The ship's course was generally west of the core of the Humboldt Current, at the edge of the east Pacific gyre, permitting us to survey waters not frequented by pelagic birding trips, which largely originate from Valparaiso or Arica, Chile, and rarely travel more than 20 km offshore. Water depths during most of the cruise were 4,000–7,000 m.

From noon 31 December to noon 12 January, we counted and photographed seabirds for c.12 hours a day (sunrise to sunset). Birds were identified to species whenever possible, time of sightings noted and correlated with location data from the ship's navigation system. The 100 m vessel, with its high decks and stabilizers, was an ideal platform for observation, permitting the use of telescopes and video camera under most sea surface conditions. Weather during the 12 days was primarily calm, sunny and warm (daytime air temperatures c.25°C). Sea surface temperatures north of 26°S were 22–26°C, reflecting the elevated east Pacific SSTs typical of ENSO events. Cooler water (<20°C) was encountered south of 28°S, closer inshore.

Fifty-four seabird taxa and over 21,000 individuals were observed (Appendix 1). Most abundant were those associated with the coastal seabird colonies of Peru and Chile, certain pelagic species and, perhaps unsurprisingly, species that would normally have been breeding on the Galápagos Islands, c.1,500 km to the north. Observations of special interest are detailed below.

Waved Albatross *Phoebastria irrorata*

A total of 153 of this Galápagos breeder was recorded, and it was recorded on all days except one, the final observation being at 30°16'S, this being the southernmost record ever. Harrison[6,7] suggests that this species is confined to waters of Ecuador and northern Peru, and in fact the first apparent Chilean record of *P. irrorata* was observed during a pelagic trip off Arica in November 1997 (Hill pers. comm.), although Jaramillo (pers. comm.) reports a fisherman's detailed description of this species off Iquique, Chile, prior to this date. In January, birds were seen individually or in small groups, and, in southernmost waters, in the company of other albatross species.

Swallow-tailed Gull *Creagrus furcatus*

Five hundred and forty-one of this Galápagos gull were observed, in flocks of four to several hundred individuals. Typically seen roosting on the water during daylight, while night-time feeding under the ship's lights was observed on several occasions. Those in the north were almost all adults in alternate plumage; large flocks of subadult and basic-plumaged birds were recorded south of 26°S. In rougher southern seas, they were difficult to detect while roosting on the water, and almost all counts represent those flushed by the ship's passage. Thus numbers recorded on the last days are probably underestimates. Considered rare in Chilean waters[2].

Blue-footed Booby *Sula nebouxii*

Six hundred and forty-eight of this Galápagos/northern Peru breeder were recorded, most in active feeding flocks of several dozen. Individuals would

occasionally follow or even land on the ship. All observations were made north of 18°S, and none was recorded in Chilean waters.

Peruvian Tern *Sterna lorata*

Relatively common (up to 100 in a day), which was unexpected as Harrison[6,7] and Enticott & Tipling[5] cite this as a coastal species. All were either non-breeders or subadults, and almost all were roosting on floating logs or other debris 25–200 km offshore, similar to the behaviour of Bridled Tern *Sterna anaethetus*. This may represent a component of the life cycle of this species, which is poorly known. It is considered rare (Jaramillo pers. comm.), and a partially pelagic lifestyle may explain the lack of reports. Reports of Least Terns *Sterna antillarum* off Mexico's Pacific coast in winter[18] suggest that other 'coastal' tern species also possess a similar pelagic component to their annual life cycles.

Other seabirds

Storm-petrels

Wedge-rumped *Oceanodroma tethys*, Markham's *O. markhami* and Hornby's Storm-petrels *O. hornbyi* were encountered virtually throughout, but were most abundant in deep (>5,000 m) offshore waters. Elliot's *Oceanites gracilis* was found primarily at depths of <500 m in Peruvian waters north of 16°S, while Wilson's *Oceanites oceanicus* was restricted to cooler inshore waters south of 26°S. Band-rumped Storm-petrel *Oceanodroma castro*, which breeds on tropical and subtropical Pacific islands, including Galápagos, was only observed at northernmost stations. Jaramillo (pers. comm.) notes that this species has not been recorded in Chile. A large *Fregatta* storm-petrel (either Black-bellied *F. tropica* or White-bellied *F. grallaria*), on 11 January, could not be reliably assigned to species. While on station, storm-petrels feeding at night sometimes came aboard in fair numbers, probably attracted by the ship's lights. These were released in the morning. Species thus recorded included *O. gracilis*, *O. tethys*, and *O. hornbyi*, but not the more abundant *O. markhami*. This may reflect a difference in feeding style, activity period or prey preference for the latter species.

Petrels

Most abundant was White-chinned *Procellaria aequinoctialis*, seen in numbers every day; every dark *Procellaria* petrel seen well or later identified from videotape was assigned to this species, although Westland Petrel *P. westlandica* is regular off Chile[8] and was specifically looked for. Grey Petrel *P. cinerea* was only recorded south of 26°S. De Filippi's *Pterodroma defilippiana* was the common small petrel, all but one of the 'cookilaria' petrels positively identified were this species, although Cook's *P. cookii* had also been expected[9,17]. Kermadec Petrel *P. neglecta* and several apparent Herald Petrels (probably *P. heraldica* but see Brooke & Rowe[4]) were encountered between 19°S and 25°S, >100 km from shore. The latter were intermediate morphs, with dark brownish upperparts including upperwing, pale belly (and sometimes throat), no M nor pale primary shafts on the upperwing, but a Kermadec-like light area on the underwing[3,19]. Numbers of Juan Fernandez Petrel *P. externa* increased southward as we approached 34°S, the latitude of the Juan Fernandez Islands, where it breeds[19]. Cape Petrel *Daption capense* was restricted to waters immediately offshore of Valparaiso.

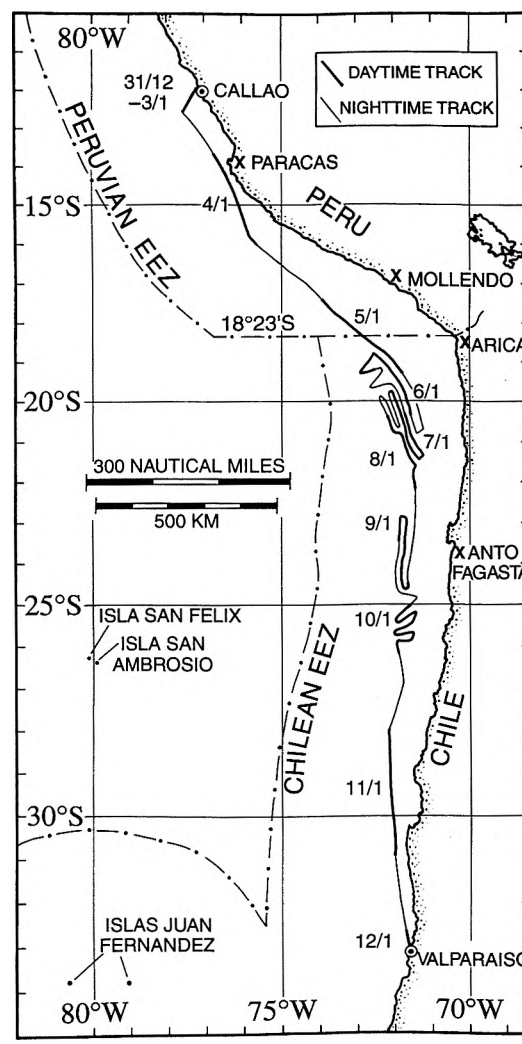

Figure 1. Cruise track of R/V Melville 31 December 1997–12 January 1998. Dates correspond with daytime track (bold lines).

Shearwaters
Sooty Shearwater *Puffinus griseus* was abundant inshore (at depths of <500 m) north of 16°S, as was Pink-footed *P. creatopus*; both also occurred south of 28°S in cooler inshore waters. Notable were large flocks of Buller's *P. bulleri* recorded on 11 January, south of 28°S, often resting on the water with boobies, cormorants and albatrosses. A single Manx Shearwater *P. puffinus puffinus* on 11 January, at 29°S, was disturbed close to the boat, along with a small party of *P. bulleri*, and provided excellent views. This small crisply black and white shearwater was separated from possible congeners on the basis of its distinctly contrasting black upperparts and white underparts, clear white undertail-coverts, largely white underwing and distinctive flight (eliminating Little Shearwater)[9,16]. Manx Shearwater occurs regularly in southern Chilean waters[8], but Jaramillo (pers. comm.) comments that the present record is significant due to its northerly latitude.

Albatrosses
With the exception of *Phoebastria irrorata*, all other albatross species were restricted to waters south of 26°S, when SSTs were declining, and thus were recorded only on the final two days of observations. Most abundant were Black-browed *D. melanophris*, Buller's *D. bulleri* and Salvin's *D. cauta salvini*; several distant 'mollymawks' could only be assigned to *Diomedea* sp. One subadult 'great' albatross (either Wandering *D. exulans* or Royal *D. epomophora*) was seen briefly at distance, but could not be positively identified.

Jaegers and skuas
Pomarine Skua *Stercorarius pomarinus* was most abundant at Peruvian stations and often followed the vessel for offal. Arctic *S. parasiticus* is considered the common *Stercorarius* in inshore waters of Peru and Chile[8]; however, most of the cruise track lay outside such areas and it was probably underrecorded as a result. Long-tailed Skua *S. longicaudus* was seen in deeper water, which is consistent with other observations[5]. Many, conservatively recorded as *Stercorarius* sp., on 6–8 January, when 220 km from shore, were probably *S. longicaudus*. Other than a single South Polar Skua *Catharacta maccormicki* on 1 January, large skuas were encountered only south of 28°S, in cool inshore waters. These were very large, bulky skuas; some exhibited a uniform dark, but warm, brown body colour overall, with pale wing flashes, suggestive of Antarctic Skua *C. antarctica*, while others displayed pale nuchal collars, greyer crowns and distinctly cinnamon underparts associated with Chilean Skua *C. chilensis*[12]. However, given the complexity of large skua taxonomy and field identification, and uncertainty over the status of *C. antarctica* in Chile (Howell pers. comm., Jaramillo pers. comm.) we conservatively assign all sightings to *Catharacta* sp.

Gulls and terns
Other than *Creagrus furcatus*, most numerous were Franklin's *Larus pipixcan* and Sabine's Gulls *L. sabini*. *L. pipixcan* was observed in very large flocks along the coast near Lima and Callao (possibly as many as 50,000, not included in the cruise total), but only c.8 were seen in pelagic waters. *L. sabini* was observed regularly in low numbers early in the voyage, and c.100 were recorded, with boobies, pelicans, cormorants and shearwaters, when we passed 17 km offshore of Paracas, Peru. Belcher's *L. belcheri*, Grey *L. modestus* and Kelp Gulls *L. dominicanus* were restricted to coastal waters (<20 km from shore).

Phalaropes
Red Phalarope *Phalaropus fulicarius* was recorded daily, typically in groups of 5–15 roosting on the water. It was most abundant north of 18°S. Rednecked Phalarope *P. lobatus* was observed once, in inshore waters off Callao, Peru.

Boobies and pelicans
Peruvian Booby *Sula variegata* was the most abundant seabird, but was primarily restricted to shallow (<500 m) coastal waters of southern Peru and off the Chilean coast south of 27°S. Most occurred in large feeding flocks, or in smaller groups travelling to and from coastal breeding colonies. Masked Booby *S. dactylatra*, in contrast, was encountered as single adults >100 km from shore; typically following the ship briefly, before returning to roost on the water. No *S. d. granti*, recently proposed as a distinct species, Nazca Booby *S. granti*[15], were seen. This is consistent with the observation that this Galápagos breeder is more frequent inshore, while nominate Masked is an offshore species[15]. Interestingly, although Redfooted Booby *Sula sula* is the most common Galápagos booby[1] and might have also been expected at sea, none was encountered. Alten[1] notes that *S. sula* feeds more upon squid and flying fish than the two larger species; thus it may not have been as affected by the warm ENSO water. Peruvian Pelican *Pelecanus thagus* was most frequently encountered <70 km from the coast.

Tropicbirds
Most common was Red-billed *Phaethon aethereus*, which occurred off both Peru and Chile; Red-tailed *P. rubricauda* was represented by one on 11 January, at 30°S. Most were roosting on the water, or would suddenly follow the ship for a short period, before wheeling off.

Penguin

Humboldt Penguin *Spheniscus humboldti* was recorded only on the first and last full days when the ship was closest (i.e. <20 km) to land.

Cormorants

Most abundant was Guanay Cormorant *Phalacrocorax bougainvillii*, seen almost entirely inshore in feeding flocks, with *Sula variegata* and *Pelecanus thagus*. Red-legged Cormorant *P. gaimardi* was seen only on the first and last days, immediately offshore of Callao, Peru and Valparaiso, Chile. Large mortalities of east Pacific seabirds have been reported during previous El Niños[10], but only a few dead or moribund individuals were noted at sea. However, Jaramillo (pers. comm.) reported large fatalities of *P. bougainvillii* and *P. thagus* in northern Chile, associated with the 1997–1998 El Niño, all of which appeared to be immatures.

Discussion

In the absence of comparable observations from a non-El Niño year, it is difficult to estimate the extent to which observed distributions and abundances were influenced by oceanographic conditions, rather being a reflection of typical, but poorly documented, distribution patterns. It is reasonable to assume that the unprecedented southward range extension for *Phoebastria irrorata* is a response to ENSO warming. Hughes[10] reported *P. irrorata*, *Creagrus furcatus* and *Sula nebouxii* inshore off Mollendo, Peru, at 17°S, during the strong 1983 El Niño, noting that the booby is only sporadic in normal years, and that the albatross and gull are normally far offshore at this latitude (at the edge of the upwelling zone). Jancke[11] and Paz Soldán & Jancke[13] report southward migration of *Phalacrocorax bougainvillii*, *Sula variegata* and *Pelecanus thagus* during the 1997–1998 El Niño, as well as an 80% reduction in the *Spheniscus humboldti* population at its principal breeding island in central Peru, apparently in response to changes in prey distribution and availability.

A relative lack of usual cool-water species in central Chilean waters was also notable; e.g. Southern Giant Petrel *Macronectes giganteus* was recorded only once, only two *Daption capense* were seen, and Antarctic Fulmar *Fulmarus glacialoides* was not observed, although all are commonly reported on pelagic trips from Valparaiso, Chile[14]. However, this could in part represent an artefact of the cruise track, as much of the near-shore region directly off Valparaiso was traversed at night.

Conclusions

Species observed were primarily those associated with the warm waters of the eastern Pacific, reflecting the intense El Niño conditions present in January 1998. Species more typical of the Peruvian/Chilean upwelling zone were largely restricted to cooler waters south of 26°S. The presence of *Diomedea irrorata* far south of its normal range indicates that long-distance dispersal of at least some cool-water species may be a normal response to ENSO events in the eastern Pacific.

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1. Waved Albatross *Phoebastria irrorata*, Peru, January 1999. Observed throughout the cruise, one on 11 January 1998, at 30°16'S, in Chilean waters, represents the southernmost record of this species (Gail Mackiernan)
2. Pomarine Skuas *Stercorarius pomarinus*, January 1999. The most numerous *Stercorarius* species in the region surveyed (Gail Mackiernan)
3. Masked Booby *Sula dactylatra*, January 1999. Only recorded well offshore, where singles would often follow the ship for brief periods (Gail Mackiernan)
4. White-chinned Petrel *Pterodroma aequinoctialis*, January 1999. Common and recorded daily (Gail Mackiernan)
5. Swallow-tailed Gull *Creagrus furcatus*, January 1999. A nocturnal feeder, the species was attracted to the ship's lights and large flocks were recorded as far south as Valparaiso, Chile (Gail Mackiernan)
6. De Filippi's Petrel *Pterodroma defilippiana*, January 1999. The most abundant *Pterodroma* petrel off the Chilean coast (Gail Mackiernan)

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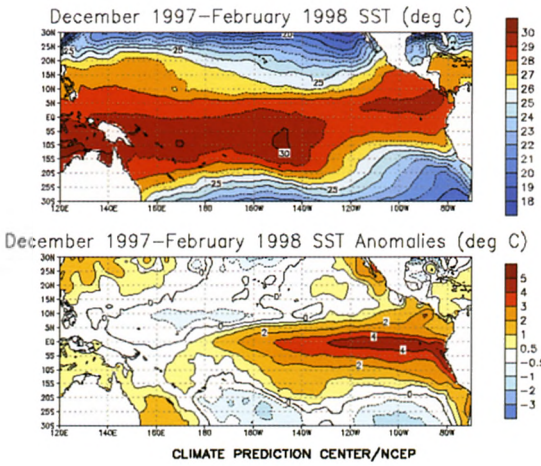

Figure 2. Observed sea surface temperatures and SST anomalies (deviation from long-term means) for austral summer 1997–1998, showing El Niño conditions in the east Pacific. (Data from Climate Prediction Center, National Oceanic and Atmospheric Adminstration, Washington, DC, USA.)

Appendix 1. Seabirds recorded between Callao, Peru and Valparaiso, Chile, during 31 December 1997 to 12 January 1998.

	Maximum daily count	Maximum daily date	Total count
Humboldt Penguin *Spheniscus humboldti*	8	11/1/98	11
Buller's Albatross *Diomedea bulleri*	7	11/1/98	7
Salvin's Albatross *D. cauta salvini*	23	11/1/98	24
Black-browed Albatross *D. melanophris*	5	10/1/98	5
Wandering/Royal Albatross *Diomedea exulans/epomophora*	1	11/1/98	1
'Mollymawk' *Diomedea* sp.	10	11/1/98	16
Waved Albatross *Phoebastria. irrorata*	40	31/12/97	153
Southern Giant Petrel *Macronectes* giganteus	1	11/1/98	1
Cape (Pintado) Petrel *Daption capense*	2	12/1/98	2
De Filippi's Petrel *Pterodroma defilippiana*	26	7/1/98	84
Stejneger's Petrel *P. longirostris*	1	5/1/98	1
'Cookilaria' sp.	101	11/1/98	204
Juan Fernandez Petrel *P. externa*	30	10/1/98	48
Herald Petrel *P. heraldica*	3	6/1/98	8
Kermadec Petrel *P. neglecta*	5	6/1 & 8/1/98	18
large *Pterodroma* sp.	1	(three dates)	3
White-chinned Petrel *Procellaria aequinoctialis*	21	10/1/98	117
Grey Petrel *P. cinerea*	2	10/1/98	2
Sooty Shearwater *Puffinus griseus*	c.1,300	4/1/98	c.1,500
Pink-footed Shearwater *P. creatopus*	32	11/1/98	60
Buller's Shearwater *P. bulleri*	c.600	11/1/98	c.600
Manx Shearwater *P. puffinus puffinus*	1	11/1/98	1
Wilson's Storm-petrel *Oceanites oceanicus*	22	11/1/98	44
Elliot's Storm-petrel *O. gracilis*	76	1/1/98	212
Band-rumped Storm-petrel *Oceanodroma castro*	15	31/12/97 & 1/1/98	32
Wedge-rumped Storm-petrel *O. tethys*	100	2/1/98	465
Markham's Storm-petrel *O. markhami*	766	7/1/98	2,027
Hornby's Storm-petrel *O. hornbyi*	90	5/1/98	470
Fregatta sp.	1	11/1/98	1
Red-billed Tropicbird *Phaethon aethereus*	4	2/1 & 10/1/98	13
Red-tailed Tropicbird *P. rubricauda*	1	11/1/98	1
Phaethon sp.	3	5/1/98	5
Peruvian Pelican *Pelecanus thagus*	204	31/12/97	354
Blue-footed Booby *Sula nebouxii*	320	1/1/98	648
Peruvian Booby *S. variegata*	c.10,000	11/1/98	c.11,000
Masked Booby *S. dactylatra*	5	5/1/98	10
Guanay Cormorant *Phalacrocorax bougainvillii*	411	31/12/97	784
Red-legged Cormorant *P. gaimardi*	30	31/12/97	40
Red Phalarope *Phalaropus fulicaria*	180	5/1/ & 6/1/98	c.500
Red-necked Phalarope *P. lobatus*	8	31/12/97	8
South Polar Skua *C. maccormicki*	1	1/1/98	1
large skua *Catharacta* sp.	9	11/1/98	9
Pomarine Skua *Stercorarius pomarinus*	27	1/1/98	104
Arctic Skua *S. parasiticus*	6	7/1/98	32
Long-tailed Skua *S. longicaudus*	8	6/1/98	24
Stercorarius sp.	30	7/1/98	97
Swallow-tailed Gull *Creagrus furcatus*	386	11/1/98	541
Laughing Gull *Larus atricilla*	2	7/1//98	2
Franklin's Gull *L. pipixcan*	2	3/1 & 5/1/98	8
Sabine's Gull *L. sabini*	100	4/1/98	108
Kelp Gull *Larus dominicanus*	20	12/1/98	46
Grey-headed Gull *L. cirrocephalus*	1	31/12/97	1
Band-tailed (Belcher's) Gull *L. belcheri*	200	31/12/97	205
Grey Gull *L. modestus*	100	31/12/97	105
Elegant Tern *Sterna elegans*	12	12/1/98	18
Sandwich Tern *S. sandvicensis*	20	31/12/97	20
Common Tern *S. hirundo*	50	12/1/98	76
Peruvian Tern *S. lorata*	100	7/1/98	214
Sooty Tern *S. fuscata*	2	9/1/98	2
Sterna sp.	12	6/1/98	19
Inca Tern *Larosterna inca*	30	31/12/97	57