

BIRDS AT SEA : A PELAGIC TRANSECT BETWEEN MADEIRA AND PORTUGAL

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With 2 tables

Portugal Continental, foi encontrada uma importante concentração de aves marinhas ao largo da costa norte de Portugal, coincidente com alguns bioindicadores de elevados níveis tróficos. É sugerido que a produtividade avícola nessa área possa estar associada com correntes de convecção induzidas pela força de Coriolis e favorecida por uma abrupta elevação do fundo do mar, no início da plataforma continental.

Much has been written about the breeding seabirds of the East Atlantic from Norway south to the Cape Verde islands. In Iberia much recent seabird work has resulted in valuable contributions to our knowledge of breeding sites and numbers. Similarly the excellent work of Jouanin, Roux and Zino among others has clarified the position in the Madeiran archipelago. (see Cramp *et al.* (1977) for these and other references).

Much less is known about the distribution of these seabirds at sea during the breeding season and tremendous lacunae still exist in our knowledge of seabird distribution generally during the long periods between breeding seasons. Land based seawatching for the past quarter century has certainly brought about changes in our thinking and knowledge and certain species are now known to be regular passage migrants whereas they were formerly considered great rarities. However, what has become clear is that the earlier conclusions, dependent upon land based observations, are constantly being refuted or modified in the light of more recent data. Remarkably little is still known about the mechanisms which cause regional and even more ephemeral movements of pelagic seabirds in coastal areas in association with meteorological conditions.

Because of the limitations of geography imposed by land based seawatching, there has been a trend towards pelagic seawatching in recent years in the Atlantic and Pacific Oceans. Some data of this type for the eastern Atlantic derive from sporadic observations, though as early as 1963, Bourne had attempted to systematise the work in the North Sea and

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elsewhere (Bourne, 1963). Again, many of these data remain anecdotal or unsubstantiated, yet the development of this field of marine ecology is of crucial importance. A knowledge of pelagic dispersal and distribution patterns is essential in fundamental terms as well as in more applied problems such as the environmental effects of offshore activity.

In August 1987, as part of an on-going research programme on seabird identification, distribution and ecology in Portuguese waters, the pelagic distribution of seabirds was investigated along a transect between Funchal, Madeira and Viana do Castelo, in northern Portugal. In this short communication, the observations made are briefly documented and discussed. A great deal of research is needed into seabird distribution in this area of the east Atlantic and it is hoped to carry out further work in the near future.

Pelagic observations (34 hours in total) began at 1400 hrs. local time on 19th August at Funchal, ending at 2000 hrs. on 21st. August at Viana do Castelo. Observations were made from the upper deck of the "Funchalense", about 9 m. above sea level. Using the methods suggested by Brown *et al.* (1975) and Harrison (1985), a 180° scan of the sea was made at ten minute intervals. The wake of the vessel was also periodically examined. Figures quoted (table 1), are of birds per hour for ease of analysis. Data are presented as an annotated species list. The weather throughout the period was dominated by the Azores anticyclone, with clear skies and very light winds between Beaufort force 1 and 3, north or north-westerly in direction. The sea surface was smooth to slightly ruffled, almost without white-caps.

SPECIES LIST

Pterodroma feae/madeira

Four single birds were seen, the first near Ilhéu de Fora, Madeira, the last within sight of Porto Santo island at 33°09'N, 16°35'W. *P. m. mollis* could be ruled out by the broken breast band, but at sea it did not prove possible to elucidate field characters to distinguish between *feae* and *madeira*, despite their clear-cut differences in the hand (Zino and Zino, 1986).

The nomenclature follows that of Zino and Zino (1986).

Bulweria bulwerii

Small numbers were observed within sight of Madeira, the Desertas group and Porto Santo island. Seen throughout 19th and 20th, numbers peaked twice on 20th, at 35°45'N, 14°12'W and at 37°20'N, 12°45'W. The first peak coincided with the appearance of cetaceans and exocoetidae. Four further birds appeared on 21st, the last being seen about 100 km from the Portuguese mainland at 40°12'N, 10°15'W. This coordinate lies beyond the point mentioned in Cramp *et al.* (1977) for Portuguese waters.

Calonectris diomedea

Small numbers were observed around the Madeiran archipelago, being last seen around 33°30'N. Apart from one or two birds at about 37°N, the species only reappeared at 40°40'N, 09°40'W, some 120 km north of Berlenga archipelago where the breeding colony holds about 100-200 pairs (Teixeira, 1984).

In the field the birds around Madeira were slightly darker-mantled than those seen closer to the Portuguese coast. Whether this corresponds to the known morphological variation between individuals from different populations is not clear.

Puffinus puffinus

Only two birds were seen in 34 hours of observation. A bird with the characters of the nominate race *puffinus* appeared within sight of Porto Santo island and a single bird resembling the race *mauretanicus* flew south off Viana do Castelo on 21st, close to shore.

Puffinus assimilis

Three birds were seen, all around 33°25'N, 16°15'W, within the archipelago of Madeira. Their south-easterly bearing towards evening perhaps suggests a return movement to roosts in the Madeiran archipelago. The species is known to frequent breeding sites out of season (Cramp *et al.* 1977), a behaviour termed protogamic by Jouanin (1964).

Oceanites oceanicus

The first bird was observed at 35°45'N, 14°12'W, associated with cetaceans (a *Ziphioid* whale of unknown species and two *Orcinus orca*) and other petrels. The second individual spent about two hours around the vessel, appearing first in the wake at 39°45'N, 10°45'W.

At around 41°08'N, 09°23'W, on 21st, the vessel passed through an area with a remarkable concentration of petrels, totalling 115 *O. oceanicus* at least. The last of these was recorded only 20 km from shore at 41°38'N, 09°05'W.

Identification of small petrels at sea is fraught with problems (Cramp *et al.*, 1977; Harrison, 1985). However recent research has highlighted the field characters and behaviour of four petrels found in this sector of the Atlantic; *Hydrobates pelagicus* (Boswall, 1979), *Oceanites oceanicus* (Finch *et al.*, 1978; Boswall, 1979), *Oceanodroma leucorhoa* (Atkin, 1979), and *Oceanodroma castro* (Brown, 1980). The extent of white on the rump, the wing-shape and the flight are useful in identifying *O. oceanicus* and at very close range (eg. birds in the ships wake), the protruding feet are diagnostic for this species.

Hydrobates pelagicus

From 35°N, north to 41°N, single birds appeared either in the wake or briefly close to the ship. At 41°08'N, 09°23'W, on 21st, the vessel passed through a large concentration of petrels including about 85 birds of this species. A few of these were still fluttering in the wake less than 20 km from shore.

Oceanodroma castro

Birds resembling this species were observed on only two occasions. The first appeared at 33°30'N, 16°10'W, with two more being seen over the next few minutes, each time singly. Another single bird was seen at 36°55'N, 13°08'W. At sea, in this sector of the Atlantic, this species must be separated from its congener *O. leucorhoa*, as well as *O. oceanicus* and *H. pelagicus*. Intermediate between these species, many authorities regard the bird's flight as distinctive. The banking, shearing and gliding action is reminiscent more of a tiny shearwater than of a petrel. Movement forward is by a series of wide, regular, horizontal zigzags, rising and falling slightly within the lowest airspace. This zigzag is quite distinctive and as pointed out by Brown (1980), is very different from the erratic flight of *O. leucorhoa* or the skimming flight of *O. oceanicus*.

Sula bassana

Only encountered close to the Portuguese coast and then only in tiny numbers. Almost all were non-adults.

Stercorarius pomarinus

Seven birds were seen, on 21st, all light phase adults. The first appeared at 40°29'N, 09°59'W, the last at 41°15'N, 09°10'W. All flew determinedly southwards without pause, on occasion high over the vessel.

Stercorarius parasiticus

Sixteen were seen over the period at sea, mainly light phase adults; some immatures close to shore on 21st, were accompanying and harrying *Sterna hirundo*.

Stercorarius skua

Four birds were seen, all on 21st, about 20 km off Viana do Castelo.

Larus fuscus

The only birds observed at sea were about 50 individuals, some 5 km off Viana do Castelo feeding on drifting surface detritus. Predominantly

the adults (c. 15) showed the characteristics of the race *graellsii*, with the exception of a single bird resembling the Scandinavian race *intermedius*, seen at close range. Though this latter race accounts for a significant minority of *L. fuscus* wintering in Portugal, August is relatively early for sightings (*pers. obs.*).

Larus argentatus

Apart from very small numbers just off Viana do Castelo on 21st, only three were seen at sea, at approximately 40°40'N, 09°40'W. These birds (all juveniles) stayed with the vessel for forty minutes before heading away north-eastwards.

Rissa tridactyla

A juvenile joined the vessel on 21st, about 15 km from the Portuguese coast, and remained in the wake of the vessel for some fifteen minutes.

Sterna dougallii

A single bird, an adult, was seen within a kilometre of the Funchal shore on 19th. It showed wear and some shortening of the tail streamers. The species is scarce but regular in the area and may possibly breed, perhaps irregularly (P. A. Zino, *pers. comm.*).

Sterna hirundo

None were seen at sea until the vessel approached 40°N, 10°W, when a small number appeared, juveniles in the minority. Very close to Viana do Castelo, about 300 were seen passing to the south, in a movement suggestive of an evening roosting flight.

Sterna paradisaea

The transect was marked by a pronounced southward movement of this species (72 birds in all), the closest to Madeira being a single bird at 33°20'N, 16°22'W.

Few were seen between 37°N and 40°N and it was only around 40°20'N, that the first juveniles were identified (about 80 km from the Portuguese mainland). The singular lack of juvenile birds in the "desert" between 37°N and 40°N is interesting.

Chlidonias niger

Five birds were seen, all between 40°40'n, 09°40'W and the Portuguese mainland on 21st.

DISCUSSION

A single transect, investigated over a short time period has obvious limitations and is a very crude indicator of seabird movement and distribution. Nevertheless, even a brief analysis of the data does reveal some obvious and interesting patterns.

The bird density and absolute numbers outside the immediate vicinity of the Madeiran archipelago was relatively low (table 1). *Calonectris diomedea* and *Puffinus assimilis* do not appear to move far from their breeding sites. Though passage of *Sterna paradisaea* was marked along the transect, it was rapid and no feeding was observed. In the sea area between 33°N and 41°N, bird density was low, with *Bulweria bulwerii* noteworthy because of its relative abundance. Small petrels were scarce there with only nine *H. pelagicus* and two *O. oceanicus* recorded.

The most interesting discovery however, is not the relative paucity of bird life between 33°N and 41°N, but rather the sudden transition to extreme richness of sealife generally at 41°06'N, 09°26'W. Using the method outlined by Cushing (1971), a crude assessment of avian tertiary productivity was applied to the transect data (table 2), in order to highlight this transition.

It is clear from table 2 that conditions around 41°06'N, 09°26'W were, at the time of observation, favourable to enhanced productivity.

Coincident with the marked concentration of bird life in this section of the transect were several bioindicators of elevated trophic levels. Whereas cetaceans had been scarce between 33°N and 41°N, over 150 delphinids were counted in the area, travelling in large schools from north to south. Both *Delphinus delphis* (c. 100) and *Stenella caeruleoalba* (c. 50) were identified. Slightly closer to shore *Tursiops truncatus* was seen, though numbers were impossible to estimate.

The sea surface on 21st was slightly ruffled with a light north-west breeze. In and around 41°N clear bands of calm water became very noticeable, over which many petrels were feeding. These 'streaks' of calm water were persistent enough to watch over long periods and the marked preference shown by feeding petrels for these slowly revolving streaks was striking. Pingree *et al.* (1974) suggest that in such bands of calm water, zooplankton tends to be concentrated at the surface by turbulent eddies of cooler upwelling water.

In pelagic work, initially the most daunting task is apparently to locate the birds. Considered in gross density terms, this would be true. However, the ecological regime within which each species operates imposes considerable limitations on distribution and certainly a factor likely to concentrate birds at sea is the presence of nutrients. In the north-eastern Atlantic a considerable area of upwelling extends along the coasts from Portugal to Guinea-Bissau (Cushing, 1971). The result is a flush of nutrients into surface levels with enhanced primary production of phytoplankton and secondary production of zooplankton. Primarily these upwel-

Table 2.-- Avian biomass at eight positions on the transect

	coordinate positions							
	32°38'N, 16°54'W	33°25'N, 16°15'W	35°19'N, 14°34'W	36°06'N, 13°41'W	39°22'N, 11°00'W	40°20'N, 10°05'W	41°06'N, 09°26'W	41°40'N, 08°51'W
N/10 :	6.0	1.6	0.0	1.5	0.16	0.3	36.0	70.0
kg/10 :	4.0	0.5	0.0	0.15	0.02	0.2	5.5	30.0

Note that N/10 is the mean number of birds/ten minute interval and kg/10 is the total relative biomass ($\text{kg}/10 = \text{N}/10 \times \text{mean mass}$); species mass data are from Cramp *et al.* (1977); Pennyquick (1969).

lings, one north and one south of 21°N (Gardner, 1978), are caused by winds rotating around the persistent anticyclones in mid-Atlantic at about 30°N. Along west facing coasts such as the Portuguese coast, these winds blow towards the equator pushing surface waters before them. These surface waters are shifted seasonally offshore by Corioli's force, and are replaced by an upwelling of cool water along the coast.

When the transect coordinates from the present study are plotted on a bathymetric map, the position 41°06'N, 09°26'W is seen to coincide very closely indeed with the zone of abrupt transition from relatively deep (1000 m) to shallow water (200 m) along the north Portuguese coast and it seems likely that along this zone, seasonal upwelling, primarily driven by Corioli's force, is greatly enhanced by the abrupt shelving of the sea-bed.

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