OBSERVATIONS OF PELAGIC SEABIRDS FEEDING IN THE AFRICAN SECTOR OF THE SOUTHERN OCEAN

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INTRODUCTION

There is a paucity of direct observations on the feeding habits of pelagic seabirds. These birds spend the greater part of their lives, and feed almost entirely, at sea. Moreover, they feed mainly at night when their vertically migrating prey are at the surface (Imber 1973, Imber & Berruti 1981). This note summarizes observations on natural feeding in the African sector (35S - 70S, 20W - 40E) of the Southern Ocean recorded while counting birds on 15 cruises of the M.V. *S.A. Agulhas*, representing approximately 1 300 hours of observation, during the period April 1979 to September 1981. Censuses were made at all latitudes in the study area. Feeding observations are recorded here in groups of apparent prey (crustaceans, squid, fish), as well as associations with cetaceans, fish and other birds, and are summarized in Table 1. Unless otherwise stated, Ashmole's (1971) terminology is used to describe observed feeding methods. Records of Subantarctic Skua *Catharacta antarctica* depredation are published elsewhere (Sinclair 1980).

CRUSTACEANS AS PREY

Dense surface swarms of krill (mainly *Euphausia superba*) were common south of the Antarctic Divergence. Neuston net trawls encountered these krill within 500 mm of the surface. The Snow Petrel *Pagodroma nivea*, Antarctic Petrel *Thalassoica antarctica*, Kerguelen Petrel *Pterodroma brevirostris* and Blue Petrel *Halobaena caerulea*, the only species commonly encountered in this area, showed little obvious interest in these swarms.

Snow and Antarctic Petrels were seen feeding more often than all the other pelagic species together. These birds are restricted within areas of sea-ice (Griffiths in press), where at the height of the austral summer they experience continuous daylight. As winter approaches, the periods of darkness increase, but this is minimized by the northward shift of the birds' distribution (Griffiths in press). Antarctic Petrels fed by four methods (Table 1). Of 14 feeding attempts observed in one hour, eight fed by surface seizing (always with wings outspread), five fed by 'contact diving' (alighting on the water and immediately dipping head underwater, thrusting the wings backward apparently driving the body downwards, and diving up to a depth of 500 mm), and one attempted to feed by pattering on the surface. Contact diving appears to be intermediate between pursuit diving, where the bird dives from the water surface, and plunge diving, where the bird dives from the air (Ashmole 1971). The prey observed were pink

TABLE 1

FOOD, FEEDING METHODS & FEEDING ASSOCIATIONS OF 21 SEABIRD SPECIES RECORDED IN THE AFRICAN SECTOR OF THE SOUTHERN OCEAN DURING THE PERIOD APRIL 1979 TO SEPTEMBER 1981

Species	Food				Feeding method						Feeding Associations
	Crustacean	Squid	Fish	Carrion	Surface seizing & scavenging	Surface filtering	Contact diving	Plunge diving	Dipping	Pattering	
Wandering Albatross		X			X						Whales
Blackbrowed Albatross											Whales
Greyheaded Albatross											Whales
Lightmantled Sooty Albatross		X			X						
Giant petrels				X	X						
Antarctic Petrel	X		X		X		X		X	X	Minke Whales
Pintado Petrel	X	X	X		X				X		
Snow Petrel	X								X		Minke Whales
Prions						X			X		Whales, penguins
Blue Petrel							X		X		
Atlantic Petrel		X			X						
Softplumaged Petrel		X			X						
Kerguelen Petrel											Whales
Whitechinned Petrel		X	X		X						Whales
Cory's Shearwater											Tuna
Great Shearwater		X			X						Tuna
Sooty Shearwater											Dolphins
Stormpetrels										X	
Divingpetrels								X			
Arctic Tern			X						X		Minke Whales
Common Noddy									X		Penguins

crustaceans. The surface swarms of krill appeared to be within easy reach of the Antarctic Petrel, but only once was the species seen to dive among these krill, with undetermined success. Snow Petrels, and, to a lesser extent, Antarctic Petrels, fed by dipping amongst ice floes broken up by the ship. This feeding method is distinct from pattering (Ashmole 1971) where the feet may be used extensively as an aid to flight (Withers 1979). Whilst no prey was visible, the birds presumably were feeding on herbivorous fauna grazing on the epontic (ice-dwelling) algae which appeared to be abundant (see also Brown 1980). The ship's bow wave often washed krill onto ice floes. Snow Petrels, and once a Pintado Petrel *Caption capense*, were quick to seize this krill by hovering momentarily above the ice. Dipping without submerging was the only feeding method seen employed by Snow Petrels (Table 1), whereas Ashmole (1971) lists surface seizing and pattering as the chief methods.

SQUID AS PREY

I never saw any bird actually catching a live squid. Dead squid occasionally were seen floating on the surface. It has been suggested (Ashmole & Ashmole 1967, Imber & Berruti 1981) that moribund squid may form a sizeable proportion of a seabird's diet.

Observations of squid being eaten by seabirds were infrequent. Four Pintado Petrels were seen sitting together on the water feeding on a squid approximately 400 mm long. It is doubtful that these birds, even collectively, could have killed such a large squid. It was probably moribund or a left-over prey of an albatross or large petrel. An Atlantic Petrel *Pterodroma incerta*, and a Great Shearwater *Puffinus gravis*, were at different times seen to seize squid (approximately 100 mm long) from the surface, only to drop them after flying short distances. One each of the Wandering *Diomedea exulans* and Lightmantled Sooty *Phoebetria palpebrata* Albatrosses, Whitechinned *Procellaria aequinoctialis* and Softplumaged *Pterodroma mollis* Petrels were observed taking squid by surface seizing. Squid were not seen to be eaten by either Snow or Antarctic Petrels although this prey type has been found in their stomach contents (Mougin 1975, Griffiths in press).

FISH AS PREY

No shoals of small fish, as may be seen on the African continental shelf, were seen in the study area. Only four seabird species were seen taking fish. All Arctic Terns *Sterna paradisaea* fed by dipping, never submerging totally. Fish (approximately 50 - 70 mm long) were the only prey observed. Antarctic Petrels took black and silver fish (about 50 mm long) by contact diving, and a Whitechinned Petrel and a Pintado Petrel were seen flying with silvery fish in their bills.

UNIDENTIFIED PREY

Very small prey objects are not likely to be seen by an observer on a moving ship. The prey of prions *Pachyptila* spp., Blue

Petrels, stormpetrels (Oceanitidae) and divingpetrels *Pelecanoides* spp. were not identified during apparent feeding attempts by these species.

Prions were seen frequently in aggregations of several hundred individuals, but never feeding as a flock at sea. They do, however, feed in flocks in the inshore zone around Marion Island (A. Berruti pers.comm.). Filter-feeding was the preferred feeding method. They occasionally fed by picking up individual prey objects by dipping (especially alongside icebergs where Snow, Antarctic and Blue petrels also fed), and rarely dived below the surface. By contrast, Blue Petrels were seen contact diving, remaining underwater for up to two seconds with undetermined success.

Most stormpetrels pattered along the surface, apparently feeding continually. This was particularly true of Wilson's Stormpetrel *Oceanites oceanicus*. None was seen to feed by any other method. No prey objects, if indeed they took any, were observed. Similarly, divingpetrels were not seen to capture anything. They were observed flying into waves without any apparent change in flight pattern, maintaining their fast wing beat until disappearing underwater. They also executed a 'belly flop', bouncing hard on the water surface whilst flying, but these did not appear to be feeding attempts.

FEEDING ASSOCIATIONS

Associations were recorded when birds took an obvious interest in other animals. Birds associated with mammals, fish and other birds, apparently in anticipation of food. However, feeding was not always observed.

Extremely few marine mammals were observed on the voyages, and then only some were accompanied by birds. Snow and Antarctic Petrels and Arctic Terns were seen feeding most actively in association with a school of about 200 Minke Whales *Baleanoptera acutorostrata*. The only prey observed at this time were fish approximately 70 mm long, taken by Arctic Terns. At different times, Wandering, Blackbrowed *D. melanophris* and Greyheaded *D. chrysostoma* Albatrosses, Whitechinned and Kerguelen Petrels and prions were seen accompanying unidentified whales. A pair of Killer Whales *Orcinus orca* was followed by 18 individuals of four species, apparently feeding in their wake. Killer Whales were seen frequently at Marion Island but were never accompanied by seabirds, although giant petrels *Macronectes* spp. were, on three occasions, seen scavenging on the remains of Southern Elephant Seals *Mirounga leonina* and penguins killed by these whales. Other associations observed were Cory's *Calonectris diomedea* and Great Shearwaters with a school of tuna (see also Ashmole & Ashmole 1967), Sooty Shearwaters *Puffinus griseus* with a school of 30 dolphins, and 10 prions with *Eudyptes* penguins. Feeding was not confirmed. At Gough Island, Common Noddies *Anous stolidus* often were seen following and feeding (by dipping) above Rockhopper Penguins *Eudyptes chrysocome*. A similar association between Antarctic Terns *Sterna vittata* and Jackass Penguins *Spheniscus demersus* has been observed in southern African inshore waters (J. Cooper pers.comm.). On none of these occasions was the prey visible.

DISCUSSION

The range of prey taken and feeding methods used suggests that the many pelagic species of the Southern Ocean are, to varying degrees, opportunists. This conclusion is supported by the high abundance of Southern Ocean birds on the trawling grounds off southwestern Africa (Sinclair 1978), where offal, discarded fish and squid are taken during feeding frenzies (pers.obs.).

Diel vertical migration of squid (Roper & Young 1975) and crustaceans (Ashmole 1971) enables Procellariiforms to feed on mesopelagic prey (Imber 1973). A nighttime feeding strategy would be feasible only north of the Antarctic Divergence where there is sufficient darkness. This would explain the lack of feeding observations of species whose distribution lies within these areas. However, in the high latitudes in the austral summer there is no, or only partial darkness. Snow and Antarctic Petrels, the two most southerly distributed procellariiforms, therefore have to feed during daylight, at least for part of the year. Any disadvantages for these birds that may arise from the shorter night and possible suppressed vertical migration (Bogorov 1946) would appear to be compensated for by the fauna associated with sea-ice at or near the surface.

The above feeding observations were recorded out of a total of approximately 160 000 birds counted during the censuses. Whilst I do not claim to have all feeding attempts recorded, and therefore hesitate to quantify the data, I am confident that less than 0,5 per cent of all birds seen were foraging. The paucity of direct observations of natural feeding accumulated over such a long period stresses the need for indirect methods of discovering where seabird species feed. With a knowledge of the prey distribution, analyses of food fed to chicks should describe the foraging areas during the breeding season. During the pelagic phase, the difficulty of capturing birds at sea in the Southern Ocean for regurgitation necessitates collection of specimens for stomach analyses. Conversely, providing that one knows the foraging range or feeding frequency, one can predict from diet analyses the approximate areas in which the species finds its preferred prey. Feeding methods can be studied easily only around fishing trawlers where large numbers of pelagic seabirds congregate (Sinclair 1978). Even though feeding may be unnatural here, at least some, if not all of the feeding methods of which a species is capable may be determined. Linking studies of diet at breeding colonies and direct studies of the ecology of prey species may eventually lead to an understanding of the feeding ecology of Southern Ocean seabirds.

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