DIET OF THE ATLANTIC PETREL *PTERODROMA INCERTA* DURING BREEDING AT SOUTH ATLANTIC GOUGH ISLAND

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SUMMARY

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Fifty-nine diet samples collected from Atlantic Petrels *Pterodroma incerta* at South Atlantic Gough Island over two years during the breeding season showed that they fed largely on cephalopods (87% by mass), especially gonatid, onychoteuthid and histioteuthid squids. A total of 63 individual prey items of 23 taxa was identified. Mesopelagic fish, notably myctophids, contributed 11% by mass to the diet. Crustaceans appeared in 29% of the stomach contents investigated but contributed little to mass. The results are consistent with a bill morphology adapted to snatching slippery prey by surface-seizing and a flight style that aids detection of widely dispersed prey. There is no evidence to suggest that Atlantic Petrels forage habitually in association with other species of seabirds.

INTRODUCTION

The Atlantic Petrel *Pterodroma incerta*, Procellariidae, is an endemic seabird of the South Atlantic Ocean. Breeding is restricted to the islands of the Tristan da Cunha group, and to Gough Island, where they are thought to be the commonest of the larger petrels with a total breeding population of several hundred thousand pairs (Swales 1965, Richardson 1984). At sea, the species ranges southwards from the Tropic of Capricorn to about 50ºS (Enticott 1991). On the open ocean along the Subtropical Convergence they are one of the most abundant petrels but they tend to avoid shallow water close to the coast (Veit 1995). Atlantic Petrels follow ships readily with a swift and careening flight, normally as solitary birds, occasionally in small groups (pers. obs.). The head and upper parts of this bird are dark brown, in fresh plumage sharply demarcated across the upper breast from white underparts. The underwing is wholly brown. Sexes are alike. Atlantic Petrels are winter breeders; birds return to colonies in February/March, eggs are laid June/July, hatching occurs in August/September and fledging in December/January (Richardson 1984).

The breeding grounds of this species are not often visited by marine ornithologists and consequently most aspects of Atlantic Petrel biology are incompletely known. We report here, comprehensively for the first time, on the diet of this seabird in order to shed light on its position in the food web of the South Atlantic Ocean and to understand to which guild of surface feeders it belongs.

MATERIALS AND METHODS

Study site

Gough Island (40º19'S, 09º56'W), 83 km^2 in extent, lies well north of the Antarctic Polar Front in the cool temperate zone of the South Atlantic Ocean. The mean monthly temperatures range between 9 and 16ºC, and annual rainfall regularly exceeds 3000 mm (Höflich 1984). A hydrological survey by Miller & Tromp (1982) classified the waters around the island as sub-Antarctic. Monthly average sea surface temperatures range between 10.3 and 15.0ºC, and westerly winds predominate (Höflich 1984).

Collection of food samples

Atlantic Petrels flying overhead at Gough Island were easily dazzled by a bright light source pointed at the sky at night, particularly on moonless, overcast nights. Taking advantage of this behaviour, we sampled the stomach contents of Atlantic Petrels on Gough Island on 11 separate nights in October 1989 and 1990, a time when they were feeding downy chicks. Birds dazzled with a 1500-W floodlight readily regurgitated a portion of their stomach contents into plastic bags on handling after they landed on the wooden planks of the helicopter landing pad near the meteorological station at Transvaal Bay. The food samples were weighed, transferred into vials and kept deep-frozen until analysis. Sampling dates and numbers of samples collected are given in Table 1.

TABLE 1

Sampling dates and numbers of samples collected from Atlantic Petrels at Gough Island

Date	Numbers
9 Oct 1989	1
11 Oct 1989	1
22 Oct 1989	12
23 Oct 1989	12
5 Oct 1990	2
6 Oct 1990	9
7 Oct 1990	1
14 Oct 1990	10
15 Oct 1990	2
20 Oct 1990	2
21 Oct 1990	7
Total	**59**

Analysis of food samples

In the laboratory samples were thawed, the stomach oil was drained, and liquids and solids were weighed separately to an accuracy of 0.1 g. The solids were then sorted into main prey categories and each was weighed separately.

Cephalopod mandibles (squid beaks) were collected loose from the diet samples or removed from the buccal masses when squids were only partially digested. The number of squids ingested was determined from the count of the number of lower beaks, disregarding all accumulated specimens without any attached flesh and missing cartilaginous edges. Beaks were identified to the lowest possible taxon by comparison with material held in the reference collection of the Port Elizabeth Museum and from the literature (Clarke 1986). Lower rostral length (LRL) of the beaks was measured with Vernier calipers to the nearest 0.1 mm and regressions (Clarke 1986, Port Elizabeth Museum unpubl. data) were used to estimate dorsal mantle length (DML) and mass of the cephalopods from LRL. The few fish present in the stomachs were invariably found in an advanced stage of digestion and their otoliths had to be used in our attempts to identify the species involved. Otoliths were compared with material held in the reference collection of the

TABLE 2

Relative abundance, frequency of occurence and estimated sizes of the prey of Atlantic Petrels at Gough Island

Taxa	Relative abundance		Mean length	Range	Mean mass
	No.	%	mm	mm	g
Argonauta argo	2	3.4	30		
Brachioteuthis sp.	1	1.7			
Chiroteuthis sp.	1	1.7	90		
Discoteuthis discus	1	1.7	121		
Gonatus antarcticus	5	6.8	309	279–348	234
Histioteuthis atlantica	2	3.4	66		
Histioteuthis meleagroteuthis	1	1.7	57		
Histioteuthis sp.	1	5.1	65	44–84	97
Onychoteuthis ?*banksi*	5	8.5	148	124–179	101
Taonius sp.	4	10.2	386	141–540	147
Todarodes sp.	3	5.1	103	102–104	39
unidentified squid	1	1.7			
Total cephalopods	**27**	**42.8**			
Myctophidae	6	8.5			
Diaphus sp. (?*effulgens*)	4	6.8			
Gymnoscopelus piabilis	*2*	*3.4*			
Lampanyctus australis	1	1.7			
Macrouridae	1	1.7			
Melamphaes simus	1	1.7			
Melanonus sp.	2	3.4			
Borostomias ?*mononema*	1	1.7			
Total fish	**18**	**28.6**			
Euphausiacea	1	1.7			
Eurythenes gryllus	9	13.6	32	16–72	2
Hyperiidea	1	1.7			
Natantia	7	13.6	47	40–60	
Total crustaceans	18	28.6			
Overall total	**63**	**100.0**			

TABLE 3

Solid constituents of Atlantic Petrel diet at Gough Island, and frequency of occurence of broad prey classes in the diet samples

	Source	Cephalopods	Fish	Crustaceans	Other
Relative proportion of drained mass (%)	Imber (1991)	70.0	17.0	13.0	–
	This study	86.7	11.0	0.9	1.4
% Frequency of occurrence	This study	86.4	62.7	28.8	1.7

Port Elizabeth Museum and with illustrations in the pertinent literature (Nolf 1985, Smale *et al.* 1995) but in most cases it was possible to identify only the family. Estimation of the reconstituted sizes and masses of the fishes was not possible. Crustaceans were identified using published keys (Barnard 1969, Kirkwood 1984). Several specimens were intact enough to be measured and weighed. The composition of the diet was investigated by mass, numbers, and frequency of occurrence.

RESULTS

The mean total mass of the stomach contents, comprising a liquid and a solid fraction, was 65.2 g (SD = 32.0 g, range 10.0–154.0 g, n = 59). The mean drained mass was 53.9 g (SD = 28.0 g, range 10.0–132.0 g, n = 59). Oily stomach liquids ranged from 0 to 58% by mass in individual samples; they comprised 17.4% of the total mass of all samples combined. The rest (82.6%) was solid prey, consisting of cephalopods, fish, crustaceans and, in one instance, blubber from an unidentified warm-blooded animal. In all, 63 individual prey of 23 taxa were identified (Table 2).

Cephalopod flesh occurred in 51 of 59 samples (86.4%) and contributed 86.7 % to the total drained mass of the stomach contents (Table 3). Table 3 lists the 11 identified cephalopod taxa and their frequency of occurrence in the samples. *Gonatus antarcticus*, followed by an onychoteuthid and *Taonius* sp. were dominant among the beaks with flesh attached (Table 2). Reconstituted masses of cephalopods, estimated from appropriate regressions, ranged from an *Argonauta argo* of 8 g to a *Gonatus antarcticus* of 355 g; the mean mass of all cephalopods consumed was 115 g. Reconstituted sizes ranged from an *Argonauta argo* of 30-mm mantle length to a *Taonius* sp. with a dorsal mantle length of 540 mm (Table 2).

Fish remains were frequently present in the diet samples but contributed little to the total drained mass of the stomach contents (Table 3). One of the fish bodies was sufficiently intact to identify the species as *Borostomias* ?*mononema*, Astronesthidae, and 17 others could be identified from otoliths retrieved from the stomach contents. Myctophidae dominated the fish component of the diet with 13 individuals tentatively identified (Table 2). Four other pairs of otoliths matched specimens of the families Macrouridae, Melamphaidae and Melanonidae in the reference collection. The rest of the fish flesh remained unidentified.

The large lysianassid *Eurythenes gryllus* was the most frequently identified crustacean in the samples (Table 3). The mass contribution of this prey class was insignificant. Three small pieces of plastic material totalling less than 1 g were found among the stomach contents of as many birds.

DISCUSSION

With the exception of a short tabulation derived from 13 samples by Williams & Imber (1982; see also Imber 1991), no other data on the diet of the Atlantic Petrel have been published. Imber (1991) identified the squid *Gonatus antarcticus*, histioteuthids and myctophid fish as the main prey components, in proportions (% mass) that were not too different from the results presented here (Table 3). Taken together, both studies suggest that cephalopods form the most important component of the diet of the Atlantic Petrel, at least during the chick-rearing period. We have no information on the species' diet at other times of the year. As Harper *et al.* (1990) point out, adults may also collect different foods for their chicks than for their own needs.

However, their bill morphology and their towering flight style, which gives them a commanding wide field of view useful in detecting widely dispersed prey, tend to support the grouping by Abrams & Miller (1986) of the Atlantic Petrel as a 'squid-eater by choice'. Few other gadfly petrels in the region match the elongated bill equipped with a strongly hooked maxillary unguis (see Fig. 4.2 in Warham 1990) that is consistent with an adaptation to snatch live slippery cephalopods from the sea surface. Surface seizing, and scavenging if prey exceeds their ability to overpower, are therefore the most likely feeding modes employed by this species. Interestingly, for a species with these main foraging modes, the incidence of plastic particles (three out of 59 samples) is quite low (Ryan 1987).

In October and November 1980 Abrams & Miller (1986) studied the distribution of seabirds in relation to hydrodynamic events in the vicinity of Gough Island and found elements of both the subtropical and the sub-Antarctic avifauna. However, the study of the seabird assemblage in the waters around the Tristan da Cunha archipelago, including Gough Island, has scarcely begun, and hence many facets of the interactions between members of that community are unexplored. With an average wingspan of 104 cm (Harrison 1983) and a body mass of *c.* 520 g (Abrams 1985), the Atlantic Petrel occupies a middle position in terms of body size in the suite of 27 co-occurring seabirds in Abrams & Miller's (1986) study. Veit (1995), studying pelagic seabird communities in offshore waters on the western side of the South Atlantic, grouped the Atlantic Petrel in respect of interspecific association with the Black-browed Albatross *Diomedea melanophris*, White-chinned Petrel *Procellaria aequinoctialis*, Great Shearwater *Puffinus gravis* and Soft-plumaged Petrel *Pterodroma mollis*. The percentage abundance data of seabirds in the Subtropical Convergence zone published by Abrams (1985) appear to support this grouping. However, as these latter are four widely-distributed species, such a numerical relationship between them and the Atlantic Petrel should not be interpreted as an indication of a functional (habitual) association.

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