The diet of grey-headed albatrosses *Diomedea chrysostoma* at the Prince Edward Islands

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Eighty-eight food samples were collected from grey-headed albatrosses Diomedea chrysostoma *at the Prince Edward Islands. Fish and cephalopods were the two main prey components of the diet, the former being predominant. It was not possible to identify most of the fish prey but the most commonly eaten squid were* Kondakovia longimana *and* Histioteuthis eltaninae *with the mass of individual squid varying between 13 g and 1 815 g. Whereas the diet was similar to that of grey-headed albatrosses at Iles Crozet it contrasted with that of birds at South Georgia which had a higher proportion of cephalopods and crustaceans in their diet. Differences between the cephalopod beaks recorded in casts and regurgitations are discussed.*

Ag en tagtig voedselmonsters is van gryskopmalmokke Diomedea chrysostoma *op die Prins Edward-eilande versamel. Vis was die belangrikste komponent van die dieet, gevolg deur koppotige diere. Meeste van die viskos moes ongeïdentifiseerd bly, maar die volopste seekatte in die dieet was* Kondakovia longimana *en* Histioteuthis eltaninae, *met massas wat wissel tussen 13 g en 1 815 g. Alhoewel die dieet soortgelyk was aan dié van gryskopmalmokke op Iles Crozet, het dit verskil van dié van voëls op Suid-Georgia deurdat laasgenoemde 'n hoër persentasie koppotiges en skaaldiere in hul dieet gehad het. Verskille tussen koppotiges se bekke wat in mis en opbraaksels gevind is, word verder bespreek.*

Introduction

Grey-headed albatrosses *Diomedea chrysostoma* occur throughout the Southern Ocean and breed at a number of sub-Antarctic sites including the Prince Edward Islands in the southern Indian Ocean (Prince 1980). The breeding and feeding ecology of the species has been investigated in detail at South Georgia (Tickell 1964, Tickell & Pinder 1975, Prince 1980). Weimerskirch *et al.* (1986) carried out a comparative ecological study of albatrosses at Iles Crozet, which included some feeding data, and Brooke & Klages (1986) collected some data on the squid prey of grey-headed albatrosses at the Prince Edward Islands. Otherwise, little is known about the species' diet from most of its breeding range.

This paper presents the results of a study into the diet of grey-headed albatrosses at the Prince Edward Islands.

Methods

Food samples were collected at Rook's Bay and Grey-headed Albatross Ridge, Marion Island (46°54'S, 37°45'E) in February - April 1985 (20 samples) and April 1987 (26 samples) during the chick-rearing period. Further samples were collected from birds at the Prince Edward Island (46°38'S, 37°57'E) colony in April 1985 (21 samples) and April 1987 (21 samples).

Adult birds were caught with a hook mounted on a long pole just as they started feeding a meal to their chick. Inverting the bird over a large plastic funnel with a polythene bag attached normally induced regurgitation of the meal (Prince 1980). At South Georgia, Prince (1980) found that there was a significant difference between the mass of a food sample collected and that of the meal fed to a chick. Although this shortfall averaged 15 per cent in grey-headed albatrosses, the food samples were still thought to be representative of the feeds delivered to chicks.

Samples collected were weighed on a pan balance, the liquid portion drained off and the remaining solids weighed. The solid material was then sorted in the laboratory and identifiable material weighed and, where relevant, measured (Prince 1980). Cephalopod beaks were identified by reference to material held in collections at the Port Elizabeth Museum. The lower rostral length of each intact beak was measured and the masses of the cephalopods estimated using the regressions given by Clarke (1985).

Results

Size of samples and liquid proportion

Slightly more than half of the food material consisted of liquid (Table 1) which is a mixture of water and lipids (Clarke & Prince 1980). Fish and cephalopods were the only significant classes of prey in the diet, both in terms of their frequency of occurrence and mass (Table 2).

Fish

Overall, nearly 60 per cent of the diet, in terms of mass, consisted of fish prey (Table 2). However, if the overall totals are broken down by year and by island a different story emerges (Table 3). Samples collected at both islands during 1987 and at Prince Edward Island during 1985 contain similar ratios of fish and cephalopods but samples from Marion Island in 1985 consisted of a much higher proportion of fish (Table 3).

The flesh of fish in the samples was frequently well digested

Table 1
Size of grey-headed albatross food samples and the proportion of liquid they contained (n = 88)

	Mean + S.D.	Range
Total Mass (g)	343 ± 165	35-850
Liquid (g)	187 ± 119	0-530
Solids (g)	155 ± 123	10-575
Proportion of liquid (%)	55,4 ± 26,4	0-96,1

Table 2
Composition of food samples collected from grey-headed albatrosses at the Prince Edward Islands (n = 88)

	Prey class				
	Fish	Cephal-opods	Crustac-eans	Penguin	Other
Number of samples containing class	52	56	13	3	5[1]
Frequency of occurrence (%)	59,1	63,6	14,8	3,4	5,7
Mass of class (g)	7 875	4 640	400	365	295[2]
Proportion of total mass (%)	58,0	34,2	3,0	2,7	2;2

1. Goose barnacles 2; Ctenophore 1; non-cephalopod mollusc 1; seal carrion 1.
2. Seal 285 g; goose barnacles 5 g; non-cephalopod mollusc 5 g.

Table 3
Inter-island and inter-year variation in the composition of grey-headed albatross samples at the Prince Edward Islands

		Proportion of total mass (%)		Fish/ cephalopod ratio
	n	Fish	Cephalopods	
1985				
Marion Island	20	77,1	17,2	4,48
Prince Edward Island	21	44,3	39,7	1,12
1987				
Marion Island	26	51,5	39,6	1,30
Prince Edward Island	21	53,7	46,3	1,16

and even in those samples showing little sign of digestion the heads were often missing. Because of this only two fish could be positively identified, using otoliths and skeletal remains. One *Channichthys rhinoceratus*, Channichthyidae (total length 350 mm, estimated mass 245 g) and a *Dysalotus alcockii*, Chiasmodontidae (standard length 164 mm, estimated mass 24 g) were found in Prince Edward Island samples. The latter species may be a rather atypical prey, however, since it constitutes a new distributional record for the area (Gon & Klages 1988).

Cephalopods

Although cephalopod flesh was found in over 60 per cent of the food samples it comprised only about one-third of the diet by mass (Table 2). Cephalopod beaks were found in many samples and the species composition is shown in Table 4. Beaks are only digested very slowly (Ashmole & Ashmole 1967, Furness *et al.* 1984) and persist through a number of meals. Consequently, only samples containing actual flesh were included in the frequency of occurrence and biomass calculations. Two species of squid predominated: *Kondakovia longimana*, Onychoteuthidae, and *Histioteuthis eltaniae*, Histioteuthidae, with other cephalopods only occurring infrequently. The beaks were used to estimate the original masses of the cephalopods eaten and these are also shown in Table 4. The size of squid taken ranged from a 13-g *K. longimana* to a 1 815-g *Moroteuthis knipovitchi*.

Crustaceans

Thirteen samples (14,8 %) contained crustaceans but in nearly all of these only one or two individuals were present, suggesting that most were probably ingested incidentally or were in the stomachs of fish and cephalopods eaten. The amphipod *Themisto gaudichaudii* was found in four samples; remains of large decapod crustaceans occurred in three samples. The remaining samples contained unidentifiable and very digested crustaceans though two probably consisted of euphausiids.

Other prey

Penguin carrion was present in three samples and one contained seal carrion. Goose barnacles *Lepas*, unidentified non-cephalopod molluscs and Ctenophores were occasionally recorded but contributed an insignificant amount to the diet.

Discussion

Diet and foraging range

The data collected during this study show that grey-headed albatrosses at the Prince Edward Islands are predominantly predators on fish, although the proportion can vary (Table 3), probably as a result of localized fluctuations in prey availability. Cephalopods were the only other main source of food. This contrasts with birds at South Georgia where cephalopods were the most important prey (49,0 %) followed by fish (24,1 %) and significant quantities of crustaceans (16,5 %) and lampreys (10,4 %) (Prince 1980). Weimerskirch *et al.* (1986) found the diets of grey-headed albatrosses at Iles Crozet to be similar to those of this study. Fish was the predominant prey with a substantial amount of cephalopods but very little crustaceans and carrion, though they did not carry out an analysis by mass of the different prey types (see Fig. 5 in Weimerskirch *et al.* 1986).

The differences in diet between birds at South Georgia and the

Table 4
Species of cephalopods found in the diet of grey-headed albatrosses at the Prince Edward Islands (total number of beaks = 105)

	Species	%	No. lower beaks measured	Mean estimated mass[1] (g ± S.D.)
Cranchiidae	*Galiteuthis glacialis*	6	6	89,7 ± 31,4
	Galiteuthis sp.	1	1	85,4
Onychoteuthidae	Unidentified	1	0	-
	Kondakovia longimana	46	45	186,8 ± 253,6
	Moroteuthis knipovitchi	2	2	982,0; 1 814,6
	Moroteuthis sp.	1	1	1 029
Histioteuthidae	*Histioteuthis eltaninae*	37	39	78,3 ± 20,7
Gonatidae	*Gonatus antarcticus*	1	1	151,7
Octopoteuthidae	*Taningia danae*	1	1	403,6
Chiroteuthidae	*Chiroteuthis* sp.	2	2	48,4; 123,1
Unidentified squid		3	0	-
Total			98	

[1] Estimated by measuring the lower rostral length and using the regression equations given by Clarke (1985).

Prince Edward Islands may reflect the availability of prey in the foraging areas of the respective populations. South Georgia birds breed south of the Antarctic Polar Front and probably feed in seas southwards to the Antarctic Peninsula (Prince & Francis 1984). Their mean foraging range has been estimated at between 522 and 772 km (Prince & Francis 1984). These seas, particularly the Scotia Sea, provide abundant prey for the albatrosses with high densities of Antarctic krill *Euphausia superba*. This comparatively large species of krill does not occur in the seas around the Prince Edward Islands, about 330 km north of the Antarctic Polar Front (Lutjeharms & Emery 1983), and whereas this oceanographic boundary is well within the potential foraging range of grey-headed albatrosses, they may spend more time feeding in zones north of this front. Abrams (1985) found that the highest concentration of grey-headed albatrosses occurred at the sub-Antarctic Front (*c.* 350 km to the north of the Prince Edward Islands) and in the Polar Frontal Zone that extends from this front south to the Antarctic Polar Front, though smaller numbers were also recorded in Antarctic waters. Although Weimerskirch *et al.* (1986) also found many birds north of the Antarctic Polar Front in the Iles Crozet-Kerguelen area, they have also noted greater numbers present in Antarctic waters.

No plastic particles were noted in the food samples but Ryan (1988) did record a low incidence of these in regurgitation casts collected at the Prince Edward Islands.

Cephalopod species in the diet

Undigested cephalopod beaks are often regurgitated by albatrosses and such casts can be collected around their breeding colonies (Clarke *et al.* 1981, Brooke & Klages 1986). However, larger beaks tend to be over-represented in these casts since they are more resistant to digestion (Imber 1973, Imber & Berruti 1981). Consequently, the species composition of the cephalopod prey is more accurately determined from regurgitations of whole meals than from casts such as those collected by Brooke & Klages (1986). These authors found that the large *K. longimana* and *Moroteuthis* sp. beaks were the most numerous in casts at the Prince Edward Islands. In addition, they found that the mean estimated mass of *K. longimana* was in excess of 1 500 g, whereas this study indicates that smaller individuals of this species are frequently taken (Table 4). Cast collections also failed to record the large proportion (39 %) of *Histioteuthis eltaninae* that were in the diet during this study. This is not surprising, given their much smaller size compared to the large beaks of the onychoteuthid squid, although differences in diet composition between years cannot be ruled out without more extensive sampling.

Squid in the diet of grey-headed and black-browed albatrosses *D. melanophris* at South Georgia were mainly *Todarodes ? sagittatus* (Family Ommastrephidae) (Clarke & Prince 1981). This family is entirely absent from our samples and the species has been replaced by *K. longimana* which were of a similar mean size (*K. longimana* 187 g; *Todarodes ? sagittatus* 157 g) and the rather smaller *H. eltaninae* (mean mass 78 g). At Iles Crozet, grey-headed, black-browed and yellow-nosed *D. chlororhynchos* albatrosses also took mainly Ommastrephidae whereas most of the squid taken by the two sooty albatrosses *Phoebetria* spp. were Cranchiidae, and Onychoteuthidae dominated wandering albatross *D. exulans* samples (Weimerskirch *et al.* 1986). These differences may reflect differences in prey distribution in the foraging areas, rather than divergent prey selection strategies between the populations.

More than 99 per cent of the cephalopod beaks collected from casts around the nests of yellow-nosed albatrosses at Prince Edward Island were *K. longimana* (Brooke & Klages 1986) whereas significant numbers of this species, *M. knipovitchi*, *H. eltaninae*, *Teuthowenia antarctica* and *Galiteuthis glacialis* were found in the casts of the two sooty albatrosses at Marion Island (Berruti & Harcus 1978). However, the full extent of any dietary overlap between these three species and the grey-headed albatross, as well as the wandering albatross, at the Prince Edward Islands will only be possible once comparative sets of full regurgitations have been collected from all five species of albatrosses.

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