JELLYFISH AND FISHERY WASTE AS FOOD SOURCES OF NORTHERN FULMARS *FULMARUS GLACIALIS* FEEDING AROUND ST KILDA

KWALLEN EN VISAFVAL ALS VOEDSELBRONNEN VOOR NOORDSE STORMVOGELS ROND ST KILDA

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ABSTRACT

Northern Fulmars were captured, ringed and released on St Kilda in August 1982. Twelve samples of regurgitated the contents of their proventriculus were studied in detail. Velella velella *(Siphonophora) was observed twice,* Hyperia galba, *a small amphipod that is often found in cavities within the umbrella of jellyfish, was recorded four times (72 individuals). All fish found in the samples were apparently taken behind trawlers (discards and offal). Some plastic particles (i.e. pellets) were present and some plant remains were probably taken while sitting at the nest.*

Northern Fulmar *Fulmarus glacialis* diets vary considerably between colonies. The catholic feeding habits of this species implicate that few samples are large enough to fully appreciate the range of prey taken (Furness & Todd 1984, Camphuysen 1990). Zooplankton forms significant food in some populations (Brown 1970, Bradstreet 1978, Camphuysen & Van Franeker 1988), fatty fish like sandeels, capelin or clupeids in others (Fowler & Dye 1987). However, the scavenging habits of Fulmars at fishing vessels have widely been used to explain its population increase and range expansion during the last two centuries (Lockley & Marchant 1951, Fisher 1952, Hudson & Furness 1988, Camphuysen 1990, Camphuysen *et al.* 1995). This would infer this latter food source to be of prime importance over a wide range.

For centuries, St Kilda has been an important breeding station of Fulmars (Figure 1; Fisher 1952). Furness & Todd (1984) were the first to describe and quantify the diet of Fulmars in these remote islands and to compare the food choice of these birds with that on Foula (Shetland Isles). With a substantial variation in diet between colonies, obviously a reflection of local food sources, it can be envisaged that food choice may also vary within a given colony between seasons. In August 1982, Fulmars were captured, ringed and

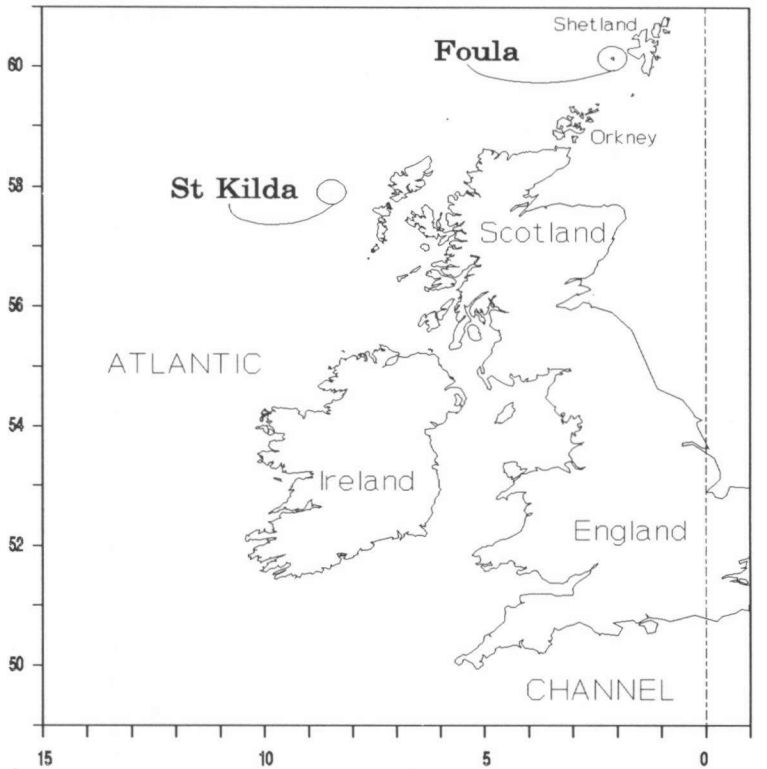

Figure 1. Location of St Kilda and Foula.
Figuur 1. Ligging van St Kilda en Foula.

released on St Kilda as part of a morphological study of this species (Van Franeker 1983). Some birds regurgitated the contents of their proventriculus during handling and this article reports on the prey items found in these samples. Although the sample size is small, the data contribute to our knowledge of the food choice of Fulmars on St Kilda and add to the data collected one year earlier by Furness & Todd (1984).

MATERIAL AND METHODS

From 13 to 27 August 1982, 152 Northern Fulmars were caught with a long-handled net from the cliff edge. The birds were not forced to give up

food (*i.e.* by means of 'Water Off Loading') but sometimes did so spontaneously. Hence, the amount of food produced by the birds was probably only seldom the full contents of the proventriculus. Samples were kept on 70% alcohol and identified to the lowest possible taxonomic level a few years later. Some plant remains may have 'polluted' the samples when the food items were collected.

RESULTS

Of 152 Fulmars caught and handled, 25 individuals regurgitated some food remains (regurgitation rate 16.4%). Only 12 birds produced readily identifiable items, including fish, crustaceans, jellyfish, nematods, plastic, bird feathers and plants (table 1). The remaining birds regurgitated fatty oil without solid particles.

FISH (PISCES) Fish occurred in six samples but in none of these could the species be identified. On three occasions, large chunks of fish liver were found and these were identified as offal produced on board fishing vessels. Large pieces of fish including parts of spinal columns, fins and other fish bones were observed in the remaining samples, apparently representing discarded fish ripped apart by the birds. Small clupeid fish, such as frequently observed by Furness & Todd (1984), were not found. Fish offal was recorded in only two of the 238 Fulmar samples studied by these authors (0.8%).

Table 1. Food items regurgitated by 12 Northern Fulmars handled on St Kilda, August 1982. Presence is indicated by '+' for fish offal, plants, and unidentified remains ('unknown'). Otherwise, the number of individual items is indicated.

Tabel 1. Belangrijkste componenten van het voedsel van 12 in augustus 1982 op St Kilda gevangen Noordse Stormvogels. De presentie van vis, plantaardig materiaal en onbekende prooiresten is aangegeven door middel van een '+', overigens is het aantal getelde exemplaren gegeven.

sample	1	2	3	4	5	6	7	8	9	10	11	12	n=	%
fish offal	+				+	+				+	+	+	6	50
pelagic Crustacea			2	32			2		10		28		5	42
jellyfish		2	1										2	17
paper, plastic				2									1	8
plants				+	+	+	+	+			+	+	7	58
Nematoda			1	20							2		3	25
feathers												2	1	8
unknown								+					1	8

PELAGIC CRUSTACEANS Five samples were found to contain the remains of crustaceans. In four samples the amphipod *Hyperia galba* was observed and three of these contained 10, 28 and 32 fine, fresh and complete specimens of this crustacean respectively. In one sample, the digested remains of some unidentified decapod (*i.e.* larger shrimp) were found. It should be noted that *Hyperia galba* is typically associated with jellyfish (particularly *Rhizostoma* spp.; Barrett & Yonge 1958) and is often found in cavities within the umbrella of the host. In 1981, *Hyperia galba* was not observed in 168 samples containing the remains of pelagic zooplankton by Furness & Todd (1984). On the other hand, the euphausiid *Meganyctiphanes norvegica*, commonly found in both the Foula and 1981 St Kilda samples, was not recorded in the present study.

JELLYFISH (CNIDARIA, SIPHONOPHORA) The 'skeleton' of the By-the-wind-sailor *Velella velella*, in fact a flat oval membrane on which, in the living animal, a diagonally set stiff sail is attached, was recorded twice. This hydrozoan is not very common around the British Isles, being a more southerly, Atlantic species, but it may occur on the Irish coast after persistent SW winds and, apparently, around St Kilda (Hardy 1956, Barrett & Yonge 1958, Sharrock 1973). These *Velella*-membranes were common on St Kildian beaches during the 1982 expedition, suggesting a common occurrence around St Kilda at that time. The regurgitated membranes were virtually intact, indicating that the birds had swallowed the entire animal.

PLANT REMAINS Seven samples were found to contain plant remains. Most specimens were damaged grass leaves or pieces of moss, neither of which could be identified as to species. Most of these remains probably 'polluted' the samples during collecting. Scurvy Grass *Cochlearia officinalis* and White Clover *Trifolium repens* were each recorded once and these plants were presumably taken deliberately by the bird at the nest or on the colony ledges, considering the very pale colour, as if digesting liquids had had their effect.

PLASTIC PARTICLES Northern Fulmars are known to take plastic, sometimes in considerable quantities (Furness 1985, Zonfrillo 1985). However, deliberate regurgitations rarely contain plastics, because the particles 'settle' in the gizzard. Pellets (2) were recorded in one bird.

NEMATODES The examination of gizzard and proventriculus in a healthy seabird often results in yields of considerable numbers of nematodes. Some-

Table 2. Frequency of occurrence (n and % of all samples examined) of prey items in regurgitates of Northern Fulmars handled in 1982 (see table 1), in regurgitated food collected by Furness & Todd (1984) in 1981.

Tabel 2. Voorkomen (n en % van alle geanalyseerde monsters) van prooisoorten in braaksels van Noordse Stormvogels die werden geringd in 1982 (zie tabel 1), in braaksels van vogels die in 1981 werden verzameld (Furness & Todd 1984).

	St Kilda 1982 (this study) n= 12		St Kilda 1981 (Furness & Todd 1984) n= 238		Foula 1978-82 (Furness & Todd 1984) n= 177	
	n	%	n	%	n	%
small fish	0		18	8	128	72
fish offal	6	50	2	1	24	14
Crustacea	5	42	169	71	19	11
Cephalopoda	0		0		1	1
jellyfish	2	17	0		0	
benthic invertebr.	0		12	5	0	
plastic	1	8	38	16	5	3
feathers	1	8	0		0	
unknown	1	8	0		0	

times, these worms are regurgitated during handling. These nematodes probably originate from the fish taken by the birds. Small amounts of nematodes were observed in three of the St Kilda samples studied.

OTHER ITEMS One sample contained some small white feathers, another sample contained some large, unidentified cheese-like chunks.

DISCUSSION

The observation made by Furness & Todd (1984), that sandeels were important prey for Northern Fulmars on Foula during 1978-1982, but were lacking on St Kilda, is confirmed by the present study. Yet, the 1982 samples from St Kilda were notably different from those collected in 1981 (table 2). While pelagic crustaceans dominated the samples of Furness & Todd (1984), fishery waste and jellyfish (with their associated amphipods) were common in samples obtained in 1982. Both studies were based on samples of regurgitates, which often only represent part of the stomach contents. Therefore, although the results may be biased to particular prey items (Creet *et al.* 1984), both studies are comparable. Differences may result from the fact that mainly chicks were sampled in 1981, and only adults in 1982. Samples from chicks comprise a mixture of several meals and these may differ from those of adults (single last meal). Nevertheless, the differences between the two

studies emphasize that the diet of an opportunistic feeder like the Northern Fulmar can not be fully determined in a single-year study, or by sampling a particular age class of birds. Even the Fulmars on Shetland, consistently feeding on sandeels during the period 1978-1982 (Furness & Todd 1984) proved to be quite capable to divert to other prey when sandeels became depleted (Okill 1989, Harvey *et al.* 1990).

The scarcity of offal and discards as components of the diet of Northern Fulmars at St Kilda in 1981 (0.8%) was thought to reflect the relative scarcity of whitefish trawlers in the area (Furness & Todd 1984). However, six of the 12 birds sampled in 1982 had been feeding on fishery waste, which is a higher fraction than in 1981. Lockley & Marchant (1951) decribed the massive numbers of Fulmars scavenging at commercial fishing vessels in the area and the data collected by Leaper *et al.* (1987) and Dändliker & Mülhauser (1988) also indicated that fishery waste may at times be of considerable importance to these birds. Fishing activity around St Kilda during the 1982 study was evidenced by several large trawlers that used the islands as shelter during periods of bad weather.

The consumption of By-the-wind-sailors, but certainly also the consumption of the amphipod *Hyperia galba*, indicates a profound interest in jellyfish by feeding Northern Fulmars. Harrison (1984) reported jellyfish consumption by a range of Pacific seabirds and during ship-based surveys in the North Sea, Fulmars have frequently been seen settling near or swimming nearby jellyfish and pecking at them (CJC *pers. obs.*, M.F. Leopold *pers. comm.*). Leaper *et al.* (1987) reported frequent sightings of Fulmars pecking at jellyfish around St Kilda. It is hard to believe that the jellyfish themselves are an interesting source of food, but the frequent occurrence of associated animals (amphipods, pelagic molluscs, or small gadoid fish) is obviously attractive (Hardy 1956, Hayward & Ryland 1995). The By-the-wind-sailors were apparently swallowed whole, but it is possible that the birds were in fact after the pelagic mollusc *Ianthina* which preys upon *Velella*. Individual By-the-wind-sailors observed in the open North Atlantic have been seen to have a number of small *Ianthina* attached to their surface. While keeping them alive in an aquarium, it has been noted that these snails were browsing on the *Velella* and gradually cleared the underside of tentacles and blastostyles. As in the larger jellyfish, it may have been these snails which make By-the-wind-sailors interesting for Northern Fulmars, although their remains have not been traced in the few samples studied. Numbers of jellyfish at the surface in mid-summer may be vast and will thus provide an interesting source of food for Fulmars, which is easy to spot and exploit.

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SAMENVATTING

De voedselkeuze van Noordse Stormvogels op St Kilda (figuur 1) werd onderzocht aan de hand van in augustus 1982 uitgebraakte prooiresten en vergeleken met monsters die een jaar eerder waren verzameld door Schotse onderzoekers op deze eilandengroep. De vogels werden gevangen vanaf de klifrand met een groot model vlindernet en na uitvoerige metingen geringd en weer vrijgelaten. Van een totaal van 152 gevangen Noordse Stormvogels werd bij 25 exemplaren genoteerd dat voedselresten of maagolie werden uitgebraakt tijdens de 'behandeling'. In totaal 12 monsters met herkenbare voedselresten werden verzameld en later uitgezocht. De belangrijkste bestanddelen van het dieet waren visresten (50% van de uitgezochte monsters), kleine garnaalachtigen (42%) en kwallen (17%). De visresten bestonden uit grote brokken vislever en visvlees met grove graten, waaruit werd afgeleid dat de vogels achter vissersschepen de overboord gezette bijvangst en snijafval hadden geconsumeerd. Numeriek dominant bij de garnaalachtigen was de amphipode Hyperia galba, *een soort die geassocieerd met haarkwallen voorkomt. Twee vogels bleken bazaantjes* Velella velella *te hebben gegeten. Net als genoemde haarkwallen worden bazaantjes overigens dikwijls vergezeld door andere organismen, in dit specifieke geval kleine mariene slakken* Ianthina *spp. Vooral vanwege de met kwallen geassocieerde garnaalachtigen, slakjes of jonge vis vormen kwallen in de zomer mogelijk een voor de vogels gemakkelijk traceerbare en wellicht zelfs overvloedige voedselbron. De vergelijking met de eerdere studie leert dat het onverstandig is om vergaande conclusies te trekken over de voedselsamenstelling op basis van één enkel veldseizoen bij opportunistisch fouragerende Noordse Stormvogels.*

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