SEABIRD 8

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Editors:
P. G. H. Evans and T. R. Birkhead

CONTENTS

The vignettes of auks are by Tim Birkhead.

EDITORIAL

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P. G. H. Evans
T. R. Birkhead

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or hyphenated vernacular names (e.g. Great Black-backed Gull, White-eyed Gull) but not in a group name (e.g. gulls, terns). Trinomials should be used only if the identity of specimens has been verified by critical comparison and if the subspecific nomenclature is relevant to the topic under discussion.

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Measurements should be given in SI (International system of units), but if the original measurements were made in non-SI units, the actual values and units should be given, with SI equivalents inserted in parentheses at appropriate points. Measurements may be given in cm.

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COULSON, J. C. and WOOLLER. R. D. 1976. Differential survival rates among breeding Kittiwake Gulls *Rissa tridactyla* . (L.). *J. Anim. Ecol.* 45: 205-213.

The author's name should be placed beneath the title of the paper and again at the end, together with the address, after the references.

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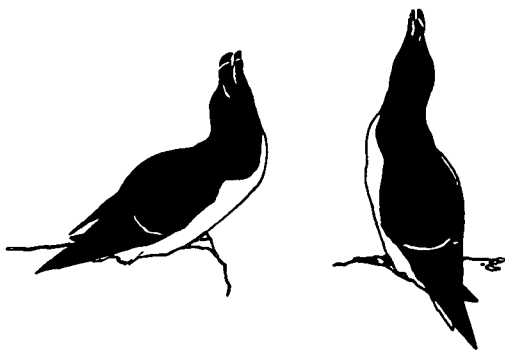
Two cases of Guillemots *Uria aalge* helping to rear neighbours' chicks on the Isle of May ⸱

S. Wanless and M. P. Harris

During a four year study of the breeding biology of Guillemots *Uria aalge* on the Isle of May, Fife, Scotland between 1981-4 we twice observed a chick being jointly raised by two pairs. This paper documents these cases and compares our findings with those of Tschanz (1979) and Birkhead and Nettleship (in press).

METHODS

Approximately six hundred breeding sites were checked 5-8 times each day from about 6 weeks before laying until all Guillemots had left the colony. Many of the birds were individually colour ringed so that interactions within pairs and between sites were fairly easy to determine. Details of breeding and which bird(s) was present was noted on each check. In addition, in 1983 four dawn to dusk watches were made on ca. 30 sites when the majority of birds had eggs and four when they had chicks; details of individual attendance patterns and chick feeding were recorded. The pair or site which received help in rearing the young is called pair or site A and the pair or site which helped is called pair or site B.

RESULTS

Under normal conditions we hardly ever saw a chick wandering off its site or left unattended. However, when severely disturbed, an adult sometimes left its young which was then brooded by a neighbouring bird. These birds included those already with young, non-breeders and failed breeders. The parent usually came back within 15 minutes whereupon the chick returned to its correct site. Failed breeders also attempted to brood young as the young made their way down to the sea.

The two sites at which pairs were involved in jointly raising a chick were adjacent and in the middle of a line of five sites set against the back wall of a broad ledge with a further three sites along the seaward edge. The eggs were incubated approximately 15 cm. apart so that the birds were frequently touching.

In 1983 at site B (the helper site), the male was colour ringed but the female and both birds on site A (the real parents) were unringed. Pair B's first egg was lost 10 days after being laid and the replacement egg lost after 35 days incubation when it should have been hatching. Female A laid very late, but incubation was normal, except on 21 June when the egg was not properly incubated. Chick sharing was first seen on 12 July, the day after pair B lost their egg and when chick A was three days old. Female B brought in a sprat *Sprattus sprattus* in the morning which was held for display (Perry 1945) and not fed to a chick. However, a sandeel *Ammodytes marinus* brought by female B in the evening was fed to chick A. At the next observation, 90 minutes later, male B was brooding the young on site B. During the next 15 days the young alternated between the two sites and was brooded by all four adults. Each pair kept strictly to its own site and pair B never intruded onto site A. We never saw any aggression between the pairs and the chick was never attacked. During checks between 14-24 July the young was being brooded by a member of pair B (six occasions) and by a member of pair A (four). This tendency for the young to spend more time with the helpers was also shown by two days detailed observations (Table 1).

TABLE 1. LENGTH OF TIME (HOURS) THAT A GUILLEMOT CHICK SPENT WITH ITS REAL PARENTS (A) AND A PAIR OF HELPERS (B) DURING TWO DAWN TO DUSK WATCHES ON THE ISLE OF MAY IN 1983.

	Age of young (days)	Real parents A	Time on site (hours)	
			Helper pair B	
			Male	Female
19 July	10	7.4	6.1	5.0
			11.1	
25 July	16	0	4.5	12.0
			16.5	

Both pairs fed the chick (male B only once) although pair A took the greater share (Table 2). Guillemots frequently bring in display fish after the loss of an egg or chick (Birkhead 1976) and these fish are sometimes snatched by neighbouring young (Birkhead pers. comm; pers. obs.). However, female B did not behave as though it was bringing in display fish but showed typical chick feeding behaviour when it arrived with a fish and immediately put its head down towards the chick, delivering the fish with an arched back and slightly spread wings (Perry 1945). Furthermore, on the Isle of May most display fish were brought in just after dawn while female B brought fish throughout the day. On 19 July, the young received a total of 10 feeds, slightly more than the mean of 8 feeds to 14 neighbouring young that day. However, on 25 July, the day it departed, it did not receive any feeds. On that day a member of pair A fed another neighbour's chick while its own was being brooded by female B.

TABLE 2. THE NUMBER (PROPORTION) OF FEEDS RECEIVED BY A GUILLEMOT CHICK FROM ITS REAL PARENTS (A) AND A PAIR OF HELPERS (B) ON THE ISLE OF MAY IN JULY 1983.

	Real parents A	Number of feeds (%)	
		Helper pair B	
		Male	Female
19 July Dawn-dusk	7 (70)	0 (0)	3 (30)
		3 (30)	
12-25 July Spot checks	11 (69)	1 (6)	4 (25)
		5 (31)	
Total	18 (69)	1 (4)	7 (27)
		8 (31)	

Both pairs spent significantly less time together on the site (16% of 88 checks) than 10 other pairs nearby which had chicks over the same period (36% of 244 checks; $\chi^2_1 = 12$, $P<0.001$). Pair B were together on the site more often (10 out of 44 checks) than the real parents (4 of 44) but the difference was not statistically significant. However, despite this reduction in time spent at the site the young was always brooded by an adult and never wandered beyond the two sites.

Normally the young is taken to sea by the male and the female visits the site for several days afterwards. Chick A left the colony at about 2100 h on 21 July when it was sixteen days old. Although slightly younger than usual, this is within the normal range for young on the Isle of May. Several nearby young also left that night. The chick was with male B from 1630-2100 h, at 2030 h a parent came onto site A, and the young and both adults had left by 2130 h. The actual departure was not seen, but it is possible that both these adults took the chick to sea. The only birds subsequently seen on either of the sites that season was an unringed bird on site A on 26 July and an unringed bird with a display sprat on 27 July, also on site A.

The situation at the beginning of the season next was complicated. Although site B was apparently re-occupied by the same pair (certainly the colour ringed male returned), site A was initially occupied by a new colour ringed male which had bred unsuccessfully elsewhere in the colony in 1983. This bird and an unringed female were present at site A until 21 April. The male then disappeared and the female re-paired during the first week of May. In 1984, chick A was first seen being brooded by a helper two days after pair B lost its egg and when the chick was six days old. The lost egg had been incubated for 57 days and was obviously not going to hatch. No detailed observations were made but the young spent most of its time on site B, brooded by a helper. The situation appeared to be more akin to complete adoption (Tschanz 1979) but neither pair was seen feeding the chick. The young left the ledge when aged 18 days, again possibly accompanied by a parent and the helper male as both were seen on the day of the chick's departure but not thereafter.

DISCUSSION

Guillemots brooding their neighbours' chicks have been documented elsewhere, e.g. in Norway by Tschanz (1979) who termed these birds "helpers" and in Canada by Tuck (1961) and Birkhead and Nettleship (in press) who referred to it as alloparental behaviour; our results broadly agree with these studies. It appears that helpers are always close neighbours, usually from an adjacent site; parents and helpers stay at their own sites and are not aggressive towards each other, and most are failed breeders (although Birkhead and Nettleship recorded helpers which had a chick, which were non-breeders and also which were birds whose chick had departed). However, on the Isle of May in 1983, the single pair of helpers which was observed, participated from soon after hatching until the young left the colony, brooded more than the real parents and provided 30% of the feeds (Tables 1 and 2). In 1984, the helpers again displayed a high degree of involvement. In both cases, we suspected that the helper male was involved in taking the young to sea, either alone or possibly accompanying the parent. These findings were similar to those on Vedöy, Norway except that Tschanz (1979) reported that the helpers contribution to feeding was minimal. Birkhead and Nettleship (in press) found that alloparental behaviour on Gannet Clusters, Canada was of relatively short duration, mostly occurring when the young were 18-22 days old, towards the end of chick-rearing, so that alloparents were not closely involved with chick rearing. They brooded when one or both parents were present at the colony and when both parents were absent but almost never fed the chick. For this reason, Birkhead and Nettleship considered that the term "helper" was misleading. Neither Tschanz nor Birkhead and Nettleship mention helpers taking the young to sea. On the Isle of May in 1983 the main difference between the pair which received help and other pairs was that the former spent very little time together on the site. However, it is impossible to know whether the chick went to the helpers because its parents were away or the parents spent longer away when they "realised" they did not need to protect the chick.

The frequency of helping/alloparental behaviour was apparently much lower on the Isle of May (probably <1% p.a.) than on Vedöy (7%, Tschanz 1979) and Gannet Clusters (8%, Birkhead and Nettleship in press). Tschanz suggested that the behaviour occurred more often during times of food shortage. On the Isle of May food was apparently easily obtained (Harris and Wanless in prep.) and members of pairs spent a considerable amount of time together on the site. Consequently most chicks had little opportunity to wander and except when severely disturbed were never brooded by neighbours.

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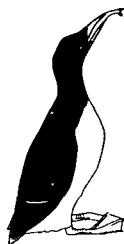
Examination of corpses of auks beached on East British coasts in February 1983

P. Hope Jones, C. F. Barrett, G. P. Mudge and M. P. Harris

During February 1983, large numbers of auks *Alcidae* died along the North Sea coasts of Britain (Underwood and Stowe 1984). The present paper reports on the age, sex and measurements of Guillemots *Uria aalge,* Razorbills *Alca torda,* Little Auks *Alle alle* and Puffins *Fratercula arctica* found dead in this wreck. It was written before the publication of an anlysis of the ringing recoveries reported during the wreck by Hudson and Mead (1984) and so allows a comparison to be made of direct and indirect assessments of the origins of these birds.

METHODS

Dead birds were collected in the second half of February from the Moray Firth (Wick to Fraserburgh), North-east England (Berwick-upon-Tweed to Hartlepool) and East Anglia (Norfolk and Suffolk). Measurements and recording methods follow those defined by Jones *et al.* (1982).

Wing, culmen length and depth were measured. Birds were sexed by dissection and the width of the left testis or the diameter of the largest ovarian follicle measured. The length and breadth or absence of cloacal bursa were noted in all species except Puffin. (This bursa is an organ which regresses completely in most bird species towards the time of sexual maturity — Rose 1981). In Razorbill and Puffin, older birds have more bill grooves than immature birds (Salomonsen 1944, Harris 1981), so the number of such grooves was used to estimate age. Razorbills were divided into adult (one white and at least two black grooves), immature (one white and one or no black) and first-winter (none). Puffins were divided into adult (more than two grooves), intermediate (two), immature (less than two) and juvenile (undeveloped bill, dark face). Immature Razorbills and intermediate Puffins may include birds capable of breeding. The right wing of each Guillemot was air-dried and colour coded using a series of specimen wings ranging from very pale brown (colour code 2, c. 6% reflectance of white light) to almost black (colour code 9, 2% reflectance). The presence of a bridle mark on each Guillemot and of primary moult in Puffins were recorded.

Complete details were not collected from all species or individuals, hence the variation in sample sizes. Statistical differences between means were tested using Student's t test, whilst chi-square tests were used to compare proportions and to assess divergence from expected 50:50 ratios; wing colour distributions in Guillemots were compared using the Wilcoxon two-sample test. The statistical significance level was taken as 5%.

RESULTS

Razorbill

Most birds were adult with 22% immature and 11% in their first winter (Table I). The sex ratio of adults was significantly biased towards females in North-east England but not elsewhere. Wing length and bill depth increased significantly with age (Table 2). The proportion of birds with cloacal bursa was highest in first year birds (all of 109 examined) and then gradually declined as the number of bill grooves increased, that is 72 (81%) of 89 with just a white groove, seven (9%) of 74 with a white and one black groove, to none

TABLE 1. AGE AND SEX COMPOSITION OF RAZORBILLS AND GUILLEMOTS IN FEBRUARY 1983.

(a) age composition

Locality	Adult	Razorbill Immature	1st winter	Total	Adult	Guillemot Immature	Total
Moray Firth	122 (60%)	46 (22%)	37 (18%)	205	43 (42%)	59 (58%)	102
North-east England	145 (62%)	54 (23%)	36 (15%)	235	71 (43%)	96 (57%)	167
East Anglia	195 (69%)	67 (23%)	22 (8%)	284	104 (53%)	92 (47%)	196

(b) sex composition

Locality	Male	Female	Total	Male	Female	Total
(i) adult						
Moray Firth	52 (43%)	70 (57%)	122	21 (49%)	22 (51%)	43
North-east England	49 (34%)	96 (66%)	145	27 (38%)	44 (62%)	71
East Anglia	80 (41%)	115 (59%)	195	44 (44%)	57 (56%)	101
(ii) immature						
Moray Firth	18 (39%)	28 (61%)	46	40 (68%)	19 (32%)	59
North-east England	17 (31%)	37 (69%)	54	66 (69%)	30 (31%)	96
East Anglia	31 (46%)	36 (54%)	67	53 (58%)	38 (42%)	91
(iii) 1st winter						
Moray Firth	22 (59%)	15 (41%)	37			
North-east England	15 (42%)	21 (58%)	36	No data		
East Anglia	12 (55%)	10 (45%)	22			

Note: Razorbills were aged on bill characters, Guillemots by presence or absence of cloacal bursa.

TABLE 2. WING AND BILL MEASUREMENTS (MM) OF RAZORBILLS AND GUILLEMOTS IN FEBRUARY 1983.

| Locality	RAZORBILL Wing length No. mean S.D.			Bill length No. mean S.D.			GUILLEMOT Wing length No. mean S.D.			Bill length No. mean S.D.		
(i) adults												
Moray Firth	114	197.1	4.4	119	19.6	1.0	43	205.9	5.2	41	12.5	0.7
North-east England	145	197.2	4.6	145	19.6	0.8	71	205.4	4.8	71	13.2	0.7
East Anglia	193	197.1	4.1	195	19.9	0.8	101	204.4	4.6	101	13.4	0.7
(ii) immatures												
Moray Firth	44	193.9	4.3	45	18.1	1.0	59	198.2	5.4	56	11.7	0.5
North-east England	51	193.1	3.7	54	18.6	1.0	100	198.1	4.4	101	11.8	0.6
East Anglia	63	194.6	4.1	67	18.9	1.0	91	199.7	5.2	91	12.4	0.5
(iii) 1st winter												
Moray Firth	37	187.5	4.2	37	14.8	0.8	No data					
North-east England	36	189.0	3.9	36	15.0	0.7						
East Anglia	27	189.8	3.3	22	15.1	0.7						
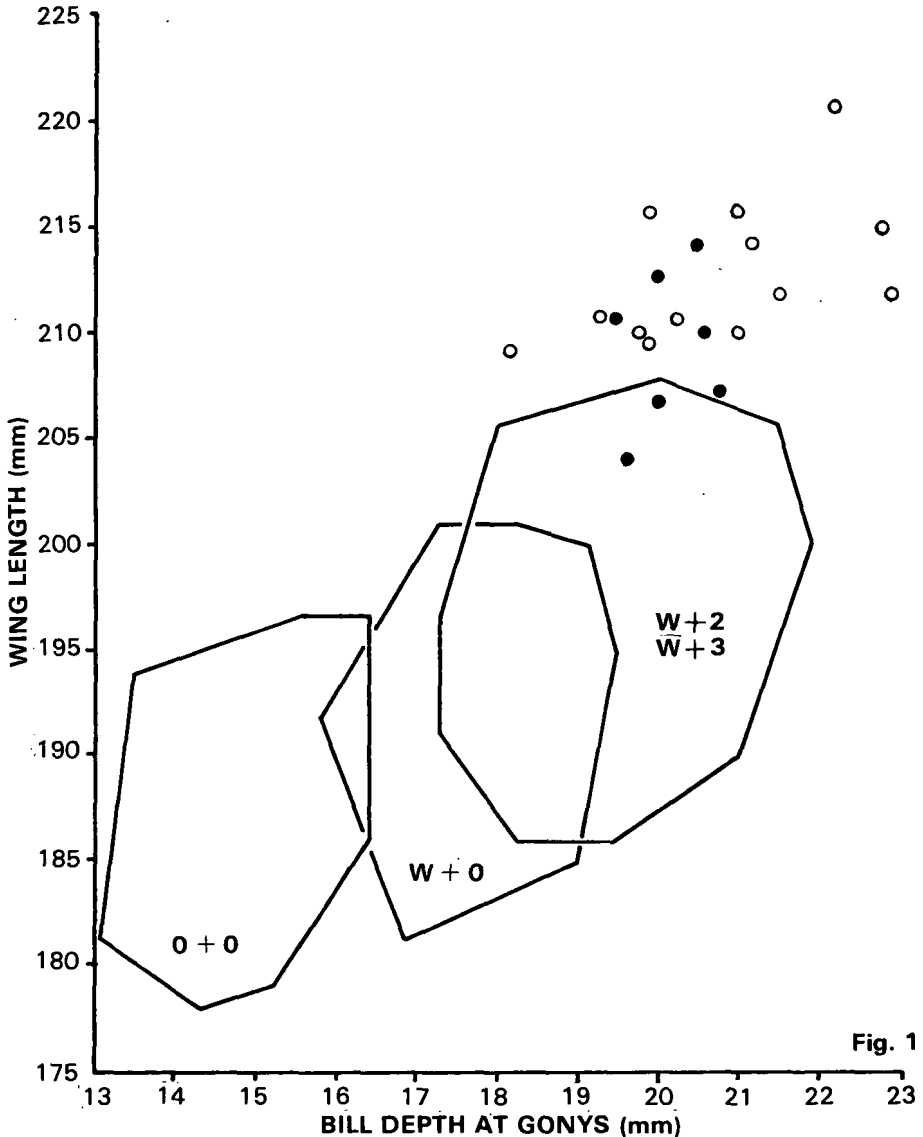
Figure 1. Distribution polygons for winglength and bill depth measurements of Razorbills wrecked in February 1983. The lines join the outermost plots of individual Razorbills assignable to the southern race *Alca torda islandica* divided by the number of bill grooves — none (0 + 0) one white only (W + 0) and those with a white and two or three black grooves (W + 2, W + 3,). Birds with a white and just one black groove are almost all included with the W + 2, W + 3 group. Individuals showing characters of *A. t. torda* are shown as open dots (adults) and closed dots (immatures).

among 462 with more grooves. Similarly the mean bursal index (length × breadth in mm) decreased from 98 in the youngest to 38 in those with just one black groove. Gonad size was greater in adults than in younger birds (Table 3).

European Razorbills are divided into two subspecies *Alca t. torda* breeding in Scandinavia and Russia, and *A. t. islandica* breeding elsewhere. The subspecies can be separated on wing length and bill depth (Salomonsen 1944). Figure 1 shows the distribution of measurements of birds with various bill-grooves. The 13 adult and 7 immature large outliers are presumed to be *torda*. These represented 2.8% of the 705 Razorbills examined.

Guillemot

There were approximately equal numbers of immatures and adults (as indicated by presence and absence of bursa) but whereas there were more females among adults, there were significantly more males than females among the immatures (Table 1). The proportion of bridled birds among those in summer plumage (where bridling is unlikely to be overlooked) was highest in the Moray Firth (6 (14%) of 43 compared to 10 (7%) of 141 elsewhere). Adults had significantly longer wings and deeper bills than immatures. There was no difference between localities in adult wing length but bill depths were significantly smaller in adults from the Moray Firth than the other two localities. Most birds had wing colour between greyish brown (colour code 5-6) and black (9) (Table 4), i.e. from the middle part of the latitudinal range of the species. At all localities, immatures were significantly paler-winged than adults. Wings of East Anglian adults were paler than those from other localities. Testis width and diameter of largest follicle were greater in adults than in immatures (Table 3).

TABLE 3. GONAD DEVELOPMENT OF RAZORBILLS AND GUILLEMOTS IN FEBRUARY 1983.

	MALES				*Testis width (mm)*			
	1	*2*	*3*	*4*	*5*	*6*	*7*	*No.*
Razorbill					% distribution			
Adult	1	7	37	38	13	3	1	180
Immature	18	55	21	5	1	0	0	66
1st winter	60	40						47
Guillemot								
Adult	2	10	27	42	12	5	2	93
Immature	49	46	3	1	1	0	0	157

	FEMALES		*mean width of largest ovarian follicle (mm)*		
	<1	*1*	*2*	*3*	*No.*
Razorbill		% distribution			
Adult	31	26	39	4	279
Immature	72	17	10	1	101
1st winter	100	0	0	0	47
Guillemot					
Adult	15	31	42	12	123
Immature	84	4	12	0	94

Note: Razorbills were aged on bill characters, Guillemots by presence or absence of cloacal bursa.

Little Auk

Using the presence of cloacal bursa as an indicator of immaturity, 27% of the 97 birds examined were immature and 73% adult. Of birds sexed, 29 were adult male, 32 adult female, 10 immature male and 15 immature female. The mean wing length of 71 adults was

TABLE 4. UPPERWING COLOUR OF GUILLEMOTS IN FEBRUARY 1983. FIGURES GIVE THE PERCENTAGE IN EACH CATEGORY RANGING FROM PALEST BROWN (2) TO BLACK (9).

	No.	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
					colour code				
(i) adult									
Moray Firth	40	0	0	0	5	17	28	20	30
North-east England	71	0	0	0	4	15	10	28	42
East Anglia	42	0	0	5	21	19	29	19	7
(ii) immature									
Moray Firth	58	0	0	3	16	24	28	17	12
North-east England	99	0	0	0	6	27	24	35	7
East Anglia	26	0	0	12	38	27	19	4	0

122.7mm (S.D. 4.6), significantly longer than the 120.7mm (S.D. 3.0) of 26 immatures. All but three wing lengths were in the range 112-130mm, the exceptions all being males, two with wings of 133mm and one of 135mm.

Puffin

Of the 85 birds aged, 31 (36%) were adult, 25 (29%) immature, 15 (18%) juvenile and 14 (17%) intermediate. Adults comprised 57% of the 21 Moray Firth birds but only 22% from East Anglia. The mean wing lengths of 29 adults and 15 first year birds were 166.5mm (S.D. 2.2) and 151.3mm (S.D. 4.5) with respective maxima of 178 and 162mm. The mean bill length of 68 birds (excluding juveniles where the bill would have still been growing) was 30.6mm (S.D. 0.5, maximum 33.0mm). Five (6%) of 89 individuals were in active wing moult and would have had their flight impaired, 38 (43%) had already replaced their primaries, 45 (51%) had not and one had an atypical mixture of new and old primaries.

DISCUSSION

Although there is some slight overlap in the wing lengths of *A. t. torda* (mean of 29 from Norwegian colonies = 208mm, S.D. 5.6, with 30% of measurements below 206mm; Anker-Nilssen & Røstad *pers. comm.*) and *A. t. islandica* (range of 176 adults in Irish and Icelandic colonies, 189-206mm), Razorbills with a wing length over 206mm are probably from far northern colonies. We have collected together measurements of 1005 birds, excepting our own, of which 26 (2.6%) had such large wings. This is gratifyingly close to the 2.8% among our 705 specimens. However, too much should not be made of this as no allowance can be made for feather wear between February and June or July when most adults were measured at the colonies. The mean wing lengths of dead Guillemots ranged from 204mm in East Anglia to 206mm in the Moray Firth, very close to the mean lengths of adults at colonies in Grampian (204mm, n = 39; Hardey and Rae *pers. comm.*) and on Fair Isle (207mm, n = 252). The maximum wing length we recorded was 218mm, well below that of northern populations, so it is unlikely that any adult birds from northern Norway were involved. The proportion of bridled birds varied from 7% in the south to 14% in the north. This suggests that most would have bred south of Shetland as colonies there, and further north, have at least 20% bridled birds present (Birkhead 1984). Presumably the East Anglian birds came from further south than did those from the Moray Firth as bridled birds are less common at the southern colonies. The fact that only a minority of individuals had black upperwing colour supports the contention that most of these birds came from southern Scotland and England.

The mean wing length of 166.5mm for adult Puffins was slightly longer than that for breeding adults at the east British colonies (means 161-163mm) and the largest two of the 29 (178mm) were outside the range of measurements (maximum length 176mm) of 3000

British breeding adults (Harris 1979). Similarly the bill length was slightly longer than most British birds. Thus a few Icelandic or northern Norwegian birds were probably included in the wreck. Too little is known of the taxonomy of Little Auks to even speculate on their country of origin.

Excepting Little Auks which must have come from the high-Arctic, our results indicate that the bulk of the birds involved probably came from British populations. Hudson and Mead (1984) reported on 278 ringed auks found in this wreck; 90% of the Razorbills were British bred as were 97% of Guillemots and 98% of Puffins. Foreign ringed auks included two Norwegian and eleven Icelandic Razorbills, one Norwegian Guillemot and two Norwegian Puffins. Apart from nearly all recoveries being reported south of the ringing site, there was no relationship between latitudes of ringing and recovery. Thus, there was fair agreement between the numerous taxonomic data and the more limited (as most birds had been ringed in Britain) but specific ringing recoveries that the wreck involved mainly populations from Scotland and northern England which are known to winter in the North Sea.

SUMMARY

The corpses of 724 Razorbills, 465 Guillemots, 97 Little Auks and 85 Puffins were examined from three North Sea locations during February 1983. Of the Razorbills, 67% were adults (61% of these being female), 22% immature, and 11% first-winter. At least 3% belonged to the northern subspecies *A. t. torda*. Of the Guillemots, 47% were adults (57% of these being female), with 53% immature; most adults probably came from northern Britain. In a small sample, the proportion of adult Puffins fell from 57% in the north to 22% in the south. Some northern Puffins were killed in the wreck. There was fair agreement between taxonomic and ringing recovery data that most of the dead birds came from Scotland and northern England.

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A case of Bigamy in the Common Guillemot
Uria aalge

Eric Verspoor

The majority of bird species are monogamous breeders exhibiting an essentially exclusive mating association between each male and female in the production of a brood (Lack 1968). The conditions leading to monogamy as opposed to polygamy or promiscuity have been the subject of much debate (e.g. Lack 1968; Orians 1969; Wilson 1975; Emlen and Oring 1977). Wittenberger and Tilson (1980) have recently presented a synthesis of the various hypotheses as to why monogamy should evolve. According to their arguments, the typically monogamous nature of the alcids such as the Common Guillemot *Uria aalge* exists because male parental assistance in incubation, egg and chick-guarding, and/or in chick feeding is essential to successful reproduction. The latter has been shown to be true in the Atlantic Puffin *Fratercula arctica* by Nettleship (1972). Any dividing of a male's attention between broods should carry a high risk of reproductive failure for at least one if not both of the broods. The observation of a case of bigamy reported here lends support to this argument.

The bigamous relationship was observed during the course of a study of the reproductive biology of the alcids breeding on the Gannet Clusters, Labrador (Birkhead & Nettleship 1981). It occurred in a group of Common Guillemot pairs being monitored for their reproductive success as described by Birkhead and Nettleship (1980). The breeding sites of about 250 pairs were mapped and those pairs containing one of each of the two morphs of the "bridling" polymorphism (Jefferies and Parslow 1976) were sexed by observing copulations in the pre-laying period. The sex of the members of 60 of the pairs was therefore known. In the 1982 breeding season, the normal male of one such pair (206) was noted to copulate with and share in the incubation of the eggs of two females, his bridled mate from the previous year and the normal female from a neighbouring site (204) whose own mate failed to return that year.

In the pre-laying period the 206 male was frequently observed to move over to the female on site 204 and copulate with her, but was only observed to copulate with the 206 female on a few occasions, even though he spent the majority of his time with her. This situation resulted in agression between the two females as the following observation shows:

> 17 June (0840h, ADT) 206♂ observed to move over to site 204 and copulate with bird there. 206♀ then moved over to site 204 and pecked at 206♂. 206♀ then returns to 206 site as does 206♂. 204♀ then follows 206 pair back to 206 site pecks at 206♀ and returns to site 204.

No other males were observed to associate with either of these females.

Both of the females produced eggs, the 204♀ on 27 June and the 206♀ on 1 or 2 July. The 206♂ was observed to share in incubation of the 206 egg the day after it was laid. The observations indicating he did so for the 204 egg are various. It is likely, but not certain, that he shared in the incubation of the 204 egg prior to the 206♀ laying. Only a single bird was observed at the 204 site during this period, but as the 206♂ and the 204♀ are the same morph it could not be determined if at any time this was the male. However, he was rarely present at the 206 site (as was the 206♀), unusual behaviour for males prior to their mates laying, indicating he could have been involved in incubating the 204 egg. After the 206♀ had laid, she was on one occasion apparently torn between incubating her egg and going

to the bird on the egg at the 204 site strongly suggesting the bird on the 204 egg was her mate. About an hour after this incident the 206 egg was observed on a ledge below the site and the 206♀ absent. Two days later the 206♀ was seen at the 204 site allopreening the bird on that egg and trying to take-over its incubation. The next day the following observation was made:

7 July   (1303h ADT) 206 pair on 206 site and bird on egg at 204. 204♀ bird gestures with head towards 206 pair. 206♂ moves over to 204 bird followed by 206♀. 204 bird rises from egg and both it and 206♂ look at it. All three birds at site 204 for 5-10 sec then 206♀ moves back to 206 site followed by 206♂. 206♂ then moves back and forth between two sites several times in next hour.

On 10 July, a bird suspected of being the 206♀ was seen to be incubating the egg on site 204 and on 11 July she was observed to take over incubation duties from 206♂ who then moved to site 206 where he preened himself. The following day the 206 pair were again at the 204 site but the 204 egg was abandoned under a lip of rock next to the site. Though retrievable it remained there even though the site continued to be occupied by the 206 pair. After 8 July the 204♀ was not observed at the site.

These observations indicate that, though normally monogamous, male Common Guillemots are capable of bigamy. Such deviations have been recorded in other typically monogamous species (e.g. Wheatear *Oenanthe oenanthe,* Brooke 1979). The outcome of the bigamous relationship observed is consistent with expectations that polygamy should lead to reproductive failure in a species where the male is required to share more or less equally in the care of the brood (Wittenberger and Tilson 1980). The failure, however, would not appear to be simply the result of the females abandoning their eggs when the male was unavailable to take over incubation as required. The inability of the 206♀ to accept her mate's presence on the egg on the neighbouring site and agressive interaction between the females would also appear to be involved. The latter is suggested both by the aggressive interactions observed and by the displacement of the 204♀ from her site by the 206♀ after the latter lost her egg and her mate was still sharing in the incubation of the 204 egg. Aggression between females has been sited by Wittenberger and Tilson (1980) as a potential factor acting against polygamy in certain polygnous passerines. Its occurrence in the present case suggests that it may be a general factor acting to discourage polygyny in the Common Guillemot, particularly in situations where unattached females attempt to pair with already paired males.

SUMMARY
A case of a bigamous male observed in the normally monogamous Common Guillemot *Uria aalge* is reported. The male involved attempted to hatch two eggs, one with his mate of the previous year and one with a neighbouring female whose previous mate failed to return. Neither egg was successfully incubated. The circumstances surrounding their loss are described.

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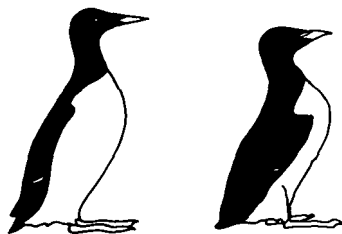
The use of playback recordings to detect and census nocturnal burrowing seabirds

Paul C. James and Hugh A. Robertson

INTRODUCTION

The nocturnal, burrow-nesting seabirds, of which examples are found in the Spheniscidae, Procellariidae, Hydrobatidae, Pelecanoididae and Alcidae are notoriously difficult to census (Cramp *et al.* 1974). Indeed, small colonies may easily be overlooked. Previous attempts to census these species have employed one of three basis techniques: direct burrow counts (Lockley 1930, Van Gessel 1978); direct burrow counts with an estimate of occupancy (Nettleship 1976, Wormell 1976, Harris and Bode 1981, Hunter *et al.* 1982, Warham and Wilson 1982); and mark-release-recapture (Harris 1966, Perrins 1967, Corkhill 1973, Alexander and Perrins 1980).

The main problem in estimating population sizes by direct burrow counts lies in the difficulty of relating the number of burrow entrances to the number of breeding pairs present. Occupancy estimates can be made indirectly, by using characteristics such as flattened soil and vegetation, droppings, feathers and odour at the burrow entrance, or disturbance of barricades at the burrow entrance; or directly by reaching into, or opening, a sample of burrows to record chicks or eggs. Mark-release-recapture involves extensive ringing of near-fledged chicks in burrows, and their subsequent recapture on the surface. By applying the Lincoln Index and knowing breeding success, a calculation of population size can be made. Although some of the methods produce satisfactory results, they can involve unnecessary disturbance to nesting birds and also involve considerable time and effort. We would like to draw attention to a technique, which as well as enabling a census of colonies to be made, gives workers a valuable tool for the rapid detection of breeding birds in small colonies, rock screes, and in multi-species communities.

GENERAL METHODS

The proposed technique involves the use of a playback recording of a species' call in order to elicit reponses from incubating individuals of the same species, therefore enabling counts of breeders to be made within a sample quadrat or from a small colony. The general use of playback recordings as an avian censusing technique has been advocated by Johnson *et al.* (1981), but in their discussion they do not consider nocturnal seabirds. Some workers have used this technique to establish the presence of birds in burrows (Evans 1973, Hunter *et al.* 1982), but this has not been done quantitatively.

The best period for the census is just following the completion of egg-laying. In addition, if the census is conducted during the day, few prospecting immatures will be present in the burrows. At census time it is necessary to know the approximate sex ratio of birds present, and the proportions of each sex that respond vocally to the playback of a particular call. If we call the proportion of males present M, and the proportion of females F, i.e. $M + F = 1$, and if we call the probability that a male, or a female will respond to playback χ, or γ respectively, then the correction factor, C, needed to calculate the number of breeding pairs from the number of responses heard is given by: $C = 1/[M(\chi) + F(\gamma)]$.

The relative values of M and F are not always 0.5:0.5 because, in species where egg-laying is very synchronous, the sex ratio underground may be biased, and if one sex has longer incubation stints this will also tend to distort the sex ratio.

METHODS

In order to evaluate the technique in the field, we carried out a sample census of Manx Shearwaters *Puffinus puffinus* using playback, and compared this with a count of burrows and an estimate of the proportion occupied. The work was carried out on 9 and 10 June 1983 on Skomer Island, Dyfed. Two quadrats (25 × 50 m and 6 × 7 m), had all burows counted in them, and occupancy estimates were derived by opening 20% of the burrows in each. These quadrats were selected to give very different breeding densities. The playback technique was used by playing male calls of the Manx Shearwater within 0.3 m of each burrow entrance for several seconds, using a Sony M-9 microcassette recorder at full volume. The total number of responses was noted for each quadrat. The correction factor was calculated as: $C = 1/[0.55(0.92) + 0.45(0.00)] = 1.98$, where the sex ratio was generated from incubation stints in Brooke (1978a) and the probability of response to a male call from Brooke (1978b). A different correction factor would have to be used if we had used female calls instead, as the frequency of responses is different (Brooke 1978b).

RESULTS

In the larger quadrat (total 153 burrows), 53% were occupied by an incubating adult, leading to an estimate of 81 pairs (= 648 pairs/ha.). In the smaller quadrat (40 burrows) 62% were occupied leading to an estimate of 25 pairs (= 5953 pairs/ha.). The total time required to complete the census for both quadrats was 180 minutes.

Using playback, 35 responses were heard in the larger quadrat and 11 in the smaller. Applying the correction factor (1.98) gave estimates of 69 pairs, and 22 pairs respectively. The total time taken was 35 minutes. The estimates are within 15% of one another, but playback took only 19% of the time.

DISCUSSION

Clearly, the main advantage of the playback technique is its saving of time in producing satisfactory estimates of the population size of burrow-nesting seabirds. Two sources of potential error (besides the estimates used in producing the correction factor, C) should be borne in mind. These are: unattended eggs (either deserted, or briefly left between incubation shifts), and eggs attended by both adults. In our experience neither of these is likely to be numerically significant. Whether the correction factor calculated here will suffice for all Manx Shearwater colonies is not known; however, the probability of Manx Shearwaters responding to playback on Skomer, Skokholm, Rhum and Puffin Island show no obvious quantitative differences, and the sex ratios of incubating birds handled were similar in all places. Amongst seabirds it appears that the incubation stint of the male is generally slightly longer than that of the female and so a figure of $M = 0.55$ may suffice in many cases, although this should be checked in each case.

The role of the playback technique in establishing if breeding is occurring is also very important as this method allows rapid location of occupied nest sites. This is particularly useful if, as often happens, a limited amount of time is available to workers visiting islands. Fowler and Butler (1982) have recently used this method to help to prove breeding in a newly-discovered colony of Leach's Storm Petrel *Oceanodroma leucorhoa*.

The use of this technique for censusing scree- or wall-nesting species, and multi-species communities, is particularly attractive. In these cases it is often impossible to decide what constitutes a nest entrance of the particular study species, and so the usual censusing methods are not applicable. From studies in these situations on Skomer and Great Salvage Island we have found that using the playback technique with the relevant calls overcomes this problem, and enables badly needed counts of these species to be carried out with a considerable saving of time and without disturbance of nesting birds.

SUMMARY

The use of playback recordings to detect and census nocturnal burrowing seabirds is proposed. This technique was tested in two sample quadrats of markedly different densities in a Manx Shearwater colony on Skomer Island, and compared to the result obtained using the traditional burrow counts with occupancy estimates. The estimates were within 15% of one another but the playback technique took only 19% of the time of the other. The potential value of this technique for censusing scree-, wall-nesting, and multi-species communities is emphasised.

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Breeding Skuas in Orkney

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INTRODUCTION

The results of the 1974-5 census of the Scottish breeding populations of Great Skua *Catharacta skua* and Arctic Skua *Stercorarius parasiticus* were reported by Everett (1982). During 1982 a survey was organised in Orkney by the present authors with the intention of updating the 1974 figures and collecting data on Arctic Skua colour phases.

METHODS

Census forms were issued to sixteen observers who were each assigned particular islands or parts of islands. The unit of counting for both species was the 'apparently occupied territory' (Furness 1982). In the case of Arctic Skuas observers were also asked to record, if possible, the colour phases of the birds present in each territory. On the advice of P. O'Donald (pers comm.) the only phase distinction made was between pale birds (with pale cream or white belly feathers) and melanic phase birds (with generally dark belly feathers). No attempt was made to distinguish intermediates. The 1982 survey required observers to record the number of pairs in which the pairings were a) melanic × melanic; b) pale × melanic; and c) pale × pale. As both members of a pair were not always present on site, a complete count of all pairings was not possible, so observers were also asked to give overall counts of the numbers of melanic and pale phase birds in the colony. It was emphasised, however, that the essential information required was the number of apparently occupied territories and that additional information should not be collected at the expense of the basic counts.

Furness (1982) listed the possible sources of counting error arising from the use of the 'apparently occupied territory' as the counting unit. These were: (a) members of a pair, standing apart, may be counted as two single territory holders (and the converse); (b) birds may not be noticed against a similarly coloured background or may be in the air or out of territory; (c) difficulties in sub-dividing large colonies may occur; (d) counts late in the season may be higher than those made earlier because a few young birds seek to establish a territory in the latter part of the season. Overall, Furness considered that the method underestimated Great Skua numbers by about 7% and Arctic Skua numbers by about 4%. Possible margins of error of at least these levels should be borne in mind when interpreting the 1982 results.

HISTORICAL DATA

Arctic Skua

The earliest reference to the Arctic Skua in Orkney appears to be in Low's 'Fauna Orcadensis', written in c. 1770 but not published until 1813. Low never saw a nest but notes that 'it continues here the whole breeding time'. Dunn (1837) states that 'numbers of this bird breed in Orkney . . . .' but adds that it was localised and strictly preserved by local landowners who considered that the species helped protect sheep by driving off eagles! Dunn found the species most numerous on the 'Holm of Eddy' (Calf of Eday). Baikie and Heddle (1848) described it as 'very abundant' during summer and stated that it bred in several parts of the islands.

Buckley and Harvie-Brown (1891) were of the opinion that at the time Hoy was the only

breeding locality of the species in Orkney. They thought that the Calf of Eday was no longer a nesting site and they presented evidence to suggest that although nesting had previously occurred in southern Sanday, it probably no longer did so. Despite quoting Salmon (1832) to the effect that the latter author had seen the species on every island and that 'their principal breeding places were Hoy and Eday', Buckley and Harvie-Brown remained sceptical, stating that they could obtain no information of Arctic Skuas having bred anywhere else than in Hoy, and here only in the parish of North Walls. However, they considered it to be 'abundant' in that parish, with sixty killed in one season to protect grouse stocks and no apparent effect upon the skua population the following year.

Wood (1916) noted that it was not quite correct to say that the only breeding site in Orkney was in North Walls as he had a clutch of eggs taken from the Brakes of Quanterness on Mainland Orkney. Omond (1925) describes it as 'not uncommon and breeding' but that he preferred 'not to mention the exact breeding places . . . . seeing that their eggs are so much desired by collectors'.

Lack (1943) quotes Miss E. V. Baxter to the effect that Papa Westray was probably colonised in 1924-5. In 1941 Lack found 14-18 pairs there as well as a single pair on Westray. He also found at least 60 pairs on the west side of Hoy between the Summer Burn and Melsetter. He could find no sign of breeding on other islands and considered reports of them nesting on Rousay to be unfounded.

By the 1960's Balfour (1968) reported that numbers had increased and the species had spread to more islands. He estimated the population on Hoy as 100-150 pairs in 1961 (although a figure of 200 pairs is given in Bannerman 1968) and noted that the Papa Westray colony had also increased. Other newly colonised islands were Westray, Eday, Sanday, Eynhallow, Gairsay, Wyre and Calf of Eday, while there were also three moorland colonies on Mainland Orkney. Cramp et al. (1974) used Balfour's (1968) data together with other figures of his, quoted in Bannerman (1968), for an estimate of the 1961 Orkney population of 160-220 pairs. Rousay and Stronsay were added to the list of colonised islands by these authors although, for some reason, Calf of Eday was omitted.

In 1969-70 the counts for 'Operation Seafarer' were undertaken. The published figures vary slightly, those from Lea (1976) being used here. A total of 232 pairs were counted with most colonies showing increases and a further 11 islands (North Ronaldsay, Holm of Papa, Faray and its Holm, Shapinsay, Helliar Holm, Holm of Scockness, Egilsay, Auskerry, Flotta, Cava and Fara) newly colonised by one to three pairs. Only Hoy showed a decline with numbers returning to the 1941 population level. However, later authors have cast doubt on the completeness of some 'Seafarer' counts and the Hoy figure may thus be anomalous.

During the 1974 survey of Orkney (Everett 1982) the total population of Arctic Skuas was found to be 717 pairs, 237 pairs of which were on Hoy. Hoy was considered to have been more fully covered than ever before, the apparent three to four-fold increase being chiefly the result of improved coverage, although some expansion had almost certainly also taken place. Westray and Papa Westray hold 93 and 86 pairs respectively, whilst Eday, Sanday, Rousay and Mainland which had previously held small populations, were now important sites with between 32 and 59 pairs each. Flotta's population had increased to 21 pairs and Fara's to 14 pairs while two new islands (not six as stated by Everett (1982)), Switha and Swona, had been colonised by single pairs.

The Orkney Bird reports covering the period 1974-81 are the source of a few subsequent counts of breeding birds on individual islands. The colony on North Hill, Papa Westray increased to 100 pairs in 1976 (Lea 1978) but held 85 and 93 pairs in 1980 and 1981

respectively. The colony on Spur Ness, Sanday held 55 pairs in 1976 (Lea 1978) but was not counted in subsequent years. In 1977 breeding was proved for the first time in the Orphir Hills, Mainland Orkney (where two pairs held territory in 1976) and two pairs nested on Swona (Lea 1978). A survey of the Rousay moorlands in 1981 (Lea 1981) showed an increase there to 91 pairs.

The historical data from 1941-1981 are summarised in Table 1.

TABLE 1. NUMBERS OF ARCTIC SKUAS (PAIRS) BREEDING OR HOLDING TERRITORY IN
ORKNEY, 1941-1982.

Island	1941 (Lack 1943)	1961 (Cramp et al 1974)	1969 (Seafarer)	1974 (Everett 1982)	1982 (present survey)
N. Ronaldsay			1	present	1
Sanday		10+	9	45	25
Papa Westray	18	18+	24	86	95
Holm of Papa			1	2	1
Westray	1	'a few'	64	93	45
Eday		6-8	11	59	101
Calf of Eday		1 +	'present'	7	22
Faray (and Holm)			3	3	1
Stronsay		1-2	7	18	44
Linga Holm					2
Auskerry			1	3	2
Rousay		15-20	11	51	94
Egilsay			1	2	1
Wyre		2-3	3-4	3	3
Holm of Scockness			2	1	1
Eynhallow		1	10	10	19
Gairsay		2-3	3-4	19	38
Sweyn Holm					1
Shapinsay			1	7	Not visited
Helliar Holm			2	1	Not visited
Mainland		2-3	5	32	67
Hoy	60+	100-150 (c. 200?)	68	237	407
South Walls					1
Fara			2	4	28
Cava			2	1	Not visited
Flotta			'present'	21	26
Burray (Hunda)					2
South Ronaldsay					7
Switha				1	Not visited
Swona				1	Not visited
TOTALS	79+	158-269	231-233	717	1034

Great Skua

The Great Skua was first recorded in Hoy in 1908 and birds were also present there in 1914. However, it was not until 1915 that breeding was proved when two pairs were found nesting (Jourdain 1917). In 1918 four pairs bred and this number was maintained until 1921 when it declined to three pairs in 1922 and two pairs in 1923 (Omond 1925). When

Serle visited Hoy in 1933 he found six pairs widely scattered over the island (Serle 1934) and by 1941 there were over 20 pairs (Lack 1943). By 1961 this had increased to over 60 pairs (Balfour 1968). The 'Seafarer' counts in 1969 showed a further increase to 72 pairs, though it is possible that not all the inland areas were covered. Even accounting for the better coverage obtained it was obvious in 1974 that there had been an unprecedented increase, with 462 pairs counted. (Everett 1982).

Elsewhere in Orkney, two to three pairs had bred on Papa Westray for some time prior to 1952 (Balfour 1959) and although there was an increase to six pairs in 1969, only four pairs were recorded in 1974. Breeding first took place on Rousay in 1955 and two pairs were nesting there in 1958, one pair in 1969 and five pairs in 1974. Westray was colonised in 1958 with one pair nesting. Two pairs bred there in 1969 and two pairs were also present in 1974. None was reported on the Mainland in 1969 but nesting was proved on the Birsay Moors (West Mainland) in 1971 and there were five pairs in 1974. A pair was found nesting in East Mainland in 1979. By 1969 single pairs had established themselves in Stronsay, Eday, Gairsay, Auskerry and Fara and the only changes in 1974 were the absence of birds on Fara and an increase to two pairs on Stronsay.

The historical data for 1969 and 1974 are summarised in Table 2.

TABLE 2. NUMBERS OF GREAT SKUAS (PAIRS) BREEDING OR HOLDING TERRITORY IN ORKNEY 1969-1982.

Island	1969 (Seafarer)	1974 (Everett 1982)	1982 (Present Survey)
Papa Westray	6	4	2
Westray	2	2	6
Eday	1	1	6
Calf of Eday	Present	1	4
Stronsay	1	2	8
Auskerry	1	1	1
Rousay	1	5	16
Eynhallow			single bird present
Gairsay	1	1	3
Mainland		5	25
Hoy	72	462	1573
Fara	1		6
Cava	1		Not visited
Flotta		1	
South Ronaldsay			2
TOTALS	87	485	1652

RESULTS OF THE 1982 SURVEY

Arctic Skua

The 1982 survey revealed a continuing increase in breeding numbers, the overall total being 1034 pairs (see Table 1). This represents an increase of 44% since 1974.

Hoy remains the stronghold with 407 pairs (38% of the Orkney total). The main colonies remain in the area detailed by Lack (1943) but the species now also nests quite extensively in the east of the island from Lyness north to Bring Head as well as in the valley of the South Burn. The Hoy figures indicate an increase there of some 72% since 1974 but this may be due in part to even better coverage.

The island of Eday now holds the next largest colony after Hoy. The count of 101 pairs there represents an increase of almost 80% since 1974. Birds are well distributed over all the remaining heathland of the island. The nearby Calf of Eday held a further 22 pairs.

The Papa Westray colony appears to have stabilised in numbers, the count of 95 pairs being close to those made over the previous eight years. All but two of the territories there are on the North Hill RSPB reserve, the skuas nesting in close proximity to over 4000 pairs of Arctic Terns *Sterna paradisaea*.

Rousay now rivals Eday and Papa Westray in skua numbers. The major colony is in the north-west of the island in the Quandale-Brings area, and again, the skuas are nesting adjacent to a very large tern colony. At least 94 pairs held territories in 1982.

Mainland Orkney is the next most important island for Arctic Skuas with 67 pairs. The majority of these are found on the West Mainland moors, especially on the Birsay Moors RSPB reserve. The total count has more than doubled since 1974.

Westray and Stronsay held 45 and 44 pairs respectively but whilst in the case of the latter this represents an increase of 144% since 1974, the Westray colony has declined by almost 52%. The reasons for this decline are not immediately apparent but may be associated with the decrease in the numbers of Arctic Terns on that island. The relationship between the numbers of these two species on Foula, Shetland has been discussed by Furness (1977). Reasons for the decline are clearer on Sanday where a decrease from 45 to 25 pairs has occurred in the same period. This decrease of 44% (or 67% since the 1976 count of 55 pairs) is the result, at least in part, of agricultural reclamation.

Four other islands hold significant numbers of Arctic Skuas and all have growing colonies. 38 pairs were present on Gairsay (increase of 100% since 1974) and 19 pairs on Eynhallow (90% increase). The Scapa Flow islands of Flotta and Fara held 26 and 28 pairs respectively (increases of 24% and 100%).

Five islands were newly colonised since 1974. They were Linga Holm (two pairs), Sweyn Holm (one pair), South Walls (one pair), Hunda (two pairs) and South Ronaldsay (seven pairs). A further seven islands which had previously held small numbers remained at between one and three pairs each.

Five islands were newly colonised since 1974. They were Linga Holm (two pairs), Sweyn not visited in 1982. They were Shapinsay, Helliar Holm, Cava, Switha and Swona. These islands held a total of 11 pairs in 1974 and, even allowing for the 100% increases that have occurred elsewhere in Orkney, the indications are that only about 20 pairs could have been missed as a consequence of these not being surveyed during 1982.

The following islands were checked and found to hold no Arctic Skuas: Holms of Ire, Little Linga, Holm of Huip, Papa Stronsay, Kili Holm, Copinsay and its Holms, Pentland Skerries, Lamb Holm and Glims Holm.

Great Skua

Coverage of this species in 1982 was excellent and the results are shown in Table 2. The only island not visited, (where Great Skuas had previously bred) was Cava. However, none had been present there in 1974 nor in 1980. The total Orkney count of 1652 pairs represents a 242% increase since 1974. Hoy, with 1573 pairs held 96% of the total and, assuming that the coverage was comparable in both 1974 and 1982, this represents a remarkable increase of 340% on this island. Numbers on Mainland Orkney also increased to 25 pairs, the majority of these being on the West Mainland moors but with two pairs in Deerness, East Mainland. Two pairs also nested on the west coast between Stromness and Yesnaby, the first time Great Skuas had been recorded in this area.

Other islands with notable increases were Rousay (16 pairs), Stronsay (8 pairs) and Eday and Fara with six pairs each. Numbers on Papa Westray, however, had declined to two pairs, the same figure as in the early 1950's. On Westray the numbers have only increased to six pairs in 24 years. Nesting was noted for the first time in South Ronaldsay in 1982.

No sign of territorial Great Skuas was found on North Ronaldsay, Sanday, Holms of Ire, Holm of Papa, Faray and its Holm, Linga Holm, Little Linga, Holm of Huip, Papa Stronsay, Egilsay, Wyre, Holm of Scockness, Kili Holm, Sweyn Holm, South Walls, Flotta, Lamb Holm, Glims Holm, Burray, Pentland Skerries or Copinsay and its Holms.

POSSIBLE THREATS TO THE ORKNEY SKUA POPULATIONS

Everett (1982) considered a number of possible threats to breeding Skuas in Scotland. Peat digging and heather burning were considered to be unimportant except on a local scale. This is basically true for Orkney although the extensive hill fires which occur with some regularity (for example on Hoy in 1981) certainly result in the temporary displacement, and, if occurring late in the season, the failure of some pairs. It is rare for Arctic Skuas to be directly persecuted but an unknown number of Great Skuas are regularly shot each year on Hoy, Mainland Orkney and Westray. The numbers involved, however, have, so far, had little effect on the status of this species. Oil pollution, was also

TABLE 3. THE COLOUR PHASES OF ARCTIC SKUAS RECORDED IN ORKNEY, 1982.

Island	Total Nos. of Pale Birds	Total Nos. of Melanic Birds
Sanday	6	44
Papa Westray	45	145
Holm of Papa	0	2
Westray	27	63
Eday	39	125
Calf of Eday	8	28
Faray	1	
Stronsay	23	56
Auskerry	1	3
Rousay	28	126
Egilsay		2
Wyre	3	3
Holm of Scockness	1	1
Eynhallow	13	23
Gairsay	16	54
Sweyn Holm		2
Mainland	39	93
Hoy	179	549
South Walls	1	1
Fara	7	41
Flotta	12	42
Burray (Hunda)	3	2
South Ronaldsay	3	11
TOTALS	455	1416

% Pale = 24.3%
% Melanic = 75.7%

considered unimportant by Everett, since skuas only rarely fall victim to oiling. This is supported also by the findings of the Orkney Beached Bird Survey; only twelve Arctic Skuas were found dead on Orkney beaches between March 1978 and February 1983 and none was oiled while of 36 Great Skua corpses found during the same period, only one showed signs of oiling. Everett considered human disturbance (e.g. by bird-watchers and photographers) the only threat facing skuas, but at present this does not appear to be an important factor in Orkney.

However, one threat not considered by Everett does appear to be of importance in the Orkney context and that is agricultural reclamation. As well as being limited by food resources, birds must also be ultimately limited by the availability of breeding habitat. Skuas prefer areas of moorland and maritime heath and such habitat is continually being lost to reclamation. Although not yet a controlling factor in the islands it is possible that individual islands may lose their skua populations as this process of 'improvement' continues. The Sanday population is already at risk; parts of the Eday moorland are threatened and only one area of Stronsay remains untouched by the plough. Orkney's skuas continue to increase but, in the long term, it is to the availability of breeding habitat, as well as to food supply that we may have to look for the controlling factor in their populations.

TABLE 4. COLOUR PHASES OF 858 PAIRINGS OF ARCTIC SKUAS RECORDED IN ORKNEY, 1982.

Island	Pairings		
	Melanic × Melanic	*Melanic × Pale*	*Pale × Pale*
Sanday	19	6	
Papa Westray	56	31	8
Holm of Papa	1		
Westray	22	19	4
Eday	45	35	2
Calf of Eday	11	6	1
Stronsay	21	8	6
Auskerry	1	1	
Rousay	50	22	6
Egilsay	1		
Wyre		3	
Holm of Scockness		1	
Eynhallow	6	11	1
Gairsay	20	12	2
Sweyn Holm	1		
Mainland	28	27	6
Hoy	190	106	20
South Walls		1	
Fara	17	3	
Flotta	7	6	
Burray (Hunda)			1
South Ronaldsay	5	1	1
TOTALS	501 (58.4%)	299 (34.8%)	58 (6.8%)

COLOUR PHASES AND PAIRINGS AMONG ARCTIC SKUAS

As noted above, Arctic Skuas were categorised as being either pale or melanic on the basis of the colouration of the belly feathering. Intermediates were assigned to one or other of the two categories on this basis.

The colour phases of 1869 birds were recorded during the 1982 survey (see Table 3). Of these 75.7% were melanic and 24.3% were pale. This compares with 26.5% pale in Shetland (n = 1006) and 21.1% on Fair Isle (n = 1000) during the period 1943-1979 (O'Donald, pers comm). Of 514 birds on Foula in 1975, 27% were pale (Furness, pers comm). The colour phases of both members of 858 pairings were recorded in 1982 (see Table 4). Of these, 501 (58.4%) were of melanic × melanic birds, 299 (34.8%) were of melanic × pale birds and 58 (6.8%) were of pale × pale.

A tendency towards assortative mating in which like phenotypes pair has been demonstrated in some populations (O'Donald 1959; Berry and Davis 1970; Southern 1943). Dis-assortative mating in which more unlike than like matings occur than expected if mating were a random process, has also been demonstrated (Bengtson and Owen, 1973). In yet other populations, matings between the two phenotypes do not appear to depart from random (Götmark, Andersson and Hildén, 1981; Bengtson and Owen 1973; Hildén 1971). The extent to which the 1982 Orkney data illustrate assortative mating is discussed by Dr. P. O'Donald in the Appendix where a comparison is also made with data from Shetland.

SUMMARY

A 1982 survey of breeding skuas in Orkney produced totals of 1034 pairs of Arctic and 1625 pairs of Great Skuas. These figures represent increases of 44% and 242% for the two species, respectively, since the survey of 1974.

Historical data are provided, tracing the growth of the populations of the two species in Orkney. In addition, possible future threats such as agricultural reclamation are briefly discussed.

Of 1869 Arctic Skuas whose colour phase was recorded, 75.7% were melanic and 24.3% were pale. Of 858 pairings where the colour phase of both birds was known 58.4% were melanic × melanic, 34.8% were melanic × pale and 6.8% were pale × pale. Analysis of the pairings provides evidence for assortative mating.

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APPENDIX

Assortative mating in Arctic Skua populations in Orkney and Shetland

Peter O'Donald

Melanic Arctic Skuas mate preferentially in Shetland. Females appear to prefer to mate with melanic males. Several lines of evidence support this statement (O'Donald 1976, 1980a, 1983). The melanic males are quicker to find a mate than the pale males. Previous breeding experience, or lack of it, has no effect on the melanic males' greater chances of finding a mate. In Shetland, the phenotypes mate assortatively: melanics mate with melanics and pales with pales more often than at random. This assortative mating is in itself evidence for female choice. Male competition would only produce assortment in the matings if males competed more fiercely for females with the same phenotype. This is most implausible. But if females have evolved a preference to mate with a particular male phenotype, theoretical calculations show that the preference should become genetically correlated with the preferred phenotype (O'Donald 1980b). Females who themselves possess the preferred phenotype will also tend to be those who express the preference. As preferential mating evolves, so does assortative mating.

It is easy to test the significance of departures from random mating. If melanic (M) and pale (P) phenotypes occur at frequencies u and 1-u, we expect purely random matings to occur at frequencies:

$$M \times M \quad u^2$$

$$M \times P \quad 2u(1-u)$$

$$P \times P \quad (1-u)^2$$

If a, b and c are the numbers of these matings observed in a sample of n (n = a + b + c) then we can estimate

$$\hat{u} = (a + \tfrac{1}{2}b)/n,$$

find the expected numbers of matings in each class, and calculate χ^2 for one degree of freedom (the sample size n, and estimate $\hat{u}$ remove two of the degrees of freedom in the three classes of matings).

Unfortunately, this is a very insensitive test of assortative matings. Even if 20% of matings of melanics with melanics had really been assortative a significant result would not have been obtained in a sample as large as that from Orkney. A further problem arises if several samples have been obtained, some giving significant, others non-significant results. Does this mean that the assortative mating differs between the sample or not? How can any such differences be tested?

To find out what may be happening in a series of samples, it is necessary to fit a model of assortative mating. The components of χ^2, corresponding to each parameter of the model and its variation between samples, can then be independently calculated (see Appendix C of O'Donald 1983 for statistical methods). In the simplest model, a proportion α of the melanic females prefer to mate only with melanic males. Since a proportion α u of the population are malanic, αu of melanic males and females mate assortatively; u (1-α) are left to mate randomly. The random matings form a proportion 1-αu of all matings. Among these random matings, melanics and pales mate with probabilities u(1-α)/(1-αu). Hence, conditional on random mating, matings have probabilities.

$$M \times M \quad u^2(1-\alpha)^2/(1-\alpha u)^2$$

$$M \times P \quad 2u(1-u)\,(1-\alpha)/(1-\alpha u)^2$$

$$P \times P \quad (1-u)^2/(1-\alpha u)^2$$

These matings represent a proportion 1-αu of all matings. The overall probabilities of matings are therefore.

$$M \times M \quad \alpha u + u^2(1-\alpha)^2/(1-\alpha u)$$

$$M \times P \quad 2u\,(1-u)\,(1-\alpha)/(1-\alpha u)$$

$$P \times P \quad (1-u)^2/(1-\alpha u)$$

Given a sample in which, as before, the following numbers of matings have been counted,

$$M \times M \quad a$$

$$M \times P \quad b$$

$$P \times P \quad c,$$

then the two parameters of the model, α and u, are estimated by the equations

$$\hat{\alpha} = \frac{ac - \tfrac{1}{4}b^2}{c(a + \tfrac{1}{2}b)}$$

$$\hat{u} = (a + \tfrac{1}{2}b)/n$$

TABLE 5. ASSORTATIVE MATING OF ARCTIC SKUAS IN ORKNEY AND SHETLAND.

Areas sampled		Orkney	Fair Isle[a]	Foula[b]	Shetland[c]	Totals
Matings	M × M	501	254	144	218	1117
	M × P	299	119	86	120	624
	P × P	58	19	26	38	141
	Totals	858	392	256	376	1882
Estimates	$\hat{\alpha}$	0.1778	0.2159	0.3898	0.4434	0.2985
	$\hat{u}$	0.7582	0.7997	0.7305	0.7394	0.7593
Value of χ_1^2		2.1189	1.0700	5.5218	11.1142	19.8249
correlation	r	0.04969	0.05225	0.1469	0.1719	
transformation	z	0.04974	0.05229	0.1479	0.1737	$\bar{z} = 0.08828$

[a] Data from O'Donald (1980a)

[b] Data from Davis and O'Donald (1976)

[c] Data from O'Donald (1960)

In this table r is the correlation coefficient of phenotypes of mated pairs.
z is the transformation.
$$z = \tanh^{-1}(r)$$
which has a Normal distribution approximately with variance

Var $(z) = 1/(n-3)$. $\bar{z}$ is the weighted mean of the values of z. This gives the χ^2 test of the significance of variation in z between samples:

$\chi_3^2 = \Sigma \ (z-\bar{z})^2/$var (z)

$\qquad = 5.3947$

P $\quad = 0.145$ (not significant)

where $n = a + b + c$ (see O'Donald 1983). These estimates are maximum likelihood estimates: they are the values that maximize the likelihood of the model; they also have the smallest statistical error.

We can now analyse the data of matings counted in Orkney in 1982 in conjunction with data of samples from Fair Isle, Foula and the rest of Shetland.

We ask: Are matings assortative? Is the assortative mating consistent in the different areas? Do the frequencies of the phenotypes vary from one area to another? Table 5 gives the data, the estimates of parameters and the χ^2 tests of simple random mating. It also gives the correlation between the phenotypes of mating pairs. This correlation is another way of estimating the assortative mating: the greater the correlation, the closer the assortment of M with M and P with P. Fisher's z transformation of the correlation r can be used to test the significance of differences in r between samples. This test (see table 5) shows that the differences are not significant. It is interesting that the values of χ^2 for the simple test of random mating should vary so widely: not significant for Orkney and Fair Isle; highly significant for Shetland. The non-significant values of χ^2 can be seen to correspond to quite appreciable estimates of mating preference (22% for Fair Isle). Much larger samples would have to be collected to get a significant result when the mating preference is only about 20%. This insensitivity of the χ^2 test is partly caused by the high frequency of the melanics in these populations. A large proportion of the random matings will be M × M. The additional assortative matings do not add much to the numbers of these matings. The χ^2 test will not detect the relatively small deviation from random

mating unless the sample is very large. By fitting an explicit model, samples can be combined, overall estimates obtained and the significance of variation between samples tested.

The general hypothesis states that Arctic Skuas mate with probabilities given by the model of mixed assortative and random mating with α and u as constant parameters. Having obtained samples of mating pairs with these hypothetical probabilities we first test the specific hypothesis that $\alpha = 0$ (no assortative mating); then, using the best overall estimates of α and u, we test the hypotheses that α and u are the same for all samples. This procedure leads to an analysis of the total χ^2 derived from the general null hypothesis (see Appendix C in O'Donald, 1983 for full details of the methods of obtaining this analysis). Table 6 shows the complete analysis of χ^2 obtained by this method.

TABLE 6. ANALYSIS OF χ^2 OF ASSORTATIVE MATING OF ARCTIC SKUAS IN ORKNEY AND SHETLAND.

Component of variation	Value of χ^2	Dfs	Value of P
Assortative mating	19.1249	1	1.22×10^{-5}
Variation in melanic frequency			
Between Orkney and Fair Isle	5.0922	1	0.0240
Between 'South' and 'North'*	5.7696	1	0.0163
Between Foula and rest of Shetland	0.1318	1	0.717
Variation in assortative mating	3.6187	3	0.306
Total variation	33.7372	7	1.93×10^{-5}

* 'South' refers to Orkney and Fair Isle combined.

   'North' refers to Foula and the rest of Shetland combined.

Note   The degrees of freedom, 'Dfs', are calculated as follows. There are 12 classes: three types of mating sampled from four different areas. To calculate the number of matings to be expected in each class on the assumption of the null hypothesis $\alpha = 0$, the four sample totals are required, removing four degrees of freedom; the estimate $\hat{u} = 0.7593$ removes one more degree of freedom, leaving seven as shown. After fitting the model of assortative mating, the estimate $\alpha = 0.2985$ removes another degree of freedom, leaving six, three for the variation in u between samples and three for the variation in α. The three degrees of freedom for the variation in u have then been analysed into individual components. This analysis produces a value of χ^2 for the test of variation in α that is somewhat different from the test using Fisher's z transformation (see table 5). Neither value is significant. The difference arises because essentially different models of assortative mating are being tested.

The assortative mating is highly significant: the null hypothesis $\alpha = 0$ is completely rejected ($P = 1.22 \times 10^{-5}$). There is significant variation in the frequency of melanics: Fair Isle has a slightly higher frequency of melanics than Orkney ($P = 0.0240$); Foula and the rest of Shetland has a significantly lower frequency than Orkney and Fair Isle ($P = 0.0163$). This decline in melanic frequency is part of the cline of increasing frequency of pales towards the north. There may also be a cline in assortative mating: the mating preference steadily increases from south to north (see table 5); if so, this is by no means significant ($P = 0.306$).

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Distribution and feeding habits of the Great Skua *Catharacta skua* in the North Sea

Mark L. Tasker, Peter Hope Jones, Barry F. Blake and Tim J. Dixon

In response to concern for the potential environmental impact of the North Sea oil industry, the Nature Conservancy Council has recently carried out a wide ranging survey of the distribution and behaviour of seabirds at sea in the North Sea. This paper is an analysis of all records of Great Skuas *Catharacta skua* from this project, made between 1979 and 1982.

METHODS

Observations were made from a large variety of non-fishing ships and oil production platforms in the North Sea. The methods used in counting Great Skuas from ships involved recording the number of birds seen per ten minutes in the 180° arc ahead of the ship. This count was later converted, using the ship's speed, to the number of birds seen per 100 linear kilometres. Counts were made throughout each year of the survey. Data for all years have been analysed together using 15'N × 30'E/W (c782 km²) rectangles as units. Records were made of seabird behaviour including any association with other species or with ships.

At platforms, the number of birds within 500m of the structure (and which were apparently not moving past the platform), were counted at intervals throughout the observer's visit. The maximum numbers of birds seen at any one count during one day were averaged by month to produce a mean maximum abundance for each month. This procedure minimised confusion from birds moving between nearby platforms and hence distorting patterns of occurrence. The results from two oil fields, Auk and Argyll, were treated together due to their relatively close proximity (50 km). Records from the following four oil fields are presented: Brent (61°05'N 01°42'E), Beryl (59°33'N 01°32'E), Auk (56°24'N 02°02'E) and Argyll (56°10'N 02°47'E). Visits to these platforms were made throughout the year and data for all years were analysed together. At least five days data for each month/platform were collected. Full descriptions of the methods used in counting seabirds from ships and platforms are described elsewhere (Blake *et al.* 1984; Tasker *et al.* 1984).

RESULTS

(a)   *Records from ships*

The first Great Skua of the year recorded by this study was in the English Channel in early March, and birds were first seen near the breeding colonies in Shetland and Orkney by the end of the month. The species was observed on most days in the North Sea until mid-November, with the majority of these sightings being in the vicinity of Shetland and Orkney. Three zones were used in the analysis of the records collected at sea: (i) the breeding area — all rectangles containing part of Orkney or Shetland; (ii) peripheral breeding zone — any rectangle adjacent to the breeding area; (iii) the remainder of the North Sea.
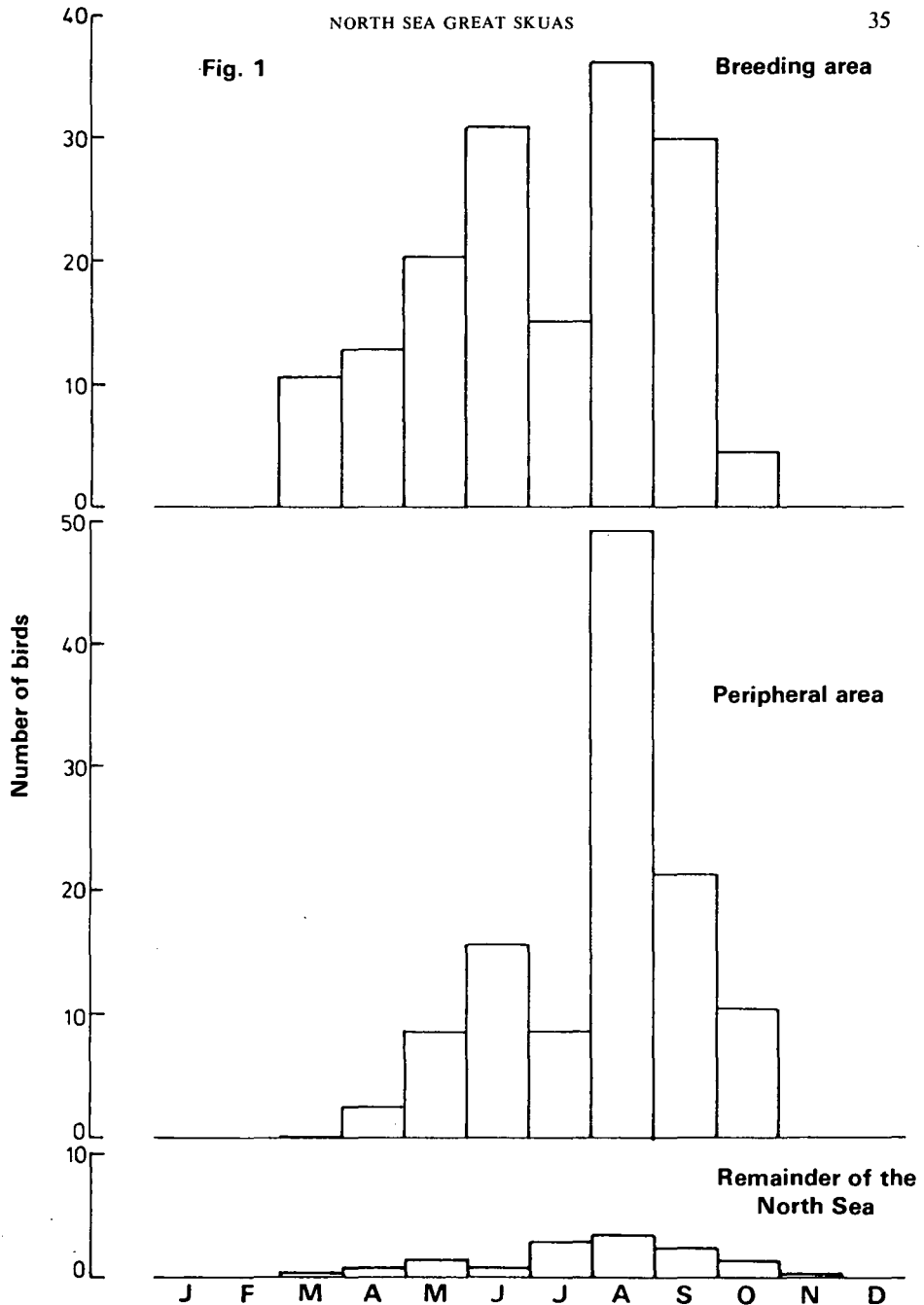
Figure 1. Average numbers of Great Skuas seen per 100 km. travelled in three areas of the North Sea (see text for area limits).

TABLE 1. PERCENTAGE OF SQUARES EXAMINED IN WHICH GREAT SKUAS WERE SEEN, FOR FOUR LATITUDE BANDS, IN THE NON-BREEDING AREA OF THE NORTH SEA, WEST OF 3° EAST. (FIGURES IN BRACKETS = NUMBER OF SQUARES EXAMINED).

						Month				
Latitude	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.-Feb.*
51°-54°	6 (19)	11 (19)	5 (39)	4 (50)	38 (51)	12 (18)	12 (16)	42 (24)	5 (18)	0 (16)
55°-56°	5 (20)	0 (16)	12 (41)	0 (15)	43 (58)	40 (37)	36 (22)	20 (31)	4 (26)	0 (31)
57°-58°	0 (35)	4 (26)	30 (35)	11 (49)	48 (37)	57 (46)	43 (31)	- (5)	7 (30)	0 (55)
59°-62°	3 (58)	4 (55)	54 (48)	27 (70)	39 (67)	62 (61)	57 (59)	18 (20)	0 (29)	0 (46)

At least one hour's observation was carried out in 90% of squares.

Mean numbers of birds seen per month per 100 km. travelled in each of these three zones is shown in Figure 1. Table 1 shows percentage of rectangles, in four latitude bands in the non-breeding area (iii), in which Great Skuas were seen, for each month. Figures 2-5 show the distribution patterns for groups of months when Great Skuas were found in the North Sea. The months grouped were those where the distribution of skuas were similar.

The two zones around the breeding area showed similar patterns of numbers, with two peaks in abundance, the first in June and the second in August. These peaks were very similar in size for the inner breeding zone, but the second peak was much larger in the peripheral breeding zone. For the remainder of the North Sea, numbers were very much lower than in the zones close to the breeding colonies, and showed relatively small changes in mean numbers seen. Before June, the vast majority of records were from the breeding areas or adjacent North Sea areas, whereas in July, birds occurred throughout the western half of the North Sea. In September, numbers started to decline in all areas and the breeding area was deserted during October, with a decline also occurring in the rest of the North Sea; very few birds were seen in November.

(b)   *Records from oil production platforms*

This species was only recorded between April and October. Figure 6 shows the mean

TABLE 2. ANALYSIS OF OCCASIONS WHEN GREAT SKUAS WERE SEEN ASSOCIATING WITH OTHER SEABIRD SPECIES. (FIGURES ARE TOTAL NUMBERS OF GREAT SKUAS INVOLVED IN AN ACTIVITY; PERCENTAGES ARE OF GREAT SKUAS INVOLVED IN AN ACTIVITY DIVIDED BY MONTH.)

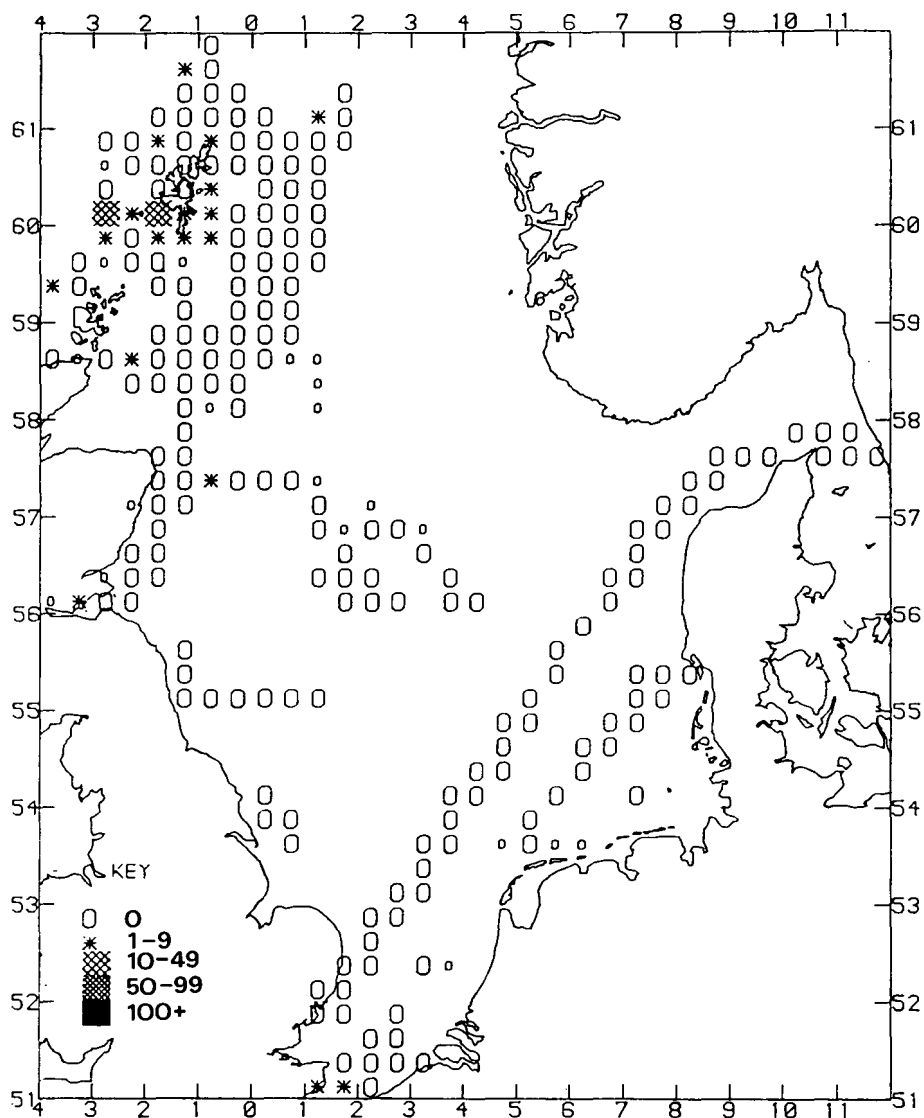|		*Month*		
Group type	*May*	*June*	*July*	*August*
Multi-species feeding assemblage	3 (8%)	32 (55%)	16 (70%)	15 (14%)
Fishing vessel associated	29 (76%)	6 (10%)	5 (22%)	70 (66%)
Klepto-parasitism				
Gannet	4 (13%)	12 (21%)	0	9 (8%)
Kittiwake	1 (3%)	4 (7%)	1 (4%)	0
Eating dead bird	0	0	0	6 (5%)
Other	0	4 (7%)	1 (4%)	8 (7%)

Fig. 2

Figure 2. Average numbers of Great Skuas seen per 100 km. travelled in the North Sea, March and April (total 4817 and 5238 km. travelled respectively). Small symbols on Figures 2-5 under 6 km. surveyed in square.
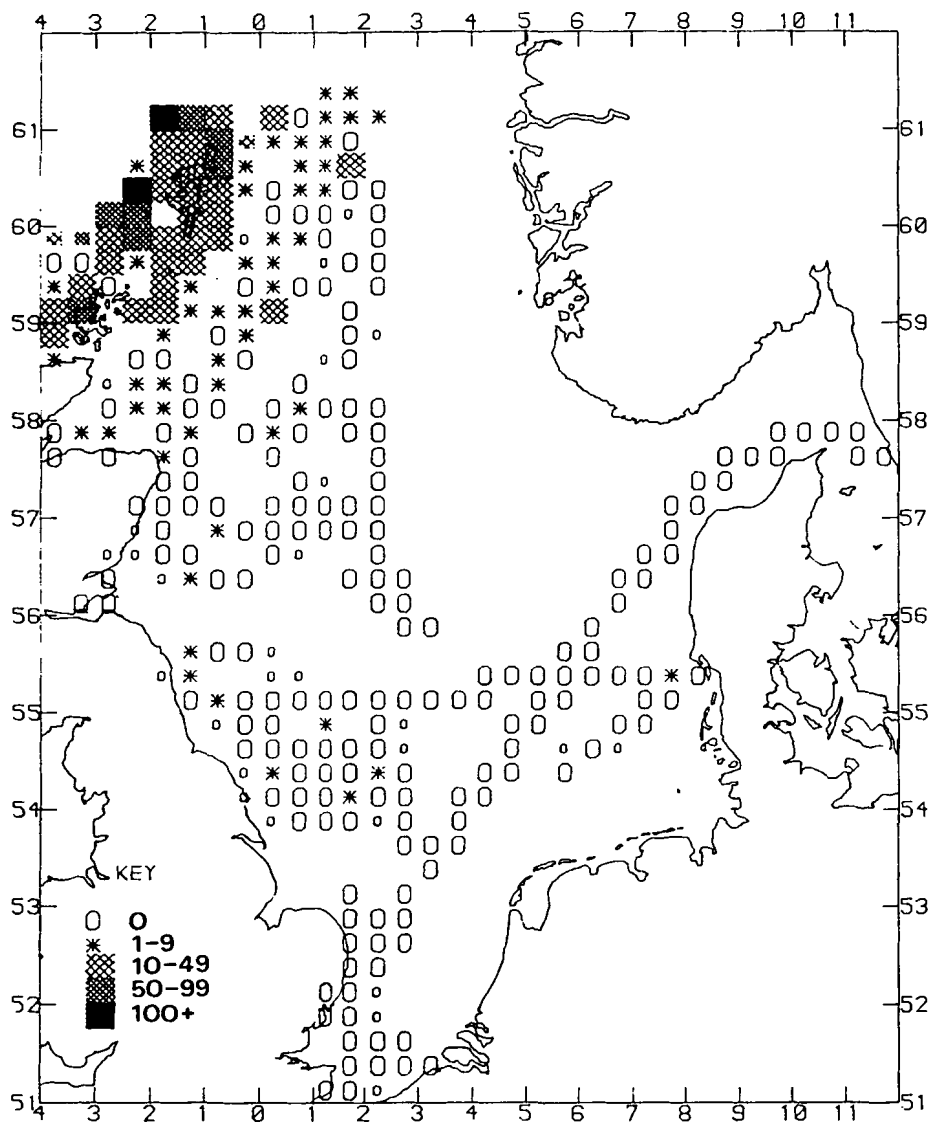
Fig. 3.

Figure 3. Average numbers of Great Skuas seen per 100 km. travelled in the North Sea, May and June
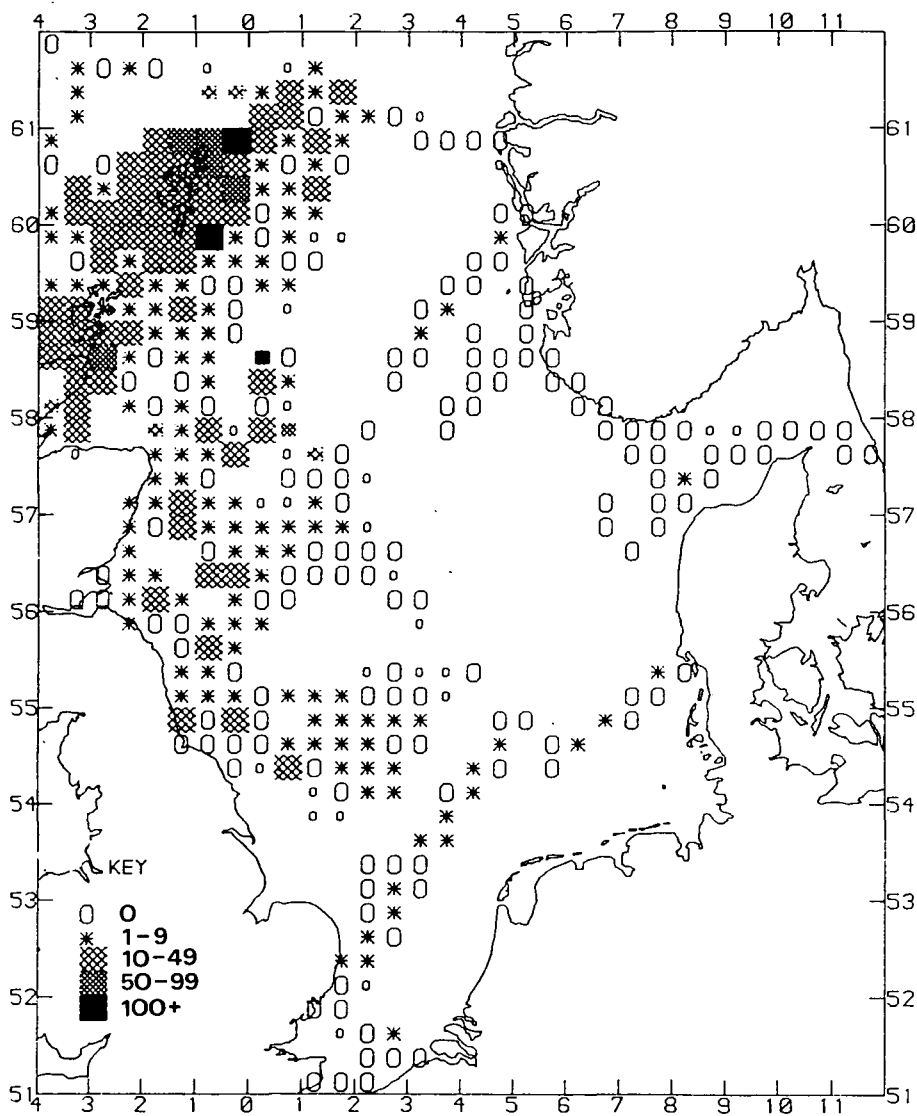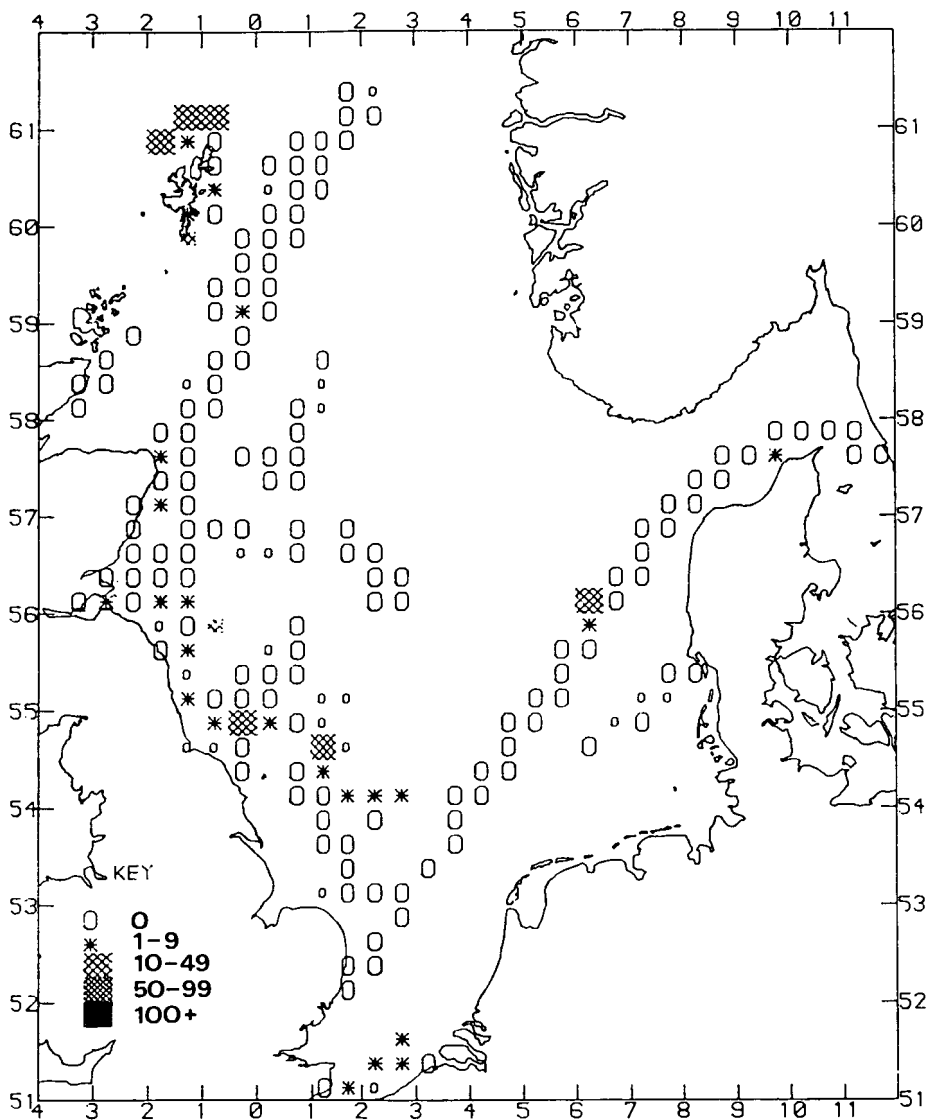(total 8731 and 6241 km. travelled respectively).

Fig. 4

Figure 4. Average numbers of Great Skuas seen per 100 km. travelled in the North Sea, July, August and September (total 7699, 7695 and 5090 km. travelled respectively).

Fig. 5

Figure 5. Average numbers of Great Skuas seen per 100 km. travelled in the North Sea, October and November (total 2695 and 2268 km. travelled respectively).

maximum daily abundance of Great Skuas at the three sample sites analysed. Patterns of attendance varied between the sites. The Brent field showed a similar pattern of occurrence to that of numbers recorded in the peripheral breeding zone (Figure 1), with peaks in June and August. However, numbers recorded at Beryl rose to a peak in July and then declined steadily, whilst around Auk and Argyll fields, birds were only seen in August and September.

(c) *Association with other species*

An analysis of associations of Great Skuas with other species is presented in Table 2. Since associations normally only occurred when Great Skuas were feeding, the groups are classified by feeding activities. The analysis is only for the Orkney/Shetland waters in order to allow comparison with Furness and Hislop (1981). Few groups occurred outside this area, or outside the months of May to August. There was an apparent change from feeding around fishing vessels in May to feeding in multi-species assemblages in June and July, returning to trawler association in August. There were only four records of individual skuas feeding on their own. Analysis of the occurrences of more than two Great Skuas on the water in a single-species group, showed no records until August, when one group of twelve, one group of five and two groups of four were observed. If these figures are included as "feeding assemblages" in Table 2, the proportion of birds in feeding assemblages rises to 30%, while those around fishing vessels falls to 52%.

TABLE 3. OBSERVED VICTIMS OF KLEPTOPARASITIC ATTACKS BY GREAT SKUAS (ENTIRE NORTH SEA)

Species	*Number of attacks*
Gannet *(Sula bassana)*	30
Kittiwake *(Rissa tridactyla)*	16
Lesser Black-backed Gull *(Larus fuscus)*	2
Great Black-backed Gull *(Larus marinus)*	1
Sooty Shearwater *(Puffinus griseus)*	1
Manx Shearwater *(Puffinus puffinus)*	1

The obvious inherent difficulty in comparing feeding methods is the different durations of each incident; it will take less time to stage a kleptoparasitic attack on a Kittiwake *Rissa tridactyla* than it will to approach a trawler, pick up food and move away again. The likelihood of observation is therefore different for each type of feeding behaviour, although it may be assumed that the duration of a particular feeding activity will not change appreciably from month to month, making comparisons valid.

Kleptoparasitic attacks were seen most frequently in June. A list of bird species attacked and the observed frequencies of these attacks are given in Table 3. These figures will probably be biased by conspicuousness and duration of each chase. For example, Gannets *Sula bassana* are very obvious and chases of this species are likely to last longer than for other species.

DISCUSSION

There have been relatively few studies of Great Skua distribution in the North Sea. Joiris (1978) found them to be present in only the northern half of the North Sea in July. In February 1978, none was seen (Joiris 1983). Observations at Helgoland showed very few records from January to March, none in the early summer, then a build up from July to a peak in October, with only one being seen in November (Kuschert 1981). This pattern was
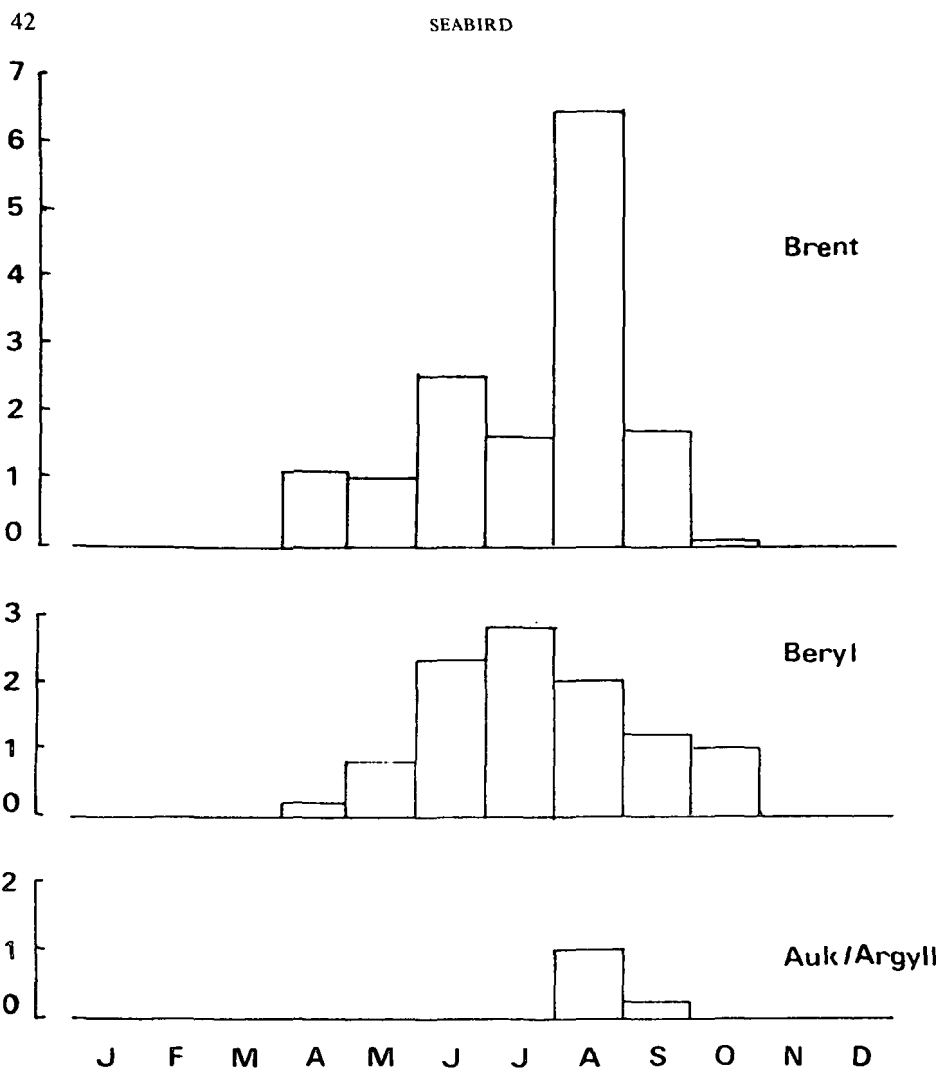
Figure 6. Mean maximum daily abundance of Great Skuas at three oil platform sites in the North Sea.

also found in observations made off West Denmark (Meltofte 1979). Between 1900 and 1978, only 42 birds were seen from Helgoland indicating the rarity of the species in the south-east of the North Sea.

Using the life table in Furness (1977), it has been calculated that at any one time in the entire Great Skua population there will be around 1735 non-breeders to every 1000 breeders (Furness pers. comm.). This high figure is due both to the longer immaturity of the Great Skua, which on average breeds first in its eighth year, and to the current

expansion rate of the population. Bearing in mind that most individuals in their first year do not return to their home waters (Furness 1978), it is likely that 55% of the birds present in northern latitudes are non-breeders.

Ringing recoveries show that immature birds return to the breeding areas later than breeding adults (Furness 1978). Counts of club sites within colonies (these birds are probably immature) have shown an increase in numbers during June to a peak in July, followed by a rapid decline in August.

Most of the Great Skuas seen between March and May in the North Sea will be breeding birds since very few ringed immature birds have been recovered before June. Birds seen outside their breeding areas at this time are probably moving between their southern wintering areas and breeding grounds. In June numbers at sea reach a peak around the colonies, possibly reflecting the return of immature birds to breeding areas. The decline in numbers at sea during July may be the result of a large influx of these younger birds into the club sites within the colonies. This movement presumably more than compensates for the increased amount of time that adults have to spend at sea foraging for food for their newly hatched young (Furness and Hislop 1981).

The departure of the immatures from club sites in August, together with fledging of young and adults leaving their territories, probably accounts for the peaks in numbers seen at this time of the year in virtually all areas and platforms. The decline in numbers in the North Sea during September was presumably associated with the birds moving south.

Although seabirds must spend much of their time at sea either feeding or actively searching for food, Great Skuas were rarely observed feeding offshore; most birds recorded were either flying or sitting on the water. Great Skuas feed using a variety of methods, the most notable of these is the kleptoparasitism of other seabirds, particularly the Gannet. They are also known to kill and eat seabirds (e.g. McKenzie 1981), and have recently been observed feeding on refuse tips in Shetland (Furness *et al*. 1981). Furness and Hislop (1981) examined the diet and feeding ecology of Great Skuas at colonies in Shetland during the breeding season. They found that birds preferred different foods, which varied according to the stage of the breeding season, and to the age of the bird. The population as a whole appeared to prefer discarded whitefish (normally gadoids) from trawlers early and late in the breeding season while preferring sandeels (*Ammodytes* sp.), caught at the surface by birds in multi-species feeding flocks, during June and early July (this pattern varied slightly from year to year). These findings would correspond well with the observed feeding behaviour at sea, if multi-species feeding assemblages are assumed to be related to irregularly occurring, large surface swarms of sandeels (Furness and Hislop 1981). It is unknown why this seasonal change in diet occurs but it may be related to a change in availability of sandeel during late July and August.

SUMMARY

The distribution and occurrence of the Great Skua in the North Sea is described using records made from ships and oil production platforms. The species was a summer migrant to the area and no birds

were recorded between mid-November and late March. Most sightings were made in the vicinity of breeding colonies in Shetland and Orkney. The large immature component of the population probably caused the large influx to other areas of the North Sea. These young birds probably also accounted for seasonal changes in numbers at sea near breeding sites. Observations made on feeding behaviour agree with previous studies of Great Skua diet during the breeding season, and indicate that birds may be feeding mainly on sandeels in June and July, but discarded whitefish at other times.

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Great Black-backed Gull *Larus marinus* predation of seabird chicks on three Scottish Islands

K. Taylor

"Nothing comes amiss to it . . . it is omniverous" (Lowe 1913) is a good general description of the feeding habits of the Great Black-backed Gull *Larus marinus*. Although this species eats a wide range of foods, it tends to concentrate on certain types of food, such as fish or seabirds, at different breeding localities. Tuck and Heinzel (1978) suggested that predation on young seabirds such as Guillemot *Uria aalge* and Razorbill *Alca torda* chicks could deplete future breeding stocks of these species at some sites. Conversely, data in Hudson (1982) indicate that Great Black-backed Gull predation of young and adult seabirds on Great Saltee Island was not detrimental to breeding stocks of prey species at this site. There are few other published data to indicate the full extent of such predation at specific colonies, or to suggest factors which influence the severity of Great Black-backed Gull predation on chicks of a given species.

This paper documents the timing and extent of Great Black-backed Gull predation on young seabirds at three Scottish colonies and relates this predation to the local and seasonal abundance of seabird chicks.

STUDY SITES

Dún (57° 48′N, 8° 34′W) (32ha) and Boreray (57° 53′N,8° 29′W) (77ha) are part of the St Kilda group of the Outer Hebrides. Data on the seabird populations of Dún and Boreray are given by Harris and Murray (1978) and Duncan et al. (1982). Forty pairs of Great Black-backed Gulls nested on Dún in 1977 and 36 pairs in 1978. At least 27 pairs of Great Black-backed Gulls had chicks near fledging age during my visit to Boreray in July 1980.

Sule Skerry (59° 05′N,4° 20′W) (14ha) is a small outlying Orkney island. Data on the island's seabirds are given by Blackburn and Budworth (1976 and in litt.). Thirteen pairs of Great Black-backed Gulls had chicks near fledging age during my visit to the island in July 1982.

METHODS

Great Black-backed Gulls at the study colonies habitually used sites near their nests as processing areas for captured avian prey. These sites are referred to here as 'middens'. Most middens were near a freshwater pool. Behavioural observations on Dún indicated that corpses of avian prey were usually left at middens, with meat picked from carcasses being fed to chicks by regurgitation at the nest (Taylor 1982).

Prey remains at middens and in pellets near nests on Dún were itemised about every seven to ten days between 15 May and 5 August 1977 and between 8 June and 9 July 1978. Remains were collected on Boreray between 8-25 July 1980 and on Sule Skerry 19-29 July 1982. The Mullach an Eilein region of Boreray was not searched due to dangerous terrain (four to five pairs of Great Black-backed Gulls bred there in 1980); but all other parts of the study sites were systematically searched for corpses. Observations on Dún covered the entire fledging periods of Guillemot and Razorbill, and the early part of the fledging periods of all other diurnal seabirds nesting on the island with the exception of Fulmar *Fulmarus glacialis*.

Parts of corpses were counted as the smallest number of complete corpses that could be assembled from all the parts found. For example, where remains consisted of pellets with feet, the corpse tally for a given species was calculated by counting the number of feet and dividing by two. Guillemot and Razorbill feet were differentiated on the basis of leg colour, tarsus width, tarsus length and thickness of the knee joint. Wing length measurements of samples of Shag *Phalacrocorax aristotelis,* Kittiwake *Rissa tridactyla* and Atlantic Puffin *Fratercula arctica* chick corpses were taken on Sule Skerry but not at the other sites.

The severity of gull predation on Razorbill and Puffin fledglings on Dún was calculated using published Puffin population and productivity figures in Harris and Murray (1978) and Harris (1980), and Razorbill productivity estimates based on data in Lloyd (1979). Such calculation was not possible for other species and sites because of inadequate population data and/or because field observations finished well before the cessation of fledging. Great Black-backed Gulls on Dún catch adult Puffins in hunting ranges near their middens (Taylor 1982), so estimates of the severity of predation assumed that chicks found at a midden had been killed nearby.

Throughout this paper the word "fledging" is used in the sense of "a chick leaving the nest site for the sea". Means are given ± one standard error.

RESULTS

SPECIES KILLED AND TIMING OF PREDATION

The numbers of chicks of different seabird species found in Great Black-backed Gull kills are given in Table 1. Only chicks of the commonest diurnal seabirds breeding at the study sites were killed. On Dún (the only study site for which complete counts of all diurnal seabirds are available) there was a positive correlation between the abundance of different species of seabird chicks in Great Black-backed Gull kills and the breeding abundance of these species on the island ($r_s = 0.718$ (tie-corrected), P<0.05, 1-t, N = 10). Observations on Dún spanned the incubation, nestling and fledging periods of Great Black-backed Gulls breeding there in 1977, and parts of the incubation and fledging periods in 1978. Predation on seabird chicks only occurred during Great Black-backed Gull nestling and fledging periods, with peak predation during the nestling period in 1977. Chicks comprised an increasingly higher percentage of the biomass of avian prey found at middens during the nestling period in 1977, reaching a peak in late July when they formed over 40 percent of the total biomass of avian prey (Fig. 1).

AGE OF CHICKS KILLED

Fulmar Kills on Dún and Boreray were of chicks of moderate size, possibly two to three weeks of age. Live Fulmar chicks were occasionally found sitting at middens away from Fulmar nesting areas on Dún, presumably having been carried there by Great Black-backed Gulls.

Gannet Sula bassana All kills on Boreray were remains of small chicks found at middens near Gannet breeding sites in the western part of the island.

Shag All Shag chick remains found on Sule Skerry were desiccated corpses of small unfledged chicks (mean wing length of five winged corpses = 121.4 ± 15.7 mm.).

Great Black-backed Gull Chicks of this species fledged on Dún in late July and early August in 1977, and three of the four dismembered chick corpses found on the island were discovered at this time (the fourth was a corpse of a young nestling found on 25 June.)

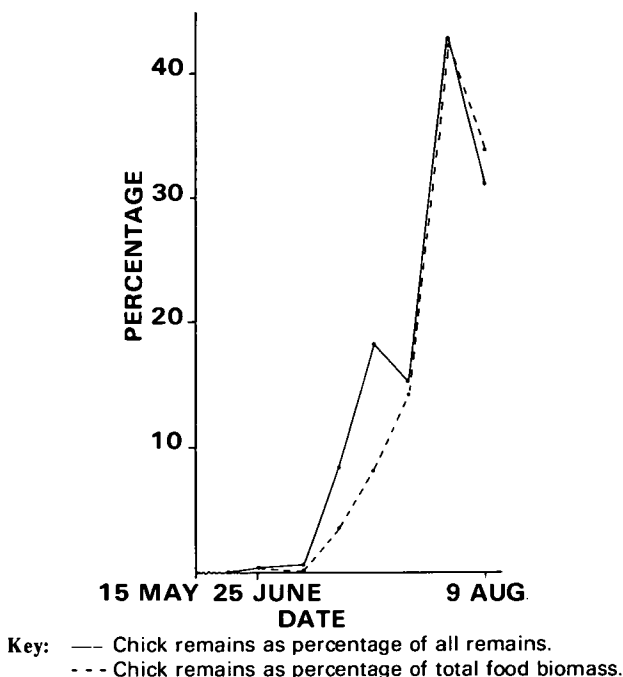*Kittiwake* Aside from the remains of six unfledged chicks found on Sule Skerry, all

Figure 1. Percentage contribution of seabird chicks to the diet of Great Black-backed Gulls on Dún between 15 May and 9 August 1977.

other kills at the three sites were of recently fledged chicks (mean wing length of 10 winged kills measured on Sule Skerry = 240.8 ± 11.6mm).

Razorbill Peak numbers of Razorbill kills on Dún coincided with peak fledging on the island (Fig. 2). Razorbill chicks were the only seabird chick prey found at middens in 1978, with remains of 31 chicks found between 25 June and 8 July, compared with 24 found during the same period in the previous year. In 1977, most kills were found at middens near a high density Razorbill nesting area in the east of Dún and near a lower density nesting area in the west. Kills peaked earlier at middens near the high breeding density area, with over 40 percent of eastern area kills being found before 12 July, compared with less than 30 percent of western area kills found in the same period. In 1978, when observations covered only the initial part of the Razorbill fledging period, 87 percent of corpses were found near the high density breeding area. All corpses which could be aged on Boreray were chicks of fledging age.

Guillemot Observations on Boreray and Sule Skerry covered the latter part of the Guillemot fledging period, and all corpses which could be aged were chicks of fledging age.

Puffin Great Black-backed Gulls were only observed killing Puffin chicks during late July and early August on Dún (the early part of the Puffin fledging period), with no killing observed at other sites. Kills were made on the ground near Puffin burrows in the early morning, the chicks possibly having been caught whilst wing exercising prior to fledging
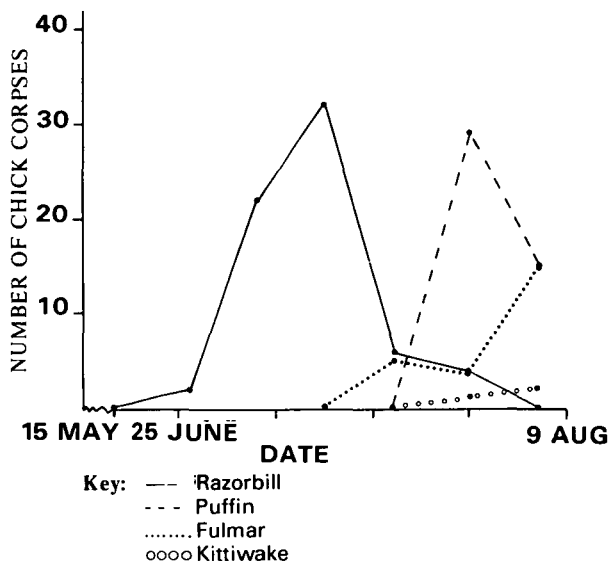
Figure. 2. Seabird chicks (other than *L. marinus* chicks) found at Great Black-backed Gull middens on Dún between 15 May and 9 August 1977.

(cf. Lockley 1953). (Other chicks were observed wing exercising outside burrows during the same period.) The chicks which were taken had little or no down on their plumage, indicating that they were near to fledging age. Herring Gulls *Larus argentatus* were seen taking smaller chicks from burrows on Dún in June and July and on Boreray in mid-July. Individual Great Black-backed Gulls were seen chasing Herring Gulls carrying downy chicks on both these islands, but the outcomes of such chases were unknown.

In 1977, the first Puffin chick kills on Dún were found on 2 August (Fig. 2), five days after the first recently fledged chicks from Dún were seen on the nearby island of Hirta (Harris 1982). All winged Puffin chick carcasses found at the three study sites had fully emerged primary feathers. The mean wing length of a sample of 47 dead chicks measured on Sule Skerry was 137.1 mm (± 0.7), indicating that the chicks were at or near fledging age, but significantly shorter than the mean wing length of 140.8mm (± 0.3) of 139 chicks measured immediately post-fledging on the island (t = -4.59, P<0.001). No Puffin chick kills were found on Dún in 1978, when observations stopped about one month before peak Puffin fledging on the island (Harris 1982). Only two carcasses were found on Boreray in 1980, when burrow checks indicated that most Puffin chicks on the island would not have fledged until a fortnight or more after my departure from the island on 25 July. Several emaciated corpses of unfledged Puffin chicks were found outside burrows on Boreray, so the two chicks at middens may have been already dead when found by Great Black-backed Gulls. (Puffin food loads were of poor quality on the island in 1980.)

PROPORTION OF FLEDGLINGS KILLED BY GULLS

Estimates of the proportions of Razorbill and Puffin fledglings killed by Great Black-backed Gulls on Dún in 1977 are given in Tables 1 and 2. A significantly higher proportion

TABLE 1. NUMBERS OF SEABIRD CHICK CORPSES FOUND AT GREAT BLACK-BACKED GULL MIDDENS AND NESTS ON THREE SCOTTISH ISLANDS.

Site	Period	Fulmar	Gannet	Shag	Species GBB Gull	Kitt.	Guill.	Raz.	Puffin	All spp. combined
Dún	15 May-5 Aug. 1977	24	n.a.[1]	—	4	3	—	66	44	141
	8 June-9 July 1978	—	—	—	—	—	—	31	—	31
Boreray ·	8-25 July 1980	5	4	—	—	3	57	23	2	94
Sule Skerry	19-28 July 1982	—	n.a.[1]	10	—	24	2	—	93	129
Total corpses		29	4	10	4	30	59 ·	120	139	395

[1]Gannets do not breed on Dún or Sule Skerry.

of Razorbill fledglings was killed in the area of low population density than in the high density area ($\chi^2 = 31.3$, P<0.001, 1df, N = 66). Locally the kill may have been as high as 14 percent of all chicks fledged (but see Discussion).

For the island as a whole, data in Table 3 indicate that only about one in every five hundred Puffin fledglings was killed by a Great Black-backed Gull. A higher proportion of fledglings was killed in the low burrow density area than in the high density area, but this difference was not quite significant ($\chi^2 = 3.22$, 2df, N = 44).

TABLE 2. NUMBERS OF RAZORBILL FLEDGLING CORPSES FOUND NEAR HIGH AND LOW BREEDING DENSITY SITES ON DÚN IN 1977 AND ESTIMATED PERCENTAGE MORTALITY OF ALL CHICKS FLEDGED.

	Low Density	High Density
Breeding pairs[1]	300	1400
Estimated fledgling production[2]	213	994
No. killed	29	37
% killed	14	4
Overall % kill	5.5	

[1]From data in Harris and Murray (1978).

[2]From productivity data in Lloyd (1979).

Significantly more fledglings killed in low density area ($\chi^2 = 31.3$, P<0.001).

TABLE 3. PUFFIN BREEDING PERFORMANCE AND FLEDGLING MORTALITY ATTRIBUTABLE TO GREAT BLACK-BACKED GULLS ON DÚN IN 1977.

Colony area	No. of burrows[1]	% burrows[2] with eggs	No. of eggs	% eggs giving[2] fledged young	No. of fledged young	No. killed by gulls	% fledged killed by gulls
Sparse	12,000	55	6,600	65	4,290	12	0.28
Dense	28,000	83	23,240	84	19,522	32	0.16
Whole Island	40,000	—	29,840		23,812	44	0.18

Notes: [1]From estimates of the numbers of occupied burrows in Harris and Murray (1977), rounded to to the nearest 1,000.

[2]From data in Harris (1980) Table 4.

DISCUSSION

From the data presented above it is possible to suggest factors which influence Great Black-backed Gull selection of chick prey species and the timing and extent of predation on chicks.

The selection of different species of chicks as prey at the study sites corresponded with the local abundance of different diurnal seabird species breeding there. This suggests that if Great Black-backed Gulls at a given site are able to satisfy their food requirements from predation on chicks of common species locally, then chicks of less common species should be largely immune from attack. Observations I made in July 1979 on Grimséy, Iceland, lend support to this suggestion. Great Black-backed Gulls in one part of Grimséy had access to many young Kittiwakes which fell from a high nesting density cliff colony down to a boulder beach. On several nights Great Black-backed Gulls were observed feeding on Kittiwake chick carcasses on the beach. These gulls did not attempt to catch Razorbill chicks which were fledging from the beach, even when such chicks passed within a few metres and took more than half an hour to join their parents in the sea. Predation on Guillemot and Razorbill chicks at two of the Scottish study sites may have been relatively heavy because these chicks were more accessible and abundant during the Great Black-backed Gull nestling period than other chicks locally, this being the stage in the breeding cycle when gulls required most food to meet the demands of their own growing chicks.

For Puffin, Guillemot, Razorbill and Kittiwake, the species which suffered the heaviest chick predation at the study sites, most predation occurred during these species' fledging periods. This is also the case at a number of other British sites (Corkhill 1973, Evans 1975, Beaman 1978, Hudson 1982); in Glaucous Gull *Larus hyperboreus* predation of Little Auk *Alle alle* and Brunnich's Guillemot *Uria lomvia* chicks (Lovenskiold 1954, Bateson 1961); and in Great Skua *Catharacta skua* predation of Kittiwake chicks (Furness 1979). For auk chicks, which are often inaccessible to predators when in nest sites, this correspondence between killing and fledging periods is likely to be because the chicks' own behaviour during or near to fledging makes them more accessible to predators at this time. For example, at the end of the nestling period Puffin chicks occasionally emerge from burrows to exercise their wings unattended by a parent (Lockley 1953). They may be then particularly vulnerable to attack. Puffin chicks reared in boulder scree or in flat areas sometimes have difficulty in flying directly out to sea during fledging and attempt to reach the water by walking. Such behaviour would make these birds very conspicuous to predators, especially if they encounter obstacles such as large rocks which hamper their progress to the sea. The same would apply to Razorbill chicks reared in boulder scree colonies such as the sites on Dún. During fledging, Razorbill and Guillemot chicks maintain auditory contact with one parent by calling loudly (Greenwood 1964), behaviour which could advertise their presence to predators.

In the case of Kittiwake, Great Black-backed Gulls at the study sites would have had access to dead and moribund Kittiwake chicks during Kittiwake fledging periods, high post-fledging mortality being a feature of Kittiwake biology (cf. Furness 1979). Beaman (1978) noted that the majority of newly fledged Kittiwakes eaten by Great Black-backed Gulls on the island of Copinsay were taken "when dead or when too weak to fly, apparently as a result of starvation" and that Great Black-backed Gulls played a minimal role in the heavy mortality of young Kittiwakes which was a regular feature of colonies in Orkney and Shetland in July and August during the period 1974-76.

An important consideration is whether, as was the case in predation of adult Puffins on Dún (Taylor 1982), individual pairs of Great Black-backed Gulls preyed on chicks in

hunting ranges near their nests and defended these ranges against most other pairs of gulls in a colony. Such behaviour would limit the extent of chick predation within a hunting range to that required to feed only a few pairs of Great Black-backed Gulls nesting nearby. Data on the timing of Razorbill kills near high and low density breeding sites on Dún lend support to the assumption that Great Black-backed Gulls caught chicks near their nests. Razorbills fledge later from low density sites than from high density sites (Lloyd 1976). Local variation in the timing of Razorbill kills on Dún thus probably reflected variation in the timing of fledging, as would be expected if Great Black-backed Gulls caught chicks near their own nests, but not if Great Black-backed Gulls from all parts of the island exploited each crop of fledglings.

Puffin and Razorbill chicks fledging from low density breeding sites on Dún suffered heavier predation than chicks fledging from high density sites. This might suggest a confusion effect, whereby Great Black-backed Gull predation success was negatively correlated with the number of chicks fledging per unit time, as has been shown for Glaucous Gull predation of fledgling auks (Williams 1975). Another interpretation of these data, which could apply even if gull hunting success was influenced by a confusion effect, is that these differences were simply a result of Great Black-backed Gulls hunting only near their own nests. If individual Great Black-backed Gulls required to eat a similar number of auk chicks before they and their chicks were satiated, predation of this number of chicks would obviously have a more serious impact in hunting ranges at low density prey breeding sites than at higher density sites.

The data presented above are likely to be a good approximation to the full extent of predation on chicks on Dún. Great Black-backed Gulls on Dún began to disperse from the island in early August, and few bird carcasses were found at middens at this time. During this period Great Black-backed Gulls moult their primary feathers, and the loss of manoeuvrability due to moult may reduce their ability to catch avian prey (cf. Bergman 1982). This could reduce predation on chicks of species such as Fulmar and Gannet, which do not fledge until the early autumn. On Dún, larger chicks in the nest later in August would thus have been open to attack from only a small number of Great Black-backed Gulls with impaired flying abilities.

Calculations of fledgling Razorbill mortality due to Great Black-backed Gull predation suggest the order of magnitude of the kill on Dún rather than the absolute kill, since population figures for Razorbills breeding on Dún are not known precisely and there are no data on Dún Razorbill productivity. The suggested mortality of roughly six percent of fledgling Razorbill chicks for Dún as a whole is similar to the estimated mortality of auk chicks due to Great Black-backed Gull predation on Great Saltee, Ireland (Hudson 1982). The actual mortality on Dún may well have been lower than six percent, since productivity estimates were based on data from Skomer, where ledge nesting Razorbills suffer from heavy egg predation by gulls and Jackdaws *Corvus monedula* (which did not occur at my study sites). Hatching success of eggs laid in the boulder scree nest sites on Dún, well hidden from predators, may have been considerably higher than that recorded on Skomer.

In conclusion, data presented here indicate that at the colony and sub-colony level, mortality of Puffin chicks due to Great Black-backed Gull predation was slight, and that due to the suggested ranging behaviour of predatory gulls this was also likely to be the case for other seabird prey species. More fieldwork at seabird colonies where chick predation occurs is needed to document the ranging behaviour of Great Black-backed Gulls when hunting chicks. Together with precise population data, this information would allow

more detailed assessment of the impact of predation on sub-colonies of different prey species than was possible in the present study.

SUMMARY

The timing and extent of Great Black-Backed Gull predation on seabird chicks on three Scottish islands is described. Most chicks killed were fledglings of the most abundant diurnal seabird species breeding at each site. At the one site where complete counts of all diurnal seabirds were available there was a positive correlation between the abundance of different species of chicks in Great Black-backed Gull kills and the local breeding abundance of these species. Predation on Razorbill and Puffin fledglings at low density breeding sites was relatively heavier than predation at high density sites. This is likely to be because Great Black-backed Gulls hunted near their own nests. There was no evidence that all Great Black-backed Gulls on an island exploited every crop of fledglings as it became available at sub-colonies of a given prey species. The extent of predation on a species within the hunting area of a pair of Great Black-backed Gulls is likely to be a function of the abundance and accessibility of different prey there.

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Kleptoparasitic behaviour of a Herring Gull *Larus argentatus* at a Puffin *Fratercula arctica* colonv

Peter J. Hudson

INTRODUCTION

The Herring Gull *Larus argentatus* is an opportunistic feeder which exploits a wide range of prey types (Spaans 1971, Schaffer 1972, Sibly & McCleery 1983). Kleptoparasitism, the robbing of procured food, has been recorded amongst the Laridae by several workers (e.g. Ingolfsson 1969, Hatch 1970, 1975, Nettleship 1972, Corkhill 1973) and the subject of kleptoparasitism is reviewed by Brockmann & Barnard (1979). This study describes the kleptoparasitic behaviour of a Herring gull which specialized in robbing fish from Puffins *Fratercula arctica.*

METHODS

Observations were made at a discrete colony of 54 Puffin nesting burrows on Skomer Island, Wales (51°44′N, 51°19′W). Each burrow was numbered, mapped and enclosed in a grid of 149 squares each of area $1.1m^2$. Density of burrows was taken as the number within the square and adjoining 8 squares, an area of $10m^2$. A small portable hide overlooked the colony so all burrow entrances and the position of any gull was easily visible. Data were collected during seven dawn to dusk watches on fine days. Additional observations were made at other Puffin colonies on Skomer. The availability of Puffins with fish was estimated by counting the number arriving at the colony and the nesting burrows entered, within each 5 minute period of observation. An attack by a gull was scored when it made obvious movements towards a Puffin, and was considered successful if the gull obtained the Puffin's fish. The gull's feeding behaviour was recorded by noting the position of the gull in the colony every 5 minutes, which Puffins it attacked, the strategy of attack, and the success of the attack. The distance from the gull to the Puffin was estimated from the grid and detailed map of the colony. The size and content of fish loads carried by Puffins on Skomer show little seasonal or year to year variation (Ashcroft 1979) and in this study the reward from a successful attack is assumed constant.

RESULTS

During this study only one Herring Gull was observed at the colony at any one time and as such these observations may reflect the behaviour of an individual gull.

AVAILABILITY OF PUFFINS AND GULL'S BEHAVIOUR

The rate of arrival of Puffins with fish at the colony varies according to time of day (Table 1; $F = 8.98$, $f_1 = 15$, $f_2 = 93$, $p<0.01$). The variation in the arrival rate did not appear to influence the presence of a Herring Gull at the colony (Table 1; $r = 0.099$, df $= 15$, $p>0.1$) or its hourly rate of food intake (Table 1; $r = 0.16$, df $= 15$, $p>0.1$). Overall, a Herring Gull was present at the colony for 51.5% of daylight hours.

The Herring Gull spent the greater proportion of its time in the dense areas of the colony where its rate of food intake was greatest (Fig. 1). The Herring Gull selectively attacked Puffins landing within 4m of it (Table 2; $\chi^2 = 329.2$, df $= 7$, $p<0.001$) and the proportion
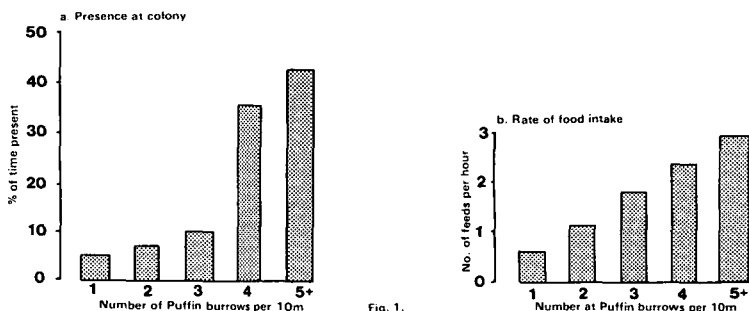
Figure 1. The feeding behaviour of a Herring Gull at a Puffin colony in relation to density of Puffin burrows; (a) the proportion of time spent by the gull at different densities; (b) the gulls rate of food intake.

landing within this distance decreased after fifty minutes (Fig. 2. $\chi^2 = 3.88$, df $\pm$ 1, p<0.05). Within this period there was an increase in the percentage of attacks that were successful but after sixty minutes the success rate fell (Fig. 3.). This change in the Herring Gull's success rate may be associated with avoidance behaviour by the Puffins. The mean duration of the Herring Gull's visits at the colony was 87.5 minutes (S. E. = 17, n = 30).

HERRING GULL'S ATTACK STRATEGY

The Herring gull attacked the Puffins in two ways, known as the fly-jump and run-chase strategies respectively. The fly-jump strategy was used to attack Puffins in the air, the gull would take-off and usually collide with the Puffin close to its burrow. The run-chase strategy was used to attack Puffins on the ground. The gull would chase the Puffin around the colony and grasp it by the tail-feathers or wing so the Puffin released its fish. The fly-jump strategy involves the gull in the energetically expensive manoeuvre of taking-off (Tucker 1969) so the net energy gain from a successful run-chase was probably greater
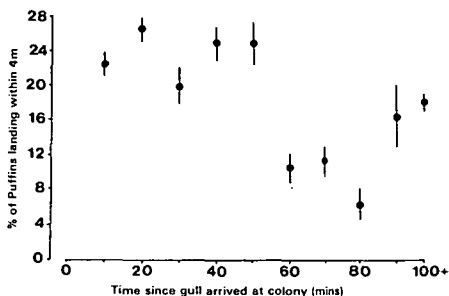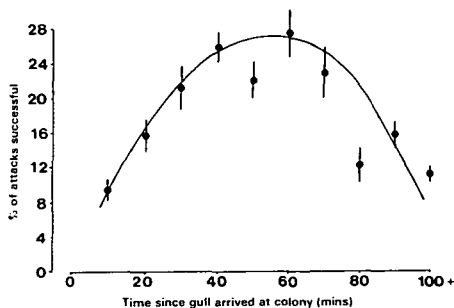

Figure 2. Percentage of Puffins landing close to (within 4 metres) the Herring Gull in relation to time since gull arrived at the colony. Mean values 1 standard error are shown.

Figure 3. Success rate of Herring Gull attacks on Puffins in relation to time since gull arrived at the colony. Mean values 1 standard error are shown.

TABLE I. DIURNAL CHANGES IN THE AVAILABILITY OF PUFFINS WITH FISH, THE PRESENCE OF THE HERRING GULL AND ITS RATE OF FOOD INTAKE. DATA FROM 7 FULL DAYS OF OBSERVATION.

TIME OF DAY

5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8

a. Number of Puffins ariving per hour:

| 43.7 | 52.0 | 36.7 | 23.4 | 26.1 | 24.3 | 17.9 | 17.9 | 17.0 | 16.0 | 20.7 | 19.7 | 24.2 | 31.4 | 36.1 | 30.0 |

b. Percent of time Herring Gull present:

| 37 | 60 | 44 | 43 | 39 | 57 | 54 | 50 | 42 | 51 | 51 | 53 | 50 | 49 | 60 | 83 |

c. Number of fish loads obtained per hour present:

| 0.38 | 0.73 | 1.30 | 0.66 | 1.09 | 1.25 | 0 | | 0.30 | 0.34 | 1.67 | 0 | | 0.95 | 0.33 | 1.77 | 1.18 | 0.34 |

than from a successful fly-jump. During this study the Herring Gull used the fly-jump for 61% of attacks (n = 303) with a success rate of 16.3% compared with 17.8% for the run-chase strategy. The Herring Gull used the fly-jump to attack Puffins on average 4.6m (n = 185, S. E. = 0.22) away and the run-chase significantly nearer (d = 5.58, p<0.001) at an average of 2.9m (n = 118, S. E. = 0.20). The success rate of the run-chase strategy decreased when the Herring Gull attacked Puffins more than 3m away (Table 2) and the percentage use of the fly-jump strategy increased significantly ($\chi^2 = 23.2$, p <0.001). These results suggest that the Herring Gull switched attack strategies when the success rate of the less strenuous strategy decreased.

DISCUSSION

This study describes aspects of the kleptoparasitic behaviour of a Herring Gull attacking Puffins for fish. Although the study may have concentrated on the behaviour of an individual Herring Gull, observations conducted at the colonies on Skomer indicate that the behaviour described is not abnormal. The results indicate that the gull's rate of food intake is a criterion influencing its behaviour at the colony. The gull spent a large

TABLE 2. ATTACKING BEHAVIOUR OF THE HERRING GULL WITH RESPECT TO DISTANCE OF ATTACK.

	DISTANCE BETWEEN GULL AND PUFFIN (m).							
	0-1	*1-2*	*2-3*	*3-4*	*4-5*	*5-6*	*6-7*	*7+*
a. Attacking behaviour:								
No. of attacks observed	35	35	60	24	21	25	23	32
No. of attacks expected[1]	3.4	14.7	20.3	10.1	27.1	39.5	22.5	119.5
b. Attack Strategy:								
No. of Fly-jumps observed	14	15	28	18	16	13	18	27
No. of Run-chases observed	21	20	32	6	5	12	5	5
% use of Fly-jumps	40	43	47	75	76	52	78	84
% use of Run-chase	60	57	53	25	24	58	22	16
% success of Fly-jumps	29	20	36	11	13	0	17	15
% success of Run-chases	24	35	16	0[2]	0[2]	8.3	0[2]	0[2]

1. Expected is calculated from the arrival rate of Puffins and assumed Puffins are attacked at random.

2. Sample sizes less than 10.

proportion of its foraging time in the more profitable dense areas of the colony but given the complex relation between availability of food (Fig. 2) and the success rate of attacks (Fig. 3), the gull's optimal time allocation at each density cannot be estimated (see review by Krebs 1978). The Herring Gull switched attack strategies when the relative success rate of the run-chase strategy fell below the more strenuous fly-jump strategy (Table 2) and in so doing obtained the greatest number of fish loads for each attack. The switching from one feeding strategy to another in order to maximise energy intake has been reported for fledgling Spotted Flycatchers (Davies 1976) and wagtails, Motacillidae (Davies 1977).

Although these results provide some evidence that the Herring Gull was foraging in an efficient manner at the Puffin colony, other constraints will influence its long term foraging behaviour. Sibly & McCleery (1983) show how Herring Gulls at Walney Island visit feeding sites only when food is available there. During weekdays and on Saturday mornings Herring Gulls regularly visited refuse tips but on Sundays and Bank Holidays when the tips were closed and refuse unavailable the gulls foraged elsewhere. In this respect the Herring Gull studied here can be expected to leave the Puffin colony when the relative profitability of an alternative food source is greater.

In this study the maximum percentage of fish loads that a chick was robbed of was 7.05% while most chicks lost less than 2% of loads. Ashcroft (1979) recorded two instances of Puffin chicks on Skomer losing one parent but fledging successfully, so it seems unlikely that Puffins on Skomer are short of food and this level of kleptoparasitism is unlikely to have any detrimental effect on the growth rate of Puffin chicks. Nettleship (1972) investigated kleptoparasitism at Great Island, Newfoundland and noted that the Puffin parents with burrows on level ground lost up to 16.2% of their fish loads to gulls. It is possible that this rate of kleptoparasitism influenced the rate at which chicks were fed and consequently their fledging weight.

SUMMARY

The kleptoparasitic behaviour of a Herring Gull attacking Puffins for fish was studied on Skomer Island, Wales. The arrival rate of Puffins with fish was greatest early in the morning and again before dusk but did not influence the Herring Gull's presence or its rate of food intake. The Herring Gull spent the greater proportion of its foraging time in the dense parts of the colony where its rate of food intake was greatest. The Herring Gull selectively attacked Puffins landing within 4 metres. Two types of attack strategy were observed and the Herring Gull switched strategies when the success rate of the less strenuous decreased. It is suggested that the rate of food intake is a criterion influencing the Herring Gull's behaviour.

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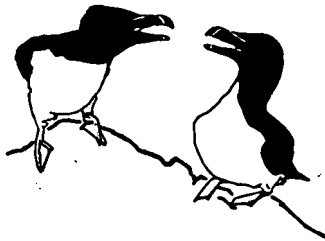
Reliability of ageing Razorbills

W. J. R. De Wijs

INTRODUCTION

In recent publications the number of bill-ridges or - grooves in bills of Razorbills *Alca torda* is used to distinguish between age-groups (Anker-Nilssen & Røstad 1981, de Wijs 1984) and this is also referred to by Glutz von Blotzheim & Bauer (1982). In particular two age-groups have been recognized for immature and older birds, distinguished by whether they possess one or two ridges/ grooves in addition to a vertical white line (referred to as W+1 and W+2 respectively). Birds up to their third year either lack additional grooves (second year) or even lack the white line (first year), which seems to develop during the second summer (Chambers 1971, Lloyd & Perrins 1977, Glutz von Blotzheim & Bauer 1982).

TABLE 1. NUMBER OF BILL-GROOVES IN RAZORBILL RELATED WITH AGE (YEARS). ALSO GIVEN ARE MEAN, SD AND N OF AGE. 1.5 GROOVES MEANS SECOND GROOVE NOT FULLY DEVELOPED.

number of grooves	1	1.5	2
definite age	–	12	8,12
minimum age	4,4,4,4, 8,9	4,4,4,4, 6,9,9,9,	8,9,17
mean of min. age	5.5	6.1	11.3
sd	2.3	2.5	4.9
n	6	8	3

Twenty breeding Razorbills were caught on Skomer Island, Wales, in 1983. All were checked for these bill-characters. Of these birds twelve had been ringed before, three as chicks, nine as breeders (so would have been at least 4 years old at ringing as this is the minimum breeding age – Glutz von Blotzheim & Bauer 1982). The remaining eight birds were unringed, but must have been at least 4 years old. The results (Table 1) do show an increase of the number of grooves with age but more importantly that part of the adult breeders have a single groove, even up to at least 9 years of age. Thus, any distinction between "bill-age" groups W+1 and W+2 would be unreliable to distinguish between sub-adult and adult Razorbills. Besides, referring to (beached) winter birds one has to bear in mind that there are geographical differences in the number of bill-grooves (Salomonsen 1944).

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Growth, Diet and Mortality of Arctic Tern *Sterna paradisaea* Chicks in Shetland

P. J. Ewins

The Arctic Tern *Sterna paradisaea* is Britain's most numerous breeding tern species, with an estimated 77,000 pairs, 85% being found in Orkney and Shetland (Thomas 1982). Despite its abundance and the relative ease of access to many colonies, this seabird has been less studied than elsewhere in northern Europe (Norderhaug 1964; Bengtson 1971; Lemmetyinen 1972, 1973a,b,c). Most British work on the biology of Arctic Terns has been carried out either on the Farnes or on Coquet Island, Northumberland (Cullen 1956, 1957; Langham 1968; Pearson 1968; Horobin 1970; Dunn 1972, 1975; Coulson and Horobin 1976). However, little information exists for the strongholds in the northern Scottish islands, and there are no published growth curves for the British Isles. In recent years large-scale colony desertions, breeding failure and inter-colony shifts of Arctic Terns have been noticed in many parts of Shetland (Shetland Bird Reports 1979-81; Bullock and Gomersall 1981). In 1978 whilst adverse weather conditions in July probably accounted for desertion of chicks in many colonies, failure of terns in May and June was thought to have been related more to food scarcity at that time (Richardson 1979). This paper presents growth curves, and data on diet and mortality of Arctic Tern chicks on the island of Mousa, Shetland (60°00'N 1°10'W) in 1983-84, in an attempt to investigate recent reproductive failures.

METHODS

Mousa is a low island of 210 ha, lying 1 km off the south-east mainland of Shetland. The surrounding shallows hold large Sandeel *Ammodytidae* stocks in summer. In recent years over 1000 pairs of Arctic Terns have bred on the island, with colonies on degraded heathland, a sandy beach and amongst boulders. For further details of the island, see Ewins (1983).

In 1983 within the study colony of an estimated 800 prs. (using methods detailed by Bullock and Gomersall 1981), an area of damp heathland c.250 m² was selected. This area extended from near the periphery to the centre of the colony and was particularly suitable for this study as chicks took cover in small tussocks of *Calluna,. Juncus* or *Festuca/Agrostis* upon disturbance, where they could be regularly retrapped. Chicks were ringed on Day 0 or 1 in this area. In 1984 nestling mortality was very high and sample sizes of known-age chicks were small. Thus age was estimated from the wing-length, using the 1983 growth data.

Daily colony visits were usually made at the same time of day (1100-1300h BST), reducing biases due to diurnal variation in provisioning rates. Wing-lengths were measured to the nearest mm (max. flattened chord), excluding the downy tips to the remiges; tarsus-length accurate to 0.1mm was taken with vernier calipers, and weights were recorded accurate to 1 g using pesola balances. All chicks found dead in the sample area were removed and if not already ringed, their wing-length used to estimate age at death. Visits were shortened in cold and wet conditions, particularly when chicks were small and every effort made to minimize disturbance at all times.
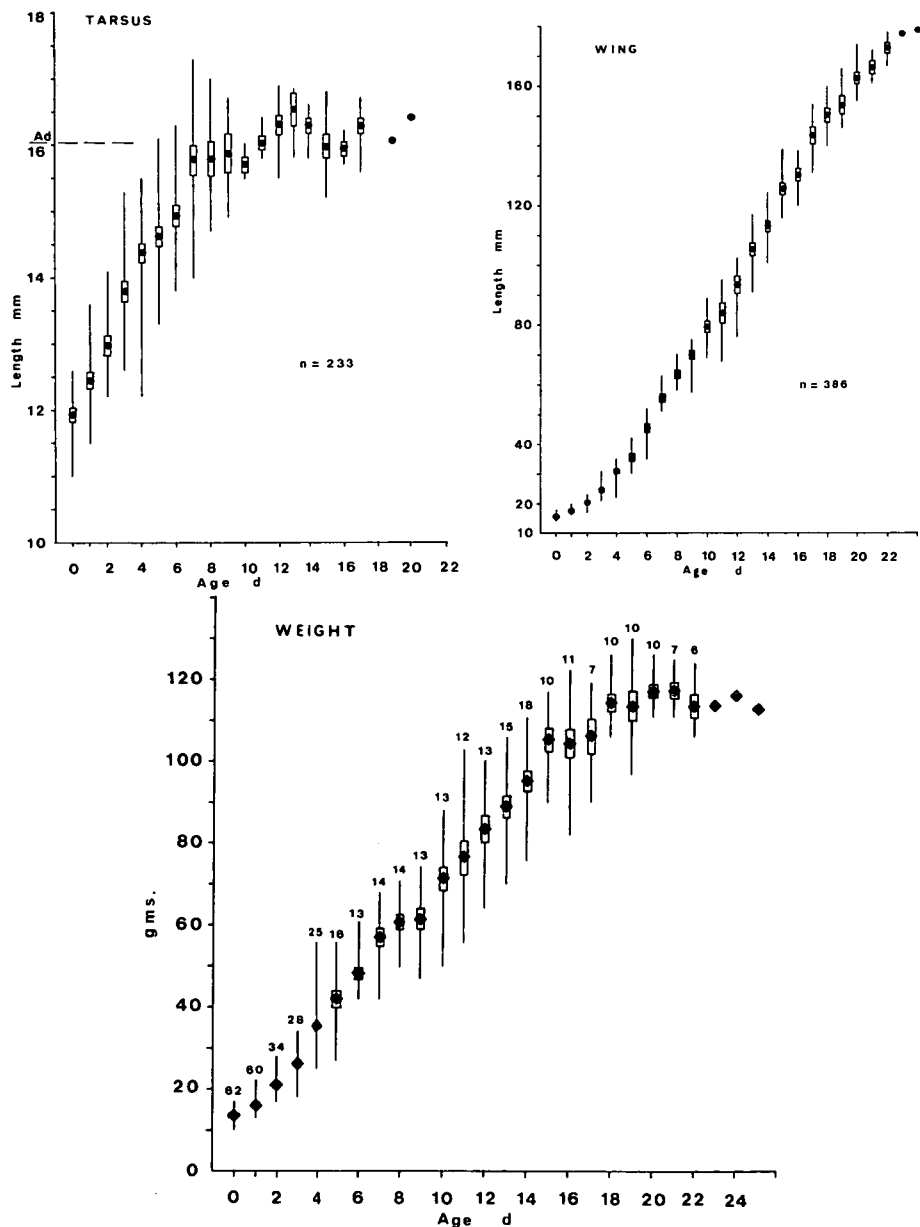
Figure 1. The growth of tarsus, wing and weight of Arctic Tern chicks on Mousa in 1983 (mean ± s.e. and range). Sample sizes are given for weights of chicks of different ages, and for total separate measurements of wing and tarsus. Ad = adult tarsus-length.

Prey species and sizes were determined from observations of adults returning from feeding areas. Fish length was estimated as fractions of the "head-bill" length ie. the distance between bill tip and the rear of the black head feathering (mean length from 6 fresh corpses was 90.8mm, s.d. 2.5). Clutch counts were made as soon as results from marked nests indicated that most pairs had completed laying. Hatching dates were from direct observations at nests and estimated from chick wing-lengths. Weather records were provided by the Lerwick Meteorological office, 15km to the north of Mousa.
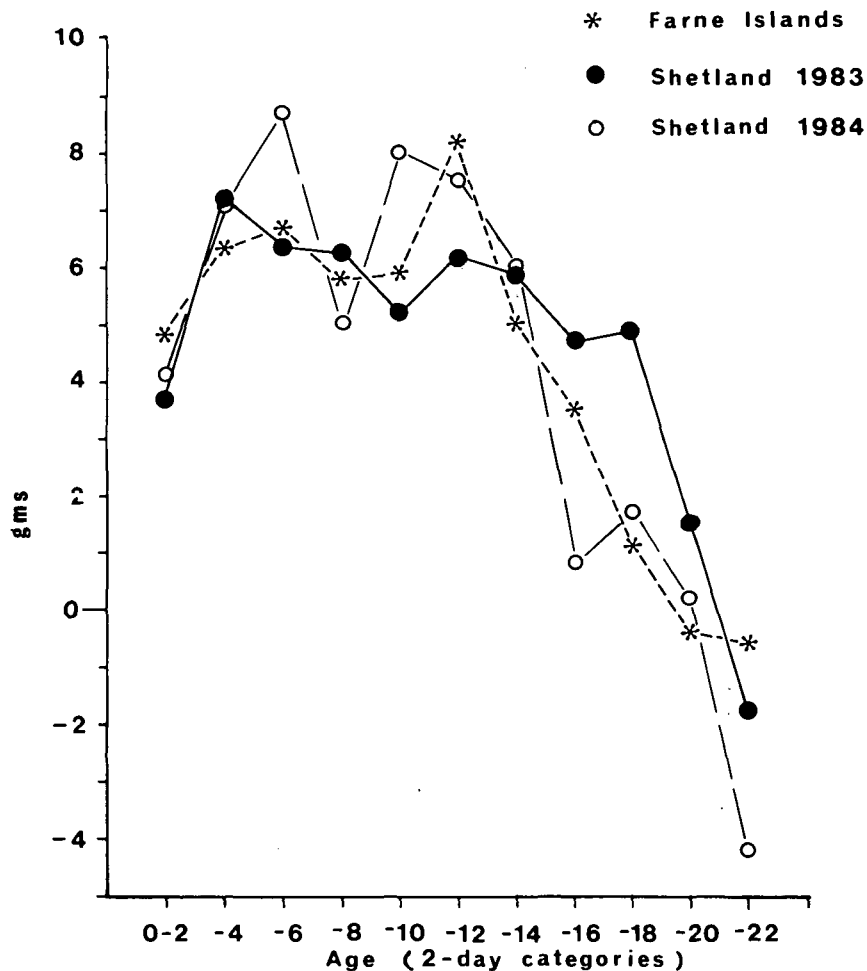
Figure 2. Average daily weight increments of Arctic Tern chicks on Mousa, Shetland compared with the Farne Islands (Pearson 1968).

RESULTS

' *Wing and tarsus*

The increase in wing-length was approximately linear from Day 4 to 20, with an average daily increment of 8.2mm between Day 4 and 14 (Fig. 1). Chicks normally fledged once
, wing-length had reached c.175mm — 64% of the mean adult wing of 275.2mm (s.d. 6.2, n = 50). Fledging periods ranged between 21-25 days. The tarsus was already well-developed at hatching, at 75% of the mean adult length of 16.1mm (s.d. 0.7, n = 13), and after Day 7 there was little further increase in length (Fig. 1).

Weight

In 1983 the average daily weight increase was fairly constant from Day 4 to 14, but thereafter declined gradually, with some chicks having a short period of weight loss just prior to fledging (Figs. 1 and 2). The growth curve in 1984 was very similar and so is not shown. Average daily weight increments of chicks 4-14 days old did not differ markedly in the two years, but in 1983 chicks that were later found dead put on an average of only 0.2 g/day, compared with 5.9 g/day for those not found dead later (Table 1). From Day 18 to 22 there was little further weight change and comparisons were made of these average 'plateau weights' between years: 1982 = 111.6g (s.d. 7.8, n = 51); 1983 = 113.1g (s.d. 7.5, n = 158); 1984 = 110.2g (s.d. 8.9, n = 20). There were no significant differences between years, but in 1983 chicks fledging in the first half of July were significantly heavier than those fledging in the latter half of July (114.0g vs 111.4g; t = 2.2, P<0.05).

TABLE 1. AVERAGE DAILY WEIGHT INCREMENTS OF ARCTIC TERN CHICKS 4-14 DAYS OLD.

Locality	*Av. daily wt. increase (g/day)*	*Source*
1983 Mousa, Shetland — all chicks	5.5	Present study
1983 Mousa, Shetland — chicks later found dead	0.2	Present study
1983 Mousa, Shetland — chicks not later found dead	5.9	Present study
1984 Mousa, Shetland — all chicks	5.3	Present study
Farne Islands, Britain	6.3	Pearson (1968)
Farne Islands, Britain	6.1-7.1	Coulson & Horobin (1976)
Kustavi, Finland	c.6.5	Lemmetyinen (1973b)

Diet

Sandeels were by far the commonest courtship prey in 1983 and 1984 (99% and 100% respectively). In 1984, they formed 97% of the observed diet throughout the season. During the early nestling period of 1983, however, 20% of fish brought in were Saithe *Pollachius virens* declining to 3% in the late nestling period (Fig. 3). Large Sandeels were taken as courtship fish — modal lengths 8-12 cm — but smaller ones were fed to chicks — modal lengths 6-8 cm (Fig. 4). Other fish species brought in to the colony were: Conger Eel *Conger conger,* 5-bearded Rockling *Ciliata mustela,* 3-spined Stickleback *Gasterosteus aculeatus* and unidentified Gadoid/Clupeid species. Although adults regularly fed on small zooplankton, dipteran swarms and discarded fish offal, none of these items were known to have been fed to chicks.
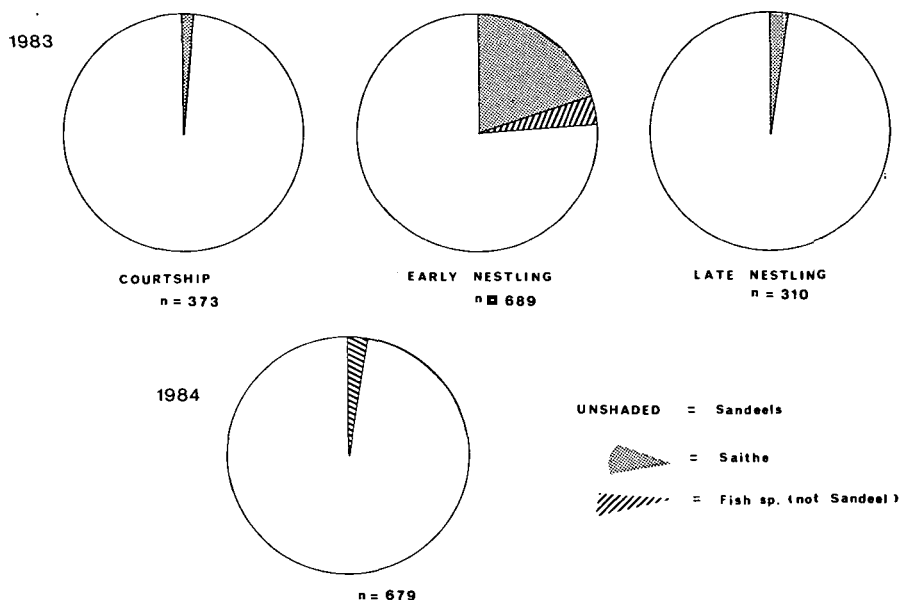
Figure 3. Prey species brought in to Arctic Tern colonies on Mousa in 1983-84.

Mortality

In 1983, 92% of pre-fledging mortality occurred within one week of hatching (Fig. 5). The corresponding figure in 1984 was 97%, but this refers to detected mortality only as many chicks and corpses were removed by aerial predators. Peak mortality occurred during the last four days of June in both years: 58% in 1983 (82% of these chicks were less than 6 days old); and 51% in 1984 (95% were less than 4 days old). The median hatching date was 20th June in 1982 and 1983, but three days later in 1984 (Fig. 6).

Although not observed in 1983, predation of tern eggs and chicks (live and dead) by Herring Gulls *Larus argentatus* and Great Skuas *Catharacta skua* was heavy in 1984. At least three individuals of both species regularly patrolled the three main terneries — strategies and success rates varying between colonies and individuals. Results from 65 half-hour watches showed that for the whole island, the average number of items taken (ie. individual chicks or eggs) was 7.2/hour by Herring Gulls and 5.0/hour by Great Skuas (these may be under-estimates since more than one egg or small chick could have been taken per peck). Raids were noted at all hours between 0400-2200h BST with no apparent periodicity, from late May onwards. Thus, an average of 220 items per day were taken by these birds. There was a tendency for raids to be more successful at the edge of colonies — borne out by the lower hatching success of nests at the edge of a colony (9%, n = 10) compared with those near the centre (77%, n = 10). From an estimated 1309 occupied nests on Mousa in 1984, less than 100 young fledged. Breeding success was much higher in 1983, with an estimated 1054 nests fledging many hundreds of young, possibly as many as 1000.
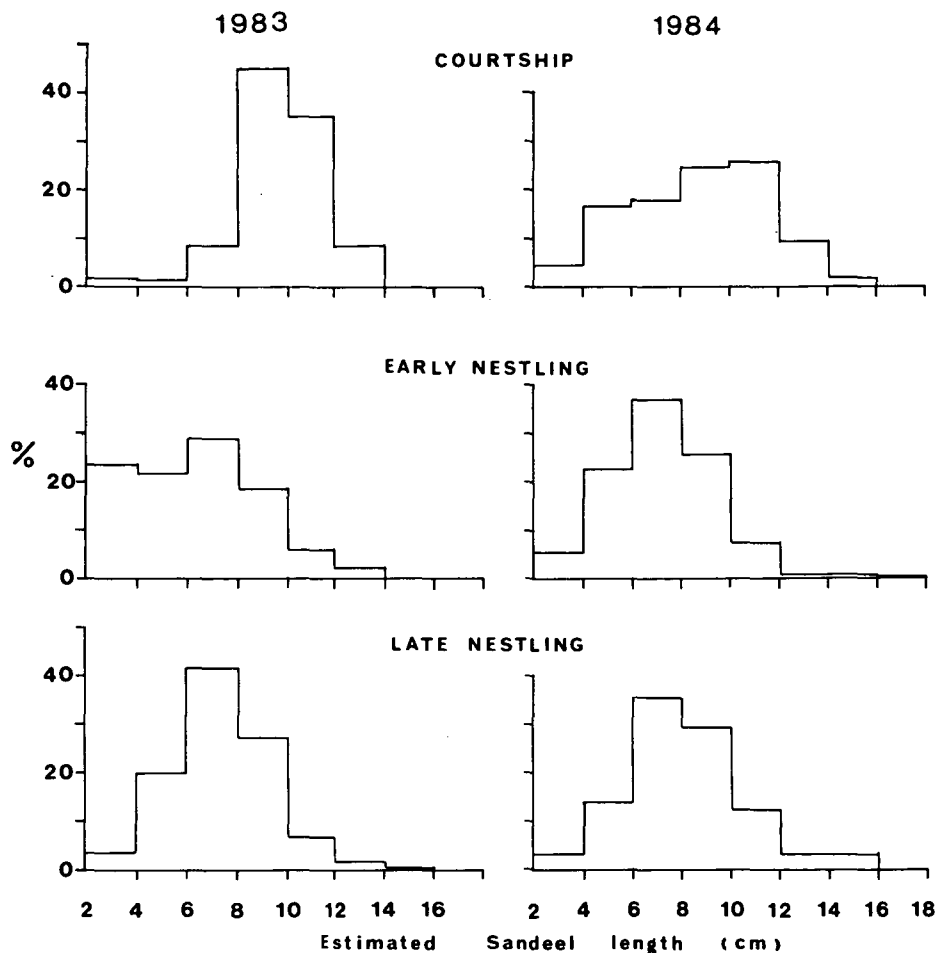
Figure 4. Frequency distributions of estimated Sandeel length classes brought in at different stages of the 1983-84 breeding seasons.

DISCUSSION

The rapid development of tarsus and wing in Arctic Tern chicks is characteristic of a nidifugous species, and both continued growing even when weight decreased. The pattern of weight increase in 1983 (a productive year by recent standards) on Mousa was very similar to that found in other parts of the range, although the asymptotic weight reached was slightly higher (Lemmetyinen 1973b). Lemmetyinen (1972) found that growth rates were severely reduced in Spitsbergen during periods of unfavourable weather and fish scarcity, largely due to the second chick to hatch showing little increase in weight and usually dying within a few days. It was anticipated that growth curves for Shetland might
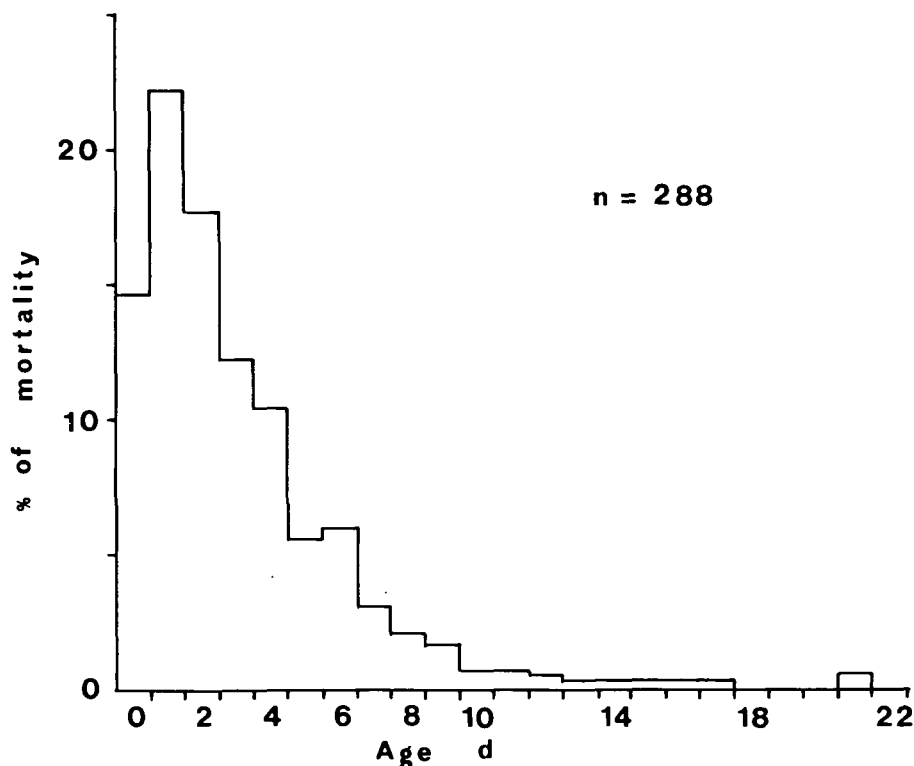
Figure 5. Frequency distribution of age at death of Arctic Tern chicks in 1983.

provide some indication of annual variations in food availability during the nestling period. Furthermore, in 1983 the average daily weight increment of chicks 4-14 days old that were later found dead was much lower than that for 'healthy' chicks (0.2 vs 5.9 g/day), However, results in 1984 (a disastrous breeding season for terns) showed little difference in observed chick growth from the previous season, and the use of this parameter may not be appropriate since measurements are always heavily biased towards healthy, surviving chicks, whilst weaker, under-nourished individuals are often quickly predated, scavenged, or decomposed.

Over 9% of pre-fledging mortality occurred in the first week of life, when the chick's thermoregulatory mechanisms are still developing; cold and wet conditions at this stage will increase the risk of death from chilling. As the mean hatching interval is 29 hours (Horobin 1970), the first chick to hatch is stronger and can give louder food-begging calls than the second. In periods of inclement weather and food shortage, it will usually receive more food (Palmer 1941). In both years the majority of chicks dying during the late June mortality peak had hatched after the median hatching date, and so it is likely that many of these were second-hatched chicks. Weather conditions in the 8-day period 25 June-2 July were compared with those during the rest of the nestling period in relation to chick mortality. In 1983, peak mortality coincided with a prolonged period of strong winds and
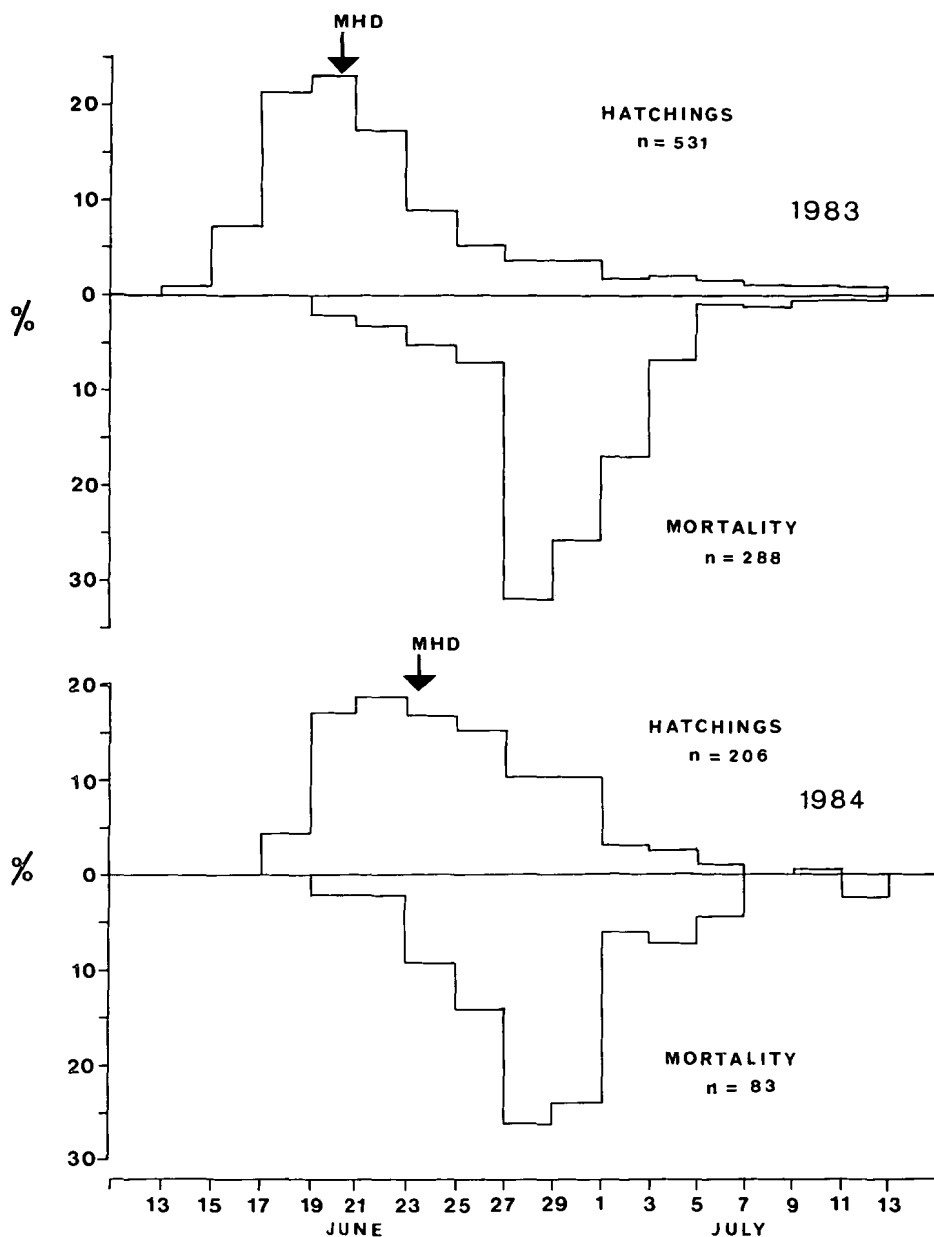
Figure 6. Frequency distributions of Arctic Tern hatchings and nestling mortality on Mousa in 1983-84. MHD = median hatching date.

'heavy rain, and exposure symptoms were noted in some chicks. However, weather conditions in 1984 were good in both periods, and no shivering or wet chicks were seen. It is suggested that factors other than chilling of chicks must account for most of the mortality in 1984.

The frequency distribution of Sandeel lengths was remarkably similar to those for industrial landings of Sandeels in Shetland (Warburton 1983), suggesting that older fish (over 10cm) are unavailable to terns and fisherman alike after June. Coincident with the heaviest nestling mortality, larger Sandeels appeared to be scarce in the early nestling period of 1983. A higher proportion of small (O-group) Sandeels were brought in then and 20% of the diet comprised young Saithe (4-8cm). This species has a lower calorific value than Sandeels of similar size (5.1 vs. 6.5 kJ/g wet weight) (Harris and Hislop 1978), but is abundant in Shetland coastal waters during the summer, and is the commonest prey item of Common Terns *Sterna hirundo* (pers. obs.). In 1984, however, Arctic Tern diet consisted almost entirely of Sandeels, and no increase in proportion of small O-group Sandeels was evident at the peak of nestling mortality. As I have no data on provisioning rates it is not possible to draw any further conclusions about the relationships between fish quality, availability, the weather and nestling mortality. Although the depredations of Herring Gulls and Great Skuas were severe in 1984 on Mousa, it is uncertain whether they were short of food themselves, or if fish were scarce for terns — leaving fewer adults to defend the colony, or whether some other factors were involved. At the rate of 220 items taken per day, and an average clutch of 2.1, it would take only 12½ days for these birds to wipe out the entire breeding attempt. In practice many pairs re-laid although none was successful. Heavy nestling mortality due to predation by Glaucous Gulls *Larus hyperboreus* has been noted in Spitsbergen (Burton and Thurston 1959).

The mean annual clutch size on Mousa did not differ significantly between 1982-84 (Table 2), suggesting that Arctic Terns experienced little food shortage in the pre-laying

TABLE 2. COMPLETED CLUTCH SIZES OF ARCTIC TERNS ON MOUSA, SHETLAND IN 1982-84.

			Clutch size:			
Year	n	1	2	3	4	Mean
1982	167	11	118	38	—	2.16
1983	178	17	123	38	—	2.12
1984	226	24	153	47	1	2.10

No sig. diff. between years in mean clutch size.

period there. However, events could have been quite different in other areas and it would not be surprising to find adults of long-lived species deserting eggs if they themselves were in poor condition. Various studies in Spitsbergen observed colony desertion and nestling mortality similar to that seen in Shetland in recent years (Norderhaug 1964; Bengtson 1971; Lemmetyinen 1972). At higher latitudes, environmental and weather conditions are less predictable than in temperate regions; in some years birds either do not breed or else abandon nesting attempts, but occasionally experience 'bumper' years which compensate for a series of poor years. It is possible that a similar situation exists with Arctic Terns in Shetland (productivity was very high in 1981 and 1982 for example). Detailed long-term studies of reproductive output and the relationships between nestling mortality, weather conditions, food availability and predation are required before the impact of the growing Shetland Sandeel fishery on Arctic Terns can be assessed.

SUMMARY

Growth data are presented for Arctic Tern chicks on the island of Mousa, Shetland in 1983-84. Weight increase compared favourably with that in other parts of the range, but the average daily weight increment of chicks subsequently found dead was much lower than that of healthy chicks. Sandeels were the commonest prey in both years. Over 90% of pre-fledging mortality occurred in the first week of life and in 1983 unusually wet and windy conditions led to fatal chilling of some small chicks. In 1984 breeding success was low throughout Shetland but nestling mortality could not be attributed to adverse weather conditions causing chilling of chicks; on Mousa most eggs and chicks were eaten by Herring Gulls and Great Skuas. As is the case for some arctic species, it is possible that a series of poor years may be offset by a few productive breeding seasons for Arctic Terns in Shetland.

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Interrupted migration and misorientation of Black Terns *Chlidonias niger* during spring migration in Andalucia

A. Paterson

The spring migration of Black Terns *Chlidonias niger* through North West Africa and into southern Iberia is generally accepted to be rapid and on a broad front (Bird 1937), although the route followed has been debated. Etchecopar and Hüe (1967) favoured a desert crossing, at least at times, although this was argued by Moreau (1967) with additional support from Hopkins (1969) who favoured a coastal route. More recently Thevenot *et al* (1980) noted that the spring migration through Morocco in 1979 was '. . . little visible' while in 1980 the same observers (Thevenot *et al* 1981) recorded a '. . . well marked' movement northwards. This suggests that the spring movement may be affected by meteorological conditions. Lambert (1983), for example, observed Black Terns as much as 160 km. offshore from Mauretania in spring 1983, a year when few were observed in the Malaga region of Andalucia. At Gibraltar the northerly movement is usually poorly marked (Cortes *et al* 1980) although there are records of large movements in the western mouth of the Strait of Gibraltar (eg. Stead 1959).

In the Malaga Bay region the northward passage generally takes place within a period of 35-40 days, commencing during the first week in April and terminating during the third week in May. Birds pass through in waves with the greatest numbers occurring during the third and fourth weeks in April and the first week in May. (Garrido *pers.comm.* and *pers.obs.*) Birds are generally to be expected in the area when light to variable winds cover the western Mediterranean, the Strait and its Atlantic approaches, and there are clear to partially cloudy skies. It is worth noting that the Sea of Alboran and the Strait may show different meteorological conditions due to the funnelling effect between the Iberian and African land masses. This may result in winds at sea in excess of force 4 (Beaufort) from the east (Levante winds) while inshore winds in the Malaga region may be only force 1-2. Westerly (Poniente) winds tend to be much more generalised throughout the area.

In the Malaga region the largest concentrations of terns in spring occur on freshwater ponds some 200 m. east of the rio Guadalhorce, approximately half way between Torremolinos and Malaga, where it flows into the Mediterranean. (Fig. 1) The ponds and river mouth represent virtually the only freshwater area of any consequence close to the coast between Gibraltar, 95 km. southwest, and the salinas at Cabo de Gato, 195 km. east.

Under normal circumstances newly arrived birds rest and feed at the ponds, at the river mouth and up to 200 m. up the river from its mouth. Some feed over the sea where the salt and river water mix and others along the shore towards Malaga within 500 m. of the ponds. There is seldom little movement away from this area, and scarcely any southwest movement along the shoreline.

The migration period during spring 1982 was marked by several periods of overcast skies of 72 hours or more, often with rain both locally and regionally, and by winds of force 4 or more from the SE quadrant. On two occasions numbers in excess of 350 Black Terns occurred in the area, with 550+ on the second occasion being the highest number ever recorded at the ponds (Garrido *pers.comm.*), and well in excess of the normally accepted maximum of ca.250. The high numbers were attributed to the prevailing weather conditions having an adverse effect upon the migration, causing misorientation and some reverse migration.

Fig. 1 Malaga Bay
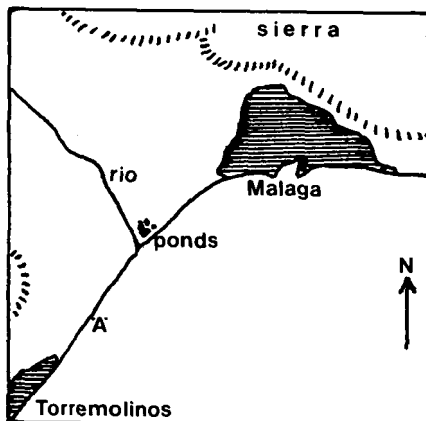
The first Black Terns were seen at the ponds on 3 April (Garrido *et al* pers. comm.) although there had been late March records of Whiskered Tern *C. hybrida*. Numbers of Black Terns remained low until 15 April with only ones and two's being recorded. The synoptic maps on 14th showed winds regionally and locally at E 2 with clear skies. This changed on 15th with winds increasing to SE 3 with overcast skies and occasional rain. On that date, thirty-eight Black Terns flew southwest along the shore at point 'A'(see Fig. 1). On 16th and 17th the winds remained generally SE 2-3 with cloud and occasional rain, as a low pressure at 1010 mbs. covered the peninsula, the Strait and part of North Africa. This extended in area on 17th with a low of 1008 mbs. developing over North Africa.

The synoptic map for 18th showed both lows almost stationary with a very slight ridge of higher pressure between them covering the Strait and Mediterranean Andalucia, with winds light to variable in the sea areas, heavy cloud and occasional rain. (Fig. 2) A visit to the ponds in the morning showed 60+ Black Terns present with winds locally at S 3. An afternoon visit to the shore at 'A' with winds locally S 4 and heavy cloud and a choppy sea
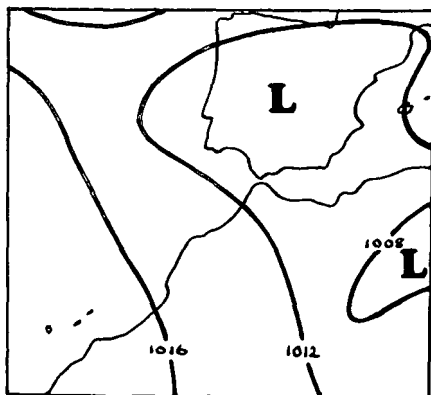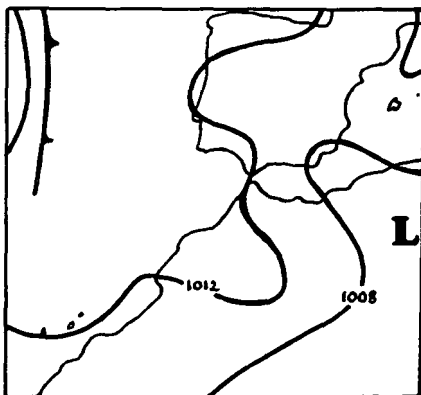
Fig. 2: 12.00 GMT. 18.IV.82

Fig. 3 12.00 GMT   19.IV.82

showed 36+ birds in the area of which 26 flew southwest without returning in the 90 minute watch period.

By 12.00h. GMT on 19th the synoptic map showed both lows filling with a general forecast for overcast skies and light variable winds throughout Andalucia (Fig. 3). Locally, the morning skies were overcast with winds at NW 1-2, increasing to 3 during the morning. By 16.00h. at 'A' 95+ Black Terns were feeding over the sea under low cloud with a base of less than 1,000 m. (judged by local sierra tops of known height.) The birds were very restless and after a while about sixty formed a loose vortex, circling and gaining height over the sea while slowly drifting southwest parallel with the shore. The maximum height gained was estimated at 250 m. After drifting southwest for some 2,000 m. over a period of 10-15 minutes the vortex broke up with the birds returning to sea level and beating back up to the original starting point where the remainder had been feeding. The whole process was repeated twice more during a 60 minute period. As far as could be ascertained no birds continued southwest after the vortices broke up.

On 20 April another low which had been forming off the Atlantic coast of Morocco moved into North Africa and the general forecast was for cloud over the whole region with Levante winds in the Strait and Sea of Alboran. Locally winds were easterly force 3 and 75+ Black Terns were at the ponds in the morning. In the afternoon 60+ flew northeast at 'A' in 45 minutes. As the observation period was shorter and later than the previous day it is not known if this was the result of a dispersed vortex or a proper movement, although some birds were seen to come in directly off the sea from the south.

By 21st winds had moved round to southerly force 1 although skies were still overcast and twenty-four birds were present at 'A' with a net drift southwest of ten birds in sixty minutes in the afternoon. During the subsequent three days few birds were seen at either 'A' or the ponds. Winds during the period varied between SE and SW force 2-3 with clear to partially cloudy skies.

By 24 April a low at 1016 mbs. was forming in the Atlantic with another widely dispersed low over North Africa at 1012 mbs. (Fig. 4). The general weather forecast was for light to variable winds over the whole of the western Mediterranean, allied with variable cloud and occasional showers. Locally the weather was for occasional cloud and winds to be southwesterly force 2-3.
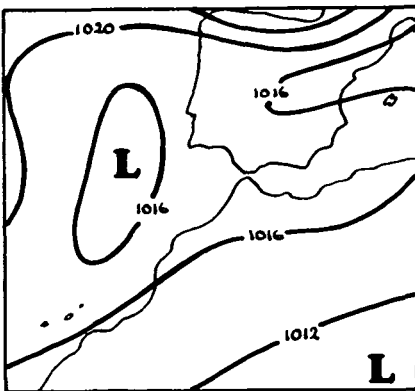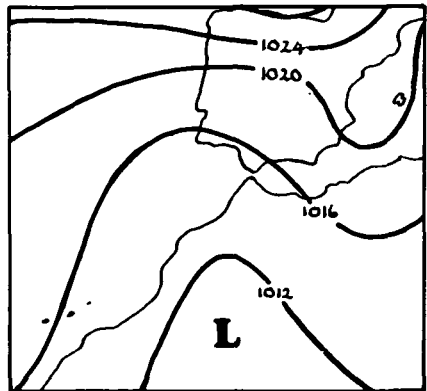
Fig. 4 12.00 GMT   24.IV.82

Fig. 5 12.00 GMT   25.IV.82

The Atlantic low had filled by the morning of 25 April and easterly winds blew over the general area which was blanketed by cloud (Fig. 5). Locally skies were starting to become overcast by 08.00h. and by 12.00h the cloud base was less than 1,500m. with easterly winds rising to 5-6 and a rapidly worsening sea state. By 15.00h. the sea at '*A*' was very rough and the east wind force 6, gusting 7. An hour's watch produced a very big southwesterly movement of 350+ birds (This watch had to be abandoned unfortunately because of finding an attempted suicide on the beach.) The same weather conditions obtained throughout 26 April but no birds were recorded at '*A*' in an hour's watch in the afternoon.

Between 27 April and 9 May numbers remained low with a maximum count of 45 moving NE at '*A*' on 29 April. There were few Black Terns at the ponds during this period.

On 7 May a low was centred over North Africa with a high out in the Atlantic at 45°N 30°W. By 12.00h. on 8th the North African low was filling and dispersing while the Atlantic high had filled slightly but was virtually stationary (Fig. 6) Winds over Andalucia and the western Mediterranean were easterly with Levante winds in the Strait, locally SE 3-4, and variable cloud.

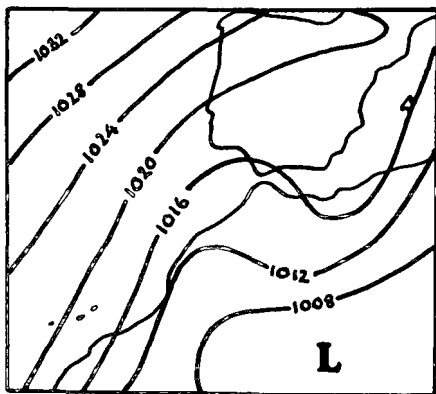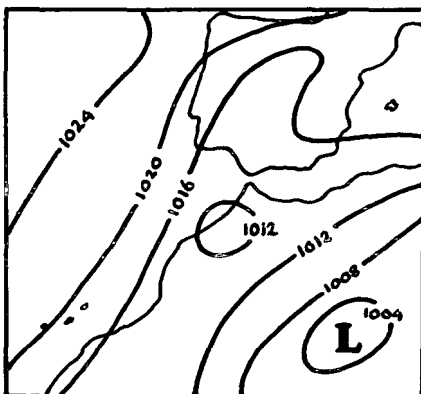**Fig. 6. 12.00 GMT 08.V.82**   **Fig. 7 12.00 GMT 09.V.82**

A small low formed over NW Africa on the morning of 9 May, with a deeper low further southeast (Fig. 7). The general forecast for the area was for variable cloud and light, variable winds. A visit to the ponds in the morning revealed 550+ individuals present. At '*A*' in the afternoon 250+ were feeding over the sea and resting on the shore itself. The weather was totally overcast with winds at E 3. The birds were very restless with many moving southwest for 3-400 m. before moving back northeast again. By 16.15h. birds had started vortexing and following the general pattern of 19 April, moving southwest at height, flocks breaking up and moving back NE at low level. In addition c.150 flew directly off southwards out to sea. After flying 3-4 km., some started to return to the shore although an estimated fifty continued moving south over the horizon.

By 10 May winds had decreased to SE 2 after clear night skies over the whole area. The lows over North Africa had filled to 1012 mbs. and winds with an easterly component flowed over the entire area. Only ten Black Terns were present at '*A*' in the afternoon. Numbers declined even further until the last spring record on 17 May.

DISCUSSION

Numbers of Black Terns on 25 April and 9 May were abnormally large for the Malaga region and the behaviour described above has apparently not been noted before by local ornithologists (Garrido pers. comm.).

The observations suggest that SE quadrant winds of force 3 or more will, when accompanied by prolonged periods of total cloud cover, concentrate much larger numbers of Black Terns than is normal on the west side of Malaga bay. Under extreme circumstances this results in the misorientation of the birds and in a reverse migration. It is worth noting that no such weather conditions or movements were observed in either 1981 or 1983.

There exists the possibility that local geographical features may add to the confusion of the birds caught in such weather conditions. Under ideal clear conditions birds may move further eastwards or inland, following the valley of the rio Guadalhorce. The valley is bounded by sierras which are easily visible from the coast, even under poor weather conditions, and the possibility must exist that when there is total cloud cover this may represent an insurmountable block to further progress. Further, the general aspect of the coastline changes quite markedly at Malaga (Fig. 1) from easterly, east of the town, to southwest on the western side.

It is therefore suggested that a combination of meteorological and geographical circumstances as described may cause larger than normal numbers of Black Terns during spring migration and result in the abnormal behaviour described.

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Andrew Paterson, Edificio San Gabriel, 2-4°-A, C/ Escritor Adolfo Reyes, Torremolinos, (Malaga) Spain.

Prolonged soaring by Cory's Shearwater *Calonectris diomedea*

Andrew Paterson

Most textbooks note that the normal flight of Cory's Shearwater *C. diomedea* is more albratross-like than that of other shearwaters, eg Watson (1966) and Bruun (1972), although Watson (p.11) notes that the species '. . soars and swoops more and flaps less and usually at greater heights that other shearwaters.' The general flight pattern (particularly under low strength wind conditions such as prevail in the Western Mediterranean in the summer months) is very low, slow and floppy with little shearing and soaring apart from the occasional short loop. Any prolonged soaring is therefore of interest and in the period September, 1980 to October 1983, of 2,350 + Cory's Shearwaters *C. diomedea* recorded over 154 days there have been noted only two instances, both on the same day.

During a watch from the shore between Torremolinos and Malaga on 22 June 1983 between 16.50 and 18.50 h GMT with the wind at SW force 2, changing during the watch to NNE force 2 and a light chop on the sea, two birds out of twenty-four were seen to perform extended soaring. The rest were behaving normally with flight as indicated above and moving SW along the line of the coast between 500 and 4,000 meters from the shore.

The first bird was seen to rise some 40-50 m. above the sea and maintain this altitude for about one and a half minutes before descending to sea level and continuing a more normal flight to the SW. During the brief period at altitude it was in loose company with four Herring Gulls *Larus argentatus.*

The second bird undertook its flight some five minutes later and was under direct observation at the beginning when it was flying SW at very low level. During the time of its flight the wind change took place. The bird changed course from SW, swung around to ENE, presumably into the wind although the change at that point had not reached the shore, and proceeded to gain height. At the beginning it was some 1.000 meters from the shore. It gained height to some 30 m., circling as it did so, possibly across the face of the wind change. It gained height further to 60 m. +, passing through a flock of Herring and Black-headed Gull *L. argentatus* and *L. ridibundus,* circled once around them. Causing some panic more typical of skua *Stercorarius* spp. presence, it continued to gain altitude until it was 80 m. and occasionally nearer 100 m.. Eventually it was at the same height as some feeding Pallid Swifts *Apus pallidus* and continued to move away eastwards at a general flight level of 50-60 m. Eventually the bird was lost in the heat haze, still soaring happily and passing over more normal flying Cory's Shearwater moving SW below it.

In conclusion, the interface and resultant turbulence, even at force 2 Beaufort, between SW and NNE, (some 220° of change) apparently offered conditions which stimulated two birds to soar, one of them to a very marked degree. The reason for this is presently not clear.

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BOOK REVIEWS

HARRISON, P. 1983. Seabirds — An identification guide. Pp. 448, 88 colour plates, over 300 distribution maps and many black-and-white drawings. London: Croom Helm Limited. £15.95. ISBN 0-7099-1207-2.

This book is described in the foreword by Roger Tory Peterson as a 'red-letter event for the field glass fraternity' and so it is. No other seabird field guide is as comprehensive nor as accurate as this one. I have nothing but admiration for someone who spent eleven years to produce this guide, learning to paint to provide all the illustrations, working his passage on trawlers and crayfishing boats, and for seven years travelling the world's oceans and islands to see all but thirty of the 312 species reviewed in this book.

The book is well laid out with the first 200 pages containing salient identification features summarised opposite each plate (that occupies a full side of each page and includes different aged/plumage phased birds). The next two hundred pages provide more detailed information on status and general range, plumage, flight, habits and 'jizz' (abbreviated to FHJ), distribution and movements (DM), and notes on distinctions between similar species (SS). The third section of the book comprises 32 pages of maps (each of 312 species is mapped) including known and probable breeding areas/islands, months of year usually present, possible areas of distribution, migratory range and vagrant records. Finally there are two pages of abbreviated references and four pages of index (divided between English and scientific names). It is very easy to find one's way around the book with sections clearly cross-referenced. However, I would have preferred the abbreviations FHJ, CM, and SS to be spelt out in full so as to draw immediate attention to the contents of those sections. Latin names to accompany each distribution map would also have been helpful (since English names are often quite variable). The inclusion of divers and grebes is a bit strange, with a number of these species (e.g. some Andean grebes) almost certainly never seeing the sea during their lifetime. They receive five times the treatment given to sea-ducks for some unknown reason.

The most important feature of a field guide is obviously that it should aid species identification. Many guides fail to do this either by not drawing attention to the critical identification features, or, particularly common, to mislead the reader by implying that species are easier to separate than they really are. Peter Harrison's guide goes a long way to overcoming these failings. Sometimes his plates lack the 'feel' that the bird would have in life, and some plates (e.g. the auks, particularly *Uria* species and Little Auk) are less good than others, whilst the background colours and stippling are occasionally a bit distracting (I am unclear as to why those that are chosen need to be quite so variable). The actual plumage features are generally pretty accurate at least for those species I know reasonably well. Personally I would have given greater emphasis to the more rounded (Common Gull-like) head shape of Iceland Gulls to distinguish them in the field from the Herring Gull-like head of Glaucous Gulls; the presence of at least some white at the base of the bill of Black-capped Petrel may be a better feature to separate atypical birds from the Great Shearwater; some mention could be made of the variability in the upperparts of Bridled Terns which may be almost as dark as Sooty Terns; and plate 201a depicting Long-tailed Skua in flight shows the wings as broad as Arctic Skua (plate 202a) when they usually appear distinctly narrower. However, these and a few other examples are trivial points, and I feel presumptious to make any criticism at all when I cannot possibly match the field knowledge of the author.

Obviously when an author has all the world's seabirds to describe, their distributions and movements to outline, it is easy to find at least some errors, and this applies particularly to distribution maps. A few examples are Pomarine Skuas shown breeding in Greenland and Bridled Terns in the Mascarenes when they do not; Great Skuas not recorded breeding in Norway, Spitzbergen and Jan Mayen when they do; the distributions of Lesser Frigatebird, Crested and Bridled Terns, Brown Noddy and White Terns should be extended to include the Maldives, and those of Brown Booby, Royal and Sandwich Terns to include the Netherlands Antilles; Common Terns breed on the Florida coast and both Laughing Gulls and Sandwich Terns breed on the Lesser Antilles whereas Royal Terns do not; Masked Booby distribution should extend across the Indian Ocean to include the Chagos archipelago; both Crested and Lesser Crested Terns breed further north in the Red Sea; Common Guillemots breed on the west coast not the east coast of Greenland.

Finally, the reference section is a little idiosyncratic and a number of important references have been omitted. In conclusion, however, I reiterate my early remarks. Any small criticisms hardly detract from this most significant addition to the ornithological literature. I highly commend it to anyone with an interest in seabirds.

P. G. H. Evans·

HARRIS, M. P. 1984. The Puffin. Pp 187, 24 b & w plates, 47 maps and figures, 20 tables and 2 appendices. Staffordshire, England: T. and A. D. Poyser Ltd.

If there was a 'top ten' of seabirds, I'm sure many people would place the puffin either at the top, or very near to it. Certainly the numerous visitors to the islands I've been on, want to know ... "where is the best place to see puffins?"

Mike Harris' book presents an in-depth account of the biology of this endearing seabird. The book follows the usual Poyser format and the first two chapters discuss puffin evolution and morphology. These are followed by three sections on distribution and monitoring, but the best parts of the book for me were the chapters on breeding biology, behaviour (written by Kenny Taylor), attendance, food and feeding, chick growth and predators/competitors. Of the last four chapters, two concern man's influence (egging/fowling and pollution) one assessing our relatively scant information on puffin migration, survival and wintering, with the last chapter addressing the crucial problem of those factors which influence puffin populations. For those interested, a mass of information detailed in 20 tables has thoughtfully been placed at the back of the book allowing a more flowing text. All this has been complemented by the numerous and delightful line drawings of Keith Brockie who has the rare gift of being able to capture the 'mood' of the birds.

Due credit has been given to other authors, yet clearly the bulk of the scientific information has come from Mike Harris' own research. Both Mike and Kenny Taylor have succeeded in presenting 'hard data' in an attractive and readable style. Having said this, the text is a little disjointed in places. For example the 'wheeling' behaviour turns up in the behaviour section (p. 104), when discussing activities at colonies (p. 110-112) and a role for this is implied in the kleptoparasitism section (p. 142) and yet no real link is made between them.

I found myself 'wading through' the (albeit important) distribution sections but was disappointed at the brevity of the fascinating chapters on behaviour and breeding biology. Similarly the role of the changing environment (chapter 15) occupies little more than a page, and the all important problem of industrial fishing gains very sparse attention (p. 186-187), though perhaps these views reflect my own particular areas of interest. Regrettably some of the figures are rather cramped and difficult to interpret and in particular fig. 4 (p. 31). Perhaps a half page on the derivation of the name 'puffin' or 'pwffingen' (ancient British) and the regional (eg: hobgoblin, poltrag) and national (eg: sea parrot) variations would have been an interesting addition. These citicisms should not detract from the book as a whole, which is an excellent account of our knowledge of "puffindom".

Unfortunately there are too many poorly written, often inaccurate, badly presented and expensive bird books nowadays. This book is none of these. It is informatively and clearly written by an experienced scientist, and published in an attractive format at £12.60, it should gain a place on the book shelf of anyone even remotely interested in birds.

Adrian del Nevo

O'DONALD, P. 1983. The Arctic Skua: a study of the ecology and evolution of a seabird. Pp. 324; 27 figures, 91 tables. Cambridge: Cambridge University Press. £25.00. ISBN 0-521-23581-2.

In the last two decades, Peter O'Donald's name has been closely associated with ever more refined mathematical models of sexual selection. Much of this has been built upon his own studies of assortative (preferential) mating between different colour morphs in the Arctic Skua. He first studied this for a doctorate between 1958-61 on Fair Isle and this book is the result of his extended studies on the same island, mainly over the period 1973-79. Arctic Skuas are dark phase (melanic), light phase or intermediate. Pales are most common (90-100%) in the high arctic, and least common (4%) in southern Finland, giving a cline in frequencies from north to south. About 20% of Shetland birds are pale phase. Pale phenotypes are presumed to be homozygotes, whereas intermediates and melanics are a mixture of heterozygotes and 'dark' homozygotes. Intermediate or dark chicks may change plumage colour at moult, though pale ones do not. Melanism is considered to be simply a pleiotropic effect of a gene (i.e. the effect of a gene which may also affect other characteristics), that primarily determines some other physiological or behavioural adaptation.

After two introductory chapters about the Arctic Skua, its systematics, distribution, population changes and methods used for study, O'Donald details information collected by others on feeding behaviour (notably kleptoparasitism) and ecology, and by himself and co-worker John Davis on the breeding biology of Arctic Skuas on Fair Isle. There follows a rather short chapter on Genetics including genetic analyses of matings between colour morphs, frequencies of each morph, and heritability estimates for breeding dates (statistically significant high values), clutch size and fledging success (insignificant low values). O'Donald then considers demographic features of the Fair Isle population — survival and reproductive rates, and intrinsic rates of increase, all in relation to age, sex, and colour morph. Sexual behaviour, particularly territoriality and mating preference are discussed as a prelude to the last one-third of the book which deals with the theory of sexual selection and how it may be involved in maintaining the plumage polymorphism.

O'Donald's conclusions are that the observed frequencies are determined by a balance of migration (diffusion of the mutant genotype, presumably the gene(s) for melanism) and selection, rather than by a balance between different selective forces (natural selection vs sexual selection) that vary with latitude. On Fair Isle, pale birds mature at an earlier average age than melanics. This gives them a selective advantage as a result of the greater chance of surviving to breed, but it is counteracted by sexual selection produced by female mating preference which favours melanic males. However, analysis of data from the Fair Isle population suggest that this cannot account for the balanced polymorphism, which must be maintained by melanics being favoured in the south of the range and migration from northern regions where pale birds somehow do better.

I found the book very stimulating and a good example of some of the interesting ecological and genetic questions which may be addressed and ways to tackle them. O'Donald's frequent use of the Chi-square and analysis of variance rather than regression analysis is also refreshing. Sometimes I feel he is overly critical of others, particularly since at least his ecological analyses are not always so rigorous. Information on both morph frequencies and population changes could have been improved. Why, for example, use only morph frequencies from counts before 1942 (Table 2.7, page 52) when there is much more recent data available? Indeed Fig. 2.7 on page 53, needs to be revised in the light of this. Likewise, rates of increase of the Fair Isle population have been calculated (Table 2.4, page 41) on the basis of figures for a number of years between 1948 (15 pairs) and 1975 (137 pairs). But (for no explained reason) he omits a higher population estimate (180 pairs) obtained in 1969 since when the population may have stabilised or slightly declined rather than continued to increase for six years as presented. Data on population estimates for Foula (Table 2.1, page 39) appear to be selective, and for some reason end at 1975 although counts have been made annually since then. Some tables lack important information such as means, sample sizes, sources for the data, methods and timing of counts (examples are Table 1.1, page 27; Table 2.4, page 41). Some assumptions are made (which seem unlikely e.g. that migration of genes is similar along the length of the cline and occurs only between adjacent colonies). But these may have important effects upon some of the conclusions, e.g. the selection vs migration model. One might expect, for example, gene flow to be greater into Shetland where populations have recently expanded than in Faeroes where they have declined.

On a more general note, I wonder if it is wise to build a theory too heavily upon observations

collected at the extreme southern edge of the range of a species which has only spread here in the last half century (certainly a short period in evolutionary time). Not only might consideration of evidence for selection and gene migration be a little premature at this stage, but the study colony may be rather atypical. In particular it will not have a stable age structure, and almost certainly will comprise a relatively high proportion of younger birds. Understandably, the ages of few individuals in the population are known exactly, but part of the sexual selection model is based upon female preference for melanic males, and could be affected if morph frequency were intercorrelated with age.

This book is clearly not aimed at the general seabird ornithologist. Large parts of it (including 37 pages of mathematical appendices) will be primarily of interest to the population geneticist or evolutionary biologist. For this reason the book is probably mis-titled since many will pick it up thinking they will find a general review of the Arctic Skua. The price of £25, however, will probably be sufficient to deter them, which in my opinion is a pity, because there is much to be gained from the results contained in this interesting book were they more accessible to the general reader.

P. G. H. Evans

LÖFGREN, L. 1984. Ocean birds: their breeding, biology & behaviour. Pp. 240; 203 colour photographs, numerous illustrations. Beckenham, Kent: Croom Helm. £16.95. ISBN 0-7099-1675-2.

Ten years of merchant naval service was obviously put to good use by Lars Löfgren and his camera and we are here treated to a splendid selection of his colour photographs of a wide variety of seabird species. The atmosphere is certainly oceanic, with 110 of the bird pictures being flight shots — those of Albatrosses and the larger Procellariiformes, Black Skimmer and Red-billed Tropic-birds are outstanding.

The book is divided into eight chapters, dealing with evolution and classification, oceanic life, seabird species, migration, ecology, behaviour reproduction and interactions with mankind. The author has succeeded in his use of explicit maps and diagrams within the text to illustrate various biological principles, enabling them to be grasped by academic and amateur alike. The chapter on seabird ecology is particularly well presented, providing a good grounding for an understanding of marine ecosystems and the importance of factors affecting nutrient movements. Although the diving families (notably the Penguins and Auks) could perhaps have been given a fuller treatment, the overall balance is right, and it is refreshing to find that the final paragraphs of the book are devoted to the spiritual dimensions of seabirds. This man undoubtedly has an enviable understanding and feeling for seabirds, and I can only recommend that you read his book.

P. J. Ewins
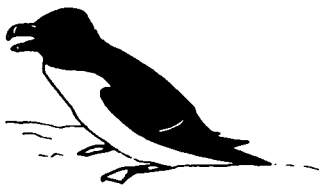
THE SEABIRD GROUP 1985

The Seabird Group was founded in 1966 to circulate news of work in progress on seabirds and to promote cooperative research on them. It is run by an Executive Committee composed of nine elected members and maintains close links with the three major British national ornithological bodies — the British Ornithologists' Union, the British Trust for Ornithology, and the Royal Society for the Protection of Birds. Membership (£5 per annum, £2.50 for students and pensioners) is open to all with an interest in seabirds; for details please contact the Secretary (address below) — payment by banker's order and deed of covenant helps the Group.

Current Executive Committee The present Committee comprises: Chairman J. P. Croxall, Secretary E. K. Dunn, Treasurer T. J. Stowe, also A. Blackburn, M. P. Harris, G. Mudge, A. del Nevo (Newsletter Editor), K. E. Partridge, M. L. Tasker, and Ms L. Underwood (co-opted).

Newsletter and Meetings Three duplicated newsletters are circulated each year to members. They contain all sorts of news including reports on research projects (particularly those with a grant input from the Group — see below), details of meetings, etc. The usual venue for the Group's annual meeting is the BTO Ringing & Migration Conference unless, as in 1985, the Group holds its own conference, in which case the meeting is combined with that. Our conferences draw on seabird workers from home and abroad to join in a forum of topical interest. In keeping with our desire to promote work in the field, practical manuals and guidelines evolve from the workshop sessions which cater for specialist topics within the conference theme; thus a manual will, in due course, be published after the 1985 conference workshop on population monitoring.

Seabird Group Grants Each year the Group has some money available to help fund research work conducted by members. All applications for grants should be submitted to the Secretary by the end of January each year and will be considered by the Executive Committee. Grants awarded in 1984 embraced ringing studies on the Scottish islands of Sule Skerry and Canna, a photographic census of Gannets in the Channel Is., auk and Gannet studies in Kerry (Ireland), Little Auk research in Spitzbergen, and a census of seabirds in the Azores. Certain areas of research may be favoured for grant support from time to time and in 1984, for example, the allocation partly reflected our willingness to support a national Gannet census, results of which will be reported later. The Azores census was prompted by the knowledge that there was likely to be a substantial, but hitherto uncounted, population there of Roseate Terns, a species which has declined in Britain to less than 600 pairs. The census, in which Seabird Group members liaised closely with local Azorean ecologists, yielded over 600 pairs of Roseate Terns, and over 2,000 pairs of Common Terns, and also revealed the first proven breeding colony of Madeiran Storm Petrels *Oceanodroma castro* in the Azores archipelago.

Site Register Scheme The Seabird Group has always sought to organise and implement national schemes to promote the participation and harness the energies of its membership, now standing at over 400. The Group membership played a major role in the national Operation Seafarer survey whose results were published in 'The Seabirds of Britain and Ireland' (1974). We have also been long associated with the Beached Bird Survey organised by the RSPB, and members regularly contribute observations to the NCC's 'Seabirds at Sea' project. The Group is now in the early planning stages of mounting a new national Site Register scheme in which regional organisers will be responsible for

marshalling up-to-date information on the location, strength and composition of the seabird colonies in their area. In this way we hope to explore changing patterns since the 1974 Seafarer survey, establish a new baseline for future changes, and create a scheme in which the membership of the Seabird Group can play an active and sustained role. Developments in the organisation and implementation of this scheme will appear in the regular Newsletters, and other Seabird Group publications.

Seabird Journal and previous reports The Group is very pleased with the successful launch of its new-look journal 'Seabird' in November 1984, of which this is the second issue (No. 8). We are especially grateful to the retiring editors P. G. H. Evans and T. R. Birkhead for compiling issues 7 and 8. From issue 9 (inclusive) editorial responsibility passes into the able hands of M. de L. Brooke, a long-standing member of the Group and active researcher on seabirds. Offers of papers should be sent to the Editor of Seabird (see below). Members of the Seabird Group receive *Seabird* free of charge; additional copies to members, and any copies to non-members, are £5 + 50p postage within the British Isles, £5 + £1 postage overseas. Postage overseas must, regrettably, be by surface mail, unless the recipient can make prior provision for air-mail. The subscription to Libraries is £7.50p per copy. At various intervals in the past, the Group has published printed reports (1-6) to which *Seabird* is the successor. Copies of the four earlier reports are available from the Secretary as follows: issues for 1969, 1971, and 1975-6 at £1, 1977-81 at £3, postage costs as for *Seabird*. There are no cost concessions for multiple orders of *Seabird* or Seabird Group Reports. Copies of the Proceedings of Seabird Group Conferences (1982 and, when published, 1985), are also available at £1 plus postage.

Who to write to As appropriate, contact the Secretary (for general enquiries about the Group and its activities, request for membership, grants, etc.), the Treasurer (for subscriptions, donations, etc.), Newsletter editor, or Editor of *Seabird*. All may be contacted through the following address: Seabird Group, c/o RSPB, The Lodge, Sandy, Beds, SG19 2DL. Please help the Group to keep its costs down by enclosing a stamped addressed envelope for reply.