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Measurements, Chick Meals and Breeding Distribution of Dovekies (*Alle alle*) in Northwest Greenland[1]

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ABSTRACT. This paper reports the results of an investigation of Dovekies (*Alle alle* L.) breeding near Cape Atholl and Siorapaluk in the Thule District, Northwest Greenland during July and August 1978. Mean values for body measurements of breeding birds were: total length = 218.2 mm (n = 265), wing length = 122.9 mm (n = 266), tail length = 40.8 mm (n = 266) and body weight = 150.5 g (n = 209). Most measurements between the sexes were not significantly different, but mean body weight of males (153.8 g) was significantly greater than that of females (147.2 g). Body weight was highly correlated with wing length and total length in males, but not in females. Food delivered to nestlings consisted primarily of copepods (*Calanus hyperboreus* and *C. glacialis*) and amphipods (*Parathemisto libellula* and *Apherusa glacialis*). Size of chick meals delivered by male and female parents did not differ significantly and average meal weight was 3.48 g (sd = 1.24, n = 204) with mean weight of meals increasing through the chick-rearing period. General information is presented on measurements of subadults, timing of breeding, feeding areas, population size and colony attendance, and predation and disturbance. The distribution of Dovekie colonies in the Thule District is reviewed and compared with earlier information.

Key words: Dovekie, morphometrics, chick diet, seabirds, NW Greenland

RÉSUMÉ: Ce rapport signale les résultats d'une étude des Dovekies (*Alle alle* L.) en saison de nids près de Cape Atholl et de Siorapaluk dans le district de Thule, dans le nord-ouest du Groenland, au cours de juillet et août 1978. Les valeurs moyennes des mesures corporelles des oiseaux en saison des nids étaient les suivantes: longueur totale: 218.2 mm (N = 265), longueur d'aile: 122.9 mm (N = 266), longueur de la queue: 40.8 mm (N = 266) et poids: 150.5 g (N = 209). La plupart des mesures ne différaient pas de façon importante entre les sexes, mais le poids moyen des mâles (153.8 g) dépassait de façon significative celui des femelles (147.2 g). Il existait une haute corrélation entre la longueur d'aile et la longueur totale chez les mâles, mais non chez les femelles. La nourriture fournie aux oisillons consistait surtout de copépodes (*Calanus Hyperboreus* et *C. glacialis*) et d'amphidopes (*Parathemisto libellula* et *Apherusa glacialis*). La taille des repas livrés aux oisillons par les parents mâle et femelle ne différait pas de façon importante et le poids moyen d'un repas était de 3.48 g (DS = 1.24, N = 204), ce poids moyen augmentant au travers de la période d'élevage des oisillons. On présente des renseignements généraux sur les dimensions des jeunes oiseaux, la période d'accouplement, les aires d'alimentation, la taille de la population et les périodes de présence des groupes d'age dans la colonie, les activités prédatrices et les dérangements. La distribution des colonies de Dovekies du district de Thule est revisée et comparée à des données antérieures.

Mots clés: Dovekie, morphométrie, régime des oisillons, oiseaux marins, nor-ouest du Groenland

Traduit par Maurice Guibord, Le Centre Français, The University of Calgary.

INTRODUCTION

Information on Dovekies (*Alle alle* L.) in Northwest Greenland is very sketchy. Collett and Nansen (1900), Kolthoff (1903), Salomonsen (1943, 1950, 1967, 1974), Duffey and Sergeant (1950), Uspenski (1958), Løvenskiold (1954), Joensen and Preuss (1972), and Norderhaug *et al.* (1977) have presented data on this alcid as part of avifaunal surveys and additional information has appeared in popular species summaries (Fisher and Lockley, 1954; Bateson, 1961; Breummer, 1972; Salomonsen, 1974). The pelagic ecology of Dovekies has been reported by Rankin and Duffey (1948), Sergeant (1952), Fisher and Lockley (1954), Brown *et al.* (1975) and Brown (1976), but detailed observations at the breeding colonies are rare (Norderhaug, 1970, 1980; Golovkin *et al.*, 1972; Zelickman and Golovkin, 1972; Evans, 1981). It has been suggested that the Dovekie (Fig. 1) is the most numerous seabird in the North Atlantic, and possibly the most abundant alcid in the world (Salomonsen, 1950; Norderhaug, 1970). The population in the Thule District, Northwest Greenland, has been estimated to be at least 30 million birds (Salomonsen, 1950, 1974), which probably comprises more than 50% of the species's total numbers (based on population data from Salomonsen, 1950, 1967, 1974; and Norderhaug *et al.*, 1977).

The main objective of our visits to Dovekie colonies in the Thule District in 1978 was to obtain throat pouch

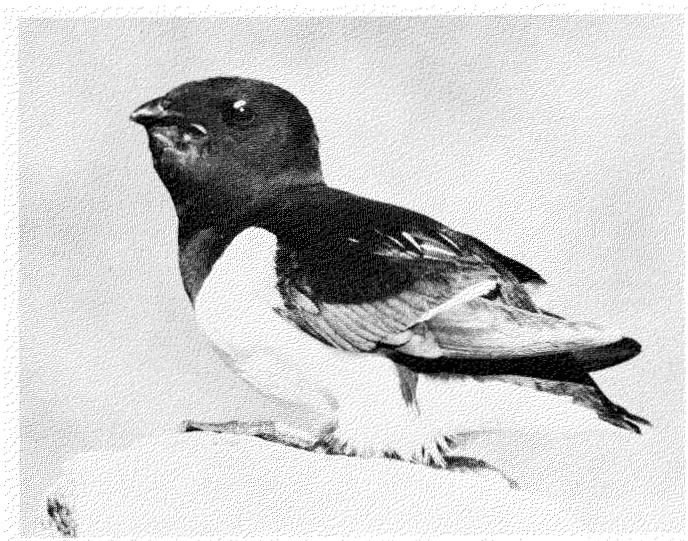

FIG. 1. The Dovekie, *Alle alle*, the most northerly distributed and abundant alcid in the Atlantic. This bird is an adult with a distended throat pouch containing food for its chick.

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contents from breeding birds during the chick-rearing period. These chick meal samples were used to determine the quantity and species composition of the food of the chick to compare with data being collected from birds in northwestern Baffin Bay during the same period. This information is important to the determination of the nutritional requirements for successful breeding by Dovekies and for the assessment of the possible effects of existing and proposed industrial activities (i.e., deep-water drilling, oil and gas transport and lead-zinc mining) upon this seabird population.

This paper presents the results of our examination of the morphology of food-carrying adults, sizes of meals being delivered to nestlings and the relationship of meal size to adult size and sex. Information derived incidentally from the major work included general features of breeding (i.e., timing, colony attendance, feeding areas, predation and disturbance) and a review of the distribution of colonies in Northwest Greenland; these data are also given. Details on composition of the food are presented in Bradstreet *et al.* (1981).

STUDY AREAS

Data were collected at two locations. Our study area for the early part of the chick-rearing phase (17 July to 3 August) included a small but high-density nesting area located 2.5 km southeast of the recently abandoned Cape Atholl Loran Station or 12 km southeast of Cape Atholl (76°18.5'N, 69°17'W) (Fig. 2). The study area was located on talus and extended 110 m up and 140 m across a southeast-facing slope of 40° (Fig. 3). The area was chosen primarily for accessibility to large numbers of breeding Dovekies, and also because of the fairly uniform exposure and slope, and the lack of a bedrock outcrop.

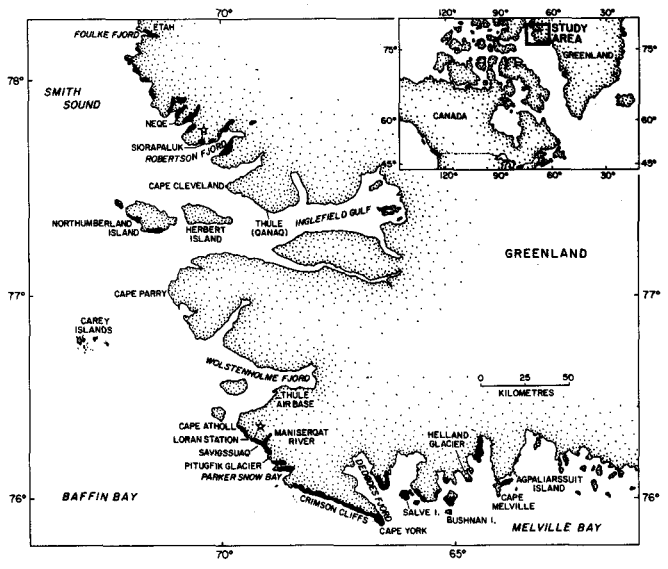

FIG. 2. Breeding distribution of Dovekies in the Thule District, Northwest Greenland. The boundaries of colonies are shown by black shading and the stars indicate the locations of the two study sites. Place names are those mentioned in the text.

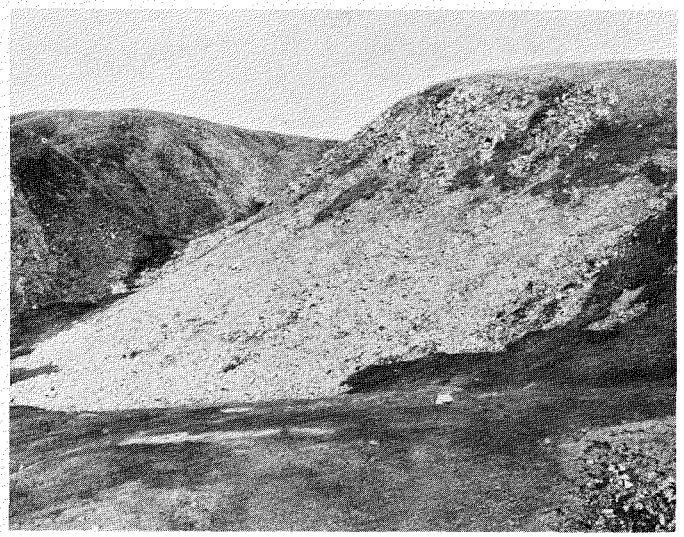

FIG. 3. Scree slope nesting habitat of Dovekies at the Cape Atholl study area, 22 July 1978.

Density of nesting Dovekies appeared to be highest mid-way up the talus slope where the average size of rock material was intermediate (0.5-1.0 m diameter), although no data comparing nesting density in areas of different sized talus were collected. Areas where the talus had become stabilized and covered with vegetation had few nesting Dovekies; partially vegetated strips of stabilized talus frequently separated high-density nesting areas. The unoccupied strips and the areas at the base of the talus slopes were covered with a lush, green mat of nitrophilous vegetation (Salomonsen, 1950).

The second study area (4-21 August), located approximately 3 km west of Siorapaluk (77°47'N, 70°45'W) with a southern exposure, was used extensively by local residents of Siorapaluk and nearby villages for catching Dovekies. The density of breeding Dovekies was not as high as in the study area at Cape Atholl, but the talus slopes reach to much greater elevations (at least 400 m) at Siorapaluk and the birds nest as far up as snow melt occurs.

METHODS

Sample 'meals' from the distensible throat pouches of adult Dovekies were obtained by collecting the birds. Dovekies were caught by two methods: monofilament snares and long-handled nets. We used snare lines stretched over large, flat display rocks where we observed Dovekies to land upon returning to the colony. The birds began to struggle soon after they were caught and frequently managed to eject food before they were secured. When only a small amount of plankton had been lost from the throat pouch, the bird was collected and the expelled food items retrieved; otherwise the bird was released and the food sample discarded.

Inuterssuak Uvdloriak, an experienced Polar Eskimo bird-netter from Siorapaluk, collected 63 Dovekies with full throat pouches in about three hours using a long-

handled net, whereas our collection rate using snares averaged 8.1 birds per hour. As with the snaring method, the biggest problem with netting was spillage and some samples had to be discarded. Birds with no food in the throat pouch were released after recording brood patch size and wing colour. Dovekies carrying food were killed immediately and throat pouch contents were removed and placed in a plastic vial of known weight. The container and contents were then weighed with a 100 g Pesola spring scale, after which isopropyl alcohol was added to preserve the contents. Each Dovekie food sample and carcass was given a sample number and labelled with date, time of capture, location and meal weight. The birds were weighed (i.e. total body weight minus food pouch contents) and measured (total length, wing length and tail length) using methods defined in Palmer (1962). Each collected bird was also examined to determine sex, brood patch size and wing colour. All captured birds were assigned to one of four categories: (1) brown-winged with no brood patch, (2) dark-winged and small brood patch (*ca.* 13 mm x 10 mm), (3) dark-winged and medium brood patch (*ca.* 21 mm x 19 mm), and (4) dark-winged and large brood patch (*ca.* 38 mm x 26 mm). First-year birds were easily recognized by brown wing colour and the absence of a brood patch (F. Salomonsen, pers. comm.). Only a few birds had wing colour intermediate between the first-year birds and the black-winged adults, and these birds usually had small brood patches. It may therefore be possible to age most subadults using brood patch size alone once sufficient data become available. Birds with adult plumage and medium or small brood patches were probably two- and three-year-old birds, though the age that Dovekies attain sexual maturity is unkown. Ten nestlings were collected late in the breeding season for measurements.

On 1 August, a survey was made of Dovekie nesting areas southeast along the coast from the Cape Atholl Loran Station (76°17′N, 69°03′W) and then several kilometres inland along the Maniserquat River.

Throughout the study notes were kept on weather conditions, timing of breeding, potential predators at the colony, bird movements and feeding areas as observed from land and water. We interviewed residents of Siorapaluk on the subject of Dovekies since the successful utilization of these birds for food requires knowledge of their life history and breeding distribution. A detailed map of the distribution of breeding Dovekies in the Thule District was sketched from memory by Uvdloriak, a resident in the region for 72 years, and compared with existing published information. No attempt was made to verify his recollections or check for changes in breeding distribution which may have occurred since he last visited the colonies in question.

The statistical significance of differences between sample means was tested using Student's t-test. The significance of divergences from expected 50:50 ratios was tested using chi-square tests (Sokal and Rohlf, 1969).

RESULTS AND DISCUSSION

Body Measurements and Regional Variation

Total, wing, and tail length measurements were obtained from 266 breeding Dovekies collected at Cape Atholl and Siorapaluk in July and August of 1978 (Table 1). The means for these measurements were 218.2 mm, 122.9 mm, and 40.8 mm, respectively. Of 209 breeding birds weighed, the mean body weight was 150.5 g.

Breeding adults captured at Cape Atholl ($n = 114$) did not differ significantly in size from those captured at Siorapaluk ($n = 95$). No significant difference in total length or wing length was found between sexes from either locality, although males average slightly larger (Table 1). However, mean body weight of breeding males (153.5 g) was significantly greater ($P < 0.001$) than mean body weight of breeding females (146.8 g).

The only significant divergence from a 50:50 sex ratio was among adults feeding young at Siorapaluk late in the nestling period, where males outnumbered females 60 to 35 ($P < 0.02$).

Eighteen 'brown-winged' subadults from Cape Atholl were measured and weighed. No significant sexual differences were found, but males average somewhat larger and heavier. Highly significant differences ($P < 0.001$) in wing length, body length, tail length and body weight were found between first-year birds and breeding adults. None of the subadults ($n = 38$) had any trace of a brood patch.

Ten nearly fledged nestlings were measured and weighed at Siorapaluk on 14 August. Although males averaged somewhat larger, the small sample size precluded any statistical examination. Nestlings close to fledging were significantly smaller than yearlings in all four measurements ($P < 0.001$).

Average body weight of breeding male Dovekies snared at Siorapaluk was significantly higher ($P < 0.001$) than comparable birds caught with long-handled nets. An explanation for possible bias in one or both of the capture methods is not apparent. Despite this difference, the measurements and weights of Cape Atholl males (all snared) were not significantly greater than those of Siorapaluk males (mostly netted) (Table 1).

Løvenskiold (1954) measured a small series of adult Dovekies from Svalbard ($n = 22$). Although the wing lengths of those birds ($\bar{x} = 123.5$ mm, sd = 2.69) averaged greater than both the males and females from the Thule District, the difference was not statistically significant. Some weights of Svalbard birds were also taken, and while the females ($\bar{x} = 149$ g, sd = 3.61, $n = 3$) did not differ significantly from Thule females, the average weight of males (173.8 g, sd = 18.1, $n = 10$) was greater ($P < 0.001$) than those recorded for Thule males (Table 1).

TABLE 1. Body sizes and weight of throat pouch food contents of Dovekies from Northwest Greenland, July and August 1978

Location and Status		Total length (mm)	Wing length (mm)	Tail length (mm)	Body weight (g)	Weight of throat pouch food contents (g)
Cape Atholl:						
Breeding	$\bar{x}$	220.2	122.6	41.2	152.7	3.14
adult ♂♂	sd	11.56	2.80	2.37	7.76	1.17
	n	56	57	57	57	56
Breeding	$\bar{x}$	218.7	122.3	40.6	146.3	3.31
adult ♀♀	sd	8.07	2.90	1.98	8.86	1.15
	n	57	57	57	57	56
Siorapaluk:						
Breeding	$\bar{x}$	218.9	123.6	41.8	154.2	3.88
adult ♂♂	sd	10.28	2.57	2.13	7.68	1.28
	n	60	60	60	60	57
Breeding	$\bar{x}$	216.2	122.5	40.9	147.6	3.66
adult ♀♀	sd	10.12	3.08	2.24	8.57	1.30
	n	35	35	35	35	35
Combined:						
Breeding ♂♂	$\bar{x}$	219.5	123.1	41.5	153.5	3.51
	sd	10.88	2.73	2.25	7.72	1.27
	n	116	117	117	117	113
Breeding ♀♀	$\bar{x}$	217.7	122.4	40.7	146.8	3.44
	sd	8.94	2.95	2.07	8.73	1.21
	n	92	92	92	92	91
All breeding	$\bar{x}$	218.2	122.9	40.8	150.5	3.48
adults measured	sd	9.68	2.80	2.43	8.81	1.24
(known and	n	265	266	266	209	204
unknown sex)						
'Brown-winged' subadults	$\bar{x}$	204.7	117.2	37.8	140.4	—
(first-year	sd	10.58	2.20	2.16	7.41	
birds)	n	18	18	18	18	
Almost fledged	$\bar{x}$	181.5	98.1	27.6	117.3	—
nestlings	sd	10.57	5.99	3.63	11.23	—
(14 August)	n	10	10	10	10	

The difference in mean body weight between the two sexes from Svalbard was also significant despite the small sample sizes ($P < 0.05$). Sexual dimorphism may be more evident in Svalbard Dovekies than in those in from Greenland, though the small sample size makes this uncertain. Løvenskiold (1954) recorded the weights of two males as 200 g and three others as 180 g. The maximum body weight recorded in the present study was 178 g.

Salomonsen (1944) compared a large series of Dovekies captured in Northwest Greenland with birds caught in the northeastern Atlantic and found no regional differences in wing length. Mean wing lengths for his series of 81 males and 49 females were 122.0 mm and 119.9 mm, respectively (standard deviations not available), somewhat below the means from the present study (♂ ♂ = 123.0 mm, and ♀ ♀ = 122.2 mm). The differences may merely be because Salomonsen's measurements were from study skins (where shrinkage is likely to have occurred) whereas ours were of freshly-killed birds (F. Salomonsen, pers. comm.).

Timing of Breeding

Uvdloriak informed us that the peak of hatching for Dovekies in the Robertson Fjord area is usually 16-18 July. Assuming a 24-day incubation period (Kartaschew, 1960), the peak of egg-laying would normally be 22-24 June. On 18 July, the first day we captured Dovekies at the Cape Atholl study area, it was apparent that most pairs either were incubating or had newly-hatched young. No more than 2% of the birds we observed on the colony had plankton in their throat pouches, and of the 21 adult-plumaged Dovekies that we snared, none were carrying meals to nestlings. The peak of hatching at Cape Atholl appeared to be about 20 July, though the absence of precise data makes this uncertain. Assuming an average fledging period of 27 days (Norderhaug, 1970), we would

have expected the peak of fledging to have occurred on 12-14 August in a normal year. This agrees well with Uvdloriak's assertion that nestlings begin to fledge in the Siorapaluk area on 11 August. However, fledging at Siorapaluk appeared to be somewhat delayed in 1978, since on 14 August there was yet little apparent reduction in the numbers of adults at the colony. Norderhaug (1980) noted similar variation in nesting phenology between years. Uvdloriak stated that, in normal years, the exodus of all birds from the colony is complete by 1 September.

Chick Diet, Meal Size and Feeding Distribution

In total, 204 'meals' were collected from the throat pouches of Dovekies returning to the colony. All food-carrying birds had large brood patches and dark wings. The meals ranged in fresh wet weight from 1.0 to 6.5 g and averaged 3.48 g (sd = 1.24). A preliminary examination of 10% of the food samples revealed little species diversity and size variation. The major food items were copepods (*Calanus hyperboreus* and *C. glacialis*) and amphipods (*Parathemisto libellula* and *Aspherusa glacialis*). Copepods dominated by frequency of occurrence (*ca.* 90% by number), but amphipods were of equal importance (or marginally higher) on a dry weight basis (copepods + amphipods comprised over 90% of total dry weight) because of their larger individual body size. Other organisms of importance included decapod larvae (*Spirontocaris* spp.) and small fish (*Boreogadus saida*).

The weights of meals carried by males did not differ significantly from those carried by females (Table 1). The average meal weight from birds caught at Cape Atholl on 26-29 July ($\bar{x}$ = 3.09 g, sd = 1.03, n = 67) was not significantly different from those caught from 30 July to 3 August ($\bar{x}$ = 3.43 g, sd = 1.31, n = 45) on the same study area (Fig. 4). However, the mean weight of meals from birds caught at Siorapaluk from 13 to 16 August ($\bar{x}$ = 3.79, sd = 1.33, n = 94) was significantly greater (P = 0.001) than that of birds caught at Cape Atholl (Fig. 4). Unlike body weight, the mean weight of meals from snared Siorapaluk birds did not differ signficantly from those that were caught with long-handled nets.

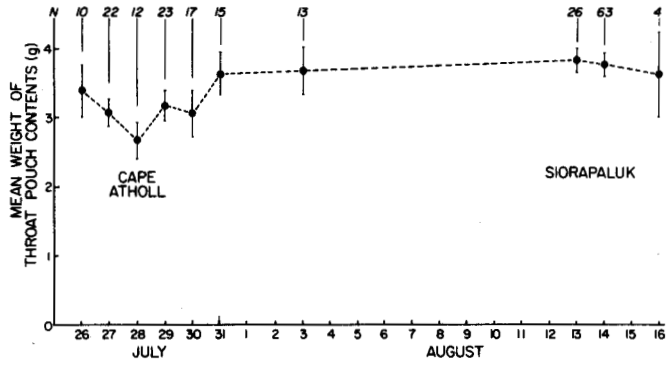

FIG. 4. Mean size of meals delivered to Dovekie nestlings in Northwest Greenland, 1978. Sample size and standard error are given for each mean.

A correlation matrix was constructed using the variables of total bird length, wing length, body weight and weight of throat pouch contents (Table 2). Body weight was significantly correlated with total length and wing length (P < 0.01) in males, but the correlation was not significant in females. Apparently factors other than body size were more responsible for body weight variation in females. Wing length was not significantly correlated with total length for either sex, but when the sexes were combined wing length was correlated with total length (P = 0.05).

The weight of the meals which adults carried back to nestlings at the colony was not correlated with total length of the adults (Table 2). However, in females, the meal weight was positively correlated to both wing length (P = 0.04) and body weight (P = 0.03). When the sexes were combined, meal weight was again significantly correlated with wing length (P = 0.005) and body weight (P = 0.006).

The weights of meals which adults carried back to nestlings at the colony were significantly correlated with wing

TABLE 2. Correlation matrix for body measurements (i.e., total length, wing length, body weight) and mean weights of food-carrying Dovekies collected at colonies in Northwest Greenland in 1978

Measurement	Total Length			Wing Length			Body Weight		
	♂	♀	Combined	♂	♀	Combined	♂	♀	Combined
Weight of throat pouch contents	N.S. (112/−)	N.S. (91/−)	N.S. (203/−)	N.S. (113/−)	+ (91/0.04)	++ (204/0.005)	N.S. (113/−)	+ (91/0.03)	++ (204/0.006)
Total length				N.S. (116/−)	N.S. (92/−)	+ (208/0.05)	++ (116/0.001)	N.S. (92/−)	++ (208/0.001)
Wing length							++ (117/0.01)	N.S. (92/0.05)	++ (209/0.001)

Figures in parentheses are sample sizes and P values (where P < 0.05) respectively.

N.S. = Correlation coefficient not significant (P > 0.05).
\+ = Correlation coefficient significant and positive (0.05 ≥ P > 0.01).
++ = Correlation coefficient highly significant and positive (P ≤ 0.01).

length and body weight of the adults (Table 2). This suggests that, while there is considerable variation in meal weights resulting from other factors, the body size of adults may play a role in determining the amount of food delivered to nestlings at each feeding. Although males were on average heavier than females, there was no significant difference in the mean weight of meals carried by each sex (Table 1).

There was considerable variation in the daily mean weight of throat pouch contents collected at Cape Atholl (Fig. 4). Weather did not appear to be the major cause of this variation, as fog and/or precipitation occurred on days with both high and low relative mean meal weights. The lowest mean for meal weights was obtained on 28 July, the only day in which we snared birds near the base of the colony. Our observations indicate that breeding was later amongst birds nesting towards the base of the slopes, because of a later snow melt at this location. Since meal size increased through the fledging period, mean meal size at the base of the slopes might be expected to be lower in this habitat than elsewhere.

Norderhaug (1970) collected 116 sample meals from adult throat pouches on Svalbard. The range in weight of these samples (0.7 to 6.8 g) was very similar to that obtained in this study. The mean weight of the Svalbard samples increased from 2.3 g in the first week after hatching to 3.5 g in the last week before fledging (no standard deviations available). This same general increase in the average meal weight as chick-rearing progresses was apparent in the data for Thule birds in 1978 (Fig. 4). This increase was associated with changes in the composition of chick meals. The mean dry weight of calanoid copepods and decapod larvae increased (from 51.4% to 59.3% and from 4.8% to 6.9%, respectively) while the mean dry weight of amphipods decreased (from 43.0% to 33.1%) (Bradstreet *et al.*, 1981).

Both sexes appeared to share equally in the brooding and feeding of chicks during the first half of the nestling period (i.e. divergences from a 50:50 sex ratio in the Cape Atholl samples were insignificant). However, the sex ratio of breeding adults captured at Siorapaluk was significantly skewed (60♂♂:35♀♀, $P = 0.02$) during the late chick-rearing period suggesting that the male's role in feeding the nestling at this time may be more pronounced than the female's. It will be important in future work to examine differences between the sexes in patterns of attendance at the colony (e.g. time of day), delivery of food to the chick, flight characteristics and susceptibility to capture, and other areas.

Large numbers of Dovekies were seen, with the aid of a 15X spotting scope, feeding more than 1 km offshore at the Cape Atholl study area. Feeding birds were most numerous where the density of bergs and pan ice was greatest. The numbers of birds at the foot of Pitugfik Glacier (Fig. 2) was frequently extremely high, but it was impossible for us to determine the existence of other comparable feeding areas farther offshore. Pitugfik Glacier may be the site of productive upwellings similar to those described by Hartley and Fisher (1936), Stott (1936) and Dunbar (1951).

During two trips by boat between Dundas and Siorapaluk via Qanaq, we recorded observations on the distribution of feeding Dovekies. No Dovekies were seen between Wolstenholme Fjord and Cape Parry, but in Whale Sound a few scattered birds were noted (Fig. 1). Directly east of Herbert Island and offshore from Qanaq were numerous feeding flocks of up to 100 birds plus many flocks flying low over the water up Inglefield Gulf to the east. Many of these birds were presumably from breeding colonies at either Robertson Fjord or Northumberland Island (Fig. 2) and were gathering food for nestlings (as evidenced by distended throat pouches). Thus these birds apparently were foraging for food at least 60 km from their nest sites. On the afternoon of 9 August and the evening of 20 August many large flocks of Dovekies were seen flying out of Robertson Fjord and heading east past Cape Cleveland. Our observations did not indicate that most prey were obtained within 2.5 km of the colony as reported by Evans (1981) for Dovekies breeding further south in West Greenland.

Population size, Colony Attendance, Predation and Disturbance

Our estimate of the breeding population at the Cape Atholl study area was at least 7000 breeding pairs. No estimate of the size of the breeding population in the Siorapaluk study area was attempted.

The age composition of Dovekies caught at the two study areas changed markedly as the nesting season progressed (Fig. 5). When we began snaring birds at Cape Atholl on 18 July, 46% of 39 Dovekies caught were first-year birds. The presence of large brood patches suggested that about half the remaining 54% were active breeders, presumably still incubating eggs. After 26 July, first-year birds were caught only in small numbers (Fig. 5). The numbers of non-breeders caught at the colony remained at about the same level as breeders until after 31 July. By 13-16 August (late in the chick-rearing period), there were

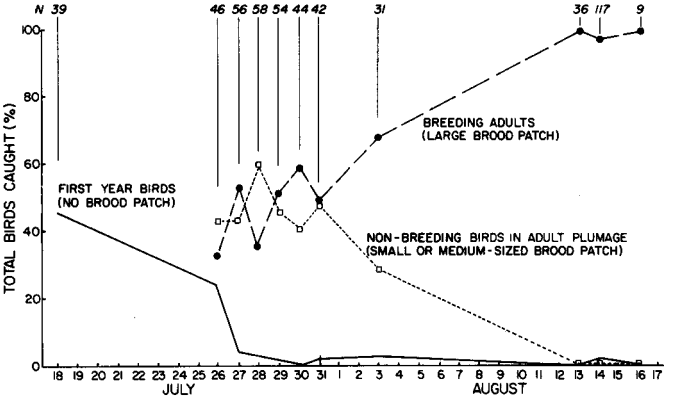

FIG. 5. Status and composition of Dovekies captured at breeding colonies in Northwest Greenland, 1978.

very few non-breeding birds present at the Siorapaluk colony (Fig. 5).

First-year birds, and probably other subadults as well, were present at the colony in large numbers only from about 0600 to 2000 h (AST). Evans (1981) also recorded high colony attendance from 0400-1400 h. This has important implications for any attempt to estimate the size of the breeding population on the basis of birds visible on sample plots. Such counts must either be conducted at "night" between 2000 and 0300 h or after mid-August when most subadults no longer attend the colonies and before adults start to leave.

Of five potential Dovekie predators observed at the two study areas, Glaucous Gulls (*Larus hyperboreus*), arctic foxes and man probably have an appreciable effect on survival and productivity, while Common Ravens (*Corvus corax*) and Gyrfalcons (*Falco rusticolus*) almost certainly do not (Salomonsen, 1950). Only one pair of Gyrfalcons was seen and did not appear to be hunting Dovekies. Ravens were uncommon at Cape Atholl and were not seen taking Dovekie eggs, nestlings, or adults. Although ravens were more numerous at Siorapaluk, they were greatly outnumbered by Glaucous Gulls which are known to prey on adult and fledgling Dovekies.

We did not witness any successful chases of Dovekies by Glaucous Gulls, but their reliance on Dovekies for food has been noted elsewhere (Salomonsen, 1950; Norderhaug, 1970). The behavioural effect of a passing Glaucous Gull on Dovekie colonies was very pronounced, particularly at the Cape Atholl study area where one passing gull was sufficient to send most of the thousands of birds perched on the colony flying out over the water. If passing gulls were frequent, the nesting slope was virtually devoid of birds for over half an hour. Even if the number of birds lost to gull predation is of minor significance, the associated disturbance may be important to success in reproduction. The behavioural reaction to passing ravens was quite similar to that for gulls. Glaucous Gulls were very numerous at the Siorapaluk colony during the period when Dovekie chicks were fledging, and undoubtedly reduced Dovekie fledging success.

Arctic foxes were observed nearly every day at both study areas. On several occasions we saw foxes carrying Dovekie eggs or adults. Although they may have had a greater impact on productivity and mortality than gulls at Cape Atholl, they clearly did not elicit a high-intensity behavioural response from the birds. To a certain extent this was also true of the other important terrestrial predator, man. Foxes were frequently tolerated at a distance of 2 m without causing "panic flights". Dovekies were less tolerant of a person moving through the colony and usually flew off when the intruder reached a distance of 5 m.

In addition to avian predators, mass panic flights were also elicited by the calving of glaciers and break-up of icebergs, actions which usually produced sounds similar to cannon fire. On several occasions we had the opportunity to observe the reaction of birds at the colony to low-flying aircraft (*ca.* 200 m). The response was higher than any observed reaction to avian predators or iceberg breakup. The most pronounced panic flight was in response to a U.S. Air Force C-141 jet on approach to Thule Air Base; almost the entire colony flew rapidly and silently out to sea, in contrast to the normal noisy circling seen in response to passing gulls. A period of 15 minutes elapsed before bird activity at the colony returned to normal.

Breeding Distribution in the Thule District

Figure 2 shows the breeding distribution of Dovekies in Northwest Greenland as known by Uvdloriak. In general, however, the distribution of sites with breeding birds agrees with the description of breeding areas given by Salomonsen (1950) and only the discrepancies are discussed below.

Salomonsen (1950) described the northern portion of the breeding range in Northwest Greenland as "the coastal cliffs from Etah almost continuously southwards to Robertson Bay (Fjord)". While small numbers of Dovekies may breed between the areas identified on Uvdloriak's map (Fig. 2), the densest nesting areas are probably accurately shown. Foulke Fjord (Etah) (78°18'N, 72°30'W) and the nunatak directly north of Neqe (77°52'N, 71°35'W) were two areas which Uvdloriak mentioned as having particularly large colonies. The nunatak (77°55'N, 69°45'W) at the head of Robertson Fjord is a questionable nesting area; apparently no one has visited it during the breeding season, but flocks of Dovekies have been seen flying inland from the head of the fjord. Uvdloriak mentioned that Dovekies nest only in small numbers on the north coast of Northumberland Island, but two major colonies occur on the south coast. He did not consider the Carey Islands a breeding area, which agrees with Salomonsen (1950, and pers. comm.). Uvdloriak also indicated many Dovekies breeding in the first bay south of Pitugfik Glacier (76°13'N, 68°50'W). While Salomonsen (1950) mentioned both sides of Parker Snow Bay (76°09'N, 68°30'W) as nesting areas, Uvdloriak indicated only the north shore. Both Salomonsen (1950, pers. comm.) and Uvdloriak felt that the highest nesting density and greatest numbers in the Thule District were to be found in the Crimson Cliffs area (*ca.* 76°02'N, *ca.* 67°30'W). Several breeding areas in Melville Bay not mentioned by Salomonsen (1950) were identified by Uvdloriak, but he was uncertain of some locations. Since Uvdloriak had only visited this area infrequently during the breeding season, it seems certain that at least some of the marked nesting areas are located incorrectly. He was unsure whether Dovekies nested at the head of DeDodes Fjord (*ca.* 76°15'N, *ca.* 67°00'W), but was convinced that there was a colony on the peninsula (76°06'N, 66°25'W) directly north of Cape York. He also indicated that Salve Island (76°03'N, 66°00'W), a smaller unnamed island (76°01'N, 65°45'W)

5 km southeast of Salve Island, and three areas on the large peninsula (*ca.* 76°03′N, *ca.* 65°30′W) east of Salve Island were Dovekie breeding sites. He was uncertain whether Dovekies breed on Bushnan Island (75°58′N, 65°05′W), but indicated that the land at the tip of Helland Glacier (76°08′N, 64°40′W) and a strip of unglaciated coast (76°16′N, 64°25′W) northeast of the glacier had nesting colonies. He also thought that only a few Dovekies nested near Cape Melville (76°06′N, 64°00′W), and was unaware of the nesting colony on Agpaliarssuit Island (76°13′N, 62°35′W). Two more small mainland nesting areas (76°13′N, 63°38′W; 76°15°N, 63°35′W) and an island colony (76°13′N, 62°35′W) were outlined by Uvdloriak. He did not know if other small colonies existed in that area, but was sure that there were no other large colonies farther down the coast.

Our own foot survey southeast from the Cape Atholl Loran Station almost to Pitugfik Glacier revealed no other colonies of comparable density and size to the Cape Atholl study area. Large numbers of birds were breeding at Savigssuaq (76°17′N, 69°05′W) and at least 6 km up the Maniserqut River from the coast. In this inland area, Dovekies were nesting on slightly sloping talus near hilltops.

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