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CONTENTS

SUMMARY

Results from studies of the breeding biology of the Little Auk in Hornsund, Svalbard, 1962-1965, are summarized.

The largest colonies are located in talus slopes along the mountain sides. Nest density of more than one nest per square metre has been observed in some colonies.

Variations in egg size appear from Fig. 5. The single egg is incubated by both parents. Hatching period is 74-77 hours. Variation in hatching time was studied, 1963-65 (Figs. 7-8). Thermoregulation in nestlings starts about 3-5 days after hatching. Growth development of the nestlings from hatching until desertion of nest is described (Figs. 10-13). When leaving the colony, Little Auk nestlings have achieved 70-95% of adult size. Nestlings leave the nest four weeks (27.1 days on the average) after hatching.

Food consists of planktonic crustaceans. Both parents take part in feeding the young. The chick is fed in average 8.5 times per 24 hours. Observed feeding rate was higher during the day than during the night, indicating no relation to possible vertical zooplankton migration (Figs. 26-27). The chicks are fed until they leave the nest. Weight decrease during the last week is explained by increased activity of the young. Amount of plankton brought in per feed was studied by catching adult birds returning from the sea. Samples varied in size between 0.7 ccm and 7.0 ccm. A slight increase in size of the food samples with age of the chick was observed (Fig.31).

Based on net weight increase of the chick from hatching until desertion of the nest,and studies of the feeding rate and food amount per feed, the ecological yield : zooplankton/ Little Auk in this ecosystem was calculated to 13.5%. It was further estimated that a colony of 100,000 pairs transports about 70 tons of zooplankton to the colony during four summer weeks. This organic transport has considerable impact on the terrestrial ecosystems in these high Arctic areas.

РЕЗЮМЕ

Подведены итоги исследований гнездовой биологии люрика в Хорнсунде (Свальбард) в 1962-1966 гг.

Самые крупные колонии располагаются на осыпных склонах гор. В некоторых колониях наблюдена плотность гнёзд более, чем в одно на квадратный метр.

Вариации яйцевого размера показаны на рис. 5. Единичное яйцо насиживается обоеми родителями по очереди. Период насиживания длится 74-77 часов. Вариации этого срока были изучены в 1963-1965 гг. (рис. 7 и 8). Термическое регулирование у птенцов начинается дней за 3-5 после выведения. Описан рост птенцов от выведения до оставления гнёзд (рис. 10-13). До оставления колонии птенцы люриков достигают 70-95% взрослого размера. Птенцы оставляют гнёзда за четыре недели (в среднем 27,1 дня) после выведения.

Пища состоит из планктоновых ракообразных. Оба родителя принимают участие в кормлении детёныша. Птенец кормится в среднем 8,5 раза в сутки. Отмеченная частота кормления оказалась выше днём, чем ночью, что не связано с возможной вертикальной зоопланктоновой миграцией (рис. 26-27). Птенцы кормятся до оставления гнёзд. Уменьшение веса на последней неделе пребывания при гнёздах объясняется повышенной деятельностью детёнышей. Количество планктона, привезённое при каждом кормлении, было определено у взрослых птиц, пойманных при возвращении с моря. Пробы колебались по количеству от 0,7 до 7,0 кубических сантиметров. Было отмечено незначительное увеличение кормовых проб по мере увеличения возраста детёныша (рис. 31).

На основе увеличения чистого веса птенца от выведения до оставления гнезда, а также по исследованиям частоты кормления и количества корма каждого кормления, экологический выход зоопланктон/люрик в этой экосистеме был вычислен в 13,5%. Дальше было подчитано, что населяющая колонию стая в 100 000 пар доставляет в неё около 70 тонн зоопланктона за четыре летние недели. Этот перевоз органического вещества оказывает значительное воздействие на земные экосистемы высокоарктических областей.

INTRODUCTION

In spite of its vast numbers, the Little Auk *(Plautus alle)* was until the 1960ies one of the least known species among Arctic birds. During the Norwegian Ornithological Spitsbergen Expedition in 1962, a suitable area for studies of the ecology of this species was found on the northern side of Hornsund, on the southwest coast of Spitsbergen (Figs.1-3). This study started in Hornsund in 1963 and continued in the summers of 1964 and 1965.

This paper presents the results of studies of the development of the young from hatching until the desertion of the nest, and studies of the food consumption by the nestling during the same period. Data on migration (NORDERHAUG 1967), on the role of the Little Auk in Arctic ecosystems (NORDERHAUG 1970), and on its distribution in the Svalbard area (NORDERHAUG et al. 1977) have been published earlier.

NEST AND EGG

The largest colonies of Little Auks in Svalbard are located in areas with talus slopes. These localities are mainly found in Hecla Hoek formations along the western coast of Spitsbergen. Colonies of many hundred thousand breeding pairs can be found here. Density of nests varies with composition and structure of the talus, but more than one nest per square metre has been observed in some colonies.

Nests are normally found half a metre or more from the surface of the slope. According to various authors (KOENIG 1911; BENT 1919; KARTASCHEW 1960; SALOMONSEN &

Fig. 1. Working area on the northern side of Hornsund, Spitsbergen. Arrow indicates the colony. Photo: NORSK POLARINSTITUTT.

Fig. 2. Little Auks on the breeding site.

RUDEBECK 1964) the single egg is laid directly on the ground. This was, however, not comfirmed by observations in Hornsund. In nearly all nests, the egg was laid on a layer of pebbles (2-4 cm in size) (Fig. 4) brought in by the parents; flying birds carrying pebbles in their bills were sometimes observed. Occasionally, fragments of lichens and dry straws were also found.

In spite of the two brood patches, the Little Auk normally lays only one egg (Fig. 4), which is incubated by both parents. In three cases, two eggs were found in the same nest, but here hatching failed totally, as only one egg was incubated at the time.

Variations in size of 195 eggs are shown in Fig. 5. As field work in Hornsund could not start until the beginning of July, egg laying and duration of incubation could not be observed. There are no recent data available, but FABER (1826) indicated an incubation period of 24 days.

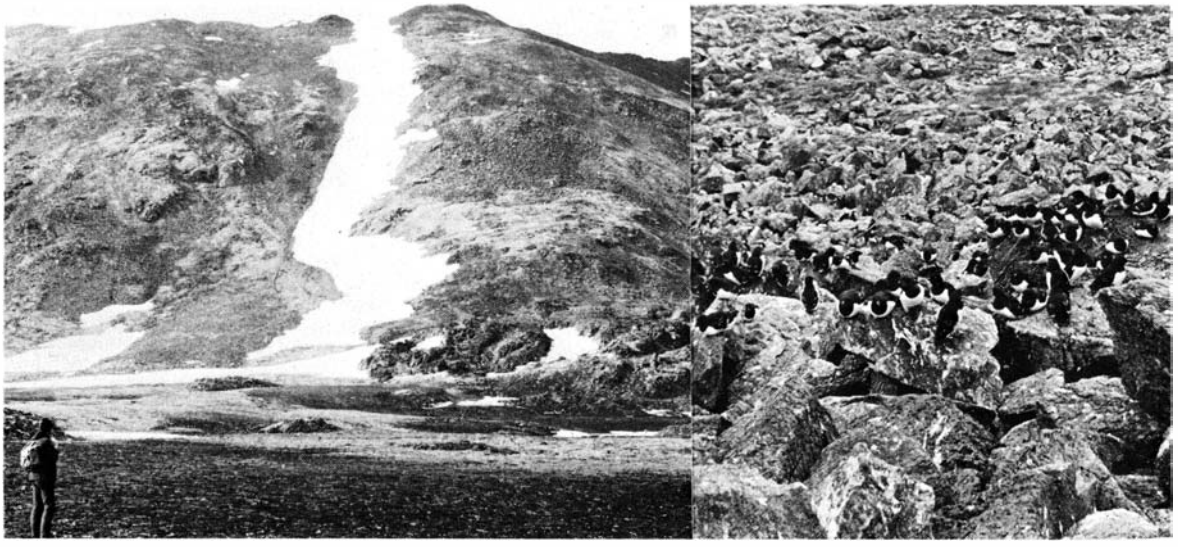


Fig. 3. LEFT: Working area, Hornsund. The colony is located on the right side of the snow slope. RIGHT: Structure of the breeding site.

HATCHING

The first star-shaped fractures in the egg-shell were seen 2-6 days before hatching actually took place. Normally the egg was pipped on the third day after fractures were observed, and hatching took place the following day. Average duration of the hatching period in 1963, 1964, and 1965 were 84, 77, and 74 hours, respectively. The somewhat longer hatching period observed in 1963, compared with 1964-65, is probably a consequence of altered working procedures. In 1963, incubating adults were released outside the nest, leaving the egg exposed. In 1964-65, the adults were released into the nest. Under these circumstances, the egg was uncovered for a shorter period. Observed hatching periods in 1963 have therefore probably been prolonged by the used working procedure. A hatching period of 74-77 hours could accordingly be regarded as more normal (Fig. 6). The date of hatching was studied in the colony in a total of 144 nests in 1963-65 (43-54 nests per year) (Fig. 7).

The observed variation in the start and end of the incubation period in 1963 and 1964 was studied in relation to variations in weather conditions in June/July. In Fig.8 egg laying in 1963-64 is reconstructed from the observed hatching curves in the colony and FABER's (1826) estimated incubation period of 24 days. These data are related to meteorological data from the nearest weather station, Isfjord Radio (NORSK METEOROLOGISK ÅRBOK 1965,1966). In spite of the fact that the colonies are located in mountain slopes where the snow cover often is not directly comparable with the snow cover on the coastal plains below, there is apparently a relation between snow cover, snow depth, and the observed variation in egg laying/hatching in these two summers. Other factors may, however also be of significance. In 1963, only small amounts of

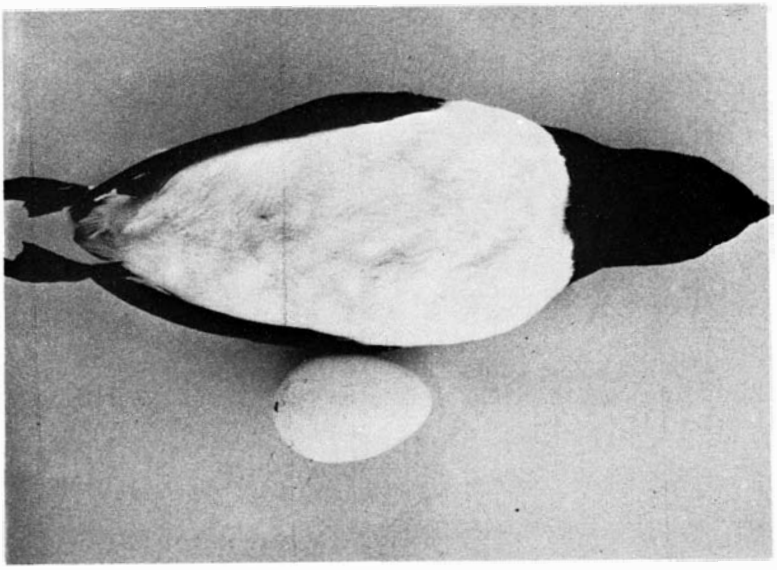


Fig. 4. ABOVE: Nest of the Little Auk.
BELOW: Egg and adult bird.

snow were still left in the middle of June. Egg-laying, however, did not start until the last week of June. Air temperature may probably also under such circumstances play an important role in the initiation of egg-laying, together with the variation in the snow cover. 1963 was, however, a very early breeding season, and hatching as early as 12 July had never been recorded from Svalbard before (LØVENSKIOLD 1964).

THERMOREGULATION

During the first days after the end of the hatching period, nestlings are not fully homeothermic and are brooded by one of the parents. No direct measurements of thermoregulation were made during the field work in Hornsund. Systematic observations on frequency of adult birds warming nestlings in control nests give, however, an indirect answer.

During the daily check, observations were made on presence/absence of adult birds in the nests. Assuming that warming of nestlings gradually ceases when they achieve adequate thermoregulatory ability, Fig. 9 gives a rough picture of the trend. The figure is based on observations in a total of 59 nests (1963-64). Data from the two years have been put together since there was no significant difference in the material from the two years. According to Fig. 9, there is a marked decrease in number of nests with adults covering nestlings during the first few days. From the fifth day, adults were only observed in one-third of the nests. From these observations there is reason to believe that sustained homeothermy is achieved 3-5 days after hatching.

Studies of thermoregulation in Alcidae have earlier been published on various species. Some of these data are summarized in Table 1.

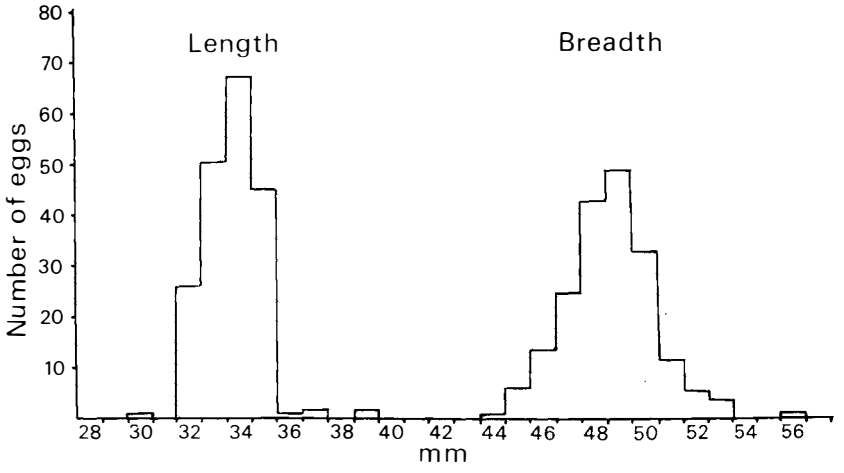


Fig. 5. Variation in egg size. The mean length of 195 eggs was 49.05 mm (range 44.9 - 56.3 mm), and the mean breadth was 34.22 mm (range 30.9 - 39.2 mm).

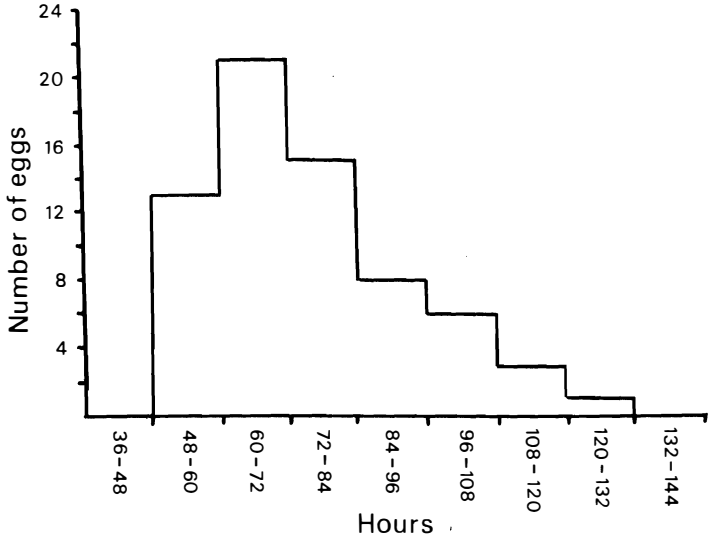


Fig. 6. Variation in the breaking period of Little Auk eggs (n = 67).

Table 1

Shift to sustained homeothermy in some Alcidae

Species	*Start of thermo-regulation*	*Reference*
Alca torda	3-4th day	BELOPOLSKI (1957) ROLNIK (1948)
Cepphus grylle	3-4th day	BELOPOLSKI (1957) ROLNIK (1948)
Cyclorrhynchus psittacula	3-4th day	SEALY & BEDARD (1973)
Plautus alle	3-5th day	This study
Uria aalge	3-8th day	BELOPOLSKI (1957) ROLNIK (1948) JOHNSON & WEST (1975)
Uria lomvia	3-8th day	BELOPOLSKI (1957) ROLNIK (1948) JOHNSON & WEST (1975)
Fratercula arctica	3-7th day	BELOPOLSKI (1957) ROLNIK (1948) TSCHANZ (1979)

GROWTH OF THE YOUNG

Young semi-precocial Alcidae are fed by the parents in the nest until the juvenile plumage is complete and slightly less than adult body weight is attained (SEALY 1973). During 1962-65 nestlings in control nests were weighed and measured daily. The main part of the material was collected in 1963-1964. In 1963 weighings took place at small, permanent stations established in the colony. In 1964, this system was further improved by using small spring balances (Pesola, ½-20 grams and 0-300 grams).

In 1963 and 1964 the study started with 54 and 57 nestlings, respectively. Of these, 34 and 35 were studied from hatching until departure to sea. Measurements of nestlings disappearing before the time of departure, have

also been utilized in the preparation of the final growth curves. Before using material from incomplete series, these measurements were compiled separately and compared with data from complete series. Since there were no apparent differences in the growth curves, the material was put together when the general growth curves were prepared. The weight curves (Fig. 10) are based on a total of 2039 weighings. The curves of wing, bill, and tarsus development (Figs. 11-13) are based on 1991, 2000, and 1990 measurements, respectively.

Since daily observations and measurements might disturb the nestlings and accordingly influence their growth and development, a control group was established. This group consisted of nests where measurements were taken with 7-9 days intervals. No significant influence on growth by the daily controls was indicated, however.

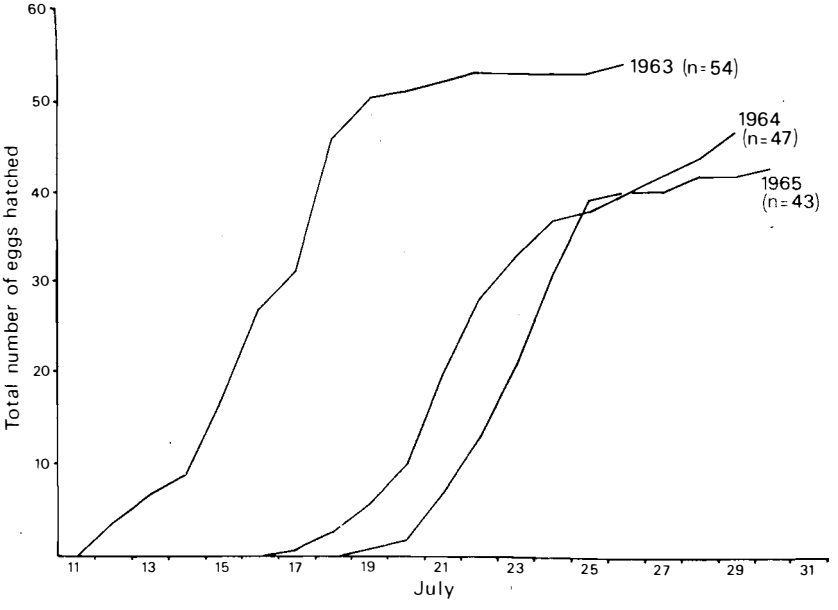


Fig. 7. Variation in hatching frequency 1963-65.

Prior to departure to sea, a weight recession occur in semi-precocial Alcidae nestlings (SEALY 1973). This weight recession (Fig. 10) in the last week before desertion of the nest may lead to the conclusion that nestlings are not fed by their parents. Studies of the feeding rates, however, show that the Little Auk parents feed their nestlings until they depart to sea. In Little Auk nestlings, the main part of the weight decrease may be caused by the marked increase in activity (movements in and out of the nest, wing-flapping, etc.) during the last days before departure. Observations of weight recession in *Cyclorrhynchus psittacula*, *Aethia cristatella* and *A. pusilla* (SEALY 1973) confirm this conclusion. Water loss during the maturation of tissues as recorded by RICKLEFS (1968) may also contribute to the observed weight recession.

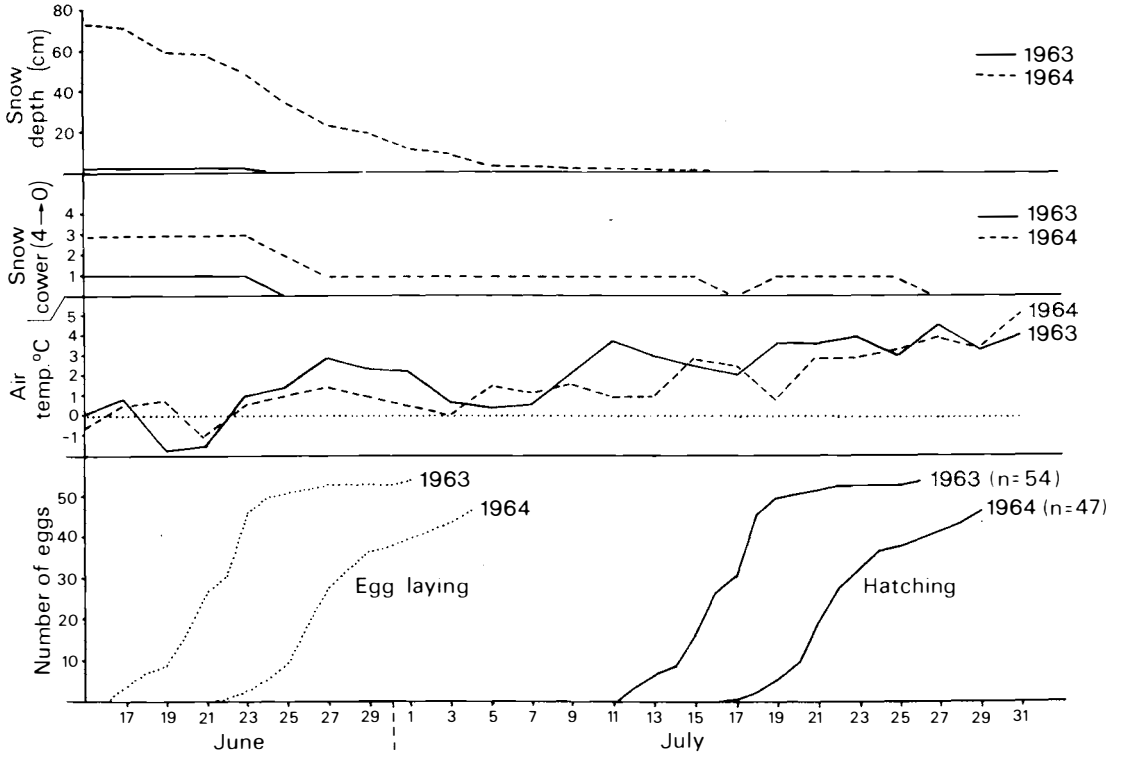


Fig. 8. Egg laying and hatching in relation to some climatic factors, 1963-64.

The average weight of adult Little Auks is 163.5 g (Table 2). The weight at hatching is 13.0%, and when leaving the nest, 69.9% of adult weight (Fig. 15).

In Fig. 14 relative weight at hatching and when deserting the nest is compared with similar data from seven other Alcidae. The *Uria* and *Alca* species represent Alcidae where chicks leave the colony at an early stage of development. The other five are species where the young leave the colony well developed and by active flight. It appears that nestlings of *Plautus alle* have a relatively high body weight when newly hatched, and a relatively low body weight when deserting the nest, compared to other Alcidae species. This may probably be an adaption to the harsh climate and the short breeding season in the high Arctic.

Bill growth during the nest period is complicated to describe as the bill is short and growth during the nest

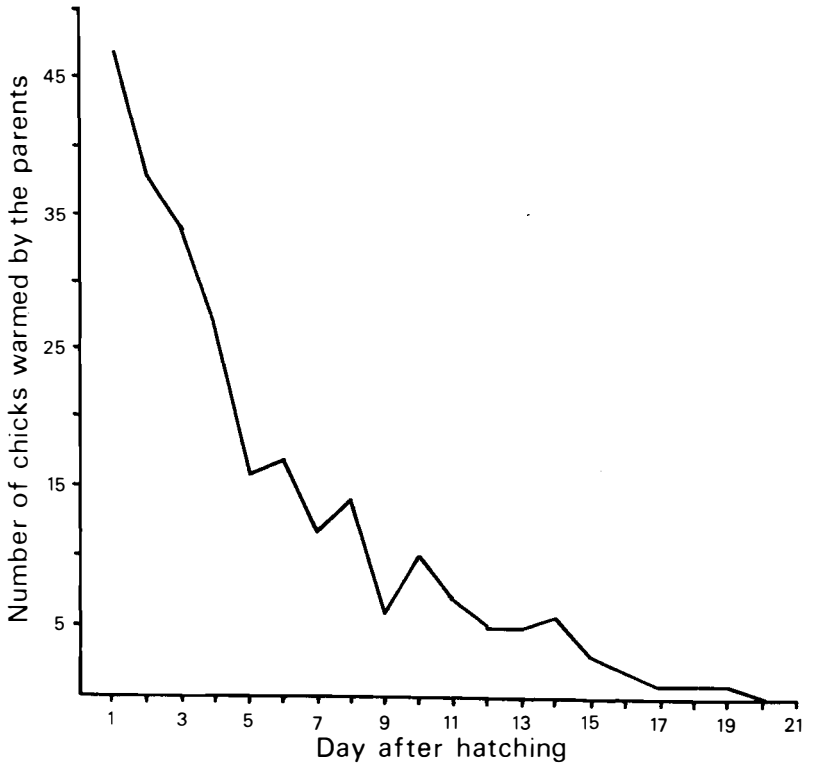


Fig. 9. Changes in the number of chicks brooded by the parents. Data from 1963 and 1964 summarized.

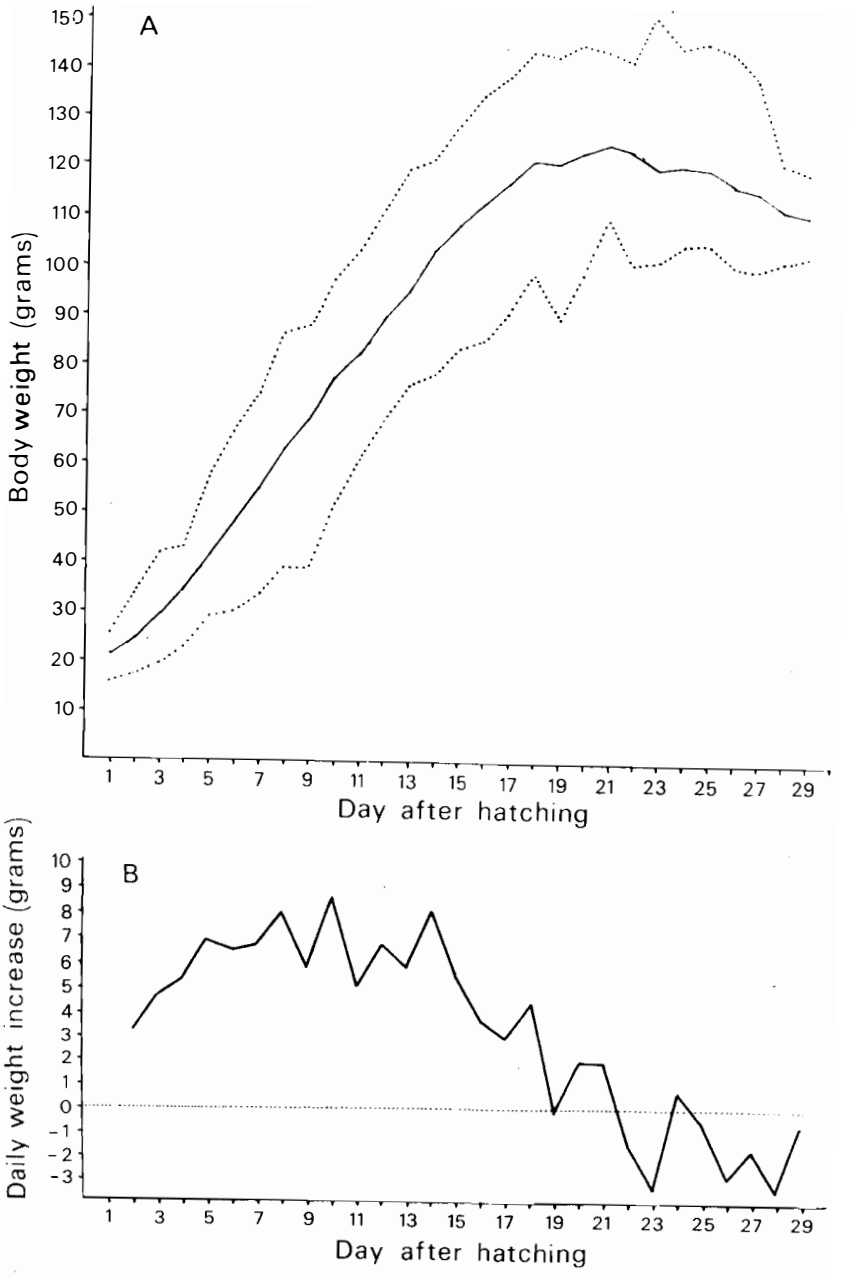


Fig. 10. Growth in body weight of Little Auk nestlings. Data from 1963 and 1964 summarized. Dotted lines on A indicate extremes.

period is only about 3 mm. Furthermore, measurements could not be taken with higher accuracy than 0.5 mm. Results appear from Fig. 12.

The relative bill length (compared with adult measurements) in newly hatched chicks is 52.2%, and when leaving the nest 73.6% (Fig. 15). Average size of adult bill is 15.2 mm (Table 2).

During the nest period, wings grow about 80 mm. With an accuracy of 1 mm, wing growth could be studied without serious problems. Results appear from Fig.11. The relative wing length in newly hatched chicks is 15.3%, and when leaving the nest, 84.9% (Fig. 15). Average length of adult wing was 118.8 mm (Table 2).

Table 2

Measurements of Little Auks

		Mean	*Range*	*n*
Nestling, 1st day				
Weight	(g)	21.52	16.0 - 25.5	84
Wing	(mm)	18.19	15.0 - 22.0	85
Bill	(mm)	7.96	7.0 - 9.5	84
Tarsus	(mm)	13.89	12.0 - 17.5	83
Nestling, 27th day				
Weight	(g)	114.33	100.0 - 143.0	41
Wing	(mm)	100.88	96.0 - 105.0	41
Bill	(mm)	11.21	10.0 - 12.0	41
Tarsus	(mm)	17.38	16.0 - 18.5	41
Adult weight	(g)	163.50	136.0 - 204.0	74
wing	(mm)	118.84	106.0 - 129.0	185
bill	(mm)	15.24	13.5 - 17.5	185
tarsus	(mm)	18.34	16.0 - 21.0	185

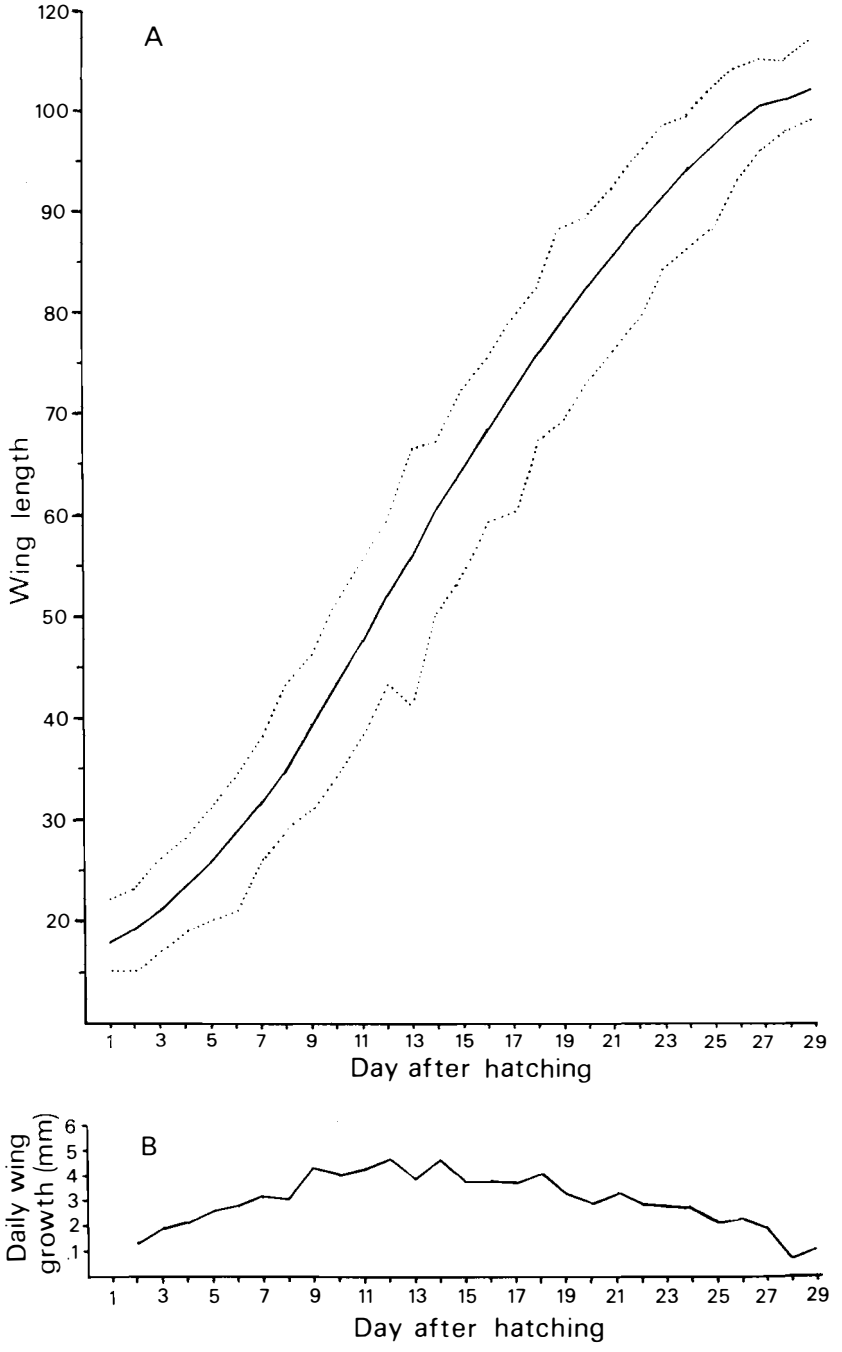


Fig. 11. Growth in wing length in Little Auk nestlings. Data from 1963 and 1964 summarized. Dotted lines in A indicate extremes.

BRUN (1958) pointed out that wing length in *Alca torda* was better age criteria than body weight. In Little Auk nestlings this is also the case, as wing growth is more or less linear and does not show the daily irregularities often observed in body weight.

Tarsus grows about 3.5 mm during the nest period, the main growth during the first 8-10 days. Study of tarsus growth is also complicated because it proved impossible to take measurements with higher accuracy than 0.5 mm. Results appear from Fig. 13. The relative length of tarsus in newly hatched chicks is 75.8% and when leaving the nest, 94.7% (Fig. 15). Average length of adult tarsus was 18.4 mm (Table 2).

Growth in bill, tarsus, wing, and weight from the time of hatching until desertion of nest is summarized in Fig. 15. Changes are seen in relation to adult measurements = 100%. See also Fig. 16. In summary, Little Auk nestlings have developed 70-95% of adult size when leaving the nest after 27 days.

PLUMAGE DEVELOPMENT

To describe various stages in plumage development on breast,mantle, and wing, studied during daily visits to the control nests, a classification system was worked out. Data were collected from a total of 69 nestlings (1963-64) checked daily from hatching until deserion of nest. Only a brief summary of plumage development will be given here. Newly hatched chicks have a thick, downy plumage in black or greyish black (Fig. 17), which changes gradually into the grey and white juvenile plumage shown in Figs. 18-20 (somewhat similar to adult winter plumage). Development of the juvenile plumage takes about three weeks and is normally fulfilled one week before desertion of the nest. In general, all down has disappeared when the young leave the nest (62 out of 67 nestlings).

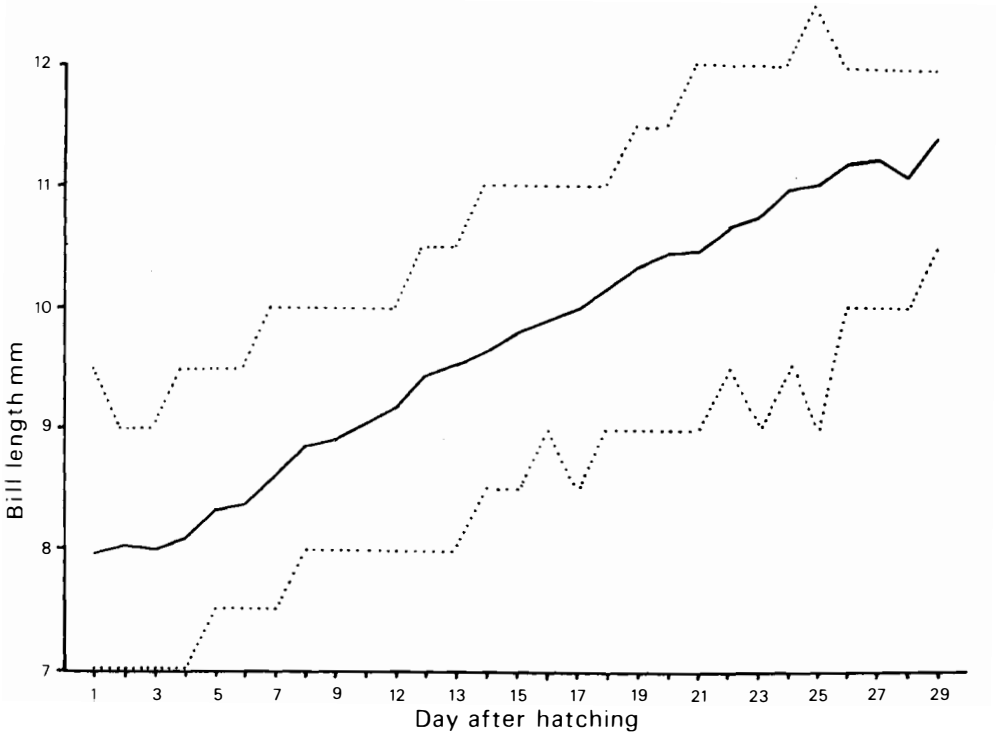


Fig. 12. Bill growth in Little Auk nestlings. Data from 1963 and 1964 summarized. Dotted lines indicate extremes.

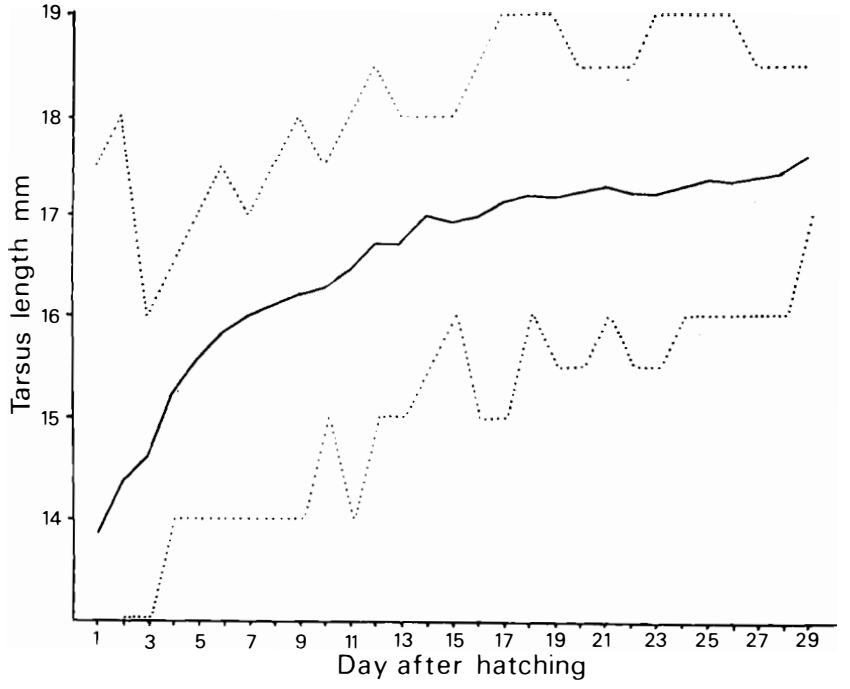


Fig. 13. Growth in length of tarsus in Little Auk nestlings. Data from 1963 and 1964 summarized. Dotted lines indicate extremes.

Reference in literature (SALOMONSEN 1944; LØVENSKIOLD 1954; SALOMONSEN & RUDEBECK 1964; HARRISON 1975) to brown colours in the newly hatched chicks or in the juvenile plumage, have not been confirmed by this study. All young, without exception, were black/blackish grey in their first plumage, and grey/white in their juvenile plumage. Brown (chocolate brown) was the typical colour of adult birds in summer plumage.

Further details on plumage development apppear from Figs. 19-21.

DEPARTURE TO SEA

In the fourth week after hatching, juvenile plumage is fully developed and the desertion of the nest starts. Departure to sea takes place by active flight. When leaving the colony, the young is normally accompanied by one or both parents. The main part of the departures took place during the late evening and night (from 2100 hours until early morning). Flight was directed towards the sea. Landing was never observed. Only on one occasion was a young observed to return to the colony after flying out.

Duration of the stay in the nest was studied in 1963-64. In a total of 34 nests the period from hatching until departure was determined with an accuracy of twelve hours (by two nest checks per day during the hatching and departure periods). In average chicks spent 27.1 days in the nest (variations 26-29 days). The ages of the young when leaving the nests appear from Fig. 21.

Compared with other Alcidae that leave the nest more or less fully developed (all except the *Alca/Uria* species), the duration of the nest period of *Plautus alle* is remarkably short (Fig. 22). The length of this period may depend on the relation between body

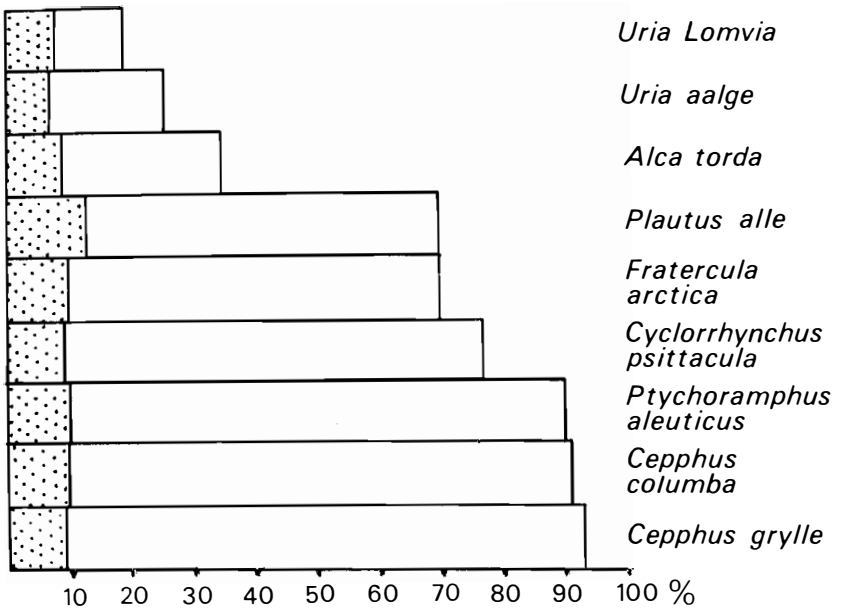


Fig. 14. Weight at hatching (dotted area) and when departing to sea, of chicks of some Alcidae (in per cent of adult weight). Data for Uria lomvia, Uria aalge, Alca torda, Fratercula arctica, *and* Cepphus grylle *from BELOPOLSKI (1957) and KARTASCHEW (1960). Data for* Ptychoramphus aleuticus *and* Cepphus columba *from DRENT (1965). Data for* Cyclorrhynchus psittacula *from SEALY and BEDARD (1973).*

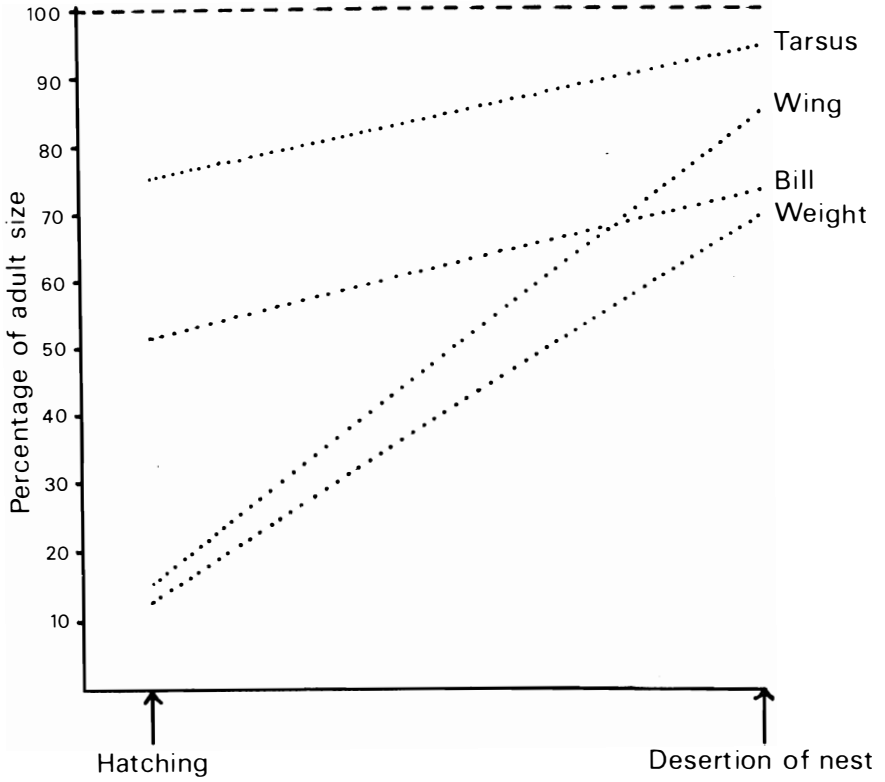


Fig. 15. Development of the young from hatching until departure to sea, in relation to adult size.

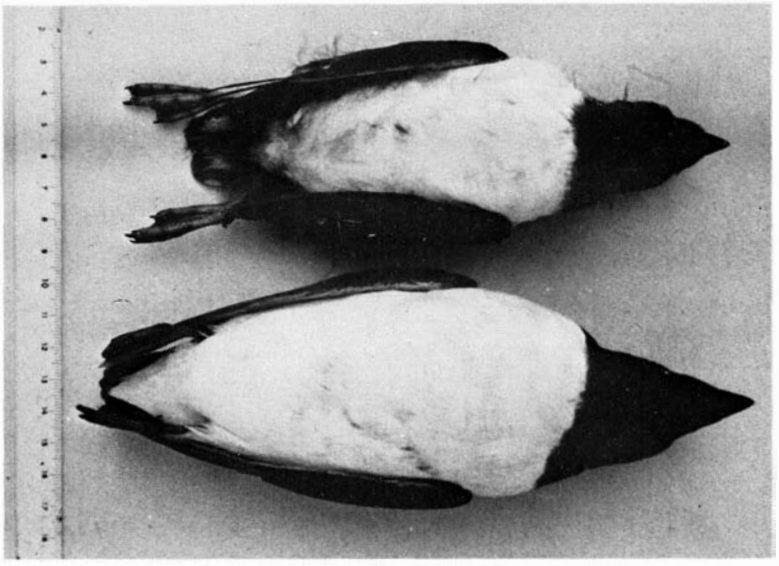


Fig. 16. Size differences between adult birds and newly fledged nestling.

Fig. 17. Chick in its first week after hatching.

weight and wing length. A relatively constant factor between body weight and wing length was reached by all Little Auk nestlings before leaving the nest. At the last check the body weight/wing length relation was on the average 1.10 in 1963 and 1.13 in 1964 (total average 1.12). See also Fig. 23.

Departure to sea took place in somewhat different periods in 1963 and 1964 (Fig. 24), reflecting the variation in the start of egg laying in the two years. In general the desertion period in the control nests was two weeks (14 days in 1963 and 13 days in 1964). More than 90% of the nests in the colony had also been deserted during this period.

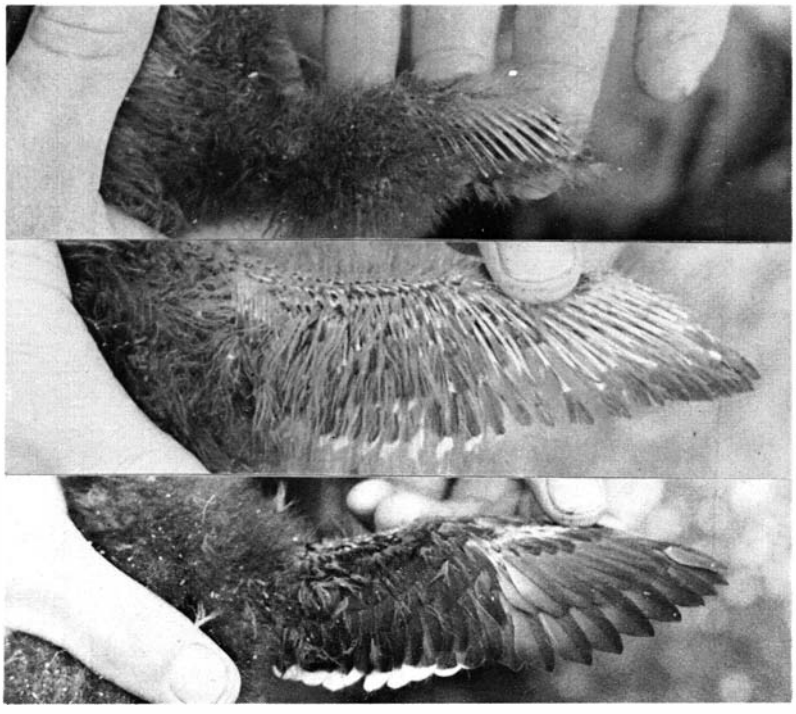


Fig. 18. Wing development in Little Auk nestlings. A: wing nine days after hatching; B: wing fourteen days after hatching; C: wing eighteen days after hatching.

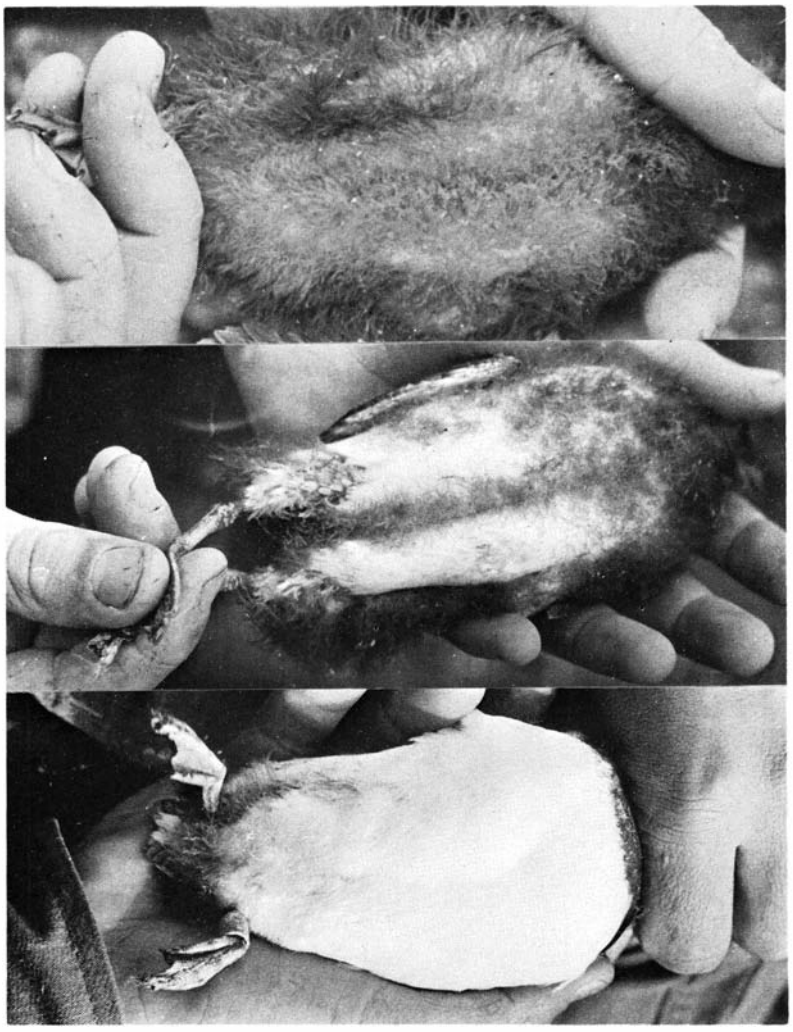
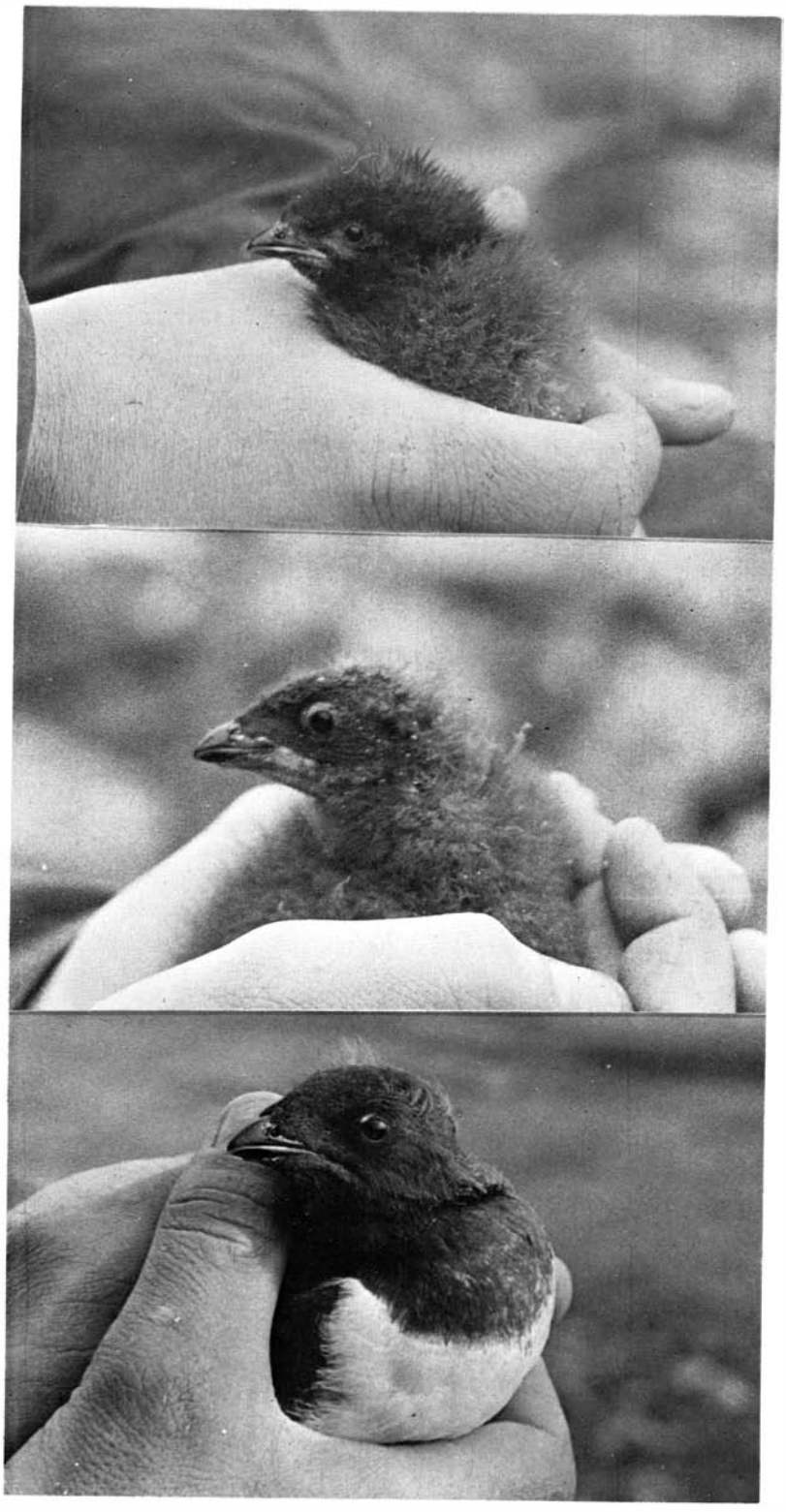


Fig. 19. Plumage development (breast) in Little Auk nestlings. A: fourteen days old chick; B: eighteen days old chick; C: twenty-one days old chick.

Fig. 20. Plumage development (head) in Little Auk nestlings. A: fourteen days old chick; B: eighteen days old chick; C: twenty-one days old chick.

→



A

B

C

FOOD

The food of the Little Auk consists mainly of planktonic crustaceans (95% or more). In 116 food samples, fish larvae were only observed once. The most important species found were *Calanus finmarchius*. Other species were *Parathemisto oblivia*, *Mysis* sp., *Euolus gaimardii* (zoea), and *Sabinea septemcarinata* (zoea). In Hornsund, *Sagitta*, *Pteropoda*, and *Ctenophora* were very common in coastal waters. These species, however, were never observed in collected food samples. Earlier publications from Svalbard mention *Calanus*, *Thysanoessa*, *Parathemisto* and *Mysis* (HARTLEY & FISHER 1936; LØVENSKIOLD 1964). HARTLEY & FISHER (1936) also mentioned two fish species, *Boregadus saida* and *Leptoclinus maculatus*, found in Little Auks from Billefjorden, Spitsbergen.

The main part of the food studies were concentrated on feeding rates and amount of food brought to the nest for feeding the young. Feeding rates in nine nests were studied from camouflage tents (four in 1963 and five in 1964). The adult birds in these nests were individually colour-marked (Fig. 25). A total of 320 feeds were registered during 885 hours of nest observations. Of these feeds, 199 were seen during survey periods of 24 hours or more.

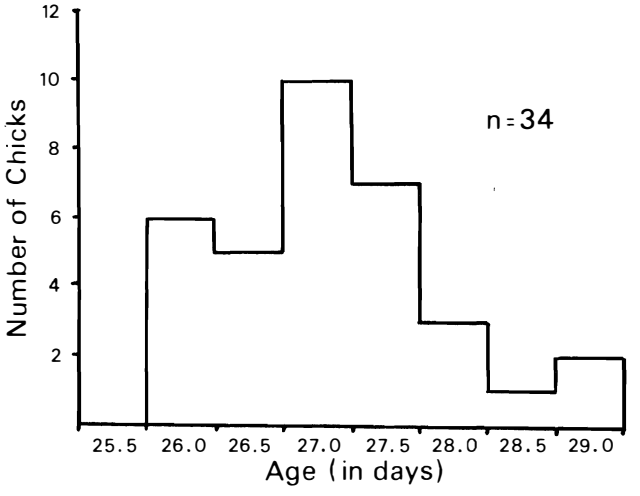


Fig. 21. Age of chicks when departing to sea 1963 and 1964.

VARIATION IN FEEDING RATES IN VARIOUS NESTS

In 1964 feeding rates were studied in five nests during 72 hours of continued observation. Results are shown in Figs. 27-28. Fig. 26 shows variation in feeding rates in these five nests from the beginning to the end of the observation period, at three-hour intervals. Fig. 27 shows the feeding rate summarized in a 24 hours period. These figures indicate a decrease in feeding rate during the night, and increased activity in the morning and late afternoon.

As mentioned earlier, the Little Auks' food in Hornsund consisted of planktonic crustaceans, mainly *Calanus*. The planktonic organisms migrate towards the surface during the night and towards deeper water during the day. Accordingly, the amount of available plankton should be higher during the night. BATESON (1961) writes in this connection: *"The majority of the planktonic animals on which the Little Auk feeds, rise to the surface water only during the night (see HARDY 1956) and indeed at their colonies the birds do appear to be coming and going more frequently at that time."* However, according to Fig. 27, the observed feeding

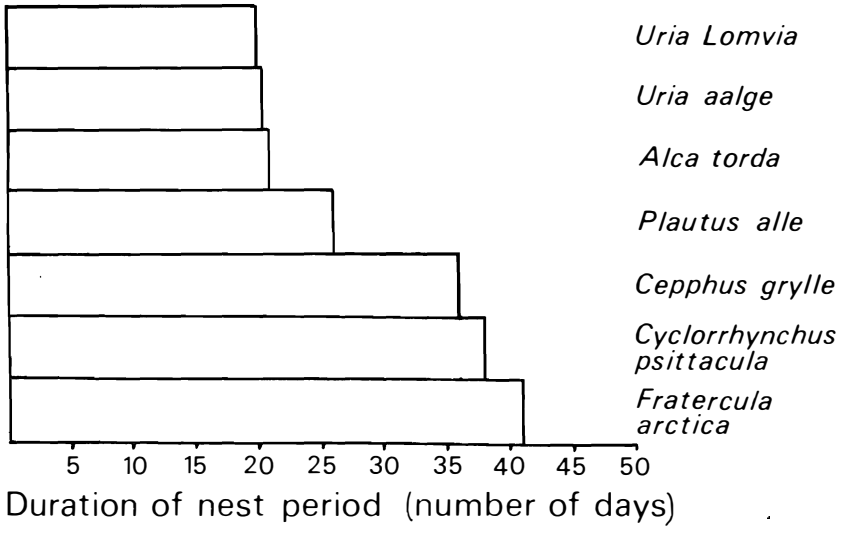


Fig. 22. Duration of the nest period of Little Auk chicks, compared with various other species of Alcidae Data from BELOPOLSKI (1957) and SEALY and BEDARD (1973).

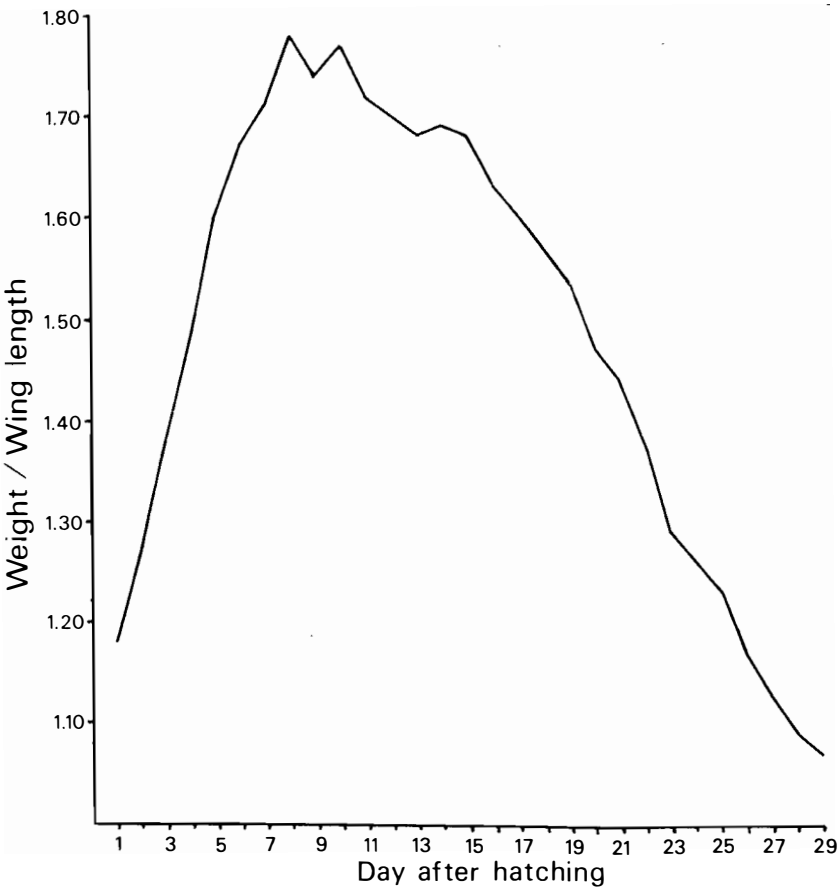


Fig. 23. Changes in the weight/wing length relation of chicks from hatching until departure to sea. Data from 1963 and 1964 summarized.

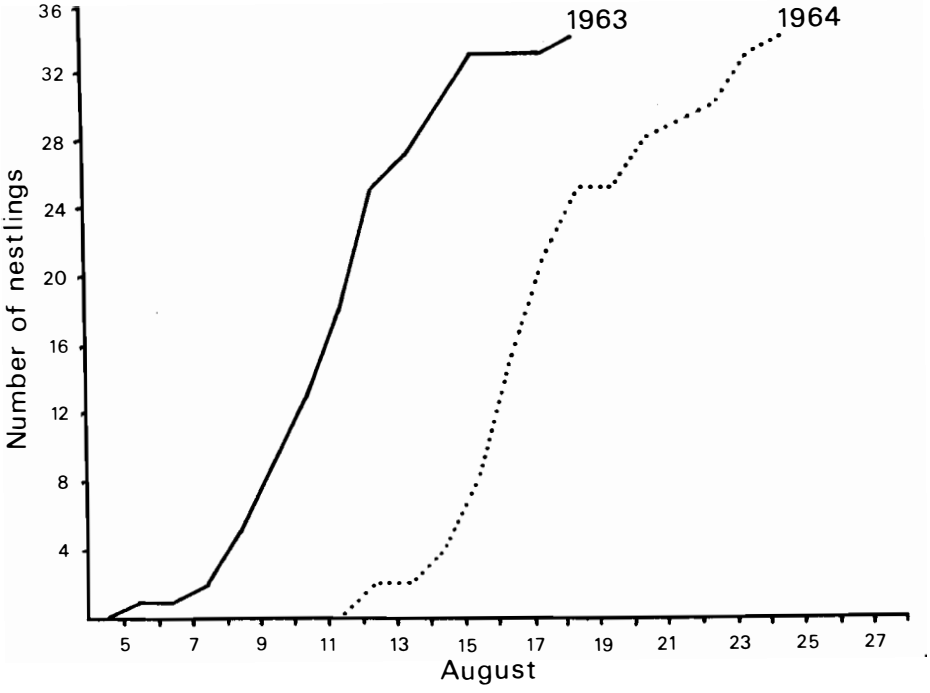


Fig. 24. Deaprture to sea of chicks in 34 nests, 1963 and 1964.

rate was higher during the day (morning and afternoon) than during the night. The explanation is probably that no marked vertical movements in the zooplankton masses take place at these high latitudes during the summer. This has been pointed out by BOGOROV (1946) based on studies in the southwestern parts of the Barents Sea. Furthermore, WIBORG (1954) could not find clear evidence for migratory movements in zooplankton between 5 and 25 metres during summer studies on the Norwegian coast (67°N - 69°N).

More recent studies of vertical movements in zooplankton in Arctic waters have (according to WIBORG pers.comm.1980) not altered this opinion. It is accordingly possible that vertical migration of zooplankton may be of less significance for the food availability of the Little Auk along the coasts of Svalbard, and that other factors may interfere with the feeding rate more markedly.

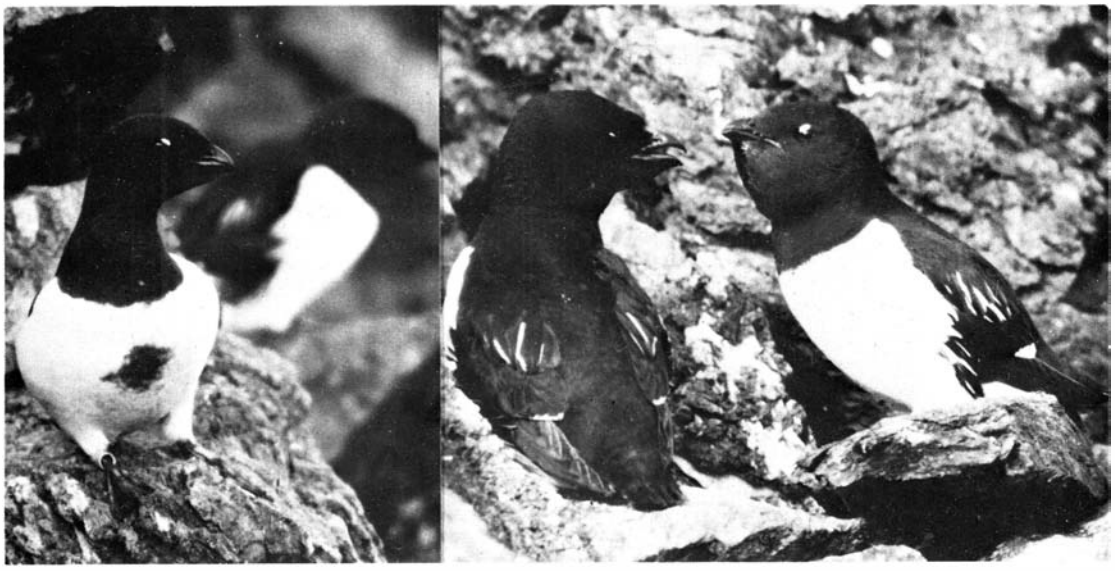


Fig. 25. LEFT: Colour-marked adult used for studies of feeding rates. RIGHT: Greeting ceremony of arriving bird loaded with plankton.

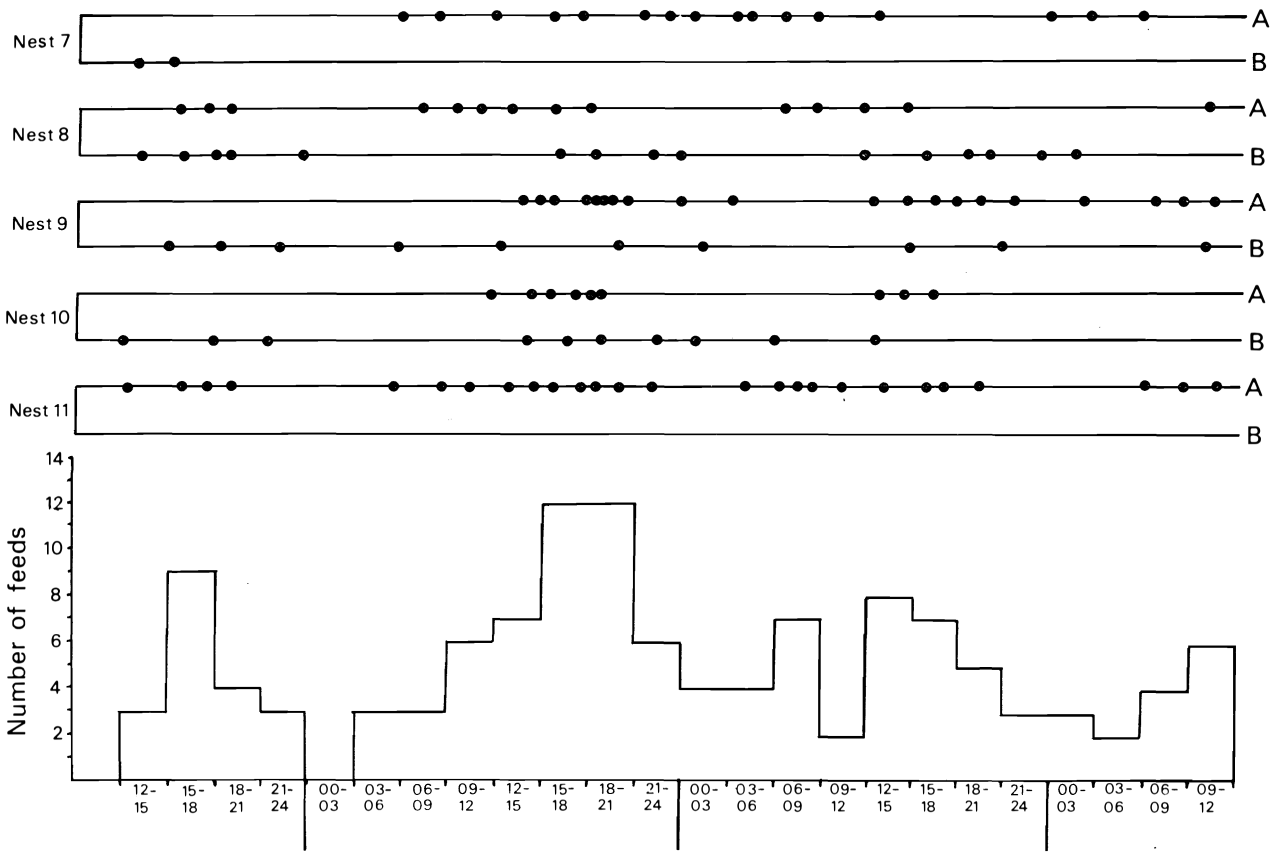


Fig. 26. Feeding rates in five Little Auk nests, 1964. ABOVE: Variation in feeding rates between parents in the five nests. BELOW: Variation in the total feeding rate in the five nests during the day.

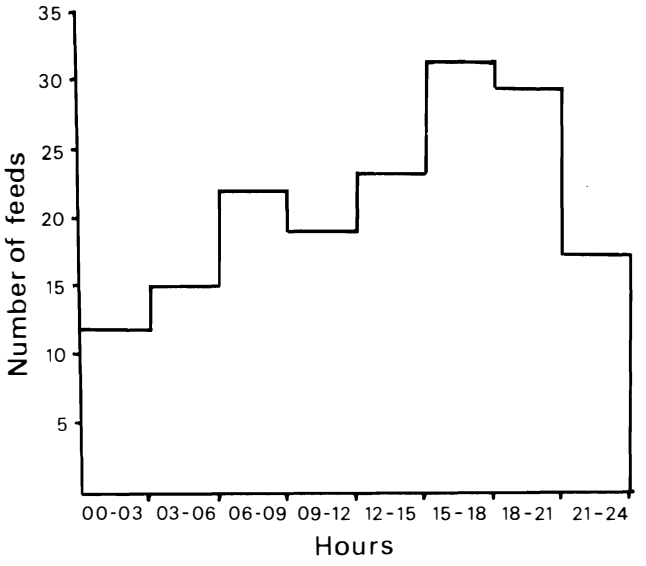


Fig. 27. Variation in the feeding rate during the 24 hours period. Based on data from four 24 hours observation periods in five nests.

Marked feeding rate differences were observed in the various nests during the same observation period, as well as in the same nest on different days. Data are available from six nests in five 24-hour periods (1963-64). Number of feeds varied between 4 and 14 per 24 hours, and average feeding rate in the six nests varied between 6.2 and 11 feeds per 24 hours. Summarized, the average feeding rate was 8.5 feeds per 24 hours (N = 199 feeds).

In Table 3 the Little Auk's feeding rate is compared with similar data from other North Atlantic Alcidae.

Table 3

Feeding rates in some North Atlantic Alcidae

Species	*Number of feeds per 24 hours*	*Reference*
Cepphus grylle	3-5	KARTASCHEW 1960
Fratercula arctica	1-5	MYRBERGET 1962
Uria lomvia	1-3	KARTASCHEW 1960; TUCK 1960; USPENSKI 1958
Uria aalge	1-3	KARTASCHEW 1960; TUCK 1960; USPENSKI 1958
Plautus alle	4-14	This study

VARIATION IN FEEDING RATES AMONG PARENTS

Individual variation in the parents' feeding rates were studied in 1963 (in four nests in one 24-hour period) and in 1964 (in five nests in four 24-hour periods). Material from 1964 illustrates the marked variations in the feeding activity of the adult birds (Table 4).

Individual variations were not only observed in the total number of feeds per 24-hour period. There were also marked individual variations in regularity between each time food was brought to the nest (see Fig. 26.

Table 4

Variation in individual feeding rates during four 24-hour observation periods, 1964.

Nest	*Parent*	*Number of feeds observed*				*Total number of feeds per parent*	*Total number of feeds per young*
		7- 8.8	*11-12.8*	*12-13.8*	*13-14.8*		
I	A	4	2	0	0	6	25
	B	3	2	10	4	19	
II	A	3	5	4	6	18	39
	B	7	6	5	3	21	
III	A	2	5	2	4	13	44
	B	11	0	10	10	31	
IV	A	3	1	5	3	12	26
	B	4	3	6	1	14	
V	A	1	0	0	0	1	34
	B	7	7	12	7	33	

The individual feeding rate variations were apparently reflecting more or less stable individual characteristics, as the same pattern in feeding activity was observed in two pairs studied both in 1963 and in 1964 (Table 5). Whether or not these differences are sex-related, is not known. In other pairs no marked difference was observed (see Table 4, Nests II and IV).

From the present study it should also be noted that a low feeding rate by one of the parents to some extent is compensated by the other. The young in Nest II was fed 39 times during four 24-hour periods (1964). The share between the parents was 18 and 21 feeds. In Nest V, one of the parents fed the nestling every time except once in the observation period. The total number of feeds was, however, approximately the same as in Nest II (34 feeds).

Table 5

Comparison of feeding patterns in two pairs, 1963 and 1964

Nest	*Parent*	*Number of feeds observed*	
		1963 (one 24-hour period)	*1964 (four 24-hour periods)*
I	012	0	6
	001	6	19
II	302	0	1
	093	11	33

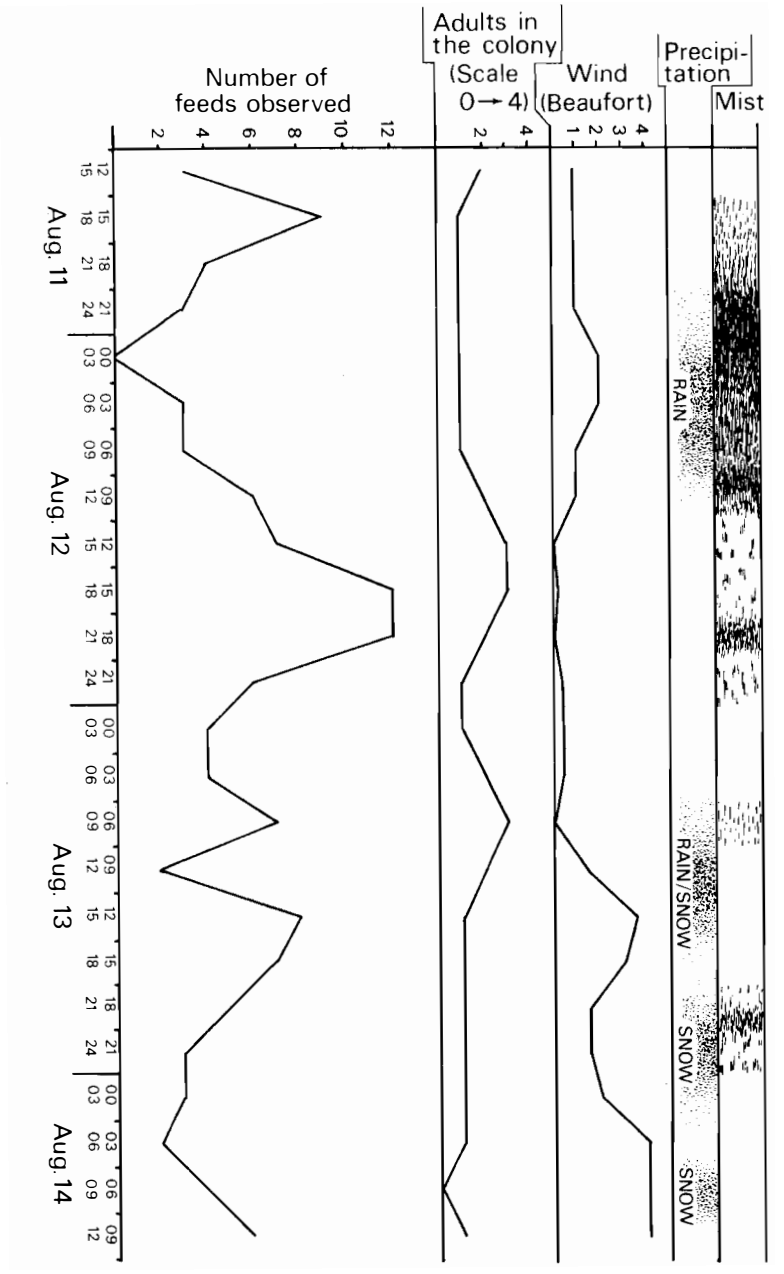


Fig. 28. Variation in feeding rate in five nests through 72 hours of continued observation (1964) in relation to changes in local weather conditions.

WEATHER CONDITIONS AND FEEDING RATES

During the observations on feeding rates, notes were also made on variations in local weather conditions (cloudiness, wind, precipitation, and visibility).

A rough synthesis of feeding rates in relation to weather conditions appears from Fig. 28 (11-14 August 1964). Changes in weather conditions are based on observations taken 56 times during the 72-hour period. Variations in density of Little Auks in the colony are described by a relative scale from 0 to 4. In general, precipitation and reduced visibility seem to influence feeding rates in a negative direction. During warm, sunny periods, adult birds returning from the sea with food for the nestlings, tend to stay longer in the colony, participating in social activities. These activities were, however, often disturbed by *Larus hyperboreus*, inducing birds to leave for the sea.

AGE OF NESTLING AND FEEDING RATE

The study of relations between feeding rates and the age of the nestlings was not satisfactory, as for practical reasons it took place in the last part of the nesting period. Table 6 summarizes results of the observation of five nestlings during a 72-hour period in 1964. In this table, the number of feeds have been related to the age of each of the nestlings.

The results give no clear answer to the question of whether or not the feeding rate is reduced towards the end of the nest period.

Table 6

Feeding rate in relation to age of the nestling
(1964)

	Day after hatching. Number of feeds observed																
Nestling	*From day*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*
	Until day	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*
A-8		10				11	9	9										
A-9								13					5	12	14			
A-10									7					4	11	4		
A-11									8					7	12	7		
A-7											7					4	10	4

AMOUNT OF FOOD

Since the food brought to the nestling consists of plankton, certain difficulties arose in finding a reliable method of studying the volume of food brought into the nest each time. In 1962 a method was developed for catching large numbers of Little Auks for ringing by using small nets on long bamboo poles (BANG et al.1963). This method was further developed in 1963 (Fig. 29) and it was possible to catch Little Auks loaded with plankton and collect complete samples without any losses. Samples were then kept in a fixed amount of 96% alcohol and later weighed under laboratory conditions. A total of 116 complete food samples were collected in 1963-64. Fig. 30 gives the variation in volume of the collected samples. One ccm of plankton corresponds to 0.97 gram. Maximum recorded volume was 7.0 ccm, and minimum was 0.7 ccm. In both years food samples were collected from the beginning of hatching in the colony and during the whole nesting period, to study variations in plankton volume per feed in relation to the age of the young.

In Fig. 31 the average sizes of collected samples have been grouped in relation to time after start of hatching in the colony. According to this material, there is a gradual increase in plankton volume per feed from the first week after hatching until the last week before the young leaves the nest. See also Table 7.

Fig. 29.
Catching of adult Little Auks for food sampling and ringing.

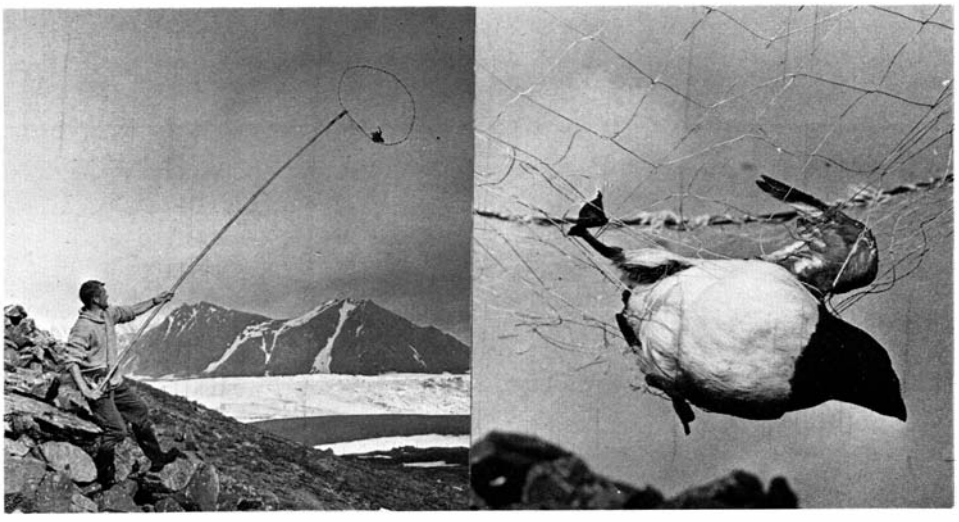


Table 7

Changes in average plankton volume per feed during the nest period

Week after hatching started in colony	*Average volume per feed (ccm)*	*Number of samples*
1	2.35	24
2	2.69	23
3	3.86	23
4	3.55	33

ECOLOGICAL YIELD: ZOOPLANKTON/LITTLE AUK

The Little Auk plays a significant role in high Arctic ecosystems. The ecological yield in converting plankton into Little Auk biomass is also remarkable (NORDERHAUG 1970). During 27 days spent by the young in the colony, the average body weight increases from 21.5 g on the first day to 114.3 g on the 27th day. The net weight increase in this period is accordingly 92.8 g.

According to the studies of the feeding rates, Little Auk nestlings are fed on the average 8.5 times per 24 hours. The average volume of plankton per feed increased gradually from the first week after hatching (Table 7). Based on average feeding rate and average plankton volume per feed in weeks 1-4 after hatching, the total amount of plankton brought in per nestling during 27 days is calculated to 710.7 ccm, corresponding to 689.4 g (1 ccm = 0.97 g). This indicates a yield of:

$$\frac{100 \cdot 92.8}{689.4} = 13.5\%$$

in the food chain from plankton to Little Auk in this ecosystem.

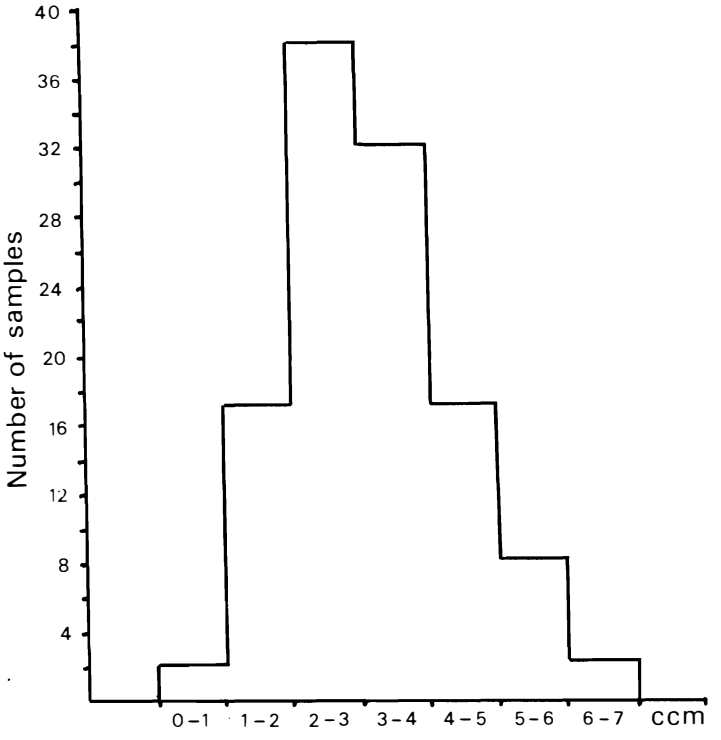


Fig. 30. Variation in size of collected food samples 1963 and 1964.

Due to the abundance of Little Auks, their plankton transport from the marine ecosystem to the the colonies has a significant impact on the terrestrial ecosystem. In general terms, a colony of 100,000 pairs brings in approximately 70 tons of plankton for consumption by the nestlings alone during four summer weeks. The ecological importance of the Little Auk to the terrestrial ecosystem of Svalbard may accordingly be significant.

There are no reliable population estimates of Little Auks in Svalbard. However, the main colonies have been registered and their probable order of size indicated (NORDERHAUG et al. 1977). The following colonies have been registered:

1000 - 10,000 pairs:	25 colonies
10,000 -100,000 pairs:	8 colonies
Over 100,000 pairs:	3 colonies

The breeding population may accordingly be in the order of 400,000 - 1,600,000 breeding pairs (taking the three

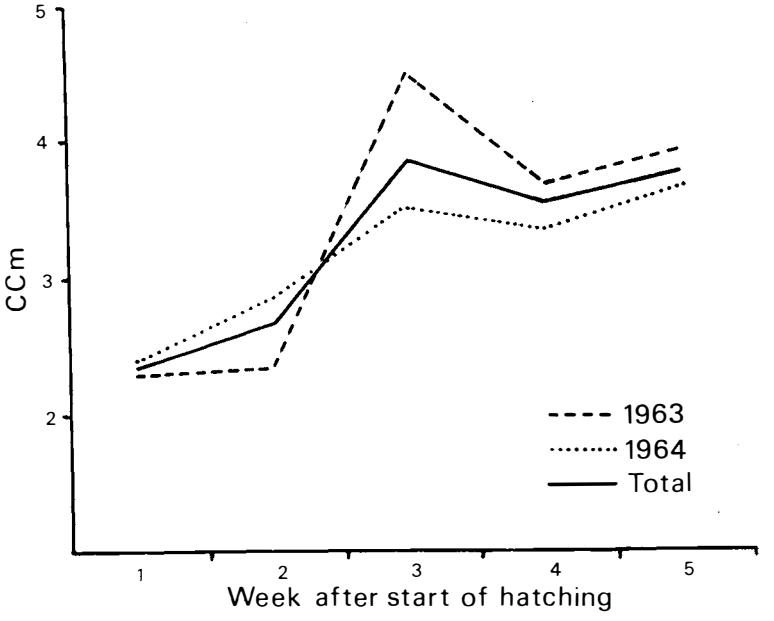


Fig. 31. Changes in size of food samples brought into the colony in relation to time after hatching started.

largest colonies in the range 100,000 - 600,000 pairs).

According to these figures, the total amount of plankton brought from the marine to the terrestrial ecosystem during four weeks may well be in the order of 280 - 1120 tons. Since colonies often are located on mountain slopes behind coastal plains, these plains accumulate organic deposits more effectively for the terrestrial ecosystem than Arctic bird cliffs close to the sea. The secondary influence of this organic transport from the marine environment is thus of significant importance to the terrestrial ecosystem.

The flow of organic deposits from the Little Auk colonies to the coastal plains below supports rich vegetation. The vegetation in turn conserves water during the summer and supports biotopes for various species of Arctic evertebrates and birds.

ACKNOWLEDGEMENTS

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Authour's address:

MAGNAR NORDERHAUG
The Ministry of Environment
Myntgaten 2
Oslo 1
NORWAY