The population of waders *Charadriidae* at Danmarks Havn, Northeast Greenland, 1975

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(Med et dansk resumé: Bestanden af vadefugle ved Danmarks Havn, Nordøstgrønland, 1975)

Dedicated to Dr. phil. Finn Salomonsen on the occasion of his seventieth birthday, 31st January 1979.

INTRODUCTION

Between 19 March and 8 September 1975 I was employed at Danmarkshavn Weather Station (76° 46'N, 18° 46'W) in southeastern Germania Land, central Northeast Greenland (Fig. 1). Besides my job I had ample opportunity for ornithological studies in the area around the weather station. Danmarkshavn Weather Station, staffed by twelve men, is the only inhabited place between Daneborg, 300 km to the south, and Station Nord, 550 km to the north.

From April 1969 to April 1971 I also worked at this weather station, and subsequently described the avifauna of the area (Meltofte 1975). In 1969 and -70 I made simple single counts of the breeding birds in a census area around the weather station. Later, after more intensive work in Peary Land in 1973 (Meltofte 1976 a), I realized that my counts from Danmarks Havn were unreliable. I planned to repeat them in 1975 and at the same time, to make more intensive breeding biological studies.

A. L. V. Manniche (1910) stayed in this area during 1906–08 with the Denmark-Expedition. That expedition was the first to explore the region carefully. Pedersen (1942) stayed one year in Germania Land in 1938–39, but did not often visit Danmarks Havn. These are the only studies of waders besides mine for the area.

Some observations of waders occurring as visitors and rare vagrants *(Calidris maritima, Phalaropus lobatus, Haematopus ostralegus,* and *Calidris melanotos)* have been published elsewhere (Meltofte 1977 a).

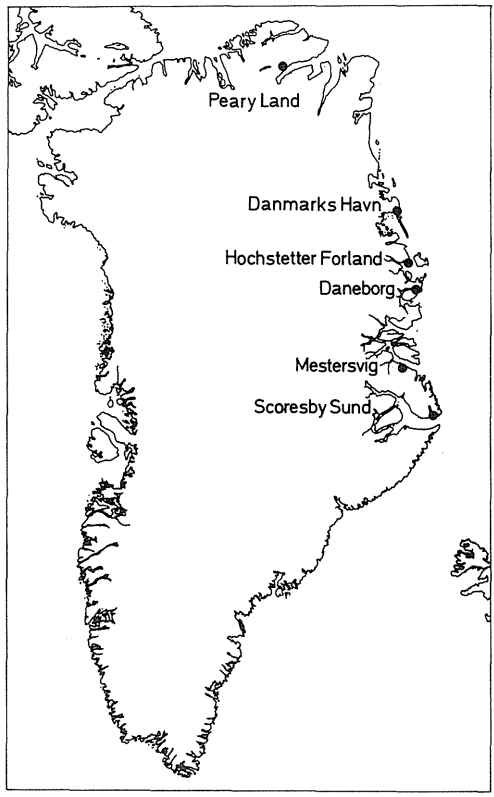


Fig. 1. Map showing localities in high arctic Greenland mentioned in the text.
Kort over Grønland med lokaliteter nævnt i teksten.

STUDY AREA

The census area at Danmarks Havn (Figs 7, 9, 13 and 17) is a big kettle-hole, surrounded by mountains to the west, north, and northeast. It is one of the most favourable areas for waders in Germania Land. It thaws earlier and is more fertile than most of the country. The limits of the 1975 census area differed from 1969 in that the big rocky area to the northeast, and part of the gravel slopes towards Harefjeldet, was omitted. The new boundary mostly followed either the edge of the surrounding mountains or large permanent or semipermanent snow-drifts. Its area was 4.49 km^2 exclusive of three lakes totalling 0.46 km^2.

The habitat was classified as follows (cf. Figs 7, 9, 13 and 17):

I: 'Swampy' meadows or marshes nearly 100 % covered with vegetation of Bryophytae, Cyperaceae, *Carex, Eriophorum, Salix arctica,* and *Ranunculus*. This habitat included level or gently sloping marshes with ponds and running water and slopes irrigated by melt-water throughout most of the summer. In addition, this habitat occurred as narrow fringes along lake edges and streams.

II: Mainly stony slopes of clay and gravel, with arctic heath vegetation cover of 50 % or more. Lichinaceae, Gramineae, Cyperaceae, *Dryas, Salix arctica, Saxifraga oppositifolia,* and *Papaver radicatum* are typical.

III: Mainly stony slopes of clay and gravel but predominantly barren fell field. Similar plants to type II, but cover much less than 50 %.

IV: Gneissic cliffs and barren stone and boulder fields, with patchy vegetation.

Large parts of type II and III were solifluction slopes, especially in the west towards Harefjeldet.

Type I covers 0.48 km^2 (10.7 %), type II 1.18 km^2 (26.3 %), type III 1.90 km^2 (42.3 %), and IV 0.93 km^2 (20.7 %). Therefore only 37 % of the census area are relatively well vegetated.

WEATHER AND CLIMATE

Danmarks Havn is situated well inside the high arctic with a July mean temperature of + 3.7° C (table 1). In 1975 both May, June, and July were somewhat colder than the mean. Positive maximum temperatures (start of thaw) began on 3 June, compared with the average of 28 May for the years 1952–73 (Meltofte 1975, 1976 a). The frost-free period totalled only 13 days during the second half of July.

Table 1. Monthly mean temperatures at Danmarkshavn Weather Station May to August 1975 compared to means 1949–76.
Månedsmiddeltemperaturer ved Danmarkshavn Vejrstation maj til august 1975 sammenlignet med midlerne for 1949–76.

	1949–76	1975
May	−6.6	−7.7
June	0.9	0.1
July	3.7	2.8
August	2.3	2.3

Small snow storms occurred several times during April and May; with winds of 35 knots on 30 May. During the days 16–18 June a storm raged with winds of up to 40 knots with snow and low temperatures. The ground was covered with 5–10 cm of new snow.

The winter's (1974–75) snowfall was apparently similar to average. More snow was present in spring than i 1969, but less than i 1970. The snow layer in high arctic Greenland is normally unevenly distributed because snow is blown into large drifts, often ice-hard, and large parts of the country remain 'semisnowcovered' with the tops of the plants, stones, and part of the ground showing through. These areas are of most decisive importance as feeding places to many birds, including waders, during the arrival and pre-laying phase. However, most of the areas relatively free of winter

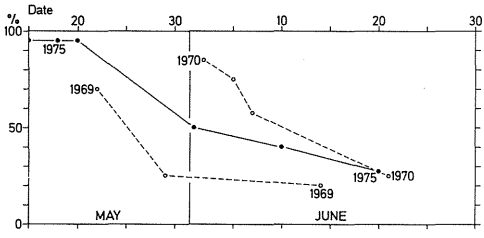


Fig. 2. Percentage uncovering from snow in the lowland at Danmarks Havn 1969, 1970 and 1975. *Sneafsmeltningen i lavlandet ved Danmarks Havn i 1969, 1970 og 1975.*

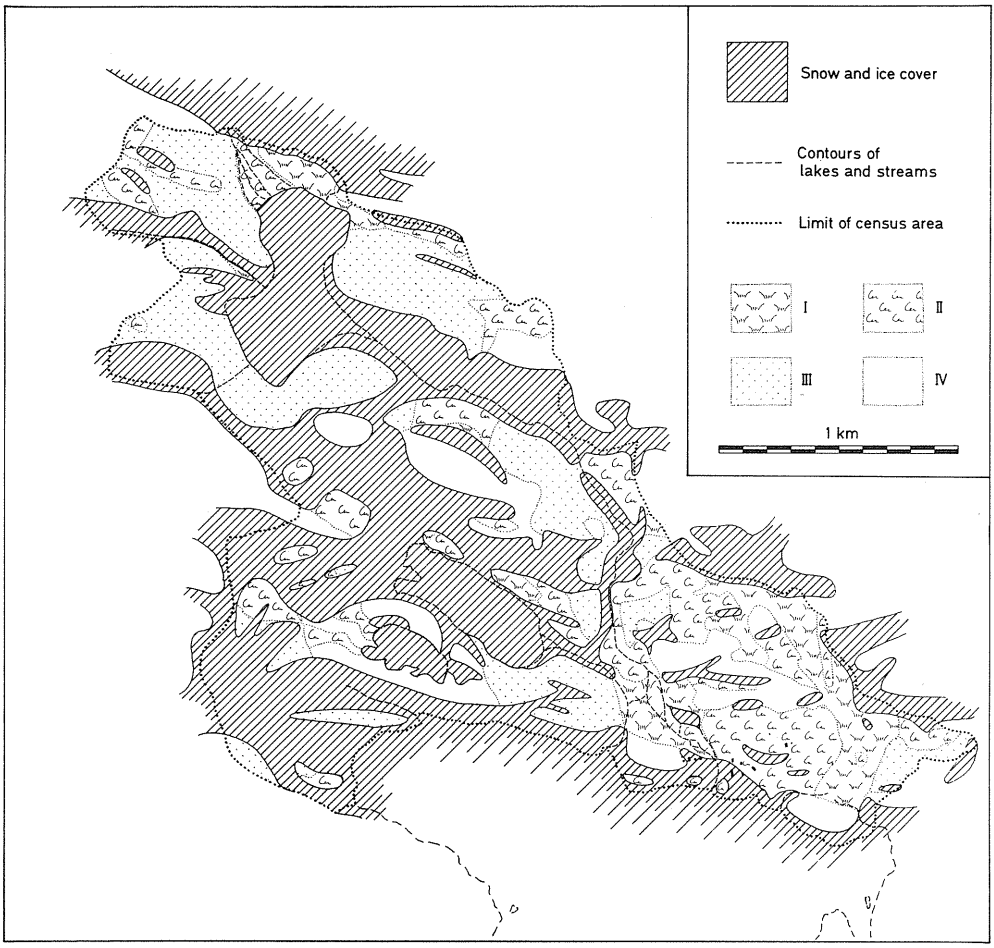


Fig. 3. Extension of snow and ice cover in the census area on 10 June 1975. Note the houses of the weather station at the outlet of the eastern rivulet.
Udbredelsen af sne og is i optællingsområdet d. 10. juni 1975. Bemærk vejrstationens huse ved det østlige elvudløb.

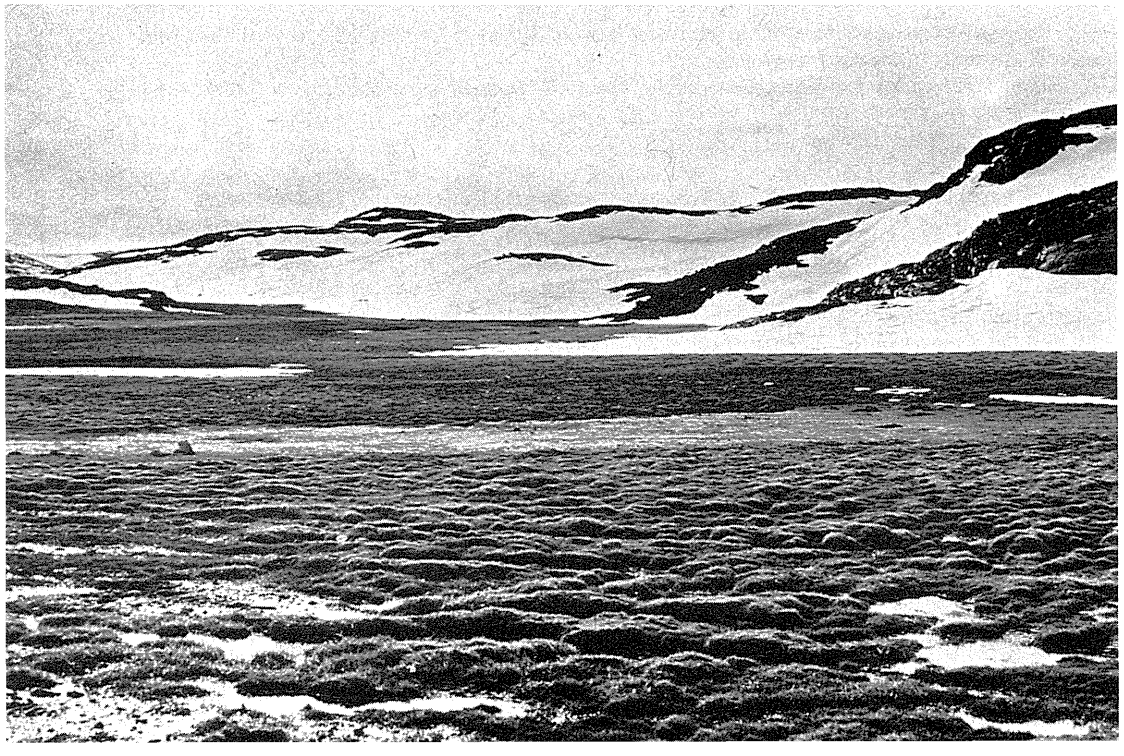
snow are barren (type III and IV). The thaw of the snow-cover in the lowland at Danmarks Havn in 1975 is compared with 1969 and -70 in Fig. 2. The estimates for 1969 and -70 are less accurate than for 1975. On 18 May the first puddles formed in the marshes, and most of the snow-cover disappeared during late May and early June, but Fig. 3 shows that uncovering took place quite unevenly. The easterly parts where most marshes are found, thawed first, while the gravelly slopes towards Harefjeldet remained snow-covered far longer. 60% of the lowland were snow-free by 10 June (Fig. 3). Figs 4 and 5 show snow cover in the eastern part of the area at different times of the spring. Running water did not appear until early June, and it was late June before water was running in all rivers.

Summarising, the summer of 1975 was cool, with little fog, and unstable with much wind, cloud, sleet and drizzle. The snow-melt was somewhat protracted compared with more favourable years, and the thaw of the lakes was significantly delayed, even compared to the very unfavourable year 1970. Even the breaking up of the fjord ice was somewhat delayed compared to more favourable years.

The first hatch of *Chironomidae* was seen flying on 2 July. From 4 July flying Diptera were numerous.

Fig. 4. View from the slope of Termometerfjeldet towards northwest over the eastern part of the census area on 31 May 1975. Note the blown off appearance of the snow cover. At this time most waders arrived. Photo converted from a colour slide.
Udsigt fra skråningen af Termometerfjeldet mod nordvest over den østlige del af optællingsområdet d. 31. maj 1975. Bemærk de afblæste flader som vadefuglene opholdt sig på ved deres ankomst sidst i maj.

Fig. 5. View from the foot of Termometerfjeldet towards northwest over the eastern part of the census area on 24 June 1975, covering partly the same area as Fig. 4. In the foreground irrigated hummocked marsh vegetation is seen. The cliffs and large snow drifts make up the limit of the census area. Photo converted from a colour slide.
Udsigt fra foden af Termometerfjeldet d. 24. juni 1975 delvis over de samme områder som på Fig. 4. Klipperne og de store snefaner udgjorde grænsen for optællingsområdet.



MATERIAL AND METHODS

Waders have often been considered so easy to record that only one or a few counts were thought necessary (cf. Dyrcz & Tomialojć 1974). After my work in Peary Land in 1973, where I followed a small wader population daily during most of the breeding season, I expressed serious doubts about the accuracy of this method (Meltofte 1976 a).

In 1975, between 15 May and 16 July, I worked nearly every day in the census area for between two and six hours – 167 hours in all. I generally walked through the area at moderate speed, looking over the surroundings carefully. Often I chose a good site and watched an area without disturbing the birds. All observations were mapped and as much information as possible concerning flocks, movements, pairs, sex, age, courtship, song, and other behaviour was added. Nests were searched for when birds behaved suspiciously, but normally I only remained for a quarter or half an hour sitting in ambush at one site. Only part of the census area was searched each day, so that the whole census area was covered regularly. Until 10 June the area within 800 m of the weather station was visited every day to follow the arrival and dispersal of the waders. The work was done at various times of the day and night.

Nests found were examined regularly, and informations on habitat, contents, and birds present were recorded. Young were ringed, weighed, and their culmen was measured. 17 adults were caught on nest in heart-shaped wire-mesh cage traps, ringed and dyed yellow with picric acid dissolved in 50 % isopropanol on all underparts of wings and belly. Adults were weighed using 'Pesola' spring balances and their wings were measured flattened with the primaries straightened on the ruler. The culmen was measured from tip to the base of feathering. Adults were sexed by plumage characteristics. Pulli were aged using weight and culmen measurements based upon data by Soikkeli (1967), Parmelee (1970), Meltofte (1976 a), Green *et al.* (1977), and data from this study.

24 adults, mainly *Arenaria interpres,* were caught in three light brown, two-shelf Japanese mist-nets situated near the meat rack of the weather station from late May to late June. These birds were also dyed and measured and examined for brood-patches.

The information presented in tables 2, 3, 4, 5 and Figs 8, 11, and 16 was obtained by comparing the daily observation maps with the final maps of territories. A territory was considered 'visited' when I passed within 100 m from the centre (nest). Both positive and negative registrations are given. The negative registrations are calculated as per cent of the total number of visits. The positive registrations are presented in per cent of the total number of observed birds/pairs. Pairs were counted as *one* registration. Two singles seen on a territory were recorded as two single observations, although they might have been mates. Such observations make up a maximum of eight per cent of the late June data for *Calidris alpina,* but only a few per cent for other species.

The column 'Attracted birds' gives other individuals attracted by birds/pairs alarm-calling because of my presence at their nest or young, or birds displaying (e.g. flight pursuits) together with other (neighbouring) birds. In the column 'Singles outside territories' flocks of more than three individuals, including gatherings on communal feeding areas, were omitted from the calculations. If the relation between an observation and a territory was considered doubtful, the observation was omitted from the analyses. The analyses, both during plotting the observations in the field and during evaluation of the registrations, are highly subjective.

In Figs 8, 11, and 16 observations at territories with known breeding schedule are shown in relation to hatching. The breeding period until hatching has been divided into 5–8 days periods, so that the laying period is separated, and pre-laying and incubation periods have been divided into appropriate periods.

The maps Figs 7, 9, 13, and 17 were drawn from stereometric vertical aerial photos exposed from an altitude of 28,500 feet on 2 August 1963 (nos. 262/449 and 450 in the Geodetic Inst. of Copenhagen). Extension of vegetation types was mapped in the field in 1975, and adjusted to the aerial photos. The distributions are simplified.

All times given are local times; that is one hour later than GMT.

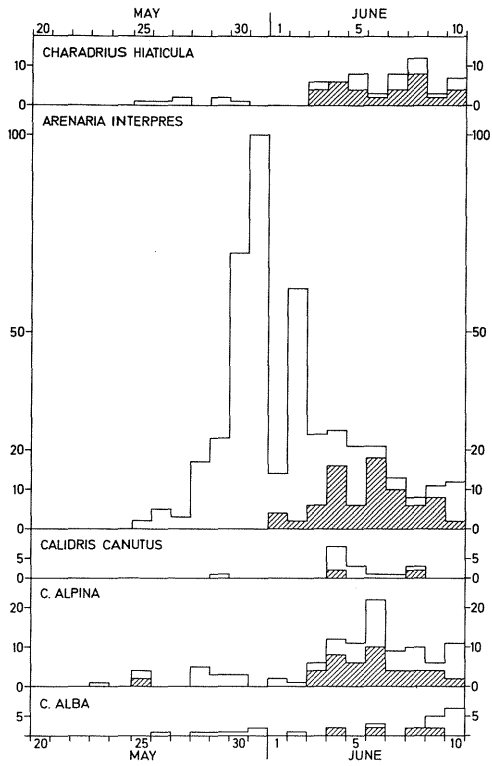


Fig. 6. Daily totals during the pre-laying period of Ringed Plovers, Turnstones, Knots, Dunlins and Sanderlings in the part of the census area situated within 800 m from the weather station. Birds appearing in dispersed pairs are hatched.
Daglige totaler for Stor Præstekrave, Stenvender, Islandsk Ryle, Alm. Ryle og Sandløber sidst i maj og begyndelsen af juni indenfor 800 m's afstand fra vejrstationen. Fugle som optrådte i selvstændige par er skraverede. Bemærk at de første fugle ankommer sidst i maj, og at de fleste kommer i de første dage i juni, hvor de optræder parvis og besætter territorier straks efter ankomsten. Kun Stenvenderne viste en markant kulmination med op til 100 fugle i flokke omkring vejrstationen inden fuglene spredtes parvis.

RESULTS

Ringed Plover *Charadrius hiaticula*

Only a few, mainly singles, were present from 25 May until 3 June. Thereafter pairs appeared and song and other display occurred (Fig. 6).

21–22 territorial pairs were recorded regularly within the census area (Fig. 7), giving 4.7–4.9 pairs/km^2. Nine proved to breed, and a further two pairs probably bred. To what extent the rest bred or attempted to breed is not known. Evidently some did not produce any young. Nests of eight pairs were found. One was predated. It contained three eggs on 21 and 23 June, but was empty on 4 July. This pair stayed close to the nest-site until at least mid-July. One clutch was abandoned during the snow storm 16–18 June. It held three eggs on 14 June and four cold eggs on 19 June. On 20 June I removed the eggs and on 27 June the same nest scrape held two eggs, and four on 3 July. Thus 8–10 days elapsed from loss of the first clutch until replacement started. The first two young in this nest hatched on 23 July, one more on 24 July. The other clutches hatched (first young) on 11, 15, 16, 23, 23, and about 24 July, respectively. One pair had at least three about five-day-old pulli on 30 July. One pair just outside the census area had four eggs on 21 June. The eggs were damaged probably by an Arctic Hare *Lepus arcticus* two days later and were slightly incubated.

Allowing 23–24 days for incubation six clutches hatched, or would have hatced, during the period 9–16 July, and five highly synchronously 23–25 July, including the replacement clutch. It seems reasonable to conclude that all the five late clutches were replacements laid after the snow storm mid-June.

Nine complete clutches held four eggs, one only three. Two eggs contained no embryo, when the others had hatched.

The nine nests were situated either in habitat type III (five nests) or poorly vegetated II (four nests). Six nests were 3–20 m from dense vegetation (I–II), the rest 50, 100 or more metres away. Table 2 shows that on 14% of visits to territories in the period 20–29 June no birds were seen. 25–27% of the registrations in July were birds attracted by alarm-calling birds/pairs. Very often up to four alarm calling birds followed me through the terrain, and very often up to 6–7 birds were alarm-calling and injury-feigning around me when I was close to a nest. Dyed birds were seen performing injury feigning up to 250 m from their own nest with eggs and joined alarm-calling pairs up to 1300 m away from hatching eggs. Birds regularly joined alarm-calling pairs 5–600 m away from their own nest. 18–22% of the registrations were of single birds or pairs not related to any territory.

Fig. 8 shows the results of all visits to eight pairs for which date of hatching was known.

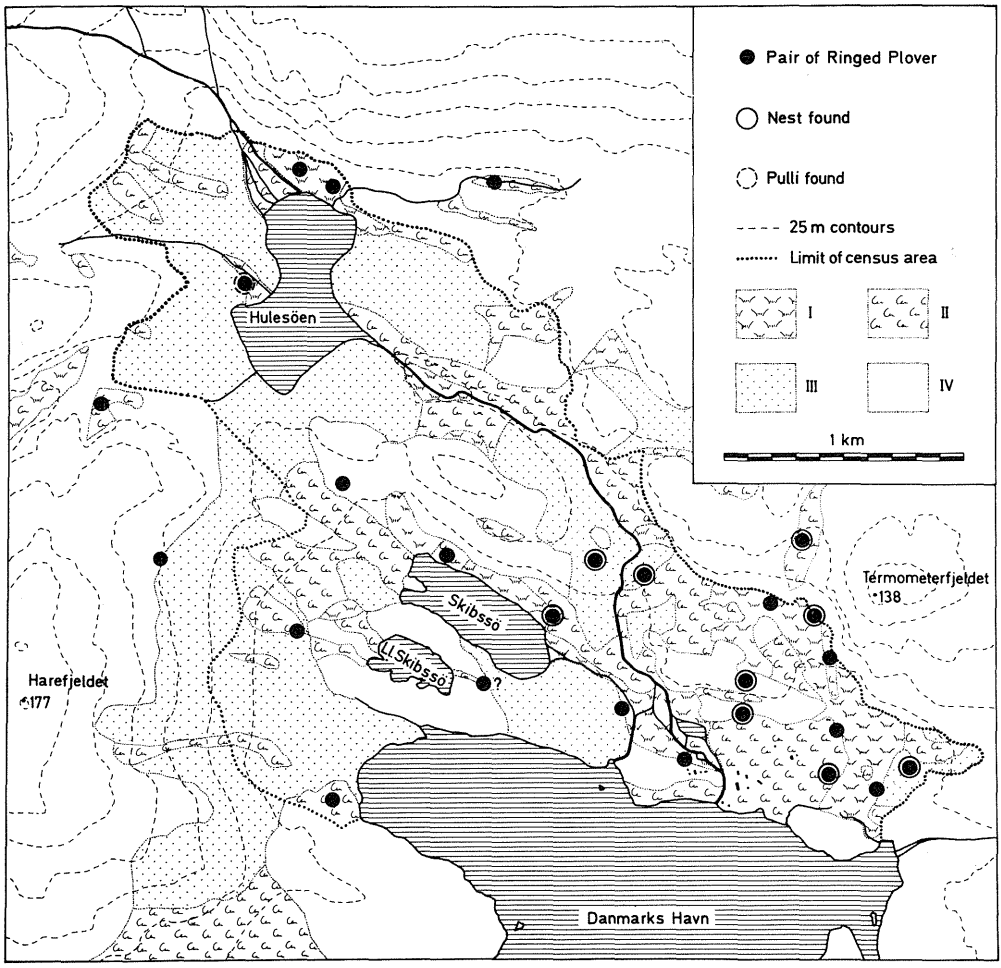


Fig. 7. Distribution of *Charadrius hiaticula* in the census area in 1975. A few pairs outside the census area are also plotted. The vegetation types are given in the text.
Fordelingen af par af Stor Præstekrave i optællingsområdet i 1975. Nogle få par udenfor optællingsområdet er også afsat. Vegetationstyperne beskrives i teksten.

Birds were mainly seen at the territory from about five days prior to egg-laying, but until the nest was found most often only one bird was seen. On two occasions (out of 35) no birds were seen on visits to nests, although the eggs were warm.

Ringed Plovers sang most frequently just prior to and during egg-laying. Alarm-calling and distraction behaviour was regularly observed from the same time and onwards.

Breeding pairs were still present on 8 August and alarm calls were heard and injury-feigning seen. 17 adults – males and females – gathered in the marsh at the weather station on the same date, some of them in flock. Up to 27 juveniles were present in the marsh and in the delta at the weather station 22–25 August. They soon left and the last bird inland (a ringed juvenile) was seen on 30 August.

Turnstone *Arenaria interpres*

The first Turnstones were seen at Danmarks Havn on 25 May. Large flocks stayed at the weather station's rubbish dump and in the marsh during the last days of May and first days of June (Fig. 6). Pairs appeared as the flocks broke up in early June, but many of the birds in the flocks were apparently already

Table 2. Percentage distribution of all registrations (also negative) of Ringed Plovers at or away from territories in selected periods during June and July. The upper part of the table gives visits at territories where no birds were seen, in per cent of the total number of visits at territories (N_1) during the actual period. The lower part gives the distribution of all registrations in per cent of the total number of registrations in the census area (N_2) during the actual period. See the text p. 73 for further explanation.
Procentuel fordeling af alle registreringer (også negative) af Store Præstekraver ved eller borte fra territorier i udvalgte perioder i juni og juli. Den øverste del af tabellen viser besøg ved territorier uden at nogen af fuglene sås i procent af det totale antal besøg ved territorier i den pågældende periode (N_1). *Den nederste del af tabellen viser fordelingen af alle registreringer i procent af alle positive registreringer i optællingsområdet i den pågældende periode* (N_2).

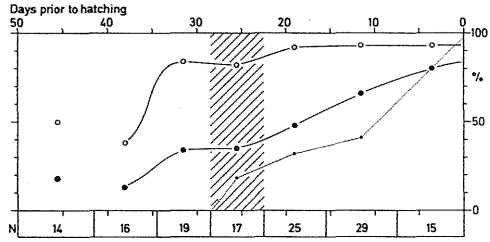
Period *Periode*	1–10 June	12–14 June	20–29 June	1–9 July	11–16 July
Territories without birds seen *Territorier hvor ingen fugle sås*	60	31	14	31	22
N_1	(81)	(36)	(96)	(74)	(60)
Pairs at territories *Par ved territorier*	31	34	29	40	30
Singles at territories *Enlige ved territorier*	45	36	43	15	26
Pairs outside territories *Par væk fra territorier*	7	8	4	4	4
Singles outside territories *Enlige væk fra territorier*	12	14	17	14	15
Attracted birds *Tiltrukne fugle*	5	8	7	27	25
N_2	(42)	(36)	(115)	(93)	(84)

mated although the first birds to arrive were males. On 28 May four birds migrated north at 4 p.m. Fights and flight pursuits increased during early June.

Fig. 8. Observations of adult Ringed Plovers at eight territories prior to hatching. ○: one of the mates seen, ●: the pair seen, dotted line: nests visited. The laying period is shaded. The registrations prior to one week before laying are unreliable. Some of the recorded pairs attended relaid clutches, and hence some of these early observations concerned earlier clutches.
Observationer af adulte Store Præstekraver ved otte territorier før klækningen. ○: en af fuglene set, ●: parret set, prikket linie: rederne besøgt. Æglægningsperioden er skraveret. Figuren viser hvor ofte parret eller kun en af fuglene sås ved besøg ved territoriet i løbet af yngletiden. Det ses at fuglene optræder på territoriet fra omkring en uge før æglægningens begyndelse og at man ofte kun ser en af fuglene eller slet ingen. Parret ses kun ved en trediedel af besøgene indtil reden findes og man oftere og oftere besøger denne hen mod klækningen.

17 pairs held territories in the census area (Fig. 9), giving 3.8 pairs/km^2. Seven pairs proved to breed. Of the rest at least five pairs probably bred, but five pairs either did not attempt to breed or failed. Some of these perhaps had their nests destroyed during the snow storm in mid-June. At one breeding site two eggs were found within a few metres from each other on 19 June and on 21 June one egg more. One apparently laid in a nest cup, the others nearby. At this site possibly the same pair had at least one 6–7 days old pullus on 30 July.

Of the six other pairs proved to breed, two



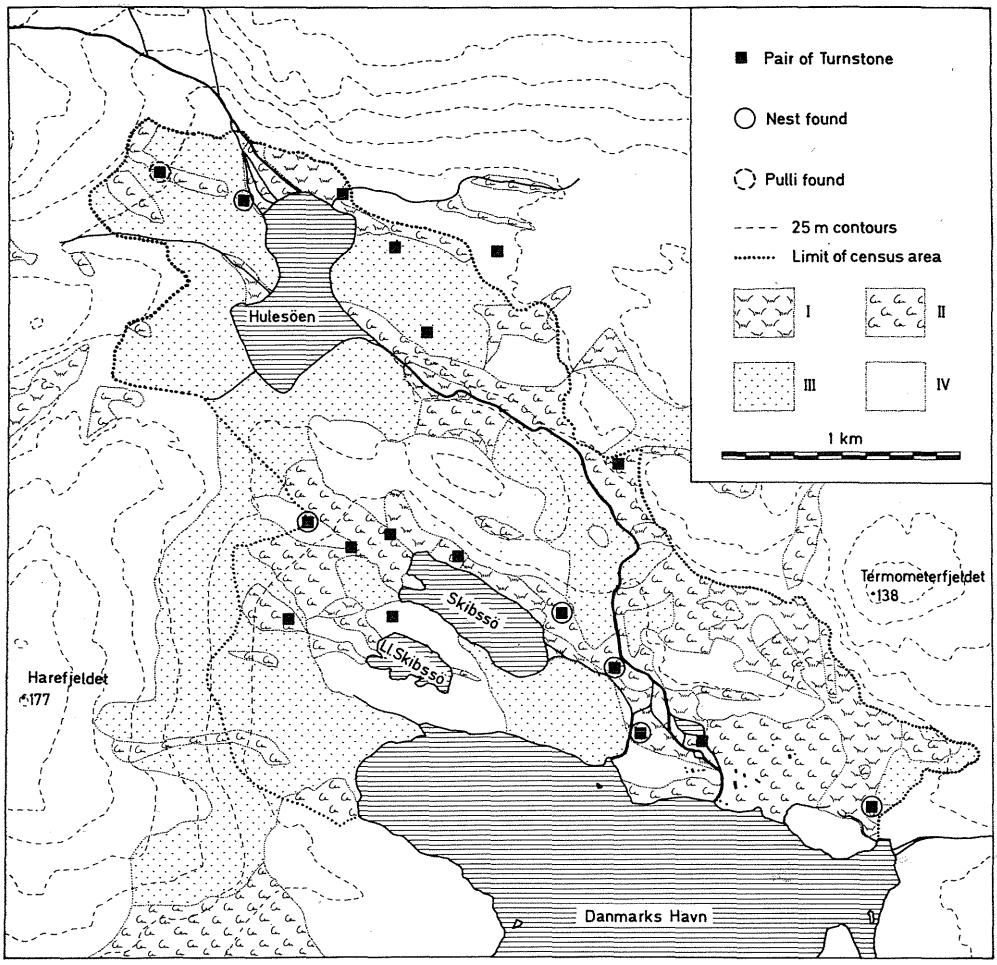


Fig. 9. Distribution of *Arenaria interpres* in the census area in 1975.
Fordelingen af Stenvenderpar i optællingsområdet i 1975.

clutches hatched on 6 July, one on 8 July, and one pair had four about six-day-old pulli on 12 July. Two clutches did not hatch. One of them (three eggs) found on 24 June was incubated until about 10 July, but on 12 July the pair still gave alarm calls at the nest, although the eggs were cold and without embryos. The other unhatched clutch, also three eggs, were starred and pipped on 9 July, but they were abandoned perhaps because I had caught and dyed the female on the nest on 3 July. She was still at the nest two days later, but thereafter only the male was seen. The three hatched clutches were all of four eggs. All eggs hatched in two of them, but in the third one, three eggs did not contain embryos. These three eggs and the other unfertile clutch were probably chilled during the snow storm in mid-June. Fig. 10 shows a nest visited just after the snow storm. The bird was incubating behind a small snow drift and ice-shell formed by the breathing of the bird.

Summarising, seven clutches hatched or probably would have hatched in the period 6–11 July. One, probably a replacement clutch, hatched 23–24 July. Allowing 22 days for incubation and 4–5 days for egg-laying, the replacement clutch was started about eight days after the snow storm. Four complete clutches were of four eggs, two of three.

Four nests were situated in habitat type II, within 1.5–20 m of type I, Two nests were situated in type III, six and 28 m from type II, respectively.

Fig. 10. Turnstone nest on 17 June during the snow storm. An ice-shell is situated to the left of the nest (badly seen on the photo), formed in the wind side of the incubating bird. All four eggs hatched successfully. Photo converted from a colour slide.
Stenvenderrede d. 17. juni 1975 under en snestorm. En sne- og isskal har dannet sig i vindsiden af den rugende fugl, som således kom til at ligge i læ. Alle fire æg klækkede.

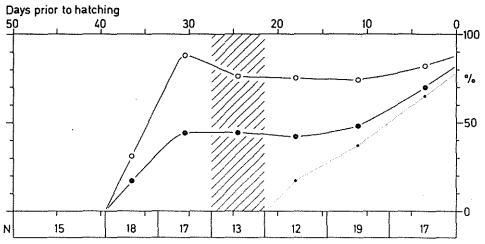


Fig. 11. Observations of adult Turnstones at seven territories prior to hatching. For further explanation see text to Fig. 8.
Observationer af adulte Stenvendere ved syv territorier før klækningen. Forklaring som til Fig. 8.

Table 3 shows that in mid and late June there were 14–15% negative visits to territories. Even omitting birds in flocks, which accounts for about one third of the individuals seen in some periods, about half the registrations during the entire season could not be related to any territory. By mid-July many of the registrations were of birds attracted by alarm-calling birds/pairs, but these figures are actually too low, as I was often able to identify the birds gathering around me, e.g. by means of dyed individuals, and thus did not record them as odd individuals. Up to eight adults

Table 3. Percentage distribution of all registrations (also negative) of Turnstones at or away from territories in selected periods during June and July. See table 2 and p. 73 for further explanation.
Registreringer af Stenvendere efter samme princip som i tabel 2.

Period *Periode*	1–10 June	12–14 June	20–29 June	1–9 July	11–16 July
Territories without birds seen *Territorier hvor ingen fugle sås*	51	14	15	39	60
N_1	(49)	(21)	(53)	(51)	(40)
Pairs at territories *Par ved territorier*	19	16	28	36	33*)
Singles at territories *Enlige ved territorier*	14	25	21	17	8
Pairs outside territories *Par væk fra territorier*	36	14	10	5	0
Singles outside territories *Enlige væk fra territorier*	31	45	38	37	31
Attracted birds *Tiltrukne fugle*	0	0	3	5	28
N_2	(74)	(44)	(92)	(59)	(39)

*) Most of these pairs were found with young away from the territories.
De fleste af disse par sås med unger borte fra territorierne.

were alarm-calling around me at one brood. Often Turnstones gave alarm calls around me when I was walking 3–400 m from their nest or young.

Fig. 11 shows the results of observations on seven pairs for which breeding schedules were known. Territories were established from about five to ten days prior to egg-laying. One or no birds were seen on more than half of the visits to territories until late in the incubation period. Even so, the increase in the number of pair observations which followed was produced by an increasing number of visits directly to nests. Several times I saw incubating birds leave the nest and walk off for about ten metres. Then they flew low over the ground and alighted 1—200 m away. Here they sat calmly waiting for me to pass by. Sometimes the mate gave energic alarm calls at the same time, sometimes no other birds were seen. On four of 28 occasions I visited nests without a single alarm call being heard. At least one pair completed incubation before I recorded them as breeders. I did not become aware of them until after hatching.

5–20 Turnstones were present daily around the dogs and the meat rack at the weather station after the pre-breeding flocks broke up in early June. At first these were mostly pairs performing mating behaviour, but from about 10 June mostly singles, predominantly males using the site as a communal feeding area. The most active period was about 5 a.m. to 7 p.m. Up to five birds slept in the area during the calm period from 11 p.m. to 2 a.m.

Nine males and females caught on the weather station and one female found dead under the aerials between 31 May and 3 June weighed 115.8 g on average, ranging 100 to 133 g (Fig. 12). None had brood patches, but the dead female (133 g) had a four mm thick and twisted oviduct and her largest follicle measured 5.5 mm. She was thus a potential breeder. Ten males and females caught and one male found dead between 7 and 12 June weighed 103.7 g on average, ranging 94 to 124 g. None had brood patches and the dead male apparently was a non-breeder. Its left testes measured c. 7 mm compared with the testes of breeders which, during this period, measure 10 mm or more (Nettleship 1973). During the snow storm 16–19 June the number of Turnstones visiting the communal feeding area at the weather station increased to a maximum

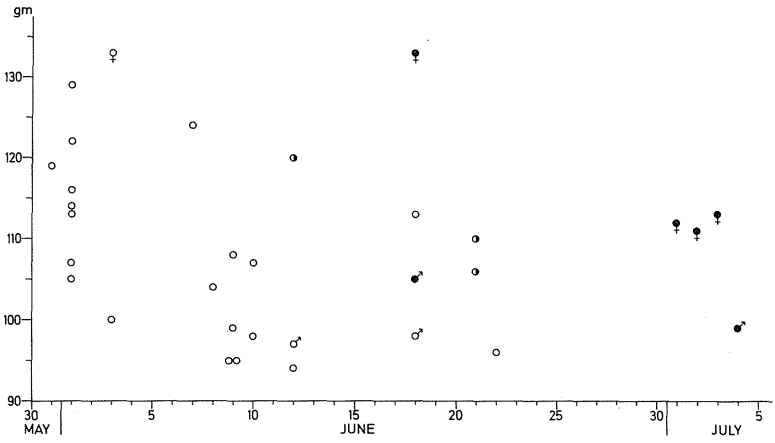


Fig. 12. Weight of Turnstones caught or found dead on the weather station during late May and June besides four individuals taken on nest in early July in the last part of the incubation period. Only birds dissected or taken on nest are plotted with sex indicated. Open circles denote birds without brood patches, filled ones denote breeders with fully developed brood patches. Half filled circles denote individuals with incompletely developed brood patches. Three birds found dead after the snow storm have been plotted under 18 June.

Vægten af Stenvendere fanget til ringmærkning eller fundet døde under antennerne på vejrstationen sidst i maj og i juni, foruden fire fugle fanget på reden først i juli. Åbne cirkler viser fugle uden rugepletter, udfyldte cirkler viser fugle med fuldt udviklede rugepletter og halvfyldte viser fugle med ufuldstændigt udviklede rugepletter. Bemærk de mange fugle med lav vægt og uden rugepletter fra 8. til 22. juni. Disse var formentlig overvejende ikke-ynglende fugle. De kraftigere fugle omkring 1. juni var formentlig ynglefugle, som endnu ikke havde udviklet rugepletter, men mange af disse fugle havde begyndt æglægningen en uge senere medens de lettere fugle endnu opholdt sig ved vejrstationen.

of 73 individuals. Seven of these had been dyed yellow at the same site in the period 31 May to 12 June where a total of 19 was dyed. Seven males and females caught or killed against the aerials in the days 18 to 22 June weighed 108.7 g on average, ranging 96 to 133 g. Only two birds, a male and a female, had fully developed brood patches. The female had ruptured follicles and extremely enlarged oviduct indicating recent egg-laying. The others had no or incompletely developed brood patches (Fig. 12 and appendix).

During the same period 20–30 birds gathered at another communal feeding area at the marsh near the weather station. The birds on the weather station probed in the snow or sat sleeping behind tussocks of grass. They fought for the best sites and up to 3–4 birds would sit close together behind one tussock. Many had ice clumps on their tarsi, and some were clearly exhausted. One was later found dead on the roost. When the snow storm ceased, the birds dispersed rapidly.

During the rest of June and early July the communal feeding areas were visited by many birds daily. At the weather station they mainly fed on dried shark meat. Peak numbers of up to 25 birds daily occurred between 2 a.m. and 6 a.m. During the rest of the day 5–10 were usually present. On several occasions birds were seen flying singly to and from the communal feeding areas at a height of about 50 m. They came from far beyond the census area. 5–10 were often seen in the communal feeding area in the marsh. Of the 23 Turnstones dyed at the weather station before 22 June, only two held territories within the census area. Several others were seen irregularly in the area and up to five were present together at the communal feeding area on the weather station in late June and early July; the last on 3 July. From about 7 July only a few Turnstones visited these sites. The decrease followed hatching.

These data suggest that birds present during early June were potential breeders, being relatively heavy but without developed brood patches. By early June the breeders dispersed and the remaining (or newly arrived) birds were relatively lighter and perhaps mainly non-breeders (younger birds) or late breeders still without well established territories. During the snow storm apparently mainly non-breeders or late breeders from a large area concentrated around the weather station. Amongst them was a number of breeders which had left their territories. During late June and early July most Turnstones were dispersed over the area and those visiting the station area were on feeding excursions from their territories. They probably included both breeders and non-breeders. From near the date of hatching non- and failed breeders left their territories and gathered in post-breeding flocks.

The first post-breeding flocks were seen on 8 July when small groups of two and three birds fed at Skibssø. Groups of up to six were seen during mid- and late July. Apparently, many of these birds were still mated, at least in the beginning of the period.

Adults were still alarm-calling inland on 8 August, but none were seen later. Independent juveniles were present in the rivulet delta at the weather station from 6 August. 3–6 were often present there until late August. In early September a few were seen until my departure.

In my report from 1969–70 (Meltofte 1975) it is stated that the first fledged juveniles of Turnstones were seen on 17 July both years. This is an error. In 1969 fledged juveniles were seen on 17 July, but in 1970 the first newly fledged juveniles did not appear until 24 July. Hence, contrary to my earlier statements (Meltofte 1976 a), there was apparently a difference in the breeding schedule between the climatically early season of 1969, and the late one of 1970.

Knot *Calidris canutus*

The first Knot arrived singing from the south and alighted in the census area on 29 May in the afternoon. From 1 June 1–8 were seen nearly every day until the end of the month. On most days one or two were singing. On 4 June 5–8 were displaying and attempted copulation was observed. One bird was not in full nuptial plumage: only head, neck, and forebreast had rufous spots. During most of June up to two pairs stayed in the census area. One of the females was the apparently immature bird described above. Five adults stayed at the weather station during the snow storm in mid-June. On 20 June 8–10 adults were present and alarm calls were heard. I do not know if these pairs attempted to breed, but I think it unlikely that any young hatched inside the census area. As early as 25 June seven Knots had gathered

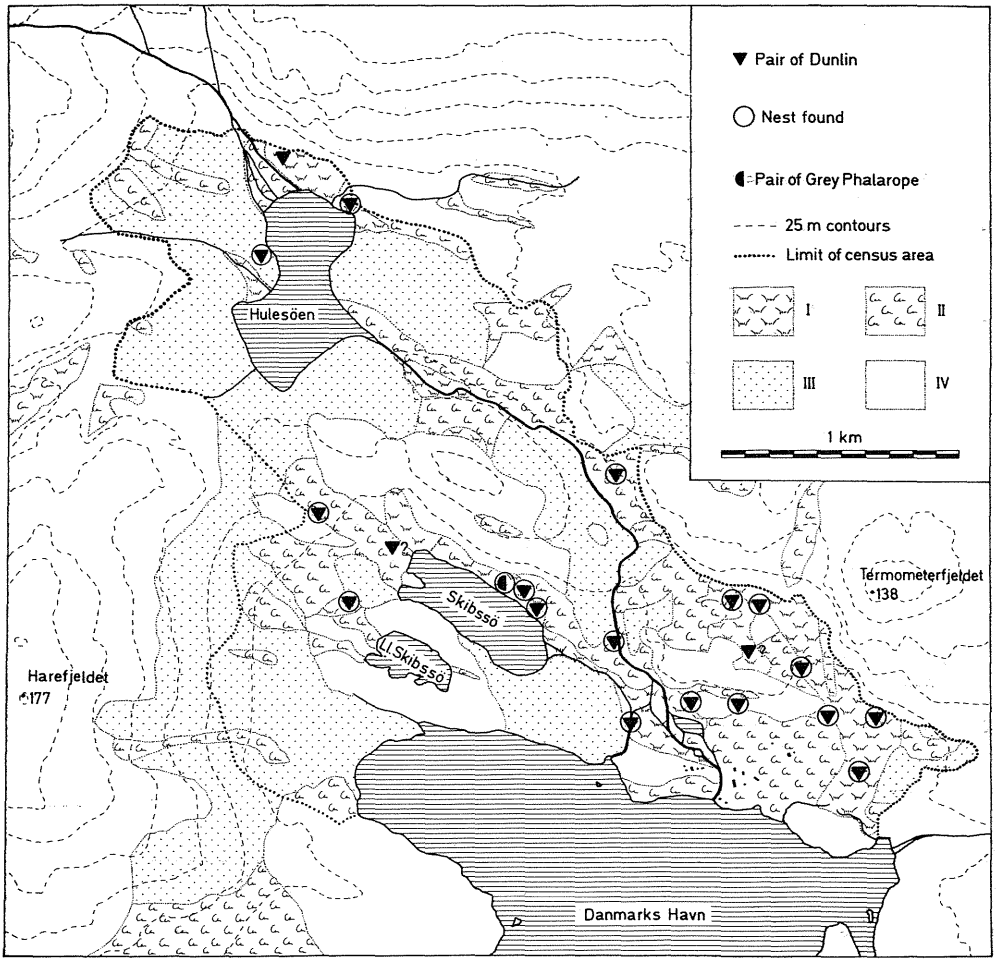


Fig. 13. Distribution of *Calidris alpina* and *Phalaropus fulicarius* in the census area in 1975.
Fordelingen af par af Alm. Ryle og Thorshane i optællingsområdet i 1975.

in a post-breeding flock. On 29 June one Knot sang and another gave alarm calls. They were the last 'breeders' seen in the census area. Groups of up to four post-breeders were occasionally seen until 12 July.

No Knots were seen again until two juveniles fed on the weather station delta on 9 August. From 20 August to my departure, groups of 1–10 Knots fed in the delta most days during low tide. One adult was present until 24 August when the number of juveniles peaked with 18 birds.

Dunlin *Calidris alpina arctica* (Schiøler)

The first Dunlin was seen on 23 May. Only a few were seen during the next ten days. In early June numbers increased and pairs appeared (Fig. 6). Birds performing song flight, territorial fights, flight pursuits and other types of display were common after 3 June.

Within the census area 18–20 pairs held territories (Fig. 13), giving 4.0–4.5 pairs/km^2. 17 nests were found, and one more pair apparently hatched young. One of the pairs disappeared in late June apparently without laying eggs in the nest. Young hatched in 16 nests on 6, 6, 9, 9, 10, 11 (three-egg clutch), 11, 14, 15, 15, 17, 18, 18, (three-egg clutch), 20, 24, and 25 July. Of these at least the last two must have been replacements. It is also possible that those hatched on and after 18 July may have been replacements following losses

Fig. 14. Dunlin nest on 17 June during the snow storm. The nest was originally more covered, but part of the snow and ice broke down when the incubating bird left the nest at my appearance. All four eggs hatched successfully. Photo converted from a colour slide.
Rylerede d. 17. juni 1975 under en snestorm. Reden var oprindeligt mere sne- og isdækket, men en del af isskallen brød ned da fuglen gik af reden ved min ankomst. Alle fire æg klækkede.

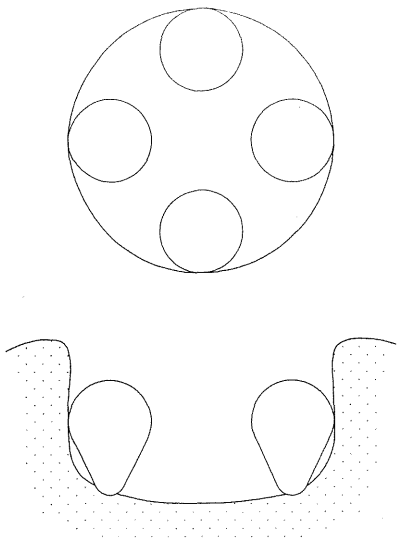


Fig. 15. Plan sketch of the situation of the eggs in two Dunlin nests (one egg in one of the nests was standing on its blunt end) observed on 6 and 9 July, respectively, where the nest bottom was wet. All dimensions after Glutz *et al.* 1975.
Skitse over æggenes placering i to rylereder med vand i bunden.

during the snow storm. Some nests survived the storm even though nearly snow-covered (Fig. 14). Several young hatched during a cold period in mid-July. Temperatures were about 0° C, and the weather was windy and damp.

14 clutches contained four eggs and two contained three eggs. Five eggs did not hatch. One egg was damaged (cracks) and had only been incubated for a few days. One egg was rotten. One was abandoned by the parents together with the young even though it was starred. A nest with four eggs was situated in the vegetation in a riverbed. Two young drowned shortly after hatching. The two other eggs were abandoned, one of them was pipped. I drained this nest and two others when water flooded the nest bottom. In two of these nests I observed that the eggs were once standing upright on their pointed ends, leaning against the sides of the nest cup, but without touching each other (Fig. 15). In one of the nests one egg stood on its blunt end. In this nest dry *Salix* leaves had evidently recently been added to the nest bottom.

Eight nests were situated in habitat type I. Most of them in grass- or moss-tussocks. Six nests lay within 3–10 m and two others within 30 m of drier vegetation. Eight nests were situated in habitat type II – within 0.5–20 m from type I, one 120 m from I, and one in extensive II. One nest was situated in a grass-tussock in type III 80 m from habitat type I.

Table 4 shows that in about one quarter of my visits to territories after mid-June there were no registrations. Between 29 % and 38 % of the registrations after the pre-laying period were of birds which could not be related to any territory. It was not until mid-July that a significant number of registrations were birds attracted by alarm-calling pairs/birds. On one occasion, four adults performed distraction behaviour at one nest. Amongst them was a yellow-dyed adult from a nest 200 m away. On some occasions two non-dyed birds were seen giving alarm calls close to a nest where one of the mates previously had been dyed yellow. Alarm-calling birds were regularly seen up to 2–300 m from their nest, and distraction behaviour was performed up to 150 m from nests. In one occasion an adult alarm-called more than 400 m from a nest with hatching young.

As mentioned earlier (p. 73), two individual

Table 4. Percentage distribution of all registrations (also negative) of Dunlins at or away from territories in selected periods during June and July. See table 2 and p. 73 for further explanation.
Registreringer af Alm. Ryle efter samme princip som i tabel 2.

Period *Periode*	1–10 June	12–14 June	20–29 June	1–9 July	11–16 July
Territories without birds seen *Territorier hvor ingen fugle sås*	51	38	26	24	20
N_1	(74)	(32)	(76)	(67)	(41)
Pairs at territories *Par ved territorier*	20	10	27	20	30
Singles at territories *Enlige ved territorier*	28	57	44	44	32
Pairs outside territories *Par væk fra territorier*	9	13	5	3	2
Singles outside territories *Enlige væk fra territorier*	43	20	24	30	19
Attracted birds *Tiltrukne fugle*	0	0	0	3	17
N_2	(75)	(30)	(79)	(79)	(53)

birds were recorded in one territory more often for Dunlins than other wader species. Often one was singing while the other mate gave alarm calls etc. Such observations have been counted as two individual observations in the analyses. However, if they are counted as pairs the percentage in the 'pairs at territories' column in mid- and late June and early July increases to 18%, 37%, and 23%, respectively. In Fig. 16 such registrations make up a maximum of 21% during egg-laying and up to 15% during incubation.

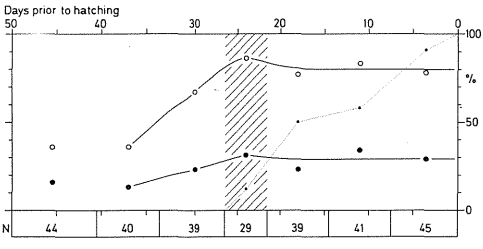


Fig. 16. Observations of adult Dunlins at 16 territories prior to hatching. For further explanation see text to Fig. 8.
Observationer af adulte Alm. Ryler ved 16 territorier før klækningen. Forklaring som til Fig. 8. Bemærk at rederne ofte besøgtes uden at nogen af fuglene sås. Kun ved ca. 30 pct. af besøgene igennem hele æglægnings- og rugetiden sås parret, og ved ca. 20 pct. af besøgene sås slet ingen. Sammenlign med de andre arter.

Fig. 16 shows that birds were seen most often during egg-laying. Contrary to the two previous species, no increase in registrations occurred following an increased number of my visits to nests during the incubation period. Thus the birds did not respond to my presence at the nest in the same conspicuous way as the other species did. Out of 84 visits to nests, no birds were seen or heard on 11 occasions. On six occasions a bird was seen, but did not give alarm calls. On eight occasions the incubating bird did not flush from the nest until I was 1–3 m from it. Thus I would have missed the bird on these occasions if I had not known the nest site.

Singing individuals were recorded at 33–35% of the visits at territories during and just prior to egg-laying. This fell to 14–17% during incubation and still further to 5% at about hatching time. Song flights ceased during the first days of July.

Only a few Dunlins visited the common feeding areas at the weather station. During the snow storm in mid-June 20–30 gathered on the marsh and 1–3 at the weather station. The first post-breeders appeared on 8 July. About 10–15 stayed in small flocks in the area during

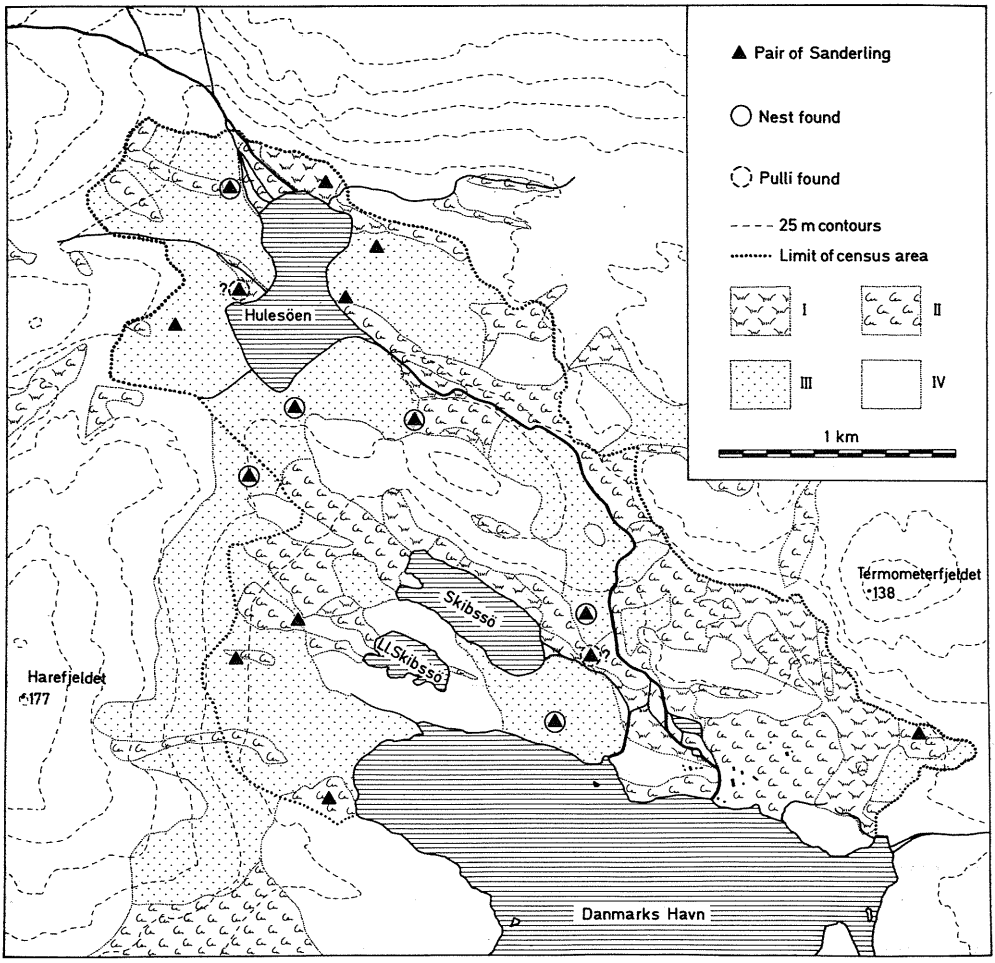


Fig. 17. Distribution of *Calidris alba* in the census area in 1975.
Fordelingen af Sandløberpar i optællingsområdet i 1975.

mid- and late July. Adults still attended juveniles inland on 8 August. 30–40 juveniles foraged on the delta at the weather station 22–25 August, some of them carrying rings. Smaller flocks were seen until my departure.

Sanderling *Calidris alba*

Only one or a few Sanderlings were seen daily from the first observation on 26 May until more birds appeared about 7 June (Fig. 6). The first pair was seen on 2 June, song was heard on 3 June and courtship display was performed from 7 June. Flight pursuits, song and other types of display increased from 12 June.

I found 13–15 pairs within the census area and one pair with a nest just outside its limit (Fig. 17). This gives 2.9–3.3 pairs/km^2. Most of them were recorded only a few times at the actual sites, most often during June. Five nests were found, including the one just outside the census area. On 30 August I found another nest containing one unhatched egg. Apparently at least one more pair was breeding, but the status of the rest is unknown.

One nest contained three eggs on 29 June, but on 2 July the nest was abandoned. One egg was missing and the nest bottom was wet. The two eggs contained embryos measuring 14 mm (stretched: 19 mm), giving an estimated age of ten days. With an incubation period of 24 days, they would have hatched about 13 July. It appeared as if dry grass leaves had been recently added in the nest bottom to keep the eggs dry. Another nest containing four eggs on

2 July was empty on 6 July, probably predated. Three clutches hatched on 13, 16, and 16 July. One about 11-day-old brood was found west of Hulesøen on 30 July, and one about seven-day-old brood was found on 15 July. On 27 July a male attended at least three newly fledged pulli west of Skibssø. With a fledging period of 18 days they must have hatched about 9 July. Thus a total of seven clutches hatched or would have hatched in the period 8–19 July. Three complete clutches were of four eggs, two others of three.

Five out of six nests were situated in habitat type III, four of them about 100 m or more from more luxuriant vegetation. One of them was situated 15 m from type II. The last nest was situated in type II vegetation, 100 m from a river bed.

The nests were visited 18 times. A pair was seen on only four occasions. On 11 occasions one bird was present, and on three occasions no birds were seen. The birds either performed distraction behaviour, or gave alarm calls or ran off quietly.

In high arctic Canada Parmelee (1970) and Parmelee & Payne (1973) found that Sanderlings laid two clutches in quick succession, and that each was reared independently by one of the mates. In southern Northeast Greenland, near Mestersvig, Pienkowski & Green (1976) found that two adults shared the incubation. At Danmarks Havn mated birds were seen in the middle of the incubation period at two nests and with one seven days old brood. The male was the most active in alarm-calling. At two other nests one of the mates was dyed yellow, and at both nests uncoloured birds were also seen incubating, thus confirming Pienkowski & Green's observations.

Table 5 presents the observations during the season. In late June and early July fewest 'territories/pair sites' were passed without any birds seen, i.e. 42–43%. Throughout the season at least 50% of the registrations could not be related to any 'territory', even excluding flocks of four or more birds.

Besides the observations at nests and broods, only few pairs were seen after early July. Song and other sorts of display were regularly performed till late June.

Up to five birds were feeding in the communal feeding area in the marsh at the weather station in mid- and late June. During the snow storm 16–19 June, up to 12 Sanderlings roosted in the weather station area and 25–30 in the marsh behind. A male Sanderling caught in a mist net on the weather station on 22 June had poorly developed brood

Table 5. Percentage distribution of all registrations (also negative) of Sanderlings at or away from territories in selected periods during June and July. See table 2 and p. 73 for further explanation.
Registreringer af Sandløbere efter samme princip som i tabel 2.

Period *Periode*	1–10 June	12–14 June	20–29 June	1–9 July	11–16 July
Territories without birds seen *Territorier hvor ingen fugle sås*	76	82	42	43	55
N_1	(21)	(11)	(31)	(23)	(22)
Pairs at territories *Par ved territorier*	14	5	18	12	10
Singles at territories *Enlige ved territorier*	4	5	14	40	38
Pairs outside territories *Par væk fra territorier*	18	33	25	16	10
Singles outside territories *Enlige væk fra territorier*	64	57	43	32	42
Attracted birds *Tiltrukne fugle*	0	0	0	0	0
N_2	(28)	(21)	(56)	(25)	(21)

patches. A male found dead in the same period had no brood patches, but its left testes measured 13 mm indicating a bird in breeding condition.

Flocks of post-breeders appeared from 8 July when a group of four was seen. In mid-July up to 25 individuals or more in flocks of up to 21 birds fed at Skibssø, Lille Skibssø and Hulesøen. Flocks of adults were still present on 27 July, and on 8 August a few adults still attended young. No Sanderlings appeared on the delta at the weather station until 21 August. From this date to my departure juveniles were regularly feeding in the delta at low tide, peaking by ten 22–25 August.

Grey Phalarope *Phalaropus fulicarius*

On 10 June one female Grey Phalarope had arrived in the census area. From 12 June a male was also present, but it was not until 19 June that they appeared together. On 25 June I found the nest with four eggs in a type I habitat just north of Skibssø (Fig. 13). Both birds were present and copulation was seen. Single birds were seen or heard within a few hundred metres from the nest from 22 to 27 June. On 1 July both mates again gave alarm calls at the nest, but later only the male was present. On 14 July four dry pulli were present in the nest.

During the incubation period the male usually left the nest when I was 50–100 m from it, and alternated between behaving quietly and giving alarm calls. On one occasion just prior to hatching he flew around me giving alarm calls 500 m from the nest. On 30 July the male was still attending the young, but later no birds were seen (only few visits).

Table 6. Estimates and counts of the population of waders (pairs) in the census area at Danmarks Havn from 1907–08 (Manniche 1910), 1969 (reduced from Meltofte 1975), and the present study.
Skønnede og optalte antal vadefuglepar i optællingsområdet ved Danmarks Havn. De tidligere høje antal par af Stor Præstekrave og Alm. Ryle skyldes formentlig overestimeringer, medens manglen på Stenvendere i 1907–08 sikkert er reel.

	1907–08	1969	1975
Charadrius hiaticula	>100	53	21–22
Arenaria interpres	0	14	17
Calidris canutus	0	0	2
Calidris alpina	50	21	18–20
Calidris alba	+	14	13–15
Phalaropus fulicarius	>1	0*)	1

*) One pair bred in 1970
Et par ynglede i 1970

DISCUSSION

Population size and distribution in the census area

Table 6 presents earlier estimates and the present census results. The figures given by Manniche (1910) are rough estimates probably covering approximately the same or a slightly larger area than the present study. The census area in 1969 was also larger, but the figures in the table are reduced to cover only the present area.

The reasons for the observed differences are probably complex. Between 1969 and 1975 only the figures for Ringed Plover are significantly different. The counts in 1969 were only single counts in late June, and I am quite sure that the high figure for that year is due to many double registrations. This conclusion is based upon greater experience since that time with the highly conspicuous behaviour of this species (see p. 74 and Meltofte 1976 a). The differences between Manniche's estimates and mine are more striking. However, I do not think that the apparent decline of Ringed Plovers and Dunlins is fully reliable. The decline may be a real one, but it's just as likely to be due to over-estimations in 1907–08. The increase of Turnstones from none in 1907–08 to the second most numerous wader now is uncontestable and corresponds to the significant increase found in Peary Land (Meltofte 1976 a). No extreme climatic conditions were involved between the actual census years, and annual variation cannot therefore have caused the differing results. Nothing is known about the area's carrying capacity for breeding waders or of annual fluctuations in the size of wader populations in high arctic Greenland.

Counting all six species together, the total wader population at Danmarks Havn was 72–77 pairs in 1975 (16.0–17.1 pairs/km^2) including all stationary pairs, whether proven breeders or not. All territorial pairs/individuals and 'site claiming' birds of any sort are considered full members of the population. The proportion of a population which breeds or

attempts to, are questions of demography and breeding success and not of population density. The population density at Danmarks Havn is the highest found in Greenland. This is due to the early disappearance of snow cover and the luxuriant vegetation of this favourable kettle-hole.

The distribution maps (Figs 7, 9, 13, and 17), show that both Ringed Plovers and Dunlins preferred the most luxuriant habitats, which were free of snow earliest, in and around the marsh areas especially in the eastern part of the census area (cf. Fig. 3). It is well known that Dunlins prefer marshy wet areas but Ringed Plovers are generally supposed to prefer dry, sparsely vegetated habitats. They do use such sites for the nest but the nest site is usually not far from fertile irrigated slopes or moist habitats. Less than half the Dunlin nests were situated directly in marsh vegetation. The others were found in grass-tussocks in drier, more barren habitats near marshy areas.

Most Turnstones and Sanderlings nested in less fertile areas, snow covered until late in spring. These were mainly in the west of the area and near Hulesøen. Turnstones preferred dry gravelly and stony sites for their nests, usually either close to or in vegetated areas. Only Sanderlings nested far from well vegetated areas, on barren and gravelly habitats, the nest situated in a patch of *Dryas* or other plants.

There may be a connection between nest-site selection and the feeding biology of the adults during the period of laying and incubation. The Ringed Plovers and Dunlins (cf. Holmes 1966) remained near their breeding site during this period and fed there. Sanderlings travelled far, and many Turnstones sought communal feeding areas far from their territories (cf. Pitelka *et al.* 1974). These differences apply only to nest sites. After hatching all waders lead their young to the well vegetated areas where food is most abundant.

Arrival and pre-laying period

In the southernmost part of Northeast Greenland the first waders arrive about mid-May (Meltofte 1976 b), but generally pioneers arrive throughout high arctic Greenland during the last ten days of May. The main influx takes place at the end of May and in early June (cf. Fig. 6). At first, flocks occur at favourable feeding sites, especially in years when there is much snow and a late thaw. The flocks soon break up into pairs and disperse.

Apparently, waders now arrive earlier than in the first part of the century (Rosenberg *et al.* 1970, Meltofte 1975). The 1975 season was a little late and the first individuals were seen at Danmarks Havn a few days later than in the very early season of 1969. Most waders dispersed during the first half of June, but the snow storm 16–18 June disturbed and altered the situation, and it was mid-summer before the last pre-breeders settled (see further below under non-breeders).

The pre-laying period of waders in the high arctic can be interpreted as a period which allows the birds to adjust their onset of breeding to the prevailing climatic conditions of the actual year (Meltofte 1976 a).

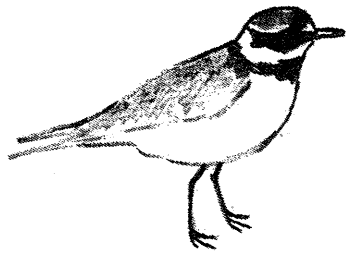
The average weight of the Turnstones caught upon arrival about 1 June is about 45 g lower than the departure weight of Turnstones on Iceland in late May (Morrison 1975), indicating a weight loss of c. 28% on this about 1400 km flight. The arrival weight at Danmarks Havn is quite similar to the arrival weight on Ellesmere Island in Canada (Morrison 1975).

Breeding schedule

Holmes (1966) and Nettleship (1973, 1974) have shown how the breeding of waders in the arctic is timed so that the hatching takes place when food conditions are optimal for the young. But local differences and annual fluctuations in onset of breeding are influenced by amount and thaw of the snow cover in the actual breeding area and season (Meltofte 1976 a, Green *et al.* 1977).

When probable replacement clutches are excluded, the egg-laying of Ringed Plovers started between 11–19 June, Turnstones between 9–16 June, Dunlins between 10–24 June, Sanderlings between 10–21 June, and one Grey Phalarope clutch was started about 20 June. Thus egg-laying occurs when mean temperatures are still near or below 0° C. A large number of replacement clutches were started in late June about one week after the snow storm. No clutches were laid later.

In 1969, a year of early thaw, the first Turnstone, Knot and Dunlin clutches were all started in early June (Meltofte 1975). In all the



years studied, flying Diptera were plentiful from early July at Danmarks Havn.

These laying dates are similar to those found in other favourable areas in high arctic Greenland (Korte & Bosman 1975, Meltofte 1976 a, Hjort 1976, Green *et al.* 1977, Meltofte *et al.* in print).

Breeding success

A total of 38 wader nests was found: ten Ringed Plovers, six Turnstones, 16 Dunlins, five Sanderlings and one Grey Phalarope. Only one Ringed Plover nest and perhaps one Sanderling nest was predated, even though foxes scrutinized the terrain daily, and I touched most of the eggs.

Nest survival was: Ringed Plover 70%, Turnstone 67%, Dunlin 94%, Sanderling 75%. A Turnstone's nest with starred eggs abandoned because of my activities, has been counted as successful. The Sanderling's nest that perhaps was predated has been omitted. A Dunlin's nest that would have been totally flooded if I had not lifted the nest has been regarded as unsuccessful. One drained Turnstone nest, and two other drained Dunlin nests might have survived anyway and have been considered successful.

Nest failures were mostly due to cold weather during the snow storm in mid-June. One Ringed Plover abandoned its nest during the snow storm. One Turnstone pair laid a clutch scattered around the nest area. Another Turnstone's clutch did not hatch probably because of chilling.

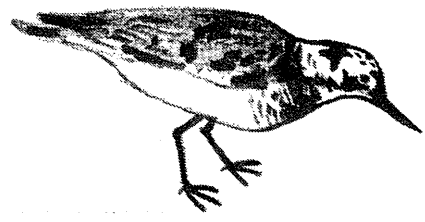
One well incubated Ringed Plover egg in each of two nests failed to hatch probably because I caught the adults. Other single eggs which failed to hatch may have been chilled during the snow storm, but as this occurred early in the incubation period, it was difficult to see if they contained embryos.

In the Ringed Plover's nest that was abandoned during the snow storm, new eggs were laid after 8–10 days, providing the first proof of relaying in arctic waders. It has, however, long been suspected that renesting occurs, because of records of extremely late hatching dates. Holmes (1966) concludes that a significant number of Dunlins in northern Alaska renested after losses due to flooding, inclement weather or predation; about one quarter of the nests found by him during four seasons were probably replacements.

Counting all findings of nests and young together, five (45%) of 11 Ringed Plovers, one (13%) of eight Turnstones, and 2–6 (13–38%) of 16 Dunlins were probably replacements. Probably no Sanderling clutches were replacements, but this may occur (Meltofte 1976 a).

The figures indicate that Dunlins survived the snow storm best, and Ringed Plovers worst. These differences apparently reflect the different degree of nest cover used by the species. Dunlin nests are much more sheltered by adjacent vegetation (see Bengtson 1963).

Floods are a permanent threat to wader nests in snow-rich areas. In the high arctic the main melt takes places during late June and early July when most waders are incubating. Strong evolutionary pressures must have been involved in nest site selection and other behaviour preventing severe losses. It has been known for years (Lind 1961) that many Charadriiformes can add more nest material under the eggs when water levels rise. At Danmarks Havn I saw this in a Dunlin nest and apparently also in a Sanderling nest. In two Dunlin nests the eggs were found standing on their pointed ends and leaning against the sides of the nests (Fig. 15). Nothing but the birds could have arranged them in this manner, which I have not seen described elsewhere. It appears to be an outstanding adaptation in that arctic wader



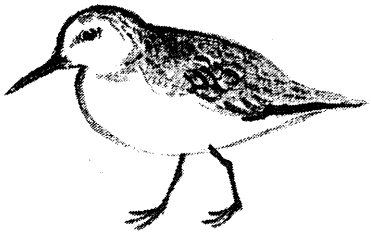
species, the nest of which is most vulnerable to flooding.

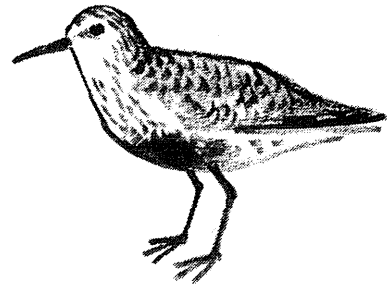
Non- and failed breeders

Many waders, especially of the larger species, do not mature until they are two or three years old (Glutz *et al.* 1975, 1977). Most immatures summer in tropical or temperate regions, and do not go to the arctic breeding grounds. Many of them do not develop full nuptial plumage.

Individuals in incomplete nuptial plumage have only been reported occasionally in high arctic Greenland, but it seems likely that a number of birds arrive at the breeding grounds as 'prospectors' during the year prior to breeding. Flocks of non-breeding birds are not present during the middle of the incubation period and most, if not all, birds seem to disperse, establish territories and mate (Meltofte 1976 a). At the time of hatching in early July, unsuccessful pairs leave the territories and congregate in post-breeding flocks. They feed on favourable sites and start the autumn migration during mid-July. Such flocks apparently contain both failed and non-breeders, but this still needs to be investigated. Four female Dunlins, collected in post-breeding flocks in the second half of July 1974 at Scoresby Sund, were non-breeders. This was probably also the case for four male Dunlins and one male Sanderling, while one female Sanderling had laid eggs, but perhaps not in this season (Korte *et al.* in print).

Many of the Turnstones visiting the communal feeding areas at the weather station daily during mid- and late June were apparently not breeding. Most of them did not have brood patches in mid-June, and of those found dead a few had poorly developed gonads. Breeders from the census area also visited the feeding areas, but the majority of birds present were probably non-breeders.





In 1969, when less snow was present during June, no such concentrations were noted at Danmarks Havn, but i 1970, a year of much snow, up to 20–30 Turnstones occurred regularly at the weather station until mid-June (Meltofte 1975). I suggest that if snow conditions are favourable these non-breeders disperse during mid-June at the latest and occupy marginal territories during the incubation period.

Some of the many registrations not related to any territory (Tables 2, 3, 4, and 5), may have been wandering non-breeders, but I do not think they formed a large proportion. Until the last pre-breeders finally dispersed after mid-June, there was clearly an impression of 'unsettlement' amongst the birds. Afterwards, there was a clear impression of peace and stability.

Observation efficiency and methods of wader censusing

My experiences from this study fully confirm and extend the results and conclusions of the study in Peary Land in 1973 (Meltofte 1976 a). Breeding waders are not easy to census. It is only possible to achieve reliable population figures by regular mapping during the period from the dispersal of the last pre-breeders until the failed and non-breeders gather in post-breeding flocks at the time of hatching. However, I have no proposals for standardization of mapping technique. My evaluations are based upon impressions and experiences and are, I think, accurate to within a few pairs. The main advice to people attempting censuses of wader populations is to spend many hours, if possible daily, in the study area. For more detailed population studies it is necessary to find as many nests and dye as many birds as possible.

At Danmarks Havn the last waders settled

before mid-summer, and the first young hatched about 6 July. Post-breeding flocks increased from a few days later. Thus the optimal census period in 1975 at Danmarks Havn lasted 2–3 weeks during late June and early July.

Waders are generally more calm and quiet in overcast and cold weather and during 'night' hours. Fewer birds are seen, but it is easier to find nests or young, as the birds are more eager to return to brood.

The material presented in the Tables 2, 3, 4, and 5 and Figs. 8, 11, and 16 is an attempt to quantify field registrations on a wader population. The material is limited and rather subjective, but nevertheless gives some interesting results. Most striking are the proportions of 'territories without birds seen' and the sum of registrations which could not be related to territories. In Ringed Plovers, Turnstones and Dunlins about one quarter of the visits to territories (nests) during late June and early July were made without seeing the birds. In Sanderlings the proportion exceeded 40 %. At the same time between one quarter and one half of the actual observations could not be related to any territory; in Sanderlings even more.

This was also noted in observations of pairs with known breeding schedule (Figs. 8, 11, and 16). At least one bird was seen on more than 75 % of the visits at territories of Ringed Plovers, Turnstones and Dunlins during the laying and incubation periods. Both mates were seen together at about one third of the visits until the nest was found, and pair observations increased by increased number of visits directly to the nest. However, such pair observations only increased for Ringed Plovers and Turnstones. On a number of visits to Dunlin nests especially, but also to the other species, no birds were seen. At some occasions I saw from a long distance that the bird simply walked off the nest long before I reached the area and flew away low over the ground (cf. Meltofte 1976 a, 1977 b). Often the bird would sit calmly at some distance and wait for me to go. No birds were seen at 6 % of the visits at Ringed Plover nests, 14 % at Turnstone nests, 13 % at Dunlin nests, and 17 % at Sanderling nests. In a further 7 % of visits at Dunlin nests a bird was seen, but no alarm calls were given and no other alarmist behaviour observed.

The significance of these variations in behaviour to wader censusing is obvious. Even when the birds do give alarm calls, or perform distraction behaviour, they often do this up to several hundred metres from the nest (or young), and they may join other alarm calling pairs more than one kilometer away. The behaviour varies from species to species, from bird to bird, and from time to time. Not even two individuals alarm calling together at one nest, can be considered a pair.

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SUMMARY

The results of one summer's study on the population of waders on a 4.49 km^2 census area in central Northeast Greenland are presented. Informations on arrival, pre-laying period, population densities, breeding schedule, habitat and nest site selection, clutch size, hatching success, non-breeders, communal feeding, post-breeding gatherings, departure and biometrics are given for *Charadrius hiaticula, Arenaria interpres, Calidris canutus, Calidris alpina, Calidris alba* and *Phalaropus fulicarius*. Many repeat nests were found following a severe snow storm in mid-June. However, nests survived even when nearly snow-covered. It was found that *Calidris alpina* may stand their eggs on the pointed end in the nest cup to avoid water in the nest bottom. Special attention is given to observation efficiency and methods of wader censusing, including behaviour related to this.

DANSK RESUMÉ

Bestanden af vadefugle ved Danmarks Havn, Nordøstgrønland, 1975

Resultaterne af en sommers undersøgelser over vadefuglebestanden på et 4,49 km^2 optællingsområde i Nordøstgrønland præsenteres. Oplysninger om ankomst, perioden før æglægningen, populationstæthed, biotop- og redepladsvalg, yngletidspunkt, kuldstørrelse, klækningssucces, ikke-ynglende fugle, fælles fødesøgningsområder, flokdannelser efter yngletiden, borttræk samt målinger og vejninger gives for Stor Præstekrave, Stenvender,

Islandsk Ryle, Alm. Ryle, Sandløber og Thorshane. Mange omlæg konstateredes efter en kraftig snestorm midt i juni. Imidlertid klarede en del reder denne periode selv om de blev næsten helt snedækkede. Det konstateredes at Alm. Ryle kan rejse sine æg op på den spidse ende i redeskålen for at undgå at æggene bliver våde af vand i redebunden under oversvømmelser. Observationseffektivitet og metoder til vadefuglepopulationsoptællinger behandles, og det konkluderes at det er nødvendigt med daglige kortlægningsoptællinger i rugetiden for at opnå pålidelige resultater.

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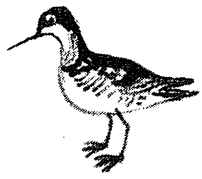


Appendix

Measurements of adults

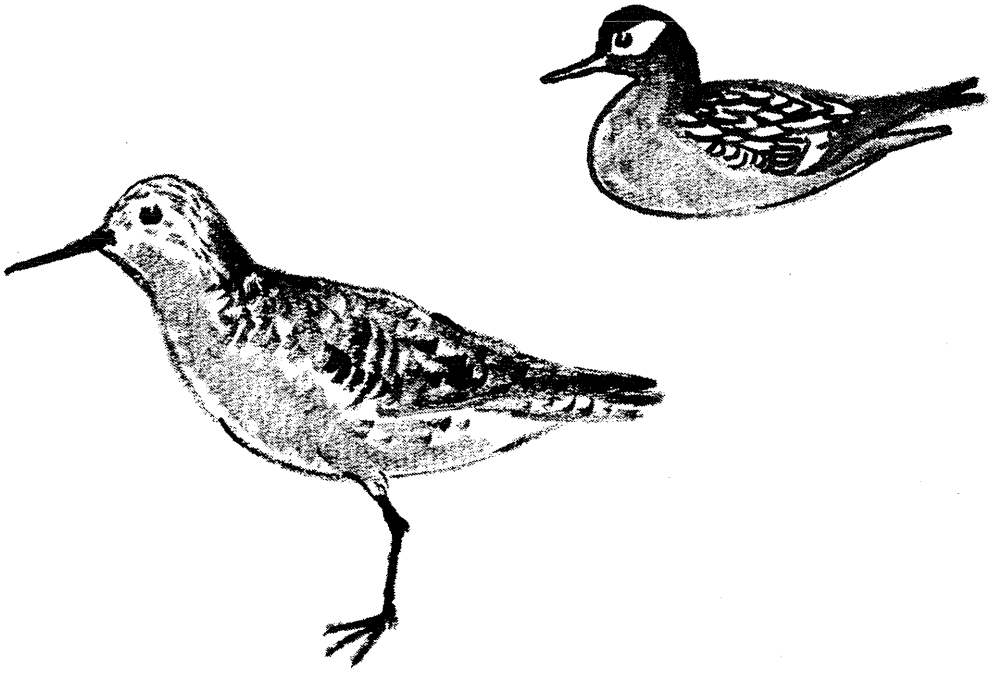
Ring no.	Sex	Date	Culmen mm	Wing mm	Weight gm	Brood patch	Notes
Charadrius hiaticula							
8116193	f.	7.7	14	140	64		breeder
8116194	f.	8.7	14	137	58		breeder
Arenaria interpres							
7046237	m?	31.5	23	162	119	–	
7046238	m?	1.6	21	158	105	–	
7046239	f?	–	22	161	113	–	
7046240	f?	–	20	155	114	–	
7046241	f?	–	23	157	122	–	
7046242	m?	–	23	156	116	–	
7046243	m?	–	22	157	107	–	
7046244	m.	–	22	157	129	–	
7046245	m?	3.6	21	153	100	–	sick legs
dead	f.	–	22	160	133	–	max ovocyte 5.5 mm
7046246	f?	7.6	23	158	124	–	
7046247	m?	8.6	21	154	104	–	
7046248	f.	9.6	23	160	108	–	
7046249	f?	–	23	151	95	–	
7046250	m?	–	23	155	95	–	
755002	m?	–	20.5	155	99	–	
755003	f.	10.6	21	163	107	–	
755004	m.	–	21	149	98	–	
755005	f.	12.6	21.5	157	120	±	
755006	m.	–	21	147	94	–	
dead	m.	–	21	159	97	–	testes c. 7 mm
755007		18.6	21	148	113	±	
dead	m.	20.6	21.5	153	105	+	
dead	m.	–	21	156	98	–	left testes 10 mm (thin)
755008	f.	21.6	22	157	106	±	
755009	m.	–	21	151	110	±	
755010	m.	22.6	21	150	96	–	
dead for many days	f.	29.6	22	160	133	+	ruptured follicles
755011	f.	1.7	22	148	112		breeder
755012	f.	2.7	22.5	164	111		breeder
755013	f.	3.7	23	148	113		breeder
755014	m.	4.7	23	162	99		breeder
dead for many days	m.	5.7	20	149		–	left testes 10 mm
Calidris alpina							
8116176		1.7	26.5	115	40		breeder
8116177		–	26.5	109	42		breeder
8116179		2.7	27	109	41		breeder
8116180		–	30	117	43		breeder
8116181		–	25	116	40		breeder
8116182		3.7	26	114	45		breeder
8116183		4.7	25	111	41		breeder
8116185		5.7	26	112	42		breeder
8116192		7.7	29	118	44		breeder

Calidris alba							
8116175	m.	22.6	25	113	48	±	meager
dead for many days	m.	27.6	25	119	48	–	left testes 13 mm
8116178	m.	2.7	21.5	126	54		breeder
8116184	f.	4.7	24.5	126	57		breeder

Pulli newly hatched (in or close at nest)

Charadrius hiaticula	Culmen	Weight
Mean	7.7	7.87
S. D.		0.229
Range	7.5–7.9	7.5–8.2
N	2	7
Number of clutches	1	3
Arenaria interpres		
Mean	10.65	11.68
S. D.		1.08
Range	10.4–11.3	9.2–12.7
N	6	8
Number of clutches	3	3
Calidris alpina		
Mean	10.12	6.84
S. D.	0.50	0.45
Range	9.5–11.3	6.1–7.9*)
N	14	21
Number of clutches	5	8
Calidris alba		
Mean	9.87	7.17
S. D.	0.36	0.55
Range	9.3–10.3	6.3–7.8
N	7	7
Number of clutches	2	2
Phalaropus fulicarius		
Mean	78.25	51.75
S. D.		
Range	7.7–8.0	4.9–5.5
N	4	4
Number of clutches	1	1

*) a one day old chick weighed only 5.3 g during a cold period



Controls of pulli growths

No.	Date	Hour	Age	Culmen mm	Weight gm	Notes
Arenaria interpres						
7550151	6.7	17.00	few hours	10.5	9.2	in nest
	8.7	15.00	2 days	12.3	13.1	40–50 m from nest
7550182	6.7	17.00	few hours	10.6	12.0	in nest
	8.7	17.00	2 days	12.3	15.1	500 m from nest
	14.7	15.30	8 days	17	49	back at nest site again
7550202	6.7	20.00	newly hatched		12.0	wet
	8.7	17.00	2 days	12.9	13.7	500 m from nest
7550211	6.7	20.00	newly hatched		12.0	wet
	8.7	15.00	2 days	11.8	12.7	40–50 m from nest
755023	8.7	18.00	<24 hours	10.5	11.6	40 m from nest
	14.7	17.30	<7 days	15.0	40	500 m south of nest
Calidris alpina						
8116186	6.7	16.00	few hours	10.0	7.7	in nest
	15.7	17.30	9 days	15.5	23.7	100 m from nest
81161901	7.7	15.00	c. 1 day	12.0	7.9	200 m from nest
	8.7	23.15	c. 2 days	13.5	10.7	same place
81161911	7.7	15.00	c. 1 day	11.1	7.4	200 m from nest
	8.7	23.15	c. 2 days	12.8	9.7	same place
8116200	9.7	16.30	newly hatched		6.6	half dry
	11.7	10.45	2 days	11.9	7.7	400 m from nest
	15.7	16.30	6 days	15.5	16.8	200 m from nest
8116210	11.7	17.30	just hatched	10.0	6.7	
	5.9	23.00	56 days		42	recaptured in Scotland (wing 118 mm)
81162392	17.7	15.00	few hours	10.0	6.6	nearly dry
	18.7	04.30	c. 15 hours		6.3	still in nest – cold weather
	18.7	13.00	c. 24 hours		6.1	still in nest – cold weather
81162403	18.7	04.30	few hours		6.6	dry
	18.7	13.00	c. 10 hours		6.4	still in nest – cold weather
81162413	18.7	04.30	few hours		6.2	nearly dry
	18.7	13.00	c. 10 hours		5.9	still in nest – cold weather
81162422	18.7	10.00	newly hatched			wet
	18.7	13.00	3 hours		6.5	nearly dry – cold weather
	27.7	10.00	9 days	15.8	19.3	400 m from nest
81162432	18.7	10.00	newly hatched			wet
	18.7	13.00	3 hours		6.0	nearly dry – cold weather

Small figures denote siblings