Observations on the incubation and post-hatching behaviour of the Greenland White-fronted Goose

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Introduction

The breeding behaviour of the dispersed nesting Greenland White-fronted Goose *Anser albifrons flavirostris* was studied in May and June 1979 as part of an investigation of Whitefront summer ecology in west Greenland (Fox & Stroud 1981a). The aim was to compare the behaviour of the Whitefront during incubation with that of the better known, more densely nesting Pink-footed Goose *A. brachyrhynchus* (Inglis 1977; Lazarus & Inglis 1978).

There have been several behavioural studies of colonially and densely nesting arctic geese, but less attention has been given to dispersed breeders. Ely (1979) briefly discusses the behaviour of the Pacific Whitefront *A. albifrons frontalis* as it relates to breeding on the Yukon-Kuskokwim Delta, but the nesting habitats and densities there are very different to those in west Greenland, and it seems likely that many aspects of Greenland Whitefront summer ecology may be peculiar to this race (Fox & Stroud 1981b).

The range of the White-fronted Goose in Greenland extends from 64°–72°N in the ice-free regions of the west. The small population size (c. 15,000) and low summer densities of birds have resulted in little published information on summer biology; neither Fencker (1950) nor Salomonsen (1950) discuss breeding behaviour.

Study area and methods

The study area of Eqalungmiut Nunât (67°50′N) is a discrete area of 750 km² close to the ice-cap and in the southern central part of the range of the Whitefront in Greenland (Figure 1). Conditions are thought to be typical of large areas of the breeding grounds although densities may be slightly higher here close to the ice-cap than in the immediate surrounding areas (V. Holthe *in litt.*, Stroud 1981a). Nesting pairs of Whitefronts were found predominantly near *Eriophorum angustifolium* dominated marshes around 50–250 m altitude. Although impossible accurately to count nests over a large area, it is thought that in favourable areas the nest density did not exceed one per 2 km². An estimate of total numbers based on a partial census in July 1979 suggested that only 16 pairs nested successfully here.

One nest was observed throughout the incubation period; continuous observations starting a week after incubation commenced. The marsh near which the nest was situated, was surrounded by heath-herb slopes dominated by *Calamagrostis purpurescens*. These merged into wetter communities along the sides of the marsh, and the nest was situated in this transitional vegetation zone. The central regions of

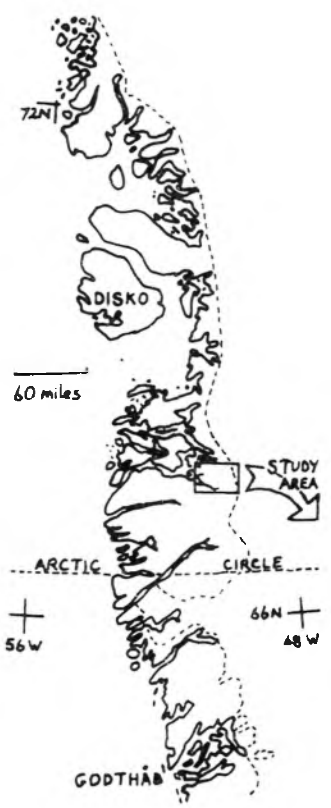

Figure 1. The breeding range of the White-fronted Goose in west Greenland showing the location of the study area, Eqalungmiut Nunât.

Wildfowl 33 (1982):63–72

the marsh contained a mixture of sedges, grasses and mosses, with numerous pools, still frozen in May. Here, *Eriophorum angustifolium* and *Carex rariflora* were important food items for the geese (Madsen & Fox 1981), although the area was also characterized by *Salix arctophila*, *Sphagnum squarrosum* and *Hippuris vulgaris*.

Observations were made from a wooden hide, 173 m from the nest, situated on a nearby hill and using ×30 and ×60 telescopes. Methods were based on Inglis (1977); the marsh was scanned every five minutes and behaviour and position of all geese recorded. Behaviour was recorded as activities and postures: the former being largely locomotory states whilst the latter generally related to the degree of alertness of the bird (see Inglis 1977 for details). Hourly meteorological records were also taken.

In presentation of diurnal rhythm data, those hours when a bird was out of sight for more than ten minutes have been excluded, as have data for the female for 36 hours and the male for 4 hours prior to hatching, since their behaviour changed significantly during this period. Presentation of long-term changes in behaviour is directly comparable to Inglis (1977).

Results

The nest was situated 500 m from Base Camp. Although the male moved further from the camp in the middle of the day (when presumably disturbance from this source would have been greatest), it is not thought that the normal behaviour of the geese was otherwise greatly altered, and indeed one afternoon the male was observed feeding only 30 m from the camp.

Breeding chronology

Clutch initiation by Greenland Whitefronts in Eqalungmiut Nunât in 1979 took place during 19–26 May. The studied goose probably laid her first egg on 22 May; the full clutch was six eggs, although only five successfully hatched. Incubation commenced on 27 May and the eggs hatched on 22 June, a period of 25 days. The nest was observed continuously (except for a break of 24 hours on 12 June), from the afternoon of 4 June until the goslings were led away to higher altitudes 10 hours after they hatched. Another nest was observed during hatching and over the period 26–29 June (Stroud 1981b). Here, the family stayed for longer at the nest site and were observed for 26 hours until they too, moved to upland lakes to feed. All results presented here are from the first nest unless otherwise stated.

Female time budget

The incubating female spent most of the day in one of two postures: head on back (48·7%) and head low (41·5% of 4,731 scans). Other postures made a small contribution to the total (Figure 2): 2·3% of the time was spent head up, followed in order of decreasing importance by drinking droplets of water from the flanks, nest adjusting, grazing, preening, egg-rolling, concealment behaviour during predator presence, flying to feed, down-plucking and others.

Long term trends in female behaviour

Feeding departures, always accompanied by the male, were regular in duration and timing (mean 24 minutes, range 15–35, n = 14), although they increased in frequency from once every other day, to occur daily between 13–19 June. She fed twice during 20 June then remained on the nest until the eggs hatched in the early hours of 22 June. Thus, over the observation period as a whole, she showed a significant increase in the time spent feeding (Figure 3).

Male time budget

During egg-laying, the male stood close to the nest and he also accompanied the female back whenever she had fed on the marsh. The remainder of the incubation period was spent on the marsh, generally about 300–500 m from the nest, but moving to within 2 m during the hours preceding the hatch. His time budget is shown in Figure 2.

Up to seven other geese were present on the marsh for short periods but generally most frequent in early incubation between 02.00 and 10.00 hours. Another pair was thought to have nested close by, but this nest apparently failed between 6 and 9 June. Hence although three, possibly four, nests were known to have been initiated near the marsh, only the study nest was successful.

The small flock of non-breeding geese

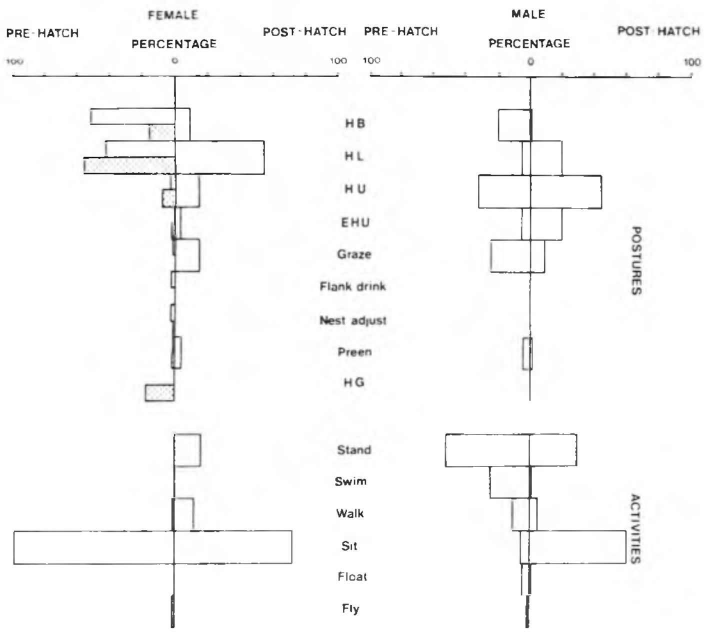

Figure 2. Time budgets for male and female geese pre- and post-hatch. In each diagram, left hand columns are the proportion of time spent before hatching and right hand columns are the proportion of time spent after hatching. Upper diagrams are postures, lower are activities. The data for female pre-hatching has been further sub-divided into behaviour in the absence of predators (upper, open columns, n = 4,661 scans), and behaviour in the presence of predators (lower, shaded columns, n = 70 scans).

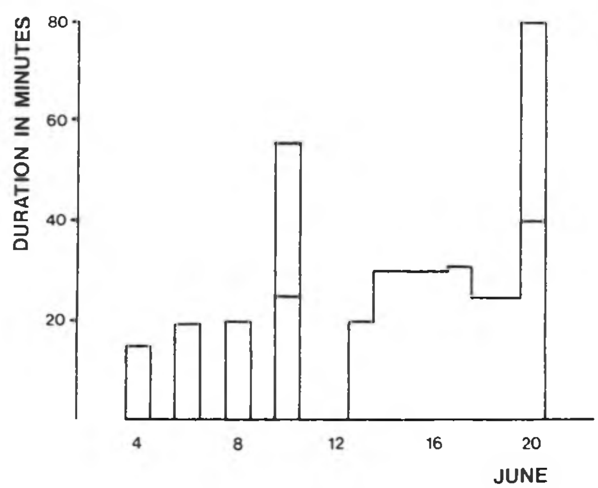

Figure 3. Total time spent feeding each day by female Greenland Whitefront during incubation. No observations were made on 12 June.

was tolerated by the male and few aggressive interactions were observed. He fed amongst them and occasionally flew with them to roost on a nearby hillside. Non-breeding geese rarely approached closer than 300 m from the nest; however, one young bird was chased from the nest area by the male after following the breeding pair back to the nest after feeding. Both sexes tried to hide when geese flew near the nest, generally more intense in response than to a predator such as Raven *Corvus corax* at a similar distance.

At the later hatching nest, the breeding pair was accompanied by an immature goose. It usually stood 2–20 m from the nest, most frequently c. 7 m. On one occasion the breeding male chased the immature from 6 to 20 m, despite closer approach previously. The male spent more time alert, less time in non-vigilant postures than the immature (14·4% of time non-viligant compared to 50·8%).

Long term trends in male behaviour

The proportion of time the male spent head up increased as incubation proceeded (Figure 4). There was no similar increase in time spent in the extreme head up posture, which was most frequently seen in the presence of predators and after the goslings hatched. Feeding declined (Figure 4), probably as the corollary of increased alertness. Time spent roosting showed little variability but was greatly reduced once the chicks had hatched. Other activities and postures remained more or less constant but combined activities of floating and swimming decline significantly.

Diurnal rhythms

The nest was in the shadow of hills for part of the day, and there were distinct diurnal cycles of temperature and light intensity at the nest and these affected behaviour (Figure 5).

Female behaviour

Between the hours of 23.00 and 07.55, the

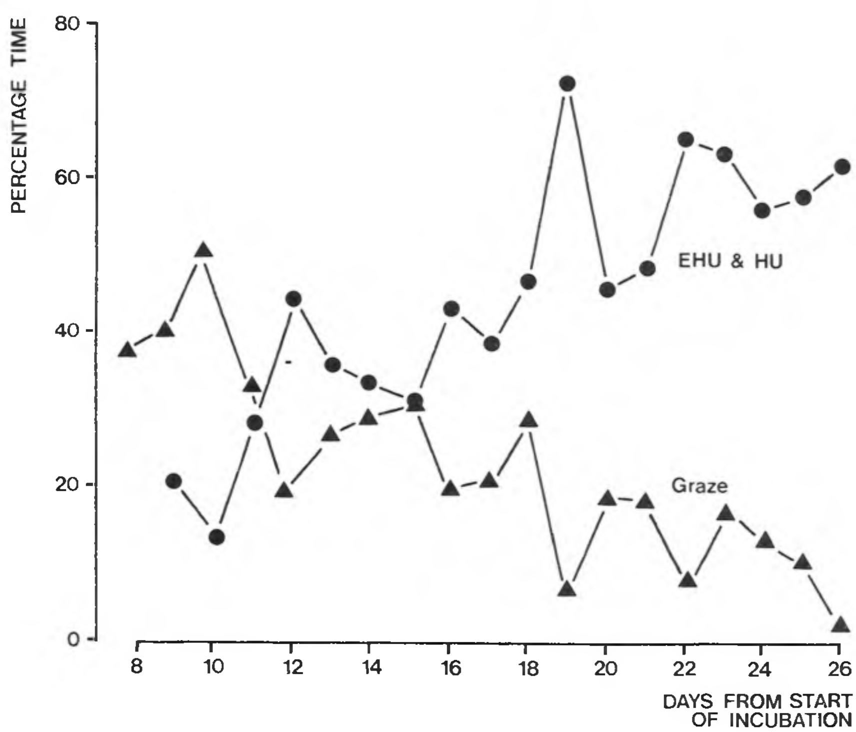

Figure 4. Long-term changes in male behaviour; grazing and extreme head up combined with head up. Values are the proportion of all scans for each day.

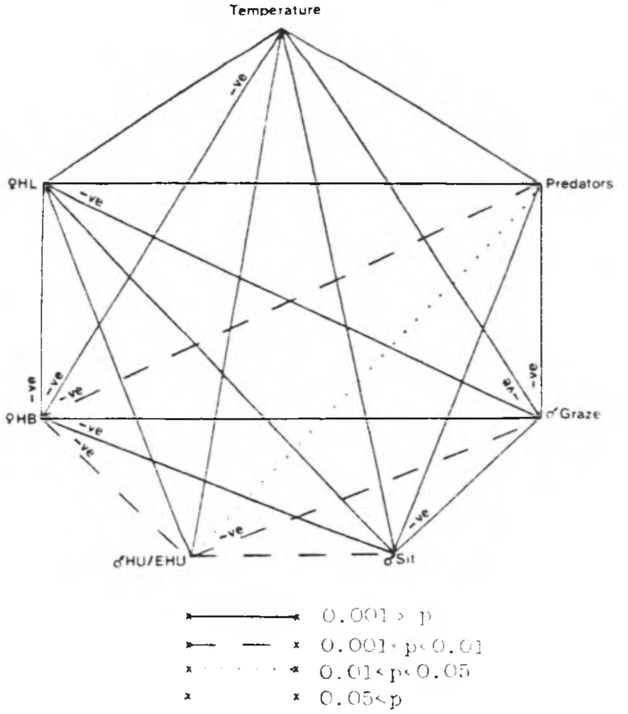

Figure 5. Correlations of diurnal behaviour. Lines joining behaviours indicate that they are significantly correlated (Spearman Rank Correlation). Type of line indicates degree of statistical significance as indicated, sign indicates positive or negative correlations.

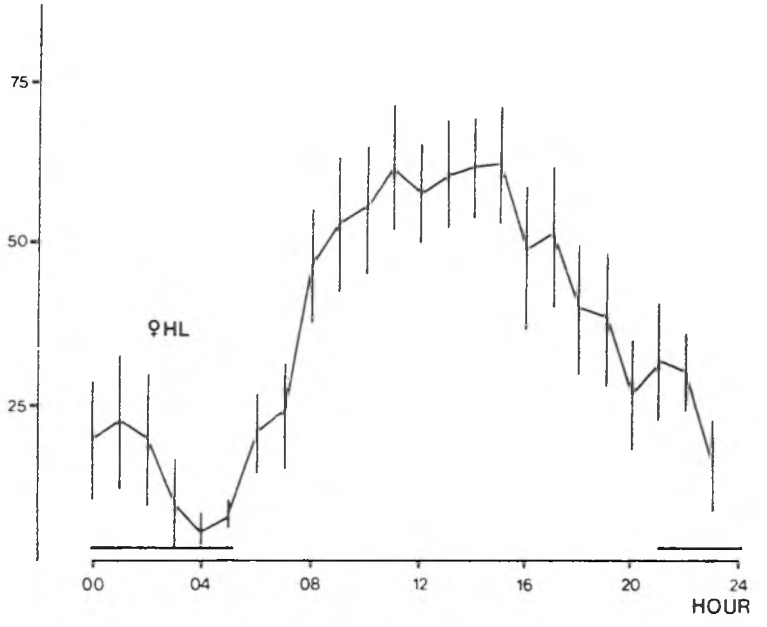

Figure 6. Diurnal changes in female alertness (head low). Values are mean hourly proportion of time spent over the incubation ± standard error of mean. Horizontal bar is the period that the nest was in the shadow of the hills to the north, i.e., 'night'.

female spent most of the time with head on back (Figure 6). The proportion spent with head low showed a close inverse relationship. The timing of the female's departures from the nest were mainly between 19.00 and 01.00 hours and these tended to be in the period of least predator activity (Figure 7).

Male behaviour

Changes in the behaviour of the male are shown in Figure 8. There was a peak of grazing between 22.00 and 05.00 hours while a high proportion of time between 06.00 and 18.00 hours was spent sitting either head up or extreme head up. Roosting (head on back) occurred throughout the day, but falling to a minimum between 16.00–19.00 hours. Preening occurred infrequently although usually between feeding and roosting. Although the sexes alternated vigilant behaviour during the pre-breeding period (Fox & Madsen 1981), the time of day at which the female was alert (head low) was the same as that of the male (head up and extreme head up) during incubation. This alert period of both sexes correlated significantly with the time of highest predator activity and temperature (Figure 5).

Post-hatching behaviour

Immediately after hatching the female showed a significant decrease in time spent sleeping (head on back) and an increase in all vigilant postures (head low, head up and extreme head up) (Figure 2). She also started to eat intensively. Preening took up a greater proportion of her time and she frequently brooded the young. The male spent more time alert, and markedly less time in other activities, whilst close to the nest before the brood left for higher lakes (Figure 2). Family behaviour during the period from 48 hours after hatching to fledging is described by Madsen (1981).

Discussion

It has been noted that some geese nest at a wide range of densities, from solitary to quasi-colonial in other areas (Ely 1979). There are several reports of Whitefronts nesting at high densities, or with some degree of gregariousness, and Table 1 shows that the breeding density varies considerably, even given that only the assessments of Ely (1979) and Mickleson (1975) are likely to be accurate. This may imply that breeding density is affected by local factors (such as predator density, habitat

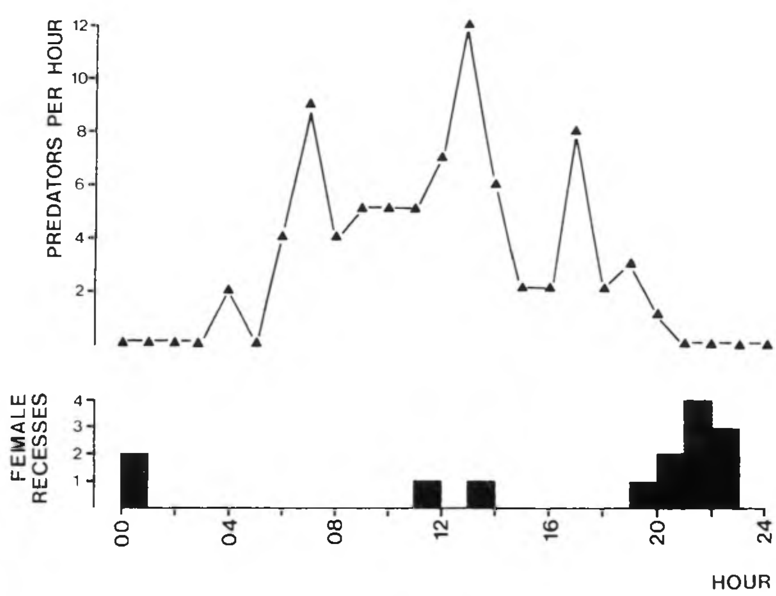

Figure 7. Relationship between abundance of predators (summed hourly occurrence of all records in the observation period) and the feeding periods of the female away from the nest. Predator records were of one Gyrfalcon *Falco rusticolus*, five arctic foxes, and 41 Ravens.

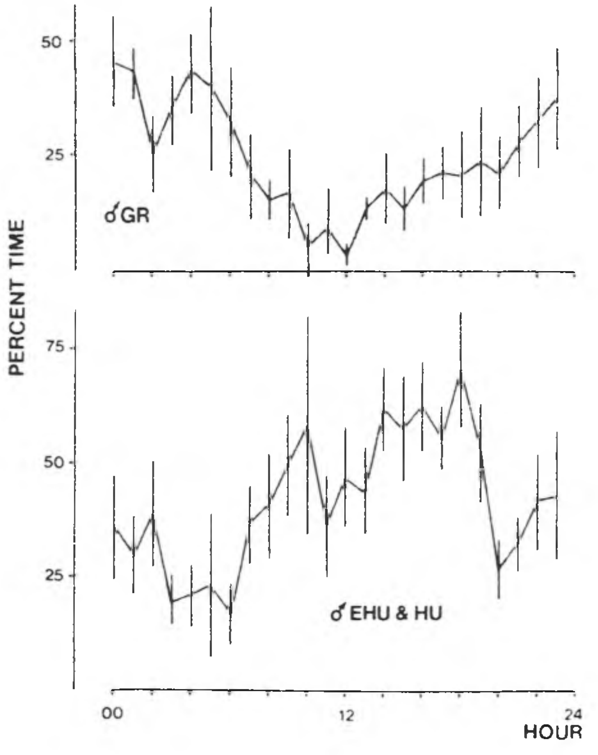

Figure 8. Diurnal changes in male behaviour; grazing and head up and extreme head up combined. Presentation as Figure 6.

Table 1. Nesting densities of White-fronted Geese.

Subspecies	Densities of pairs (per km^2)	Study area (km^2)	Size	
Anser albifrons frontalis	0·4	S1800	Alaska	Dzubin *et al.* 1964
	2	10·4	Yukon-Kuskokwim Delta, Alaska	Mickelson 1975
	3·0	9·8	Yukon-Kuskokwim Delta, 1977	Ely 1979
	4·7	9·8	Yukon-Kuskowkim Delta, 1978	Ely 1979
	5·7	?	Old Crow Flats, Alaska	Dzubin *et al.* 1964
	14	1·3	Yukon-Kuskokwim Delta, Alaska	Michelson 1975
	23–30	?	Point Barrow, Alaska	Dzubin *et al.* 1964
Anser albifrons flavirostris	<0·5	10	Eqalungmiut Nunât, Greenland	Stroud 1981a

availability or topography), and that aspects of breeding behaviour may also vary with density.

There was no evidence of any aggregation amongst nesting geese in Eqalungmiut Nunât, and the smallest measured inter-nest distance of 1,170 m was very much greater than even the dispersed Pacific Whitefront (mean of 170 m, Ely 1979). Such dispersed breeding probably relates to the patchiness of the feeding marshes, predation and the small proportion of geese breeding (Fox & Stroud 1981b). In Alaska the nesting habitat utilized is the dominant vegetation over vast areas of tundra (e.g. the Yukon-Kuskokwim Delta: Ely 1979; Dzubin *et al.* 1964; Mickleson 1975), whilst in Greenland the marshes and wetlands are discrete.

In the last days of laying (27/28 May) the male remained very close to the nest for 20 hours. This may represent a defence against intra-specific nest parasitism or rape, which has been reported for the Pacific Whitefront by Ely (1979), Lesser Snow Geese *Anser caerulescens caerulescens* by Mineau & Cooke (1979) and Barnacle Geese *Branta leucopsis* by Owen & Wells (1979). The male spent most of the day more than 300 m from the nest during incubation, much further than reported distances for other species.

The one occasion when the nest was visited by another goose, the male was present and the intruder flew off after threats. At the second nest, three immature geese were seen less than four metres from the nest a few hours before hatching; however, despite a lack of any overt aggression the male positioned himself between the nest and the geese. Inglis (1976) points out that it is difficult to envisage any evolutionary advantage in harrassment of colonially nesting geese by conspecifics, other than perhaps rape or the eating of eggs. For solitary breeders such an advantage is even more remote, and in almost 500 hours of observation no such attacks were noted. Both sexes did, however, hide when strange geese flew near the nest.

If a predator attacked the nest, the male could be present within a few seconds, demonstrated by the almost instantaneous response to the call of the female when she left the nest to feed. The female is camouflaged against a background of dead grasses and sedges, and when Ravens approached within 200 m of the nest, she frequently placed her head low on the ground reducing her silhouette and hiding the conspicuous white forehead in the vegetation (Fowles 1981). Two geese attempting to hide in this way would be more conspicuous than one, and thus it may be of advantage for the male to be some distance from the nest so that he does not advertise its presence to predators after the clutch is complete.

The time spent incubating each day by the single Greenland Whitefront studied (99.99%) is greater than both dispersed Pacific Whitefronts (97.3%; Ely 1979) and densely nesting Pinkfeet (96·2%; Inglis 1977). There is a marked increase in the time spent off the nest in the later stages of incubation (Figure 3). During incubation reserves of food accumulated over-winter and on arrival become progressively depleted (Ankney & MacInnes 1978), and the increased time spent feeding is consistent with a greater need.

The greater time spent on the nest by both races of Whitefront compared with Pinkfeet can be explained by the protective function of the colony. The female Pinkfoot never feeds far from the nest (Inglis 1977), and if a predator approaches, neighbouring geese provide sufficient alarm to allow her to return to the nest. Whitefronts do not have this protection and thus leave the nest for very short periods when there are fewest predators active.

It is surprising that the female did not always cover the eggs with down, since uncovered and unprotected eggs would seem to be at some risk from Ravens. The reasons for the male's protection of his mate rather than the nest, presumably derive from the relatively small risk of nest predation compared with the importance of allowing the female to feed undisturbed by possible harrassment from other geese.

The total time spent grazing declined over incubation, probably because grazing is of less importance than altertness which correspondingly increases. This situation is very different from that of the male Pinkfoot which shows an increase in feeding and thus a low level of alertness until five days before the hatch, after which feeding declines and alertness markedly increases (Inglis 1977).

After hatching the male is largely responsible for the protection of the family, allowing the female to feed intensively (Figure 2; Madsen 1981). Thus it is important that the male should be in good condition at hatching, and surprising that he tolerated other geese on the marsh, presumably competitors for food. It may be that the marsh was large enough so that the feeding of other geese had little overall effect on the quantity of grazing. These non-breeding birds were free to move between feeding sites as the thaw released marshes throughout June, and probably followed a gradient of plant growth through the study marsh and onto the plateau areas (Madsen & Fox 1981). The breeding male however, is restricted to feeding in a relatively small area. Non-breeders are likely to be tolerated by the male because of their transitory competition at any one site.

When the immediate post-hatching budgets are compared with those during incubation in the presence of predators (Figure 2), it can be seen that they are closely similar. Thus the behaviour shown immediately after hatching, presumably the period of greatest risk to the goslings, may be anticipatory of predators.

The association of an immature goose with the breeders of the second nest was only observed after hatching, although the bird was present throughout incubation. The role of the immature Whitefronts in families after hatching is described by Madsen (1981) and Stroud (1981b). It is possible that this behaviour, previously noted by Ely (1979) in Pacific Whitefronts, is a form of alloparental care, whereby non-breeding birds in their first or second summers remain with their parents and this aspect deserves further study.

The marked rhythm of both male and female behaviour described here has only rarely been reported in arctic nesting geese. Inglis (1977) found that Pink-footed Geese showed no diurnal rhythms during a daily observation period of 05.00–23.00 hours, although a few observations carried out outside those hours found that females were invariably on the nest with the male sitting close by.

It is probable that the geese are responding to environmental cues such as temperature and light intensity when changing behaviour. Ultimately, the geese probably respond to the activity of predators, being more alert when there is greatest chance of attack from either arctic fox *Alopex lagopus* or Raven. If the frequency of fox calls is an accurate reflection of their activity, then from counts made over 24 hour periods they seem to be less active during the early hours of the day. Thus vigilant behaviour seems to be timed in both sexes as to be greatest when there is most risk of predation.

Prop *et al.* (1978) found that nesting Barnacle Geese in high-arctic Svalbard (77°N) showed a distinct diurnal rhythmicity in the timing of their feeding. Males left the nesting island to feed on the nearby mainland most frequently at night (18.00–03.00 hours) whilst the females fed more often in the day (09.00–17.00 hours). The timing of feeding by the female was attributed to two factors: the smaller energetic costs of rewarming eggs on return, and the higher concentrations of carbohydrates available in forage typical of arctic plants in the 'day' (Wilson 1954). Both these factors will apply in Eqalungmiut Nunât, so the fact that the female Greenland Whitefront chooses a later time of day to feed may indicate that these benefits are outweighed by the greater predation risk to a solitary nesting goose.

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Summary

A behavioural study during the summer of 1979 in west Greenland of the incubation and immediate post-hatching period of two Greenland White-fronted Goose *Anser albifrons flavirostris* nests is reported, totalling about 500 hours of continuous observation. At the time of clutch completion the male stood a few metres from the nest, but later moved away and spent the rest of the incubation period feeding on a nearby marsh. At hatching he moved closer to the nest once more. Both sexes show strong diurnal rhythmicity, being most alert when predator activity is at a maximum. The significance of these cycles is discussed with reference to other arctic diurnal cycles. The male shows a significant increase in time spent vigilant over the incubation period which affects the time apportioned to other activities such as grazing. The female left the nest roughly once a day at a constant time (low predator activity) and for a constant period; however, the frequency of these recesses increased throughout incubation. At the time of hatch, both sexes markedly changed their behaviour, the male becoming more attentive allowing the female to spend longer feeding. The significance of this change is discussed and the association of an immature goose with a nesting pair is mentioned. The results of the study are compared with previous work undertaken on the densely nesting Pink-footed Goose *A. brachyrhynchus*.

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