The pre-nesting behaviour of the Greenland White-fronted Goose

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Introduction

During 1979, the breeding biology and ecology of the Greenland White-fronted Goose *Anser albifrons flavirostris* was studied in Eqalungmiut Nunât, West Greenland (67° 32′ N, 50° 30′ W) (Fox & Stroud 1981). This paper discusses the significance of feeding activity and vigilance patterns of goose pairs prior to egg-laying, on arrival at the breeding grounds.

The nutritional reserves acquired by arctic nesting geese are limited by the increase in body weight that the birds can carry during spring migration (Ryder 1970), while the condition of the birds on arrival is of considerable importance in determining reproductive success (Newton 1977; Ankney & MacInnes 1978). Generally, nesting commences shortly after arrival on the breeding grounds, being limited by the period of rapid yolk development, with stimuli dating from events just before or at the time of migration from the final spring staging areas to the nesting grounds (Raveling 1978). The Lesser Snow Goose *Anser caerulescens caerulescens* and Ross's Goose *Anser rossii* commence egg-laying within three to five days of arrival, the Canada Goose *Branta canadensis* and the Greenland White-fronted Goose regularly nest ten to thirteen days after arrival (Raveling 1978; Salomonsen 1950). In most species, geese arrive at the breeding areas when food is in short supply and the female feeds very little during egg-laying and incubation. Pre-nesting feeding and its significance has received scant attention in the literature, although there is little doubt that it is a widespread and common phenomenon.

The Greenland White-fronted Goose breeds in the low arctic region of West Greenland between 64°N and 73°N and shows delayed nesting after arrival in the nesting areas. They usually arrive in early May and commence egg-laying between 20 and 28 May (Fencker 1950). In 1979, the first birds observed on the study area were seen on 7 May, with numbers building to a peak of 93 birds on 12 May. By 17 May the passage was largely complete with birds dispersing to nesting sites and away to higher altitudes. Egg-laying commenced on average on 22 May, giving a pre-nesting period of 10 days.

On the basis of behavioural studies, it is suggested that the female maximizes her feeding activity while the attendant gander spends the majority of his time alertly protective.

Study area and methods

When the geese arrived, the thaw had commenced and snowfalls were infrequent. However, most substrates remained frozen and during the peak period of arrival, the geese were confined to an area known as Kûk Marshes, a part of the glacial melt-river flats isolated from the main sandur flood plain by the Kûk dune system. The resulting wetland has developed into brackish pools and areas of freshwater marsh of some 4 km^2 in extent. The drier zones are characterized by grass and heath with much bog whortleberry *Vaccinium uliginosum*, willow *Salix glauca*, birch *Betula nana* and small reed *Calamagrostis* spp., areas of open mud colonized by poa *Puccinellia* spp. (principally *P. deschampsioides*), marsh arrow-grass *Triglochin palustre* and on substrates of greater organic content, *Calamagrostis neglecta*. In addition, there were many pools of varying depths, often with sharply defined edges containing mare's-tail *Hippuris vulgaris*.

Faecal analysis and direct observation showed the arriving geese to be feeding on the perenniating roots of *Puccinellia deschampsioides* and bulbils of *Triglochin palustre*, as well as the developing shoots of *Hippuris vulgaris* submerged in some of the pools (Fox & Madsen 1981).

The entire area could be watched from a ridge 300 m north of the marshes, affording concealed approach and views over all the goose feeding sites. Observations using 20–45× telescopes commenced on 9 and 10 May, culminating in a full 24 hr watch from 0945 hr on 11 May.

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Two methods were used:-

(i) At fifteen minute intervals, the marsh complex was scanned and the location and activity of all geese present on the pools and marshes noted. The activity classes used in this study are as follows:

1. Feeding—includes all actions involved in various types of feeding e.g. grazing, up-ending, feeding below the surface of water, probing in mud.
2. Alert—equivalent to the posture of extreme head-up of Inglis (1977).
3. Inactive—equivalent to stand and sit postures of Inglis (1977) and excluding roosting.
4. Walk—movement with head in head-up posture of Inglis (1977).
5. Roost—standing or sitting with head on back in typical roosting posture.
6. Swim.
7. Chase/chased—behavioural interactions of geese, according to direction of aggressive encounter.
8. Preen.
9. Drink.
10. Fly.

(ii) Concurrently, pairs of birds were watched whilst actively feeding and the behaviour of both birds noted and timed.

The latter method was primarily intended to examine the patterns of alertness and feeding, the exact time of each change in activity of the pair being noted. The generally later arrival of young birds in Eqalungmiut Nunât, together with the distinctive behaviour of these pairs suggest that the birds under observation were likely to be nesting geese.

The data collected using method (ii) were analysed for male and female and segregated on the basis of pairs feeding in flocks and those feeding in isolation. These results were then analysed in two forms: firstly, the data were summed on an hourly basis and the proportion of time spent in each activity was calculated and expressed as a percentage; secondly, the length of time spent in a particular activity without interruption was calculated and mean values evaluated for each hour of the day. Data are combined for 11 and 12 May, and were derived from observations taken from many different pairs. Several pairs contributing to the study were watched both in isolation and in company with other groups of birds.

Results and discussion

Diurnal behaviour patterns

Observations from quarter-hour scans on 11 and 12 May were pooled with those of 10 May (there being no difference between behaviour patterns on different dates) and are shown in Figure 1.

(i) Feeding—68% of the total diurnal activity of the geese was spent feeding (a mean of 16·4 hr/day), although it should be noted that there are considerable differences between the sexes as described below. There is a decrease in feeding activity in both sexes during the coldest hours (between 0100 and 0500 hr) with a peak in foraging activity immediately preceding the short roosting period. This is similar to patterns observed in feeding geese on the wintering grounds in England (Owen 1972).

(ii) Roosting—11% of the diurnal activity is spent roosting (2 6 hr/day), regular roosting only being observed during the periods of lowest temperatures.

(iii) Alert—10% of the diurnal activity is spent alert (2·3 hr/day), with a constant proportion of alert birds during the roosting phase when the geese gathered into large roosting groups.

(iv) Resting—There appear no trends in the patterns of inactivity amounting to 6% of diurnal activity (1·5 hr/day).

(v) Preening—Most preening activity took place during the main roosting period, comprising 3% of activity (0·7 hr/day).

(vi) Other activity constituted 2% of the total diurnal activity (0·5 hr/day).

Behavioural studies of feeding pairs

Table 1 summarizes the results of the activity studies of foraging pairs from which the following points arise:

(i) In both solitary and flocked pairs, the goose spends significantly less time in the alert posture and more time feeding than the gander.

(ii) In terms of the proportion of time spent feeding, the gander gains advantage from joining flocks, with a corresponding decrease in the proportion of its time spent in the vigilant posture.

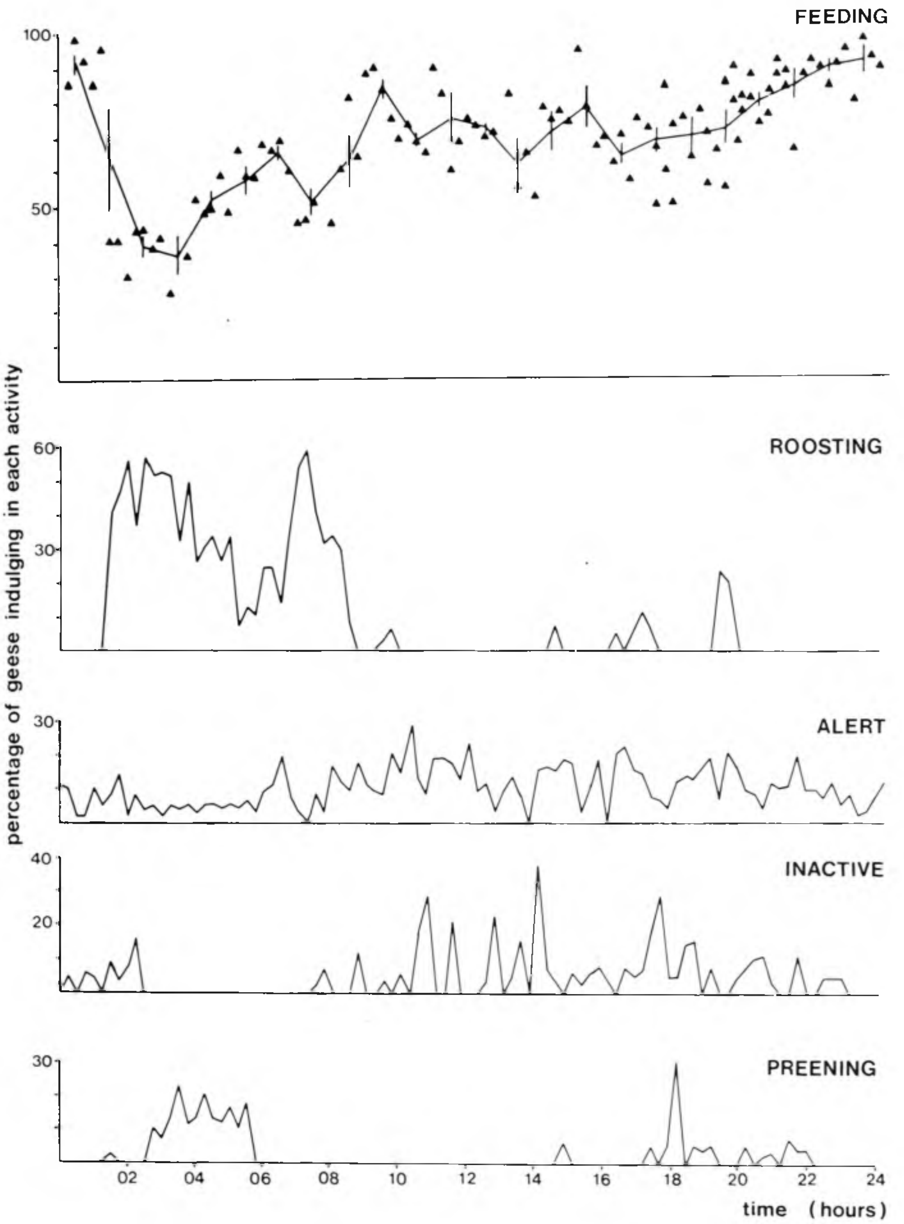

Figure 1. (i) Plot of percentage Greenland White-fronted Geese feeding against time. Kûk Marshes, West Greenland, 10–12 May 1979. (ii) Percentage of geese roosting, (iii) Percentage of geese alert, (iv) Percentage of geese resting, (v) Percentage of geese preening.

Table 1: Comparison of activity scores of male and female geese in flocks and solitary pairs. Values area means and the f-ratio and level of statistical significance are given for each comparison.

Solitary Pair Gander 65·2%	27·65***	Solitary Pair Goose 18·4%
10·34**		4·42^{ns}
Flock Pair Gander 44·3%	5·87*	Flock Pair Goose 7·8%

(i) Comparison of mean percentage time spent in alert activity on an hourly basis.

Solitary Pair Gander 20·2%	22·96***	Solitary Pair Goose 63·3%
6·06*		2·85^{ns}
Flock Pair Gander 44·3%	2·85*	Flock Pair Goose 60·4%

(ii) Comparison of mean percentage time spent feeding on an hourly basis.

Solitary Pair Gander 6·42 mins	5·98*	Solitary Pair Goose 3·14 mins
1·21^{ns}		4·10**
Flock Pair Gander 3·39 mins	3·63^{ns}	Flock Pair Goose 1·71 mins

(iii) Comparison of mean length of time spent uninterrupted in alert activity on an hourly basis.

Solitary Pair Gander 2·78 mins	12·81***	Solitary Pair Goose 6·83 mins
0·66^{ns}		1·04^{ns}
Flock Pair Gander 3·16 mins	7·62**	Flock Pair Goose 8·62 mins

(iv) Comparison of mean length of time spent in uninterrupted feeding activity on an hourly basis.

(iii) There is no significant advantage to the female in social feeding, either in terms of increased feeding or decreased alert behaviour.

(iv) In terms of the uninterrupted periods spent in each activity, the relationships are essentially the same as for the total allocation of time spent in each activity, although the variances result in many of the comparisons not being statistically significant.

Analysis of vigilance periods of the gander and diurnal activity allocation to alertness (Figure 2) indicates that as the percentage time allocated to vigilance increases, the non-vigilance period shortens and alertness time increases in length, a relationship demonstrated in the House Sparrow *Passer domesticus* by McVean and Haddlesey (1980). There is no such relationship evident in the data for the female goose and there is no such correlation in

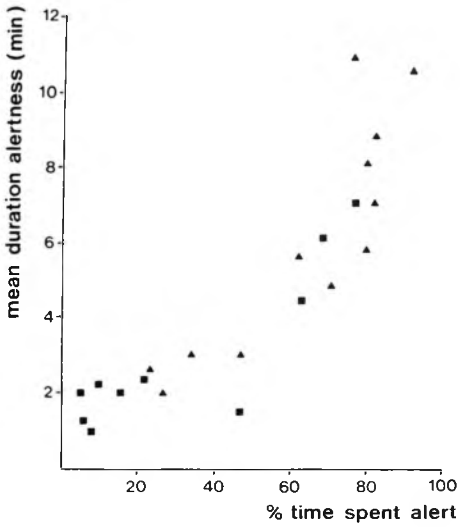

Figure 2. Vigilance schedules of ganders in attendance with feeding geese.

either sex for feeding activity, suggesting that it is the vigilance activities of the gander that are most critically controlled.

In solitary pairs there was always a compensatory change in activity between the two birds, commencement of feeding by one bird resulting in the resumption of alert posture by the partner. This contrasts with the shared feeding activity frequently observed in flocks. On most occasions it appeared that it was the alert bird which initiated the change. When solitary pairs flew to join flocked birds, the flight was invariably initiated by the gander.

In flocks, observations showed no significant difference from theoretical values based on 68% of diurnal activity spent feeding (see Figure 1 (i)) with both birds feeding independently for equal periods (Table 2). The pairs gained benefit by joining flocks through the increased time spent feeding simultaneously, as well as a general increase in feeding as a percentage of all activity.

During observations of flocked birds, 64 agonistic interactions were observed between pairs. The gander was involved in significantly more encounters than the goose (U-test, $\chi^2 = 11{\cdot}9^{***}$), driving away other feeding pairs at distances up to 10 m. These findings are similar to those of Boyd (1953) from wintering flocks of European Whitefronts *A. albifrons albifrons*, although the distances involved between geese in aggressive encounters were greater than those he recorded. Furthermore, the aggressive interactions seemed very intense, with birds frequently pursued to flight. This may be due to the patchy and scarce nature of the food resource as well as the proximity to the onset of nesting.

Conclusions

Any supplement to the reserves of the female on arrival at the breeding grounds will maintain or even improve her general nutrient status and increase her chances of reproductive success. In 1979, between the peak arrival date and mean date of nest initiation, the female geese of breeding pairs spent over two-thirds of their time feeding on highly nutritious subterranean food items (Dennis *et al.* 1978; Whitten & Cameron 1980; Thomas & Prevett 1980). There would thus appear sufficient time for the female to obtain a significant amount of nutrition on the breeding grounds prior to nesting as suggested by Ely (1979) in Pacific Whitefronts *A. albifrons frontalis*.

In order to optimize her foraging activities, it is of value to the goose to spend maximal periods in uninterrupted bouts of feeding. This is seemingly achieved by the behavioural response of the attendant gander which keeps close (generally less than

Table 2. Comparison of periods of simultaneous feeding by goose and gander in solitary pairs and flock pairs with theoretical values; Kûk Marshes, Eqalungmiut Nunât, May 1979.

	Total observation time (min)	Total time when either gander or goose was feeding	Total time when both birds feeding together
Solitary	489	232 (47·4% total)	11 (4·7% feeding)
Flock	461	311 (67·5% total)	105 (33·8% feeding)
Expected flock		68·0% total	33·0% feeding

Solitary v. Expected flock	$\chi^2 = 120{\cdot}31$,	p<<0·001
Flock v. Expected flock	$\chi^2 = 0{\cdot}022$,	p ns

5 m) to her; in this protective role, in solitary pairs, the gander spends most of his time alert. In flocks, the protective burden is shared between more birds and the ganders show no significant difference in time spent alert when compared to the female, which do not decrease the time spent feeding.

The solitary-nesting Greenland White-fronted Goose shows little territorial behaviour on the nesting areas, so the gander's influence on nesting success is less than in colonial nesting geese (Ryder 1975, Mineau & Cooke 1979; Owen & Wells 1979). However, the gander still provides an important protective function at the nest site and against predation, and it is clearly of importance to optimize his fitness during the pre-nesting phase.

The formation of flocks of feeding animals has been explained in the past in response to three different factors: (i) the uneveness in food resource in time or space (e.g. Thomson *et al.* 1974); (ii) predation, a flock providing potential shelter to an individual from attack (e.g., Hamilton 1971); or (iii) sharing the vigilant role between many individuals to the benefit of all (e.g. Dimond & Lazarus 1974; Abramson 1979). In the pre-nesting social feeding of the Greenland White-front, it is likely that all three factors are acting. The bulbils of *Triglochin palustre* are buried in open mud, and there are no visual cues for the feeding geese to locate this important food item, thus it would seem that flocking would enhance chances of feeding success. By contrast, *Puccinellia deschampsioides* retains above ground litter and tends to grow in small dense patches, possibly favouring feeding in solitary pairs. Birds feeding on *Hippuris vulgaris* gain a measure of protection whilst browsing in open water. During the observations, both Gyr Falcon *Falco rusticolus* and arctic fox *Alopex lagopus* were watched attempting to prey on the geese, and doubtless these two species represent a considerable threat to the geese.

The factors affecting flock-formation and social feeding in the Greenland White-fronted Goose during the pre-nesting period are thus primarily the nature of the food items and the threat from predators.

Acknowledgements

Substantial financial contributions were received by the Greenland White-fronted Goose Study from the Department of Fisheries and Forestry, Dublin, the NATO Eco-Sciences Panel, WAGBI and the World Wildlife Fund, Denmark. Other valuable support and advice was given by the Royal Geographical Society, the University College of Wales and Wildfowl Trust. The expedition would have been impossible without Royal Air Force logistical support and Racal-Tacticom Ltd loaned high quality radio equipment. Dr Myrfyn Owen gave advice and criticism, David Stroud and Dr Shirley Agnew read the manuscript critically and Anne Fox gave statistical advice.

Summary

Greenland White-fronted Geese *Anser albifrons flavirostris* were observed feeding for up to ten days between the peak period of arrival and the onset of nesting in west Greenland. Birds fed on highly nutritious subterranean plant perenniating organs for 68% of their diurnal activity, roosting only during the period of sub-zero temperatures. Attendant vigilant ganders in solitary pairs enabled female geese to feed for maximal, uninterrupted periods. The males gained advantage from joining flocks of other geese, spending less time alert with a corresponding increase in the proportion of their time spent feeding, although there appeared no advantage to females in social feeding.

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