A lunar rhythm in the nocturnal foraging activities of wintering Barnacle Geese

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Introduction

While in their winter quarters, Barnacle Geese *Branta leucopsis* sometimes forage at night. Night activity is usually reported to be associated with moonlit periods, and a full reversal of the normal foraging rhythm can take place around full moon (cf. Ebbinge *et al.* 1975). Other goose species show similar behaviour. It is generally thought that night activity may function to increase the time available for foraging by taking advantage of moonlight, and it may be especially important when daytime grazing is limited by disturbance (Owen 1980). The nocturnal habits of geese contrast with those of many other animals, which reduce their activity during moonlit periods (Anderson 1966; Jahoda 1973; Morrison 1978; Trillmich & Mohren 1981). This is generally thought to reduce predation risks, but Jahoda's (1973) work on the grasshopper mouse *Onychomys leucogaster breviauritus* suggests that the lowered activity is actually a response to reduced food availability. Geese may be in greater danger in darkness, due to the predation risk posed by foxes, and hence they may be prevented from night feeding except when there is moonlight (Owen 1980). There are very few data available on the nocturnal movements of geese and the purpose of this note is to describe in detail some observations on night foraging of Barnacle Geese we collected during a winter study of their feeding ecology. This note compliments an earlier paper on their day-time movements (Ydenberg *et al.* 1983).

Methods

The observations were collected during eight month's residence in 'De Herdershut', the field station of the Rijksuniversiteit Groningen, on the island of Schiermonnikoog in the Dutch Waddenzee. Between November 1977 and April 1978, daily observations of Barnacle Geese were made on Schiermonnikoog by ourselves and other biologists who used the field station.

Some 3200 Barnacle Geese winter on Schiermonnikoog and commute daily between the polder (a large dairy pasture where all winter grazing takes place) and their roost on the adjacent salt-marsh (Ydenberg *et al.* 1983). The field station is situated directly in the main flight path between polder and salt-marsh, and as such it is ideally placed to monitor movements of the geese. Barnacle Geese are usually very noisy while they commute, and so it was a simple matter to record the time of their flights. Whenever we heard geese at night, we attempted to locate them in the polder by walking or cycling on the single main road running down the centre of the polder, or on the elevated dyke skirting its perimeter. By moving quietly and listening carefully we were able to locate geese even on very dark nights, though usually it was not possible to observe them. Such nocturnal surveys were made on every night around full moon, and also on other nights scattered through the remainder of each lunar cycle, from mid-November to early February. Very bad weather occasionally made it impossible for us to make any observations.

Results

The data for the three months in which Barnacle Geese used the polder are shown in Figure 1. The pattern is the same in each month. As the moon waxes, Barnacle Geese take up night foraging while retaining their day-time visits. At the full moon day-time visits to the polder cease entirely and the birds forage only at night. Sporadic foraging around the day roost on the salt-marsh was also observed at this time. After the full moon the geese abruptly revert to their normal rhythm of daytime foraging and roosting at night, which persists until the next full moon.

Figure 2 shows that night-time activity is confined to periods when the moon is above the horizon. In spite of this, light intensity does not seem to be important. Many of the nocturnal visits to the polder were made on nights of heavy overcast or dense fog, while no visits were made on bright clear nights

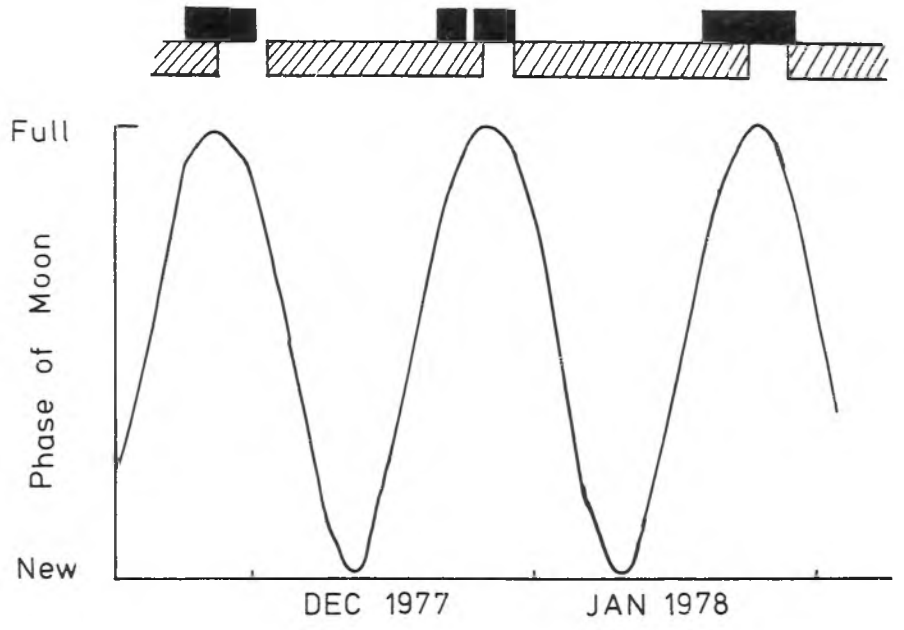

Figure 1. Nocturnal foraging in relation to moon phase. Night-time visits indicated by black horizontal bars at the top of the figure. Hatched bars indicate day-time foraging. The foraging rhythm is inverted at the full moon.

with, for example, a half moon.

Disturbance did not seem to play an important role either. Our field log records many days of high disturbance levels which were not associated with night foraging. For example, disturbance was high on 19 and 20 November 1977 (due to an abundance of day visitors to the island) and on 2 December (due to a rabbit shoot in the polder). Barnacle Geese made night visits only between 22 and 30 November (our log records no extraordinary disturbance levels then), which was the full moon period.

In Figure 3 we show that the timing of nocturnal visits to the polder also have a close correspondense with the high tide. However, the possibility that the geese were forced to leave their roost by the height of the spring tides at full moon does not seem a feasible hypothesis, since equally high tides occurred at the new moon, when no nocturnal visits were recorded.

Discussion

There are no foxes *Vulpes vulpes* on Schiermonnikoog, and so we cannot be sure that the night-time activities of Barnacle Geese in even complete darkness are due to release from this predation risk. However, the close correspondence of nocturnal foraging with the lunar cycle suggests another explanation. Our observations show a remarkable similarity to those made by Spencer (1953) and Hale (1980) on the roosting behaviour of Lapwings *Vanellus vanellus* and Curlews *Numenius arquata*. These birds showed a pattern of roosting identical to that reported here for Barnacle Geese, with a complete inversion of the normal activity cycle occurring at full moon. Both authors report that the visibility of the moon had no effect on night activity. The Lapwings remained near their normal feeding grounds and fed (probably on earthworms) throughout the night, but the presence of *Scrobicularia* shell fragments on the Curlew day roost after night foraging suggested that they had flown the 60 km to the coast and fed there.

One way to explain this pattern of activity is to hypothesize that a heightened activity of the invertebrate prey of Lapwings and Curlews at the full moon made night foraging a profitable strategy. Lunar activity cycles with a peak of activity at full moon are known for both terrestrial and aquatic insects (Saunders 1976), and for marine invertebrates as well. The functional significance of these lunar rhythms is unclear,

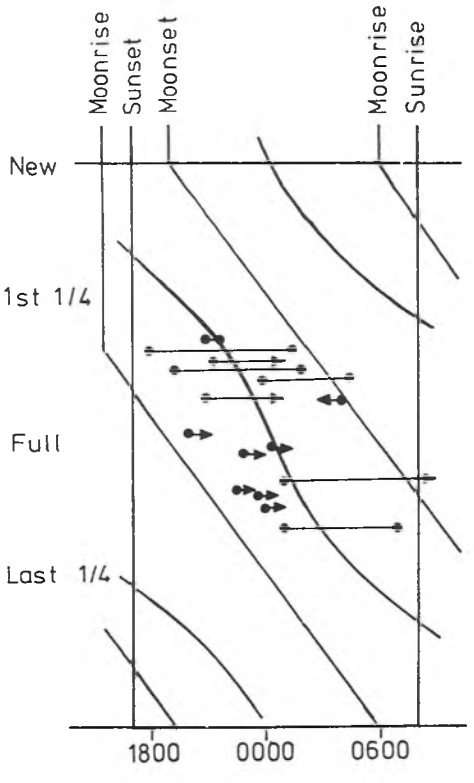

Figure 2. Nocturnal foraging in relation to sun, moon, and tide. Approximate sunset and sunrise times are given; the actual times varied about ½ h on either side of the lines. The phase of the moon is given along the vertical scale, while the diagonal lines show moonrise and moonset. The dotted diagonal lines indicate high and low tide. The duration of each recorded visit by geese to the polder is indicated by the horizontal bars. Where arrival and departure times could not be ascertained an arrow head replaces the terminal dot. These then record minimum visit duration. The visits take place entirely while the moon is up and around high tide.

though it may be related to favourable breeding conditions in the case of marine invertebrates.

It is remotely possible that the night-time excursions of Barnacle Geese on Schiermonnikoog to their feeding grounds are also timed to take advantage of a high availability of invertebrate prey. While Barnacle Geese are not known to consume animal matter, their cogeners Brent Geese *B. bernicla* are known to feed on ragworms (*Nereis* spp.; Drent *et al.* 1978), and Canada Geese *B. canadensis* have been recorded to feed on earthworms on pastures near Reading (Richard Sibly, pers. com.). A second possibility is that the quality of plant food varies on a lunar schedule. Many salt-marsh plants exhibit diel cycles in salt secretion (Waisel 1972), but, so far as we know, lunar cycles have never been recorded.

In any case, the close association of the night-time activity with the lunar and tidal cycles, regardless of the light or disturbance levels, suggests the function of this unusual activity has to do with conditions linked directly to these cycles. Only further field work will be able to provide an answer.

Acknowledgements

We wish to thank Theo Boudewijn and the many other friends who assisted us with the night-time observations.

Summary

Observations were made on the night-time foraging of Barnacle Geese *Branta leucopsis* wintering on Schiermonnikoog in the Dutch Waddenzee. Night foraging took place only around full moon. As the moon waxed, the geese fed both by day and by night, but at the full moon, they fed only at night. Foraging abruptly reverted to its normal rhythm after the full moon. The visibility of the moon seemed to play no role in the night-time activity of Barnacle Geese, nor did day-time disturbances seem important. The similarity of these observations to those of inland roosting Lapwings *Vanellus vanellus* and Curlews *Numenius arquata* in England, which also invert their foraging routine around full moon, leads us to suggest that, like these birds, Barnacle Geese may have been hunting for invertebrates whose activity was keyed to a lunar cycle.

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