On renesting in semi-captive Barnacle Geese

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Laying a second clutch of eggs after the first has been destroyed is common in ducks (Sowls 1955) and Canada Geese *Branta canadensis* nesting in low latitudes (e.g. Craighead and Craighead 1949; Brakhage 1965). The ability to replace clutches which are lost due to predation or flooding may be important to an individual's lifetime reproduction. Cooper (1978) removed the clutches of 31 pairs of Canada geese at various stages of incubation. Fourteen of 20 which had incubated for 2 days renested, whereas none of the 11 that had incubated further did so. In this study we determine the likelihood of semi-captive Barnacle Geese *Branta leucopsis* renesting after removal of their first clutches at various stages of incubation.

Methods

The study flock consists of 250 free flying Barnacle Geese at Slimbridge, England (51°44'N 2°25'W). All the birds are individually marked and life history records, including the age of the birds, clutch sizes and egg measurements, have been collected annually since 1974. The birds nest within a 40 ha area which is surrounded by a fox proof fence. They graze on high quality lawns and are provided with grain twice a day, together with a high protein supplement before and during the breeding season. Owen and West (1988) provide more background information.

The date of the start of incubation of the first clutch, the date of removal of eggs and the date of the laying of the first egg of the second clutch were recorded during visits every two days. Incubation was considered to start the day after the laying of the last egg (eggs are laid every 20–24 h). Nesting attempts were interrupted by removing all the eggs and down from nests. The distances between the first and second nest locations were measured. Data from 1985, 1986 and 1987 were lumped; nest initiation dates (the first egg dates) were adjusted according to the median date of all first clutches in each year.

Results

Of the 116 birds whose first clutches were removed during incubation 44% renested. In three cases pairs nested for a third time, after the removal of their second clutch. The five variables that we tested differed significantly between birds that did and did not renest (Table 1). Birds that renested had spent a significantly shorter time incubating their first clutch. Only 10% of the birds that incubated their first clutches for more than 16 days (two-thirds of the total incubation period) renested compared to 57% of those with shorter incubation periods. Older birds renested significantly more often. The date of incubation initiation, clutch size and total clutch weight also influenced the occurrence of renesting but are not independent of the birds' age (unpublished data).

The time between the ending of the first nest attempt and the first egg of the second clutch (renesting interval) related most significantly to the length of time spent incubating the first clutch (Figure 1) and to a lesser extent to the age of the bird. The first clutch size and weight, and the date in the season of the start of incubation of the

Table 1. Comparison between those birds that did lay a second clutch and those that did not.

	Did Renest	Did not Renest	t-test	P (2-tail)
Age of Female	7.857	5.523	$t_{112} = 2.97$	<0.01
Incubation period	8.431	14.227	$t_{115} = 5.58$	<0.01
Date in season of start of incubation of first clutch	0.157	4.955	$t_{115} = 2.38$	<0.05
First clutch size	4.980	4.600	$t_{114} = 2.03$	<0.05
Total weight of first clutch	51.375	47.076	$t_{101} = 2.03$	<0.05

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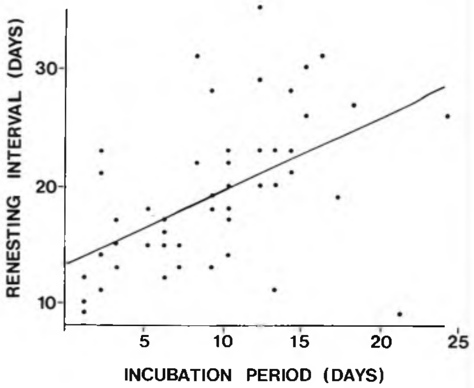

Figure 1. Renesting interval (days between removing eggs of the first clutch and laying of the first egg of the second clutch) plotted against incubation period (days between start of incubation of first clutch and removing eggs of that clutch). Fitted regression line: $y=13.24+0.643x$; $r_{51}=0.554$, $P<0.01$.

first nest did not contribute significantly to the relationship with renesting interval (Table 2).

There was no significant relationship between the renesting interval and the distance between the first and second nest site; sixty percent of the second clutches were laid in the same nest site as the first.

Discussion

Arctic nesting geese in the wild experience a very short breeding season, the lack of time prohibiting renesting. Lofts and Murton (1968) suggest photo-refractoriness prevents late breeding attempts in birds. The flock of Barnacle Geese at Slimbridge experience a different photoperiod cycle to wild birds which may cause changes in the onset of refractoriness (see West *et al.* 1986). Murton and Westwood (1977) suggest that photo-refractoriness may not be triggered at all by the relatively short "long" days late in the English summer as compared to the very long days in the Arctic. This may explain the frequent renesting in our geese, even if clutch loss occurs late in the season. The less frequent occurrence of renesting in June may indicate the onset of refractoriness at about this time. Alternatively, physiological preparations for moult, occurring at this time, may take precedence.

Our finding of a higher occurrence of renesting and a shorter renesting interval in older birds agrees with other studies (Doty *et al.* 1984; Swanson *et al.* 1986). We found, as did Klopman (1958) and Cooper (1978), that the length of the preceeding incubation affects the chance of renesting. This may be due to regression of the ovary or to a more general departure from the reproductive state as incubation progresses. However, instances of pairs renesting after undergoing full incubation and a period of rearing young have been recorded in Slimbridge Barnacle Geese (West *et al.* 1986) and in a Canada Goose (Brakhage 1985).

Donham *et al.* (1976) showed in female Mallard *Anas platyrhyncos* that follicles remaining after egg laying were arrested in development just prior to the rapid yolk deposition phase. Ankney and MacInnes (1978) reported numerous small non-vascularised follicles as well as large developed follicles in the ovaries of pre-laying Snow Geese. In the domestic hen follicles entering the rapid growth phase but not yet ovulated become atretic (Gilbert 1971). Thus eggs of second clutches probably arise from follicles which had remained arrested, prior to the rapid development phase, at the end of first clutches. Donham *et al.* (1976) also showed that LH (Luteinising Hormone) returned to levels that occur during laying and that follicular growth was initiated just one day after clutch loss. Follicle maturation into a fully developed egg took 12–13 days in the Cackling Goose *Branta canadensis minima* (Grau, quoted

Table 2. Multiple regression of renesting interval of Barnacle Geese (multiple r = 0.693).

Variable	Coefficient	t_{40}	P (2-tail)
Incubation period	0.652	4.612	<0.001
Age of female	0.415	2.441	<0.050
Total weight of first clutch	−0.077	0.683	0.499 ns
First clutch size	0.547	0.436	0.666 ns
Date in season of start of incubation of first clutch	−0.042	0.410	0.684 ns

Most renesting intervals were greater than the period needed for follicular maturation, suggesting that additional factors are involved. Tinbergen (1987) found birds which fledge most young from their first clutch started their second clutches later. This suggests that the amount of investment in the first clutch influences the speed with which a bird can lay the second clutch. We found that birds with longer incubation time and large clutch size had longer inter-clutch intervals. One of the reasons for this may be the rate at which females can replenish spent fat and nutrient reserves. Swanson *et al.* 1986 showed that when food availability was reduced, renesting intervals increased. The super abundance of food at Slimbridge may, therefore, be responsible for the high level of renesting and the short renesting intervals.

These results show that even arctic breeding geese are physically capable of renesting; other northern species have also renested at Slimbridge. Presumably it is the severe ecological constraints and perhaps some photoperiodic adaptations to the arctic environment that make renesting unlikely in the natural situation.

A small number of Barnacle Geese may have renested in Svalbard 1987 (Jesper Madsen pers.comm.). In a colony of 17 nests in the Tusenoyane achipelago (77°10'N 22°0'E) geese were seen on territories on 14 June. At this time Polar Bear *Ursus maritimus* and Arctic Skua *Stercorarious parasiticus* predation pressure was quite high in the area. When visited on the 25 July, 8 geese were still nesting, although the normal hatching date would be 1 July. On 29 July three females had broods and four were still incubating. One ringed female, seen incubating on 25 and 29 July returned to Scotland that winter but had no family in attendence. A ringed male paired to an unringed female, was attending a nest with 5 eggs on 25 July and a brood of five on 29 July. This bird was not resighted in Scotland.

Summary

Nests of 116 semi-captive Barnacle Geese in southern England had their clutches removed at various stages of incubation. Within a period of 8 to 35 days 44% renested. Renesting occured most often in older birds that had spent a short time incubating their first clutch.

A local photoperiod cycle which is inadequate to cause the geese to become photorefactory, together with a super abundance of food at Slimbridge may influence such renesting.

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