

PREDATION AND HABITAT DISTRIBUTION OF PHEASANT NESTS: A CASE OF IDEAL FREE DISTRIBUTION

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1. INTRODUCTION

In this study we analyze predation on Pheasants' nests, emphasizing its spatial and temporal occurrence. Artificial nests were used. The distribution of natural nests in the study area is discussed. A comparison is made with the ideal free distribution, the distribution predicted by Fretwell (1972) for animals that can settle without regard to dominance or territoriality if the suitability of a habitat is affected by the number of animals settled earlier. The best habitats are used until their suitability has decreased to correspond to that of the second best etc.

Several studies of Pheasant and duck reproduction have shown that the hatching success is highest in habitats that offer concealed nest sites (Joselyn *et al.* 1968, Bengtsson 1972, Jones & Hungerford 1972, Schranck 1972). Schrank (1972) found that heavy cover which restricted predator movements constituted better protection for duck nests than light cover, irrespective of plant species. Dwernychuk & Boag (1972) on the other hand found that nesting success of ducks was not lower in dense cover where the nests were invisible. They explain this fact either as a result of a much higher nest density in heavy cover and a higher predator activity or a human disturbance of vegetation during the study. Moreover, it has been stated that predation rate is highest and the difference between habitats least for unbrooded nests (Dwernychuk & Boag 1972, Schranck 1972). Pheasants prefer nesting in the densest cover available (Gates

1966, Joselyn *et al.* 1968). Kuck *et al.* (1970) found that early nesting occurred in residual cover types, whereas renesting occurred in cover types such as hayfields. Both types are the best available during the relevant time of the season.

Reproduction was examined in a population study on the Ring-necked Pheasant *Phasianus colchicus* (L.) in southern Sweden (Göransson 1980). The Pheasants in the study area started egg laying in the first two weeks of May. As the mean laying period is 13 days and the incubation period is 23 days, hatching should occur in early or middle June. However, most Pheasant clutches in this area do not hatch until late June or early July. The delay is explicable if the Pheasants abandon their first eggs as has been recorded in Pheasant breeding pens (Wagner *et al.* 1965). However, it could also be explained by predation, especially if predation is heavy in the beginning of the breeding season when the vegetation offers little cover for the nests. This aspect is studied in this paper.

2. STUDY AREA

The study area was situated in the Revinge area in southern Sweden (55°42'N, 13°26'E), and most of it was covered with pasture on mineral soil. *Dactylis glomerata* (L.) dominated the vegetation. There were marshy areas surrounded by more luxuriant vegetation on peat soil. These areas, the moist meadow habitat, supported the highest densities of breeding Pheasants. A distinct feature of this habitat was the nettle *Urtica dioica* (L.) in monospecific stands with a radius of 1-10 m, occasionally more. We consider these stands a distinct nest habitat. Grasses (*Phalaris arundinacea* (L.), *Deschampsia caespitosa* (L., P.B.)) and sedges *Carex* sp. however dominated the moist meadows. There were also scattered stands of *Aegopodium podagraria* (L.) and *Filipendula ulmaria* (L., Maxim) where the Pheasants nested, but these stands were less common. Numerous copses with birch *Betula pubescens* (Ehrh.), alder *Alnus glutinosa* (L., Gaertn.) and willow *Salix* sp. surrounded the wettest parts of the peat soils.

The experimental area covered 60 ha in 1974 and 90 ha in 1975. Five pairs of Hooded Crows *Corvus cornix* (L.) nested in this area in 1974 and 1975 (Loman unpubl.). Badgers *Meles meles* (L.) regularly exploited the area and the popu-

lation density was one badger per km² in both years (Göransson unpubl.). Other potential nest predators present were red fox *Vulpes vulpes* (L.), stoat *Mustela erminea* (L.), polecat *M. putorius* (L.), and Magpie *Pica pica* (L.). The number of breeding Pheasant hens in the experimental area was about 50 during both years (Göransson unpubl.). In 1976 the formerly used experimental area was abandoned and artificial nests were scattered over a large (c. 15 km²) part of the Revinge area.

3. METHODS

Due to the difficulty of finding enough natural Pheasant nests, we used artificial nests to study the predation rate. For some aspects, however, data from natural nests were also used. Nests were used in experiments between 15 May and 20 June in 1974-76. The artificial nests were sited only in typical nesting habitats with the exception of 1975 when some nests were placed in more exposed habitats (dry meadows) than are normally used by Pheasants in this area. The range of typical nesting habitats was determined by nests found by chance in the study area. The artificial nests were checked twice during each experiment, after two and seven days or, in one case, after two and 14 days. In 1974 and 1975 the nests were assigned at random to 10 × 10 m² squares from a map of the area. Within each square, the artificial nests were placed in the most typical nesting site available. In 1976 we followed roads that run through typical nesting habitats. Every 150 m we left the road and placed a nest 50 m from it. Each nest contained three eggs of domestic or bantam hen. The eggs were painted to resemble Pheasant eggs. They were placed in the vegetation so as to mimic natural nests and care was taken to minimize disturbance of the vegetative cover. Nests in dense nettle stands could be placed and checked when standing on the periphery of the stands. Wherever possible, natural landmarks were used to locate the nests, but 45% of the nests were marked with a stick, placed 20 m away from the nest. This distance was considered by Picozzi (1975) to be sufficiently large to prevent Crows to associate sticks with nests. In our experiments predation was not significantly higher on marked than on unmarked nest ($\chi^2 = 0.27$, $P = 0.70 - 0.50$). In 1974 the nests were put on a bed of sand in order to secure tracks from predators. In a pilot study in 1973 the effect of sand beds on the probability of predation was tested, but no significant effect was found (360 nests, 120 of which with sand beds, ($\chi^2 = 0.18$, $P = 0.70 - 0.50$).

If the eggs had disappeared or were left in the nests but broken in a characteristic fashion and emptied, the predation was ascribed to birds. In these cases mammalian tracks were always absent, but in several cases foot prints or beak marks from Crows were found. If the shells were more or less crushed and left in the nest, predation was ascribed to mammals. When pad marks were found, the predator was always a badger. It is possible that foxes or stoats had taken some of the eggs from completely emptied nests. However, in many cases when the nests were empty, the eggs (that were marked with ink) were found at Crows' shell dumps (Göransson & Loman 1976, Loman & Göransson 1978).

Incubating hens were radio-tracked in order to determine the nesting habitats chosen by wild Pheasants in the study area. These hens were trapped and equipped prior to egg laying and they represent a random sample in the experimental area. A total of 28 nests were found in this way. The

fate of the nests found was also used to supplement data on the activity of different predators in different habitats.

4. RESULTS

Effect of season and habitat on predation rate

Predation on artificial nests was higher in May than in June (Table 1). In 1974 the difference was significant (1974: $\chi^2 = 10.25$, $P < 0.001$; 1976: $\chi^2 = 2.28$, $P > 0.05$). The 30 ha dry meadow area which was added to the experimental area in 1975 provided less cover than the 60 ha moist meadow area studied in 1974 and 1975. In 1975 predation was considerably higher in the dry meadow area (80%; $n = 40$) than in the moist meadow (17%; $n = 81$) ($\chi^2 = 18.0$, $P < 0.001$). Usually, Pheasants do not nest in this dry habitat.

Table 1. Predation rate on artificial nests during the nesting season. The predation rate refers to the full exposure period of seven days. The experiments in 1975 are excluded as they were only conducted in June

| Start of experiment | Nests checked | Per cent nests preyed upon |
|---------------------|---------------|----------------------------|
| 12 May 1974 | 90 | 86 |
| 12 June 1974 | 72 | 53 |
| 7 May 1976 | 41 | 54 |
| 11 June 1976 | 35 | 26 |

Nest site choice and predation rate

Nettles attained the same height as other kinds of vegetation in May, but grew higher in June, especially compared with grasses (Fig. 1). Nettle stands were more difficult to penetrate than grass for the human eye and we believe that they offered more concealed nest sites. Out of 28 natural nests that were located by radio tracking of the hens, 19 were situated among nettles. If there was no habitat preference the expected number of nests in the nettles would be less than three, as this habitat constituted less than 10% of the area. Predation on artificial nests in grass and in the more protective nettle stands was equal (49%, $N = 84$ and 48%, $N = 98$).

Predators

Most predation was due to birds, primarily

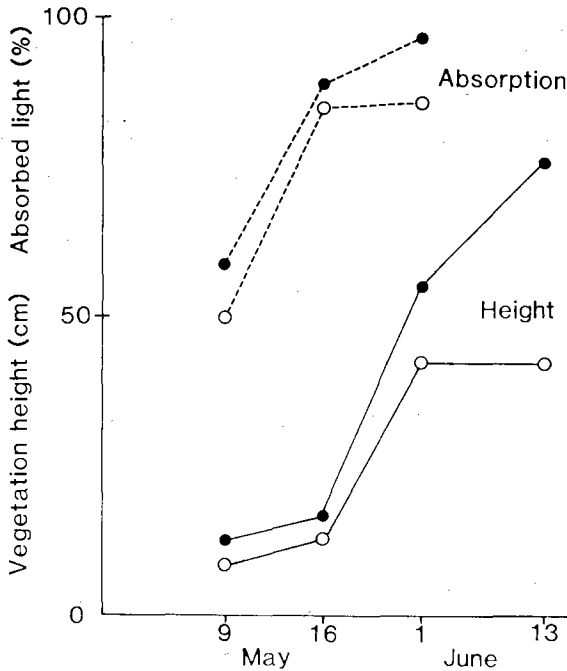


Fig. 1. Height and light absorption in grass and nettle vegetation during May and June 1975. Light absorption is measured at ground level and an expression for cover density. Black dots indicate nettle, circles indicate grass.

Table 2. Proportion of artificial nests preyed upon by birds or mammals in different years. The number of nests preyed upon is given in brackets

| Period | Number of nests | Nests preyed upon (%) by | |
|---------------------|-----------------|--------------------------|---------|
| | | birds | mammals |
| 1974 (May and June) | 162 | 65 | 1 |
| 1975 (June) | 127 | 20 | 11 |
| 1976 (May and June) | 76 | 42 | 0 |

Crows. In 1975, however, badgers were also important predators (Table 2). If we combine the data from the artificial and the 28 natural nests,

mammals were more important predators on nests in nettles (59% preyed upon by badgers and 41% by birds, $N = 17$) and birds on nests in grass (22% preyed upon by badgers and 78% by birds, $N = 27$) ($\chi^2 = 6.04$, $P < 0.05$).

Effect of exposure time on predation rate

Predation rate (proportion of available nests lost per 24 h) was calculated separately from the start of the experiment to the first check after two days and from this moment to the end of the experiment after seven days or, in June 1976, after 14 days. The rates were usually highest at the beginning of the period of exposure (Table 3). This tendency was, however, not seen in 1976. Combining all years the difference was significant ($\chi^2 = 40.99$, $P < 0.001$).

5. DISCUSSION

The fact that the nests were placed out and checked by humans may have given clues to predators that hunt by vision as well as by olfaction. However, the important points in this study are not the absolute values *per se* but the differences between predation rates under different conditions. Even the comparison between predation during the first two days of exposure and later should be valid. To check the nests after two days puts all remaining nests in the same position as they were at the start of the experiment as far as human clues are concerned. If differences in predation rate remain, this must be due to differences not related to the checking of the nests. One line of evidence suggests that predation was not much facilitated by our presence; artificial nests close to a nest already preyed upon were not more often preyed

Table 3. Predation rate during the first two days and during the following days when the artificial nests were exposed to predation. The exposure time was seven days in all experiments except in June 1976 when it was 14 days. Predation rate is expressed as the per cent of nests lost per day. The number of nests at the start of the experiment and still present after the first two days, respectively, are given within brackets

| Time of experiment | Predation rate during the first two days | Predation rate during the following days |
|--------------------|--|--|
| 1974 May | 38 (90) | 13 (34) |
| June | 22 (72) | 5 (44) |
| 1975 June* | 6 (90) | 3 (81) |
| 1976 May | 4 (41) | 13 (38) |
| June | 1 (35) | 5 (34) |

* The nests in the 30 ha of dry meadows are excluded.

upon than other nests (Loman & Göransson 1978). If Crows were watching us for information, it is to expect that nests close to each other, that were placed out and checked in succession, should often all be preyed upon.

The predation from badgers and Crows fluctuated between the years (Table 2) although populations remained at a stable level. We suggest that the high badger predation in 1975 may be due to individual specialization of one badger. The smell of the paint used on the eggs may have influenced the level of predation but not the difference between the years and habitats as the same kind of paint was used at all times. The high predation from Crows in 1974 may be due to the fact that spring was unusually dry, causing a late development of the vegetation and thus less cover for the Pheasant nests. In contrast to this, Jones & Hungerford (1972) reported an opposite effect of weather. At times of cool and rainy weather, when insect activity was low, Magpies turned to eggs as alternative food.

We found a decrease in egg predation as the season progressed (Table 1). As Crows had more difficulty in finding well covered nests, we believe that this decrease is due to the growth of the vegetation. The high predation on early clutches in our study area is probably a sufficient explanation for the late hatching of successful broods.

A relatively high proportion of the nests present was lost during the first days of exposure (Table 3). This is reasonable as Crow territories are abutting and the Crows probably search most of their territory every day (Loman 1985). If some nests are poorly concealed, these will be lost during the first days. This fact may partly explain why predation on natural nests is higher during the laying than during the incubating period as shown by Dwernychuk & Boag (1972) and Schranck (1972).

We think that Pheasant nest density and predation rate in nettle and grass habitat fulfills the assumption and predictions of the ideal free distribution (Fretwell 1972): a. The nettle stands offer the most concealed nesting sites. b. This habitat is scarcer than the grass habitat. It covers less than 10% of the moist meadows and the grass habitat more than 70%. c. The Pheasant nest density was highest in the nettle stands;

more than 50% of those belonging to radio-tracked hens were found in this habitat. d. Predation was approximately equal in the two habitats. This is consistent with the predictions of the theory; animals should nest in the best habitat until the advantage of this habitat is offset by the higher density of occupants. Usually, the advantage is food and this is offset by depletion but in our case the advantage is superior cover. But a high density of nests will counteract this advantage if it leads to an increased attention from predators. That this will indeed happen is likely as the nettle stands are of conspicuous appearance. This interpretation corresponds to that of Dwernychuk & Boag (1972) in their study of duck nestings.

A possible alternative advantage that may explain the higher density of nests in nettle stands than elsewhere is microclimate. High vegetation offers less extreme conditions than low (Francis 1968), which is important for hatching success.

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7. SUMMARY

The predation rate on artificial and natural nests of the Ring-necked Pheasant was studied. It was higher in May than in June. The decrease in predation rate occurred simultaneously with an increase of cover provided by vegetation. The predominant predator was the Hooded Crow, but in one year the badger was also an important predator. The natural density of Pheasant nests in the study area was higher in the uncommon nettle habitats compared to the habitats dominated by grasses. Predation rate on artificial nests however did not differ between nettle habitats and moist grass meadows. The predation rate of artificial nests decreased with prolonged exposure time.

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9. SAMENVATTING

Dit artikel gaat over verschillen in predatie onder verschillende omstandigheden op natuurlijke en kunstmatige legfels van de Fazant in Zweden. Predatie was groter in mei dan in juni. Deze afname in de loop van het seizoen viel samen met een toename van de vegetatiedichtheid. Belangrijke predatoren waren de Bonte Kraai en de das. Onder natuurlijke omstandigheden was de dichtheid van de nesten veel groter in de relatief weinig voorkomende brandnetelvegetatie, dan in de meer algemene grasvegetatie. Het percentage gepredeerde kunstmatige legfels was evenwel gelijk in beide vegetatietypen. Dit wordt als volgt verklaard: de nestdichtheid in de brandnetelvegetatie neemt toe, omdat de nesten in dit vegetatietype minder opvallen en dus beter tegen predatie beschermd zijn. Een toenemende nestdichtheid heeft echter een omgekeerd effect op predatie, omdat predatoren hun zoekgedrag dan speciaal op de brandnetelvegetatie gaan richten. Dit resulteert in een evenwichtstoestand, wanneer de dichtheid in de brandnetelvegetatie zo groot is, dat de predatiedruk weer gelijk is aan die in de grasvegetatie. - J. V.