

Seasonal changes in the gut length of the willow grouse (*Lagopus lagopus*) in Finnish Lapland¹

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The lengths of the small intestine and caeca were recorded in 83 willow grouse (*Lagopus lagopus*) shot in Finnish Lapland in February 1981-January 1982. The length of the combined caeca of the males decreased from April-May to a minimum value in June-July and increased again to the same winter maximum, while the length of the small intestine increased from June-July to August-September and then again decreased until the next winter, no changes taking place during the course of the winter, spring and early summer. Similar trends were shown regardless of age or sex. It is concluded that the length of the caeca depends mainly on the amount of fibrous food eaten. The large absorption surface of the long small intestine is needed when the willow grouse eat considerable quantities of berries in August-September.

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1. Introduction

Gut lengths in various gallinaceous birds depend on hormones, gut microbes, parasite load, rhythm of feeding, composition of diet and amount of food eaten (Moss 1972). Seasonal changes have been recorded in the gut lengths of these (Levin 1963, Pendergast & Boag 1973, Moss 1974, Brittas 1980) and other birds (review in Sibly 1981). Since Brittas' (1980) data on the willow grouse (*Lagopus l. lagopus* L.) covered only the period from September to May, it seemed justified to study seasonal changes in the small intestine and caeca lengths of this tetraonid species throughout the year. This paper is a preliminary report on one year's observations in Finnish Lapland.

2. Material and methods

Eighty-three willow grouse were shot from two areas, Inari and Salla, in Finnish Lapland in February 1981-January 1982. The birds were frozen in Lapland and sent to Oulu, where they were weighed (without crop contents), sexed and aged (Bergerud et al. 1963), and the lengths of the small intestines (from gizzard to the junction of the caeca) and caeca measured. All the measurements were carried out by the same person using the same technique (without stretching the gut). No appreciable numbers of parasites were found in the guts.

The crop contents were removed and dried in an oven at 65°C for two days. The main plant remains were sorted out

from these dried samples, and their crude fibre contents were determined by Viljavuuspalvelu Oy using the glass-wool filtration modification of the Weende method.

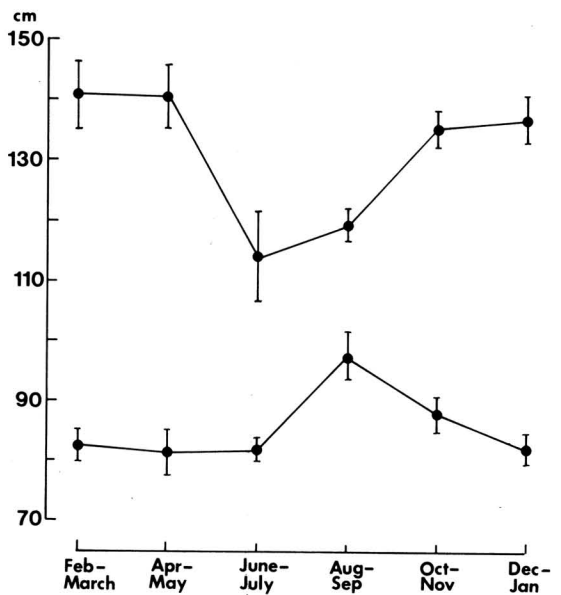


Fig. 1. Seasonal changes (means \pm S.D.) in the small intestine (lower curve) and combined caeca (upper curve) lengths of the male willow grouse in Finnish Lapland.

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Table 1. Comparison of the small intestine and caeca lengths (mean±SD) in the sex and age groups of willow grouse captured in Finnish Lapland during one year.

| Season | Caeca | | | | | Small intestine | | |
|--------|------------|----|------------|----|-------------|-----------------|----------|----------|
| | Male | n | Female | n | t-test | Male | Female | t-test |
| XII-V | 140.0±10.0 | 21 | 129.7± 7.2 | 6 | 2.81 p<0.01 | 82.2± 5.2 | 82.5±8.7 | 0.08 ns |
| VI-IX | 118.7± 7.3 | 14 | 116.2± 9.2 | 14 | 0.80 ns | 95.2± 7.2 | 90.9±9.1 | 1.38 ns |
| X-XI | 135.5± 6.1 | 18 | 123.6±12.1 | 10 | 2.91 p<0.01 | 87.9± 5.5 | 89.7±5.3 | 0.85 ns |
| | Adult | | Juvenile | | | Adult | | Juvenile |
| XII-V | 142.9± 6.6 | 15 | 131.2± 9.4 | 12 | 3.64 p<0.01 | 81.7± 6.1 | 82.9±5.7 | 1.10 ns |
| VI-IX | 120.4± 9.9 | 5 | 116.9± 8.5 | 23 | 0.74 ns | 91.8±10.9 | 93.8±8.2 | 0.28 ns |
| X-XI | 134.1± 8.4 | 12 | 129.1±11.4 | 16 | 1.33 ns | 87.8± 5.7 | 89.1±5.3 | 0.62 ns |

3. Results

The length of the combined caeca of the male willow grouse decreased from April–May to June–July, and increased again to the same winter maximum, while the absolute length of the small intestine increased from June–July to August–September and then again decreased until the next winter, no changes taking place during the winter, spring and early summer (Fig. 1). Similar trends were shown regardless of age and sex (Table 1). The caeca of the males shot in October–May were longer than those of the females shot at the same time (Table 1). Correspondingly, the adults killed in December–May had longer caeca than the juveniles killed at the same time (Table 1). In absolute terms, there were no differences in the length of the small intestine between the young and adult birds, or the males and females (Table 1).

4. Discussion

The willow grouse has long caeca, the total combined length sometimes exceeding 140 cm (Pulliainen 1976), where the digestion of cellulose takes place either mainly or solely (Moss & Parkinson 1972, Gasaway 1976). The digesta are separated at the end of the small intestine, one portion entering the caeca through narrow constrictions as a creamy-brown pulp, and the rest continuing to be excreted as woody droppings (Moss & Parkinson 1972). The droppings from the caeca are composed of dark, wet matter which is homogeneous in appearance.

The present results support the findings of Brittas (1980) that the length of the combined caeca increases during the course of early winter and that of the small intestine simultaneously decreases. However, no evidence was obtained in the present study to support his observation (Brittas 1980) that the young willow grouse have longer caeca than the adults in early autumn.

Brittas (1980) explains the major seasonal

changes in the gut lengths of the willow grouse as follows: "Since the winter diet consists of a lot of fibres, the importance of the bacteria of the caeca is emphasized in their digestion, whereas the role of the small intestine in the digestion simultaneously decreases".

In the present study area the snow disappears at the end of May or beginning of June, and may appear again in late September, but usually in October. Stems of *Vaccinium myrtillus* constitute the main food item of the willow grouse in snowless terrain in autumn and spring (Tanhuanpää & Pulliainen 1969). Their crude fibre content (per dry weight) varies at least within the range 25–38 % (Pulliainen et al. 1968, Myrberget 1979, the present study).

In winter the willow grouse of Finnish Lapland mainly feed on *Betula* spp. (Pulliainen & Iivanainen 1981), the mean crude fibre content of which is 23–26 % (Pulliainen 1976, Myrberget 1979). In addition, they will also eat any available twigs of *Salix* spp. (Pulliainen & Iivanainen 1981), the crude fibre content of which varies within the range 9–30 % (Pulliainen 1976, the present study).

During the vegetative season the diet of the willow grouse includes leaves of *Vaccinium* spp., *Andromeda polifolia* and *Ledum palustre*, spore capsules of *Polytrichum*, and berries of *Vaccinium* spp. and *Empetrum nigrum*, especially in August–September (present study). The leaves of *Vaccinium uliginosum*, for instance, contain 23 % crude fibre (per dry weight; present study).

Thus the seasonal changes recorded in the length of the caeca cannot be solely caused by the crude fibre content of the diet. The *Vaccinium myrtillus* stem diet of the autumn and spring may even contain more fibre than the winter *Betula* diet, especially since catkins constitute a considerable part of the latter. This would presuppose an increase in the length of the caeca in the spring, whereas this is not the case (Fig. 1).

It is likely that the amount of food eaten is more important than the crude fibre content of the diet in determining the length of the caeca during the

long season when fibrous food is consumed. Pulliainen (1976) has shown earlier that light willow grouse, which have to eat more food than heavier ones, have longer small intestines and caeca per 100 g of body weight than the latter in mid-winter. This is when they are exposed to low temperatures (below the lower critical temperature of -8.5°C ; Irving 1972:165) during the light period of the day and need a lot of food (in late winter they cannot rest in snow burrows because of the icy snow surface), whereas less energy is needed in the summer. The advantage to the willow grouse of long caeca is that, if necessary, more food can be processed each day without any change in its digestibility.

The lengths of the small intestine recorded in the present willow grouse in August–September suggest that this part of the digestive tract is important in the utilization of berries, especially their flesh, for which the bacteria of the caeca are not needed. A large absorption surface is needed as the flesh of the berries passes rapidly through the intestine.

It is interesting to compare the gut lengths of the willow grouse with those of the starling (*Sturnus vulgaris* L.). The relative length of the combined caeca (percentage of intestine length) is

135 % in the former species (Pulliainen 1976), but 2 % in the latter (Pulliainen et al. 1981). Both show seasonal changes, however. Al-Joborae (1980) recorded the shortest caeca in the starling in May, when the proportion of animal food in the stomach contents was highest, but the length of the intestine shortened from winter to summer in this species, too. Thus the functional principle is different from that of the willow grouse, which feeds on plant material throughout the year, the most notable changes in the composition of the diet being from fibrous matter to the flesh of berries and vice versa.

Sibly (1981) discusses the costs of carrying a longer gut, and points out that an animal carrying more food takes greater risks because it is slower. Hawk attacks on woodpigeons at Brassica sites appeared to be more successful during the hour before sunset, which is when the pigeons are filling their crops (Kenward 1978, Kenward & Sibly 1978). The willow grouse of Finnish Lapland not only have the longest guts but also heaviest crops in mid-winter (Pulliainen 1981).

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