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Age Structure of Hunted Male Capercaillies *Tetrao urogallus* L., 1758 (Galliformes: Phasianidae) in Bulgaria as Revealed by Examination of Museum Collections*

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Abstract: The study aimed to determine the age structure of male capercaillies *Tetrao urogallus* L., 1758 in Bulgaria based on specimens preserved in collections. We studied 206 birds from the museum collections of the Sitnyakovo Palace (Rila Mnt.) and the National Museum of Natural History, (Bulgarian Academy of Sciences). The age of the birds was determined by the shape of the beak, the shape of the outer feathers of tail, the length of the beak, the length of the beak furrow and the height of the beak at the base. For each of the characteristics used, we divided the birds into three age classes: juvenile (up to 14 months), subadult (between 14 and 60 months) and adult (over 60 months). Of all individuals studied, 92 (44.7%) were juveniles, 64 (31.1%) were subadults and 50 (24.3%) were adults. We found an inconsistency in determining the age of individuals using only one of the characteristics. We proposed to use the angle of curvature of the beak for the age determination. We recommend introducing the requirement to examine more somatometric characteristics in the rare cases when shooting of capercaillies is allowed. This will allow the correct estimation of the age of capercaillies and the accumulation of database information, which will be useful for the management of this difficult to be studied and economically important species.

Key words: age determination, age classes, new characteristics, hunting management

Introduction

The capercaillie *Tetrao urogallus* L., 1758 is a Eurasian bird species having a fragmented distribution range. Bulgaria is situated in the most southern part of the geographical range of the species. Because of its fragmented distribution and decreasing numbers in the country, it has the status of "endangered" at the national level (Boev & Nikolov 2015). Although it is under a regime of conservation and regulated use, the species is a subject of significant hunting and has economic value. To ensure the sustainable development and conservation of capercaillie population, it is important that permissions for the so-called "management shooting" are to be given only for the oldest individuals. The correct age determination of the males is essential for the study of capercaillie populations and for planning its sustainable use.

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The age of capercaillie, either of shot specimens or alive individuals in the wild, can be determined using different methods. Moss (1987a,b), Borchtchevski (2011), Moss & Borchtchevski (2015) and Borchtchevski & Moss (2014) used craniometry to study the age structure of birds from Scotland and NW Russia. Linden & Vaiisinen (1986) also used craniometry to analyse the sex and geographic variation of the capercaillie skulls from Finland. Wegge & Larsen (1987) in Southeast Norway, Moss (1987a) in Scotland, and Genov (2021) in Bulgaria presented the measurement of the height of the beak at the base as an informative approach to examine the age structure. According to Kalinin (1981), initially Bancik (1969) used the characteristics of the beak of male capercaillies to estimate their age. Later on, Zavyalov (2016), Genov (2021) and Stahrovski (2023) considered the shape, curvature of the beak and the length of the furrow under the crest of the beak as an approach to determine the age of capercaillie; according to Kirikov (1944), the furrow is lacking in juveniles. Based on the shape of the beak, it is possible to determine the individuals as "juvenile", "subadult" and "adult". Based on the curvature of the beak and the length of the furrow in the adult male capercaillies, Zavyalov (2016) and Genov (2021) categorised individuals as 1-year, 3-years, 5-years, 7-9 years and more than 10 years old.

Another approach used the relationship between the age of capercaillie and the shape of the primary fly feather (Couturier & Couturier 1980, Genov 2021), the outer tail feather (Wurm 1922, Genov 2021) and the angle of opening of the tail fan (Wurm 1922, Kalinin 1981, Zavyalov 2016, Fokin 2019) to estimate the age of capercaillies. Ikonomov (2001), Zavyalov (2016) and Genov (2021) found that, with the ageing of roosters, the feathers under the beak became more elongated and the "beard" was clearly pronounced.

The age determination during hunting trips and in the wild can also be done by weighing individuals (Couturie & Couturier 1980, Kolev & Botev 1980, Storch 1993, Borchtchevski 2011, Borchtchevski & Gilyazov 2016, Borchtchevski et al. 2017, Borchtchevski & Khomyakova 2018, de Juana & Kirwan 2020). However, this is difficult and uncertain because the weight of capercaillie varies geographically and seasonally. Age determination of adult specimens in nature only by the white spots on the tail fan, which form a solid line on the spread tail with ageing, is also subjective (Ikonomov 2001, Zavyalov 2016). All these methods have further limitations because they allow dividing individuals into only into two categories, i.e. "juvenile" and "adult". All the cited articles defined "juveniles" as individuals up to 14 months old, "subadults" as individuals from 14 months to 4–6 years old, "adults" as individuals of 7-9-years old and "old" as individuals more than 10 years old.

The capercaillie has hunting and management importance and is an object of sport hunting. After individuals have been shot down, they are made into a trophy or exhibition object – so-called "medallion", combining the head, a small part of the breast and the tail fan (or only part of the tail feathers). When it is necessary to determine the age of a bird that is part of a museum or hunting collection, it is necessary to select characteristics and methods that make it possible to identify the age based on the available preparation.

The present study aimed to establish the age structure of the shot male capercaillies from two museum collections in Bulgaria.

Materials and Methods

Two hundred and six birds from the museum collections of the Sitnyakovo Palace near Borovets Resort (Rila Mnt.) and the National Museum of Natural

Table. 1. Geographical origin and numbers of the capercaillie individuals from collections in Bulgaria used in the present study.

Collection	Age	Pirin Mnt.	Rila Mnt.	Rhodopi Mnts.	Plana Mnt.	Unknown	Total
Sitnyakovo Palace near Borovets Resort, Rila Mnt.	Juvenile	-	39	14	-	-	**53**
	Subadult	-	34	3	-	-	**37**
	Adult	1	21	-	2	-	**24**
National Museum of Natural History, Bulgarian Academy of Sciences	Juvenile	-	15	1	-	23	**39**
	Subadult	1	8	4	1	13	**27**
	Adult	-	11	1	-	14	**26**
Total		2	128	23	3	50	206

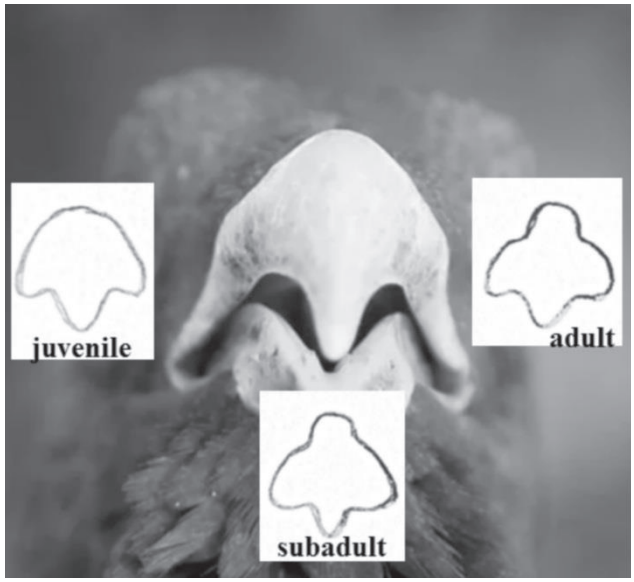

Fig. 1. Shape of the beak of the three age classes of the capercaillies (Bancik 1969).

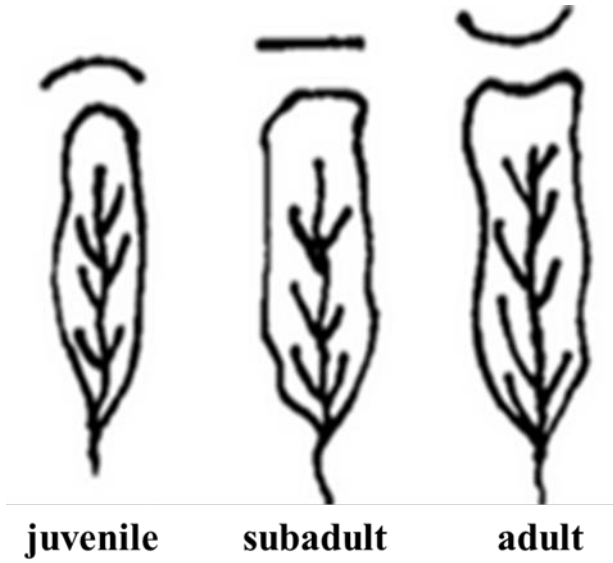

Fig. 2. Shape of the outer tail feather of the three age classes of the capercaillies (Kalinin 1981).

History at the Bulgarian Academy of Sciences in Sofia were examined. The birds had been shot down over a period of more than 80 years of the 20th century and originate from the main habitats of the species on the country (Table 1).

Information on the age of the birds was not available. The age of the birds was determined by the shape of the beak (Bancik 1969) (Fig. 1) and the shape of the outer tail feather (Kalinin 1981) (Fig. 2).

In addition, we tested the following characteristics to check whether it was possible to determine the age of capercaillies by using only one of them:

BL – beak length: the distance from the tip to the point where the upper part of the beak touches *os nasale* of the skull (Genov 2021);

BFL – beak furrow length: the distance between the most front to the most back point of the beak furrow (Genov 2021);

BH – beak height at the base: the distance between the point where the upper part of the beak touches *os nasale* of the skull and the point where the lower part of the beak touches the mandible (on closed beak) (Moss 1987a) (Fig. 3).

The characteristics were measured by an electronic calliper with an accuracy of 0.01 cm. Basic descriptive statistics, i.e. the mean and standard deviation (SD), were calculated for each of the abovementioned three metric traits. By each of the applied characters, we divided the birds into three age classes (juveniles, subadults and adults) based on BL and BH or into two age classes (subadults and adults) based on BFL.

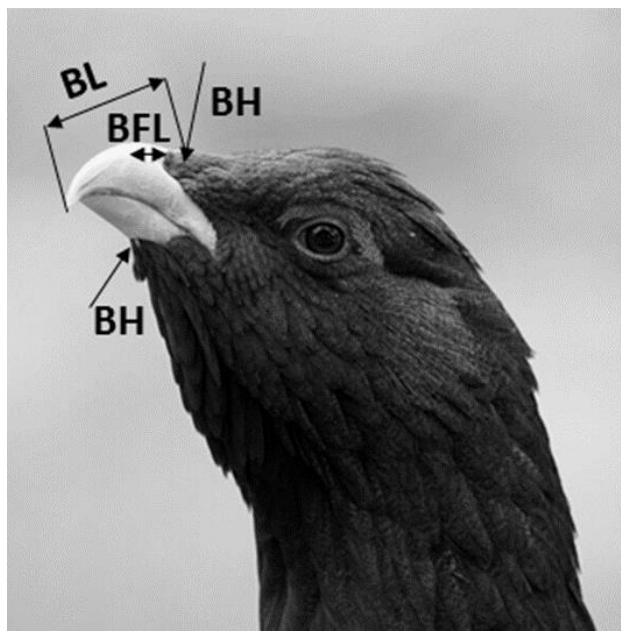

Fig. 3. Beak length (BL), beak furrow length (BFL) and beak height at the base (BH) of the capercaillies.

The differences between the means of BL and BH of the three age categories were tested by One-way ANOVA test with the Tukey-Kramer post-hoc test; the means of BFL in the two age categories were tested by Student's t-test (McDonald 2014). Statistically significant differences were considered at $p<0.05$. The visualization of the differences in the mean values of these three characteristics was made by the program Past.4.03.

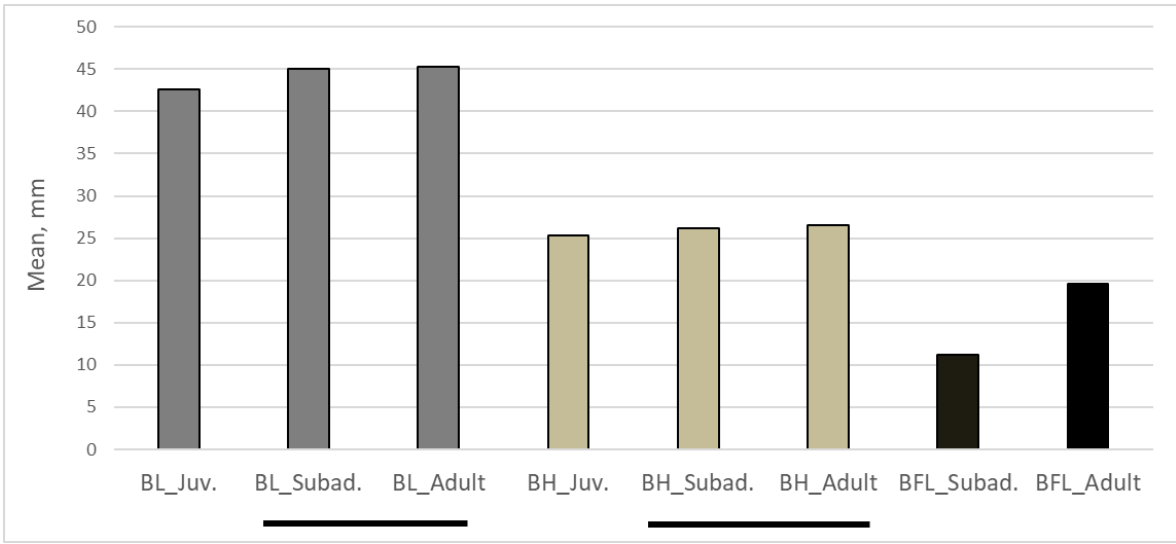

Fig. 4. Mean value of the three characteristics – beak length (BL), beak furrow length (BFL) and beak height at the base (BH) – for juveniles, subadults and adults of the capercaillies. Pairs of means grouped by a horizontal line are not significantly different from each other (Tukey-Kramer post-hoc test, P>0.05)

Results

Of all studied individuals, 92 (44.7 %) were juveniles, 64 (31.1 %) were subadults and 50 (24.3 %) were adults. They were tested by the characters associated with the shape of the beak and shape of the outer tail feather (Table 1). The age identification of the birds by the measurements of the characteristics of beak length, beak furrow length and beak height at the base was analysed by previously assigning the individuals to one of the groups – juvenile, subadult, and adult.

We found that the mean values for BL were 42.6±3.95 SD for juveniles, 45.0±3.59 SD for subadults and 45.3±4.24 SD for adults, being close and therefore not reliable to be used as a distinguishing character. For BH, the mean values were 25.3±2.13 SD for juveniles, 26.2±2.23 SD for subadults and 26.5±2.60 SD for adults, also with close values.

There were inconsistencies in determining the age of individuals by using only one characteristic. This is especially valid for subadult and adult individuals, where age determination is more difficult. The ANOVA test for BL showed that there was a significant difference in the three groups ($F_{2.203}$=10.552; p<0.001). To check where exactly the differences are, we used the Tukey-Kramer post-hoc test. The test showed that there was a statistically significant difference only between juveniles vs. subadults and juveniles vs. adults, but not between subadults vs. adults (Fig. 4). The ANOVA test for the BH also showed that there was a significant difference in the three groups ($F_{2.201}$=5.872; p=0.003). The Tukey-Kramer post-hoc test showed that there was a statistically significant difference only between juveniles vs. subadults and juveniles vs. adults. However, there was no significant difference between subadults vs. adults (Fig. 4), i.e. it would not be possible to identify correctly the age of capercaillies only by this characteristic.

Fig. 5. Angle of the beak curvature for the age determination of the capercaillies by the present study to be used for age determination of male capercaillie.

As the beak furrow of young individuals has been not observed (Kirikov 1944, Zavyalov 2016,

Genov 2021), the birds can only be divided into subadults and adults using this character. The mean values of this characteristic were 11.3 ± 4.85 SD for subadult and 19.5±4.96 SD for the adults, with different minimum and maximum index limits in both age classes. We detected statistically significant differences ($t = 8.98$; $p < 0.001$) in the mean values of the subadult and adult groups for BFL (Fig. 4). This allows the conclusion that this characteristic could be used for the age discrimination between the subadult and the adult categories.

Discussion

The present study of the age of male capercaillies from museum collections showed the highest percentage of young individuals. This high percentage of shot down young birds may be due to (1) the greater numbers of the species and the more numerous young individuals in the population in the past or (2) incorrect age determination of the living birds.

Our attempt to identify the age of capercaillies by the characteristics proposed by Genov (2021) showed that the character BL alone could not be applied to differentiate clearly the three age groups. However, the character BFL could be used to determine the subadult and adult age categories of the species. The results for BH measured at the base showed similarity to those of Moss (1987a) for subadult and adult individuals.

We believe that the characteristic beak curvature, which has been considered by Ikonomov (2001), Zavyalov (2016), and Stahrovski (2023) as a reliable character, can also be used for age determination. To avoid subjectivity in its control, we propose to introduce the measurement of the angle of beak curvature – by crossing the two imaginary lines running from the base and the tip of the beak (Fig. 5). This could provide an opportunity for numerical evaluation of the trait and, therefore, to be used to determine the age categories. However, to evaluate the application of the proposed characteristic, it must be applied to birds whose age is known.

Based on the present study, we can propose two recommendations:

1) Permissions for shooting capercaillies to be based on implementation of examination of more body characteristics. This will help to identify correctly the age of capercaillies and to accumulate the database information, which will be useful for long-term management of this economically important species.

2) The presented methods for the age determination of capercaillies from museum collections can be used in combination as a non-invasive age estimation method when needed to determine the age of live birds.

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