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IMPACT OF ENVIRONMENTAL FACTORS ON THE SIZE OF RED DEER (*CERVUS ELAPHUS* L.) ANTLERS

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Abstract

Red deer has been reintroduced in 18 lowland and mountain former habitats by releasing animals from two neighbouring populations, supposed to be genetically identical. The mean values of measurements of trophies obtained from newly-created and initial populations have been compared by Student's t-test. The significant differences found did not depend on new habitats remoteness, as well as on the mean age of animals hunted for trophy. Evidently, it seems that ecological variables are the most important cause of red deer trophy size variability, and further investigations are needed to study the relationship between altitude, climate, vegetation, etc. and the most important trophy measurements.

Key words: antler size, beam length, circumference of beam and coronet, trophy quality, weight of antlers.

Introduction

Red deer (*Cervus elaphus* L.) is the most famous large game species in Bulgaria. This animal became nearly extinct during the 19th century. About 1850 the red deer disappeared from North-East Bulgaria but several hundred individuals were still present in their habitats over Stara Planina Mountain and the Valley of Kamchia River. About 50 years later, at these same regions, only about 50 red deer have been counted (Bajchev 1968).

It can be assumed that at the end of the century, no more than several hundred individuals were still present at two neighbouring game-breeding stations in Eastern Bulgaria – Palamara and Sherba.

Since 1945, a project for red deer reintroduction has started. Animals from both stations have been released into former red deer habitats all over the country. During the period 1946–1981, 981 red deer from Palamara as well as 269 animals from Sherba were released. Thus, it has been reintroduced in former habitats.

This process might be considered as a large scale field experiment, where red deer originated from two interrelated neighbouring areas and supposed to be similar genetically, has been released into regions with different ecological (environmental) variables.

The problem of possible predominance either of genetic or ecological factors influences on the shape of red deer trophy is still open. This paper aims at showing similarity or differences between trophies obtained from different habitats, where red deer populations have been created by use of genetically similar animals.

Study Areas, Material and Methods

Since about 1970 trophy hunting has started as an aspect of 'harvesting' the newly-created red deer populations.

According to CIC Formula for the Measurement and Evaluation of Trophies (Ninov 2004), 253 red deer trophies, obtained by international hunters in 19 hunting areas all over Bulgarian territory within the period 1983–1987, have been measured, i.e. from: 1) Palamara and Sherba – *n*=47; 2) Seslav – *n*=3; 3) Karakus – *n*=10; 4) Tundzha – *n*=3; 5) Slanchev briag – *n*=5; 6) Trakia – *n*=5; 7) Tervel – *n*=27; 8) Cherni Lom – *n*=24; 9) Preslav – *n*=16; 10) Buzludzha – *n*=17; 11) Bukovets – *n*=28; 12) Chumerna – *n*=3; 13) Uzana – *n*=5; 14) Ticha – *n*=3; 15) Murgash – *n*=19; 16) Izvora – *n*=16; 17) the Rhodopes – *n*=17; 18) Pirin – *n*=5.

Measurements considered to be of the greatest importance to the total evaluation of trophy quality, have been taken into account: the weight of antlers (W), kg; average length of mean beam (ALMB), cm; average circumference of coronet (ACC), cm; circumference of lower beam, left (CLBL), cm; circumference of lower beam, right (CLBR), cm; circumference of upper beam, left (CUBL), cm; circumference of upper beam, right (CUBR), cm and the number of tine ends (NTE).

The age-group of animals, as well as the approximate age (years), have been determined by using the degree of teeth wear either on supramaxilla and mandible. The height and thickness of antler base-bone, as well as the transparence of skull sutures, have been used as additional criteria for age determination of red deer (Stubbe and Lockow 1994).

Distances between Palamara, Sherba and the remaining hunting areas have been measured on a map.

Arithmetic mean (*M*) and standard deviation (*Sd*) of trophy measurements have been calculated. The significance of differences between the mean values of the same measurements of trophies obtained from 'initial' and 'newly-created' red deer populations have been accessed by Student's t-test.

Results and Discussion

Mean values (*M*) and standard deviations (*Sd*) of the most important measurements of red deer trophies from the 'initial', i.e. Palamara and Sherba, and 'newly-created' populations are given in Table 1. Due to lack of significant differences in trophy size between Palamara and Sherba (t_{max} = 1.267; df = 45; P > 0.05), trophies originated from both hunting areas have been grouped (Table 1).

Trophies from Buzludzha, Bukovets, Murgash, Izvora and the Rhodopes had significantly lower weight and circumferences than animals originated from 'initial' population (Table 1 and Table 2).

Deer from Tervel, Cherni Lom, Uzana and Ticha have formed longer beams than in Palamara and Sherba, while beams from Izvora have been significantly shorter (Table 1 and Table 2).

The results obtained have shown that red deer tended to form longer antlers but with lower weight in mountain habitats of Stara planina Mountains and the Rhodopes Mountains.

As red deer origin was considered identical, the significant differences in

Table 1. Mean values and standard deviations (*M/Sd*) of the most important red deer trophy measurements from 'initial' (Palamara and Sherba) and 'newly-created' populations.

Area/n	Age, years	W, kg	ALMB, cm	ACC, cm	CLLB, cm	CLRB, cm	CULB, cm	CURB, cm	NTE
Palamara and Sherba	10.0	7.22	104.18	26.3	16.0	15.8	15.1	15.1	13.0
n=47	1.9	1.27	6.0	1.9	1.4	1.1	1.2	1.1	2.3
Seslav	9.3	8.2	100.3	27.3	15.6	15.3	14.0	14.3	13.0
n=3	1.7	1.7	9.7	2.8	1.5	1.7	0.7	0.6	1.7
Karakus	9.3	7.4	106.3	27.1	15.8	15.3	14.7	14.8	13.4
n=10	1.7	1.4	8.2	2.3	1.8	1.2	1.1	1.3	2.6
Tundzha	8.3	6.5	98.0	25.7	14.7	15.0	14.0	13.9	12.0
n=3	1.5	1.0	2.7	1.8	0.5	0.7	0.5	1.0	1.7
Slanchev briag	8.4	6.2	100.5	25.5	15.4	15.3	14.5	14.6	12.6
n=5	1.8	1.3	9.2	1.9	1.4	1.4	1.5	1.6	2.1
Trakia	8.2	6.5	104.4	25.2	14.9	15.0	14.2	14.5	13.2
n=5	2.9	1.9	4.2	2.1	1.2	1.0	1.4	1.1	1.3
Tervel	10.2	7.8	108.6	27.4	15.9	15.7	15.1	15.2	13.4
n=27	1.5	1.4	8.8	2.14	1.2	1.4	1.4	1.2	2.3
Cherni Lom	10.9	7.8	107.7	27.5	15.6	15.9	15.2	15.3	14.2
n=24	1.9	1.2	6.6	2.4	1.5	1.7	1.8	2.0	2.6
Preslav	9.0	6.6	100.6	25.4	14.6	14.9	13.8	13.9	12.6
n=16	1.8	1.5	12.5	2.2	1.6	1.7	1.1	1.3	2.4
Buzludza	9.2	5.4	102.0	23.6	14.6	14.8	13.6	14.1	12.8
n=17	2.4	1.2	7.3	1.5	1.5	1.7	1.4	1.8	2.1
Bukovets	10.0	5.6	101.3	24.0	14.4	14.4	13.2	13.3	12.4
n=28	2.0	1.1	7.4	2.2	1.4	1.2	1.1	1.1	2.3
Chumerna	9.7	8.0	101.6	26.8	15.7	15.3	14.3	14.4	14.5
n=3	1.5	0.8	4.6	1.8	1.3	0.8	1.1	1.0	0.7
Uzana	10.8	7.7	115.6	25.3	16.2	16.5	15.1	15.1	14.8
n=5	1.9	1.5	9.0	0.8	1.8	1.7	1.2	0.9	3.4
Ticha	9.0	7.5	112.6	26.4	16.3	16.6	14.7	15.1	13.7
n=3	1.0	1.1	7.6	3.0	2.0	2.4	1.8	2.0	1.2
Murgash	9.1	5.9	102.8	24.3	14.6	14.6	13.4	13.5	12.4
n=19	1.7	1.4	7.7	2.2	1.4	1.6	1.4	1.4	1.9
Izvora	8.9	6.2	99.5	25.9	14.9	14.7	14.3	14.3	12.2
n=16	2.6	1.8	11.7	3.9	1.6	1.7	2.2	2.2	2.6
The Rodopes	9.7	6.3	106.6	25.9	15.0	14.9	14.5	14.7	12.1
n=17	2.4	1.4	6.8	2.7	1.3	1.2	1.4	1.9	1.8
Pirin	9.0	6.8	104.2	25.7	14.8	15.2	14.2	14.5	14.4
n=5	1.4	1.7	8.6	1.4	1.1	1.2	1.0	1.3	1.3

Note: Area/*n* – hunting area/sample size; arithmetic mean values/standard deviations of: W, kg – weight of antlers; ALMB, cm – average length of mean beam; ACC, cm – average circumference of coronets; CLLB, cm – circumference of lower left beam; CLRB, cm – circumference of lower right beam; CULB, cm – circumference of upper left beam; CURB, cm – circumference of upper right beam; NTE – number of tine ends.

Table 2. Significance of differences between the mean values of red deer trophy measurements from 'initial' and 'newly-created' populations.

Area	W, kg	ALMB, cm	ACC, cm	CLLB, cm	CLRB, cm	CULB, cm	CURB, cm
Initial population	ns	ns	ns	ns	ns	ns	ns
Seslav	ns	ns	ns	ns	ns	ns	ns
Karakus	ns	ns	ns	ns	ns	ns	ns
Tundza	ns	ns	ns	ns	ns	ns	ns
Slanchev briag	ns	ns	ns	ns	ns	ns	ns
Trakia	ns	ns	ns	ns	ns	ns	ns
Tervel	ns	+	+	ns	ns	ns	ns
Cherni Lom	ns	+	+	ns	ns	ns	ns
Preslav	ns	ns	ns	--	-	--	--
Buzludza	--	ns	--	--	--	--	--
Bukovets	--	ns	--	--	--	--	--
Chumerna	ns	ns	ns	ns	ns	ns	ns
Uzana	ns	++++	ns	ns	ns	ns	ns
Ticha	ns	+++	ns	ns	ns	ns	ns
Murgash	----	ns	----	----	----	----	----
Izvora	-	-	ns	-	--	ns	ns
The Rhodopes	--	ns	ns	-	--	ns	ns
Pirin	ns	ns	ns	ns	ns	ns	ns

Note: ++++ – values are higher at level $P \leq 0.001$; +++ – values are higher at level $P \leq 0.02$; + – values are higher at level $P \leq 0.05$; ---- – values are smaller at level $P \leq 0.001$; -- – values are smaller at level $P \leq 0.01$; - – values are smaller at level; $P \leq 0.05$; ns – not significant at $P \leq 0.05$.

some antlers parameters observed might be related to other factors, i.e. (i) age of animals; (ii) population density (Schreiber and Lockow 1988); geographic isolation or remoteness of 'new-created' populations from 'initial' one; (iii) ecological variables (mostly in connection with availability of forage), such as altitude, climate (Mysterud et al. 2005, Torres-Porras et al. 2009), vegetation, etc. but mostly during early life stage (Schmidt et al. 2001).

In the most of scientific articles studying impact of environmental factors on red deer population, body mass of both sexes was used as dependent variable instead of antlers weight (i.e. Langvatn and Albon 1986, Langvatn et al. 1996, Mysterud et al. 2001). Although it was known that antler size to be heritable despite substantial age- and environmental-related variations, till present day it is very little known about environmental influences on growing dynamics of some parts of antlers. Heritability, the proportion of variation in antler size, attributable to genotype, varied from 25 % to 75 % (Harris et al. 2002). It is known that growth of antlers depends on age (Harris et al. 2002), but also on individual's nutritional state and fitness (Kruuk et al. 2002). For example, after heavy snow winters stags develop antlers with significantly smaller number of tines than in mild winters.

The trophy measurements tend to increase with the age of red deer and reach their maximal values at the age of 11–13 along European distribution of the game species (Bečejac et al. 1984, Botev 1985, Lockow 1991). As shown in Table 1, red deer have been hunted at the age of 8–10 and the differences between the mean age of animals harvested from 'initial' and 'newly-created' populations were not significant at $P < 0.05$, as well as the mean number of tine ends; as the animals from 'initial' and 'newly-created' populations in analyses came from the same age group, the antlers size differences could not be assigned to the stags' age. But today it is known that one of the most important factors in comparison of wild ungulates is cohort effect (Post et al. 1997, Rose et al. 1998, Forchhamer et al. 2001, Gaillard et al. 2003).

The average distance between Palamara and Sherba and the other hunting areas examined has been positively but not significantly correlated with the number of significant differences in mean values of trophy measurements (r = +0.187 to +0.2; df = 15; $P > 0.05$). Thus, geographic isolation between Bulgarian red deer populations might not been considered of great importance concerning trophy size.

Conclusion

Evidently trophy size differences could be better explained by ecological factors in different habitats. Genetic factors and geographic isolation could have minor importance. Further investigations are needed to study the role of biological (such as age) and environmental variables in red deer trophy formation.

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