DOCTORATE (PhD) DISSERTATION THESIS

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RELATIONS OF CERTAIN PHENOTYPIC TRAITS IN RED DEER (Cervus elaphus hippelaphus)

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1. INTRODUCTION AND OBJECTIVES OF THE RESEARCH

The utilization of red deer in Hungary is mainly for trophy hunting and the venison is a secondary product on the market and the majority of it is exported.

The quality of Hungarian red deer is hallmarked also by the fact that in the leading red deer breeder country of the world New Zealand even nowadays they use Hungarian bloodlines in breeding, both for venison, improving antler quality and velvet antler production.

My study was focused on two areas: in our country the red deer stocks can be divided into free ranging populations and herds bred under farm conditions. Because I had no chance to collect data of antler development in closed herds, I processed data originating from free ranging populations.

Regarding the free ranging red deer populations in Hungary:

1. The aim was to analyse and compare the parameters of red deer antlers originating from two different counties from 1997 to 2007 taking the effect of age and year into consideration, using the dataset of the National Game Management Database.

Considering that the number of farmed red deer increases and its economical importance grows, and from this relatively new young farm animal branch we possess - understandably - relatively few relevant data, therefore I focused my research on, to answer the following questions regarding some important characteristics of Hungarian red deer populations kept under farm conditions, mostly at the University Game Management Centre, Bőszénfa:

2. Changes of different body parameters during growth until 10 months of age depending of sex and year.

3. Analyses of relations between different body parameters until 10 months of age.
4. Testing different growth models on basis of data of red deer calves kept on our own farm from birth till 7-8 months of age.
5. The relations of age, bodyweight and calving rate of red deer hinds.
6. Changes of bodyweight of red deer calves originating from hinds of different age depending on sex at the age of 5 months (at weaning) and at the age of 11 months.

2. MATERIAL AND METHODS

This study focuses on two areas: free ranging and captive (farm) populations. The following table summarized the main parameters and important informations related to my research program.

Topic	n	Objectives	Examination time
Examinations on free ranging populations			
Analyses of antler data	6867	- „county" effect - age effect - relations between antler traits	1997-2007
Examinations on captive (farm) populations			
Analyses of body parameters	292	- sex effect - year effect - sex × year interaction - relations between body parameters	2008-2009
Examination of growth	10	- model testing	2010
Relations between age, body parameters and reproduction of hinds	271	- age effect on the calving rate	2011
	55	- the effect of growth in young age on the calving rate in case of 2-years-old hinds	2009-2011
Examination of calve rearing	199	- the effect of hind age on the live weight of offsprings	2011

2.1. Analysis of the antler parameters of free ranging red deer population in two different counties

The qualification of red deer trophies happens by CIC scoring system in Hungary; the data were collected by the National Game Management Database. The National Game Management Database put the dataset at my disposal which included the trophy data of red deer stags shot in two counties (Somogy and Bács-Kiskun) from 1997 to 2007 by hunters. I completed these

with the shot dataset described in the annual official report of the National Game Management Database.

The effect of age, county and year were tested on the antler parameters by non-parametric tests.

The relation between antler parameters was examined by correlation analyses and on basis of the correlation coefficients. Factor analyses were conducted in order to get more detailed information regarding the relation between antler parameters.

2.2. Examinations on farmed red deer populations

2.2.1. Change of different body parameters of farmed red deer

The examinations started in 2008 at the Kaposvár University Game Management Centre. The bodyweight and four body parameters (girth, hip width, head length and head width) of 161 red deer calves (♂: 73, ♀: 88) were measured. Repeated measurements were taken in 2009 on 131 calves (♂: 70, ♀: 61). The measurements were taken at the same age of calves to ensure the comparability of data of both years. I measured the calves 4 times (in July: at 2 months of age, in October: at 5 months of age, in January: at 8 months of age, in March: at 10 months of age) in each year.

The effect of sex and year and their interaction was tested by multivariate analyses of variance.

The tests of the relations between the bodyweight and other body parameters were made by correlation analyses.

2.2.2. Growth modelling of red deer calves from birth until 7-8 months of age

On our private red deer farm an opportunity presented itself to measure calves repeatedly allowing to carry out their growth model tests.

The calves were measured 6 times (at birth, in September, in October, in November, in December and in January). Beside bodyweight 4 body parameters were measured (girth, hip width, head length and head width).

34 different growth models were tested on the data. The 5 best fitting models were chosen for each body parameter and they were described in detail.

2.2.3. The relations between age, body parameters and reproduction of hinds

The data of 271 red deer hinds was collected in 2011 at the Kaposvár University Game Management Centre. The hinds were divided into 3 groups according to their age when they were calving first (2 years old first calving, 3 years old first calving, older and more times calving). The diffences in calving rate (alive calves) was statistically analysed by Chi squared test.

The group of 2 year old hinds calving the first time were divided into two additional groups: calved and barren (non-calving). One-way variance analysis was used to examine the differences - if there is any - in body weight and body parameters (girth and hip width) and their growth in young age (5 and 10 months of age) among the two groups.

2.2.4. Examination of the calve rearing ability of hinds

The effect of age of the hinds on the weaning weight of their male and female offspring (n=199) was examined. In the statistical evaluation multivariate variance analysis was used.

3. RESULTS

3.1. Analysis of the antler parameters of free ranging red deer population in two different counties

There were significant differences ($P<0.05$) between the counties in the case of main beam length, length of brow tine, length of bay tine, and length of tray tine. Considering the length of main beam and the length of tray tine the trophies originated from Somogy county were longer but in case of other parameters the antlers from Bács-Kiskun county had higher scores.

Because there were significant differences in case of 4 antler parameters between the counties, further analyses on the antler data were done for both counties separately.

The antler parameters have shown the same trend in both counties, they have grown year to year up to 13-14 years of age then they began to decline. Age effect was significant ($P<0.05$).

During the examined period the population showed signs of becoming younger in both counties. The average estimated age of qualified stags shot in Somogy county decreased 0.8 year and that of the county Bács-Kiskun decreased 1.6 years between 1997- 2007.

On basis of the factor analyses the antler parameters were divided into four groups in both counties: the first one: the circumferences, the second one: the length of main tines, the third one: the number of tines and the fourth one: the length of main beam. The difference between the two counties was in case of classing the antler weight. In Bács-Kiskun county the factor analyses classified the antler weight in the first group, to the circumferences, but the data originated from Somogy county were got in the third group, to the

number of tines. The compositions of the groups were exactly the same in both counties except the antler weight.

3.2. The results of examinations carried out on farmed red deer populations

3.2.1. Change of different body parameters of farmed red deer

The male calves were significantly ($P<0.05$) greater than females in the case of all examined body parameters (body weight, girth, hip width, head length, head width) at every measurement time (2, 5, 8 and 10 months of age).

During the examination significant ($P<0.05$) year effect was found which was the most important in case of body parameters measured at 2 and 5 months of age, then in the winter period – at 8 and 10 months of age – the differnces diminished.

The interactions of sex and year were not significant in most cases and if so they represented a very small percentage related to total variance.

Strong correlations were found between body weight and girth and hip width for the male calves (r=0.81-0.86) and females (r=0.7-0.86) both at 5 and 10 months of age. The bodyweight measured at 5 months of age closely correlated with bodyweight at 10 months of age ($r_{male}=0.83$; $r_{female}=0.78$). There were moderate to weak correlations between head width and the other parameters at 5 (r=0.11-0.58) and 10 months (r=0.2-0.38) of age in both sexes.

3.2.2. Growth modelling of red deer calves from birth until 7-8 months of age

In the case of the 5 best fitting models the differences between the measured and estimated body parameters are small for each body measurements. It is characteristic for each estimating model that the accuracy of estimation is

independent of knowledge of body size measured at birth. Application of each curve requires the detailed knowledge of birth date. The accuracy of the estimation was independent of sexes of red deer calves in case of all parameters except the hip width.

3.2.3. The relations between age, body parameters and reproduction of hinds

During the examinations the calving rate of 2 years old hinds (65.5%) calving the first time was significantly the lowest. There was no significant difference between the 3 years old (85.4%) hinds – calving the first time and older (88.6%) hinds calving more times.

Regarding the 5 and 10 months bodyweight, girth and hip width no significant difference ($P<0.05$) could be found between the 2 years old calving and non-calving hinds.

3.2.4. Examination of calf rearing ability of hinds

The older hinds reared significantly ($P<0.05$) heavier calves than the 2- and 3-years-old ones, and the calves of 3 years-old hinds were heavier than the calves of the 2-year-old hinds.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Analysis of the antler parameters of free ranging red deer population in two different counties

The population showed signs of becoming younger and younger in both counties during the examined period. In spite of this a small growth was observed in the case of antler parameters. The reason for this could be that the environmental conditions became more favourable as a consequence of the reduced population density.

All antler parameters grew till the age up to 12-13 years of age after which a declining tendency appeared. It would be worthwhile to analyse additionally antler parameters of stags of different regions and with known age, to gain more profound and exact knowledge regarding antler development of Hungarian red deer (C. e. hippelaphus).

The differences found regarding the classification according to antler weight indicated by the correlation examinations could be explained by characteristics not considered during the judgement procedure (shape of crown and circumferences of points). Extending the evaluations including these traits may contribute to more successful typization the antler developed of deer of different regions (for example the crown shape of deer living the flood area of Dráva river).

4.2. The examinations carried out on farmed red deer populations

4.2.1. Change of different body parameters of farmed red deer

The effect of sex within the total variance grew significantly as the population grew older in all measured traits. This effect was the most marked regarding the head width. This phenomenon is in close connection to later antler development in stags.

It deserves special attention that year effects cause even a larger proportion of the total variance compared to sex effects in all traits closely correlating with body weight (girth, hip width) during the intensive growth phase (in July, in October). Phisiologically is logical that year effect significantly diminishes during the short daylight period when growth intensity sharply declines and also the additional winter feeding automatically contributes to diminishing the year effect.

The correlations regarding body parameters measured at weaning (5 months of age) showed high statistical correlation with measurements taken later in January and March. The reason for this is that the growth of young deer is most intensive till the weaning period (in October). The calves were reared and fed later in confinement. During the short day period the intensity of growth dramatically slows down irrespective of rearing environment.

4.2.2. Growth modelling of red deer calves from birth until 7-8 months of age

The best fitting model is suitable to estimate the bodyweight (by average of 2 kg) in a very important period in farm practice from birth to 7-8 months of age without the necessity of measuring body weight at birth, which is very difficult or impossible in practice. The date of birth is necessary to use this curve but its determination is easily observable without seriously disturbing the herd.

4.2.3. The relations between age, body parameters and reproduction of hinds

My evaluations showed that the reproductive performance of hinds at the age of 2 years is lower compared to older stocks, one reason of which is probably also the fact that these young hinds grow quite intensively, therefor additional body weight gain is considerable. This finding corresponds to results obtained in other evaluations, where genetically different red deer stocks were examined. In the Hungarian farmed red deer population the high reproductive performance of the hinds is stable between 3 till approximately 14 years of age. The long reproductive lifetime of the farm population is a great advantage compared to other pasture based meat producing animal sectors as beef cattle and sheep. Because of this a relatively small proportion of the active hind population has to be replaced by young, 2-year-old hinds characterized by lower reproductive capacity.

4.2.4. Examination of calf rearing ability of hinds

The two main findings that the 3-year-old and older hinds rear heavier calves in both sexes compared to 2-year-olds, and the long reproductive lifetime of hinds, leads to a very favourable position regarding the meat production potencial of the red deer population and this type of farming sector utilizing pastures.

5. NEW SCIENTIFIC RESULTS

1. Small but significant ($P<0.05$) differences were observed between the antler parameters of the two counties (Somogy and Bács-Kiskun) in the case of main beam length, brow tine length, bay tine length, and trey tine length.
2. The main results of factor analyses based on the partial correlation coefficients between the antler parameters (antler weight, length of main beam, length of brow tine, length of bay tine, length of tray tine, circumference of coronet, lower circumference, upper circumference, total number of tines) are:
    - The main beam showed weak relation with the other antler parameters
    - There was strong correlation between the circumferences (coronet, lower, upper)
    - The antler weight showed the strongest correlation with the total number of points in Somogy county and with the circumferences in Bács-Kiskun county.
3. The effect of sex on the body parameters (body weigth, girth, hip width, head length and hed width) in farmed red deer was found significant ($P<0.05$). Year effects were significant ($P<0.05$) in case of

body weigth, girth, hip width, head length. The head width of male calves showed different growth from the other body parameters in both examined herds. Head width was not influenced by year effect.

4. Sex and year effects were equally important significant factors determining the proportion of variance observed in the case of all body parameters The interaction between sex and year were in most cases not significant or contributed only a very small part to the observed total variance.
5. Different growth models were tested for the body parameters of red deer calves to find the best fitting curves for each parameter from birth till 7-8 months of age. The best fitting models selected from the 34 possible ones were the following:
    - live weight gain: $-0.61+9.93*age^{0.41}$
    - growth of girth: $(264.12*age*girth\ at\ birth)+(girth\ at\ birth^{2.97})^{0.34}$
    - growth of hip width: $25.56-16.78*0.99^{age}$
    - growth of head length: $19.23+1.28*age^{0.50}$
    - growth of head width: $13.43-6.02*0.99^{age}$

    The best fitting model is suitable to estimate the bodyweight of calves (by an average of 2 kg) in a very important period in farm practice from birth to 7-8 months of age independently of sex. To use the model only the exact time of birth and one bodyweight measurement is essential.

6. The growth rate of pregnant (calving) and barren (not pregnant) 2 year-old females was examined. There were no significant ($P<0.05$) differences between the two groups (calved and yeld) in the case of body weigth, girth and hip width at their 5 and 10 months of age and their growth (from 5 to 10 months).

7. The calves reared by 2-year-old, 3-year-old and older hinds significantly differed in body weight at weaning and 11 months of age in both sexes. The 2-year-old hinds reared the smallest calves and 3-year-old and older hinds reared significantly ($P<0.05$) heavier calves at both times of measuements. My results are similar in tendency to Scottish (C. e. Scotticus) and New Zealand populations despite the fact that their genetic background, the climate, type of pasture and management systems are different regarding all populations. The bodyweight of the deer calves examined under our conditions is significantly superior compared to the Scottish populations and are very similar to the present day New Zealand type red deer populations intensively selected since over 40 years and also improved by imported stocks originated also from Hungary.

6. PUBLICATIONS ON THE SUBJECT OF THE DISSERTATION

Scientific publication:

Foreign language

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Hungarian language

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Hungarian language

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Sugár L., **Bokor J.**, Nagy J., Tóth Cs. (2010) Agancsos borjak, ágas-bogas csaposok. Magyar Vadászlap 2010. június 357-359.