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SELECTION OF APPLICABLE MORPHOMETRIC PARAMETER FOR AGE ESTIMATION IN ROE DEER (*Capreolus capreolus* L.) FROM EASTERN CROATIA

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ABSTRACT

Population of roe deer (*Capreolus capreolus*) living in the selected hunting estates in the Eastern Croatia has been studied. Specimens were collected at locations in hunting estates: Osijek, Podunavlje, Spačva and Kunjevci, which differs in habitat composition and characteristics of roe deer's populations. Aim of the study was to determine the most applicable parameter among size of the body parts for classification of live individuals into age groups. Total of 161 individuals was measured. The most pronounced body measures: head length and body length have linear increase in relation to age. Continuous growth throughout age classes was significant for the head length and for the body length. The lowest values of measured parameters were confirmed for Podunavlje and Kunjevci, the significantly higher values were in Osijek, while the values were intermediate in Spačva. Based on the results, a recommendation for the age estimation in live roe deer is to observe head length and eye position in relation to snout.

Kew words: roe deer / age estimation / morphometric parameters / Croatia

1 INTRODUCTION

Age estimation of free living game animals and proper division in age groups is critical for understanding population dynamics and development of management strategies. Very precise methods are used to determine age in dead animal: antler beam diameter, tooth wear and replacement, molar tooth ratio, eye lens weight (Mysterud and Østbye, 2006, Stubbe, 1997, Ueckermann and Scholz 1976, Almasan and Rieck, 1970, Andersen, 1953). Age estimation in live roe deer can be enduring, since there is no reliable visible characteristic (Strandgaard, 1972). Body dimensions and body weight in roe deer vary, depending on age, sex, habitat type, season, population size and number of competitor species. Body weight of same individual can vary up to 3 kg during the day, depending on the quantity of food taken (Danilkin, 1996).

2 MATERIAL AND METHODS

The investigation encountered roe deer populations in four selected hunting estates in the Eastern Croatia, during two hunting seasons: 2003/2004, and 2004/2005. Locality Osijek has 80% of agriculture land in habitat structure, while the forest land is scattered (ca. 20%). Roe deer is without a competitor, but population size is under the habitat capacity. Locality Podunavlje comprise mainly agricultural cropland, without forest cover. Age and sex structure of roe deer is in disorder, with wild boar and red deer present in small number. Locality Spačva is typical forested area (90% forest cover), where the habitat is suitable for settlement of roe deer, wild boar and red deer. Locality Kunjevci is also typical forested area (80% forest cover), with populations of roe deer, fallow deer, mouflon and wild boar.

Total of 161 individuals of roe deer has been col-

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lected and measured (25 in Osijek, 38 in Podunavlje, 54 in Spačva, and 44 in Kunjevci). Among the range of measured body parameters, for this paper we selected the head length and body length as the most pronounced in free nature.

All measurements were done using measuring tape with centimetre scale. Head length was measured from the upper lip, across the nasal and frontal bones, to occipital bone. Body length was measured from the upper lip, across the nasal and frontal bones, crest of the neck, and shoulder up to tail base (Stube, 1997). Measurement data were arranged into following age groups: up to 1 year (fawns); 2 years; 3 and 4 year; 5 and more years. Individuals were not arranged according to sex for this analysis.

Collected data were analyzed and presented in three parts. First part aimed to determine growth continuity of measured parameters according to age groups; second part is related on comparison between localities, while third part links the values of measured parameters with characteristics of habitat. All statistical analyses were run by using the SPSS for Windows, version 16.0.1. In order to determine whether values of head length and body length between localities are statistically significant, test of significance (LSD) was performed. An analysis of relationship among habitat type (portion of agricultural land), number of competitor species and measured parameters by age groups, was done aiming to determine difference in head length and body length at compared localities.

3 RESULTS AND DISCUSSION

Both values of head length and body length showed increasing related to age groups (Table 1). Growth of both parameters is almost linear in relation to age. Continuous growth in all age groups (Fig. 1, Fig. 2) was significant for the head length at all four localities: Osijek

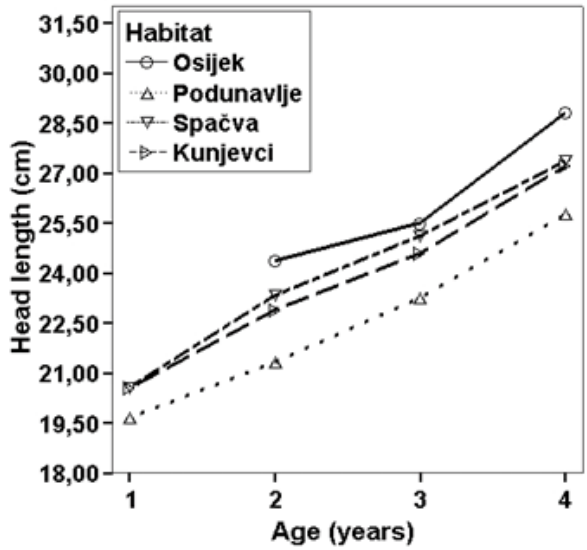

Figure 1: *Relation between growth of head length and age of roe deer*

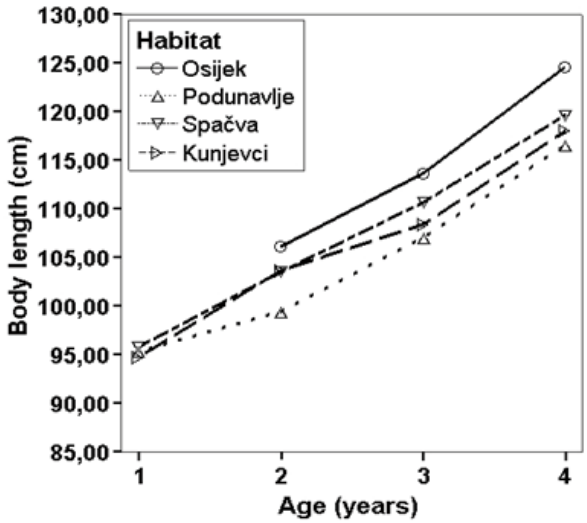

Figure 2: *Relation between body length and age of roe deer*

Table 1: *Mean values of measured parameters according to age groups and localities*

Age group	Parameter (cm)	Habitat			
		Osijek	Podunavlje	Spačva	Kunjevci
1 year	Head length	-	19.67	20.58	20.55
	Body length	-	95.33	95.80	94.75
2 year	Head length	24.38	21.33	23.34	22.90
	Body length	106.13	99.44	103.53	103.66
3-4 year	Head length	25.51	23.27	25.12	24.60
	Body length	113.67	107.07	110.67	108.41
5 and more years	Head length	28.82	25.77	27.37	27.22
	Body length	124.63	116.59	119.68	118.04

Table 2: *Multiple comparisons for head length and body length amongst selected localities*

Dependent Variable	(I) Habitat	(J) Habitat	Mean Difference (I–J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Head length (cm)	Osijek	Podunavlje	3.66600(*)	0.61442	0.000	2.4524	4.8796
		Spačva	2.07711(*)	0.57717	0.000	0.9371	3.2171
		Kunjevci	3.15236(*)	0.59757	0.000	1.9721	4.3327
	Podunavlje	Osijek	−3.66600(*)	0.61442	0.000	−4.8796	−2.4524
		Spačva	−1.58889(*)	0.50520	0.002	−2.5868	−0.5910
		Kunjevci	−0.51364	0.52838	0.333	−1.5573	0.5300
	Spačva	Osijek	−2.07711(*)	0.57717	0.000	−3.2171	−0.9371
		Podunavlje	1.58889(*)	0.50520	0.002	0.5910	2.5868
		Kunjevci	1.07525(*)	0.48456	0.028	0.1181	2.0324
	Kunjevci	Osijek	−3.15236(*)	0.59757	0.000	−4.3327	−1.9721
		Podunavlje	0.51364	0.52838	0.333	−0.5300	1.5573
		Spačva	−1.07525(*)	0.48456	0.028	−2.0324	−0.1181
Body length (cm)	Osijek	Podunavlje	10.63189(*)	2.20215	0.000	6.2822	14.9816
		Spačva	7.87770(*)	2.06864	0.000	3.7917	11.9637
		Kunjevci	11.71264(*)	2.14174	0.000	7.4823	15.9430
	Podunavlje	Osijek	−10.63189(*)	2.20215	0.000	−14.9816	−6.2822
		Spačva	−2.75419	1.81069	0.130	−6.3306	0.8223
		Kunjevci	1.08074	1.89377	0.569	−2.6598	4.8213
	Spačva	Osijek	−7.87770(*)	2.06864	0.000	−11.9637	−3.7917
		Podunavlje	2.75419	1.81069	0.130	−0.8223	6.3306
		Kunjevci	3.83493(*)	1.73672	0.029	0.4046	7.2653
	Kunjevci	Osijek	−11.71264(*)	2.14174	0.000	−15.9430	−7.4823
		Podunavlje	−1.08074	1.89377	0.569	−4.8213	2.6598
		Spačva	−3.83493(*)	1.73672	0.029	−7.2653	−0.4046

($R^2 = 0.66$), Podunavlje ($R^2 = 0.67$), Spačva ($R^2 = 0.89$), Kunjevci ($R^2 = 0.89$); and for the length of body: Osijek ($R^2 = 0.80$); Podunavlje ($R^2 = 0.81$); Spačva ($R^2 = 0.79$), Kunjevci ($R^2 = 0.86$).

Results of the test of significance (LSD), performed in order to determine whether values of head length and body length between localities have significance, are presented in Table 2. Locality Osijek had significantly higher values than other localities. Locality Spačva had significantly lower values than Osijek, but significantly higher than Podunavlje and Kunjevci. The lowest values were found for Podunavlje and Kunjevci, with no significant differences among them. Research carried out in Denmark (Klein and Strandgaard, 1972) pointed out that largest individuals and those with highest growth rate were situated in areas with lower population density, and with higher portion of woodland in habitat structure. Oppositely, smaller individuals, in term of body length, were recorded in areas with higher population density and higher portion of agricultural land.

Andersen *et al.* (1998) determined that adult male in France and Poland hardly reach 80% of body weight of male in Scandinavia, while female living in forested habitats in Poland reach 70% of size of female in Scandinavia. In average, roe deer with lowest size, i.e. smallest, are from the Germany and France; of middle size in the Carpathian area and eastwards, Bulgaria, Slovakia, Czech Republic and Poland. The biggest roe deer in Europe originated from northwest Baltic, Latvia and Lithuania. Historical trend of decreasing body height of roe deer in Europe (Kratochvil, 1988) indicates that on the start of first millennium it was 76 cm, while today is about 70 cm (in Moravia, Poland) and 68 cm in Germany. Since the roe deer is territorial animal with low migratory dispersion (Danilkin, 1996) it can be concluded that contact between populations from selected localities does not exist in our research. Values achieved for head length and

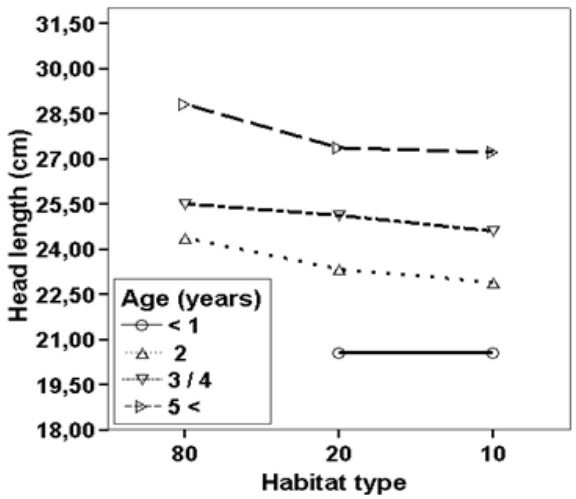

Figure 3: *Relation between head length of roe deer and percentage of agricultural land in habitat structure*

body length can be only result of the conditions at habitat or inside local population.

Relation between head length and habitat type (Fig. 3) in age group of up to 1 year is not significantly correlated ($R^2 = 0.00$); correlation is evident in 2 year ($R^2 = 0.20$), and 3–4 year old animals ($R^2 = 0.13$), and is more pronounced ($R^2 = 0.28$) in individuals from age group 5 and more years.

Relationship among body length and habitat type indicated no significant dependence in age group of up to 1 year ($R^2 = 0.03$); marginal dependence is in 2 year old animals ($R^2 = 0.05$), while it is evident in age group 3–4 year ($R^2 = 0.17$). In individuals from age group 5 and more years, dependence is more pronounced ($R^2 = 0.42$).

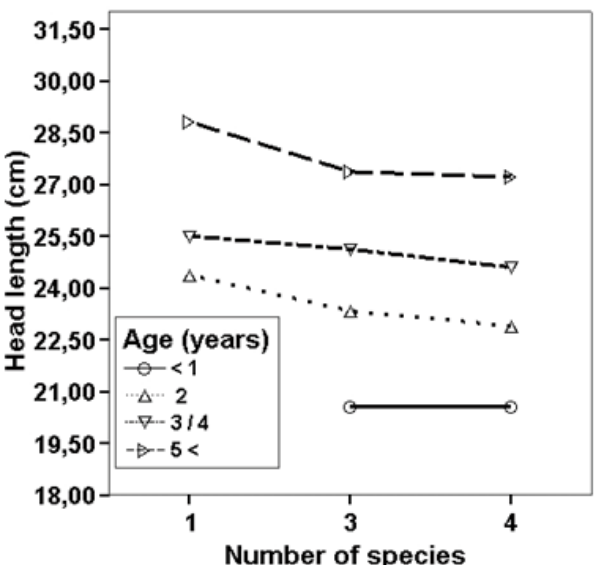

Figure 4: *Relation between head length of roe deer and number of competitor species*

There was no significant correlation among head length and number of competitor species in age group up to 1 year ($R^2 = 0.00$). Correlation is evident in age groups: 2 year ($R^2 = 0.20$), 3–4 year ($R^2 = 0.14$), while it is more pronounced ($R^2 = 0.27$) in age group 5 and more years (Fig. 4). Relationship among body length and number of competitor species is not significantly correlated in age classes: up to 1 year ($R^2 = 0.03$) and 2 year ($R^2 = 0.04$), while it is evident ($R^2 = 0.18$) in animals from age group 3–4 year, and more pronounced ($R^2 = 0.41$) in age class 5 and more years.

Values determined between localities for age class up to 1 year (mostly comprising fawns) and individuals during second year show no substantial differences. It can be explained by intensive growth and development of body and skeleton in roe deer which terminates at 24–26 months (Gaillard *et al.*, 1998, Danilkin, 1996). Differences between localities are distinctive when comparing age groups: 3–4 year, and 5 and more years.

From analysis presented in Fig. 3 and Fig. 4 it can be concluded that primary factors affecting bigger or smaller body size in roe deer are: size and density of population, number of competitor species and percentage of agricultural land in habitat. In our research, the biggest body size in age classes above 3 year is recorded at locality Osijek. Roe deer in this area is without a competitor species, while due to high hunting pressure its population is under the habitat capacity. The smallest body size of roe deer is recorded in nursery Kunjevci, with patches of open land within closed forested area, and high number of competitor species: fallow deer, mouflon and wild boar. Density of roe deer is above 10 animals per 100 ha, which is not large number. Considering that 10 mouflons, 14 fallow deers and about 10 wild boars per 100 ha share the same habitat with roe deer, it become evident that habitat capacity reached its upper limit for the game nursery. Pettorelli *et al.* (2003) emphasized that forest openings, a grassy fields dominated by herbaceous plants, is main factor that determines maximal population size and body mass of roe deer. Researches from Denmark (Klein and Strandgaard, 1972) confirm settlement density as the main factor for body size in roe deer. Mysterud and Østbye (2006) reported increase in both body and antler weight of roe deer with increase of distance from the forest edge.

Knowing that roe deer have the ability to change its phenotype in response to changes in the environment, the practical question is which element of phenotype is most applicable for age estimation in live individuals. The research presented in this paper pointed out that increase in head length and body length is continual at

all localities and body sizes. Special attention is needed for observing head length and eye position in relation to snout, so the individual can be recognized and classified as young, middle-aged or mature. When observing in free nature, one can see that eye position is going far away from the top of the snout, and it is related to age.

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