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Zoometric characteristics of the european roe deer (*Capreolus capreolus)* hunter-harvested in north-eastern Poland

Charakterystyka zoometryczna tuszy sarny europejskiej *Capreolus capreolus* z łowisk północno-wschodniej Polski

Summary. The aim of this study was to characterize the carcasses of European roe deer (*Capreolus capreolus*) hunter-harvested in north-eastern Poland. The average carcass weights and measurements of male, female and young roe deer, and the correlations between these parameters were determined. The average carcass weight of bucks (after the removal of the head with antlers), does and yearlings, harvested in the study area, was 17.19 kg, 17.24 kg and 11.03 kg, respectively. The height at sacrum and the height at withers of bucks, does and fawns reached 71.62 and 66.55 cm; 71.48 and 64.88 cm; 64.68 and 58.87 cm, respectively. The carcasses of male fawns were smaller and heavier than the carcasses of female fawns, which could result from stronger and thicker muscles and bones in the former. There was a high correlation between chest circumference and the other body measurements in individuals of both sexes and all age groups, which suggests that chest circumference may be a good indicator of carcass size and quality in roe deer.

Key words: roe deer, carcass weight, zoometric measurements

INTRODUCTION

The body weight and size of the European roe deer (*Capreolus capreolus*) may vary widely depending on geographical, climatic and environmental conditions [Perzanowski 1997]. The carcass weight and measurements of deer are also determined by other factors, such as the age and growth rate of individual animals [Bobek *et al.* 1984].

Kulak and Wajdzik [2009] demonstrated that the carcass weight and skull measurements of roe deer are useful parameters in ecotype classification. According to the above authors, different ecotypes of the roe deer can be distinguished based on selected body and carcass parameters.

The aim of this study was to characterize the carcasses of European roe deer (*Capreolus capreolus*) hunter-harvested in north-eastern Poland. The average carcass weights and measurements of male, female and young roe deer, and the correlations between these parameters were determined.

MATERIALS AND METHODS

The experimental materials comprised the carcasses of roe deer hunter-harvested via selective culling in north-eastern Poland (Province of Warmia and Mazury), in two hunting seasons, 2006/2007 and 2007/2008. All animals were harvested during the open season, i.e. males (bucks) – from 11 May to 30 September, females (does) and yearlings – from 1 October to 15 January.

Zoometric measurements were performed at the Meat Processing Plant "Las" Ltd. in Olsztyn to determine the average carcass weight and size of bucks, does and yearlings. A total of 366 carcasses, including 146 carcasses of males, 132 carcasses of does and 88 carcasses of fawns (44 carcasses of male fawns and 44 carcasses of female fawns) were analyzed in both hunting seasons. Carcasses were measured using a measuring stick and a tape measure, accurate to 0.5 cm. The following measurements were taken (Fig. 1):

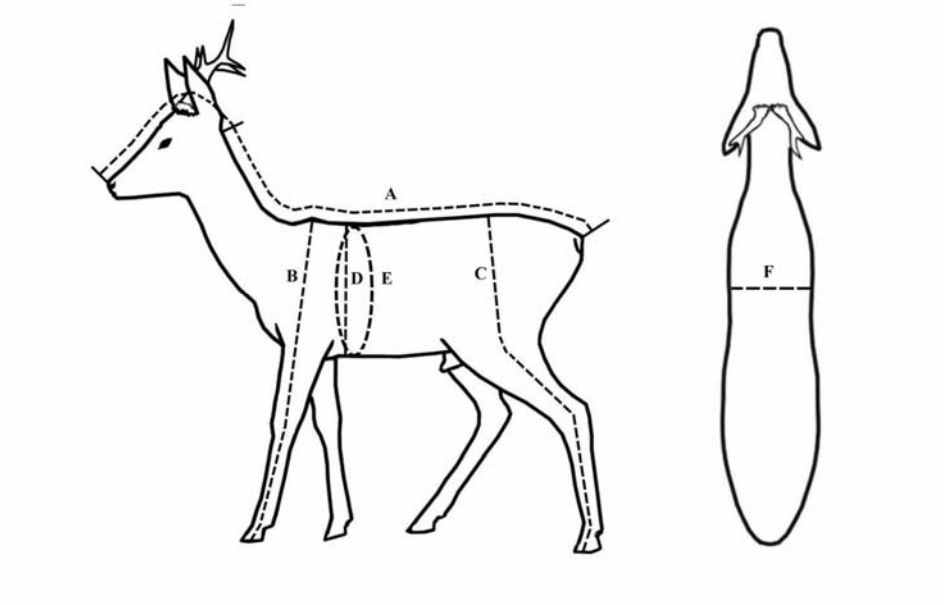

Fig. 1. Zoometric measurements taken
Ryc. 1. Schemat wykonanych pomiarów zoometrycznych

A – carcass length – in males – after the removal of head with antlers, from the atlas, along the spine, to the base of the tail; in females and fawns – from the nose, along the center of the head and the spine, to the base of the tail.

B – height at withers – from the highest point of the withers to the central point at the base of the front leg, along the front leg, to the hoof, with front legs perpendicular to the carcass.

C – height at sacrum – from the highest point of the back, along the hind leg, to the hoof.

D – chest depth – at the deepest point, just behind the shoulders.

E – chest circumference – just behind the withers and the shoulders.

F – chest width – at the widest point, just behind the shoulders.

Carcass weight was determined following evisceration and the removal of head with antlers in bucks, and following evisceration in does and fawns. Carcass conformation was estimated in male and female fawns separately All carcasses were weighed using an electronic scale, accurate to 0.5 kg. Data on the weight of carcasses and the time of harvest were provided by the Meat Processing Plant "Las" Ltd. in Olsztyn.

The results were processed statistically using STATISTICA 5.0 PL software. Arithmetic means ($\overline{x}$) and standard deviations (S) were determined for carcass weight and measurements. The coefficients of correlation (r) between carcass weight and measurements in the groups of bucks, does and fawns were calculated. The significance of differences between means was estimated by a one-way analysis of variance in a non-orthogonal design [Bochno *et al.* 2001].

RESULTS AND DISCUSSION

Carcass characteristics of adult roe deer

Table 1 presents the average carcass weight and measurements of male and female roe deer. The average carcass weight of 146 males and 132 females harvested in the Province of Warmia and Mazury over the entire experimental period reached 17.50 kg (after the removal of head with antlers) and 17.24 kg, respectively. The average height at withers of bucks and does was 66.55 cm and 64.88 cm, while the average height at sacrum was 71.62 cm and 71.48 cm, respectively. Chest dimensions were significantly higher in males than in females.

The average carcass weight of roe deer bucks and does noted in the present study was substantially lower than that reported by Petelis and Brazaitis [2003] for male and female roe deer harvested in south-western Lithuania, at 23.7 kg and 21.2 kg, respectively. Roe deer harvested in north-eastern Poland were heavier than those shot in the Czech Republic, whose average carcass weight reached 15.21 kg and 14.92 kg, respectively [Vach 1993].

The carcass weight of roe deer from different Polish subpopulations has been studied previously. In an experiment conducted by Kałuziński [1978], the average carcass weight of male and female roe deer in the Wielkopolska region reached 16.3 kg and 15.70 kg, respectively, and it was lower than in the present study. The average carcass weight of bucks and does in the macroregion of northern Poland was 16.58 kg and

16.50 kg, respectively [Janiszewski *et al.* 2009]. The above data point to relatively good quality of the roe deer subpopulation from the Province of Warmia and Mazury.

Table 1. Carcass measurements (cm) and average carcass weight (kg) of male and female roe deer
Tabela 1. Wymiary zoometryczne (cm) oraz średnia masa tuszy (kg) kozłów i kóz

Parameter Cecha	Males – Samce				Females – Samice			
	$\bar{x}$	$x_{min.}$	$x_{max.}$	S	$\bar{x}$	$x_{min.}$	$x_{max.}$	S
Carcass length Długość tuszy	83.21	66.00	95.00	5.11	113.71	97.00	127.00	6.23
Height at sacrum Wysokość w krzyżu	71.62	65.00	80.00	2.66	71.48	61.00	81.00	3.46
Height at withers Wysokość w kłębie	66.55^{a}	57.00	73.00	3.06	64.88^{b}	55.00	72.00	3.57
Chest circumference Obwód kl. piersiowej	63.77^{A}	52.00	74.00	4.76	60.37^{B}	51.00	68.00	3.64
Chest depth Głębokość kl. piers.	22.32^{A}	18.50	26.00	1.61	17.25^{B}	11.00	25.00	4.38
Chest width Szerokość kl. piers.	19.70^{A}	10.50	25.50	4.69	12.73^{B}	9.50	17.00	1.26
Carcass weight Masa tuszy	17.50	11.00	25.50	2.54	17.24	12.50	22.00	2.30

a, b – $P \leq 0.05$
A, B – $P \leq 0.01$

According to some authors [Dziedzic 1991, Graczyk 1978, Wajdzik and Jamrozy 2001], roe deer dwelling in various environmental conditions can be divided into two ecotypes, the field ecotype and the forest ecotype. Janiszewski and Kolasa [2007] demonstrated that the carcass weight of roe deer bucks is affected by environmental factors. The average carcass weight of individuals representing the field and forest ecotype, harvested in north-eastern Poland, reached 17.15 kg and 15.65 kg, respectively. Such a trend was also noted in the field and forest subpopulations of the European roe deer in Lithuania [Petelis and Brazaitis 2003]. Klein and Strandgaard [1972] who analyzed the European roe deer population in Denmark also found that field ecotype animals were characterized by higher body weight and measurements.

According to Brzuski *et al.* [1997], zoometric measurements support a description of the physical appearance and constitution type of roe deer. The cited authors reported that the body size of males changes with age, and the growth process is over at around five years of age, when the height at withers, body length and chest circumference of bucks reach 71.2 cm, 114.5 cm and 65.4 cm, respectively. In a study by Vach [1993], the average carcass length and height at sacrum of roe deer does harvested in the Czech Republic reached 107.40 cm and 69.64 cm, and the reported values were lower than those noted in the present experiment.

The correlations between the carcass parameters of male roe deer were statistically highly significant (tab. 2). The highest values of the correlation coefficient were observed between chest circumference and chest depth, and between chest circumference and carcass weight (r = 0.79 in both cases). It should be stressed that chest circumference was also highly correlated with other carcass measurements (tab. 2). Janiszewski and Kolasa [2007] also reported the highest coefficient of correlation between chest circumference and carcass weight (r = 0.79). Thus, the value of this parameter can be considered to be constant.

Table 2. Coefficients of correlation (r) between carcass measurements in male roe deer
Tabela 2. Współczynniki korelacji (r) pomiędzy wymiarami samców sarny

Parameter Cecha	Carcass length Długość tuszy	Height at sacrum Wysokość w krzyżu	Height at withers Wysokość w kłębie	Chest circumference Obwód klatki piersiowej	Chest depth Głębokość klatki piersiowej	Chest width Szerokość klatki piersiowej
Carcass length Długość tuszy						
Height at sacrum Wysokość w krzyżu	0.42**					
Height at withers Wysokość w kłębie	0.43**	0.75**				
Chest circumference Obwód klatki piersiowej	0.53**	0.59**	0.46**			
Chest depth Głębokość klatki piersiowej	0.48**	0.47**	0.40**	0.79**		
Chest width Szerokość klatki piersiowej	0.38**	0.51**	0.35**	0.74**	0.59**	
Carcass weight Masa tuszy	0.63**	0.59**	0.52**	0.79**	0.68**	0.56**

** $P \leq 0.01$

Table 3 data show that the majority of coefficients of correlation between carcass measurements in female roe deer were highly significant. In does, similarly as in bucks, the highest correlation (r = 0.83) was found between chest circumference and carcass weight. Relatively high coefficients of correlation were also observed between carcass weight and the remaining carcass parameters.

Table 3. Coefficients of correlation (r) between carcass measurements in female roe deer
Tabela 3. Współczynniki korelacji (r) pomiędzy wymiarami tuszy samic sarny

Parameter Cecha	Carcass length Długość tuszy	Height at sacrum Wysokość w krzyżu	Height at withers Wysokość w kłębie	Chest circumference Obwód klatki piersiowej	Chest depth Głębokość klatki piersiowej	Chest width Szerokość klatki piersiowej
Carcass length Długość tuszy						
Height at sacrum Wysokość w krzyżu	0.41**					
Height at withers Wysokość w kłębie	0.33**	0.78**				
Chest circumference Obwód klatki piersiowej	0.56**	0.61**	0.47**			
Chest depth Głębokość klatki piersiowej	0.06	0.38**	0.36**	0.02		
Chest width Szerokość klatki piersiowej	0.38**	0.05	-0.03	0.56**	0.79**	
Carcass weight Masa tuszy	0.58**	0.67**	0.53**	0.83**	0.16	0.36**

** $P \leq 0.01$

High coefficients of correlation between chest dimensions and the other carcass measurements suggest that the analyzed parameters may be used to describe the body conformation and physical condition of the European roe deer, which is consistent with the findings of Czyżowski *et al.* [2009]

Carcass characteristics of roe deer fawns

The carcass weight and measurements of male and female fawns are shown in Table 4. The average carcass weight of all fawns dwelling in the study area was 11.03 kg, and their carcass measurements were as follows: carcass length – 100.14 cm, height at sacrum – 64.68 cm, height at withers – 58.87 cm, chest circumference – 53.47 cm, chest depth – 14.32 cm, chest width – 15.93 cm.

Janiszewski *et al.* [2008] reported that the average carcass weight of roe deer fawns harvested in the Forest Division of Mrągowo during the hunting seasons of 1998/1999 to 2005/2006 was 11.04 kg. The average carcass weight of animals inhabiting four

Table 4. Carcass measurements (cm) and carcass weight (kg) of roe deer fawns
Tabela 4. Wymiary (cm) i masa (kg) tuszy koźląt

Parameter Cecha	Fawns – total Koźlęta – ogółem				Male fawns Koźlęta męskie				Female fawns Koźlęta żeńskie			
	$\bar{x}$	$x_{min.}$	$x_{max.}$	S	$\bar{x}$	$x_{min.}$	$x_{max.}$	S	$\bar{x}$	$x_{min.}$	$x_{max.}$	S
Carcass length Długość tuszy	**100.14**	92.00	114.00	4.75	**100.21**	92.00	114.00	5.97	**100.08**	93.00	107.00	3.29
Height at sacrum Wysokość w krzyżu	**64.68**	57.00	73.00	3.23	**64.05**^{b}	59.00	69.00	2.66	**65.32**^{a}	57.00	73.00	3.68
Height at withers Wysokość w kłębie	**58.87**	52.00	67.00	3.32	**58.05**^{b}	53.00	67.00	3.39	**59.68**^{a}	52.00	66.00	3.13
Chest circumference Obwód klatki piersiowej	**53.47**	45.00	64.00	4.09	**53.32**	45.00	64.00	5.19	**53.63**	49.00	60.00	2.71
Chest depth Głębokość klatki piersiowej	**14.32**	8.50	21.00	4.10	**13.79**^{B}	8.50	20.00	3.93	**15.84**^{A}	9.50	21.00	4.29
Chest width Szerokość klatki piersiowej	**15.93**	9.00	21.00	4.34	**15.68**^{a}	9.50	21.00	4.19	**16.18**^{a}	9.00	21.00	4.59
Carcass weight Masa tuszy	**11.03**	8.00	13.30	1.21	**11.23**^{A}	8.00	13.10	1.39	**10.83**^{B}	9.30	13.30	0.99

a, b – $p \leq 0.05$
A, B – $p \leq 0.01$

provinces in the macroregion of northern Poland was insignificantly higher, at 11.2 kg [Janiszewski *et al.* 2009]. The reported values are comparable with those noted in the present study, which indicates that the average carcass weight of approximately 11 kg is typical of juvenile roe deer in the studied areas.

Height at withers, height and sacrum and chest dimensions were higher in female fawns than in male fawns (tab. 4), but males were marked by significantly higher carcass weight. Differences in the carcass weight of male and female fawns were also noted by Toigo *et al.* [2006] in the French roe deer population, where juvenile males were by around 0.8 kg heavier than females. In a study conducted by Vach [1993] in the Czech Republic, the average carcass weight of female fawns was 10.19 kg in September, 10.69 kg in October, 10.39 kg in November and 10.37 kg in December. The average carcass length and height at sacrum of female fawns reached 99.2 cm and 68.6 cm, respectively. The findings of the cited author show that female and male fawns from the Czech roe deer population are taller but shorter than the animals harvested in the region of Warmia and Mazury in Poland.

Table 5. Coefficients of correlation (r) between carcass measurements in roe deer fawns
Tabela 5. Współczynniki korelacji (r) pomiędzy cechami tuszy koźląt ogółem

Parameter Cecha	Carcass length Długość tuszy	Height at sacrum Wysokość w krzyżu	Height at withers Wysokość w kłębie	Chest circumference Obwód klatki piersiowej	Chest depth Głębokość klatki piersiow.	Chest width Szerokość klatki piersiow.
Carcass length Długość tuszy						
Height at sacrum Wysokość w krzyżu	0.19					
Height at withers Wysokość w kłębie	0.06	0.58**				
Chest circumference Obwód klatki piersiowej	0.56**	0.22	-0.05			
Chest depth Głębokość klatki piersiowej	-0.23	0.35*	0.43**	0.23		
Chest width Szerokość klatki piersiowej	0.45**	0.11	0.30	0.55**	0.25	
Carcass weight Masa tuszy	0.40*	0.53**	0.23	0.64**	0.18	0.05

*P ≤ 0.05,
**P ≤ 0.01

Previous research results indicate that the carcass weight of roe deer fawns is determined by numerous factors. A study carried out in the Niepołomice Forest showed that the body weight of juvenile roe deer decreased by approximately 10% during mild winters and by 20% during severe winters [Bobek *et al.* 1984]. Gaillard *et al.* [1996] studied two roe deer populations from two regions of France differing in mean annual temperature and population growth. The cited authors demonstrated that the average carcass weight of animals was higher in cold years and in areas characterized by low population density. Similar trends were observed by Pettorelli *et al.* [2002].

Table 6. Coefficients of correlation (r) between carcass measurements in male fawns
Tabela 6. Współczynniki korelacji (r) pomiędzy cechami tuszy koźląt męskich

Parameter Cecha	Carcass length Długość tuszy	Height at sacrum Wysokość w krzyżu	Height at withers Wysokość w kłębie	Chest circumference Obwód klatki piersiowej	Chest depth Głębokość klatki piersiowej	Chest width Szerokość klatki piersiowej
Carcass length Długość tuszy						
Height at sacrum Wysokość w krzyżu	0.51*					
Height at withers Wysokość w kłębie	0.14	0.48*				
Chest circumference Obwód klatki piersiowej	0.70**	0.22	-0.22			
Chest depth Głębokość klatki piersiowej	-0.23	0.38	0.45	-0.27		
Chest width Szerokość klatki piersiowej	0.57*	-0.01	-0.41	0.68**	-0.83**	
Carcass weight Masa tuszy	0.54*	0.32	-0.07	0.62**	-0.08	0.28

*P ≤ 0.05,
**P ≤ 0.01

Roe deer have a wide distribution range in Europe where they occupy different habitats, therefore the patterns of body development of this species seem particularly interesting. Pelliccioni *et al.* [2004] investigated the effect of gender and date of birth on the body weight of fawns in their first month of life. The birth weight of fawns did not vary significantly, and it oscillated around 1500 g. When fawns were divided into two catego-

ries based on their birth weight, it was found that the growth rate of light-born fawns was significantly faster than that of heavy-born fawns. In this way roe deer fawns compensate for their low body weight at birth.Tables 5–7 present the coefficients of correlation between carcass measurements in roe deer fawns.

Table 5 shows the coefficients of correlation between carcass parameters in both male and female fawns. The lowest correlation was noted between chest depth and chest width, while the highest correlation was observed chest circumference and carcass weight (r = 0.64). In adult animals, both males and females, the highest coefficients of correlation were also reported between those two parameters. In male fawns, chest circumference was highly correlated with chest width (r = 0.68) and carcass weight (r = 0.62) (tab. 6). In female fawns, the highest correlation was observed between chest depth and chest width (r = 0.91) (tab. 7).

Table 7. Coefficients of correlation (r) between carcass measurements in female fawns
Tabela 7. Współczynniki korelacji (r) pomiędzy cechami tuszy koźląt żeńskich

Parameter Cecha	Carcass length Długość tuszy	Height at sacrum Wysokość w krzyżu	Height at withers Wysokość w kłębie	Chest circumference Obwód klatki piersiowej	Chest depth Głębokość klatki piersiowej	Chest width Szerokość klatki piersiowej
Carcass length Długość tuszy						
Height at sacrum Wysokość w krzyżu	-0.16					
Height at withers Wysokość w kłębie	-0.07	0.65**				
Chest circumference Obwód klatki piersiowej	0.10	0.28	0.26			
Chest depth Głębokość klatki piersiowej	-0.25	0.31	0.37	-0.23		
Chest width Szerokość klatki piersiowej	0.32	-0.21	-0.25	0.43	0.91**	
Carcass weight Masa tuszy	0.08	0.76**	0.61**	0.37	0.48**	-0.26

*P ≤ 0.05,
**P ≤ 0.01

CONCLUSIONS

1. The average carcass weight of bucks, does and yearlings was 17.19 kg, 17.24 kg and 11.03 kg, respectively.

2. The height at sacrum and the height at withers of bucks, does and fawns reached 71.62 and 66.55 cm; 71.48 and 64.88 cm; 64.68 and 58.87 cm, respectively.

3. The carcass weights and measurements of fawns varied depending on gender. The carcasses of male fawns were smaller and heavier than the carcasses of female fawns, which could result from stronger and thicker muscles and bones in the former.

4. The highest correlation was observed between carcass weight and chest circumference in individuals of both sexes and all age groups, which suggests that chest circumference may be a good indicator of carcass weight in roe deer.

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Streszczenie. Celem pracy było scharakteryzowanie tusz sarny europejskiej (*Capreolus capreolus*) bytującej w rejonie północno-wschodniej Polski. Charakterystyka ta obejmowała średnie masy kozłów, kóz i koźląt, wymiarów zoometrycznych tusz wymienionych grup zwierząt oraz wzajemnych zależności między tymi cechami. Stwierdzono, że średnia masa tuszy samców pozyskanych na badanym terenie wynosiła 17,19 kg (bez głowy z porożem), samic 17,24 kg, a osobników w pierwszym roku życia 11,03 kg. Wykazano, że tusze koźląt męskich charakteryzują się mniejszymi wymiarami, lecz większą masą w porównaniu z koźlętami płci żeńskiej, co może wskazywać na lepsze umięśnienie bądź mocniejszy kościec tych osobników. U wszystkich analizowanych grup płciowo-wiekowych sarny stwierdzono wysoką zależność pomiędzy obwodem klatki piersiowej a pozostałymi cechami. Może to sugerować, że pomiar ten może być dobrym parametrem służącym do określenia wymiarów i jakości tuszy.

Słowa kluczowe: sarna europejska, masa tuszy, wymiary zoometryczne