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DIVERSIFICATION OF THE BODY WEIGHT AND QUALITY OF THE ANTLERS IN MALES OF THE ROE DEER (*CAPREOLUS CAPREOLUS* L.) IN SOUTHERN POLAND EXEMPLIFIED BY SURROUNDINGS OF CRACOW

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Abstract. The comparative evaluation of the roe deer (*Capreolus capreolus* L.) males being existent in four diverse regions of the Cracow surrounding (Fig. 1) in respect to physiographic and climatic forms have been established. The body weight, measurements and weight of the skull and measurements as well as form of the antlers were assumed to be the estimation criteria of individual quality of the roe deer males. The lowest individual quality had been affirmed to roe deer that being existent in Jurrasic Scienic Parks and the highest to males from Miechów Upland and Proszowice Plateau. It has been proved that skull dimension of roe deer from the Cracow surrounding had not concessed to the best Polish roe deer populations.

Key words: roe deer, individual quality, Cracow surrounding, body weight, skull dimension, antlers dimension

INTRODUCTION AND STUDY AIM

The roe deer (*Capreolus capreoulus* L.) is the most abundant representative of the family *Cervidae*, not only in Poland, but also in Europe. As an eurytopic species, thanks to a great biological plasticity, it is able to live in different habitats. The roe deer occurs in lowlands as well as in mountains and it is present in large and small forest complexes and also, more and more frequently, in woodless areas, among cultivated fields [Pielowski 1999].

Research conducted hitherto showed that individual quality of males (roebucks), estimated on the basis of the body weight and antlers, is in Poland quite diversified [Chrzanowski 1977, Fruziński et al. 1982, Dziedzic 1991, Żurkowski and Chartmanowicz 1998, Drozd et al. 2000]. According to the Bergmann's rule individuals of the least body weight occur in the western part of the country, while the heaviest ones can be found in central, eastern and southeastern Poland [Pielowski 1999].

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Surroundings of Cracow are characterized by a great diversification of physiographic forms [Czeppe and German 1980], soils [Raport... 2000] and climate [Hess 1969] and this is why biotopes of the roe deer occurrence are diversified. It is, therefore, possible to make a hypothesis that due to a considerable geographic and environmental diversification of this area there may occur differences in individual quality of the roe deer inhabiting individual biotopes. Initial studies carried out by Matysiak [1997] showed that roebucks taken in different biotopes of Cracow's surroundings were diversified in respect of size and weight of the body.

The purpose of this study was to determine whether in the Cracow region there is a significant diversification of individual quality of the roe deer males (roebucks). The body weight, measurements and weight of the skull, and form and measurements of the antlers were assumed to be the estimation criteria.

CHARACTERISTICS OF THE STUDY AREA

Studies were carried out in the northwestern part of the Małopolska administrative province (voivodship) delimited by the following geographic coordinates: N = 49°42'33" to N = 50°22'52", and E = 19°08'42" to E = 19°32'34" (Fig. 1).

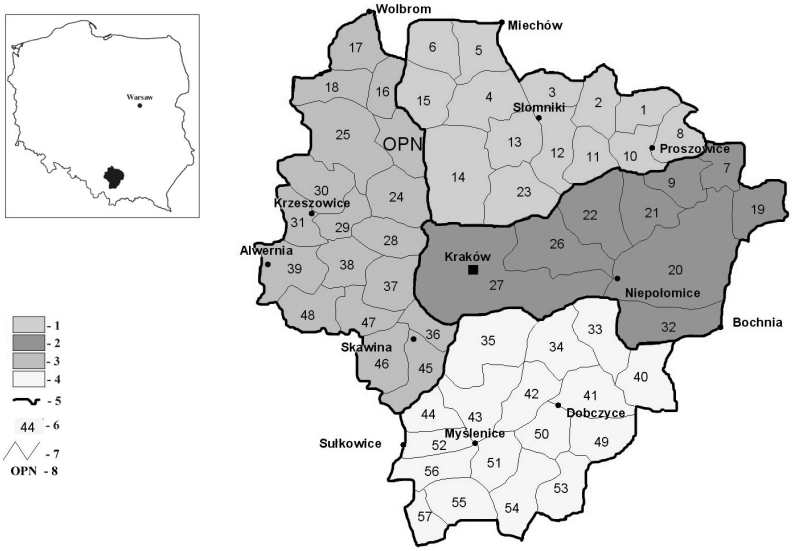

Fig. 1. Division of the study area into hunting units and regions of the roe deer occurrence: 1 – region of Miechów and Proszowice, 2 – region of Niepołomice and area near the Vistula river, 3 – region of Jurrasic Scienic Parks, 4 – region of piedmont areas and mountains, 5 – boundaries of regions, 6 – numbers of hunting units, 8 – Ojców National Park

Rys. 1. Podział terenu badań na obwody łowieckie i rejony bytowania saren: 1 – rejon miechowsko-proszowicki, 2 – rejon niepołomicko-nadwiślany, 3 – rejon Jurajskich Parków Krajobrazowych, 4 – rejon gór i pogórzy, 5 – granice rejonów, 6 – numery obwodów łowieckich, 7 – granice obwodów łowieckich, 8 – Ojcowski Park Narodowy

According to division of Poland into geographic regions [Kondracki 1977] this area is situated in the southwestern part of the Małopolska Upland (also called Polish Uplands [Gilewska 1999]) and northwestern part of the Western Carpathian Mountains.

According to division of the country into natural forest regions [Trampler et al. 1990] this area is located within the range of two regions: VI Małopolska Region (provinces: Cracow-Częstochowa Upland, Central Małopolska Upland and Sandomierz Lowland) and VIII Carpathian Region (provinces: Central Beskid Foot Hills, and Makowski and Wyspowy Beskid Mountains).

The study area was divided according to Matysiak [1997] into four regions (Fig. 1) separated on the basis of differences in measurements of the roe deer body. These regions are diversified in respect of geography and climate (Table 1).

Table 1. Characteristics of regions of the roe deer occurrence
Tabela 1. Charakterystyka rejonów środowisk bytowania saren

Region Rejon	Symbol of region Symbol rejonu	Mean annual temperature[a] Średnia temperatura roczna[a]	Mean total annual precipitation[a] Średnia roczna suma opadów[a]	Lenght of the growing season[a] Długość okresu wegetacyjnego[a]	Period of snow cover presence[a] Okres zalegania pokrywy śnieżnej[a]	Height above the sea level[b] Wysokość nad poziom morza[b]	Forest cover[c] Lesistość[c]
		°C	mm	days – dni	days – dni	m	%
Jurrasic Scienic Parks Jurajskie Parki Krajobrazowe	JP	7.6	744	200-220	95	215-470	16.5
Miechów--Proszowice Miechowsko--proszowicki	MP	7.3	600-700	210-220	90	250-380	4.7
Niepołomice--Vistula Niepołomicko--nadwiślany	NV	7-8	760	210-225	50-60	227-301	13.6
Piedmont areas and mountains Gór i pogórzy	PM	6-8	800-1000	180-210	65-105	230-904	26.4

[a]Hess 1969.
[b]Czeppe and German 1980.
[c]Legislation gazette of Cracow Voivodship no. 8, pos. 114 (Dz. Urz. Woj. Krak. nr 8, poz. 114).
[a]Hess 1969.
[b]Czeppe i German 1980.
[c]Rozporządzenie... 1997.

In total the study area covered over 320 thousand hectares, including 69.3% of cultivated fields and meadows, 16.1% of forests, 14.3% of people dwelling areas, and 0.3% of nature reserves [Rozporządzenie... 1997].

METHODS AND MATERIALS

Studies were carried out during 1999-2004 and included measurements of 678 males of the roe deer taken in 57 hunting units. The detailed information concerning the number of individuals representing respective regions is presented in Table 2.

Table 2. The place of collection and numbers of measured material
Tabela 2. Miejsce zbioru i liczebność materiału pomiarowego

Region Rejon	Symbol of region Symbol rejonu	Number of hunting units Liczba obwodów łowieckich	Number of measured animals Liczba pomierzonych zwierząt
Jurrasic Scienic Parks Jurajskie Parki Krajobrazowe	JP	17	201
Miechów-Proszowice Miechowsko-proszowicki	MP	14	168
Niepołomice-Vistula Niepołomicko-nadwiślany	NV	9	96
Piedmont areas and mountains Gór i pogórzy	PM	17	213
Total – Ogółem		57	678

The body weight (without the head) was determined using a decimal balance, equal to 100 grams. The skull of each investigated individual was prepared and its weight was determined together with the antlers (without the jaw), i.e. a gross weight of the antlers, using a laboratory balance, exact to a gram. Also the following measurements were taken: the maximum length of the skull (Fig. 2 – measurement 1), its zygomatic width (measurement 2), length of beams – height of spikes (measurements 3 and 4), length of front tines (measurements 5 and 7) and length of hind tines (measurements 6 and 8). Measurements 1 and 2 were taken with a slide caliper, exact to 0.1 millimeter, while measurements 3-8 with a steel tape 6 mm wide, exact to a millimeter.

Forms of the antlers were described using a point system presented in Table 3. In all age classes the tine was assumed to be a branch at least a centimeter in length.

Age of animals was determined, precision of a year, on the basis of wear of premolars (PM) and molars (M) of the mandible [Rieck 1970, Pielowski 1999]. The study material was divided into three age classes:

– class I – 2-year-old individuals (first antlers),
– class II – 3- and 4-year-old individuals (second and third antlers),
– class III – 5-year-old individuals and older (fourth and subsequent antlers).

Statistical calculations were made using the program Statistica 6.0 pl [StatSoft 2004] at the significance level of $\alpha = 0.05$. The following tests were used: Shapiro-Wilk, Levene, Fisher-Snedocor (one way analysis of variance) and NIR. Also position statistics were calculated [Stanisz 1998].

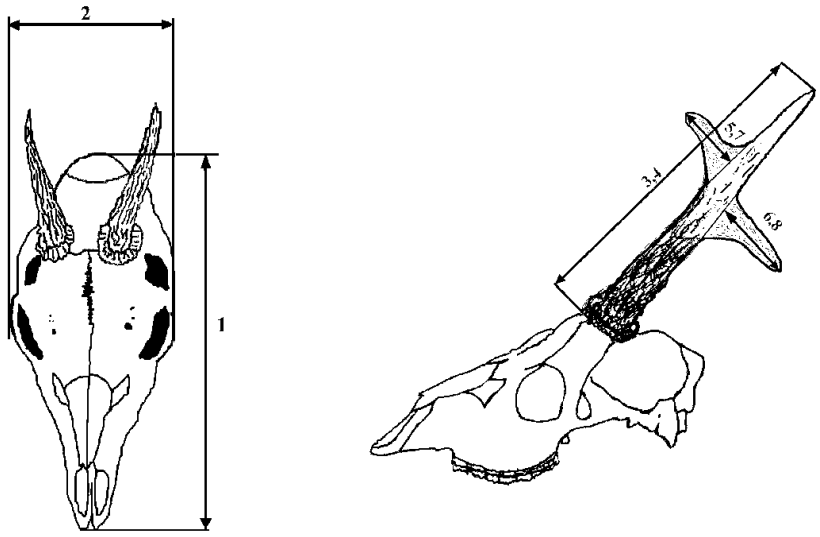

Fig. 2. The method of taking measurements of the skull and antlers of the roe deer
Rys. 2. Sposób przeprowadzenia pomiarów na czaszce i porożu sarny

Table 3. The point system used to describe forms of antlers of the roe deer males
Tabela 3. System punktowy zastosowany do opisu form poroża samców sarny

Form of antlers Forma poroża	Numbers of points Liczba punktów
Spike buck Guzikarz	0.0
One – antlered buck Jednotykowiec	0.5
Brocket, permanent spike buck, buck with malformed rack Szpicak, szydlarz, myłkus	1.0
Buck with forked asymmetrical antlers Widłak nieregularny	1.5
Buck with forked symmetrical antlers Widłak regularny	2.0
Six – point buck with asymmetrical antlers Szóstak nieregularny	2.5
Six – point buck with symmetrical antlers, eight – point bucks, five – point bucks Szóstak regularny, ósmaki i dziesiątaki	3.0

RESULTS

Shapiro-Wilk and Levene tests showed that the analysed chance variables (the body weight, dimensions and weight of the skull and form and dimensions of the antlers) were characterized by a normal distribution and homogeneity of variance. This permitted to use a parametric analysis of variance.

The body weight was characterized by a great variation, depending on the age of individuals and place of taking. The mean body weight of animals in age class I was 15.1 kg, in age class II 17.3 kg and in age class III 17.9 kg (Fig. 3).

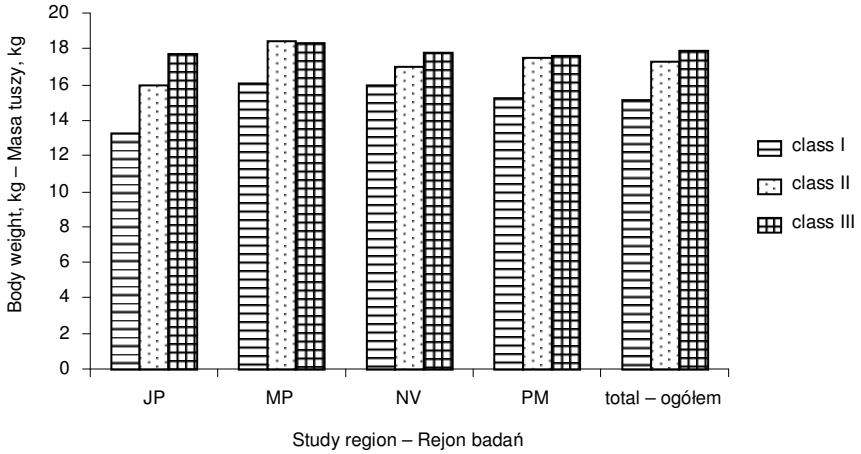

Fig. 3. Mean body weight of the roe deer males of individual age classes in respective study regions
Rys. 3. Średnie masy tusz samców sarny poszczególnych klas wieku w wyróżnionych rejonach

The mean body weights of roebucks of age classes I and II in the region of Jurrasic Scienic Parks (JP) were the lowest ones, amounting to 13.3 and 16.0 kg respectively. The analysis of variance (class I – $F = 7.600$, $p < 0.001$; class II – $F = 6.140$, $p < 0.001$) and the NIR test showed that the mean body weights (in age classes I and II) in the region JP were statistically significantly lower than those calculated for the remaining regions. The heaviest roebucks of age class I (16.0 kg) were taken in the Niepołomice--Vistula region (NV) and in the region of Miechów Upland and Proszowice Plateau (MP) and of age class II (18.4 kg) in the region of Miechów Upland and Proszowice Plateau (MP). In age class III the body weight of roebucks was similar in all regions, ranging from 17.6 to 18.3 kg and it was not significantly diversified.

A zygomatic width of the skull, measured at zygomatic arches, was increasing with increasing age of individuals in all regions (Fig. 4).

The smallest mean width of the skull was found in individuals of age class I. It varied from 8.6 to 8.7 cm, depending on the region. Roebucks having the largest zygomatic width belonged to age class III (9.4-9.5 cm). The one way analysis of variance did not permit to reject a zero hypothesis about equality of the mean width of the skull in successive age classes in respective regions (class I – $F = 0.915$, $p = 0.44$; class II – $F = 1.568$, $p = 0.20$; class II – $F = 0.714$, $p = 0.55$).

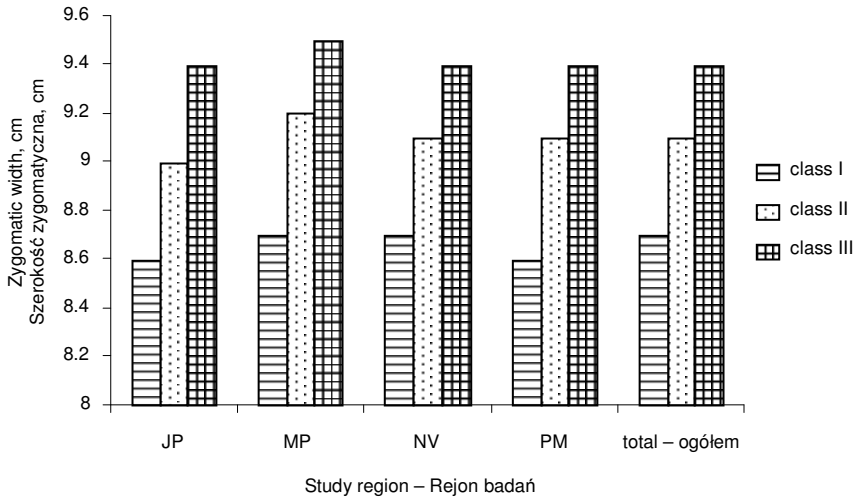

Fig. 4. Mean zygomatic width of the skull of the roe deer males of individual age classes in respective study regions
Rys. 4. Średnie szerokości zygomatyczne czaszek rogaczy poszczególnych klas wieku w wyróżnionych rejonach

Similarly as a zygomatic width of the skull, also its total length was increasing with increasing age in all investigated regions (Fig. 5). Within the entire study area the mean value of this feature was 8.7 cm for 2-year-old individuals, 9.1 cm for 3- and 4-year-old ones and 9.4 cm for roebucks of age class III.

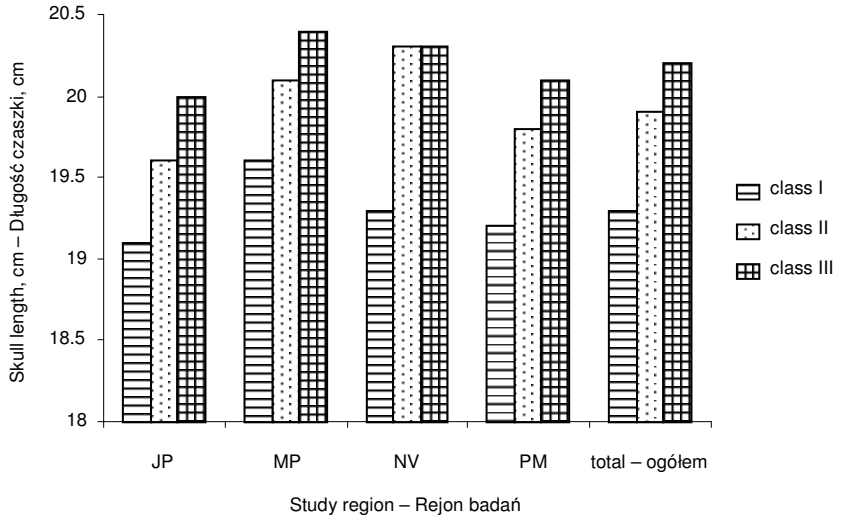

Fig. 5. Mean length of the skull of the roe deer males of individual age classes in respective study regions
Rys. 5. Średnie długości czaszek rogaczy w klasach wieku w wyróżnionych rejonach

Skulls of roebucks from the region of Jurrasic Scienic Parks (JP) were characterized by the smallest length in all age classes, but only in class I they were significantly shorter than skulls of roebucks from the Miechów Upland and Proszowice Plateau (MP; $F = 4.160$, $p = 0.009$). In the remaining age classes differences were insignificant.

Within the entire study area the mean gross weight of the antlers was increasing with increasing age. It was 183.8 g in 2-year-old roebucks, while in age class III it was almost twice as great, reaching 361.9 g (Fig. 6).

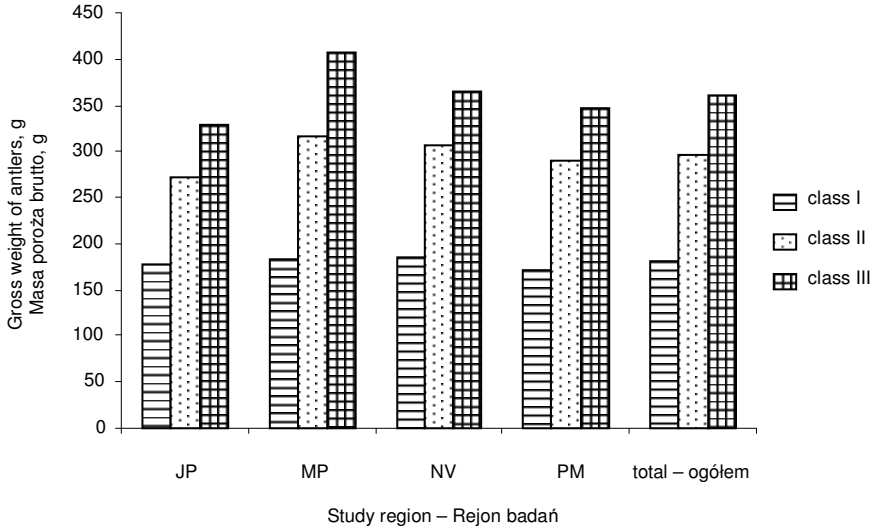

Fig. 6. Mean gross weight of antlers in individual age classes in respective study regions
Rys. 6. Średnie masy poroża brutto w klasach wieku w wyróżnionych rejonach

In age class I the mean skull weights in respective regions were similar to one another and ranged from 171.6 to 185.4 g. The Fisher-Snedocor test showed differences in age classes II ($F = 4.074$, $p = 0.009$) and III ($F = 3.017$, $p = 0.04$). The lowest mean skull weights were found in roebucks taken in the region of Jurrasic Scienic Parks (II – 272.7 g, III – 328.4 g). They were significantly different ($p_{II} = 0.009$ and $p_{III} = 0.006$) from skull weights of roebucks taken in the Miechów Upland and Proszowice Plateau (II – 316.4 g, III – 407.1 g).

In all the investigated regions the length of both beams was increasing with increasing age of roebucks (Table 4). In age class I the mean lengths of beams were close to one another, ranging from 10.8 to 12.2 cm and the analysis of variance did not show their statistically significant diversification due to the region of their origin.

In age class II the highest spikes were formed by roebucks taken in the Miechów Upland and Proszowice Plateau. They were significantly higher (left beam – $F = 3.058$, $p = 0.03$; right beam – $F = 3.317$, $p = 0.02$) than those formed by roebucks from the region of Jurrasic Scienic Parks (JP) and the region of piedmont areas and mountains (PM; Table 4).

In the oldest (5-year-old and older) roebucks the mean lengths of beams were close to one another in all regions, ranging from 19.3 to 20.6 cm. During growth of the antlers

Table 4. Mean length of beams and front and hind tines of roebucks
Tabela 4. Średnie długości tyk oraz odnóg: przednich i tylnych pozyskanych rogaczy

Study region Rejon badań	Age class Klasy wieku	Beam length, cm Długość tyki, cm		Length of front tine, cm Długość odnogi przedniej, cm		Length of hind tine, cm Długość odnogi tylnej, cm	
		left lewej	right prawej	of left beam tyki lewej	of right beam tyki prawej	of left beam tyki lewej	of right beam tyki prawej
JP Jurrasic Scienic Parks Jurajskie Parki Krajobrazowe	I	11.5	10.8	0.9	0.8	0.08	0.1
	II	16.5	16.5	2.2	2.1	1.5	1.5
	III	20.3	20.1	2.8	3.4	2.5	2.7
MP Miechów-Proszowice Miechowsko--proszowicki	I	11.0	11.2	1.2	1.4	0.2	0.2
	II	19.3	19.1	3.5	3.7	2.7	2.9
	III	20.9	20.6	4.2	4.4	2.9	3.1
NV Niepołomice-Vistula Niepołomicko--nadwiślany	I	12.2	11.9	2.2	2.2	0.2	0.1
	II	18.2	18.1	3.1	2.8	1.7	1.4
	III	19.3	19.7	2.9	3.2	2.5	2.6
PM Piedmont areas and mountains Gór i pogórzy	I	11.5	12.1	1.0	1.0	0.3	0.2
	II	16.7	16.3	2.7	3.1	1.9	2.1
	III	19.3	19.4	2.9	3.2	2.3	2.3

various branches are formed on the beam and therefore a form of the antlers is an important factor taken into account during evaluation of their quality. In all age classes the mean length of the front tine on both beams was greater than that of the hind tine. The smallest mean lengths of the hind tine ranged from 0.08 to 0.1 cm, while those of the front tine from 0.8 to 0.9 cm and they were found in roebucks of age class I taken in Jurrasic Scienic Parks. While the longest tines were found in roebucks of age class III (hind tine: 2.9-3.1 cm, front tine: 4.2-4.4 cm) taken in the Miechów Upland and Proszowice Plateau (MP). However, the differences in tine length in roebucks taken in different study regions were statistically insignificant.

The form and weight of the roebuck antlers also depended on external factors, mainly on availability and quality of winter forage. The evaluation of quality of the roebuck antlers was carried out on the basis of the proposed point system (Table 3). According to this evaluation the highest indexes were obtained for roebucks of age class III from the Miechów Upland and Proszowice Plateau (2.78) and also from the region of piedmont areas and mountains (2.77). In age classes I and II the antlers of the worst quality were produced by roebucks living in Jurrasic Scienic Parks.

In age class III quality of the antlers of roebucks from this region was similar to that found for animals taken in other regions. In all regions the mean number of points was increasing with increasing age of individuals (Fig. 7).

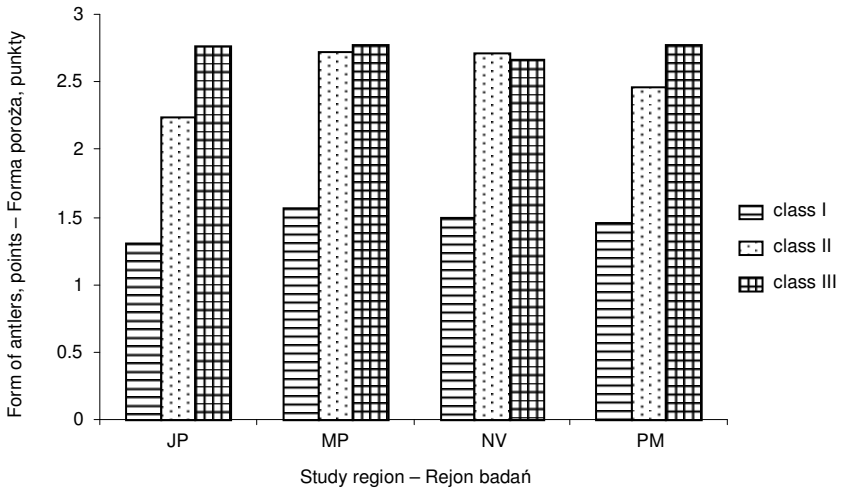

Fig. 7. Form of antlers in respective regions
Rys. 7. Formy poroża w poszczególnych rejonach

RECAPITULATION AND DISCUSSION

The roe deer is a resident animal, rarely leaving its home range [Pielowski 1999] and therefore its phenotypic characters are to a great extent associated with its home habitat [Chartmanowicz et al. 1992, Pielowski 1999]. It has been assumed that environment is a dominant factor affecting its body weight [Dziedzic 1991]. It was found during the present study that roebucks of the greatest body weight were occurring in the Miechów Upland and Proszowice Plateau and also in the Niepołomice-Vistula Divide, while weight of the body of roebucks from Jurrasic Scienic Parks was the smallest one (Fig. 3). A higher body weight of the roe deer taken north of Cracow may result from the fact that in this region, little covered by forests, mostly the so called field roe deer are taken. These animals are of a better individual quality than those of the forest ecotype [Fruziński et al. 1982, Pielowski 1993, Wajdzik and Jamrozy 2001].

In Table 5 the mean body weight of roebucks of respective age classes living in surroundings of Cracow are compared with that of roebucks from Western Volhynia, Roztocze, Opole region, Piska Forest, Lublin region, and surroundings of Poznań. The results of this study showed that the roe deer "of Cracow" was considerably heavier than individuals taken in the Piska Forest surroundings of Poznań and Opole region (forest ecotype) and at the same time lighter than individuals taken in eastern Poland (Western Volhynia, Roztocze and Lublin region).

A relatively high body weight of the roe deer taken in the area of the present study may indicate that biotopes there are vary favorable for this species assuring a food base permitting its optimal development.

A zygomatic width of the skull of roebucks taken in surroundings of Cracow was increasing from 8.7 cm in animals of age class I to 9.4 cm in those of age class III (Fig. 4), and it was greater than in the roe deer males occurring in surroundings of Poznań (8.1--9.0 cm) [Dziedzic 1991].

Table 5. Mean body weight of roebucks in selected regions of Poland, kg
Tabela 5. Średnia masa tusz kozłów z wybranych rejonów Polski, kg

Region Region	Geographic coordinates Współrzędne geograficzne	Body weight, kg Masa ciała, kg		
		age class I I klasa wieku	age class II II klasa wieku	age class III III klasa wieku
Cracow (regions JP, MP, NV, and PM together) Kraków razem rejony JP, MP, NV, PM	N = 50°03'10" E = 19°59'12"	15.1	17.3	17.9
Western Volhynia[a] Zachodni Wołyń[a]	N = 50°43'15" E = 23°15'31"	16.0	17.0	19.6
Roztocze[a]	N = 50°36'48" E = 22°58'33"	14.8	17.1	18.5
Opole region – field roe deer[b] Opolszczyzna – sarna polna[b]	N = 50°27'46" E = 17°00'29"	14.7	17.0	18.1
Opole region – forest roe deer[b] Opolszczyzna – sarna leśna[b]	N = 51°04'23" E = 17°42'26"	11.9	13.3	14.4
Piska forest[c] Puszcza Piska[c]	N = 53°37'41" E = 21°48'31"	13.3	15.7	17.1
Lublin region[d] Lubelszczyzna[d]	N = 51°14'17" E = 22°34'14"	15.1	17.8	18.8
Surroundings of Poznań[e] Okolice Poznania[e]	N = 52°33'16" E = 17°06'46"	11.6	13.9	15.7

[a]Chartmanowicz et al. 1992, [b]Wajdzik and Jamrozy 2001, [c]Żurkowski and Chartmanowicz 1998, [d]Dziedzic 1991, [e]Szczerbiński et al. 1972.
[a]Chartmanowicz i in. 1992, [b]Wajdzik i Jamrozy 2001, [c]Żurkowski i Chartmanowicz 1998, [d]Dziedzic [1991], [e]Szczerbiński i in. 1972.

The length of the skull increased as the age of individuals increased from 19.3 cm in age class I to 20.2 cm in age class III. These values were similar to the length of the skull of the roe deer from the Lublin region [Chrzanowski 1977].

In males of the roe deer the weight form and height of the antlers change as they get older. The weight of the antlers was characterized by a considerable variation depending on the animal's age and the region (Fig. 6). In age classes II and III the smallest weight of the antlers was found in the western part of the study area (JP) while the highest in the Miechów Upland and Proszowice Plateau. The mean gross weights of the antlers in respective age classes found during this study were among the highest in Poland (Table 6).

The mean length of beams, calculated in this study varied from 10.8 cm in age class I to 21.5 cm in age class III and it was similar to the length reported in Polish [Dziedzic 1991] as well as foreign [Hell et al. 1978] literature.

According to Stachowiak [1985] the antlers with tines of 2.5-3.5 cm in length are considered to be normally developed and above 5 cm to be very well developed. A study reported in this paper showed that front and hind tines were characterized by a different degree of development. In all age classes the front tines were longer and their measurements were within the range (at its lower limit) of tine lengths given in literature [Stachowiak 1985].

Table 6. Mean gross weight of antlers of the roe deer males in selected regions of Poland, g
Tabela 6. Średnia masa poroża brutto samców saren w wybranych rejonach Polski, g

Region Region	Weight of antlers in grams Masa poroża w gramach		
	age class I I klasa wieku	age class II II klasa wieku	age class III III klasa wieku
Cracow (regions JP, MP, NV, and PM together) Kraków razem rejony JP, MP, NV, PM	181.8	296.8	361.9
Lublin region[a] Lubelszczyzna[a]	146.3	278.6	334.9
Opole region – field roe deer[b] Opolszczyzna – sarna polna[b]	162.2	267.8	332.4
Opole region – forest roe deer[b] Opolszczyzna – sarna leśna[b]	134.2	215.5	254.7
Piska forest[c] Puszcza Piska[c]	145.4	249.5	286.0
Surroundings of Poznań[d] Okolice Poznania[d]	109.0	237.0	262.2

[a]Dziedzic 1991, [b]Wajdzik and Jamrozy 2001, [c]Żurkowski and Chartmanowicz 1998, [d]Fruziński et al. 1972.
[a]Dziedzic 1991, [b]Wajdzik i Jamrozy 2001, [c]Żurkowski i Chartmanowicz 1998, [d]Fruziński i in. 1972.

CONCLUSIONS

1. Roebucks of the smallest body weight were found in the region of Jurrasic Scienic Parks, and the heaviest ones in the Miechów Upland and Proszowice Plateau.

2. The gross weight of the antlers in 3-year-old and older roebucks, was the lowest in the region of Jurrasic Scienic Parks. The heaviest antlers were produced by roebucks of the Miechów Upland and Proszowice Plateau. The mean weight of the antlers found during this study was greater than that reported for other regions of Poland.

3. Measurements of skulls of roebucks taken in the study area were similar to those in roebucks of the Lublin region which showed that population of the roe deer in the Cracow region is of a good quality.

4. The mean lengths of the front and hind tines in all areas investigated during this study were equal to lower values reported in literature and the front tines were better developed than the hind tines.

5. Quality of the antlers estimated according to the assumed point classification, in roebucks of age classes I and II was the lowest in the region of Jurrasic Scienic Parks. Roebucks of age class III had the antlers of similar quality in all the investigated regions.

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ZRÓŻNICOWANIE MASY CIAŁA I JAKOŚCI POROŻA U SAMCÓW SARNY EUROPEJSKIEJ (*CAPREOLUS CAPREOLUS* L.) W POŁUDNIOWEJ POLSCE NA PRZYKŁADZIE OKOLIC KRAKOWA

Streszczenie. W pracy przeprowadzono ocenę porównawczą samców sarny europejskiej (*Capreolus capreolus* L.) bytujących w czterech zróżnicowanych pod względem fizyczno-geograficznym i klimatycznym rejonach okolic Krakowa (rys. 1). Jako kryterium oceny jakości osobniczej rogaczy przyjęto: masę tuszy, wymiary i masę czaszek oraz wymiary i formę poroża. Najniższą jakość osobniczą stwierdzono u saren bytujących w rejonie Jurajskich Parków Krajobrazowych, a najwyższą u kozłów z Wyżyny Miechowskiej i Płaskowyżu Proszowickiego. Dowiedziono, iż pod względem wymiarów czaszek sarny bytujące w regionie krakowskim nie ustępują najlepszym polskim populacjom tego gatunku.

Słowa kluczowe: sarna europejska, jakość osobnicza, okolice Krakowa, masa ciała, wymiary czaszek i poroża

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