A C T A   T H E R I O L O G I C A

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Relations between the Age and Size of Red Deer in Poland

[With 8 Tables & 8 Figs.]

Statistically significant relationships were found between the age of red deer and the undressed body weight, weight of internal organs (heart, lungs, liver, and kidneys), weight of kidney and intestinal fat, dressed body weight, volume of stomach content, and the weight of stomach and intestines (content included). The relation between age and the six variables was best expressed by the 2nd degree regression equation $Y = a_1t^2+b_1t+c_1$. Correlation coefficients between all the measured variables were statistically significant. The highest correlation was between undressed and dressed body weights in females ($R = 0.9795$) and for undressed body weight and the weight of internal organs in males ($R = 0.8766$).

I. INTRODUCTION

Information about the herbivore population biomass is of prime importance in studies of energy flow between trophic levels within an ecosystem. Analyses of the herbivore biomass should consider both sex and age structure classes of the population because of considerable differences in size and physical condition of animals among these classes.

This paper describes the age-size relations of red deer (*Cervus elaphus* Linnaeus, 1758) inhabiting managed forests in lowland Poland.

II. EXPERIMENTAL AREA AND PROCEDURES

The study was conducted at the Forest Research Institute's three experimental forest districts, namely: Józefów (Lublin province, 22°56′ — 23°10′ E, 50°25′ — 50°32′ N), Pszczyna (Katowice province, 18°33′ — 19°08′ E, 49°05′ — 50°02′ N), and Smolniki (Olsztyn province, 19°29′ — 19°31′ E, 53°32′ — 53°36′ N). Site relations, timber stands, and herbaceous vegetation in these forests are described elsewhere (Dzięciołowski, 1967).

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Red deer were killed during four hunting seasons from 1964 to 1968. The hunting seasons opened each year on September 1 and closed on February 10 or 20. Killed animals (Table 1) were immediately transported to the field laboratory and weighed (before dressing) to the nearest 0.1 kg. After the animals were dressed, weights were taken of the stomach with intestines, the internal organs (lungs, heart, liver, and kidneys), the dressed carcass (both sexes with heads), and the fat separated from the kidneys and intestines. Contents of rumen, abomasum, reticulum, and omasum were measured volumetrically in litres. Animal age was determined by teeth replacement, erruption, and wear (Bieger, 1965). Samples were taken by a hunter in Pszczyna and by a wildlife ranger in the other forest districts.

The number of killed deer (159) was sufficient for an overall statistical analysis but unequal distribution among the three forest tracts precluded an analysis of size and condition of red deer in relation to environment. Among authors working on similar problems the number of animals was highly variable. Markgren (1966) described the development of captive European moose (*Alces alces* L.) calves on the basis of two individuals. Gill & Jaczewski (1957) published the weight and capacity of alimentary tract for 3 red deer. Short (1964) studied selected anatomical indices, weight of stomach tissue, and volume of stomach parts in 15 white-tailed deer (*Odocoileus virginianus* Zimmermann). Baychev (1967) calculated the proportion of venison in carcasses of 24 red deer from Bulgaria. Taber, White & Smith (1959) studied the condition of mule deer (*Odocoileus h. hemonius* Raf.) based on 50 individuals. Markgren (1964) investigated the puberty, dressed body weight, and tooth development of 122 yearling moose. Greer (1965) correlated age with dressed body weight for 427 elk (*Cervus canadensis* L.). Mystkowska (1966) gave the weights for 473 dressed bodies of red deer from Poland and calculated the gain in body weight for different age classes. Greer & Howe (1965) in their studies on age-body weight relationship handled the material of 1100 elks.

Table 1.

Distribution of study material according to place of origin and time of collection.

Experimental forest tract	Number of red deer individuals harvested in the season of:				Total
	1964/65	1965/66	1966/67	1967/68	
Józefów	4	3	6	12	25
Pszczyna	10	1	3	5	19
Smolniki	34	31	25	25	115
	48	35	34	42	159

The statistical analysis included the following independent variables: X_1 — body weight before dressing; X_2 — weight of internal organs (lungs, heart, liver, and kidneys); X_3 — weight of kidney and intestinal fat; and X_4 — body weight after dressing. Dependent variables were: Y_1 — volume content of all stomach parts; and Y_2 — weight of stomach and intestines with their contents. The means, standard deviations, and correlation coefficients of the above variables were calculated for males and females separately. Results are compiled in tables 5 and 6.

The following regression equations were used to examine relations between the six measured variables and age (t) for both sexes.

$$\text{Ist degree: } Y = at + b$$
$$\text{IInd degree: } Y = a_1t^2 + b_1t + c_1$$
$$\text{IIIrd degree: } Y = a_2t^3 + b_2t^2 + c_2t + d_2$$

The 2nd degree formula gave the greatest increase in the value of the squared correlation index R^2. Thus it was adopted as the best to equalize the empirical data

Table 2.

Individual growth in the red deer population studied based on mean values of the 6 biometric characters measured.

Sex	Age in yrs	Volume of stomach content in 1.		Undressed body weight in kg		Weight of stomach and intestines in kg		Weight of internal organs in kg		Weight of fat in kg		Dressed body weight in kg	
		n	mean	n	mean	n	mean	n	mean	n	mean	n	mean
FEMALES	0	18	5.67	18	61.9	18	9.25	18	3.75	18	0.22	18	43.9
	1	5	6.60	5	79.2	5	8.59	5	4.71	5	0.20	5	58.8
	2	13	8.60	13	97.2	13	17.08	13	5.02	13	0.59	13	67.8
	3	8	10.10	8	104.3	8	17.89	8	5.86	8	0.52	8	72.5
	4	15	11.37	15	116.1	15	22.32	15	5.81	15	0.59	15	79.5
	5	8	11.62	8	122.5	8	26.78	8	6.30	8	0.77	8	82.8
	6	8	13.00	8	126.4	8	22.11	8	6.28	8	0.74	8	83.9
	7	8	12.00	8	129.5	8	24.20	8	6.14	8	0.80	8	89.6
	8	5	12.00	5	131.8	5	16.18	5	6.89	5	0.89	5	90.4
	9	1	14.00	1	134.0	1	28.00	1	6.00	1	1.10	1	91.0
	10	2	12.00	2	132.5	2	28.75	2	7.82	2	0.48	2	90.0
	11	3	11.33	3	122.2	3	17.15	3	6.37	3	1.55	3	86.3
	12	1	13.00	1	133.0	1	22.00	1	6.66	1	1.16	1	95.0
	13	1	12.50	1	92.0	1	17.00	1	4.20	1	0.33	1	64.0
Total		96	9.88	96	104.4	96	18.2	96	5.48	96	0.59	96	71.9
MALES	0	13	6.6	13	64.0	13	11.42	13	3.77	13	0.15	13	44.8
	1	1	15.0	1	126.0	1	30.00	1	7.50	1	0.20	1	85.0
	2	0	—	7	82.0	1	11.70	1	3.52	1	0.48	1	61.0
	3	6	14.4	6	135.7	6	25.50	6	7.01	6	0.70	6	97.1
	4	5	14.3	5	163.0	5	26.10	5	8.60	5	0.42	5	122.0
	5	5	11.2	5	188.0	5	23.90	5	8.07	5	1.29	5	143.4
	6	5	11.3	6	187.8	6	22.31	6	8.30	6	1.71	6	146.8
	7	3	3.1	3	186.0	3	13.60	3	9.75	3	4.82	3	141.0
	8	8	3.1	8	224.5	8	15.35	8	10.62	8	4.36	8	180.8
	9	3	3.7	3	208.2	3	15.63	3	12.96	3	3.57	3	166.5
	10	3	8.2	3	201.5	3	20.73	3	10.15	3	1.96	2	178.5
	11	2	9.8	2	183.5	2	21.70	2	9.28	2	2.45	2	143.0
	12	2	1.8	2	188.0	2	11.75	2	9.58	2	1.72	2	155.5
	13	1	3.0	1	221.0	1	12.00	1	11.50	1	0.92	1	182.0
	14	1	2.0	1	181.8	1	10.00	1	10.00	1	0.50	0	—
Total		59	8.0	60	157.7	60	18.15	60	7.97	60	1.69	59	121.3

for all variables. The IIIrd degree formula only slightly increased the R^2 valuee Calculations were done on an electronic computer »Odra 1204« in the Computation Centre, Polish Academy of Sciences, Warsaw.

III. RESULTS

1. Females

The mean content of all stomach parts was correlated with all other variables (Table 5). It was lowest (5.7 l) in the group of several-month--old calves and highest (14.0 l) in the group of 9-year-old hinds. Older animals dropped irregularly (Table 2).

Undressed body weigths averaged 61.9 kg for the group of calves and 134 kg for the group of 9-year-old females. Weights of older females declined irregularly (Table 2). Undressed body weights were highly correlated with remaining variables, particularly with the dressed body weight ($R = 0.9795$) (Table 5). Undressed body weights increased rapidly with animal age up to 8 years, but fell off sharply thereafter (Fig. 1).

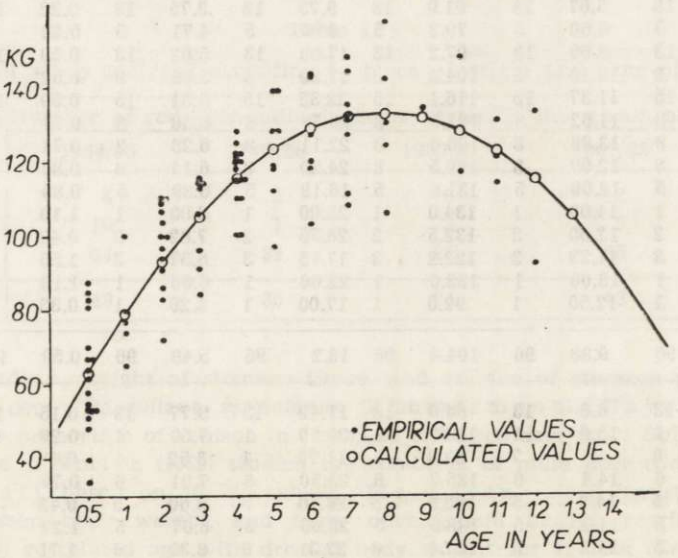

Fig. 1. Relationship between undressed body weight and age in the group of females according to the equation
$$x_1 = 1.096\ t^2 + 17.47\ t + 63.04$$

The weight of stomach with intestines was significantly correlated with remaining variables (Table 5). The weights were irregular among subsequent age classes (Table 2), probably because of individual variation in the fill-up of the alimentary tract.

The weight of internal organs increased irregularly from 3.75 kg in calves up to a maximum of 7.82 kg for two 10-year-old females. A weight of 4.20 kg was recorded for one 13-year-old female (Table 2). The weights of internal organs were highly correlated with the remaining variables (Table 5). The highest coefficients were with undressed ($R = 0.8029$) and dressed body weights ($R = 0.8034$). There was a gradual increase in the

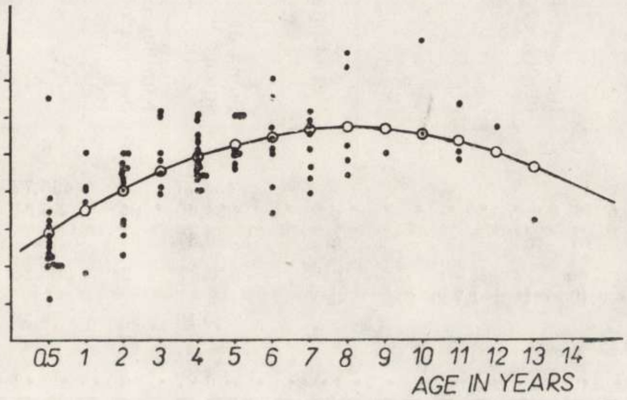

Fig. 2. Relationship between the weight of internal organs and age in the group of females according to the equation
$x_2 = -0.04238\ t^2 + 0.689\ t + 3.828$

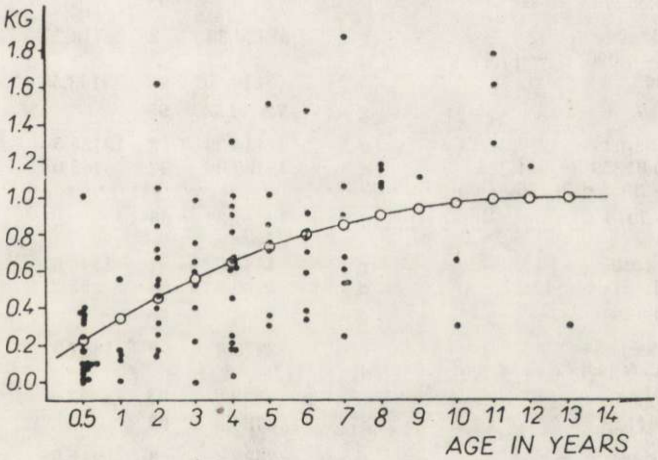

Fig. 3. Relationship between the weight of kidney and visceral fat and age in the group of females according to the equation
$x_3 = -0.004911\ t^2 + 0.1229\ t + 0.2254$

weight of internal organs along with animal age up to 8 to 9 years and a slow decline for older females (Fig. 2).

The weights for kidney and intestinal fat increased irregularly from 0.22 kg in calves to 1.55 kg in the three 11-year-old females. They de-

Table 3.

Testing of the relationship between red deer biometric characters and age (t) in the group of females.

r — regression, d — deviations, g — general.

Character	Regression of degree	Variation	Sums of square	Number of degrees of freedom	S^2	$F_{emp.}$	$F_{0.05}$
1	2	3	4	5	6	7	8
Y_1	Ist degree	r	455.77	1	455.77	45.85	3.95
	$Y_1 = 0.6841\ t + 7,130$	d	934.60	94	9.94		
	$R^2 = 0.3278$	g	1,390.37	95			
	IInd degree	r	610.27	2	305.13	36.41	3.10
	$Y_1 = -0.1039\ t^2 + 1,730\ t + 5,657$	d	780.10	93	8.38		
	$R^2 = 0.4389$	g	1,390.37	95			
	IIIrd degree	r	616.27	3	205.42	24.43	2.71
	$Y_1 = 0.006104\ t^3 - 0,2065\ t^2 + 2.141\ t + 0.435$	d	774.10	92	8.41		
	$R^2 = 0.4432$	g	1,390.37	95			
X_1	Ist degree	r	40226.38	1	40226.4	116.63	3.95
	$X_1 = 6.427\ t + 78.59$	d	32420.00	94	34.49		
	$R^2 = 0.5537$	g	72646.38	95			
	IInd degree	r	57436.38	2	28718.2	175.59	3.10
	$X_1 = -1.096\ t^2 + 17.47\ t + 63.04$	d	15210.00	93	163.55		
	$R^2 = 0.7906$	g	72646.38	95			
	IIIrd degree	r	57466.38	3	19155.5	116.10	2.71
	$X_1 = 0.01359\ t^3 - 1,325\ t^2 + 18.38\ t + 62.55$	d	15180.00	92	165.0		
	$R^2 = 0.7910$	g	72646.38	95			
Y^2	Ist degree	r	1548.8	1	1548.8	28.07	3.95
	$Y_2 = 1.261\ t + 13.17$	d	5186.0	94	55.2		
	$R^2 = 0.2300$	g	6734.8	95			
	IInd degree	r	2775.8	2	1387.9	32.60	3.10
	$Y_2 = -0.2928\ t^2 + 4,209\ t + 0.019$	d	3959.0	93	42.6		
	$R^2 = 0.4122$	g	6734.8	95			
	IIIrd degree	r	2825.8	3	941.93	22.17	2.71
	$Y_2 = 0.01753\ t^3 - 0.5874\ t^2 + 5,390\ t + 8.379$	d	3909.0	92	42.49		
	$R^2 = 0.4196$	g	6734.8	95			
X_2	Ist degree	r	67.0	1	67.00	55.37	3.95
	$X_2 = 0.2622\ t + 4.429$	d	113.3	94	1.21		
	$R^2 = 0.3716$	g	180.3	95			
	IInd degree	r	92.7	2	46.33	49.18	3.10
	$X^2 = -0.04238\ t^2 + 0.689\ t + 3.828$	d	87.63	93	0.94		
	$R^2 = 0.5139$	g	180.29	95			

1	2	3	4	5	6	7	8
	IIIrd degree	r	92.68	3	30.89	32.45	2.71
	$X_2 = -0.0003516\ t^3 -$	d	87.61	92	0.952		
	$-0.03647\ t^2 + 0.6653\ t + 3.841$						
	$R^2 = 0.5141$	g	180.29	95			
X_3	Ist degree	r	5.25	1	5.25	37.50	3.95
	$X_3 = 0.0734\ t + 0.295$	d	13.18	94	0.14		
	$R^2 = 0.2849$	g	18.43	95			
	IInd degree	r	6.59	2	2.80	20.25	3.10
	$X_3 = -0.004911\ t^2 + 0.1229\ t$	d	12.84	93	0.14		
	$+ 0.2254$						
	$R^2 = 0.3576$	g	18.43	95			
	IIIrd degree	r	5.60	3	1.87	13.45	2.71
	$X_3 = -0.0001431\ t^3 - 0.002505$	d	12.83	92	0.14		
	$t^2 + 0.1132\ t + 0.2306$						
	$R^2 = 0.3038$	g	18.43	95			
X_4	Ist degree	r	18038.1	1	18038.1	117.9	3.95
	$X_4 = 4.303\ t + 54.63$	d	14380.0	94	152.98		
	$R^2 = 0.5564$	g	32418.1	95			
	IInd degree	r	24758.1	2	12379.0	150.23	3.10
	$X_4 = -0.6853\ t^2 + 11.20\ t +$						
	$+ 44.92$	d	7660.0	93	82.4		
	$R^2 = 0.7637$	g	32418.1	95			
	IIIrd degree	r	24784.1	3	8261.4	99.56	2.71
	$X_4 = 0.01269\ t^3 - 0.8986\ t^2$						
	$+ 12.06\ t + 44.45$	d	7634.0	92	82.98		
	$R^2 = 0.7645$	g	32418.1	95			

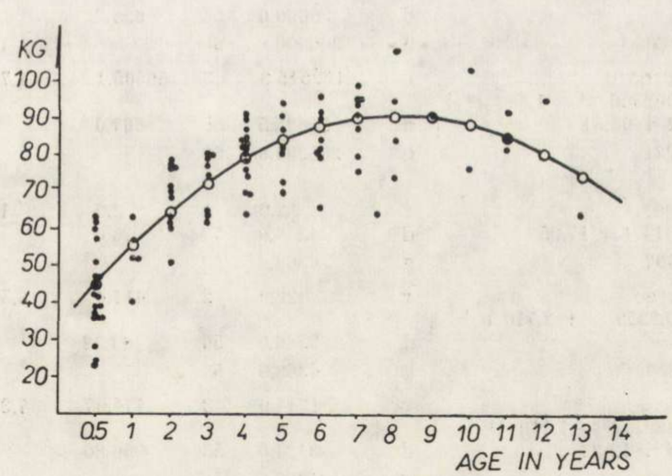

Fig. 4. Relationship between dressed body weight and age in the group of females according to the equation

$$x_4 = 0.6853\ t^2 + 11.20\ t + 44.92$$

Table 4.

Testing of the relationship between red deer biometric characters and age (t) in the group of males.

r — regression, d — deviations, g — general.

Character	Regression of degree	Variation	Sums of squares	Number of dogrees of freedom	S^2	$F_{emp.}$	$F_{0.05}$
1	2	3	4	5	6	7	8
Y_1	Ist degree	r	71.5	1	71.5	1.60	4.02
	$Y_1 = -0.4043\ t + 9.914$	d	2466.0	55	44.8		
	$R^2 = 0.0229$	g	2537.5	56			
	IInd degree	r	246.5	2	123.2	2.90	3.17
	$Y_1 = -0.09856\ t^2 + 0.7065\ t + 8.279$	d	2291.0	54	42.4		
	$R^2 = 0.0971$	g	2537.5	56			
	IIIrd degree	r	560.5	3	186.8	5.01	2.78
	$Y_1 = 0.03627\ t^3 - 0.07765\ t^2 + 3.748\ t + 6.953$	d	1977.0	53	37.3		
	$R^2 = 0.2209$	g	2537.5	56			
X_1	Ist degree	r	128140.8	1	128140.8	93.57	4.01
	$X_1 = 12.58\ t + 91.26$	d	78060.0	57	1369.5		
	$R^2 = 0.6214$	g	206200.8	58			
	IInd degree	r	169510.8	2	84755.4	129.4	3.16
	$X_1 = -1.672\ t^2 + 31.43\ t + 63.50$	d	36690.0	56	655.2		
	$R^2 = 0.8220$	g	206200.8	58			
	IIIrd degree	r	169515.3	3	56505.1	84.7	2.77
	$X_1 = 0.0002586\ t^3 - 1.668\ t^2 + 31.41\ t + 63.51$	d	36685.5	55	667.0		
	$R^2 = 0.8221$	g	206200.8	58			
Y_2	Ist degree	r	2.9	1	2.9	<1	4.01
	$Y_2 = 0.5619\ t + 17.85$	d	4366.0	57	76.6		
	$R^2 = 0.0007$	g	4368.9	58			
	IInd degree	r	822.9	2	411.4	6.5	3.16
	$Y_2 = -0.2355\ t^2 + 2.710\ t + 13.94$	d	3546.0	56	63.32		
	$R^2 = 0.1884$	g	4368.9	58			
	IIIrd degree	r	1244.9	3	414.97	7.3	2.77
	$Y_2 = 0.04681\ t^3 - 1.110\ t^2 + 6.635\ t + 12.23$	d	3124.0	55	56.80		
	$R^2 = 0.2849$	g	4368.9	58			
X^2	Ist degree	r	299.3	1	299,3	79.4	4.07
	$X^2 = 0.6102\ t + 4.741$	d	214.8	57	3.8		
	$R^2 = 0.5822$	g	514.1	58			

1	2	3	4	5	6	7	8
	IInd degree $X_2 = 0.05881\ t^2 + 1.273\ t +$	r	350.4	2	175.2	60.0	3.16
	$+ 3.766$	d	163.7	56	2.9		
	$R^2 = 0.6816$	g	514.1	58			
	IIIrd degree $X_2 = -0.002337\ t^3 - 0.01512\ t^2$	r	351.5	3	117.2	39.6	2.77
	$+ 1.077\ t + 3.851$	d	162.6	55	2.96		
	$R^2 = 0.6837$	g	514.1	58			
X_3	Ist degree	r	41.2	1	41.2	11.4	4.01
	$X_3 = 0.2555\ t + 0.3384$	d	206.7	57	3.6		
	$R^2 = 0.1662$	g	247.9	58			
	IInd degree $X_3 = -0.04094\ t^2 + 7196\ t$	r	66.0	2	33.0	10.15	3.17
	$- 0.3409$	d	181.9	56	3.2		
	$R^2 = 0.2662$	g	247.9	58			
	IIIrd degree $X_3 = -0.01258\ t^3 + 0.1943\ t^2$	r	96.4	3	32.1	11.68	2.77
	$- 0.3383\ t + 0.1190$	d	151.5	55	2.8		
	$R^2 = 0.3889$	g	247.9	58			
X_4	Ist degree	r	99924.0	1	99924.0	102.73	4.02
	$X_4 = 8.848\ t + 70.29$	d	53500.0	55	972.7		
	$R^2 = 0.6513$	g	153424.0	56			
	IInd degree	r	118774.0	2	59387.0	92.55	3.17
	$X_4 = -1.844\ t^2 + 29.64\ t + 39.68$	d	34650.0	54	641.7		
	$R^2 = 0.7742$	g	153424.0	56			
	IIIrd degree $X_4 = -0.1532\ t^3 + 1.019\ t^2 +$	r	121384.0	3	40461.3	66.93	2.78
	$+ 16.79\ t + 45.28$	d	32040.0	53	604.5		
	$R^2 = 0.7912$	g	153424.0	56			

clined to 0.30 kg for the 13-year-old female (Table 2). The weight of fat was highly correlated with the remaining variables. The best correlation ($R = 0.6499$) was with the dressed body weight (Table 5). Fat weight increased slowly with age to a maximum at 13 years (Fig. 3).

The mean dressed body weight of 43.9 kg for the calf group increased up to 91.0 kg for the 9-year-old female. The dressed weight was 64.0 kg for a 13-year-old female, but 95 kg for a 12-year-old female (Table 2). Dressed body weight was highly correlated with all other variables (Table 5). The highest correlation ($R = 0.9795$) was with undressed body weight. Body weight increased with animal age up to a maximum of 8 years and then declined rapidly (Fig. 4).

2. Males

The mean volume of stomach content was highly correlated with all variables (Table 6). The volumes were lower in the group older than

Table 5.

Table of correlation coefficients for the group of 96 females.

	Y_1	X_1	Y_2	X_2	X_3	X_4
X	9.8802	104.4260	18.2391	5.4828	.5901	71.9323
S	3.8057	27.5088	8.3758	1.3704	.4381	18.3763
	14.4830	74.3083	19.1506	2.5129	.5737	43.9867
	74.3083	756.7332	169.3983	30.2683	7.4643	495.1470
	19.1506	169.3983	70.1543	5.8674	1.2617	108.1179
Q	2.5129	30.2683	5.8674	1.8780	.2766	20.2315
	.5737	7.2617	1.2617	.2766	.1920	5.2322
	43.9867	495.1470	108.1179	20.2315	5.2322	337.6864
Y_1	1.0000	.7098*	.6008*	.4818*	.3440*	.6290*
X_1		1.0000	.7352*	.8029*	.6193*	.9795*
R Y_2			1.0000	.5112*	.3438*	.7024*
X_2				1.0000	.4607*	.8034*
X_3					1.0000	.6499*
X_4						1.0000

$\bar{x}$ — vector of arithmetic means, S — vector of standard deviations, Q — matrix of covariance, R — matrix of correlation,
* — correlation significant at confidence level P = 0.99.

Table 6.

Table of correlation coefficients for the group of 59 males.

	Y_1	X_1	Y_2	X_2	X_3	X_4
X	8.0810	157.7433	18.1460	7.9653	1.6883	121.1000
S	6.7314	60.6808	8.5332	3.0298	2.1041	52.3423
	45.3119	—30.5500	52.5172	—5.2983	—6.9983	—70.6383
	—30.5500	3682.1585	132.4705	161.1567	79.0659	3161.7696
	52.5172	132.4705	72.8150	1.5919	—4.7818	100.2597
Q	—5.2983	161.1507	1.5919	9.1795	3.4990	129.9195
	—6.9983	79.0659	—4.7818	3.4990	4.4272	78.7800
	—70.6383	3161.7696	100.2597	129.9195	78.7800	2739.7152
Y_1	1.0000	—.1763	.7987*	—.3563*	—.5097*	—.2005*
X_1		1.0000	.2558*	.8766*	.6193*	.7618*
R Y_2			1.0000	.0616	—.2663*	.0530
X_2				1.0000	.5489*	.5892*
X_3					1.0000	.6296*
X_4						1.0000

* Correlation significant at confidence level $P = 0.99$. Other denotations as in Table 5.

7 years in comparison to the younger stags. This is a result of killing adult stags during the rutting time when their food consumption is considerably reduced.

The mean undressed body weight of 64.0 kg in the calf group increased

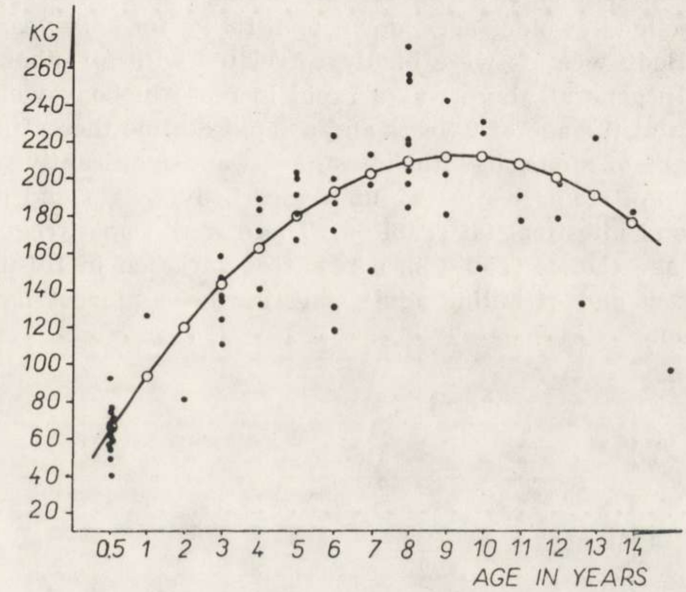

Fig. 5. Relationship between undressed body weight and age in the group of males according to the equation

$$x_1 = -1.672\ t^2 + 31.43\ t + 63.50$$

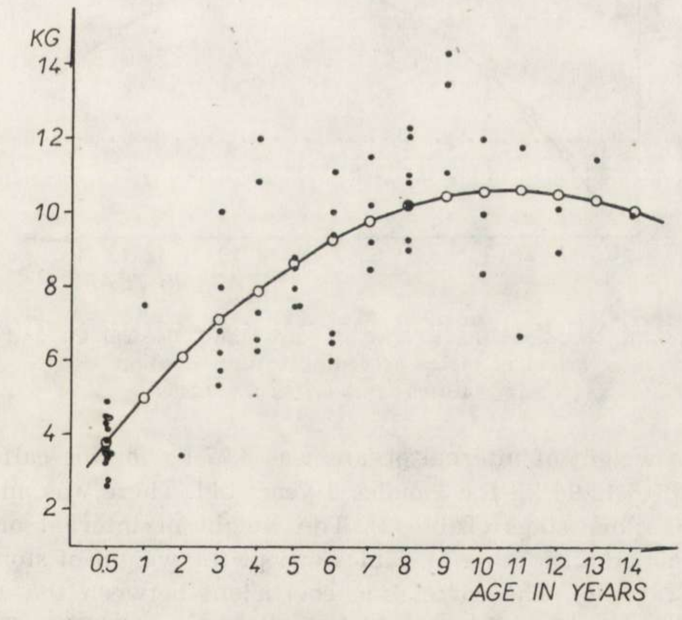

Fig. 6. Relationship between the weight of internal organs and age in the group of males according to the equation

$$x_2 = -0.05881\ t^2 + 1.273\ t + 3.766$$

up to a maximum of 224.5 kg for the 8 stags that were 8 years old. Weights declined at older ages, down to 181.8 kg for a 14-year-old male (Table 2). Body weights were highly correlated with all other variables (Table 6). In general, there was a rapid increase in body weight up to a maximum at the age of 9 years and a rapid decline thereafter (Fig. 5).

The weight of stomach with intestines was significantly correlated with volume of stomach content, undressed body weight and the weight of kidney and intestinal fat (Table 6). There were some irregularities in individual age classes (Table 2), a result of variation in fill-up the alimentary tract and of killing adult stags during a time of limited food consumption.

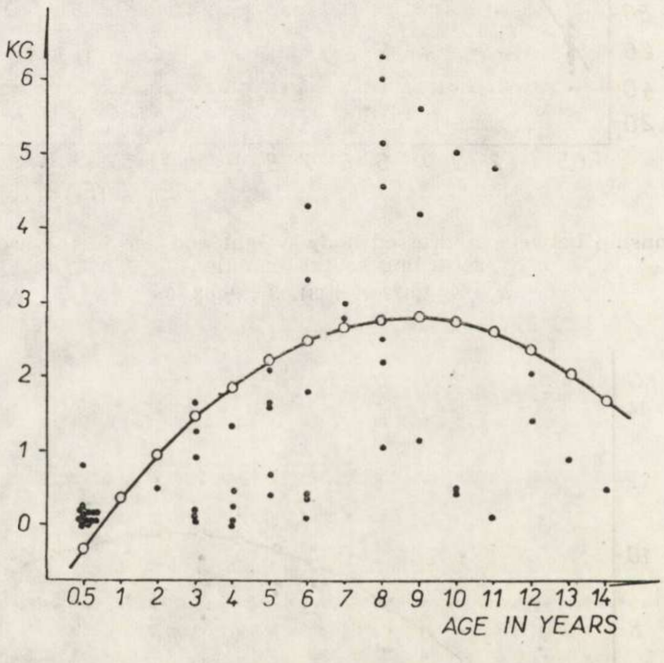

Fig. 7. Relationship between the weight of kindly and visceral fat and age in the group of males according to the equation
$$x_3 = -0.04094\ t^2 + 0.7169\ t + 0.3409$$

The mean weight of internal organs was 3.77 kg for the calf group. It increased up to 12.96 kg for 3 males 9 years old. There was an irregular decrease for older stags (Table 2). The weight of internal organs was highly correlated with other variables except the weight of stomach with intestines (Table 6). The correlation coefficient between the weights of internal organs and undressed body weight was 0.8766. There was a distinct increase in the weight of internal organs with animal age up to a maximum at 11 years. At older ages there was a rapid decline (Fig. 6).

The mean weight of kidney and intestinal fat was 0.15 kg for calves. The three 7-year-old males had the maximum value of 4.82 kg. A decline to 0.50 kg was noted for a 14-year-old male (Table 2). Fat weight was highly correlated with remaining variables (Table 6), particularly with undressed body weight ($R = 0.6193$) and dressed body weight ($R = 0.6296$). Fat weight increased (Fig. 7) with animal age up to a maximum at 9 years. It declined afterwards.

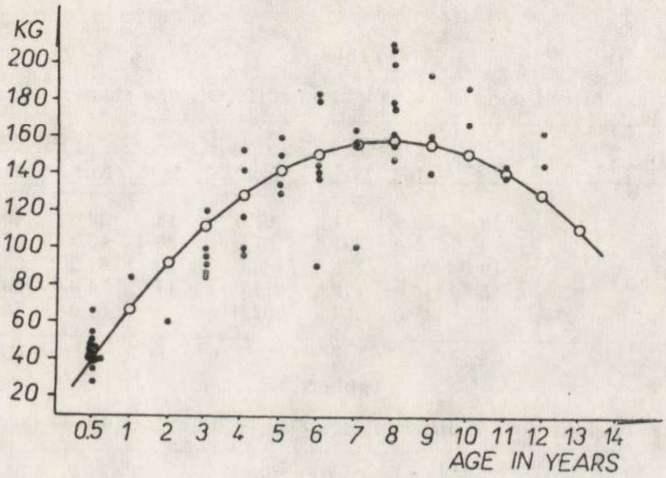

Fig. 8. Relationship between dressed body weight and age in the group of males according to the equation

$$x_4 = -1.844\ t^2 + 29.64\ t + 39.68$$

The mean weight of dressed bodies was 44.8 kg for calves and 180.8 kg for 8-year-old males. The mean weight for two 12-year-old males was 155.5 kg but one 13-year-old male weighed 182.0 kg (Table 2). Dressed body weight was highly correlated with other variables (Table 6), particularly with undressed body weight ($R = 0.7618$). There was an increase in body weight with animal age up to 8 years. At older ages the weight was usually less (Fig. 8).

IV. DISCUSSION

The dressed body weight of red deer increases steadily from the group of calves up to the 8 to 11 year age class, and then decreases as animals get older (Table 7). Deer weights presented by Mystkowska (1966) are higher than those of this study in 2, 3, and 4 age classes for males, and in 1, 2, and 3 for females (Table 7). Differences are remarkable in the 3rd age class of adults.

Growth of red deer in this study (Table 8) differs considerably from that reported by Mystkowska (1966). Body weight in females increased up to the 3rd age class. The greatest increase was between the 1c and 2 groups (34.3%). In the 4th age class there was an obvious decline in weight. The increase in body weight of males between 1c and 1b groups was insignificant since it was based on a single observation. The big increase occurred between the 1c and 3rd age class. As in hinds there was a regress of weight in the 4th age class.

Table 7.

Variation in red deer body weight in different age classes (in kg).

Age class	Males				Females			
	N	Min.	Mean	Max.	N	Min.	Mean	Max.
0 (up to 1 yr)	13	28.3	44.8	67.0	18	23.0	43.9	63.0
I (1—3 yrs)	8	61,0	91.0	121.0	26	40.0	67.0	80.0
II (4—7 yrs)	19	91.0	138.5	184.0	39	64.5	83.2	99.0
III (8—11 yrs)	15	140.0	172.6	211.0	11	74.0	89.3	108.0
IV (12 yrs and more)	3	147.0	164.3	182.0	2	64.0	79.5	95.0

Table 8.

Increase in body weight during different age classes (the class 0 was taken as 100%).

Sex	Age—class						
	0	Ia	Ib	Ic	II	III	IV
♀♀	100.0	22.3	54.4	65.2	89.5	103.4	81.1
♂♂	100.0	89.7	36.2	116.6	209.2	285.3	266.7

A comparison of stag body weight in the 2nd age class (Table 7) with data given by Baychev (1967) indicates a higher weight of deer in Bulgaria. The average weight of 15 Bulgarian stags in the 2nd age class was 179.0 kg, with a range of 90.0 to 228.0 kg. In this study the average weight of 19 stags in the 2nd age class was only 138.5 kg, with a range of 91.0 to 184.0 kg. Baychev's scarcity of weight data (N = 24) precludes the comparison of other age classes.

In this study red deer attained their highest undressed body weights at 8 years of age for females and 9 years for males. Dressed body weight was greatest for animals of both sexes at 8 years of age. These ages of maximum body weight for red deer are greater than the age of 7 years cited by Flerov (1952, after Greer & Howe, 1965). Greer & Howe (1965) have reported on the age of maximum body weight for several cervids. They state that white-tailed deer (*Odocoileus virginianus*) attain maximum weight at 5 to 6 years of age. Males of mule deer (*Odocoileus hemonius columbianus*) increase in body weight throughout their lives, whereas the females attain their peak at 3 to 4 years and maintain it until the age of 7 years. Moose (*Alces a. alces*) are heaviest at 10 to 11 years. Based on the weight of 427 individuals, Greer (1965) found that the inflexion in body weight of elk (*Cervus canadensis*) occurred in males at the age of 6 years and in females at 7 years.

In this study the male group dominated in body weight (undressed and dressed) over the female group (Table 2). Based on the weights of 473 carcasses of red deer Mystkowska (*l.c.*) also found a quite obvious sexual dimorphism. Murie (1951), after Greer & Howe, 1965) found that the general weight domination of elk males over females may not occur until after the first year of life.

The dressed body weight of red deer in this study comprised not less than 70 to 80% of the undressed body weight. In a population of 122 yearling moose Markgren (1964) found the dressed body weight was only 55 to 60% of the undressed body weight. On the basis of 24 carcass weights of red deer killed in Bulgaria Baychev (*l.c.*) found that the dressed body weight was 77% of undressed body weight in stags and 67% in hinds.

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WIELKOŚĆ OSOBNICZA JELENIA SZLACHETNEGO W POLSCE

Streszczenie

Zadaniem niniejszej pracy było prześledzenie zmienności osobniczej wielkości jelenia szlachetnego z nizinnej części areału tego gatunku w Polsce. Materiał (N = 159) pochodził z trzech obwodów łowieckich, położonych na terenie nadleśnictw: Józefów (woj. lubelskie), Pszczyna (woj. katowickie) i Smolniki (woj. olsztyńskie) i uzyskany był w ciągu czterech sezonów polowań (1964—1968). Dokonano pomiarów następujących sześciu cech: 1) ciężaru ciała przed patroszeniem, 2) ciężaru narządów wewnętrznych (płuca, serce, wątroba, nerki), 3) ciężaru tłuszczu z okolicy nerek i jelit, 4) ciężaru ciała po patroszeniu, 5) objętości treści żołądka oraz 6) ciężaru żołądka i jelit (wraz z treścią) (Tabela 2). Dla wartości pomiarów tych cech wyznaczono dla samców i samic średnie arytmetyczne, odchylenia standardowe i tablice (macierze) współczynników korelacji (Tabele 5 i 6). Celem zbadania zależności cech od wieku wyliczono równania regresji wszystkich trzech stopni (Tabele 3 i 4).

Obliczenia te wykazały, że zależność II-go stopnia najlepiej wyrównuje dane empiryczne (Ryc. 1—8). Stwierdzono statystycznie istotną zależność pomiędzy wiekiem zwierząt a wartościami wszystkich analizowanych cech. Wartości te wzrastały z wiekiem do pewnego okresu a następnie malały u zwierząt najstarszych (Ryc. 1—8).

Byki osiągają największy ciężar tuszy przed patroszeniem w wieku 9 lat a łanie w wieku 8 lat. Ciężar tuszy po patroszeniu osiąga wartość maksymalną u 8 letnich zwierząt obu płci. W poszczególnych klasach wieku samce są cięższe niż samice, zarówno przed jak i po wypatroszeniu.