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INTERRELATIONS BETWEEN THE HEART MASS, CARCASS MASS AND AGE IN MALE EUROPEAN ROE DEER (*CAPREOLUS CAPREOLUS*)

WSPÓŁZALEŻNOŚCI MIĘDZY MASĄ SERCA, MASĄ TUSZY I WIEKIEM U SAMCÓW SARNY EUROPEJSKIEJ (C*APREOLUS CAPREOLUS*)

Summary. The study was conducted on 83 hearts of roe deer aged one to nine. The animals were divided into three groups depending on their age: one-year-old, two- to three-year-old, as well as four-year-old and older. It was concluded that the mass of heart and carcass increases with age. However, the average heart to carcass mass ratio, which is contained between 1.13-1.24%, is not statistically different between the age groups. It proves the balance of changes the animal is undergoing in the course of its life. High correlation (r = 0.7) between the heart mass and carcass mass in male roe deer also proves this fact.

Key words: roe deer, heart, carcass, age

Introduction

The dependencies between body mass of animals and the parameters of their internal organs are being examined in numerous fields of animal science. The relations between age and body mass with anatomical and physiological parameters of heart are of particular interest (DOBSON and HEADRICK 1995). Morphological changes taking place in the organism are an important aspect during the postnatal period. They are described as allometric dependencies showing the heart growth in relation to the body mass or carcass increase during ontogenesis. Domestic animals are subjected to artificial selection

and the impact of artificial environment in the process of domestication, as well as in the ongoing process of improving their characteristics. As a consequence, their internal organs and their durability are changing. On the other hand, animals living in populations inhabiting natural ecosystems, are not subjected to such human influence. The relations between their body type and cardiovascular system provide information on the morphological adaptation of wild animals to their natural ecosystems (PICCIONE et AL. 2009, GANDOLF et AL. 2010).

Wild species can be used as a model or a natural control group for comparing study results of domesticated animals belonging to the same or closely related taxa. There is a significant deficit of morphometric information on animals living in natural populations and in natural conditions. This statement includes artiodactyla. Modern study and diagnostic methods allow for obtaining detailed information on heart and other organs. Information on characteristics and heart condition can be obtained by echocardiography. SANTAMARINA et AL. (2001) conducted such a study on roe deer. The coronary arteries in roe deer, which supply heart with blood, were described by FRĄCKOWIAK et AL. (2007).

The aim of this study was to analyse the heart mass in roe deer and compare it with the results of studies of other species. Determining the influence of age on the postnatal development of the analysed features is an additional aspect of the study.

Material and methods

The study was conducted on 83 male roe deers obtained by means of hunting in the Polish forests of the Wielkopolska region. The heart was dissected from each animal and then weighted with precision to 1 g. For the carcass mass, precision of 0.5 kg was adopted. The carcass was deprived of the heart, lungs, alimentary canal, liver, kidneys, genitals and head. The animals were between one and nine years of age. Age classes defined by the Polish Department of Hunting were used for statistical analysis. According to the above regulations, class I is composed of animals aged one to three years, while animals, which are four years of age and older are classified as class II. Our study also included animals in the first year of their life. For that reason it was classified as group A (n = 13), while males in class I were classified as group B (n = 33) and males in class II as group C (n = 37).

The study includes basic statistical analysis, one-way ANOVA, Fisher's Least Significant Difference test (LSD) and Pearson's correlation. Heart mass index was also calculated and compared against the carcass mass according to the following equation: Heart and Carcass Mass Index (HCMI) = heart mass/carcass mass × 100%. The analysis was conducted in Statisica v. 10.0. software.

Results

At the first stage of the study the basic statistical characteristics of the heart mass, carcass mass and HCMI was performed (Table 1). After concluding that the analysed features are characterised by normal distribution and they fulfill the criteria of homoge-

Table 1. Basic statistics of features for three age groups
Tabela 1. Podstawowe dane statystyczne cech trzech grup wiekowych

Age group Grupa wiekowa	Mean Średnia	Minimum value Wartość minimalna	Maximum value Wartość maksymalna	Standard deviation Odchylenie standardowe
Heart mass (g) – Masa serca (g)				
A	175	130	265	33
B	195	144	291	28
C	219	173	265	24
Carcass mass (kg) – Masa tuszy (kg)				
A	14.5	10	20	2.9
B	17.2	15	20	1.3
C	18.6	14	21	1.5
Heart and Carcass Mass Index (%)– Indeks masy serca i tuszy (%)				
A	1.24	0.93	1.90	2.5
B	1.13	0.86	1.62	1.5
C	1.18	1.02	1.42	0.9

neity of variance, one-way ANOVA was performed. The analysis showed that the only features characterised by a statistically significant difference are heart mass and carcass mass. For mean values of HCMI, the ANOVA did not reveal any differences that would be statistically significant.

Applying LSD test as a *post hoc* procedure, revealed which age groups are different in terms of heart and carcass mass. As a result of the test it was concluded that the differences between each group are statistically significant at $P \leq 0.01$ or $P \leq 0.05$.

At the last stage of the study, the Pearson's correlation coefficients were calculated for the examined parameters (Table 2). All the analysed relations are statistically significant. A strong correlation occurred between heart mass and carcass mass (Fig. 1), while the correlations with age were moderate.

Table 2. Pearson's correlation of the analysed variables
Tabela 2. Korelacja Pearsona analizowanych zmiennych

Variable Zmienna	Carcass mass Masa tuszy	Age Wiek
Heart mass – Masa serca	0.70*	0.49*
Carcass mass – Masa tuszy	–	0.55*

*$p < 0.05$.

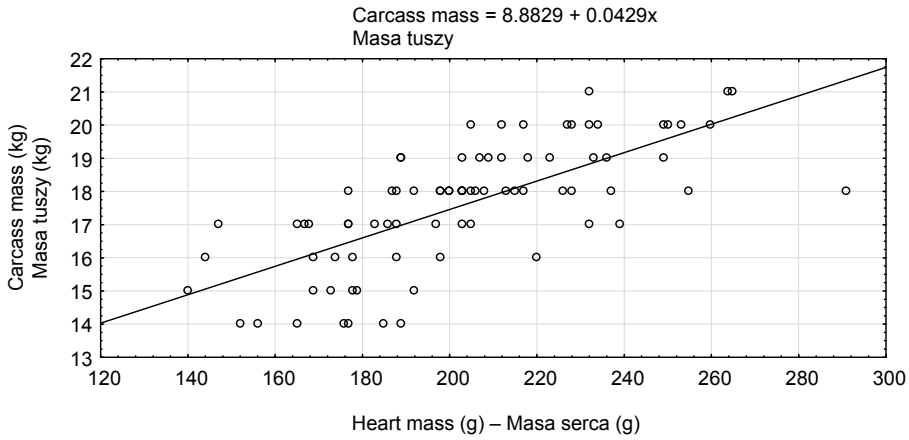

Fig. 1. Heart mass versus carcass mass
Rys. 1. Zależność między masą tuszy i masą serca

Discussion

The heart of all mammals is characterised by similar architecture. According to PROTHERO (1979), the ratio of heart mass to body mass is constant in mammals and it amounts to 0.6% regardless of the species. In the light of this general biological rule, it is worth reminding that in domestic mammals, this coefficient sometimes comes in different values than in their wild protoplasts. Comparing the dimensions and relative heart mass in wild boar and domestic pig can be an interesting example. In wild boar, the heart is noticeably heavier in relation to body mass – the coefficient amounts to 0.59%. At the same time in pig, the coefficient is contained between 0.27-0.32% (RÜHL 1971, WYSOCKI et AL. 2010). The loss of relative heart mass occurs in the species of domestic animals, which are bred as a meat source. A contradictory trend can be observed in species such as horse or dog, which are characterised by very high level of physical activity. Only in coldblood horses this ratio is 0.6%, which is identical to wild species. The horses used for races obtain much higher values which fluctuate around 1% (BLUM 1925). In dogs, the ratio of relative heart mass and total body mass also has different values depending on the breeding direction. The ratio amounts to 0.64% in St. Bernard, 0.75 in German shepherd and 0.78 in hunting dogs (pointer) (BALMER 1937). Interestingly, in cats these dependencies have different values as they amount to 0.55% in males and 0.51% in females (SICHERT 1935), which can be related to less active life of this species. Interestingly, in a female of Asian elephant (aged 50, ZOO Poznań, Poland) the heart mass was 19,850 kg at the body weight of 3 t and the ration of relative heart mass to total body mass was 0.66%. In a young, 10-year-old elephant, the heart mass was much lower – 14 kg (FRĄCKOWIAK et AL. 2006).

In the study on roe deer, the authors were forced to use the carcass mass instead of body mass. As a result the index that was constructed (HCMI) had much higher values than 0.6%. Its mean values amount to 1.24% in one-year-old males, 1.13% in two- to

three-year-old males and 1.18% in older males. Given that the carcass mass constitutes above 50% of the body mass, these results indicate that the heart also constitutes above 0.6% of the body mass. The HCMI values are not statistically different in age groups of roe deer. For that reason it can be concluded that with age, the carcass mass and heart mass increase proportionally in roe deer. In our study, we observed that the increase of the heart mass along with age does not depend on cardiac fatness. None of the examined organs had adipose tissue on its surface. It appears that even though the roe deer stops to grow at the age of two, its heart is developing much longer. It is indicated by the results of LSD test, which showed that even between B and C groups, the heart mass difference is highly statistically significant and it amounts to 24 g. This is the approximate mass gain of the heart in roe deer during several years.

On the other hand, the increase of carcass mass is strongly related to the fatness, which increases with age. However, significant fluctuations of carcass mass can be observed in Cervidae, including roe deer, depending on the availability of food in a given calendar year (WECKERLY et AL. 1987, KOMOSA et AL. 2013). CAVALLINI (1997) obtained interesting results when examining the heart mass of fox. The author concluded that animals with a lot of fat tissue had lighter hearts. On the other hand, physical activity in natural ecosystems is conducive to the increase of heart mass. The daily activity of Cervidae is different in different seasons (SCHEIBE et AL. 1999, BERGER et AL. 2002). Seasonal changes of food resources, combined with fluctuating physical activity can also affect the changes in proportions between the body mass and carcass or heart mass. However, the analysis of these relations requires further detailed studies.

Conclusions

1. The heart and carcass mass increase in male roe deer in different age groups.
2. The average ratio of heart mass to carcass mass is not statistically different in various age groups and it is contained between 1.13-1.24%.
3. There is a high correlation (r = 0.7) between heart mass and carcass mass of male roe deer.

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Streszczenie. Badania przeprowadzono na 83 sercach sarny w wieku od roku do dziewięciu lat. Zwierzęta podzielono na trzy grupy wiekowe: osobniki jednoroczne, osobniki dwu- i trzyletnie oraz osobniki czteroletnie i starsze. Stwierdzono, że wraz z wiekiem zwiększa się zarówno masa serca, jak i masa tuszy. Jednak średni stosunek masy serca do masy tuszy nie różni się istotnie statystyczne w poszczególnych grupach wiekowych i zawiera się w przedziale 1,13-1,24%. Świadczy to o równowadze zmian, które zachodzą w czasie życia zwierzęcia. Potwierdza ten fakt także silna korelacja (r = 0,7) pomiędzy masą serca a masą tuszy samców saren.

Słowa kluczowe: sarna, serce, tusza, wiek

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