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

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STUDIES ON THE EUROPEAN HARE. XXX[1]

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Variability of the Body Weight of European Hares

[With 2 Tables & 2 Figs.]

The variability of body weight in the population of hares *Lepus europaeus* Pallas, 1778, was investigated in the material (N=3833) from hunting in Eastern Poland during 8 years (1965—1972). The age of hares was estimated from the eye lens weight. The mean weight of young hares ranged from 3.94 to 4.09 kg, and of adult hares from 4.47 to 4.62 kg. In majority of seasons the differences in the mean body weights were not significant both in young and adult animals. Moreover, a considerable constancy of the mean weight of a sample from the population was found at the proportion of young to adult hares close to 1:1. The body weight of hares shot in November and December was compared. In the years of thick snow cover and negative ambient temperatures a significant decrease of body weight in adult hares and inhibition of growth in young animals was observed. During mild early winter months the mean body weight of hares increased. In all 8 seasons higher mean body weights were observed in females than in males, these differences being significant ($P<0.01$) in 4 seasons and in the whole material.

1. INTRODUCTION

Body weight is the main parameter used for the estimation of population biomass and production. It is also an important index in the evaluation of health and condition of individuals. Knowledge of the weight of hares is also important from the point of view of economy in the calculations of biomass of the game.

The studies on the body weight of hares were carried out mainly in the western part of Poland (Poznań District) — Caboń-Raczyńska (1964), Petrusewicz (1970), Pielowski (1971, 1971a), but also in other regions of the country (Pielowski, 1962, 1969). These indicated a definite trend of increase of hare body weight from West

to East. The variability of body weight was usually analysed after dividing the material into two age groups: young animals born in the year of study, and 1.5-year-old and older hares. Only Pielowski (1971, 1971a) has at his disposal the absolute age of individuals, and this enabled him to draw the curve of body weight growth. The variability of body weight in the annual cycle in Poland was presented in a previous study (Caboń-Raczyńska, 1964). Analogous data for New Zealand hares were reported by Flux (1967), and the differences between samples taken in particular years by Pielowski (1962, 1969).

The principal aim of the present study is to present changes in the body weight of hares in one population in consecutive years. Age dependent variability, the effect of climatic conditions on individual growth and the state of health in the autumn winter hunting season were also taken into consideration.

2. MATERIAL AND METHOD

The investigations were carried out during 8 consecutive hunting seasons in the years 1965—1972 on the area of one hunting field-forest plot ca 20,000 ha situated in the Białystok Province, Hajnówka District (52°35'N, 23°30'E). The total body weights of European hares *Lepus europaeus* Pallas, 1778, shot during hunting were analysed. Immediately after death the animals were weighed on a tangent balance with the accuracy up to 0.01 kg. The sex was determined by inspection of external sex organs. The age was estimated on the basis of dry weight of the eye lens according to the method described by Caboń-Raczyńska & Raczyński (1972). The material was analysed in two age classes: 1) young — hares aged not more that 9 months, 2) adult — hares older than 15 months. Altogether 3833 hares were examined including 1883 young and 1950 adult individuals.

3. RESULTS

3.1. Age-dependent Variability

Figure 1 shows the distribution of body weight of hares during 5 seasons. It indicates the ranges of variability among both young and adult hares during the 8-year period of study. A considerable constancy of the ranges of variability of adult hares, of (3.20) 3.50 kg to 5.30 kg (5.88) should be emphasized. The occurrence of peaks of relative weight frequency falling in each season for 4.40 kg is also characteristic for the population. The variability of body weight of young hares is higher, due mainly to differences in the minimum values and ranges from 2.00 to 5.00 kg although single individuals reach 5.30 kg. Oscillations of the numbers in weight classes do not show any regular trend which would allow conclusions to be drawn on the size of particular litters in the group

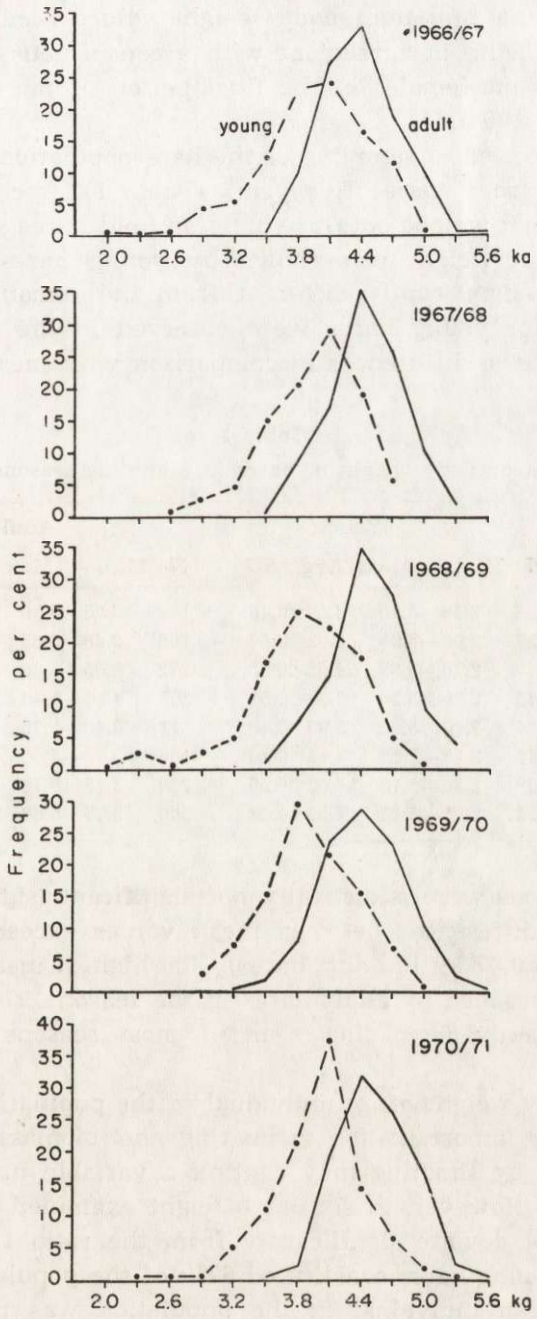

Fig. 1. Distribution of body weights of young and old hares in 5 selected seasons.

of »this-year« hares. In the group of young animals the peaks of maximum frequence for different weight classes fall in particular years. The hares showing minimum body weight values occur rarely in the population, this being in agreement with a conspicuous decrease in the number of pregnant females in the final period of the breeding season (Raczyński, 1964).

The identical period of sampling of the hare population enables a comparison of data from consecutive years (Table 1). A considerable constancy of the mean weight both in young and old hares should be noted. The lowest mean weight was shown by young hares in the season 1968/69. This is significantly different from the remaining years. The highest values for young hares were observed in the seasons 1970/71 and 1972/73, but the differences in comparison with mean values of the

Table 1

Mean body weight of hares in 8 hunting seasons.

Season	Young			Adult			Total
	N	Min. — Max.	Avg.±*SD*	N	Min. — Max	Avg.±*SD*	Avg.
1965/66	153	2.10—5.10	4.04±0.46	143	3.25—5.50	4.47±0.31	4.25
1966/67	357	2.00—5.05	4.02±0.54	155	3.60—5.65	4.47±0.32	4.16
1967/68	247	2.70—5.35	4.05±0.45	272	3.65—5.40	4.52±0.32	4.29
1968/69	242	2.20—5.20	3.94±0.51	295	3.50—5.40	4.54±0.35	4.27
1969/70	314	2.70—5.00	3.99±0.43	393	3.40—5.75	4.49±0.42	4.27
1970/71	182	2.45—5.25	4.09±0.40	166	3.70—5.70	4.62±0.27	4.34
1971/72	229	2.30—5.10	4.02±0.55	226	3.15—5.70	4.51±0.36	4.26
1972/73	159	2.05—5.15	4.09±0.49	300	3.75—5.88	4.56±0.38	4.40

majority of seasons were statistically not significant (significance occurs at the level of differences between mean values exceeding 0.10 kg in young hares and 0.07 kg in adult hares). The highest mean body weight, of 4.62 kg, was reached by adult hares in the season 1970/71. This value differed significantly from the mean of most seasons ($0.05>P>0.01$, Table 1).

The mean body weight of an individual in the population of a definite age structure is important for estimating the biomass. A population sample obtained by shooting may contain a variable number of young and adult hares. However, in six out of eight examined seasons the age structure did not deviate significantly from the ratio 1:1. Only in the 1969/67 season young hares constituted 67% of the population. The mean body weight of an individual in the population was then the lowest (4.16 kg), significantly different from the remaining seasons (Table 1).

In the last season, 1972/73, young hares constituted only 35% of the sample. Because of this the mean weight of the population sample was the highest (4.40 kg) and also significantly different from the weight of hares in the remaining seasons ($P<0.01$).

3.2. Growth and Condition of Hares

During the whole hunting season young hares grow and adult hares show changes in body condition. The order of magnitude of these changes is perceptible by comparing the mean body weight of young and old

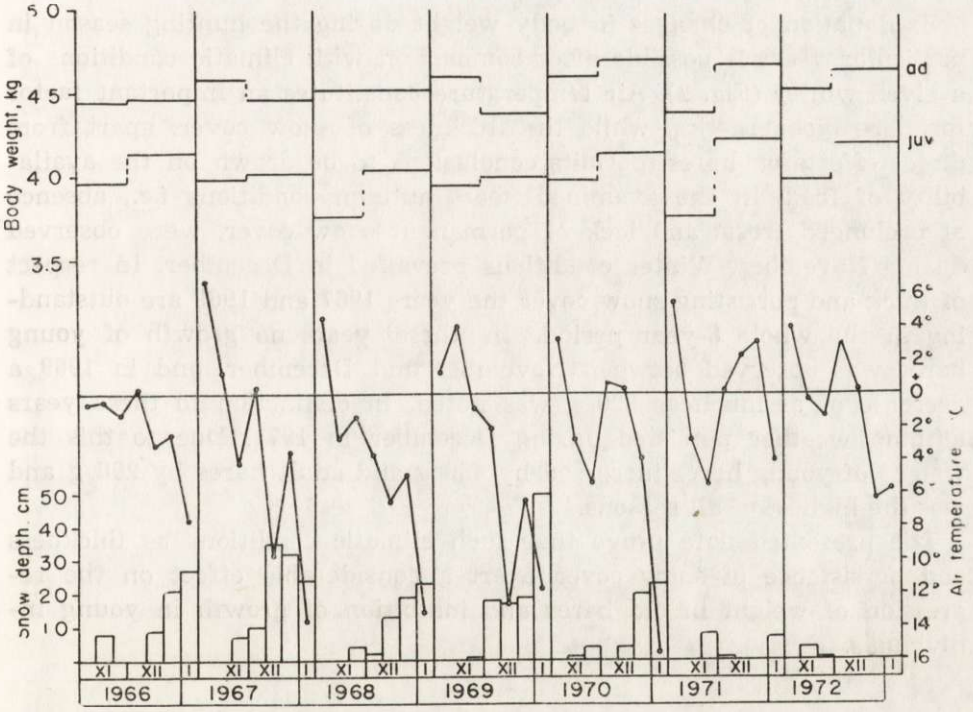

Fig. 2. Variability of the mean body weight of young and old hares in November and December in relation to climatic conditions.

Bars correspond to the maximum thickness of the snow cover in decades. The mean decade temperatures are conected by the continuous line. In the upper part of the diagram changes of the mean hare weight in November (XI) and December-January (XII—I) are given.

hares shot in November with those shot in December. Hares killed before 10th January of the next year, usually in one hunting were included in the latter group (Fig. 2).

The mean body weight of young hares shot in November is, in the majority of hunting seasons, significantly lower than in December. The years 1967 and 1969 are exceptional in that the differences were negligible; this can be interpreted as the inhibition of growth of young hares. The most considerable growth was observed in 1971 (0.46 kg).

In adult hares samples taken in November and December showed either a significant rise of body weight (years 1970, 1971, 1972, $P<0.01$), or decrease (1967, 1969) — $P<0.01$, or even lack of significant differences (1966, 1968). Since in this group of animals weight increases are in principle not caused by growth, the observed differences refer to changes of body conditions.

Explanation of changes in body weight during the hunting season in particular years is possible after comparison with climatic conditions of a given winter (Fig. 2). Air temperature constitutes an important factor for hare bioenergetics, while the thickness of snow cover, apart from direct effects on hares, permits conclusions to be drawn on the availability of food. In the examined years autumn conditions *i.e.*, absence of prolonged frosts and lack of permanent snow cover, were observed during November. Winter conditions prevailed in December. In respect of thick and persisting snow cover the years 1967 and 1969 are outstanding in the whole 8-year period. In these years no growth of young hares was observed between November and December, and in 1969 a decrease of as much as 220 g was noted. In distinction to these years autumn weather persisted during December in 1971. Due to this the weight of young hares increased by 460 g and adult hares by 280 g and was the highest of all seasons.

The presented data prove that such climatic conditions as thickness and persistence of snow cover exert a considerable effect on the regression of weight in old hares and inhibition of growth in young individuals.

3.3. Variability of Weight in Males and Females

In each season females showed higher body weight than males (Table 2), but only in four seasons (1966/67, 1968/69, 1971/72, 1972/73) were these differences statistically significant ($0.05>P>0.01$). The mean body weight of males and females from all 8 seasons showed a significant difference in favour of females.

In young hares the mean body weights were in some seasons higher for females and in others for males, while in the whole material a non-significant difference in favour of females was observed.

Hence the phenomenon of sexual dimorphism in the body weight becomes distinctly visible only in large series of material and only in adult individuals.

4. DISCUSSION

The problem of variability of body weight of hares killed during hunting was studies by many authors, often using many data. Rieck (1956), Szederjei (1959), Hell & Farkaš (1963) reported that the mean weight of hares during the hunting season may considerably differ in different years. Hell & Farkaš (1963) explain this correctly by the relation to the number of young hares in samples collected by shooting. Pielowski (1969) demonstrated that conspicuous differences exist in the mean body weight of individuals derived from different provinces in different years and that they are caused by a variable share

Table 2

Mean body weight of males and females of adult hares, and statistical differences (Dif.) between both sexes (— non significant, + significant at $P<0.1$).

Season	Males			Females			
	N	Min.—Max.	Avg.±*SD*	N	Min.—Max.	Avg.±*SD*	Dif.
1965/66	85	3.25—5.15	4.38±0.48	59	3.88—5.20	4.49±0.29	—
1966/67	73	3.75—5.15	4.37±0.26	77	3.60—5.65	4.55±0.41	+
1967/68	117	3.65—5.40	4.47±0.35	151	3.65—5.30	4.53±0.33	—
1968/69	144	3.65—5.30	4.44±0.34	154	3.50—5.40	4.61±0.36	+
1969/70	171	3.40—5.15	4.43±0.39	219	3.50—5.75	4.53±0.43	—
1970/71	79	3.70—5.15	4.55±0.30	89	3.90—5.70	4.65±0.34	—
1971/72	113	3.15—5.20	4.44±0.38	115	3.40—5.70	4.57±0.38	+
1972/73	138	3.75—5.30	4.48±0.39	162	3.75—5.88	4.63±0.33	+

of young hares in the population sample. This and other authors base their conclusions either on materials not divided into age classes, or distinguish young and old hares by the method of Stroh, in which the error in classifying young animals in the second half of the season may reach ca 40% (Caboń-Raczyńska & Raczyński, 1972). Such errors disqualify this method in the studies of the age structure of a population. For this reason the conclusions from the quoted above papers should be treated with caution.

Our investigations indicate that within one population, having an equal proportion of young and old hares the mean body weight shows a considerable constancy during the 8 eyar period. The highest difference (0.24 kg) occurred only between two extreme seasons 1966, when the

proportion young to old individuals amounted to 67:33, and in 1972 when old individuals prevailed (35:65).

Smaller differences between seasons is, in most cases, statistically not significant. These differences occurred in a group of young-of-the-year hares despite the fact that the age structure of this group may show large variability within years. It seems, however, that during hunting the majority of hares are individuals born in the first part of the reproductive season, during which they had better conditions of growth and development (Raczyński, 1964). The hares from late litters play a much smaller role in the dynamics of population since they are subjected (Rieck, 1956), to the highest rate of elimination due to epizooty in the autumn period.

Hewson (1968) drew attention to the effect of density phase on the body weight of hares, *L. timidus scoticus*. During the period of low numbers and slow recovery higher body weights of females during the reproductive season were found. According to the author this indicated a more intensive reproduction of hares. I observed similar situation in the season 1970/71 which occurred after the disastrous winter 1970. In that season the mean body weight of young and old hares reached then the highest values (4.09 and 4.62 kg, respectively — Table 1). It can be supposed that after severe and long winter the period of reproduction began later than in other years and most of young hares were born in the optimal period. It is worth emphasizing that in 1970/71 a decrease in the number of young hares below 3 kg was observed, which dominated the class of 3.5 kg. This indicates that the breeding season was not prolonged. A certain analogy can be drawn with the observation of Naumov (1960) on the mountain hare in Jakucja. In the years following a long winter a compensation of reproduction was found in the form of one large litter instead of two smaller litters. Ascertainment of the highest body weight in old individuals may be explained by survival of the fittest individuals in conditions of increased mortality during severe winters. This idea is supported by the fact that the distribution of the eye lens weight in the season 1970/71 shows a gap of 30 mg between the juvenile and adult groups. Such separation between these two groups has not been observed in other seasons. Hence it seems probable that very few one-year old individuals (born in 1969) survived the winter of 1970 and this in effect increased the mean age of the reduced population.

The occurrence of seasonal variations in the body weight was reported by several authors for the hare (Szederjei, 1959; Rieck, 1956; Pielowski, 1962, 1969, 1971; Flux, 1967) and for related species

(Newson & de Vos, 1964; Hewson, 1968). In an earlier paper the author did not observe any seasonal differences (Caboń-Raczyńska, 1964) but there were too few data.

The differences in the body weight of hares in the autumn-winter season appear to concern mainly the body condition. The winter fall of body weight was explained by Pielowski (1969) as the response to early winter and snow cover. For the whole territory of Poland this fall during two months of the hunting season was considerable (mean by 110 g), and in the Poznań province the difference was even higher (300 g). Using labelled hares Pielowski (1971) observed decreased body weight in all age groups in winter. Flux (1967) reported that in New Zealand hares have a distinct seasonal rhythm, different for males and females. The males reach maximum weight in the middle of winter at the beginning of the reproduction season; the females show reversed rhythm. Newson & de Vos (1964) described a rhythm of body weight changes in *Lepus americanus* Erxleben, 1777, similar for males and females with the peak falling for summer and late autumn. Changes in the body weight in the autumn-winter period are, according to Flux (1967, 1971), related to the deposition of perinephric fat. The deposition of fat is much higher in old hares and may be regarded as a change in body condition.

The decrease of body weight in the population of hares examined occurred in the unfavourable climatic seasons which caused deterioration in the conditions of life and required mobilization of all reserves of the organism. This process concerns mainly adult hares. Young animals also probably mobilize their fat reserves but the principal reaction depends on the inhibition of growth. During mild winters (1970/71 and 1972/73) young hares grew intensively even in December. Even adult hares showed weight increases, interpreted as an improvement of the body state Thus it appears that environmental conditions at the beginning of winter affect the population composition, and the reduced food supply may give the most pronounced effects in young hares born in the second part of the reproductive season and still showing intense growth.

The dimorphic variability in the body weight of hares during the whole year was observed by Flux (1967). The occurrence of small differences in favour of females was emphasized by Kröning (1963). Hell & Farkaš (1963) found the differences in favour of males. Volf (1960) and Caboń-Raczyńska (1964) did not observe any differences between the weight of males and females in the year cycle.

The present observations indicate that the sexual dimorphism is not always clearly manifested. Flux (1967) pointed out that dimorphic

differences may be related to better survival of females. As it is known from the investigations of Pielowski (1971) the hares show body weight increases up to 4th year of life, and better survival of females may influence their weight. However, as appears from the study of Petrusewicz (1970), the percentage over many years of old individuals in the population is very small, thus they cannot affect the obtained results. It seems that the higher weight of females is a real phenomenon, providing that representative series of material are available for analysis.

The results obtained indicate that the division into age groups is essential for biometric characteristics of a given hare population. Full comparative value is possible only in series collected in correponding periods which exclude the effect of seasonal variability. For *Lepus europaeus* the best period for collection falls at the break in the reproductive activity and at the period of stable body weight; hence at the beginning of winter.

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ZMIENNOŚĆ CIĘŻARU CIAŁA ZAJĄCA SZARAKA W CYKLU WIELOLETNIM

Streszczenie

Ciężar ciała zający badano na serii 3833 osobników pozyskanych w sezonie polowań (XI—XII—10.I.) z jednej populacji w Polsce Wschodniej (pow. Hajnówka, woj. Białystok) w ciągu 8 kolejnych lat (1965—1972). Materiał analizowano w dwóch grupach wiekowych — młode pochodzące z przyrostu w danym roku i stare — powyżej 15 miesięcy życia. Klasyfikację wiekową przeprowadzono w oparciu o ciężar soczewki.

Średni ciężar ciała zający w latach jest wysoce stały w obu grupach wiekowych: u młodych wahał się w zakresie 3.94—4.09 kg; u dorosłych odpowiednio: 4.47—4.62 kg (Ryc. 1, Tabela 1). Zarówno u młodych jak i starych zający w większości wypadków różnice w średnich ciężarach ciała były statystycznie nieistotne.

Średni ciężar zający w próbie z populacji różni się istotnie tylko wówczas gdy przewaga jednej klasy wiekowej nad drugą jest duża (Tabela 1). Przy proporcji klas w próbie zbliżonej do stosunku 1:1 średni ciężar próby w różnych latach jest bardzo stały.

Podczas łagodnych zim ciężar zający w grudniu istotnie wzrastał w stosunku do zający z listopada (zarówno u młodych jak i dorosłych). W czasie ostrych, wczesnych zim (1967 i 1969) przy minusowych temperaturach i wysokiej pokrywie

śnieżnej w grudniu, obserwowano zahamowanie wzrostu u młodych i istotny spadek ciężaru ciała u starych zajęcy (Ryc. 2).

Dymorfizm płciowy w ciężarze ciała stwierdzono tylko u dorosłych zajęcy we wszystkich sezonach (Tabela 2), przy czym w 4 sezonach i całym zbiorczym materiale różnice były statystycznie istotne ($0.05 < P < 0.01$).