

STUDIES ON THE EUROPEAN HARE. XXV.

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The Individual Growth Curve of the Hare

[With 1 Table & 5 Figs.]

Repeated measurements of the body weight of 30 marked young European hares during the whole period of their growth provided sufficient data for tracing the individual growth curve of the hare. The average weight of newborn animals was 107 g. Rate of growth increased markedly after the first 15—18 days of life, soon reaching an average daily weight increase of 32.5 g after which it gradually decreased. Hares attain optimum body weight for the first year of life at the age of about 240 days. Increase in body weight lasts up to the fourth year of life. Body weight is subject to seasonal fluctuations, decreasing in winter, such decrease being greatest in hares less than one year old.

I. INTRODUCTION

There are exceptionally few data available so far on the individual growth of the hare, and there are absolutely no field data. Although Müller-Using (1962) and Rieck (1963) give the weight of the hare at different ages as from the time of birth they do not state the sources from which they obtained this information. It must be assumed that the data were obtained from hares reared in cages. Material of this kind on individual growth are obviously burdened with a considerable degree of error. Reference may be made to the study by Pilarska (1969) among the most recent studies on growth of hares reared in captivity.

There is a considerable demand for field data on the individual growth curve of the hare, as such data would fill a serious gap in contemporary knowledge of the hare's biology, are essential for carrying out studies on the biological productivity of this species and can in fact also be of use in practical game management for correct establishment of game management in relation to the hare, which in many European countries is one of the most important species of game animals.

The purpose of the studies presented in this paper was to obtain a greater amount of material under field conditions in order to trace the individual growth curve of the hare, *Lepus europaeus* Pallas, 1778, which would simultaneously illustrate the course of growth on the basis of material representing a population.

II. METHODS

The method adopted for this study was to trace the rate of growth of young hares under field conditions where ever possible from the first day of life. This is only possible by means of individual marking of the hares found and their subsequent periodical inspection. In view of the rapid dispersal of young hares from the site of their »nest« a few days after birth it is very difficult to find them even after a short time, not to mention the necessity for inspecting them at various times during the first year of life. The reflex of escape from an enemy appears in a hare as early as the age of two weeks, and it is practically impossible to chase and catch a month-old hare. Attempts at catching them by means of a specially trained hunting dog also failed. The only solution is therefore to carry out these studies in an enclosed area. This area must however be sufficiently large and the habitat sufficiently varied for the hares in it to live under conditions analogical with, or at any rate differing very little from those prevailing in an open game area.

The Polish Hunting Association Research Station at Czempin possesses an enclosed area of this kind. It is contained within the Station experimental game area situated in the west part of Poland in the Poznań voivodship. The enclosed area is 21 ha in size and consists of 8.5 ha of arable land, 1.5 ha of meadow, 9 ha of forest with a varied tree stand, with trees in different age classes, and 2 ha of lawn, roads and built-up areas. It has a wire-netting fence 2 m high which also extends 50 cm into the ground, and barbed wire, but this does not completely prevent the hares escaping from the enclosure nor their entry into it. It does, however, undoubtedly form a considerable obstacle to free communication. The enclosure was effectively secured against unauthorised entry by humans, and all the agricultural work carried out took into consideration the requirements of the studies made. Heavy machinery was not used, neither were chemical preparations, apart from artificial fertilizers.

The stock of adult hares in the enclosure consisted of approximately 30 individuals, amongst which females predominated. Density was thus not much higher than in some parts of this game area outside the enclosure, in which parts up to 100 hares per 100 ha are encountered. Leverets were found during the regular inspections of the area, and also accidentally. These hares were weighed and measured, then marked with small light aluminium ear-tags.

Repeat reports of marked hares were obtained by catching the animals in automatic live-traps which, together with the other type of trap used, formed the study area into an extensive trapping system. Many of the hares, especially the old ones, were also caught during the net captures periodically carried out. Some small hares were caught by hand.

Some of the leverets were caught for the first time when a few or several days old. Their age was established by comparing some of their biometric parameters with the curves of these parameters for animals of known age. Body length, ear

length and length of hind foot measured in all the individuals caught, proved to be of little use for this purpose on account of the great individual variations. Body weight was the value with the least dispersion during the first days of the animals' life (Fig. 1), and this value was used as the basis for determining age.

In order to increase the amount of material a selection was made of data on some of the hares marked when quite young and then caught repeatedly in previous years. These are animals bearing ear-tags with numbers below 591 (Fig. 1 and 2).

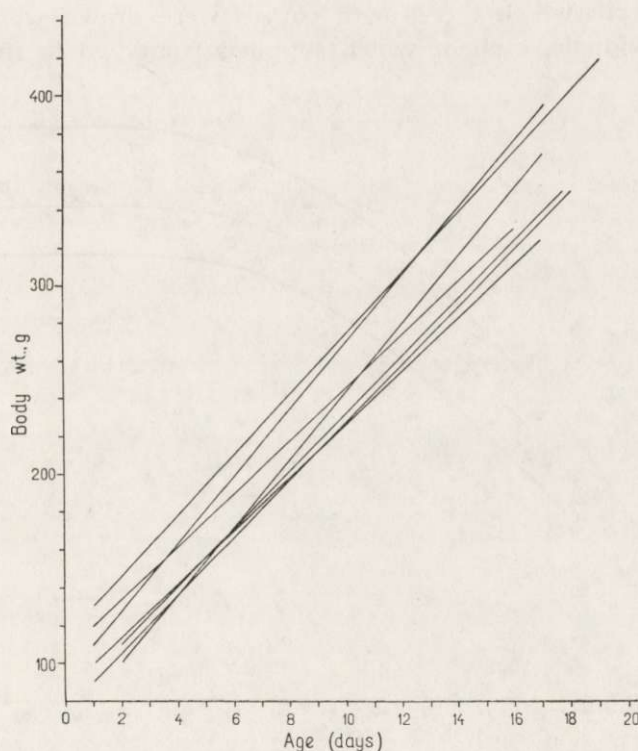


Fig. 1. Increase in body weight of the hare from 1st to 19th day of life.

Data on the body weight of adult hares at different ages were collected for the winter season of 1969/1970 during the annual mass captures of hares in the experimental areas of the Research Station. These apply to marked hares of known age. Details of the methods used are given by Pielowski (1971).

III. RESULTS

The weight of 54 one- and two-days old hares varied within limits of 65 g to 115 g, with average weight of 107 ± 25.9 g. The hares examined were born at different times during the reproduction season and came from litters of varying sizes. The calculated mean value would thus

appear to reflect the average weight of newborn hares in the study area fairly accurately.

Differences in the body weight of leverets from the same litter may be considerable, the extreme differences being 85 g and 155 g in a litter of two and 90 g and 130 g in a litter of four.

Average weight of a completely newborn hare thus constitutes about 1/40 of the body weight of an adult hare.

The data from which the growth curves were drawn were obtained from 30 individuals, each of which supplied from two to five data on

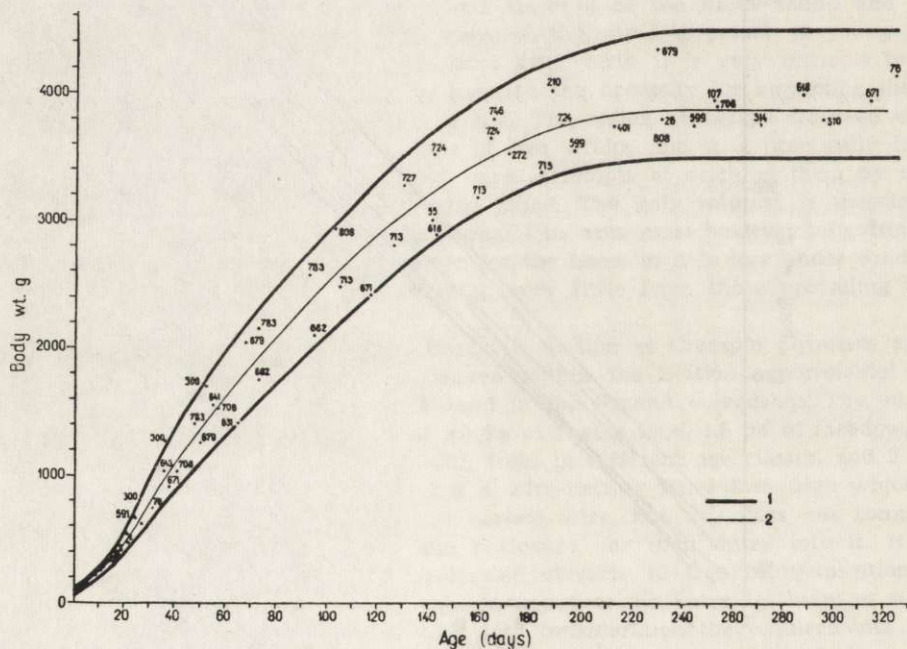


Fig. 2. Individual growth curve of the hare during first year of life.
1 — Observed range, 2 — Average.

weight. These hares were born in different months and therefore represent the whole reproduction period. The course taken by the growth process in 19 individuals was traced in 1969, the remainder come from earlier years. The curve drawn on the basis of data obtained from a period of several years thus characterises the average individual growth of a hare in the region of Poland studied (Fig. 2). In the final phase of the curve, on account of the lack of a sufficient number of data describing the range of variations in body weight at this age, the limits of extent of dispersion were defined on the basis of measurements of body weight of a large number of hares during the first year of life

(with distinctly perceptible thickening of the epiphysis on the forearm). They were weighed during the annual captures of hares in the experimental areas. This range, after omitting hares obviously not yet fully grown, came within limits as wide as 3.500 g to 4.500 g. The average value for the first ten days of December 1969, when young hares attained maximum weight in that season, was 3.870 ± 342 g.

As from the age of approximately 20 days the range of individual variation in the hare's body weight is considerable, and of course increases with age. At the age of 240—300 days it is as much as almost $\frac{1}{4}$ of the whole body weight. The growth curve of the hare exhibits the S-shaped course typical of many species of animals (Fig. 2). Growth rate distinctly increases after the first 15—18 days of life. This is probably connected with the transition found at this period of the hare's

Table 1
Average daily growth rate of the hare.

Days of life		Avg. daily increase in body wt., g
from	to	
1	20	17.0
21	40	32.5
41	60	25.0
61	80	22.5
81	100	20.0
101	120	20.0
121	140	17.5
141	160	12.5
161	180	10.0
181	200	5.0
201	220	4.0
221	240	2.0

life (Koloso v *et al.*, 1965; Pielowski, 1966; Flux, 1967) from its mother's milk to independent feeding on plant food. Between the twentieth and fortieth day of life the average daily increase in body weight is as much as 32.5 g. Rate of growth gradually decreases in the subsequent periods of the animal's life (Table 1).

Hares attain optimum body weight for the first year of life at the age of about 240 days, that is, 8 months. This date, however, depends to a great degree on the length of the period between birth and the beginning of winter, since growth is inhibited during winter.

The parallel studies made on the hare's length of life and its capacity for survival (Pielowski, 1971) permitted of obtaining data on the body weight of older individuals of known age. It was found on the basis of measurements of 114 individuals that the body weight of the

hare increases up to the fourth year of life. Maximum increase in body weight takes place between the first and second year of life. Two-year old hares weighed on an average 4.250 g (increase of 380 g). The average weight of three-years old hares was 4.310 g (increase of 60 g) and four-year old 4.390 g (increase of 80 g). In even older hares body weight is maintained on the same level (Fig. 3).

Seasonal variations occur in the hare's body weight. During winter it decreases, decrease being greatest in young hares. The relevant studies were made during the season of an exceptionally hard and long

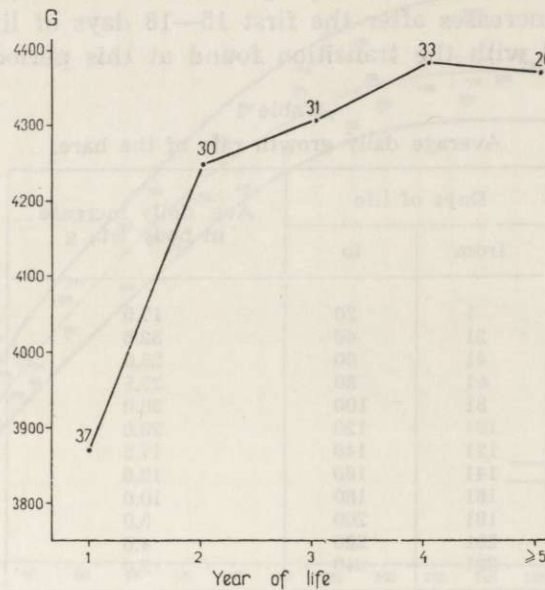


Fig. 3. Average weight increase in the hare in different years of life. Numbers of individuals used for calculating averages are given.

winter. The mean decrease in body weight of young hares was as much as 370 g, that is, 9.6%. In two-years old and older hares this was appropriately smaller, being 150 g, that is, 3.5% (Fig. 4). In years with a mild winter the decrease in body weight is most probably smaller. Decrease in the body weight of hares as the result of winter conditions was also found by Szederjey (1959).

IV. DISCUSSION

The data on the body weight of newborn hares to be found in literature differ greatly. According to German data newborn hares weigh

130 g (Müller-Using, 1962; Rieck, 1963). Flux (1967) gives weights within limits of 100 to 165 g for New Zealand. The three smallest individuals weighed by this author were 100, 100 and 115 g and the three largest — 160—165 g. The average values were undoubtedly about 130 g. The weights given for newborn hares by Soviet authors are smaller (Koloso v, Lavrov & Naumov, 1965). According to these authors they vary from 80 to 140 g, and are most often from 100—110 g. These data coincide very closely with the results of measurements given in this study. This may suggest that smaller hares are born in the most easterly regions of Europe, but such a hypothesis is not very probable. The differences are more like to result from the fact that not all the researchers had a sufficiently large amount of material at their disposal and their material was not sufficiently accurately dated. It is in fact only newborn animals which are still damp which should be considered.

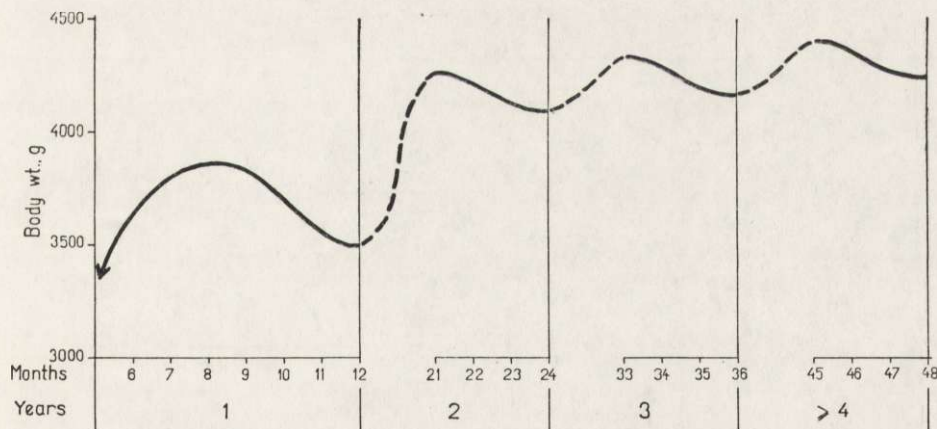


Fig. 4. Annual fluctuations in individual growth curve of the hare.

As soon as they receive their first abundant supply of milk their weight appears to increase markedly. According to Flux (1967) the milk in the stomach of such hares weighs 36 g. After a few days of life, when the leverets are still in the »nest«, their weight increases by 60—80 g. Measurement taken from embryos prepared from killed females must be treated with caution (Flux, 1967). The material presented in this study is also not of uniform reliability. Not all the 54 small hares taken for weighing were undoubtedly newborn, even though a large number of uncertain data were completely omitted. This would seem to show that the factual mean weight of newborn hares may be even smaller than 107 g.

The individual weight curve obtained for a hare differs from an analogical curve drawn on the basis of data by Müller-Using (1962) and Rieck (1963). It is possible that under the milder climatic conditions of West Germany, more favourable to the breeding of hares, that their growth is more rapid during the first months of life (Fig. 5). The growth curve for hares given by Petruszewicz (1970) for Polish conditions is more similar. The author very successfully extrapolated this curve from the laboratory curve given by Pilarska (1969), but incorrectly brought it to the body weight of adult individuals as early as the level of 270th day of life of the hare.

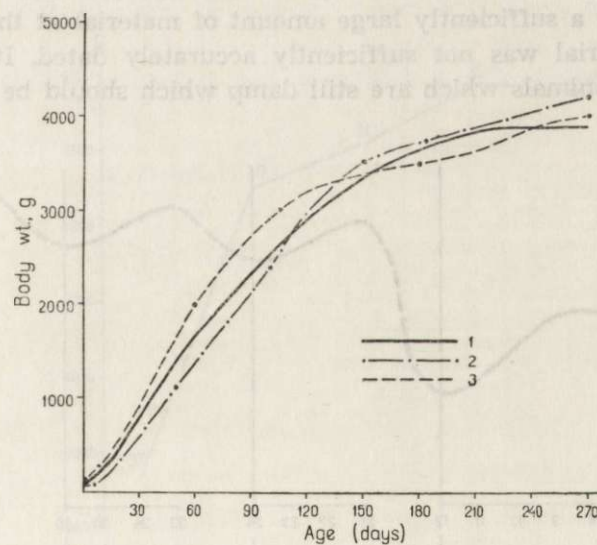


Fig. 5. Growth curves of the hare given by different authors.

1 — own data, 2 — after Petruszewicz (1970), 3 — after Müller-Using (1962).

The statement that increase in the body weight of the hare does not end in the first year of life is by no means new. Many authors have found that hares more than one year old are heavier than hares less than one year old (Rieck, 1956; Hell & Farkaš, 1962; Pielowski, 1962; Petrov, 1964; Flux, 1967, and others). The age criterion they use, *i.e.* palpation of the epiphysis of ulna, at best only permits of differentiating two age classes of hares — younger than one year and older. C a b o Ń - R a c z y ń s k a (1964) distinguishes four age classes in hares on the basis of the skull structure and finds a distinct increase in body weight in consecutive age classes, but she also allocates all hares over one years old to one age class.

In connection with the increase in the hare's body weight found to occur up to the age of 4 years the suspicion is created that this finding may be based on an artefact. Although there is no doubt that individuals several years old are on an average heavier than two-year old, it is possible that this is not the result of their continued individual growth but is the consequence of selective elimination from the population of lighter individuals, the condition of which is probably poorer. The phenomenon found would then indicate that from the population aspect the older age classes are represented by individuals heavier in weight and in better condition. This would not, however, be proof that increase in individual weight continues up to the age of four years. The studies being carried out on this question, based on marked hares, will solve this problem in a few years time.

Caboń-Raczyńska (1964) did not find seasonal variations in the body weight of adult hares, which contradicts the results obtained in the present study. The above author was not in a position to distinguish between two-, three- and four-year old individuals, and therefore treated all these age groups jointly as adult hares. These variations were consequently effaced as the result of data overlapping, e.g. on two-year old hares at the beginning of the winter period, three-year old hares from the middle of this period and four-year old hares from the end of winter. This question is well illustrated and explained by figure 4.

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KRZYWA WZROSTU OSOBNICZEGO ZAJĄCA

Streszczenie

Celem pracy było uzyskanie danych terenowych na temat krzywej wzrostu osobniczego zająca. W środowisku bardzo urozmaiconym na ogrodzonym terenie o powierzchni 21 ha, oznakowano potomstwo żyjącego tam pogłowia zające. Młode zające kolczykowano drobnymi aluminiowymi plakietkami z wrytym bieżącym numerem. Drogą późniejszego chwywania znakowanych osobników w samoczynne pułapki żywołowne oraz w sieci udało się uzyskać pewną ilość wiadomości powtórnych o zającach w różnym wieku. Pozwoliło to wykreślić krzywą wzrostu dla całego zbioru osobników reprezentujących badaną populację.

Na podstawie pomiarów 54 okazów wyliczono średni ciężar noworodków, wynoszący $107 \pm 25,9$ g. Ciężar ich waha się od 65 do 155 g. Tempo wzrostu zająca zwiększa się wyraźnie po pierwszych 15—18 dniach życia. Łączy się to prawdopodobnie z jego przejściem w tym wieku z pokarmu matczynego na pokarm roślinny. Optymalny dla pierwszego roku życia ciężar ciała zające osiągają w wieku ca 240 dni. Po chwilowym zahamowaniu wzrostu w czasie zimy ciężar dalej wzrasta. Na podstawie pomiarów 114 okazów, o znanym wieku stwierdzono, że ciężar ciała powiększa się do czwartego roku życia; najwięcej pomiędzy pierwszym a drugim rokiem, potem coraz mniej.

Ciężar ciała zająca podlega sezonowym wahaniom. W okresie zimowym spada. Najbardziej obniża się on u zające młodych. W czasie ostrej zimy 1969/70 średni ubytek ciężaru ciała w tej klasie wieku sięgał 10%. U zające starszych ubytek był mniejszy i wyniósł średnio 3,5%.