POLSKA AKADEMIA NAUK
INSTYTUT ZOOLOGICZNY

ACTA ORNITHOLOGICA

Tom XIII Warszawa, 15 VIII 1971 Nr 3

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Studies on the postembryonic growth and development of the Partridge, *Perdix perdix* (L.)

Studia nad rozwojem postembrionalnym kuropatwy, *Perdix perdix* (L.)

Изучение постэмбрионального роста и развития серой куропатки, *Perdix perdix* (L.)

[With 4 graphs and 1 table in the text]

Abstract. 96 Partridge chicks were taken at the onset of the study on the growth and development of Partridges and it was terminated having 25 ten-week-old chicks. The rate of growth, the curve presenting the increases in basic parameters, the curve for the weight increases, and the curve of regression for the coefficient of the dynamics of growth have been included, as well as the fledging table which can be used as a guide for determining the age of young Partridges.

INTRODUCTION

The Partridge, *Perdix perdix* (L.), a representative of the order *Galliformes* is a natural inhabitant of open and semiopen forest and forest-steppe habitats in Europe and the Near Asia. As all *Galli* it is a typical precocial bird; it stays in the nest only for the first few hours after the moment of hatching and then the parents take the whole flock of 10–15 birds out onto the field. After three weeks the young display their first attempts at flying, and after five weeks they are able to start their independent life. However, they do not leave, as a rule, their family flock until the next spring, i.e. they stay together up to the moment of the onset of spring sexual display.

A large increase in arable lands, intensive afforestation, and the introduction of the "three-field" rotation system in the XIXth century contributed to the period of prosperity enjoyed by partridges. Partridges favour areas out of crop and small peasant holdings with a wide range of crops cultivated there. With the present trend of progressive intensification and specialization, a rapid decrease in areas out of crop and a gradual transformation into the cultivation of large monocultures, the Partridge is unexorably deprived of its food basis. The employment of chemicals on growing crops and the introduction of mechanization on a large scale lead to the destruction of the natural environment and adversely affect the numbers of the Partridge population. And consequently in the present stage of the transformation of the natural environment for the Partridge, studies on the biology of this species assume a particularly important character.

Studies on the development and growth of the Partridge, were started by HAMMOND (1946) who also determined some regularities in the individual development of mammals and birds, and he analysed them as two parallel processes, (1) growth, i. e. an increase in the size of the body until the given individual is completely grown up, (2) development of forms consisting in changes in the proportion of tissues and organs up to the moment when complete somatic maturity is attained. Other investigators, particularly the Soviet ones, single out development processes as the expression of the formation of new organs and new functions and physiological processes in the organism. Thus development understood in this way is a continuous process lasting all through the life of a given animal. FABIAN (1957) recorded that when an organism undergoes the process of growth certain slow downs are inevitable, and that they occur in a wave-like fashion. BÖGRE (1958) divided the period of the postembryonal growth into several stages each having its own "intensity of growth".

MATERIAL AND METHOD

The investigation was carried out in the period between June 1st, 1968 and September 13th, 1968. They were started on 96 one-day-old Partridge chicks and the study was ended having under close observation 25 ten-week-old Partridges (no measurements were carried out in respect of nine-week-old chicks). All the Partridges were taken from the Experimental Breeding Center of the Polish Hunting Society at Nowy Przybyszew.

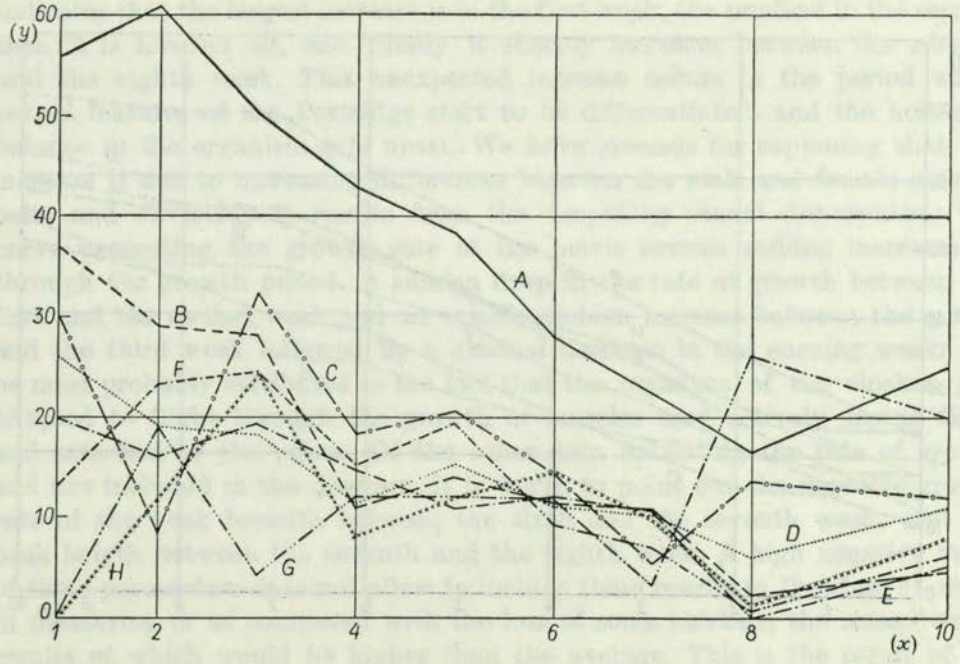
The investigation included an analysis of the growth and development which comparised the body weight and biometric measurements taken every 7 days in the morning before the birds were fed. The body weight was taken on the technical scales for weighing eggs, and after 4 weeks on the technical tangent-balance to the nearest 1 gramme. The following measurements were taken: 1) the body weight, 2) the length of the *tibiotarsus* from the proximal end of the *tibia* bone to the process joining the distal end of the *tibia* with the *tibiotarsus*, 3) the length of the *femur* from the *trochanter major* to the proximal end of the *patella* in the knee-joint, 4) the width at which the hindlimbs are set — the distance between the *trochanter major* of the two *femur* bones, 5) the width at which the forelimbs

are set — the distance between the processes of the *coracoideum* bones forming together with the *scapula* and the *clavivula* the glenoid cavities for the bone of the *humerus*, 6) the length of the *antebrachium* from the process on the proximal part of the *ulna* to the distal root of the *radius*, 7) the length of the *humerus* from *tuberculum laterale* on its proximal end to the joint bulge on the distal end, 8) the length of the beak — the maximum distance between the lateral sides of the *rhamphoteca* on the beak, 10) the length of the *sternum* — the length of its *crista sterni*. These measurements were taken with the slide gauge and the metric tape to the nearest 0.1 mm. Besides the birds were photographed every week against the background of a centimeter net 10 by 10 cm in size.

Applying the classical statistical methods of the biological analysis of growth the following points were calculated for each of the measurements: a) the rate of growth calculated from the following formula:

$$T = \frac{Wk - Wp}{0.5\,(Wk + Wp)}\,100\,\% \qquad (1)$$

where: Wk — value of the measurement for the week in progress, Wp — value of the measurement from the previous week. The data for the most important measurements are presented in graph 1. b) Mean values of measurements



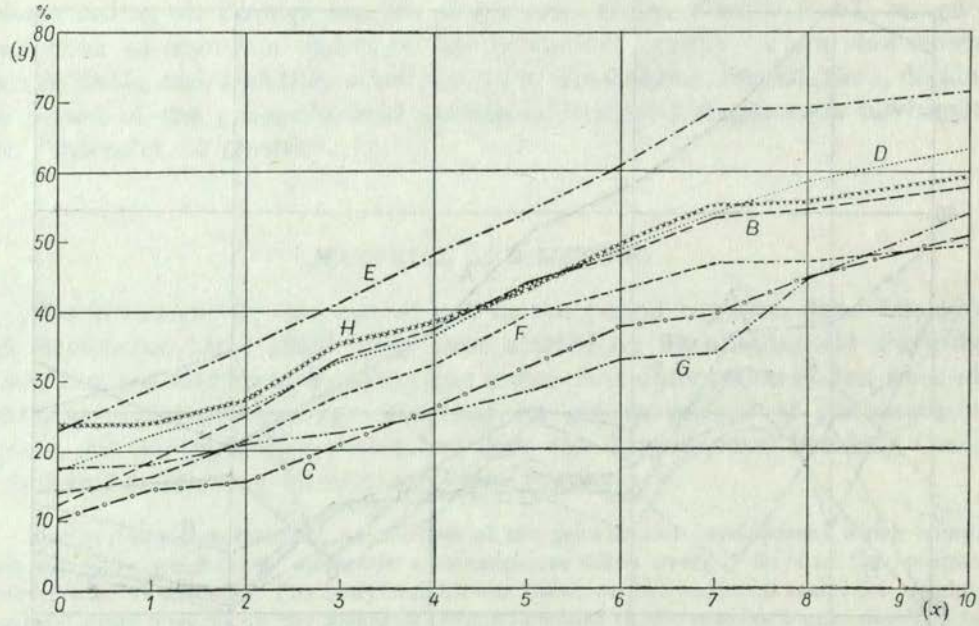
Graph 1. Curves presenting the rate of growth of separate parts of the body of Partridge chicks up to the tenth week of life. x — age of chicks (in weeks), y — rate of growth, A — body weight, B — arm, C — length of the *sternum*, D — length of the *femur*, E — of the *tibiotarsus*, F — of the forearm, G — hindlimbs gap, H — forelimbs gap.

taken as a basis of the growth curve up to the age of 10 weeks (graph 2). c) The coefficient of growth intensity (K) calculated with the logarithmic method (FABIAN, 1957; BÖGRE, 1958) for the body weight of Partridges at the following age classes: 0–21 days, 21–42 days, 42–70 days. Coefficient K was calculated on the basis of the following formula:

$$K = \frac{Sxy - \frac{Sx\,Sy}{n}}{Sx^2 - \frac{(Sx)^2}{n}} \qquad (2)$$

where: S — total, x — number of days of life, y — mean value of the measurement, n — number of weeks in the study period.

Value K was plotted on the curve of regression according to the formulas: $y = Kx + b$; $b = y - Kx$; where: y — mean value of ln body weights for the study period, x — average for mean body weights for successive weeks, b — the distance between the straight line and the abscissa (graph 3). d) A curve presenting the mean body weight of chicks in separate weeks of life was drawn on the basis of absolute data for each week of the study period (graph 4).



Graph 2. The course of curves presenting the growth of separate parts of the body of Partridge chicks up to the tenth week of life. x — age of chicks (in weeks), y — length of the given part of the body (in mm), B — length of the arm, C — length of the *sternum*, D — of the *femur*, E — of the *tibiotarsus*, F — of the forearm, G — hindlimbs gap, H — forelimbs gap.

e) The rate and manner of fledging were closely observed while carrying out the weekly measurements. When analysing the fledging of Partridges the symbols where taken from SZULC-OLECHOWA (1964), where p_0 — feather's quill, p_1 — the vane scarcely distinguished in the shape of bud, p_2 — lightly developed vane on the calamus, p_3 — fully developed feather.

RESULTS

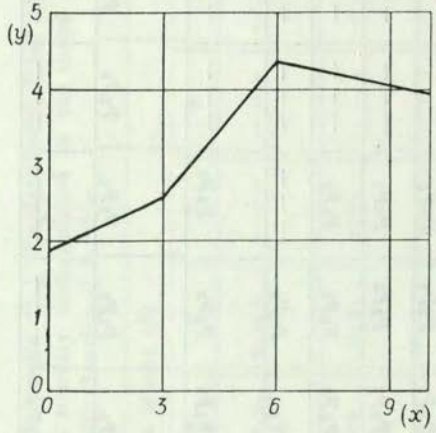
The diagrams of the rate of growth in separate weeks of life (graph 1) indicate a dynamic and uneven growth in the first three weeks of life. Next there is a gradual decrease in the rate of growth of separate organs between the third and the eighth week. The rate starts increasing from the eighth week. This can be explained in either of the two ways: either a new wave of growth occurs in this period (HAMMOND, 1946), or this is the beginning of fat deposition before the winter which affects the size of the body and obviously the body weight. We are provided with interesting material by an analysis of the curve of growth rate for the width at which the bones of the hindlimbs are set as its course differs from that of other curves. This curve, when compared with diagrams characterizing the rate of growth of other body dimensions, indicates that the largest increase is in the first week, the smallest in the second, then it is levelled off, and finally it sharply increases between the seventh and the eighth week. This unexpected increase occurs in the period when sexual features of the Partridge start to be differentiated, and the hormonal balance in the organism gets upset. We have grounds for supposing that this increase is due to increasing differences between the male and female *sternum* belts and obviously it results from the deepening sexual dimorphism. The curve presenting the growth rate of the pelvis reveals sudden increases all through the growth period. A sudden drop in the rate of growth between the first and the second week and an equally sudden increase between the second and the third week followed by a gradual decrease in the ensuing weeks can be most probably attributed to the fact that the organism of the chicken gets adapted to flight through the growth of muscles used actively during flight and attached to the pelvis. Of the other data indicating the rate of growth and not included in the diagram, it is worth to point out the negative growth rate of the beak breadth between the sixth and the seventh week, and the beak length between the seventh and the eighth week. A high negative value of these parameters does not allow to include these results in the class of errors in measuring or as connected with the loss of some chickens the measurement results of which would be higher than the average. This is the result of the hardening of the chicken's *rhamphoteca* and the ensuing alterations in the proportion. In the process the outermost layers of the *rhamphoteca* become worn out and fall off. The rate of growth for the beak breadth amounts, between the sixth and the seventh week, to 3.3 %, and for the beak length,

Table 1. The rate of fledging of separate parts of body of the Partridge, *Perdix perdix* (L.). Explanations: lined squares — fully developed coverts; dotted squares — only down. P_0 — feather's quill, p_1-vane scarcely distinguished in the shape of bud, p_2 — lightly developed vane on the calamus, p_3 — fully developed feather.

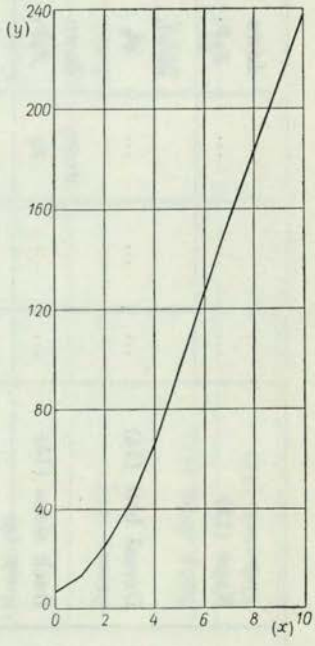
Parts of the body and pteryla (1)		First day(2)	Age in weeks (3)									
			1	2	3	4	5	6	7	8	9	10
Pterylium capitale	Crown (4)	...	...	...	...	p_2	$p_2p_3p_1$	$p_3p_2p_1$	— — —	— — —	— — —	— — —
	Head sides (5)	...	...	...	...	...	down p_1	p_2p_1	p_3p_2	— — —	— — —	— — —
	Head bottom (6)	...	...	...	...	...	down p_0	p_0p_1	p_1	p_1p_2	p_2p_3	— — —
	Lore (7)	...	...	...	down p_0	p_1p_2	$p_2p_3p_1$	p_2p_3	— — —	— — —	— — —	— — —
	Neck sides (8)	...	...	...	down p_0p_1	p_1	p_1	p_1p_2	p_2	p_2p_3	p_3p_2	— — —
Pterylium gastrale	Neck (9)	...	...	...	down p_0	p_1p_2	$p_3p_2p_1$	$p_3p_2p_1$	p_2p_3	p_3p_2	— — —	— — —
	Breast (10)	...	...	...	down p_1	p_1p_2	p_2p_3	p_3p_2	p_3p_2	p_3p_2	— — —	— — —
	Body sides (11)	...	...	...	down p_0	p_1p_2	p_2p_1	$p_2p_3p_1$	$p_3p_2p_1$	p_3p_2	— — —	— — —
	Abdomen (12)	...	...	...	...	p_1	p_1p_2	$p_2p_1p_3$	$p_3p_2p_1$	p_3p_2	p_3p_2	p_3p_2

Pterylium spinale	Nape (13)	...	...	...	down p_0p_1	$p_0p_1p_2$	$p_2p_3p_1$	p_2p_3	p_3p_2	– – –	– – –	– – –
	Dorsal belt (14)	...	...	...	down p_0	$p_0p_1p_2$	p_2p_3	p_2p_3	p_3p_2	p_3p_2	p_3p_2	p_3p_2
	Back sides (15)	...	...	down p_0	down p_0p_1	down p_0p_1	p_1	p_1	p_1p_2	p_1p_2	$p_3p_2p_1$	p_3p_2
	Crissum (16)	...	...	...	...	p_1	p_2p_3	p_2p_3	– – –	– – –	– – –	– – –
Pterylium caudale	Upper tail coverts (17)	...	...	...	...	...	...	down p_0	p_0p_1	p_1	p_1p_2	p_2p_1
	Under tail coverts (18)	...	...	...	...	p_0p_1	p_1p_2	$p_2p_3p_1$	$p_3p_2p_1$	p_3p_2	– – –	– – –
	Rectrices (19)	...	...	p_0	p_1	p_2p_3	p_2p_3	p_3p_2	p_3p_2	– – –	– – –	– – –
Pterylium alare	First remiges (20)	p_0p_1	$p_0p_1p_2$	p_1p_2	$p_1p_2p_3$	$p_1p_2p_3$	$p_1p_3p_2$	p_2p_3	p_3p_2			
	Second remiges (21)	p_0	p_0p_1	p_1	p_1	$p_1p_2p_3$	$p_1p_2p_3$	p_2p_3	p_3p_2	– – –	– – –	– – –
	Third remiges (22)	p_0	p_0p_1	p_1	p_1	$p_1p_2p_3$	$p_1p_2p_3$	p_2p_3	p_3p_2	– – –	– – –	– – –
	Second coverts (23)	...	...	p_0p_1	p_1p_2	p_2	p_2	p_2p_3	– – –	– – –	– – –	– – –
	Wing coverts (24)	...	...	down p_0	p_0p_1	p_2p_2	$p_1p_2p_3$	p_2p_3	p_3p_2	– – –	– – –	– – –
Pter. crurale	Legs (25)	...	...	...	...	down p_0	p_1	p_1p_2	p_1p_2	p_2p_3	p_2p_3	p_3p_2
Pter. anale	Anal belt (26)	...	...	p_0p_1 down	down p_1	p_1p_2	p_2p_3	– – –	– – –	– – –	– – –	– – –

between the seventh and the eighth week, to 7.65 %. The data for the coefficient of growth intensity (K) (graph 3) support the conclusion that 0–3 week-old Partridges grow most dynamically. The respective values of coefficient K are as follows: up to the third week of life — 0.0840, between the third and the sixth week — 0.0478. There are almost no variations in the intensity of growth between the sixth and the tenth week and it amounts to 0.0487. As far as the linear increase in separate parts of the bird's body is concerned (graph 2), beside the case of a sudden increase in the distance between the bones of hind-limbs as described above, the process of growth occurs, as a rule, quite smoothly. The curve presenting the growth of the *femur* is most even and, consequently, this parameter can be taken as an index of the chickens' age. This becomes self-explanatory when we take into account that Partridges are running birds and that their hindlimbs are the main locomotoric means. The curve presenting the increase in body weight assumes, up to the first ten weeks, the form of a typical sinusoidal growth curve (graph 4). The rate of juvenile fledging worked out by the author can be used effectively for assessing the age of young Partridges (cf. Table 1).



Graph 3. The course of the curve presenting the regression of the coefficient of growth intensity (K). x — age of chicks (in weeks), $y - b$ (component of regression equation).



Graph 4. Variations in the average body weight of Partridge chicks for separate weeks of life. x — age of chicks (in weeks), y — average body weights of the Partridges analysed (in grammes).

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Accepted for publication 24 VII 1970,
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STRESZCZENIE

Badania przeprowadzono w okresie 1 VI–13 IX 1968 w Ośrodku Polskiego Związku Łowieckiego w Nowym Przybyszewie. Rozpoczęto je na 96 jednodniowych piskletach kuropatwy, zakończono na 25 osobnikach 10-tygodniowych.

Opracowano zmiany rozwojowe poszczególnych elementów ciała i przyrosty wagowe piskląt. Na wykresach umieszczono: tempo wzrostu (wykres 1) i krzywą wzrostu (wykres 2) dla następujących pomiarów: długości kości ramieniowej, przedramienia, uda, przedudzia, mostka, rozstawu kości biodrowych i rozstawu kości barkowych oraz dla ciężaru ciała (tylko tempo wzrostu). Ponadto wykreślono przebieg krzywej regresji dla współczynnika siły wzrostu K (wykres 3) oraz zmiany przeciętnego ciężaru piskląt kuropatwy w poszczególnych tygodniach życia (wykres 4). Opracowane wyniki wskazują, iż najbardziej dynamiczny wzrost następuje w okresie 0–3 tygodni życia, a krzywa wzrostu ciężaru ciała przybiera postać typowej sinusoidalnej krzywej wzrostu. Ponadto opracowano tempo i sposób opierzania się młodych kuropatw (tabela 1). Uzyskane dane mogą służyć jako klucz do oznaczania wieku piskląt kuropatwy.

Objaśnienia do wykresów i tabeli:

Wykres 1. Krzywe tempa wzrostu poszczególnych części ciała piskląt kuropatwy do 10 tygodnia życia. x — wiek piskląt w tygodniach; y — tempo wzrostu; A — ciężar ciała; B — ramię; C — długość mostka; D — udo; E — przedudzie; F — przedramię; G — rozstaw kości biodrowych; H — rozstaw kości barkowych.

Wykres 2. Przebieg krzywych wzrostu poszczególnych części ciała piskląt kuropatwy do 10 tygodnia życia; x — wiek piskląt w tygodniach; y — długość badanej części ciała

(w mm); *B* — ramię; *C* — długość mostka; *D* — udo; *E* — przedudzie; *F* — przedramię; *G* — rozstaw kości biodrowych; *H* — rozstaw kości barkowych.

Wykres 3. Przebieg krzywej regresji dla współczynnika siły wzrostu *K*; *x* — wiek piskląt (w tygodniach); $y-b$ (składowa równania regresji).

Wykres 4. Zmiany przeciętnego ciężaru piskląt kuropatwy w kolejnych tygodniach życia; *x* — wiek piskląt (w tygodniach); *y* — średni ciężar badanych kuropatw (w g).

Tabela 1. Tempo opierzania się kolejnych części ciała kuropatwy. Objaśnienia; rubryki zakreskowane — okrywa dojrzała, rubryki zakropkowane — wyłącznie puch; p_0 — pałka pióra; p_1 — chorągiewka ledwo wyróżniająca się w postaci pączka; p_2 — chorągiewka ledwo rozwinięta na dutce; p_3 — pióro dojrzałe; (1) — części ciała i upierzenie; (2) — pierwszy dzień; (3) — wiek w tygodniach; (4) — wierzch głowy; (5) — boki głowy; (6) — spód głowy; (7) — kantar; (8) — boki szyi; (9) — szyja; (10) — piersi; (11) — boki ciała; (12) — brzuch; (13) — kark; (14) — pas grzbietowy; (15) — boki grzbietu; (16) — kuper; (17) — pokrywy podogonowe; (18) — pokrywy nadogonowe; (19) — sterówki; (20) — lotki pierwszorzędowe; (21) — lotki drugorzędowe; (22) — lotki trzeciorzędowe; (23) — barkówki; (24) — pokrywy skrzydłowe; (25) — nogawice; (26) — pas odbytowy.

РЕЗЮМЕ

Исследования были начаты 1 VI 1968 на однодневных птенцах серой куропатки и окончены 13 IX 1968 на особях в возрасте 10 недель. Исследованиям подвергнуты были 96 птенцов, из которых до последней фазы исследований осталось 25 особей. Работа была выполнена на Станции Польского общества охотников в Новом Пшибышеве. Прослежена возрастная изменчивость отдельных элементов тела и прирост веса птенцов. На графиках представлены: темп роста (граф. 1) и кривая роста (граф. 2) для следующих промеров: длина плечевой кости, предплечья, бедра, голени, грудины, расставления бедренных костей и расставления плечевых костей, а также для веса тела только темп роста. Кроме того был начерчен ход регрессии для коэффициента силы роста *K* (граф. 3) и изменения среднего веса птенцов по неделям (граф. 4). Полученные результаты указывают на то, что наиболее интенсивный рост происходит в период 0-3-недельного возраста, а кривая увеличения веса тела принимает вид типичной синусоидальной кривой роста. Кроме того был прослежен темп и способ оперения молодых птиц (табл. 1). Полученные данные могут быть использованы в качестве определителя возраста птенцов серой куропатки.

Обьяснения к графикам и таблице:

График 1. Кривые темпа роста отдельных частей тела птенцов серой куропатки до 10-недельного возраста. *x* — возраст птенцов в неделях; *y* — темп роста; *A* — вес тела; *B* — плечо; *C* — длина грудины; *D* — бедро; *E* — голень; *F* — предплечье; *G* — расставление бедренных костей; *H* — расставление плечевых костей.

График 2. Ход кривых темпа роста отдельных частей тела птенцов серой куропатки до 10-недельного возраста. x — возраст птенцов в неделях; y — длина исследуемой части (в мм); B — плечо; C — длина грудины; D — бедро; E — голень; F — предплечье; G — расставление бедренных костей; H — расставление плечевых костей.

График 3. Ход кривой регрессии для коэффициента силы роста K; x — возраст птенцов в неделях; y—b составная уравнения регрессии.

График 4. Изменение среднего веса птенцов серой куропатки по неделям. x — возраст птенцов в неделях; y — средний вес в г.

Таблица 1. Темп оперения отдельных частей тела серой куропатки. Объяснения: заштрихованные графы — зрелое оперение, крапчатые графы — исключительно пух; p_0 — стержень пера; p_1 — опахало едва видно в виде пучка; p_2 — опахало едва развито на стержне; p_3 — зрелое перо; (1) — части тела и оперение; (2) — первый день; (3) — возраст в неделях; (4) — верхняя часть головы; (5) — бока головы; (6) — нижняя часть головы; (7) — уздечка; (8) — бока шеи; (9) — шея; (10) — грудь; (11) — бока тела; (12) — живот; (13) — затылок; (14) — спинная птерилия; (15) — бока спины; (16) — хвостовая часть; (17) — подхвостье; (18) — надхвостье; (19) — рулевые, (20) — первостепенные маховые, (21) — второстепенные маховые; (22) — третьестепенные маховые; (23) — плечевые перья; (24) — верхние кроющие крыла; (25) — перья голени; (26) — хвостовая область.

Redaktor pracy — dr M. Józefik

Państwowe Wydawnictwo Naukowe — Warszawa 1971
Nakład 990+90 egz. Ark. wyd. 1; druk. $^{3}/_{4}$. Papier druk. sat. kl. III, 80 g, B1. Cena zł 6.—
Nr zam. 560/71 — Wrocławska Drukarnia Naukowa —