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Relative Growth Rates in Large and Small Races of Pigeons.

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Castle and Gregory[1,2] showed that cell multiplication is more rapid in the eggs of a large race of rabbits than in one of small adult size, although the absolute size of the eggs before cleavage and the rate of differentiation during prenatal growth were not different in the 2 cases. Here the adults of the large race were fully 3 times as large as those of the small race; at birth, however, individuals of the large race were only twice the size of newborn of the small race. Painter[3] had earlier obtained evidence that 12-day embryos of this same large race of rabbits contained more cells than did embryos of the small race when studied at the same age. Finally, Robb[4] found that the percentage growth-rate from birth to puberty is the same in these 2 races of rabbits, but after puberty this rate is more depressed in the small race. He failed to find evidence that pituitary difference is at any stage the basis of the growth difference.

In the present study we wished to learn from large and small races of common pigeons the extent to which differential growth is demonstrable by size at hatching, and the extent and time-relations of differential growth rates in the post-hatching period. This limitation of our problem relieves us here of the citation of a large body of literature. While this study was in progress Byerly[5] published rather extensive data concerning the growth of embryos from a larger (2.77 kilos) and a somewhat smaller (2.01 kilos) race of fowls. From the 10th day onward it was found that the embryos of the heavier race were slightly heavier than those of the lighter race; but in eggs of the same weight from the 2 breeds the size difference tends to disappear toward hatching time, probably due to the equivalence of a strictly limited food supply. A relation between size of egg and ultimate size of the contained embryo was indeed earlier well known in fowls, and in this laboratory it has long

[1] Castle, W. E., and Gregory, P. W., *J. Morph. and Physiol.*, 1929, **48**, 81.

[2] Gregory, P. W., and Castle, W. E., *J. Exp. Zool.*, 1931, **59**, 199.

[3] Painter, T. S., *J. Exp. Zool.*, 1928, **50**, 441.

[4] Robb, R. C., *Brit. J. Exp. Biol.*, 1929, **6**, 293.

[5] Byerly, T. C., *J. Morph. and Physiol.*, 1930, **50**, 341.

been recognized to hold for pigeons. Kaufman[6] has published a series of papers dealing with body and organ growth in a race (unnamed) of pigeons, and in one of these studies[7] has compared the rate of growth in chick and pigeon embryos. Data showing the exceptionally high rate of growth of ring doves and pigeons have been reported by Riddle[8] and by Lienhart.[9]

Four well-known and long-established races were chosen for study. We may here consider the weight of all these birds at 105 days (after beginning development; 87 days after hatching) as representing the mean adult weight of the 2 sexes. It is true that these birds all increase very slightly in weight—particularly during autumn and winter—after 105 days; but by using these fairly accurate figures we avoid practically all error due to seasonal change, since the present weights were obtained from March to August, inclusive. The adult weights, thus defined (and confirmed by the weights of numerous adults), are: For Tipplers, 278 gm.; Magpies, 296 gm.; Homers, 398 gm.; Runts, 565 gm. The largest race (Runts) is thus twice the size of the smallest (Tipplers).

Weights were obtained on the newly hatched young and (on some or many of these young) at 3-day intervals thereafter. The data thus obtained for the 4 races are presented in the form of smoothed curves. Eggs of pigeons are incubated unequally and they hatch between the 17th and the 19th day, usually on the 18th day. In any event their weight was obtained at hatching and at 3-day intervals thereafter, and the age at hatching is uniformly considered 18 days; at 3 days after hatching the bird is, by our method of reckoning, 21 days old. The weights as given are true weights of the body after deducting (when necessary) the weight of the contents of the crop.

There are several sources of error in obtaining the true growth-curve of any race of pigeons. When there are 2 young in a nest they each grow less rapidly than if only one were present. When a squab has attained a weight of 100 gm., and remains healthy, it will probably attain to four-fifths of its adult weight within the next 7, 15, or 25 days—depending normally upon the amount of food it receives from its regurgitating parents. An example of this decisive influence of extraordinary food conditions was shown by a bird of mixed blood whose adult weight is, and was expected to be, about

[6] Kaufman, L., *Biol. Generalis*, 1927, **3**, 105.

[7] Kaufman, L., *Mem. Inst. Nat. Polonais a Pulawy*, 1929.

[8] Riddle, O., *Am. J. Physiol.*, 1928, **86**, 248.

[9] Lienhart, R., *C. R. Soc. Biol.*, 1931, **107**, 47.

530 gm. Fed as the sole occupant of a nest by extraordinary parents this bird weighed 346 gm. on the *twelfth* day after hatching. In view of this great source of variability in animals measured during the 24-day to 50-day stages of growth a large number of weights is here of less significance than a much smaller number obtained from healthy birds under essentially standard conditions. During the collection of these data many of the young taken for measurement became infected with intestinal *Capillaria,* or developed other disease. We have either discarded such data entirely, or retained only such weights as were obviously obtained before the onset of disease. It thus happens that we have recorded more weights for early growth-stages than for later ones. The data presented include 1098 individual weights; of these 443 are for Tipplers, 177 for Magpies, 336 for Homers, and 142 for Runts. The decrease in weights soon following the 50-day stage reflects the fact that the young birds were removed from their parents, and assumed wholly self-feeding habits, at this period.

There is one source of apparent error—really involving a peculiar or abnormal condition of egg-size in one part of our material—that could not be avoided by us. Our stock of Runts was showing various ill effects of inbreeding before these studies were started. It happens, therefore, that our measurements on the young of this race have been limited to valid measurements on only 3 to 6 individuals, except for 19 weights of embryos at hatching. But it is precisely these weights at hatching that contain unavoidable error, since the inbreeding of this race has led to, or has been accompanied by, a marked reduction in egg size—and therefore of embryo size —during the past few years. Before intensive inbreeding the eggs of this race had an average weight (110 eggs) of 22.5 gm.; but during the past 2 years, which is the period covered by this study this average (170 eggs) has decreased to 19.9 gm. The embryo weights at hatching have almost or quite certainly undergone a like reduction. Our data show that this handicap (as compared with the large Homers) on hatching weight persists at 3 and 6 days after hatching; but in all of the following 27 periods the young Runts are larger than those of the Homers of corresponding age. This abnormality of the weights of Runt embryos at hatching, with rapid subsequent recovery of normal size, well shows therefore that an environmental limitation (diminished egg size) during this early period of embryonic growth does not prevent the expression of the genetic or other growth factors in post-natal growth.

At hatching the average weights of the embryos of the 4 races

were as follows: Tipplers (19), 11.3 gm.; Magpies (13), 11.5 gm.; Homers (16), 14.7 gm.; Runts (19), 14.0 gm. Since the adult weights of these races were 278, 296, 398 and 565 gm., respectively, it is clear that a part—though only a part—of the racial size difference is expressed by the weights at hatching. For the 2 smaller races the difference at the 2 periods is slight—this being about 2% at hatching and 6% in adults; for Tippler and Homer, we find 30% at hatching and 43% in the adults; for Tippler and Runt (abnormal), 24% at hatching and 103% in adults. For Magpie and Homer these values are 28% and 34%; for Magpie and Runt (abnormal embryo size), 22% and 91%. For the two large races, Homer and Runt, the embryos of the former are actually 5% larger than the (abnormally small) embryos of the Runt, though the adult Runts exceed the Homers by 42%. Thus, in all cases the racial size difference of pigeons is only partially expressed in the size of the embryos at hatching.

A large share of the ultimate size difference in these races is attained through differential rate of growth increment after hatching and most of this increment occurs during the first 18 days after hatching. During this 18-day period (18th to 36th day) the average daily percentage increment is 23.3 in Tipplers, 24.6 in Magpies, 25.7 in Homers, and 27.5 in Runts. *These values stand in the same relative order as does adult body weight in the 4 races concerned.* Instantaneous relative growth-rates calculated from fitted curves (for Tipplers, Homers and Runts) demonstrate the significance of these percentage increments. This differential rate of growth in the earliest stages after hatching provides an interesting

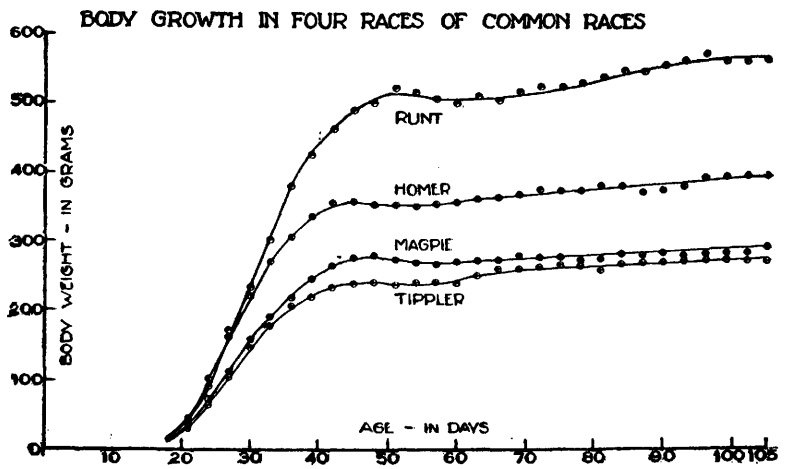

FIG. 1.

variation from the conditions described by Robb in the large and small races of rabbits otherwise studied by Castle and Gregory. There the rate of post-natal growth was identical in the 2 races until after puberty; in pigeons the total size difference is attained before puberty. This difference, however, is in no way disconsonant with the basic contribution of Castle and Gregory.

Summary. Data on relative growth-rates have been obtained for 2 small and 2 large races of common pigeons from the time of hatching to a period, 87 days later, at which their adult body weight is practically attained.

The weights of embryos of these 4 races at hatching demonstrate that racial size difference is only partially and very imperfectly expressed by size differences attained during embryonic life. A large part of racial size difference in pigeons is rapidly attained early in the post-hatching period by differential growth-rate, and practically all of adult size difference is attained before puberty.

These are marked variations from the time relations of differential growth in the large and small races of rabbits studied by Castle and Gregory, but such variations offer nothing adverse to their main conclusion. We consider it an open question, to be investigated within each species or group, whether and to what extent endocrine (pituitary) difference influences racial differences of growth-rate at a particular developmental stage; but wholly probable that such endocrine difference is an effective factor in the growth of higher animals at one or another stage.

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Glycosuria in Rabbits Following Injections of Saline Extract of Anterior Pituitary.

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A relation of the anterior pituitary to carbohydrate metabolism has often been suspected on the basis of the frequent occurrence of hyperglycemia and glycosuria in acromegaly, and of anatomical changes in the anterior pituitary in diabetes mellitus, but such a connection was not indicated experimentally until Houssay and Biasotti[1]

[1] Houssay, B.-A., and Biasotti, A., *Comp. rend. de la Soc. biol.*, 1930, **104**, 407; 1930, **105**, 121.