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Sexual Maturity and Body Changes in Layer Type Hens[1]

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ABSTRACT

The growth of organs and tissues in the laying fowl were studied from 4 to 76 weeks of age. A marked increase in the weight of the sexual organs began at the beginning of pubertal growth. During the period of their rapid growth there was little change in the growth of skeletal muscle and the liver, but there was an increase in bone mass, liver fat and body fat. The onset of pubertal growth was associated with an increase in the amount of body calcium and phosphorus. However, by the time the bird entered the laying period a fall in calcium and phosphorus occurred. Breast muscle increased in weight during the pubertal growth, but thigh muscle weight remained unchanged. Both muscles however decreased in size during the beginning of the laying period.

INTRODUCTION

Genetic selection has been an important factor in achieving the remarkably high performance of modern laying strains of fowl. Both improved husbandry and diet have also made important contributions to the efficiency of the reproductive effort of laying birds. Further improvement and the maintenance of this high performance will require a more basic understanding of the physiology of growth and maintenance of reproductive and associated tissues. Currently, little knowledge is available even of general aspects of growth of the laying bird. This study was directed toward investigating the growth of certain tissues of laying birds both prior to, during and after the onset of sexual maturity.

MATERIALS AND METHODS

Ninety-six four-week-old female Thornber 808 chicks were obtained from the Poultry Research Centre. They were provided with food and water *ad lib*. Groups of six birds were killed at the following ages: 4, 6, 8, 12, 16, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30 and 76 weeks by intravenous injection of Nembutal (Abbot Laboratories Ltd., Sodium pentobarbitone, Vet. C). All birds were plucked and dissected immediately following death.

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The dissected organs were the breast muscles (the pectoralis and the supracoracoideus), and the thigh muscles (all muscles associated with the femur), the liver, ovary and oviduct. The breast and thigh muscles and the liver were freed from visible fat, weighed and stored in a deep freeze ($-20°C$) until they were required for chemical analysis.

In the functioning ovary of the mature pullet, the follicles containing oocytes of stage 6, as described by Gilbert (2), and larger, were removed. The ovary and oviduct, thereafter, were separately weighed and placed in a hot-air oven at 100°C for water content determination. The rest of the body carcass was weighed and placed in a polythene bag, which was sealed and kept in a deep freeze until required for chemical analysis.

The water content of the skeletal muscles (breast and thigh), liver and the remaining body carcass was determined by mincing the thawed samples and then placing them in a hot-air oven at 100°C until a constant weight was reached. Dry weight of the ovary and oviduct was obtained from intact organs. Dried muscle samples were ground to a fine powder and fat and protein content was determined on a duplicate aliquots. The total fat content was determined by Soxhlet continuous extraction apparatus using chloroform as the solvent. Total protein was determined by the Standard Kjeldahl Method. The factor 6.25 was used to convert nitrogen to protein. Calcium, phosphorus and potassium content of the dried body carcass samples was determined by X-ray fluorescent spectrometry as described by Jenkins and De Vries (5). The total bone mass was calculated from the calcium results obtained from direct chemical analysis of body carcass. The calculation was based on the assumption that 99 % of the total body calcium of the domestic fowl is in the skeleton (8) and that adult chicken bone contains between 12.8 g and 13.5 g of calcium in 100 g of fresh fat-free bone as has been found by Dickerson (1) and Sagher (7).

RESULTS AND DISCUSSION

Growth curves for the whole body and various organs are shown in Figs. 1 and 2. Although the major growth period of the body occurs prior to puberty, a considerable weight increase was evident both during the pubertal and laying periods. The point of inflexion marking the onset of pubertal growth occurred at 18 weeks. An unusual feature of the growth curve was the sharp fall in body weight coinciding with the beginning of the laying period.

In addition to the marked, but irregular, growth of the ovary and oviduct during the pubertal period, the bone mass was also shown to undergo a considerable increase (Fig. 2). Less marked increases in the weight of liver and breast muscle were observed during this period, in both cases accompanied by considerable irregularities in their growth rates. There was little evidence of pubertal growth in the thigh muscle. Decreases in size of the breast muscle, thigh muscle and bone mass coincided with the fall in body weight occurring during the initial part of the laying period.

As shown in Figs. 3 and 4, changes in some major chemical components of the body, muscles and liver closely follow total weight changes. However, notable exceptions were the protein content of the body and liver. In both these cases it would appear that increased fat deposition accounts for a considerable proportion of the increased weight gained during the laying period.

The onset of sexual maturity is rapid in the laying hen. Most of the growth of the oviduct and ovary is accomplished between the 18th and 20th weeks. However, the increase in body weight during the pubertal growth period could not be accounted for by the growth of the sexual organs alone: other organs and tissues were found to increase in

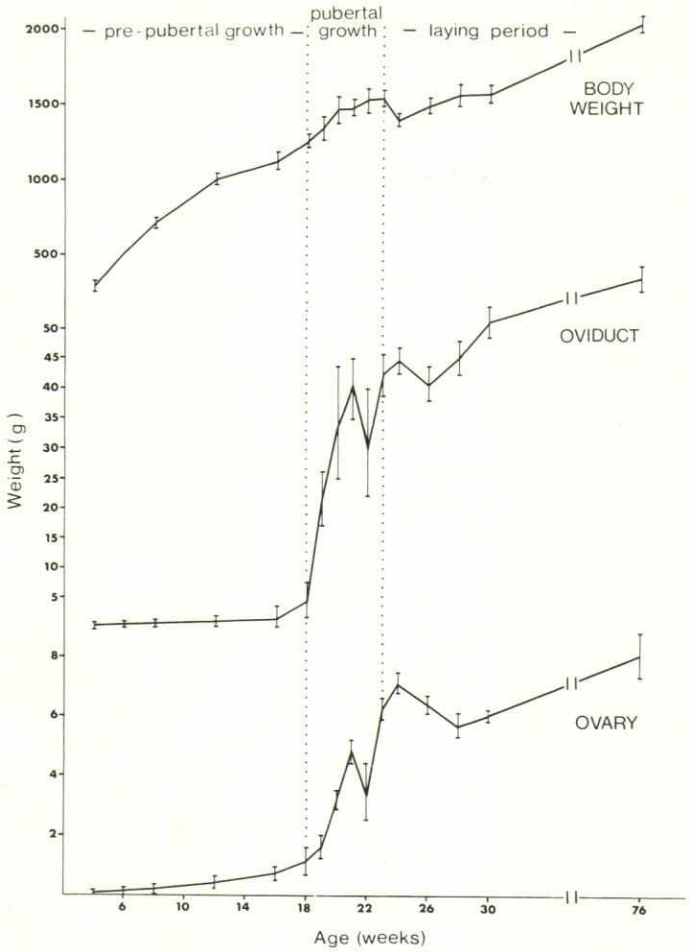

Fig. 1. Body changes before, during and after pubertal growth in laying type hens. Values are mean of six birds + S.E.M.

size during this period. Bone mass undergoes approximately a 50% increase during pubertal growth (Fig. 2). The increase during this period is due mainly to an increase in the body calcium and phosphorus (Fig. 4). The amount of body calcium and phosphorus increases significantly during the period of pubertal growth and before laying. Figure 4 shows the changes in body calcium, phosphorus, potassium, protein and fat. The increase in body calcium and phosphorus is probably due to an increase in calcium and phosphorus absorption. It has been reported by Taylor *et al.* (8) that during the pre-laying period the retention of calcium and phosphorus from the digestive tract increases. The total skeleton weight also increases by 20% during this period. Significant, but less marked, increases in liver and breast muscle weight also occur during pubertal growth (Fig. 2) both of which represent important components of the total body increase.

The results obtained in this work show an increase in the total liver fat and protein during the pubertal growth period and prior to laying (Fig. 3). This increase is an essential part of the synthesis of yolk lipids and proteins. The role of the liver in the synthesis of yolk materials is well established, and it is known to undergo a considerable increase

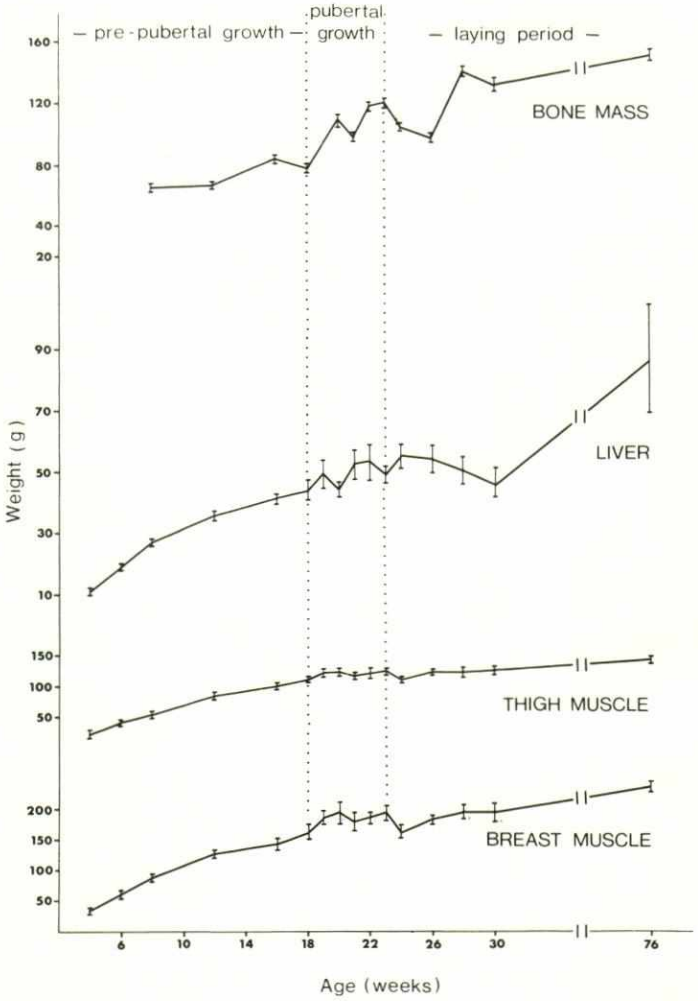

Fig. 2. Body changes before, during and after pubertal growth in laying type hens. Values are mean of six birds + S.E.M.

in size under the influence of sex hormones (4). Plasma lipids, phosphoproteins and lipovitellin levels are known to increase considerably during pubertal growth (3 and 6).

The significance of the increase in breast muscle size at puberty is not so obvious. There is a sharp decrease in size of this muscle during the onset of laying which suggests that its growth during puberty may provide a store of protein and/or energy which is used later as egg formation begins.

In this study the onset of sexual maturity is characterized by a sharp fall in body weight, mainly due to a reduction in muscle protein and bone mass. These changes might indicate that these losses of body components may also be attributed to the early demands of egg formation. However, recent findings (P. J. Sharp, 1973, personal communication) have shown that a similar decrease in body weight occurs in the cockerel at the end of the pubertal growth period. The growth changes in the laying bird may not, therefore necessarily be associated with the onset of egg formation and will require further investigations to understand their significance.

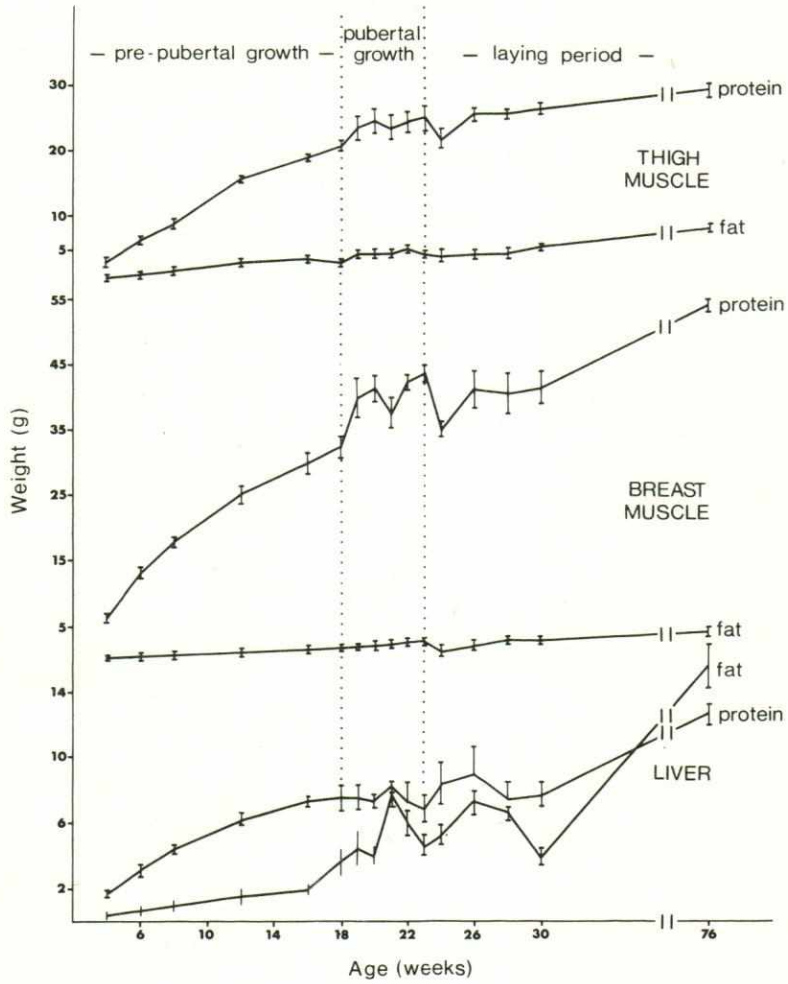

Fig. 3. Body changes before, during and after pubertal growth in laying type hens. Values are mean of six birds + S.E.M.

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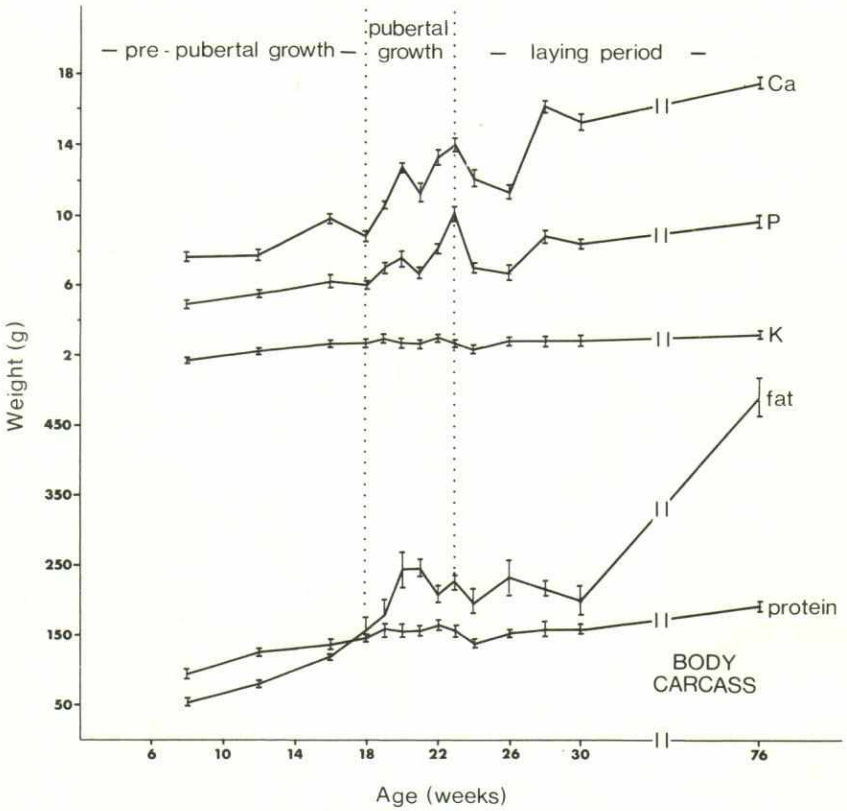

Fig. 4. Body changes before, during and after pubertal growth in laying type hens. Values are mean of six birds + S.E.M.

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