VTH KEITH GOODERHAM WATERFOWL LECTURE

Sexual maturity and laying performance in ducks

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Controlling growth and delaying sexual maturity substantially improves both rate of lay and breeding performance.

Restricting feed when rearing laying and breeding ducks reduces growth and delays physiological development measured in terms of bone and feather growth, behaviour and sexual maturity in relation to liveweight measured as a percentage of ad libitum liveweight.

Controlling growth improves synchronisation between growth and sexual development to an extent that significantly reduces but does not prevent internal ovulation. This is in contrast to ducks reared on ad libitum feed, where internal ovulation is frequent and is probably responsible for their inferior laying performance compared to birds reared on restriction.

High temperatures reduces mature liveweight of ad libitum fed ducks, which significantly delays age at sexual maturity, and there is evidence of an interaction in the effects of temperature and liveweight on age at sexual maturity. This should be taken into account when considering the extent to which growth to 20 weeks should be limited by feed restriction to delay sexual maturity in hot climates.

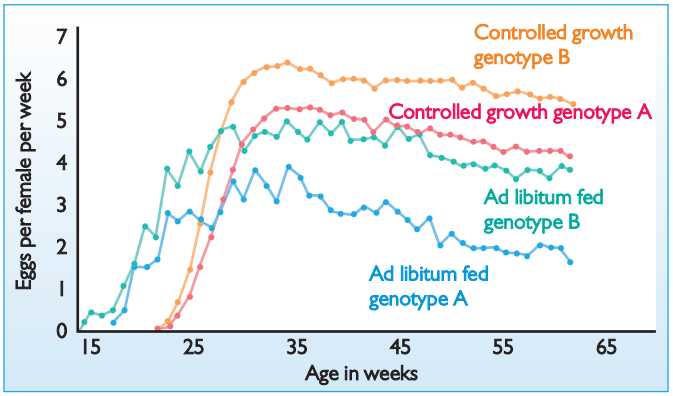

Fig. 1. Laying performance of two Pekin genotypes A and B reared on ad libitum and restricted feed to achieve 70 and 75% respectively of ad libitum fed mature weight at 18 weeks of age. To avoid precocious sexual maturity, both ad libitum and restricted fed birds were reared on a step-down non-stimulatory light programme of 23 hours to eight weeks when, daylength was decreased weekly in equal steps, to provide 17 hours at 18 weeks of age. Birds were given ad libitum and timed feed restriction respectively from 21 weeks. Data from Cherry (1993).

There is a widely held view that increasing liveweight and percentage of body fat is highly likely to substantially reduce laying performance.

However, Pekin parent stock reared on feed restriction to nine weeks, and then subsequently allowed, by provision of ad libitum feed to achieve about 95% of ad libitum liveweight at 18 weeks, although very much fatter than fully restricted birds at sexual maturity achieve similar rates of lay.

The evidence suggests the increased rate of lay obtained from birds reared on restriction compared to birds reared on ad libitum feed from day-old is not a consequence of differences in percentage body fat at sexual maturity but is probably a result of delayed sexual maturity, and perhaps permanent changes to the neuro-endocrine system arising from stringent feed restriction in the early weeks of life.

Changes in natural or artificial daylength during rearing can significantly affect age at sexual maturity. Increasing daylength during rearing or reducing the age at which artificial light is increased reduces age at sexual maturity, but restricted feeding can affect this response.

There can be a significant interaction between rearing light programme and liveweight at 20 weeks affecting age at sexual maturity for birds reared on either a step-down or constant 17 daylength, compared with birds reared on a step-up light programme.

The rearing light programme can affect not only age at sexual maturity of laying ducks but also subsequent rate of lay. Increasing daylength by more than three hours during the latter stages of rearing can reduce post peak laying performance and this might be described as a photorefractory response.

Excellent results have been obtained by maintaining Pekin parent ducks and drakes on a constant daylength of 17 hours from day-old

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Fig. 2. Effect of liveweight at 18 weeks expressed as a percentage of mature ad libitum fed liveweight on age at sexual maturity, Pekin genotypes A and B with mature weights of 4.94 and 4.1kg in four trials were given similar step-down lighting programmes during rearing and a 17 hour daylength in lay, birds were changed from quantitative feed restriction to timed feeding at different ages. Data from Cherry (1993).

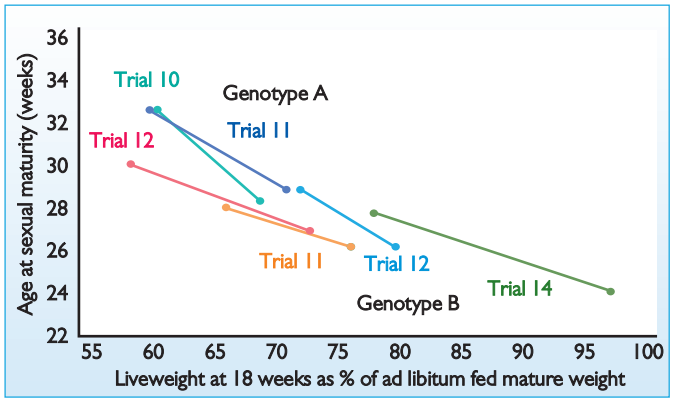
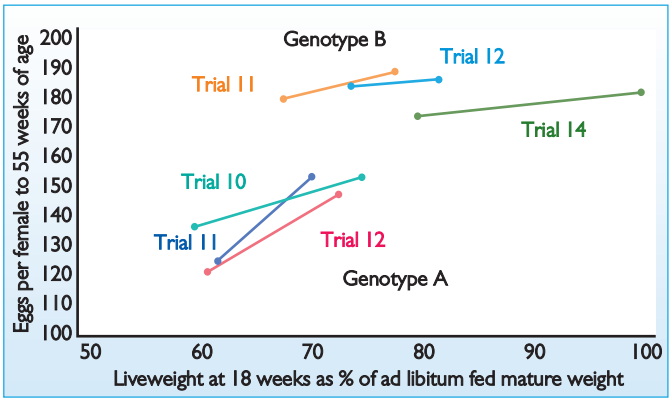


Fig. 3. Effect on laying performance in four trials of liveweight at 18 weeks expressed as percentage of ad libitum fed mature weight. Genotypes and lighting programmes as in Fig. 2. Data from Cherry (1993).



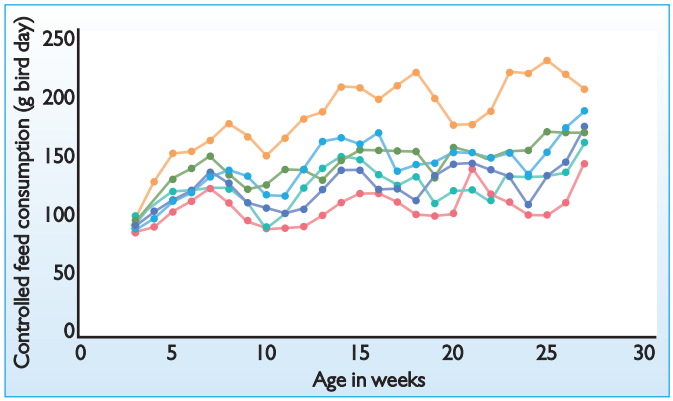


Fig. 4. The effect of nutrient concentration on daily feed intake of Genotype A reared on feed restriction to achieve 65 and 75% of ad libitum fed mature liveweight at 26 weeks. Birds were reared on a step-down-step-up lighting programme with increased daylength from 16 or 20 weeks. Data from Cherry (1993).

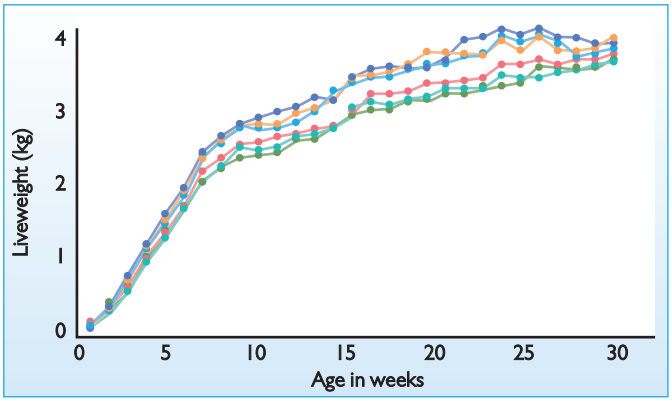


Fig. 5. Growth of genotype A, reared on three alternative diets to achieve 65 and 75% of ad libitum fed mature liveweight at 26 weeks of age. Treatments as in Fig. 4. Data from Cherry (1993).

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until the end of the breeding cycle. This programme is simple and applicable at all latitudes.

Rearing of parent stock

Until about 1970, breeding stock in the USA and Europe were selected from table ducklings fed for maximum live weight gain. Selection was based on growth rate and appearance, sometimes with an assessment of carcase quality made by handling the live bird. Selected birds were then reared to sexual maturity either extensively or in semi-intensive accommodation and with ad libitum feeding.

Selecting breeding stock in this manner was very effective in increasing rate of growth but also indirectly selected for increased appetite, fatness and mature live-weight, and unfortunately, for reduced reproductive fitness. Mature live-weight increased substantially between 1960 and 1975 and anecdotal evidence suggests that by about 1970, egg production and hatchability had declined to less than about 130 eggs per laying female and >60% respectively.

Duck breeding companies experiencing a continuing decline in reproductive performance, and knowing that the broiler industry was improving reproductive potential of its breeding stock by restricting feed intake during growth to sexual maturity, began to investigate restricted feeding.

Controlled feeding

Fig. 1. shows the effect of feed restriction on two Pekin genotypes. Genotype A was selected for growth and efficiency of feed conversion (mature live-weight 4.9kg) and genotype B was selected for egg production as well as growth (mature live-weight 4.1kg).

Both genotypes, when fed ad libitum, came into lay at about 16 weeks of age and reached 50% lay about four weeks before restricted fed birds.

They produced about 100 and 170 eggs by 60 weeks of age, whereas restricted fed birds produced 173 and 211 eggs, respectively.

Increased mature size and ad libitum feeding to sexual maturity were both associated with increased multiple ovulation and consequently double yolked eggs and substantially lower egg production.

Controlling the feed supply during rearing delays sexual maturity, reduces multiple ovulations as measured by the incidence of double-yolked eggs and increases rate of lay for both egg-producing and table Pekin genotypes.

Restricted growth delays physiological development, measured in terms of feather growth, behaviour and sexual maturity, probably in relation to the degree of restriction measured as a percentage of ad libitum liveweight. The potential for further growth remains until sexual maturity when the capacity for further growth is lost.

Post-mortem examination of birds at sexual maturity and at the conclusion of lay confirms the internal organisation between growth and sexual development is affected by growth to sexual maturity. Feed restriction delays sexual maturity and improves synchronisation between growth and sexual development to an extent that significantly reduces, but does not prevent internal ovulation. This is in contrast to birds reared on ad libitum feed, where internal ovulation is frequent and is probably responsible for their inferior laying performance (see Fig. 1) compared to birds of the same genotype reared on restriction.

Temperature affects feed intake, growth and subsequent ad libitum mature liveweight, but does not appear to inhibit physiological development to the same extent as quantitative feed restriction causing the same reduction in live weight.

As a consequence, in order to successfully delay sexual maturity in hot climates it is probably necessary to relate restriction to ad libitum growth in that climate.

Fig. 2 summarises the relationship between restricted fed liveweight at 18 weeks and age at sexual maturity for genotypes A & B reared on a step-down lighting programme.

Analysis of results of several well replicated trials provides the following estimate of restricted live weight at 18 weeks, measured as a percentage of ad libitum mature live weight (x), upon age at sexual maturity:
● Age at sexual maturity (weeks) = 42.43 – 0.199x.

All trials with both genotypes show a consistent effect of liveweight upon sexual maturity, with each 10% reduction in live weight associated with 14 days delay in sexual maturity. Increasing live weight in the range 60-95% of ad libitum mature live weight at 18 weeks for birds reared on severe restriction from day-old is accompanied by an improved laying performance to a fixed age (see Fig. 3).

Fig. 6. Relationship between plucked bodyweight (kg) and percentage skin and fat measured at 21 and 25 weeks of age. Treatments as in Fig. 4 and growth to 26 weeks as in Fig. 5. Data from Cherry (1993).

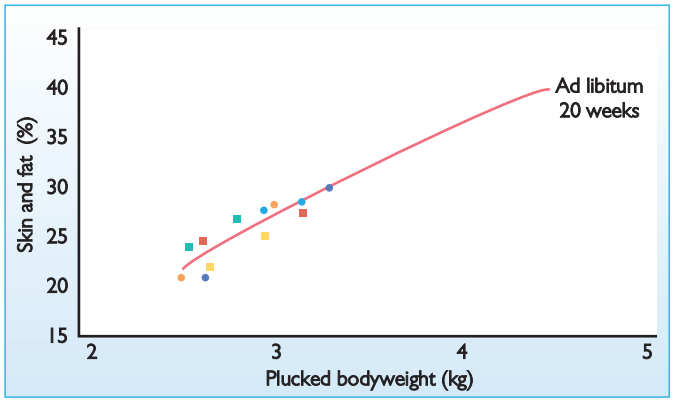
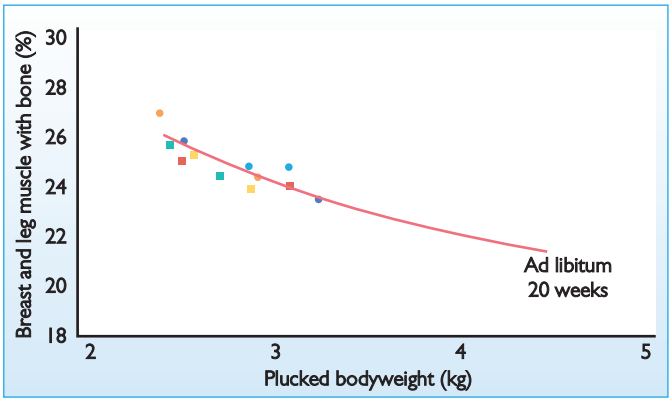


Fig. 7. Relationship between plucked bodyweight (kg) and % breast and leg muscle with bone, measured at 21 and 25 weeks. Treatments as in Fig. 4 and Fig. 6. Data from Cherry (1993).



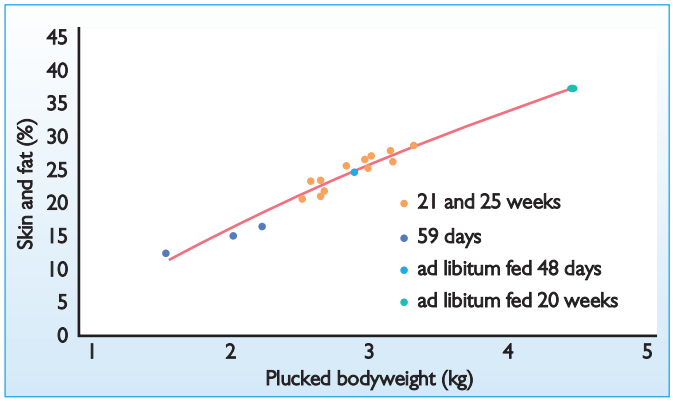


Fig. 8. Relationship between plucked bodyweight and % skin and fat for Genotype A recorded at different ages in three separate; data from Cherry (1993).

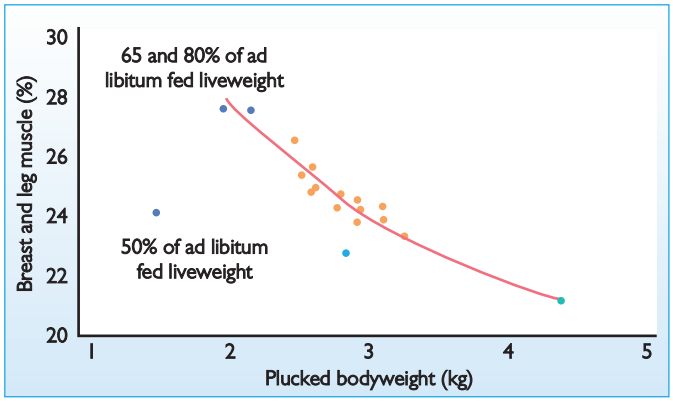


Fig. 9. Relationship between plucked bodyweight (kg) and % breast muscle and leg muscle with bone for Genotype A recorded in three trials. Key as in Fig. 8; data from Cherry (1993).

This is a consequence of earlier age at sexual maturity extending the effective laying period.

Body composition

Figs. 4 and 5 describe the treatments, feed intake and growth recorded in a trial designed to investigate the opportunities for altering body composition of parent stock reared on restriction to achieve 65% or 75% of ad libitum live weight at 25 weeks of age. Dietary treatments began at day-old and continued until the start of egg production at about 25 weeks. Adjusting the level of feed restriction on a weekly basis controlled growth. Analysis of feed intake shows that, in spite of very wide differences in protein intake growth to 20 weeks of age was principally controlled by energy consumption (x, MJ ME, 0-20 weeks):

- 20 week live weight (kg) = 1.276 + 0.0095x.

Samples were taken for carcase dissection from all treatments when birds were 21 and 25 weeks of age. The effects of the treatments upon body composition expressed as a percentage of plucked weight show that the percentage of skin and fat increased with age (Fig. 6), while the percentage of breast and leg meat with bone decreased over the same range of plucked body weight (Fig. 7).

Analysis of carcase dissection data along with that for ad libitum fed birds of the same genotype aged 20 weeks provides the following estimates of body composition as a function of plucked body weight (x, kg):

- Skin and fat (%) = -16.5 + 17.6x - 1.133x2.
- Breast and leg muscle with bone (%) = 40.68 – 7.63x + 0.731x2.

These results show that the principal factor affecting body composition of females approaching sexual maturity is body weight, and there is little if any opportunity to alter body composition at any specific live weight through manipulation of diet composition.

Figs. 8 and 9 show the relationship between plucked weight and weight of skin and fat, and breast meat and leg muscle and bone, expressed as a percentage in three trials. Birds in these trials were of the same genotype, reared on ad libitum and restricted feed using different nutrient specifications and killed at different ages.

Neither age nor ad libitum or restricted feed or alternative nutrient specifications during rearing had any significant effect on body composition at a given weight. The proportions of the Pekin duck appear to be determined by growth, with body composition being a simple function of size alone.

The Pekin duck is able to achieve sexual maturity and maintain a satisfactory rate of lay over a range of body compositions, and the opportunities for altering body composition by feed restriction are limited by the fixed relationship of body composition to body weight.

Effect of day-length

Changes in natural or artificial daylength during rearing can significantly affect age at sexual maturity. Increasing daylength during rearing or reducing the age at which artificial light is first increased will reduce age at sexual maturity in a linear manner, if the ducks are given enough feed to allow ovarian development.

Rearing light programme can affect not only age at sexual maturity but also subsequent rate of lay.

Increases in natural or artificial daylength of more than three hours during the latter stages of rearing can reduce post-peak laying performance. This is described as a 'photorefractory' response. Excellent results have been obtained by maintaining meat strain ducks and drakes on a constant photoperiod of 17 hours from day-old until the end of the breeding cycle (see Fig. 10).

This program is simple and applicable at all latitudes and deserves to be adopted as the standard method for rearing Pekin breeding stock.

Rearing light programme can significantly affect male sexual maturity, but there appears to be no advantage measured in terms of improved early fertility in rearing males on a different light programme to females.

Summary

Experimental evidence along with substantial commercial experience confirms excellent results have been obtained by controlling growth from day-old to sexual maturity (see Fig. 11) and maintaining Pekin parent ducks and drakes on a constant daylength of 17 hours from day-old until the end of lay. ■

Fig. 10. Laying performance of six commercial flocks of Genotype B hatched between March and November and given a constant 17 hour daylength from day-old to the end of lay. Birds were reared on feed restriction to achieve about 75% of ad libitum fed mature liveweight at 20 weeks of age. Average laying performance to 50 weeks was 147 eggs per female, based on number alive at 20 weeks of age. Data from Cherry (1993).

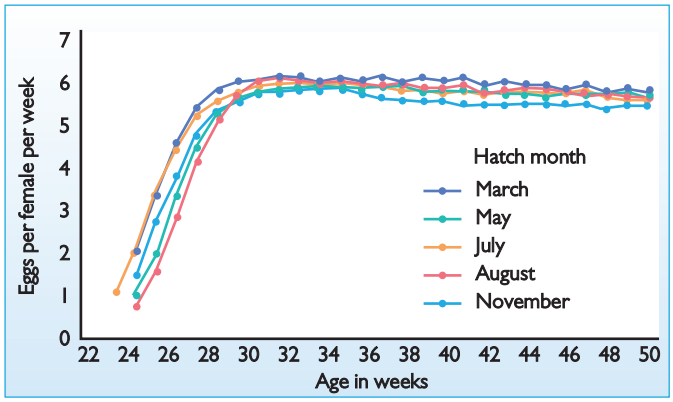


Fig. 11. Rate of lay of six large commercial flocks of Pekin parent stock hatched at about the same time of year and given similar environment, nutrition and husbandry during lay. Age at sexual maturity was 26 weeks, average egg production over 40 weeks based upon number housed was about 225 eggs per female, mature egg weight was about 89g and mortality, infertility and hatchability were 7.65, 4.8 and more than 80% respectively. Data from Cherry (2008).