GENETIC AND PHYSIOLOGICAL ASPECTS OF GROWTH, BODY COMPOSITION AND FEED EFFICIENCY IN MICE

by

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CANDIDATE'S CERTIFICATE

I certify that the substance of this thesis has not already been submitted for any degree and is not being currently submitted for any other degree.

I certify that any help received in preparing this thesis, and all sources used have been acknowledged in this thesis.

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SUMMARY

Genetic and physiological aspects of growth, body composition and feed efficiency between 3 and 8 weeks of age were studied in three lines of mice, two of which had been selected over 10 generations for high (H) and low (L) 8-week body weight; and a third, randombred control (R). The physiological parameters studied were: chemical composition of the whole body (WB) and its carcass (C) and non-carcass (NC) parts, digestible energey intake (DEI), and energy requirements for maintenance and for growth. The genetic parameters measured were: direct and correlated selection responses, direct genetic effects of the offspring (g^O), maternal genetic effects (g^M), direct heterosis (h^O), maternal heterosis (h^M) and recombination effects in the offspring (r^O).

Individual body weights, feed intake and determinations of water, fat, protein and ash for the WB, C and NC were available for 421 mice sampled weekly from 3 to 8 weeks of age. The NC parts accounted for 60.2 to 66.8 percent of the WB. The H line mice grew faster and were heavier than the controls at all ages, whereas the L mice showed slower growth rate and were lighter. Weights of water, fat, protein and ash increased as a result of selection in the H line and decreased in the L line. Expressed as percentage of the fresh WB, the protein and water showed a decrease but fat and ash an increase in the H line. Difference between the R and L lines for percent chemical components was generally not significant. Fat showed larger between-line variation than any other chemical constituent. Although leaner than both the R and L lines at low body weight, H line became fatter with increasing body weight. When chemical composition traits were expressed as percentage of dry body, differences between lines for fat, protein and ash were accentuated. On a fat-free basis, between -line differences for water, protein and ash were reduced.

Allometric coefficients *b* obtained from the regression of log fat weight on log weight of the WB for the L, H and

R lines were respectively 1.60 ± 0.12, 1.48 ± 0.10 and 1.73 ± 0.10 for the fresh and 1.61 ± 0.08, 1.61 ± 0.09 and 1.87 ± 0.09 for the dry body. Neither slopes nor elevations of the regression lines for fat were significantly different between the R and L lines, whereas H and R line comparisons were significant for both slopes and elevations. The higher b value for fat on a dry weight basis in the H line was at the expense of b values for protein and ash which were reduced considerably.

Water percentage was significantly lower and fat percentage higher in the NC than in C parts. The proportion of ash was higher in the C part. However, in spite of important differences in the C and NC for the proportion of different tissues, the pattern of growth of tissues in the individual parts followed an overall pattern of growth of the whole body.

Females had higher fat percentage than males between 3 and 8 week growth period but not significantly so at 6 and 8 weeks. Differences in fat percentage between the two sexes increased when compared on a dry weight basis.

There was no indication of differences between lines in percent digestibility. Weekly maintenance food and energy requirements during active growth period on a restricted level of feeding were 1.25g, 1.35g and 1.50g, and 21.0kJ, 22.7kJ and 25.2kJ per g of body weight for the H, R and L lines, respectively. Adult mice showed 10 to 16 percent less maintenance food needs than the growing mice. The ranking of the lines for maintenance food requirements was consistent over the two feeding trials involving young or adult mice. The estimates of maintenance food requirements for growing H, R and L mice, calculated from the extrapolation of the regression of weight gain between 3 and 5 weeks on *ad libitum* feed intake during this period, were respectively 1.26 ± 0.10,1.32 0.14 and 1.29 ± 0.20 per g of body weight per week.

Average weekly maintenance energy requirements per gram of body weight on *ad libitum* feeding calculated as the difference between DEI and increase in body energy as fat and protein during 3 to 8 week growth period were 19.52 ± 0.36kJ, 21.84 ± 0.29kJ and 23.36 ± 0.33kJ for the H, R and L lines respectively. The weighted averages for weekly maintenance energy requirements on a per gram of body weight basis on restricted and *ad libitum* feeding for the H, R and L lines were 20.11kJ, 22.09kJ and 23.95kJ respectively.

It was concluded that the increased gross efficiency of the H mice over the controls was due to their relatively reduced maintenance requirements and greater efficiency of energy utilization for growth. There were no significant differences between the H and L lines in the efficiency of energy utilization and a higher gross efficiency of the H line relative to the L line was because of significantly lower maintenance requirements of the H line. The differences between the R and L lines for gross efficiency were small. The R line had a lower maintenance requirement and a greater proportion of energy available for growth as compared with the L line. However, because of a comparatively less efficient use of energy available for growth by the R line, the differences in the overall efficiency of the two lines were not significant. The mean efficiencies of utilization of energy for growth for the H, R and L lines were 10.3 ± 0.6, 7.8 ± 0.7 and 13.9 ± 2.1 percent, respectively.

Phenotypic differences between the H, R and L lines were partitioned into g^O, g^M, h^O, h^M and r^O. The traits studied were body weight, body composition, weight gain, feed intake and feed efficiency. A mating scheme was designed and procedures for calculating unconfounded estimates of the genetic effects developed. An experimental study was made by using a three-way crossing scheme by which 13 genetic groups were produced.

Data on 3-week body weight were available for 1035 mice. Determinations of fat and protein at 3 and 8 weeks, 8-week body weight, and 3-8 weeks weight gain, feed intake and feed efficiency were made on 475 mice.

Differences in direct genetic effects between the H and L lines were significant for all traits. Comparisons between the H-R and R-L were significant for a majority of traits. Direct genetic effects favoured the larger line in every comparison between lines. Maternal genetic effects were more important for weaning traits than for postweaning traits. F_1 crosses between the H and L lines showed heterosis for body weight and fat weight at 3 weeks and feed efficiency. Heterosis in the HxR F_1 was significant for 8-week body weight, feed intake and weight gain and in F_1 crosses between the R and L lines for body weight and protein weight at 3 weeks and feed intake. Maternal heterosis was calculated in crosses involving H and L lines and was significant for body weight and protein weight at 3 weeks. Recombination effects were not significant for any of the traits studied.

It was concluded that the direct genetic effects account for a major part of the differences between the H, R and L lines. The proportion of maternal genetic effects was relatively small, but important for weaning traits and declined in postweaning traits. Heterosis observed in a number of traits in this study provided evidence of existence of significant non-additive genetic variance between these mouse lines. Maternal heterosis in the F_1 dams was responsible for an enhanced preweaning growth of the progeny.