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Comparative Study of Effects of Gravity on the Growth of Hamsters and Mice

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Comparative Study of Effects of Gravity on the Growth of Hamsters and Mice[1]

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Abstract. Syrian golden hamsters appear to withstand gravitational stress better than white mice. When these animals were subjected to four weeks of continual centrifugation at four times the Earth's gravity (4 G's), both showed a definite decrease in body mass during the first week, then a subnormal growth rate for the remaining three weeks of exposure as compared to their controls living within the Earth's gravity (1 G).

Physical considerations suggest that gravity is one of the factors which control growth. Very little experimentation with gravity and its effects upon growth of animals has been undertaken. This is especially true with respect to prolonged exposure of the animal to several times the Earth's gravity.

Matthews (1953) reared rats under continual centrifugation at 3 G's for 1½ years and found that they showed subnormal growth as compared to their controls. Gray and Edwards (1955, 1956) reported similar studies with wheat coleoptiles. Kelly *et al.* (1957, 1959) have found definite anatomical and physiological effects upon the development of chickens exposed to continuous centrifugation. A definite depression of growth of Drosophila larvae and of white mice when exposed to continuous centrifugation has been demonstrated in our laboratory (Wunder *et al.*, 1955, 1959, 1960). All workers have shown that the effects of gravity upon growth and development of the organisms cannot be denied. This paper deals with the comparative studies made in our laboratory on the white mouse and golden hamster subjected to four times the Earth's gravity for prolonged periods of time. Such effects were produced by continuous centrifugation in a type of centrifuge which is described by Walters *et al.* (1960). Our studies have shown a definite loss of body mass during the first seven to eight days of exposure to 4 G's, then a gradual increase in body growth thereafter in both mice and hamsters (Figures 1 and 2). Possible reasons for these changes in growth will be discussed later in this paper.

MATERIALS AND METHODS

Syrian golden hamsters and white mice (NLW strain) were

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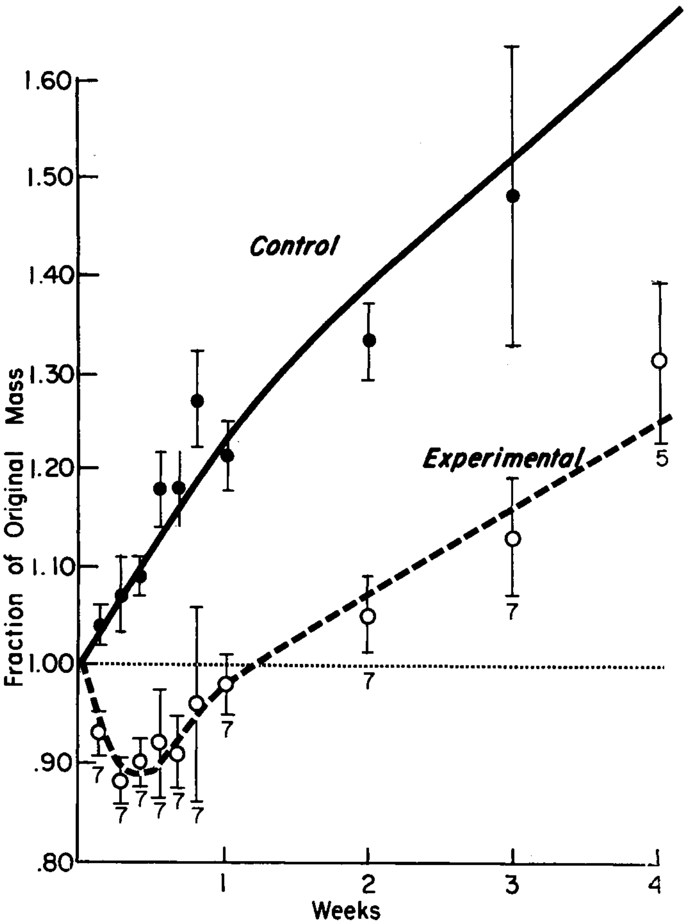

Figure 1. Growth of female hamsters exposed to 4 G's. Standard errors are shown by vertical lines above and below experimental points. Numerals next to the experimental points indicate the number of experimental animals and also the number of control animals.

placed in specially designed centrifuge cages when five weeks of age. Control litter mates of comparable body mass were placed in identical cages but kept under the influence of normal gravity (1 G). All animals received nearly identical diets of laboratory rat chow and uncooked potato, with the exception of the hamsters, which received green lettuce once weekly. The potato served as the only source of water. The experimental temperature was maintained at 22° C. The centrifuge cages were divided into two compartments by a metal partition. One hamster was placed in each compartment, whereas several mice were grouped together in each compartment due to smaller size.

The experimental animals were kept under continuous centrifuga-

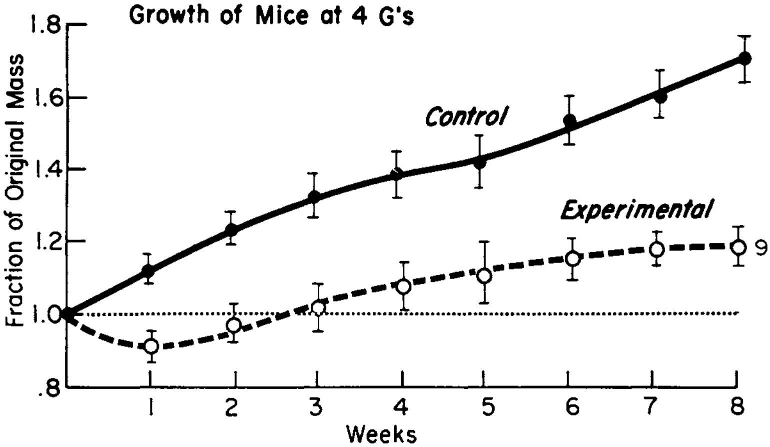

Figure 2. Growth of female white mice exposed to 4 G's. Growth is shown for extended time beyond the 4 week period cited in this paper. Standard errors are shown by vertical lines above and below experimental points. Numerals next to the experimental points indicate the number of experimental animals and also the number of control animals.

tion except for a very short time each day for feeding and weighing.

After four weeks of centrifugation, the hamsters and some mice were removed from the centrifuge and autopsies were performed. Body measurements were made, and various organs were removed and weighed. These results will be reported elsewhere when analysis is completed. Femur bones were removed, cleaned of tissue, weighed, and the primary axes of each were measured.

Other animals were autopsied when five weeks of age (i.e., at the time when usual exposure to gravity begins) and their relative body mass, etc., was determined for comparison.

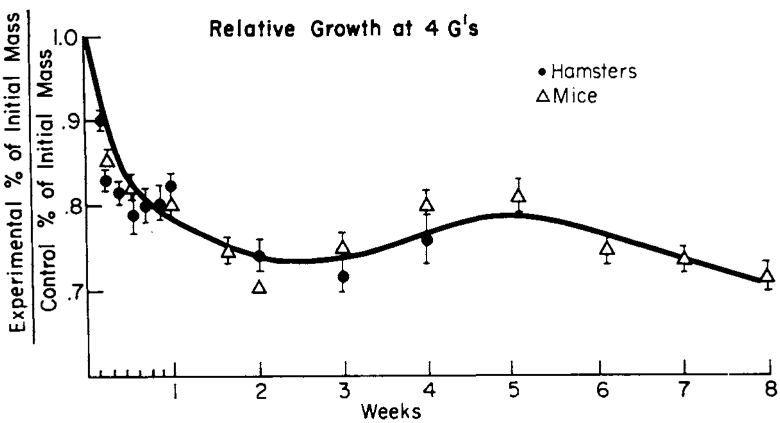

Figure 3. Relative growth of hamsters and mice exposed to 4 G's for 4 weeks. Standard errors are shown by vertical lines above and below experimental points.

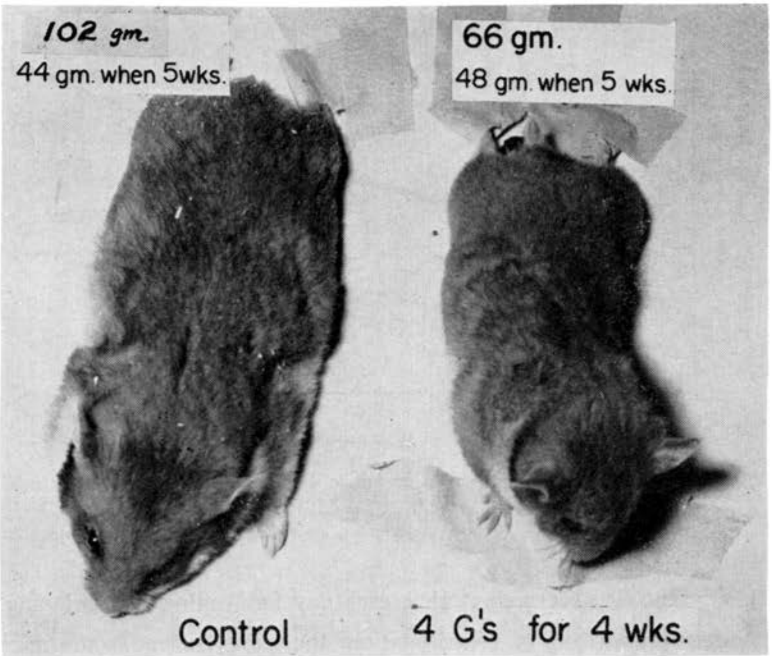

Figure 4. Photograph of typical hamster pair. Control animal on left and experimental animal on right, with indicated body weights shown, after 4 weeks of centrifugation at 4 G's.

Results and Discussion

From all indications thus far, it appears that the hamsters adapt to gravity stress sooner than the smaller mice. In previous studies made in our laboratory, it has been found that mice can live for as long as one year at 7 G's, and for as long as two years at 2 G's. From these results it is quite probable that the hamsters would also live an entire lifespan under this increased gravity, although at this time such experiments have not been carried out on this animal. Mice have bred and reared their young in our centrifuge.

It is shown in Figures 1 and 2 that both hamsters and mice show a decrease in body mass during the first week of centrifugation. This initial loss in mass is to a large extent attributable to a decreased food consumption during the first week.

Moving pictures have been taken of the hamsters during centrifugation, and from all indications the animals are definitely able to consume the food. It is shown also in Figures 1 and 2 that after the first week a definite rise in growth and an increase in food consumption occurs, suggesting physiological adaptation.

Figure 3 shows the relative growth of hamsters and mice as found in our studies.

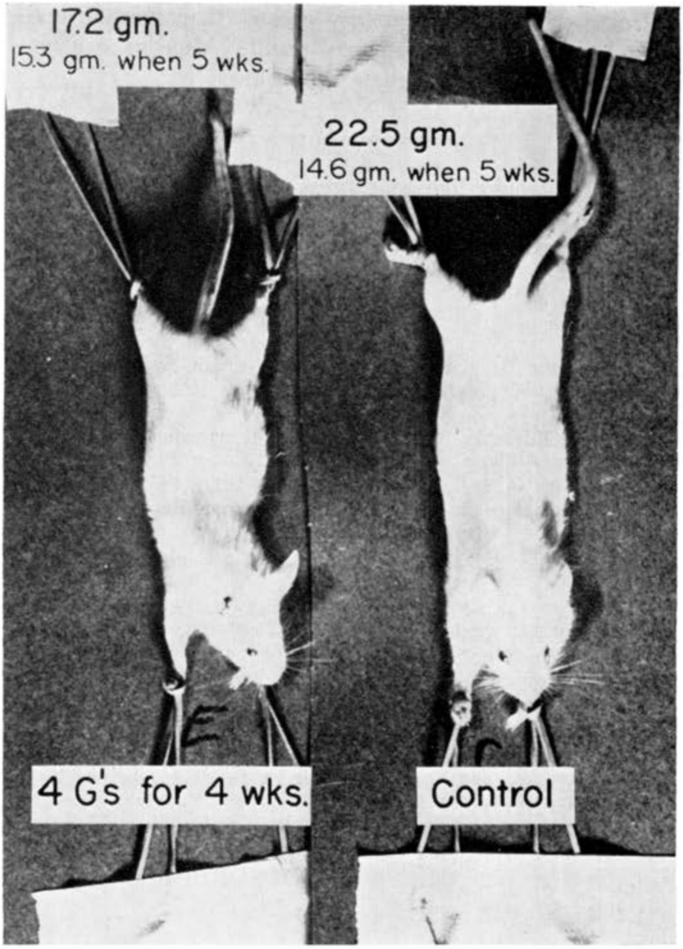

Figure 5. Photograph of typical mouse pair. Control mouse on right, experimental animal on left, after 4 weeks of centrifugation at 4 G's.

Centrifugation presumably has an effect upon the circulatory system of the animals. Venous return to the heart is undoubtedly affected. Analysis of these studies is not complete at the present time. The physiological and anatomical changes of the organs and skeleton of centrifuged animals are now under observation in our laboratory.

Skeletal parts (e. g., femur bone) of both animals show definite changes in growth, and seem to grow better than the other organs during centrifugation. These femur bones assume a more circular cross section. Gray and Edwards (1955) found similar effects in the growth of the wheat coleoptile.

In summary, both mice and hamsters show specific changes in body size when exposed to gravity greater than normal, and signs of nearly complete adaptation may result. Mice have given birth to and reared young under these conditions.

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