

A COMPARATIVE STUDY OF NORMAL AND PIEBALD HAMSTERS*

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A coat-color mutation in the golden hamster (*Cricetus auratus*) was recently described (Foote, 1949). Preliminary studies of this mutant strain, designated piebald because of the white coloring about the face and eyes, suggest that there are variations from normal associated with the coat-color change. Keeler (1947a, 1947b) has indicated that certain coat-color genes manifest themselves in all parts of the mammalian organism by producing modifications of morphology, physiological nature, and behavior. In this piebald strain of hamsters the first morphological difference observed, other than coat color, was that these animals appeared smaller and their body weights were less than those of normal animals. A preliminary study of this weight difference has been reported (Foote and Bullock, 1949).

This report brings together some of the data accumulated during the past two years in comparing the piebald strain of hamsters with normals. Studies described here are for body weights, litter size and mortality, and reproductive tract abnormalities. Coat color for the mutant strain will be described and sex distribution discussed.

RESULTS

Coat color.—The animals of the hamster colony used in this study

were graded on the basis of coat color. The normal coat coloring for this species of hamster is light brown on the back and white on the underside, with a brown band across the chest between the forelegs. White areas extend from the fronts of the forelegs and from the throat region up and forward across the cheek pouches (fig. 2). An animal with coat color of this kind was graded as P-0.

The first noticeable variation from normal toward piebaldness is the appearance of a strip of white in the center of and at right angles to the brown band between the forelegs. This area of white becomes wider as animals tend more toward the piebald condition until the brown area is entirely absent. Animals showing variations in the degree of white on the chest were graded P-1 to P-5 (fig. 2). The animals graded P-5 have no brown color on the underside and are completely white on belly, chest, and throat. Animals in grades P-1 to P-5 show the normal brown color on the back.

Animals graded P-6 to P-10 show varying degrees of white on the nose, face, and back, and lack all brown color on the underside (fig. 3). Young animals will show the piebald color pattern as soon as they become pigmented after birth, on about the third day, and the pattern is never varied as the animal becomes older.

In the present paper the hamsters in grades P-0 to P-2* (344 ani-

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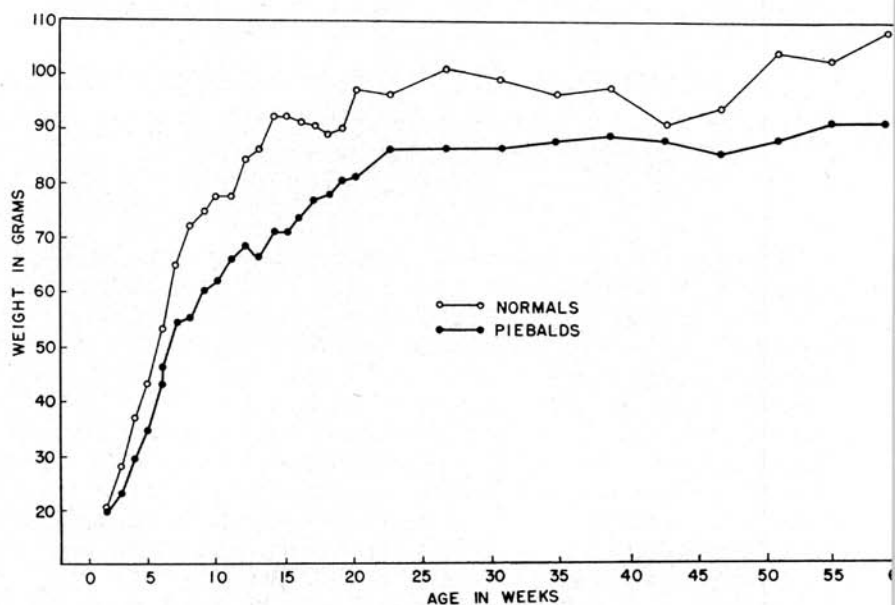


FIG. 1.—Comparison of mean body weights of normal and piebald hamsters. Points up to 23 weeks plotted by weeks; points after 23 weeks plotted by months.

TABLE 1.—SEX DISTRIBUTION

	P-0	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	
Females.....	72	62	36	9	16	9	6	7	9	4	8	23
Males.....	71	81	22	10	12	7	12	5	8	1	10	23
Total.....	143	143	58	19	28	16	18	12	17	5	18	47

mals) are considered to be normals, while those in grades P-3 to P-10 (133 animals) are considered piebalds.

Sex distribution.—In the total colony of 477 animals the sexes were almost equally divided, 238 females and 239 males. Distribution by sex and grade is given in table 1.

Body weight.—The first observed variation from normal in the piebald animals, other than coat color, was in body weight. It appeared that they were somewhat smaller and weighed less than normals.

Body weights were taken weekly for a period of 58 weeks on a Hanso Dietetic Scale, on Friday afternoon of each week, before the animals had been fed for that day. All animals were fed the same diet of leaf lettuce, laboratory chow, and milk. Weights of most animals were taken from the time they were 16 days old to the time of weaning. The total number of animals weighed each week varied somewhat since they were being used in other studies and some had to be sacrificed.

Normal animals showed a consis-



FIG. 2.—Undersides of normal and piebald female hamsters showing varying grades of piebaldness. Female on upper left is P-0; female on lower right is P-10.

FIG. 3.—Backs of same animals as in fig. 2. All are in same relative positions in both photographs.

TABLE 2.—BODY WEIGHTS
Mean weights in grams

Age in Weeks	Normal males		Piebald males		Normal females		Piebald females	
	No. Wts.	Mean Wt.	No. Wts.	Mean Wt.	No. Wts.	Mean Wt.	No. Wts.	Mean Wt.
2.....	27	20.48	13	20.69	13	17.77	12	17.50
3.....	27	27.59	28	22.82	17	25.59	21	20.05
4.....	38	37.74	37	28.27	45	35.38	28	27.71
5.....	46	45.39	46	35.28	47	39.02	30	33.33
6.....	31	52.77	49	44.72	35	52.43	27	44.93
7.....	26	64.39	52	53.60	36	64.00	29	53.69
8.....	36	71.50	45	56.01	44	70.95	32	53.84
9.....	33	72.36	53	59.84	27	73.30	40	58.30
10.....	30	76.43	50	62.72	17	76.65	26	61.00
11.....	22	78.90	36	63.88	13	80.07	20	66.50
12.....	20	81.50	28	66.07	13	87.07	17	68.82
13.....	13	80.92	19	65.31	10	90.10	16	65.81
14.....	11	85.54	9	70.44	8	99.00	10	72.81
15.....	14	86.21	16	68.00	9	98.33	13	72.84
16.....	10	80.50	15	73.06	8	99.62	10	71.80
17.....	4	86.75	11	78.81	3	92.33	8	73.12
18.....	12	81.25	15	74.60	8	96.25	10	74.70
19.....	4	87.50	14	77.23	2	90.50	6	84.66
20.....	7	91.57	13	79.46	3	97.00	6	82.50
21-60.....	114	98.05	235	84.70	50	92.45	118	89.38

tently heavier body weight than did piebald animals (fig. 1), as indicated by mean weekly weights of total number of normal animals compared to mean weekly weights of total number of piebald animals. The difference in the mean weights of the two groups for the period of 58 weeks was 12.13 grams. The greater body weight of normals becomes apparent when the animals are about 3 weeks old and the difference in weight between normals and piebalds gradually increases until they reach the age of 14 to 15 weeks. Apparently it is at the approximate age of 15 weeks that the hamster begins to reach its adult weight, since from that time on no great increase in weight is evident.

The weight difference between piebalds and normals remains more or less constant after the animals reach their adult weights. While the weight attained at 20 weeks remains

somewhat stable, the piebald and normal females show little weight difference as adults. The weight difference between normals and piebalds is accounted for by the weights of the males of the two groups (table 2). Of the 4 groups of hamsters, normal males, normal females, piebald males, and piebald females, the normal males are heaviest while piebald males weigh the least.

Litter sizes and litter mortality.—In the hamster fewer young are born to piebald mothers than to normal mothers. When litters are produced from matings of normal males with normal females the litters are larger (mean litter size of 6.69), and more of the young survive (4.81). If either or both parents are piebald there are fewer young in a litter (4.76), and the mortality of the young is higher (2.72 surviving). Litter size and mortality are given in table 3.

TABLE 3.—LITTER SIZE AND LITTER MORTALITY

	No. of Litters	Total Young Born	Young per Litter Born	Young per Litter Surviving	Total Young Surviving	Percent Young Surviving
Normal male X						
Normal female.....	62	415	6.69	4.81	300	72.29
Normal male X						
Piebald female.....	8	50	6.25	3.50	50	56.00
Normal female X						
Piebald male.....	35	191	5.46	3.63	127	66.49
Piebald male X						
Piebald female.....	50	202	4.04	1.96	98	48.52
Normal female X						
Piebald male.....						
Normal male X						
Piebald female.....	93	443	4.76	2.72	253	57.12
Piebald female X						
Piebald male.....						
Normal male X						
Piebald female.....	43	241	5.60	3.14	135	56.01
Normal female X						
Piebald male.....						
Entire Colony.....	155	858	5.54	3.57	553	64.44

The young from piebald parents are smaller and weaker than normal young and as a result the mother animals, whether normal or piebald, are prone to destroy them. In addition to this factor, piebald mothers are more nervous and do not care for their young as well as normal mothers. The young of piebald mothers are more likely to starve and die from neglect.

Reproductive tract abnormalities.

—In piebald animals a condition of either partial or total sterility may exist, especially in females. No detailed study has been made of the cause of sterility in the male piebald animals, but in the case of one male, graded P-10, who was mated numerous times to both piebald and normal females, no young were born. Cases of non-fertile matings are more common among piebald animals than in normals. Such non-fertile matings may be due to a con-

dition of sterility in the male, the female, or both.

In a group of 42 piebald females that were sacrificed the reproductive tracts of 7 were abnormal. Among normal females, one with an abnormal reproductive tract was found in a total of 165 females sacrificed. The abnormalities observed were in the horns of the uteri. Of the 7 piebald females with abnormal tracts, 4 had no left uterine horn, one had a right uterine horn missing, and one had no uterine horns. In one instance the right horn was absent, but the left horn had been pulled across the body cavity and attached near the right ovary. Two of the 7 females had no left kidneys. In the normal female the left uterine horn was absent. In all of these cases the ovaries, fallopian tubes, and lower portions of the reproductive tracts appeared intact.

All females with reproductive

tract abnormalities had at some time been in estrus, exhibited the usual sexual behavior, and had copulated. Each had mated at least twice and some as many as 6 times. In only one case were young known to have been born and that female had a record of four matings, three of which had been non-fertile. After the fourth mating she gave birth to a single animal. After the mother animal had been sacrificed it was found that she had only one uterine horn, the right.

The investigation of these reproductive tract abnormalities is incomplete and more detailed study is in progress.

DISCUSSION

Coat-color changes in hamsters (*Cricetus auratus*) similar to the one described in this paper have occurred in other hamster colonies in this country. Dr. Margaret Ward Orsini, in a recent personal communication, stated that piebald animals which appeared in her colony and were then inbred for several generations, developed a greater degree of whiteness than have these animals in the colony here. Hayner (1949) reported a white-faced hamster mutant appearing among the animals in his hamstery. As far as is known no studies of the genetics of this piebald mutation in the hamster have appeared in the literature.

Data presented in this paper suggest that there are certain morphological variations and possible differences in maternal behavior between piebald and normal hamsters which may be related to the coat-color modification of the piebald animals. Keeler (1947a) has advanced the hypothesis that such differences, in many mammalian forms, are due

to a relationship between a mutant coat-color gene and its correlated modifications of morphology, physiology, and behavior. Even though results obtained from these studies of the piebald mutant suggest that there is such a relationship, no definite statement should be made until the genetics of this strain of hamsters is more fully understood and other studies completed.

Results presented here for the normal hamster vary little from those reported by Bond (1945). Body weights of normal animals in this colony show a slightly higher mean body weight up to the time the animals are 100 days of age. After that age the weights are approximately the same as those given by Bond, with normal males being heavier than normal females.

Bond found that the mean litter size in her colony was 6.93, as compared to a mean litter size of 6.69 reported here.

SUMMARY

1. Normal hamsters (grades P-0 to P-2) show a greater body weight than do piebald hamsters (grades P-3 to P-10).
2. The sex ratio is 1:1 among normal and piebald animals.
3. Normal hamsters have larger litters than do piebald hamsters, and more young survive in litters produced by normal animals.
4. Reproductive tract abnormalities occur more frequently in piebald females.
5. The differences in morphology and behavior of piebald hamsters may have a relationship to the mutant gene or genes producing the coat-color change.
6. Those animals considered

normals in this study have body weights and young per litter similar to those given for a different hamster colony.

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