STUDIES OF SIZE INHERITANCE IN GUINEA PIGS

by

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INTRODUCTION

An experiment designed for a study of inheritance of size and conformation in guinea pigs has been in progress at the Animal Husbandry Department for several years. Two inbred lines differing in size and conformation have been established, and various crosses and backcrosses involving these lines have been made.

Ibsen (1927) described briefly some desirable color and conformation characteristics for guinea pigs based upon types of guinea pigs which won prizes at cavy shows. With this as a basis, lines of "show" (good type) and also of "non-show" (poor type) animals were established. Wong (1937) made a preliminary study of the differences between these lines and of the F_1 individuals compared with either line.

The purpose of this study was to make a more complete genetic analysis of the differences between these lines with larger numbers of animals as well as with the additional crosses and backcrosses available. The numbers available, however, were still not large enough for this study to be considered complete.

MATERIALS AND METHODS

In the year 1913, Dr. Ibsen began a line of guinea pigs in which there was a rather high degree of inbreeding; later in 1922 an unrelated female was introduced into the line since there was danger of the line becoming extinct. From that time, two other unrelated females were used after which close inbreeding--generally brother-sister- or father-daughter-matings were used. Weights were taken for all females at parturition, showing these mated inbred females did not exceed 900 grams in weight. Due to their small size, narrow, shallow heads, and poor body type, these animals were chosen for the "non-show" type.

The show stock was begun more recently. Some of the animals which had large size and good conformation were also sterile. This was true especially after the animals had become fat. As a consequence, large animals with somewhat less desirable conformation were used for breeding. This line too, has been subject to close inbreeding for several years.

For both lines in this experiment albino segregates were used, the purpose being to prevent differences in color from interfering in judging conformation.

Body weight was recorded at birth, and later, at regular periods of time, a series of ten measurements in addition to weights were taken. The various body measurements were designed to show as well as possible how general the effect of the size factor (or factors) was, and also to give some information concerning conformation.

Table 1. A summary of measurements used.

Measurement	Units	Accuracy
Body weight	grams	nearest 0.1 g.
Body circumference	centimeters	" 0.5 cm.
Body length	"	" 0.5 cm.
Depth of head	"	" 0.1 cm.
Depth of upper lip	"	" 0.1 cm.
Length, ears to tip of nose	"	" 0.1 cm.
Length, supraoccipital to tip of nose	"	" 0.5 cm.
Breadth between ears	"	" 0.1 cm.
Breadth between eyes	"	" 0.1 cm.
Length of ears	"	" 0.1 cm.
Breadth of ears	"	" 0.1 cm.

The instruments used in making these measurements were: a small Fairbanks balance, a steel rule, a tape measure, a scale marked out on the desk (for body length), and a roller calliper (both inside and outside). The accuracy of these instruments in each measurement is given (Table 1). Measurements were taken at 2 months, 4 months, 6 months, 9 months, 1 year, 1 year 3 months, 1 year 6 months, 2 years, and each 6 months thereafter as long as the animal lived.

The evidence from the data included in this paper indicates that there is a single dominant gene for large size which is the major factor causing the size difference between the two strains. There are probably other factors, but these are of relatively minor importance until after the age of one year.

In order to determine the ratios in the cross and backcross generations, it was necessary to have a system for classification. It was found that for many measurements, there was some overlapping between a few of the show and non-show animals; for this reason, and also since errors in measurement were possible, a combination of three measurements was used for classification. The maximum value for each measurement was taken from values at nine months, one year, and one year three months of age. A minimum was decided upon for classes of show animals (Table 2); those animals produced as a result of crosses or backcrosses which exceeded the minimum in at least two measurements were classed as large, while those below this minimum for at least two measurements were classed as small.

Table 2. Minimum values of measurements for animals classed as large animals.

Measurement	Minimum values	
	Mated females	Unmated females and all males
Body length	28.5 cm.	29.5 cm.
Distance between eyes	2.9 cm.	2.9 cm.
Body weight	900.0 g.	950.0 g.

To test the accuracy of this somewhat arbitrary method of classification, animals of the two "pure" lines were classified. With one exception (a "show" female was classed as small) all fell into their expected groups.

It might be added that there was no conclusive evidence that any of the "show" animals were homozygous for the large size factor. Consequently the above mentioned small[1/] female was probably produced as the result of segregation out of the recessive genes carried by heterozygous parents. She was not mated, so this could not be proved definitely, but her other measurements were consistent with this assumption.

[1/] For convenience, from this point on, the terms "show" and "non-show" will be used in this paper to designate members of the two original strains while "large" and "small" will be used to refer to various segregates, cross and backcross animals classed thus by means of the method just described.

ENVIRONMENTAL FACTORS

These animals were kept under as nearly uniform conditions as possible. All were fed the same basic diet as described by Wong (1937). The "grain" mixture was supplemented with salt and green feed throughout the year. During the winter sprouted oats were used for greens, while in the summer months, blue grass, alfalfa, green wheat, etc. were fed. These greens, which supply the essential vitamin C, varied in quantity and in quality throughout the year, and from year to year. There was also some other substance, possibly the grass juice factor, which is necessary for optimum growth, present in abundance in the summer greens.

The mating boxes contained one male, two females, and the litters of the females until removed. Since the gestation period for guinea pigs is approximately 68 days, and the young were removed when they were 60 days old, one female would have at most only one of her litters in the cage at any one time.

Suitable replacements could not always be made at once when mated animals died. Consequently the full quota of old animals was not always present in any cage at any one time. Likewise the number and size of the young present in any cage varied.

Despite the fact that more was fed to the animals in crowded cages, there was a tendency for these animals to have less feed per animal than those in less crowded cages. There was also less milk available for each animal of a large litter.

After the animals were 60 days old, they were placed on a feeding experiment. Here they were in individual cages, and had identical rations. After 12 weeks of the feeding experiment, they were discarded, mated, or placed in special male or female boxes.

Since males when put together tend to fight, the male boxes were designed for only one animal. The unmated females were kept in larger boxes with from four to five in a box. Occasionally, all the females in a box were observed to be running around the edges of the box. The isolated males were less active and seemed to get fatter as a consequence.

Some animals in the female and mating boxes would chase and bite others. When measurements were taken, the bitten animals could be recognized by the clotted blood and open wounds on their backs. In extreme cases, the data from these animals were not used since they were obviously retarded in their growth.

Guinea pigs are affected by seasonal changes. Hot weather above 90° F. has an unfavorable effect upon them, while the green feed when available, especially during the spring, is very favorable for growth. In studying the weights of nearly mature fetuses, Ibsen (1928) concluded that during the summer the average litter size was increased but that for litters of three there was little or no change in weight compared to other seasons, the supposition being that the summer's heat offset the advantage of better feed.

To study the effects of season upon adult weight, large animals (show, F_1 and F_2) were classed according to the season in which they were born, and an F test was run upon their weights at one year of age (Table 3).

Table 3. A comparison of body weights at one year of age of 10 large animals born during each different season.

Quarter year	Mean body weight in grams
January - March	953.30
April - June	1016.40
July - September	928.50
September - December	964.70

F= 2.74

5% level 2.86
1% level 4.38

The differences in Table 3 are not quite significant. However, some weight should be given to them since it is possible that with larger numbers the difference between groups would be significant. Observing these results, it is likely that the animals which were the heaviest at one year of age were those which reached that age during the season April - June, while those which were one year of age during the hot season, July - September, were the lightest, and those of the other two seasons were intermediate and similar to each other.

Except for mated females which were in steady production of young and were classed separately, no allowance or correction was made for these environmental factors. Consequently they add to the variability of the data used.

A STATISTICAL ANALYSIS OF THE DATA[2]

A comparison was made (Table 4) to determine the actual differences between the show and non-show animals. For each one of the measurements, the mean of the show males was greater than that of the non-show males. Those in which differences were highly significant were; the distance between the eyes, body weight, and depth of head. Significant differences were found in the length of the head from the ears to the tip of the nose, and in the depth

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[2] Statistical methods and terms used are in all cases those described by Snedecor (1938).

of the upper lip. While the show males were consistently above the non-show males in the other measurements, the values were well below significance.

Despite the fact that many years' records of measurements taken from females at parturition indicated that mated show females were definitely longer than mated non-show females, no significant difference in body length was found between the non-mated show males and the non-mated non-show males. This apparent inconsistency can be explained, at least in part, by the fact that the non-show females were consistently much better breeders than the show females, and were undoubtedly retarded in growth by the burden of this heavy production. Due to a lack of unmated non-show females, a direct test for this assumption is impossible. However from Tables 5 and 7 there is evidence that the heavy production of young retarded the growth of females since the differences between non-show males and mated non-show females were much greater than those between unmated show males and females. The effect upon body length was found to be the greatest.

The results in Table 5 indicate that even in the case of unmated animals, there is a sexual difference. Castle (1916) noticed that in different races of inbred guinea pigs, males had consistently longer heads than females.

Table 4. A comparison of 7 unmated show males and 5 unmated non-show inbred males.

Measurement	Show males		Non-show males		F
	Mean	Coef. of Variability	Mean	Coef. of Variability	
Body length	29.71 ± .17	1.5%	29.50 ± .20	1.5%	0.682
Body circumference	25.50 ± .49	5.1%	25.96 ± .39	3.5%	0.590
Distance between eyes	3.14 ± .04	3.5%	2.78 ± .20	16%	47.5**
Distance between ears	2.83 ± .05	4.4%	2.78 ± .07	5.8%	0.05
Length, ears to tip of nose	6.50 ± .09	3.5%	6.18 ± .02	0.7%	9.09*
Length, supra-occipital to tip of nose	8.30 ± .13	4.3%	8.04 ± .09	2.7%	2.41
Depth of head	3.77 ± .04	2.7%	3.42 ± .07	4.7%	20.0**
Depth of upper lip	2.57 ± .09	9.3%	2.28 ± .02	2.0%	6.22**
Length of ear	3.77 ± .05	3.3%	3.40 ± .14	9.1%	24.1**
Breadth of ear	2.61 ± .07	7.6%	2.48 ± .04	4.0%	0.75
Body weight	1017.57 ± 24.33	6.3%	858.8 ± 13.8	3.6%	34.01**

5% level=4.84
1% level=9.65

* significant
** highly significant

Table 5. A comparison of 7 show males and 8 unmated show females.

Measurement	Show males Mean	Show males Coef. of Variability	Show females Mean	Show females Coef. of Variability	F
Body length	29.71 ± .17	1.5%	29.81 ± .15	1.4%	0.01
Body circumference	25.50 ± .49	5.1%	26.31 ± .42	4.5%	1.34
Distance between eyes	3.14 ± .04	3.5%	2.98 ± .03	2.9%	9.29**
Distance between ears	2.83 ± .05	4.4%	2.86 ± .04	3.9%	0.62
Length, ears to tip of nose	6.50 ± .09	3.5%	6.00 ± .06	2.9%	19.8**
Length, supraoccipital to tip of nose	8.30 ± .13	4.3%	8.13 ± .12	4.1%	0.87
Depth of head	3.77 ± .04	2.7%	3.39 ± .03	2.3%	5.95*
Depth of upper lip	2.57 ± .09	9.3%	2.29 ± .03	4.1%	7.40*
Length of ear	3.77 ± .05	3.3%	3.91 ± .03	2.4%	5.80*
Breadth of ear	2.61 ± .07	7.6%	2.60 ± .07	7.2%	0.00
Body weight	1017.57 ± .23	6.3%	1050.28 ± 24.46	6.2%	0.77

5% level=4.84
1% level=9.65

* F value is significant
** F value is highly significant

Table 6. A comparison of 7 F_1 males and 7 show males.

Measurement	Show males		F_1 males		F
	Mean	Coef. of Variability	Mean	Coef. of Variability	
Body length	30.64 ± .16	1.4%	29.71 ± .17	1.5%	15.8**
Body circumference	26.47 ± .45	4.5%	25.50 ± .49	5.1%	1.72
Distance between eyes	2.96 ± .03	2.6%	3.14 ± .04	3.5%	13.04**
Distance between ears	2.80 ± .08	7.1%	2.83 ± .05	4.4%	0.31
Length, ears to tip of nose	6.23 ± .03	1.4%	6.50 ± .09	3.5%	7.60*
Length, supraoccipital to tip of nose	8.19 ± .14	4.4%	8.30 ± .13	4.2%	0.27
Depth of head	3.66 ± .08	5.5%	3.77 ± .04	2.7%	1.72
Depth of upper lip	2.76 ± .08	7.2%	2.57 ± .09	9.3%	1.67
Length of ear	3.73 ± .03	2.3%	3.77 ± .05	3.3%	8.00**
Breadth of ear	2.59 ± .05	4.8%	2.61 ± .07	7.6%	0.00
Body weight	996.01 ± 18.7	5.0%	1017.57 ± 24.33	6.3%	0.42

5% level=4.75
1% level=9.33

* significant
** highly significant

Table 7. A comparison of 5 non-show inbred males and 5 non-show inbred mated females.

Measurement	Males		Females		F
	Mean	Coef. of Variability	Mean	Coef. of Variability	
Body length	29.50 ± .20	1.5%	27.40 ± .33	2.7%	22.9**
Body circumference	24.96 ± .39	3.5%	23.60 ± .39	2.8%	6.11*
Distance between eyes	2.78 ± .20	1.6%	2.58 ± .05	4.6%	10.0*
Distance between ears	2.78 ± .07	5.8%	2.44 ± .06	5.5%	10.5*
Length, ears to tip of nose	6.18 ± .02	0.7%	5.62 ± .12	4.8%	16.4*
Length, supraoccipital to tip of nose	8.04 ± .09	2.7%	7.46 ± .15	4.4%	12.1*
Depth of head	3.42 ± .07	4.7%	2.90 ± .05	3.8%	28.2**
Depth of upper lip	2.28 ± .02	2.0%	2.00 ± .08	9.5%	8.00*
Length of ear	3.40 ± .14	9.1%	3.28 ± .04	2.4%	2.21
Breadth of ear	2.48 ± .04	4.0%	2.28 ± .07	7.0%	4.44*
Body weight	858.8 ± 13.8	3.6%	719.4 ± 54.6	17.0%	4.91*

5% level=5.32
1% level=11.26

* significant
** highly significant

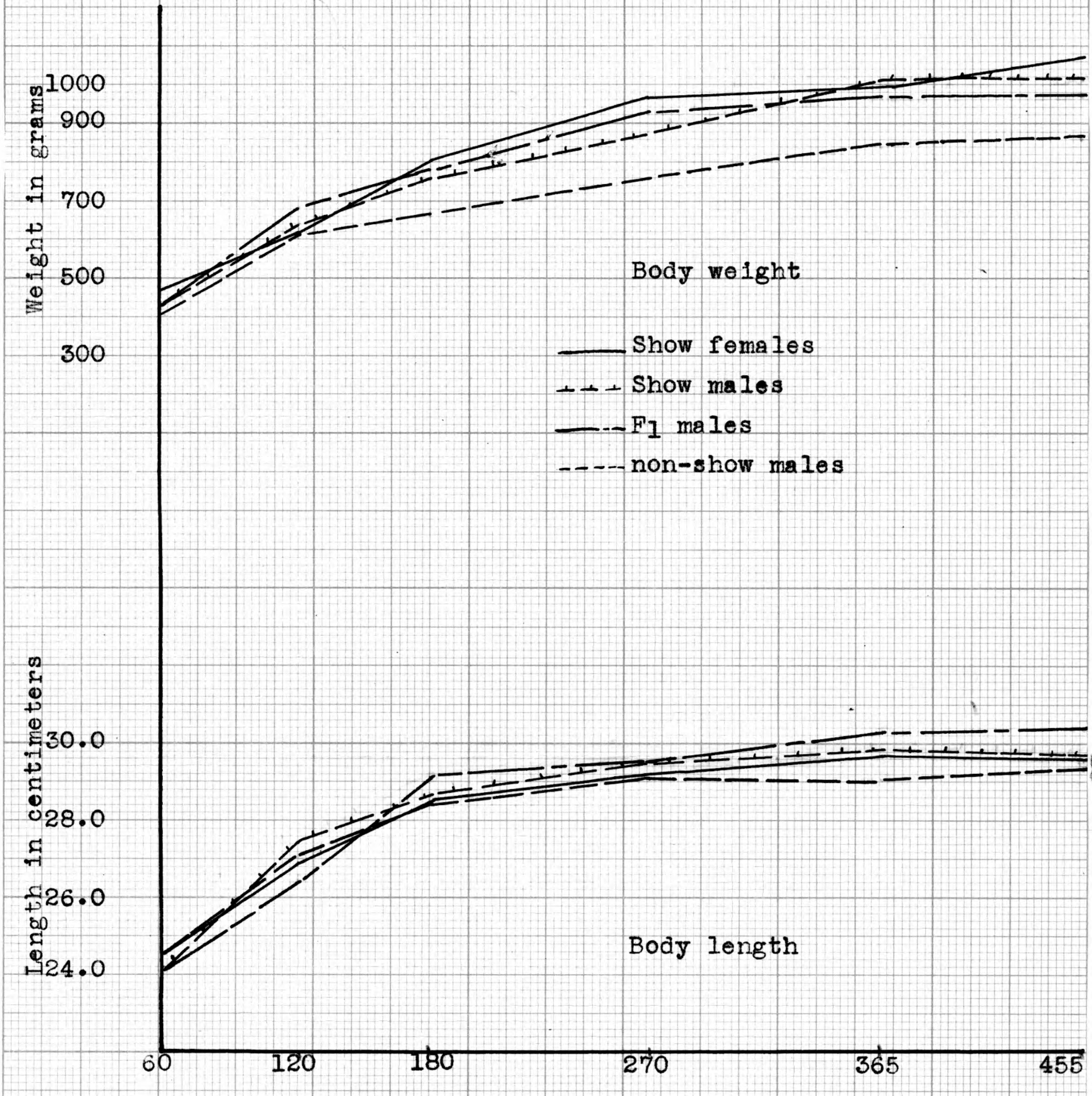

Fig. 1. Graphs showing growth in body length and body weight.

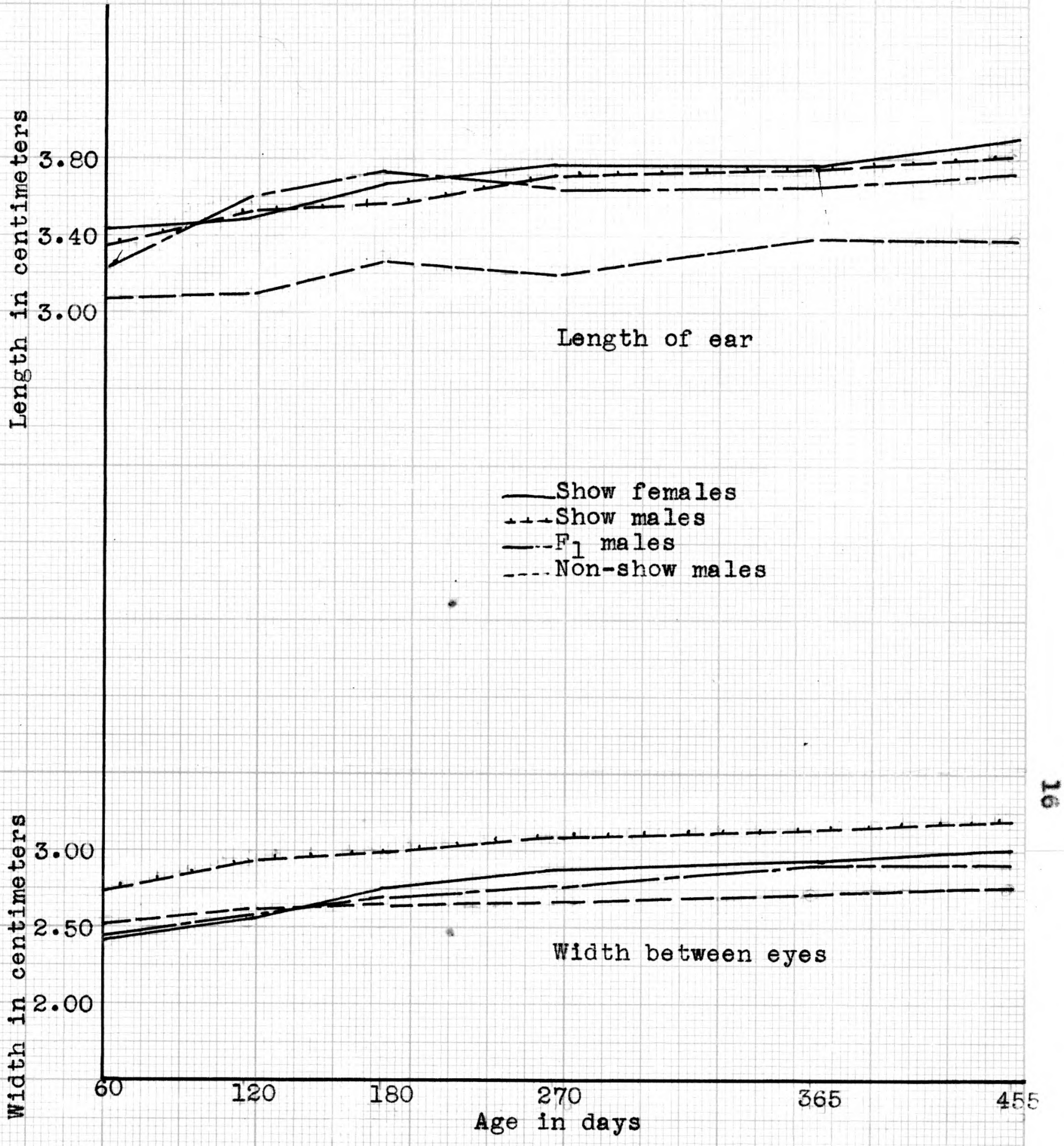

Fig. 2. Graphs showing growth in width between eyes and length of ear.

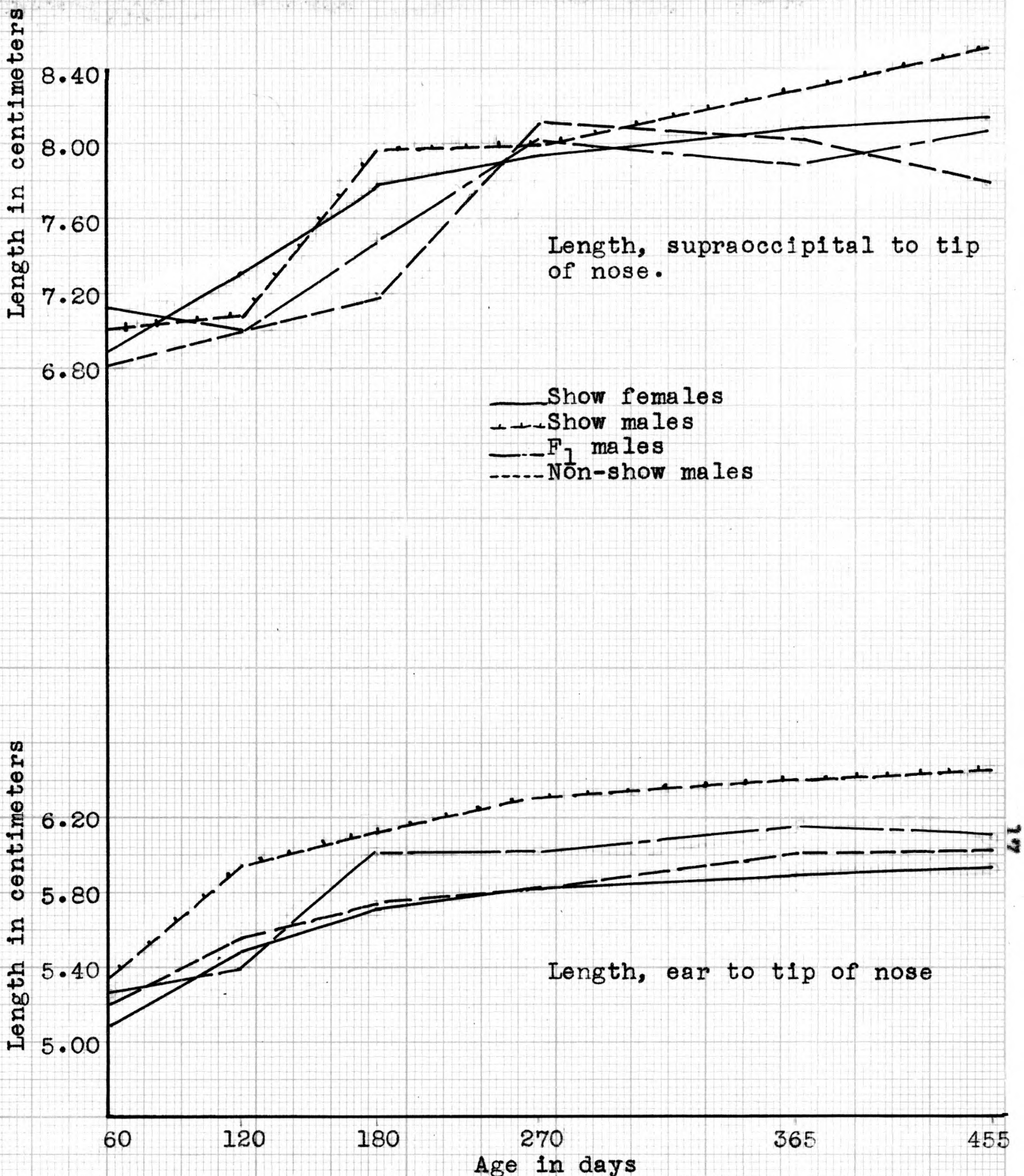

Fig. 3. Graphs showing growth in the length from the ear to the tip of the nose, and of the length from the supraoccipital to the tip of the nose.

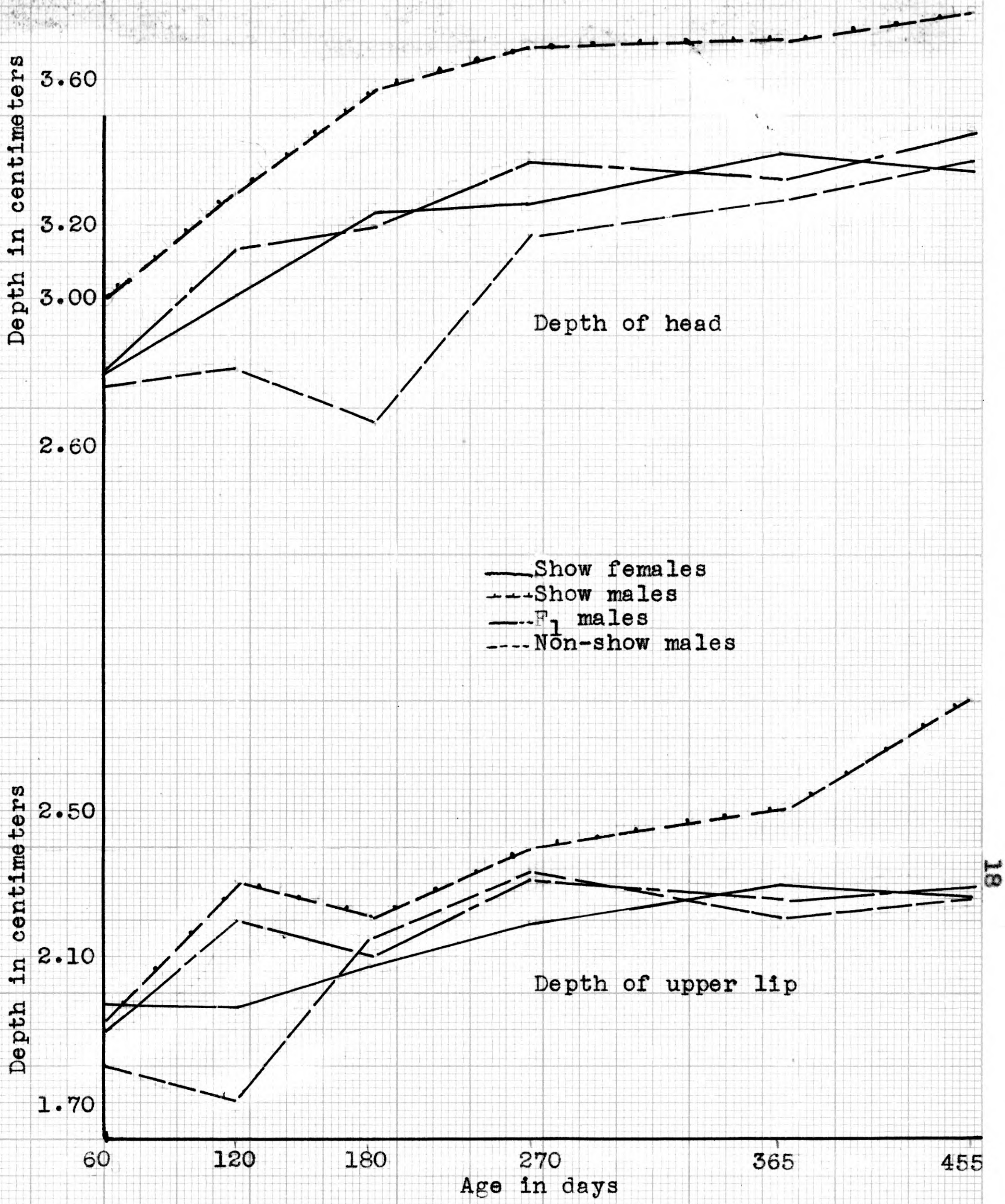

Fig. 4. Graphs showing growth in the depth of the upper lip and depth of head.

This has been confirmed in the present experiment, and in addition it has been found that males definitely have broader and deeper heads than females. Females, however, have longer ears than males. The difference in ear length is just above the significant level for F. However, some additional weight can be given to this, since in the comparison of non-show males with mated non-show females, the males exceeded the females in all measurements except ear length.

Unmated F_1 and show males were found to be very similar for most measurements (Table 6), and, as Wong (1937) had concluded, it is evident that the major difference between the show and non-show lines is due to one or more dominant genes. Differences between show and F_1 males could be due to heterosis, more specific modifiers of size, or in some cases in which the difference was not great, to sampling errors. The cause of these differences will be discussed later.

In order to determine the number of genes causing the general size difference between the show and non-show lines, a number of F_2's and backcrosses to recessives (non-show) were produced (Table 8). From the ratio of large animals to small animals, based upon the classification described, the number of genes was estimated.

Table 8. A summary of the ratio of large to small animals in cross and backcross generations.

Parents Type of mating	Sex	Offspring Ratio large;small	 Expected ratio for 1 pair of allelomorphs
Show ♂ and Non-show ♀	males	16:2	18:0
	females	14:3	17:0
Non-show ♂ and show ♀	males	1:0	1:0
	females	4:0	4:0
F_1 ♂ and Non-show ♀	males	6:5	5.5:5.5
	females	10:5	7.5:7.5
Non-show ♂ and F_1 female	males	8:8	8:8
	females	11:4	7.5:7.5
F_1 ♂ and F_1 ♀	males	13:3	10.7:5.3
	females	17:8	18.6:6.2
Total	males	44:18	43.2:18.8
	females	56:20	56.6:21.2

Table 8 compares the actual results of classification to the expected results, if the factor for large size were a single dominant, and all show animals were homozygous for it, while non-show animals were the recessives. The total results for both males and females were surprisingly close to the expected, indicating that the major size difference is due to a single factor.

There was evidence that the show males were not homozygous for the large size factor. Occasionally, a small "segregate" has been produced within that line. Usually, however, these animals were found to be "environmental runts", which, when mated together produced normal, large offspring. In the most marked cases the small size of the environmental runts was due to illness.

Sometimes small F_1's were produced, and in such cases, the show parent was tentatively classed as heterozygous for the large size factor. Five such apparently heterozygous individuals were found, lists of their offspring were made, and classified according to size. Of the 33 "F_1" offspring of these animals, 18 were classed as large, and 15 as small. This is very close to the 1:1 ratio expected if these five large type were all heterozygous. In one case, a small "F_1" was mated to a non-show female; the three offspring produced were all small. However, much larger numbers would be required to show definitely that large offspring were never produced by such a mating.

The F_1's produced by reciprocal crosses were used for a test for sex linkage of the size factor. Due to poor fertility of show females, only a few F_1's were produced with these as mothers; all of these were large (Table 8). Larger numbers of F_1's were produced with non-show females as the mothers, and all but a few of these were large (some small F_1's were produced due to the fact that some of the show parents were heterozygous). Since the female is the homogametic sex, F_1's produced with non-show females as the mother would be a test for sex linkage. If the factor were sex linked, all the males of this type would be small, and all the females large. This was not the case for either type of F_1, and thus this factor must be considered autosomal.

A careful study of the measurements of the F_1 and F_2 animals indicated the probable presence in the non-show animals of a dominant factor (or factors) for reduced width between the eyes. Due to the appearance of the dominant gene in both of the reciprocal F_1's, this factor was considered as autosomal. In the F_2 generation there was evidence of segregation such that both large and small animals had both "wide" and "narrow" heads. The ratio in the F_2 generation was for the males, 12 wide eyed: 2 narrow eyed; for the females, 5 wide eyed: 8 narrow. If this were a single factor, a 3 wide: 1 narrow ratio would be expected in both cases. The actual results do not fit the expected for a single factor very well, but while the results are not conclusive, this is the best explanation.

Due to small numbers, high variability, and overlapping of groups, definite evidence for other specific modifiers was not found. There is possibly a dominant factor (or factors) present in the non-show animals causing an increased body length. However, the increase in body length of the F_1 over its show parent could have been due to hybrid vigor, but since the body weight was not affected (Table 6) this explanation is rather unlikely.

Further tests for these specific modifiers could be made by first establishing lines for each of them, and then making crosses, or by using the method of Green (1931) and others with mice, in which the effects (linked or manifold) of various known genes upon size was tested. Since most of the known genes in guinea pigs express themselves in coat color and eye color, and since albinism is completely or nearly completely epistatic to other coat and eye color characters, such a study could not be made very well with albino guinea pigs.

McPhee and Eaton (1930) in a study of a cross between light and heavy strains of guinea pigs found the F_1 offspring approached the heavy type, but they found no clear segregation of size factors in the F_2 generation. (Their data indicate that their large animals are too small to carry our large size factor.) They concluded that size was due to factors separate from those effecting fertility, mortality, and monstrosities, but they did not determine the mode of inheritance.

Due to the very small numbers in the two lines, the complete range for various measurements within the lines probably was not established, but with larger numbers, there would be a better basis for classification. The best, and final test for any classification would be then, the breeding performance of animals classified. Small segregates should act genetically the same as non-show animals. However, care should be taken that "environmental runts" be recognized as such! Such a study would require very careful observation of all animals on the experiment.

Ritzman (1923) used ratios between various measurements to represent body proportions in sheep. This method was employed with the modification that the product of two measurements was divided by a third, while Ritzman's ratios were each based upon the quotient of the values of two measurements (Table 9).

Table 9. A comparison of ratios of head width and depth length in different types of animals.

Type of animal	ratio:	$\frac{\text{depth of head x distance between eyes}}{\text{length of head}}$
Show males	$\frac{3.77:3.14}{6.50}$	1.82
Show females	$\frac{3.39:2.98}{6.00}$	1.68
Non-show males	$\frac{3.42:2.78}{6.18}$	1.54
Non-show females	$\frac{2.90:2.58}{5.62}$	1.33
F_1 males	$\frac{3.66:2.96}{6.23}$	1.74

From Table 9 the head type of the show males was found to be the best, while males had a better head type than females, and the show type were definitely better than the non-show. F_1's were not so good as the show type, due in part to the "narrow head" factor. (The broad, deep, short head is considered the best type.)

Wright (1932) and others have concluded that size factors are usually general in action, but that there are some of less importance which are more specific. The results reported in Table 9 indicate that the large size factor has a somewhat differential effect upon head measurements as well as a general effect. These results were modified slightly by the presence of the factor for "narrow head" in the non-show and F_1 animals.

As a result of this study of the measurement data, three measurements are considered to be of little value since they are practically the same in all types of animals studied. They are body circumference, distance between ears, and breadth of ear. Body circumference, however, could be of use in studying the fattening of older animals. These three measurements were difficult to make accurately.

A STUDY OF BIRTH WEIGHTS

A study was made to determine if there was any relationship between birth weights and the size of the mother, or the ultimate size of the young.

Table 10. A comparison of birth weights by means of the t test with grouped data.

Groups compared	$n_1 - n_2$	Standard error of difference	t	Value of t for 1% level	Value of t for 5% level
Large males and large females	129	3.63	0.85[1]	2.616	1.979
Small males and small females	80	5.16	0.39[1]	2.638	1.990
Total large and total small	209	2.82	4.55**	2.601	1.972

[1]males are greater

** t value is highly significant

Table 11. A summary of results determined by linear regression. The sample is 10 in each case.

Relationship to be tested	sb	t	r
Litter size and weight at 1 year of age, large males	19.509	-0.8351	-.2551
Birth weight and litter size, large males	2.629	-2.997*	-.69*
Birth weight and litter size, large females	1.794	-5.74**	-.876**

Values of t for significance:
1% level 3.250
5% level 2.262
* Value is significant

Value of r for significance:
1% level .732
5% level .602
**Value is highly significant

Table 12. The relationship of litter size to other measurements tested by means of linear correlation.

Relationship to be tested	df	6x 6y	r	Levels of significance for r 1%	5%
Birth weight and litter size large males and females	145	1.543	-.601**	.208	.159
Litter size and body weight at 6 months, small males and females	49	1.318	-.245	.345	.273

** Value for r is highly significant

Table 13. A comparison of litter size and birth weights of different types of animals, 324 animals used.

Type of parents	Sex of offspring	n	Mean birth weight (Live animals only)	Mean litter size	Percent born dead (abortions excluded)	Number dead
Show and Non-show	males	47	83.30	2.79	4.0	4
	females	50	76.67			
Show or F_1 male and F_1	males	36	92.65	3.08	7.5	6
	females	38	87.64			
Show and Show	males	39	89.88	2.77	13.3	12
	females	39	88.62			
Non-show and Non-show	males	37	78.49	2.42	16.7	15
	females	38	77.92			

From the results of Table 13, it is noted that the birth weight is influenced by the size of the mother. This is in agreement with the work of Ibsen (1928), Eaton (1932), and others. The high negative correlation between birth weight and litter size (Tables 11 and 12) apparently does not fit in with the results reported in Table 13.

The following explanation will probably reconcile these discrepancies. The results of Tables 11 and 12 are based upon animals taken from the general population which reached an ultimate large size. This general population consisted of a large proportion of F_1 (show males mated to non-show females) and F_1 backcross to non-show (females). As a result, the animals in Tables 11 and 12 are chiefly crossbreds whose mothers were non-show females. Thus in effect, Tables 11 and 12 test the variation within a group, while Table 13 shows the relation between group means.

The percentage dead at birth in the two inbred lines (Table 13) is higher than in the two cross matings. This holds true even to the point that non-show animals which have been inbred longer than the shows have a slightly higher percent dead at birth. In the other two groups, this relation to the degree of inbreeding (of the offspring) is also apparent.

Eaton (1932), quoting work done by Haines in which the number of corpora lutea were counted in females shortly before parturition, pointed out that the number exceeded that of the number of fetuses, and fetuses were found in various stages of resorbtion. It is highly possible, then, that the effect of inbreeding observed in Table 13 was brought about by a combination of lethals, or possibly just a lowered vitality. Assuming the degree of inbreeding of the offspring and their mother to be of about equal importance, the results of the mean litter size can also be explained! While this explanation fits the results of Table 13, these numbers are not large enough that they could be considered as conclusive proof of the theory.

The above results lead one to the conclusion that the difference in litter size between the show and non-show animals is not an effect of the large size factor.

THYROID ACTIVITY RELATED TO SIZE

The show type animals were, in addition to being larger than the non-show type, also more quiet, and it was thought that possibly the action of the gene for small size was through the thyroid. Experiments were made to test for this.

Schmidt and Hughes (1938) found that in mongrel dogs there was a fairly wide normal variation of the cholesterol concentration in the blood. Since hypothyroidism has as one of its symptoms a low concentration of blood cholesterol, it was thought that possibly the normal variation of size as well as of blood cholesterol might be a function of thyroid activity.

Total blood cholesterol was determined by a modification of the Bloor-Sackett method (Koch, 1937, p. 155-156). Tests were made upon both heavy and light animals. (Table 14.)

Table 14. Concentrations of total blood cholesterol in milligrams per 100 cc. of blood in guinea pigs of different weights.

	Males		Females	
	Weight (in grams)	mgm/100cc.	Weight (in grams)	mgm/100cc.
	784.8	94.7	535.3	115
	826.9	88.0	804.1	91.6
	874.7	94.4	824.2	101.6
	892.3	96.3		
	893.6	117.	878.4	110
	956.4	82.4	901.5	113
	965.2	99.6	980.6	102
	999.8	89.3	984.4	116
	1030.4	91.2		
Total	18224.1	852.9	5908.5	749.2
Average	913.79	94.8	844.07	107.0

The results in Table 14 are definitely negative. There is no apparent relationship between normal variations in total blood cholesterol and normal variations in size. While these results are far from conclusive as an index for thyroid activity, there is, however, no indication that these variations in size are associated with variations in thyroid activity.

THE EFFECTS OF CASTRATION

Very large animals were frequently sterile, or, at best, produced young less often than did the small type; the infertile animals were also fat. In order to determine if a lack of the sex hormone were the cause for the size difference and fatness, several animals were castrated, and their growth was recorded.

The animals to be castrated were chosen from those born at as nearly the same time as possible, and their littermates were used as controls. All were castrated at about weaning (21 days old), but before sexual maturity (taken as the minimum age at which fertilization for sex has taken place). Five males and two females were castrated. Of these, two males were of the non-show type, and all the rest were F_1 backcrosses to non-show females. Apart from the fact that they were castrated, two (the non-show males) would be expected to be small, but the other five had equal chances for being large or small. All of these animals were in good health and gained weight soon after castration.

Measurements of these animals have been taken until the age of nine months, at which time all of the castrated animals were characterized by their small size (see Figs. 1, 2, 3, 4) and wild behavior. This indicated that the absence of the sex hormone did not produce the large, docile animals expected, but was in agreement with the results of Steinach [Prizbram (1914)] at least so far as the size is concerned. The sexual differences in head measurements was not evident, and all castrates resembled rather small non-show females in size.

The two castrated females were bitten quite badly while they were in the same box with uncastrated females. Since they were the only ones in the box bitten, it was believed that other females might have mistaken them for males. For this reason, their measurements are no doubt somewhat lower than they should be. Two males caught bad colds at the end of the feeding experiment, but were given large quantities of green feed, and recovered in about a week.

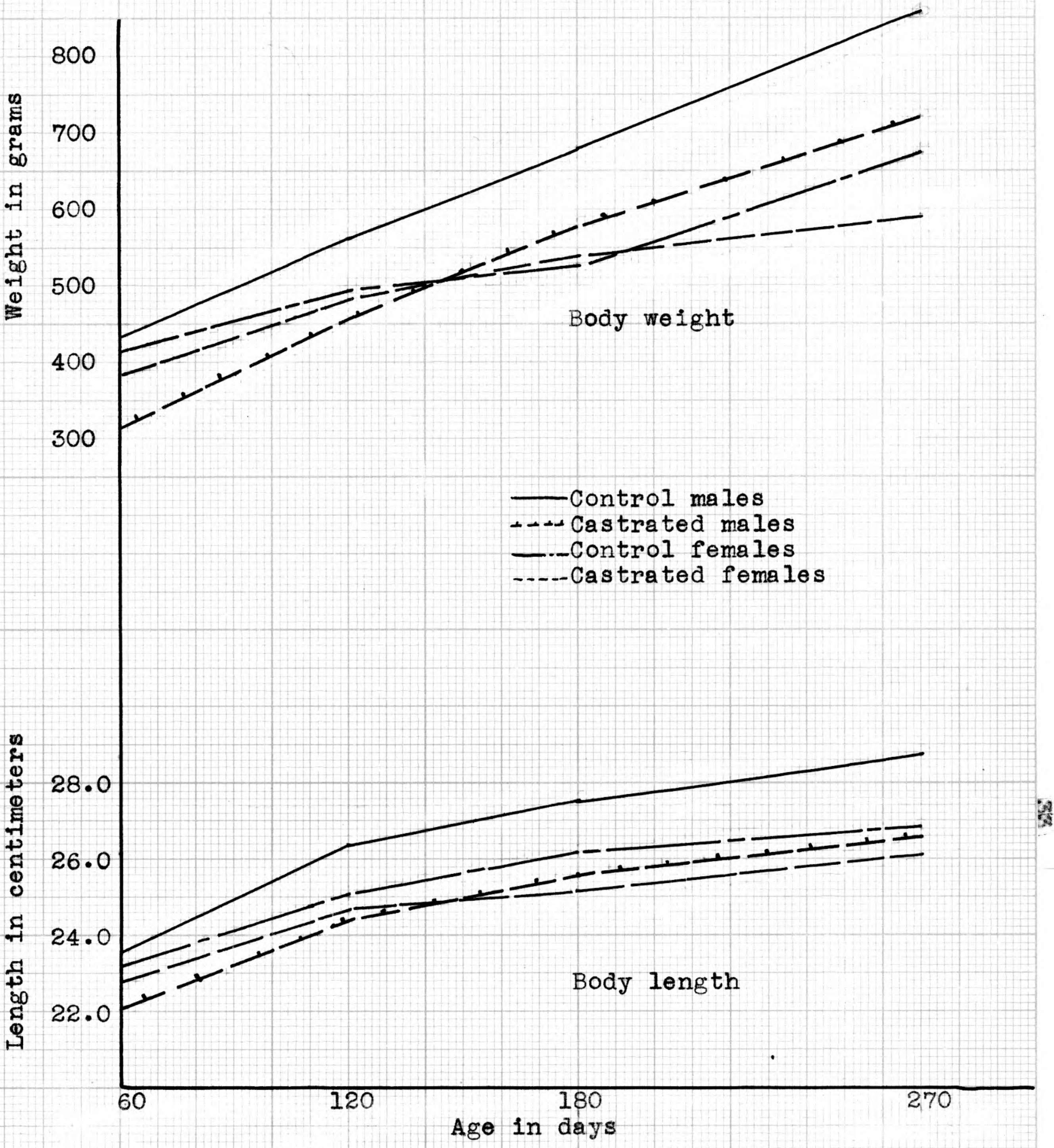

Fig. 5. Graphs showing growth of body length and body weight in castrated animals and their controls.

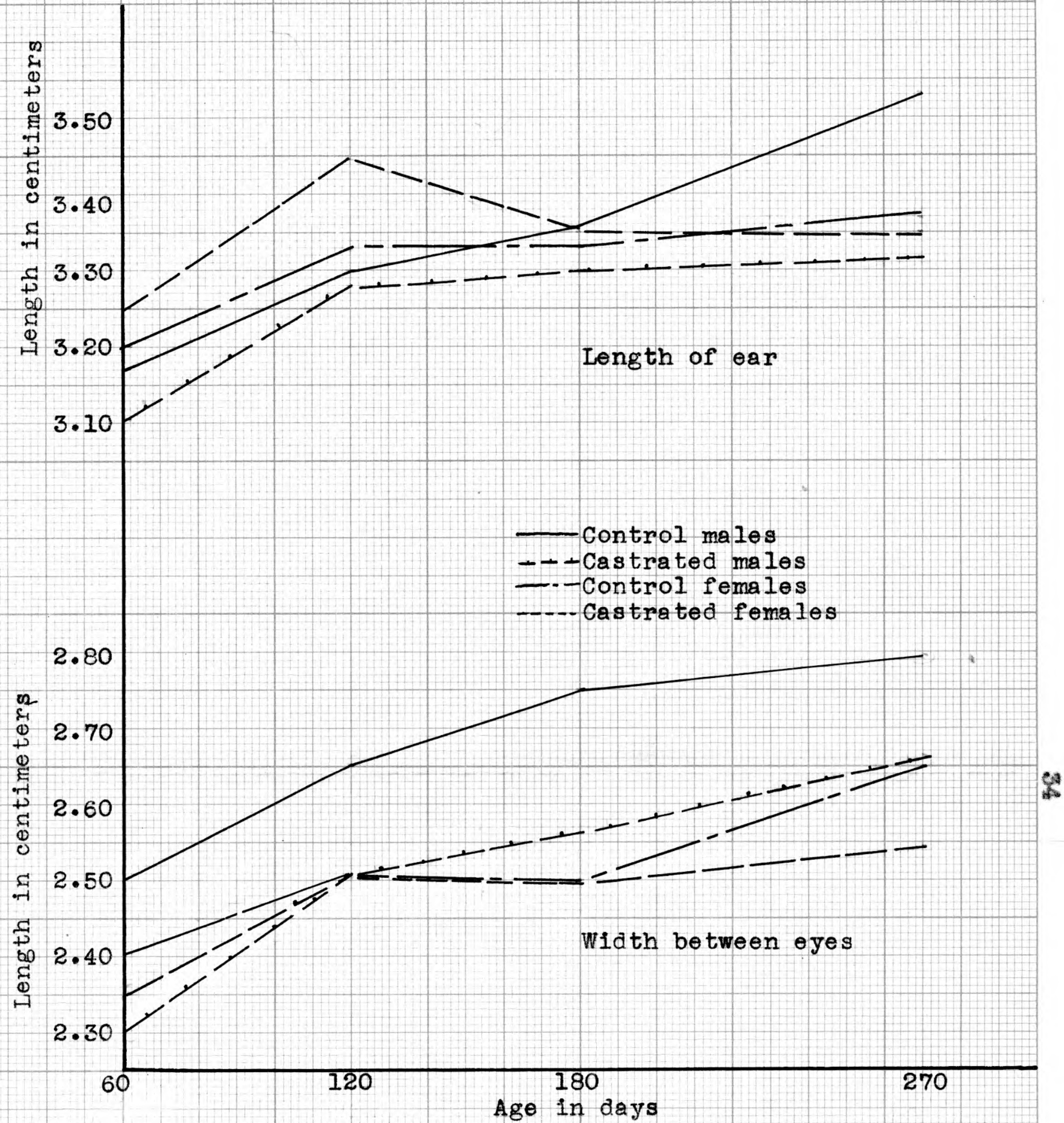

Fig. 6. Graphs showing growth of ear length and width between eyes in castrated animals and their controls.

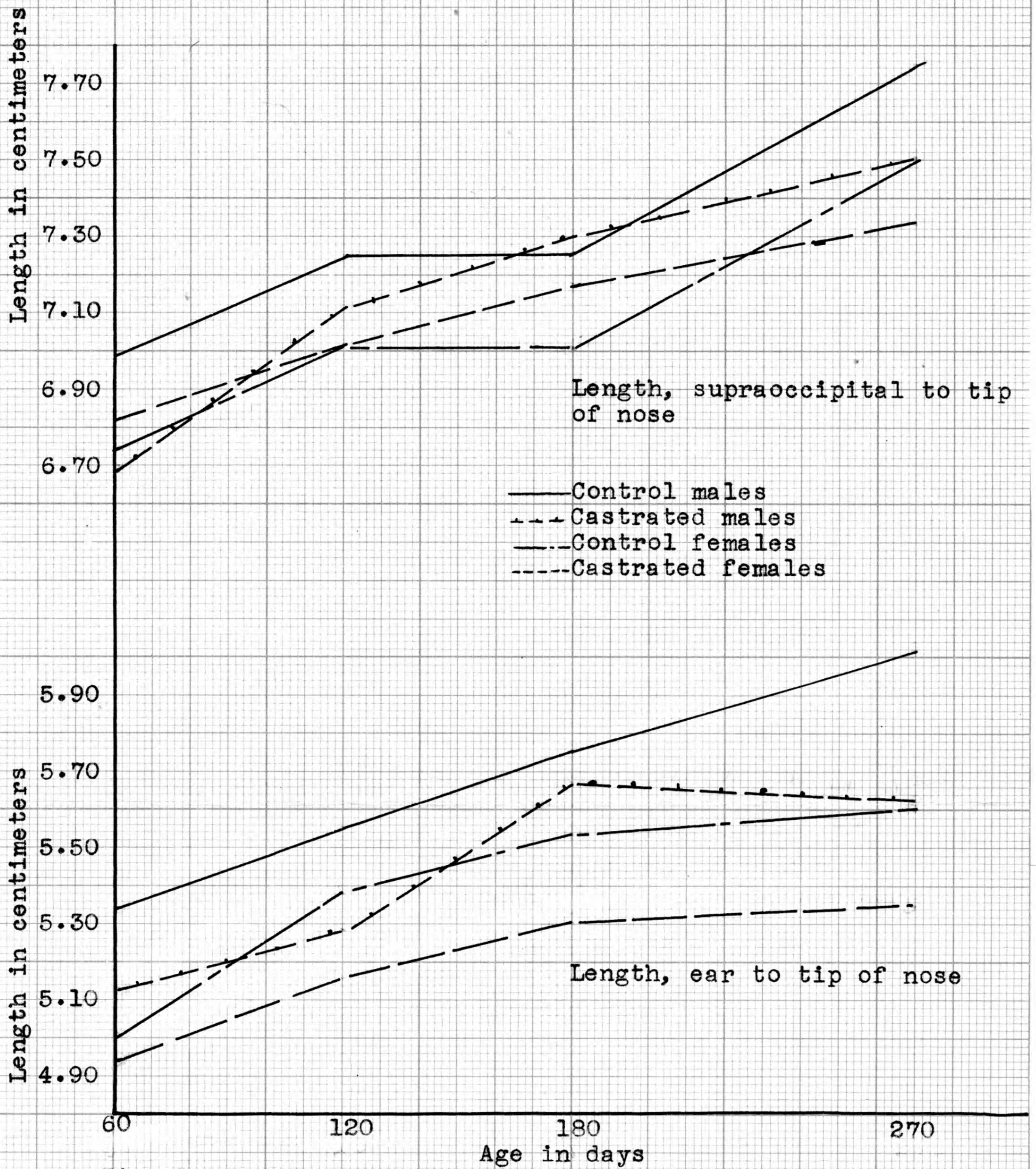

Fig. 7. Graphs showing growth of the length from the ear to the tip of the nose, and the length of the supraoccipital to the tip of the nose in castrated animals and their controls.

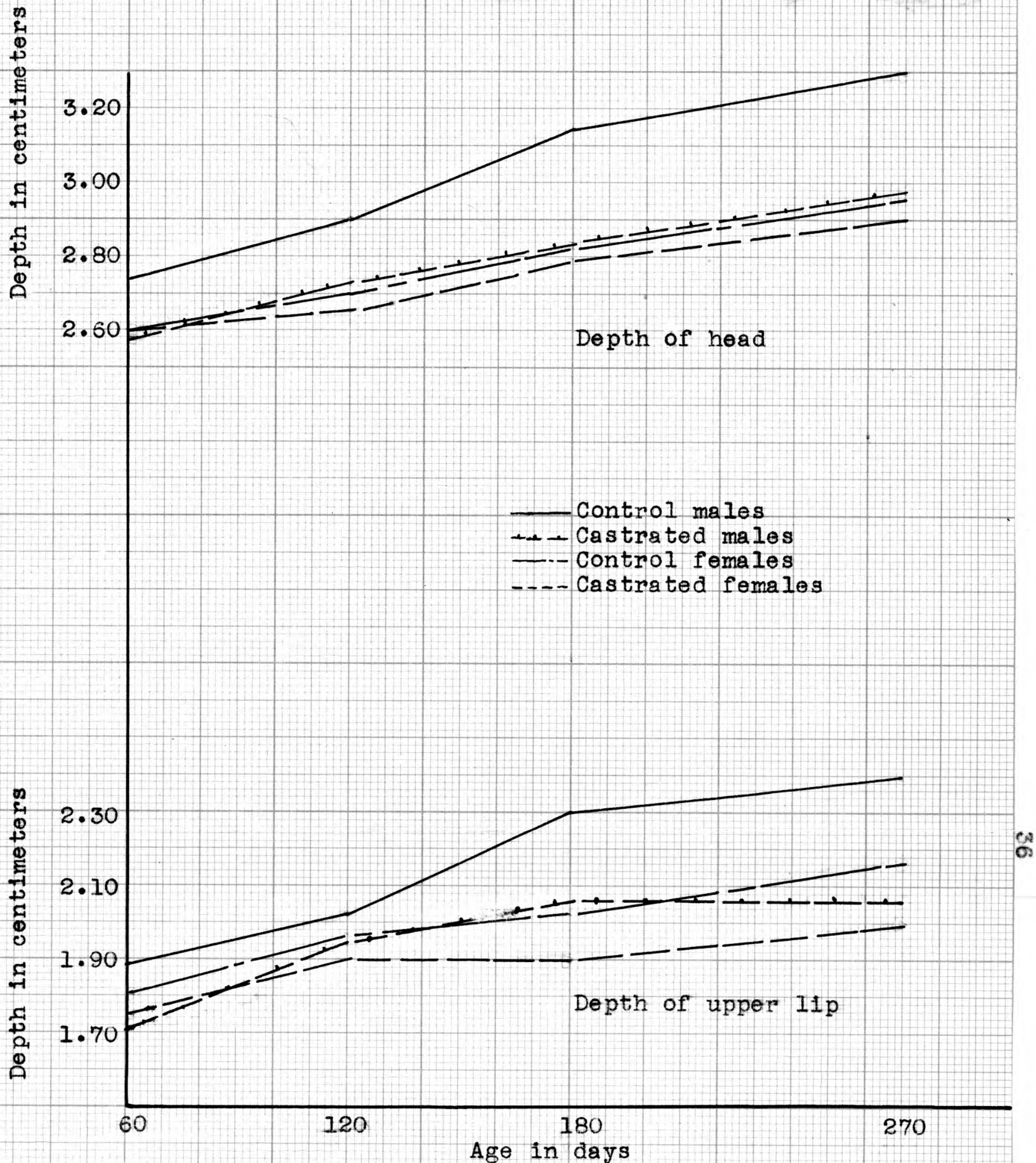

Fig. 8. Graphs showing the growth of the depth of the upper lip and the depth of the head in castrated animals and their controls.

SUMMARY

1. A genetic study has been made of size differences between two inbred strains of guinea pigs. Data from the two lines, and from various crosses and backcrosses were used.

2. Differences in environment were responsible for a high variability in all of the measurements.

3. The lack of sufficiently large numbers in addition to the high variability made a conclusive analysis of these data difficult.

4. Fairly good evidence is available for a single autosomal dominant factor for large size.

5. There are indications of an autosomal dominant factor for decreased width of head present in the non-show strain. Evidence for other specific size factors is not clear cut.

6. Males were found to have larger heads than females. For most measurements, these differences are significant. On the other hand, females had longer, larger ears than males.

7. Birth weights of males were consistently but never significantly greater than those of females.

8. Birth weights were influenced by the size of

the mother and the litter size.

9. The degree of inbreeding of both the mother and of the offspring probably were major factors in determining litter size and the percent dead at birth.

10. Tests for a relationship between total blood cholesterol and body size were negative, indicating that probably this size difference was not due to thyroid activity.

11. Castrated animals were smaller and more wild than their litter mates, indicating that lack of sexual activity in the sterile animals was not responsible for large size. Sexual differences in measurements were not apparent in these animals.

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