DEVELOPMENT OF THE NURSING MOUSE

MUS MUSCULUS

THESIS FOR DEGREE OF M.S.
MICHIGAN STATE COLLEGE
DWIGHT J. STRICKLER

1940

THESIS

This study was conducted under the direction of Dr. H.R. Hunt, Head of the Zoology Department of Michigan State College, East Lansing, Michigan.

DEVELOPMENT OF THE NURSING MOUSE, MUS MUSCULUS

by

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A THESIS

Submitted to the Graduate School of Michigan State College of Agriculture and Applied Science in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

Department of Zoology

1940

THESIS

Acknowledgments

The author is indebted to Dr. H.R. Hunt for helpful suggestions and criticisms throughout the course of the investigations and in the preparation of the manuscript, to Michigan State College for the opportunity it afforded in this research.

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Part I

Introduction

Introduction

The purpose of this investigation is to describe the external changes that take place in the mouse, (Mus Musulus) from birth to the weaning time. The study of the postnatal development of rodents has been slighted, though many embyological investigations have been conducted on the prenatal history of mammals. Thus our present subject has had little attention. The author was unable to find any literature which had direct bearing on the present work. It is true that many striking changes in development occur while the embryo or fetus is still inside its mother's womb, yet development by no means ceases at birth. Birth is a mere incident which occurs when the new individual is sufficiently advanced to allow its transference from a protected uterine environment to the external world. Various species of animals are found to differ as to the exact stage of development of certain characters at the time of parturition. The guinea-pig is well on its way to maturity at the time of birth when you compare it to the new-born mouse.

The purpose of this study is to determine the time when ten characters appear postnatally. Comparisons of six strains of mice show interesting differences and resemblances in rates of development. A time-table has been worked out from which one is able to determine the

age of a mouse between the first and the fourteenth day after birth.

The greater part of this investigation was conducted in the rodent colony of the department of zoology at Michigan State College. A portion of it was carried on at Olivet College, Olivet, Illinois.

External appearance of the new-born mouse.

At the time of birth the mouse is very immature and helpless. It is entirely naked except for fine, apparently colorless hairs on the sides of the nose. It is several days before an examination under the hand lens reveals a sparse pubescent condition on the dorsal region of the neck. Hair first appears on the neck, later on the back, then on the ventral side. The tail and ears develop hair still later, and finally the animal is completely covered.

The toes are present at the time of birth, but are connected by a web which later disappears. The toe nails are visible at parturition, but are very small and soft.

The animal appears pink to red in color, because of (or, as a result of) the hemoglobin content of the blood. Apparently the skin is devoid of pigment, though the eyes of dark-eyed strains may show color. The tip of the external ear is bent laterally and ventrally and is attached to the side of the head for the first few days after birth. The eyelids are closed at birth, though there is a line across the region of the future palpebral fissure.

The newborn mouse is not anatomically complete; therefore many changes occur after birth. The animal is utterly dependent on its mother for food and care for about two weeks before it becomes partially self-sustain-

ing. Postnatal development continues rapidly during this period. Close observation reveals that the young remain in the nest constantly during the first fourteen or fifteen days. Although many changes occur during this dependent time, we will attempt to describe but ten of the prominent ones, namely:

1. Appearance of pigment in the skin.
2. Appearance of hair on the dorsum.
3. Release of the ear pinna from the side of the head and its assumption of the erect adult position.
4. The development of the palpebral fissure.
5. Disappearance of the web between the toes.
6. The coming of color in the hair.
7. The appearance of the milkridge in the female.
8. The time that the incisors erupt.
9. The opening of the eyes.
10. Opening of the auditory canal of the ears.

The accompaning graphs do not show the time of the appearance of vibrissae, and toe nails, since these are present at birth. This report does not deal with pigmentation of the eye. The quality of pigment in the iris may be noted at birth. Those animals which show no pigment in the eyes at delivery are homozygous pink-eyed, the pink color being the result of the blood in the organ. The new-born mice which do show pigmentation of the eyes are those from dark-eyed strains.

There was notable variability in the time when pigment appeared in the skin and hair of the dorsal side of the different strains. In the individual, however, there was a definite day on which pigment appeared in this dorsal area, particularly on the shoulders. The first appearance of pigment to the naked eye was counted as on this day. The same consideration applies to the appearance of hair pigment.

It is interesting to note that only in the females did the milkridge develop to the extent that it could be seen externally. This investigation did not include a microscopic study to determine whether the ridges begin to develop in the male and then atrophy. At no time during the period of observation do the nipples develop in the male to the extent that they can be seen with a hand lens.

The female milk-ridge probably begins to form before birth. In postnatal life the milk-ridges continue to grow slowly, up to the time of puberty. At the time of parturition a great number of blood vessels can be seen on the right and left sides of the ventral surface running parallel to the length of the body. The pigment of the skin soon obstructs the view of this system of blood vessels. Later there appear in the course of development little raised spots which are probably the outward contour of immature alveolar glands.

Objectives of the Investigation

An investigation of the growth and development of the mouse is of practical value to geneticists who work with this animal.

A time-table has been worked out that enables one to determine within a day or two the age of a mouse up to the fourteenth or fifteenth day after birth. It is not always convenient to examine pregnant females daily to determine the day of birth of the litter. With such a chart as ours at hand one may determine the age of the young mice with remarkable accuracy.

The purpose of this investigation was to work out a technique for measuring the postnatal development of mice; then to apply that technique to a number of animals to determine the time of appearance of certain characteristics in question.

Reviews of Past Investigations

As was stated before, the writer was unable to find any previous work on the postnatal development of the mouse. There are on record a few articles bearing indirectly on this investigation. A brief summary of these is in order.

Gates and Hazen (3, 1925) have studied the litter size, birth weight, and early growth of mice. The sex ratio was found to be practically 100:100. Males and females weighed the same at birth, but the females grew faster than the males during the first three weeks. The growth rate of both sexes increased gradually at first, slackened about the nineteenth day, and finally increased as the young become independent. The mortality was greatest when the young began to stop nursing.

According to Snell (13, 1929) in the dwarf mouse, which was derived from a strain of black silver mice, the opening of the eyes is delayed two or more days beyond its usual time of occurrence at 14 days. Despite their greatly reduced size, the dwarf mice are fairly healthy. In vigor they are somewhat sub-normal. The animals were also found to be sterile. Mature individuals are only about one-fourth the weight of their normal brothers and sisters, scarcely bigger in fact than an ordinary mouse 16 or 17 days old. It is not until the 14th day, however,

that their reduced size begins to manifest itself.

Green, C.V. (5, 1931) reported linkage between general size and color characteristics. In the matter of weight, brown mice of both sexes are significantly heavier than blacks at the age of 181 days. If the chromosomes carrying the recessive genes for color also possess genes influencing size, then the back-cross mice with the recessive factors will tend to be larger than those with the dominant allelomorphs. Browns of a back-cross generation significantly exceeded blacks in body length.. Dilute animals similarily differed from intense in body length and probably in tail length as well. The fact that size in mice is influenced by genes can scarcely be questioned any longer.

The work of Green (4, 1936) on the nature of size factors in mice dealt with various quantitative characteristics. His data showed that the F_1 means fell into two general classes: one in which the means are intermediate between those of the two parent species and the other in which they equal or surpass the larger parent. General external dimensions, (body length, tail length) and weight fell into the first, while skeletal dimensions fell into the second class. Humerus length, however, is intermediate. These results point to the probable deduction that not all size characters are equally subject to the influence of general factors.

Part II

Material

Material

It is conceivable that different strains of mice might develop at different rates after birth. Therefore, varied types characterized by different hair or eye colors, were used in the experiment. Three highly inbred stocks were available; pink-eyed dilute browns, dilute browns, and leadens. Brother x sister matings were made between animals within each of these strains to produce litters for this study. Three other types were used which had been somewhat inbred in the rodent colony at Michigan State College, but they were probably far from homozygous. These strains were white-bellied black agoutis, chocolates, and dark-bellied black agoutis. Brother x sister matings were not always made with these animals during the experiment.

The foundation animals of the white-bellied black agouti type ($A^{W}A^{W}BBCCDD$) were derived from Little's A.W. stock. The animals used were descendants from male B58213, and females B58214, B58215, and B58216. These animals were from stock inbred for sixteen generations. For a few generations at Michigan State College Rodent Colony this strain was not propagated through sibling matings.

The foundation-animals of Chocolate inbred stock, or dark-eyed browns, were derived from Kel799 female, Kel800 male, Kel801 male, and Kel802 female. All re-

ceived from the Bussey Institution at Harvard University.

The ancestors of the dark-bellied black agoutis (AABBCCDD) were received from Little's Stock C$_{3}$H. They were males B58220 and B58221, and females B58222 and B58223. These animals were from stock inbred for thirty-seven generations.

The pink-eyed dilute brown short-eared inbred stock came originally from Professor W.H. Gates, of Louisiana State University, in February 1934. It had been inbred by brother x sister matings since the fall of 1926. After receiving these animals, brother x sister matings were not practiced until August 6, 1934, when a single pregnant female was isolated whose litter constitutes the beginning of inbreeding for this experiment.

The foundation stock of Little's inbred dilute browns was received from W. S. Murray in March 1934. These foundation animals were male 10131, female 10132, male 10133, and female 10134. All were siblings. Inbreeding by brother x sister matings of this strain continued during the experiment.

The inbred foundation animals of Leadens were received from J. M. Murray in February 1934. They were the offsprings of Murray's 32111 and 32110. These were from a line throwing six toes on the posterior feet. J. M. Murray's records showed that these animals had a pedigree of seven generations of brother x sister matings. This

strain was continued by sibling matings during this investigation.

Part III

Methods

Methods

As previously indicated, no one has extensively studied the postnatal development of any trait in mice except weight. Therefore the necessary techniques for this study had to be invented at the beginning of the investigation. A great number of preliminary animals were first studied in order to familiarize the author with the problem. The records of these were not included in the totals.

The investigation was prosecuted under closely controlled conditions. No doubtful data were included in the records.

The animals to be studied were kept in galvanized iron metal cages with wire mesh tops. Each cage was approximately twelve inches long, deep, and wide. From four to six breeding females were placed in each breeding cage with one male. As previously indicated, brother X sister matings were used exclusively in the highly inbred pink-eyed dilute brown, leaden and dilute brown stocks. Such close inbreeding was not usually practiced with the other types.

The cages containing breeding stock were observed daily for pregnant females. Every such female was immediately isolated in a cage like the breeding cage and was watched daily to determine the date of birth of her litter. Each new-born mouse was marked on the day of

birth by cutting off a toe to enable one to distinguish it thereafter from its litter mates.

A dysentery, probably caused by a streptococcus germ, was prevalent in the rodent colony during the period of this investigation. This disease appeared in mice usually within a fortnight after birth, and was frequently fatal. When an affected infant was found, it was killed and its records were not used. The facts were recorded, and the mother was forced to drink a solution of 5% copper sulphate. At the time experience seemed to indicate that this substance killed the pathogenic germs in the mother's intestines. It was believed that adult mice could carry the germ in the intestines without showing the loose fecal discharge. The prevalence of this disorder made great cleanliness mandatory.

Cages, water bottles, and food racks were sterilized with steam before being used. The cages in use were cleaned and rinsed with a concentrated sodium hypochlorite solution, (commercial H.J.H. solution) every seven days. Wood shavings on the floor of the cages provided litter. Paper shreds were found to be the most satisfactory nesting material.

Water was furnished from gravity bottles which were thrust through the top of the cages. Food and water were always available for the animals.

Each animal was examined on the day of birth and on

every day thereafter until all characters under scrutiny had developed. Observations were made at the same hour on consecutive days in order to make the time intervals between observations constant.

Collecting of Data

A separate data sheet, (Figure I) was used to record the observations for each infant mouse. A record was made on the individual data sheet on the day when a character being studied appeared. Various means were used in detecting and observing the development of these characters.

Each individual mouse was carefully examined in direct daylight. The mouse was placed on a light background and observed with the aid of a hand lens. The lens was mounted on a tripod, and was placed directly above the portion of the specimen under observation.

The time of appearance of the groove which is the forerunner of the palpebral fissure was determined by examining the naso-lachrymal region of the future groove first, then scrutinizing the area over the eyeball, and finally the future site of the posterior termination of the groove.

In noting the severing of the membrane which holds the pinna in a tight fold against the side of the head, it was not necessary to employ the lens, since the character was easily detected with the naked eye. This character was very definite in its development, the change occurred rather suddenly between the time of two observations. One day the pinna would be tightly attached to the side of the head and on the very next day both ear

flaps would be erect. These conditions are illustrated thus:

Diagram showing position of pinna before severing of the limiting membrane.

Diagram showing position of pinna after the severing of the limiting membrane.

The separation first appeared at the tip of the fold and then worked back along the two margins. Following the severing of the membrane which holds the ear flap in its folded position the pinna assumed an erect orientation as the sketches show.

Following the pinna's assuming an upright position, a direct observation could be made of the opening of the external auditory canal. After the release of the pinna the auditory canal remained sealed by a membrane. This covering was found at the outer end of the entrance. From the time the ear flaps let loose until the canal opened was about nine days. The opening was very small at first and as the membrane was absorbed the entrance became larger. Record for this character was made at the first sight of an opening, then by the next observation the membrane had completely disappeared. In making this

examination the animal was held to the light in order that the slighest opening might be observed.

The examination for skin color proceeded as follows: The individual was held in direct natural light and moved to various angles with the direction of light. The neck region, the general dorsal portion, the sides and ventral part were carefully observed for indications of pigment. Again it was found that the examination was more successful with the naked eye. Direct inspection without the lens permitted a general view of the body and afforded a comparison of the various regions as to color origin.

As previously stated in the section on external appearance of the new-born mouse, the toes are present at the time of birth, but are connected by a web which later disappears. This disappearance was studied with the aid of a hand lens. The mouse was held between the fore-fingers of one hand while the lens was adjusted for distance between it and the foot of the animal. With this method it was easily determined whether the toes were held together by the connective membrane. Each foot was examined to determine whether there was any difference in the time of the disappearance of the web on the four feet of the same animal.

The determination of the first appearance of hair on the animal was made in good natural light. The mouse was held loosely between the fore-fingers and turned in var-

ious positions to insure a complete inspection of all parts of the body. At first a hand lens was used, but later naked-eye inspection was found adequate. Each observation began in the region of the vibrissae and proceeded over the dorsum, the caudal region, the lateral portions, and finally the ventral side.

The method used in detecting the presence of hair color was the same as that followed in the examination for skin color. The animal was held in direct natural light, and the examination was made without the aid of the lens. This made possible a quick comparison of the various regions of the individual as to hair color origin. The observation covered the whole exposed portion of the hair.

The technique employed in detecting the milk-ridge was to place the animal on its back with the ventral portion properly illuminated. A hand lens permitted a clear view of the milk-ridge region. The entire ventral surface was observed for any indication of the character.

The head of the mouse was held between the thumb and fore-finger, and slight pressure to the axial region of the jaws opened the mouth. In this manner the gums were exposed, permitting an unobstructed view of the incisor area. Previous to the eruption of the incisors the gums were studied carefully. A probe was drawn over the region of the incisors in order to detect whether the incisors

had emerged through the surface of the skin. Record of first appearance of incisors depended on actually seeing the tips of these teeth.

An attempt was made to study the rate of development of the molar teeth, but it was found necessary to kill the animal in order to study the molars, so this character was omitted from the investigation.

It was easy to time the opening of the eyes. Again the animal was held in an advantageous position with regard to light, and a hand lens was used to detect the severing of the junction of the eye lids. The opening occurred rather abruptly; one observation would show the lids firmly closed while the next observation (twenty-four hours later) revealed the open eyes.

Each mouse was weighed daily during the first fourteen days after birth. The fairly inactive mouse was placed on the pan of an ordinary chemical balance. The weighing was accurate to within a hundreth of a gram. The weights were recorded daily on the specimen's data sheet (Figure I). The purpose of this procedure was to determine whether there were correlations between early growth and the times of appearance of the different characteristics.

Variables Kept Constant

It is a commonplace fact that the rate of postnatal growth is affected by at least one environmental factor, food. It is therefore conceivable that other features of postnatal development might be influenced by various other environmental agencies.

Therefore a number of variables, which might have had an influence on development, were kept reasonably constant.

Only first and second litters of an individual were used, so that differences in development due to litter order were minimized. The parents were all relatively young.

The litter size was kept constant. Five animals per litter was the standard size, except that a few large and small litters were studied to observe the effect of this factor on rates of development.

The room temperature was recorded three times daily. The maximum fluctuation was found to be from 70° to 92° F. The variation was probably even less in the nest of the young, for it was noticed that the mother tried to regulate the nest temperature by the amount of covering. However, thermometer readings were not made in the nests.

Only healthy, vigorous animals were used in the study. Wherever the parents or young were diseased, the data

were discarded.

The stock animals were fed Fox Chow[1], while the isolated females with young were fed a balanced ration consisting of ground grains. Fresh water was kept before all animals constantly.

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1. Fox Chow is manufactured by Purina Mills, Ralston Purina Company, Davenport, Iowa.

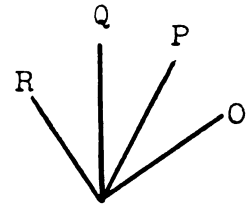
Guaranteed analysis of Fox Chow:

Crude protein, not less than----------20%
Crude fat, not less than----------3.0%
Crude fibre, not more than----------6.0%

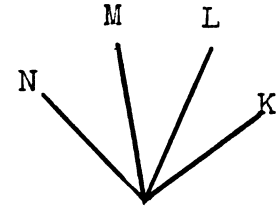
Explanation of the Individual Data Sheet (Figure I)

Complete records concerning each mouse were kept on an individual data sheet (Figure I) assigned to the animal when it was first observed.

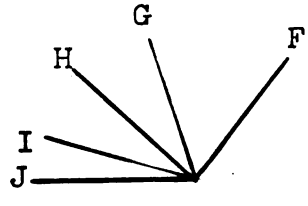
The individuals of a new litter were marked by removing the tip of various toes from the feet. For example animal "B" of a litter would have the tip of the second toe from the outside of the right hind foot removed. "C" would be the individual with the tip of the third toe on the right hind foot removed. Similarly the remaining litter members were carefully marked in a manner as indicated by the diagram (Figure X).



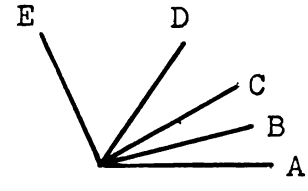
Left front foot



Right front foot



Left hind foot



Right hind foot

Figure X, Diagram for marking individual mice.

To secure permanent marking it was necessary to remove the entire distal part to the base of the first joint with a pair of very fine cuticle scissors. The toes at birth are very small so that extreme care was used in the marking process to make sure that the web of the foot was not severed when the distal portion of the toe was removed.

The identification letter for a particular mouse was placed in the space provided at the upper left corner of the data sheet. The sex of the individual was not recorded until the time of weaning. At this time the date of weaning and the sex were entered on the record.

A check mark (✓) was entered on the data sheet at the day on which a given trait first appeared. The data sheets were filed by litter and strain of mice in order to facilitate the recording process.

PART IV

RESULTS

Results

Interpretation Of The Timetable (Fig. III and IV)

Experimenters with mice may sometimes find it impractical to observe breeding mice daily in order to obtain the exact age of the young. One purpose of this investigation has been to construct a "timetable" by which one could determine the age of a young mouse, of unknown birth date, by noting its degree of development. Such "timetables" are presented in Figures III and IV. By noting the degree of development of pigment, hair, ears, eye lids, toes, milk ridge, and incisors in an individual mouse, an investigator can now determine its age, within a day or two, by referring to these Figures. A time chart such as that in Figure IV might well be kept for reference in an easily accessible place in a mouse colony.

To determine the age of a young mouse, list the traits that have developed and those that have not, then find its most probable stage of total development by referring to Figure IV. This will place the mouse in one of the vertical columns of the Figure. By following this column to its bottom one can determine the probable age of the mouse.

Pigment of the skin does not characteristically appear until the third day. The author has found, as in-

dicated by the timetable, that 33.2% (99)[1] of the cases studied exhibited color on the third day. The mode for appearance of color is on the fourth day, when 41.9% (125) of the individuals showed color. There was a decline on the fifth and sixth days, for 16.1% (48) and 8.7% (26) showed color for the first time on these days. The mean for the development of pigment in the skin is 4.00±.036 days (Figure III).

Thirty-one and six-tenths per cent (117) of the total number developed hair on the dorsum during the third day. A great majority, 61% (226) produced hiar on the fourth day. Only 7.2% (27) were found to develop hair on the dorsum for the first time as late as the fifth day. The fourth day is the characteristic time for dorsal hair development. The mean for this character is 3.75±.021 days (Table I).

The span of time in which the pinna of the ear was released was also rather brief, covering but three days. Nine and seven-tenths per cent (35) released their pinna on the third day; 71.4% (255) of the total number of animals released the ear flaps on the fourth day. The fifth day finds but 19% (68) releasing their ear flaps. The mean and modal times for severing of the pinna membrane are 4.10±.020, and fourth days respectively.

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1. The number of animals that developed a character on a certain day is recorded in parenthesis. These numbers can be found in Table II and II continued.

The palpebral groove developed at about the same time as the three traits just discussed. Six and six-tenths per cent (24) manifested this development as early as the third day. Forty-six and six-tenths per cent (168), the modal class, showed the groove on the fourth day. The examination reveals 30.6% (111) developing the groove on the fifth day, and 16.3% (59) on the sixth day. The mean frequency for this character was 4.56±.031 days. A considerable interval of 9.2 days exists between the development of the groove and the opening of the eye.

Only 5.5% (18) of all animals showed the disappearance of the web between the toes on the fifth day. On the sixth day 35.0% (114) exhibited severing of the toe webs. On the seventh day 38.4% (125) showed the severing. The seventh day was also found to be the modal time for this character, while the mean 6.76±.109 was slightly earlier than the mode. Nineteen per cent (62) broke the toes. Only 1.8% (6) of the group remained to fall in the ninth day period. Both the probable error of the mean and Figures II, III, and IV show that this is one of the more variable traits studied.

The character, hair color on the dorsum, first appears over a period of five days. On the sixth day after birth it was found that 0.9% (3) of the animals revealed color in the dorsal hair. Nineteen and eight-tenth per cent (65) showed hair color the seventh day. The majority of the

animals studied showed color for the first time in the dorsal region on the eighth day. This is the modal class, and consisted of 51.3% (168) of the specimens. Twenty-seven and two-tenths per cent (89) showed hair color on the ninth day. Only 0.6% (2) came in the tenth day period. The mean for this character was 8.06±.030 days.

The character mammary glands is not hard to detect because small nipples appear so that they can be seen by the naked eye. On the ninth day the milk-ridge appeared on the ventral side of 8.4% (12) of the females under observation. Fifty-seven and seven-tenths per cent (82) developed the ridge the tenth day. As this number indicates the tenth day was the modal period while the mean was 10.3±.039 days for this character. On the eleventh day 28.8% (41) of the animals studied showed the milk-ridge, while the twelfth day revealed 4.9% (7).

As the developmental timetables (Figures III and IV) show, the incisors of the young mouse may erupt sometime between the eighth and twelfth days. There was no animal to cut its incisors before the eighth day, and there was no specimen found to develop its incisors later than the twelfth day. Note that only .3% (1) of the mice had cut incisors on the eighth day. Nine and four-tenths per cent (32) erupted incisors on the ninth day. The mode, or 44.1% (150) fell in the tenth day period. The mean for the character in question was 10.5±.032 days. Twenty-

eight and five-tenths per cent (97) developed these teeth on the eleventh day after birth. The twelfth day showed the per cent of 17.6 (60) for incisor eruption.

The ear, after the erection of the pinna, still remains sealed by a delicate membrane which serves as a protection for the developing inner ear. The membrane remains intact until comparatively late in postnatal development, insuring the maximum protection to the organ of hearing.

The small vibrissae on the nose region serve as functional sense organs substituting for hearing until the ear has had an opportunity for development. Gradually, as the animal approaches the complete functional development stage of the ear, he turns from relying on the sense impressions received through the nose and body hairs to those sense impressions received through the ear. The ear membrane disappears very rapidly once the process has started. The membrane seems to be absorbed. At first a small orifice appears in the membrane, later more complete receding of the tissue takes place, and the development of the internal contours of the external ear become more prominent.

In 8.5% (28) of the cases examined (on the twelfth day) it was found that the ear membrane had disappeared. On the thirteenth day 44.5% (147) of the individuals had opened the membrane to the inner ear. The fourteenth day

found 31.5% (104) of the mouse ears open for the first time. By the fifteenth day all the mice had completed the process, as the remaining 15.4% (51) broke the ear membrane on that day. The mode for the development of this character was the thirteenth day, while the mean was 13.54± .03 days.

The eyes open late in postnatal development. In this case, as with the ear, the sense of sight is delayed until the later part of the period of its dependence on the mother. The palpebral groove, the site of the future opening, is complete on approximately the fourth day, as noted earlier in this discourse. But the eyes completely open much later in development. Characteristically this may be observed as early as the twelfth day, since 4.5% (15) opened their eyes on this day. The thirteenth day found 35.7% (120) opened the eyes. The fourteenth day provided the largest per cent, 39.8% (134) and the fifteenth day 19% (64). The remaining 0.8% (3) completed the process as late as the sixteenth day. The mode for the opening of the eyes was at the fourteenth day, and the mean was 13.76±.032 days.

Comparison Between The Six Strains

The total results for all the strains of mice studied are tabulated and presented graphically in Tables I and II and Figure II, respectively. A total of 370 individual mice were involved in this tabulation.

Of the 370 individuals studied it was interesting to tabulate the results of the various characters noting the number rather than the % of the animals that developed these characters on various days (Table I and II).

To the present point we have been discussing the pooled data from all the strains, but it is important to determine whether the behavior of individual strains is significantly different in any respect from the averages for all of them.

In comparing white bellied black agouti mice with the totals of all strains, the developing characters were found to be less variable than these totals. These facts are graphically represented in figures II and V. The tabulations for the white bellied black agouti strain are recorded on table III and for the totals on table I.

Figure VI shows that in the chocolate strain the variation for all characters studied were significantly less than those for the totals of all strains of mice under observation. The records for the totals are recorded graphically in Figure II. Few animals made up the chocolate

strain in comparison with the total of all animals studied. This probably had some bearing on the limited variations of characters recorded for Chocolates.

Consider now the dark bellied black agouti. If Figure VII could be superimposed on Figure II it would be seen that the modes for each character agreed in a significant manner except in the case of palpebral groove and the disappearance of the web of toes. There was a wider variation for the development of all characters found in the totals when compared to the black agouti.

As Table VI and Figure VIII show, pigment of skin and pigment of hair are not recorded. The pigmentation was so limited in the pink-eyed dilute browns that reliable data on these traits were wanting. In all other respects the pink-eyed dilute brown strain closely approximates the averages for all six strains. This agreement is remarkable, considering the small number of pink-eyed dilute browns.

There were more animals of Little's dilute brown type raised than any of the other strains. Records are tabulated on Table VII and graphically shown on Figure IX. In comparing Figure II and IX they are found to be rather identical. There is little or no difference in the variations for each character.

Few leaden animals were raised, but it is quite interesting to note the correlation of Figures II and X. The smallness of the group for leadens is probably the reason for any noted differences. The data for leadens inbred

stock is tabulated on Table VIII.

In the comparison of black agouti and white bellied black agouti, (Table X) a significant difference in the means of the following characters was found: pigment of skin, palpebral groove appearance, incisor eruption and the opening of the ears.

Table IX shows a comparison of black agouti and Gate's pink-eyed dilute browns with significant differences of the means of all the characters studied except for hair appearance.

Table XI contains the comparisons made between back agouti strain and leadens. Significant differences were found of the means in skin color, hair appearance, ear pinna release, a marked difference in palpebral groove development, mammary glands, and opening of the eyes and ears.

Table XII which tabulates the differences of the means of various characters for the black agouti and chocolate strains. The following means showed a marked difference: pigment of skin appearance, hair appearance, mammary gland development, opening of eyes, and opening of ears.

A comparison of black agouti and Little's dilute brown (Table XIII) showed significant difference in all of the characters observed except for hair color and opening of eyes.

Little's dilute brown stock was used to make a com-

parison between large and small animals. The size was determined on the basis of weight. This comparison may be found tabulated in Table XIV, and graphically shown in Figure XII, and XII continued. A significant difference was found in comparing the means for the two extreme sizes in the following characters: pigment of skin, ear pinna, palpebral groove, hair color, mammary glands, opening of ears, and opening of eyes. The exact number of animals studied in each case are recorded in Table XV.

Figure XI graphically illustrates in an interesting manner the comparison of the means of all observed characters for the six strains of mice studied in this investigation.

PART V

Discussion

The present investigation has dealt with the postnatal development of the nursing mouse up to the time of weaning. Various tabulations have been recorded of the rates that different strains developed the characters in question. The genetics of these developments are wanting.

It would be of interest to know the exact mode of inheritance governing the rates of development of the various characters of mice. On the other hand, one might study the environmental factors which express themselves in development. The characteristics of the developed organism are not only influenced by a complex of interacting genetic factors, but depend to a considerable extent upon the environment in which these factors act. A rough distinction may be drawn between the external environment (as those various agencies outside the organism which may have an influence upon it, such as temperature, light, food, and so on), and the internal environment, including all those stimuli which have their origin within the body itself.

In the mouse there are various internal secretions which enter the blood from the ductless glands, namely, hormones. It is thought that these hormones have a marked influence upon many physical features. Some of these hormones regulate and correlate the general processes of development, and the attainment of normal maturity

depends upon their presence in proper amount. One must bear in mind that these secretions provide one item of the general environment within which the genes act. The secretion itself may often be one channel through which a gene affects specific characters. There is undoubtedly a complex series of interactions between the genetic factors, the endocrine secretions, and other agencies of the internal environment during development. There are many avenues to the approach of the mode of inheritance of these characters in question.

Definite conclusion in this field would aid in the solving of many present-day questions. A few of the unsolved problems in connection with this investigation are the following:

1. Does the age of the father or mother have any influence on rate of development?

2. What is the relation of parity and the time of postnatal appearance of characters?

3. Is there a correlation of body weight with the development of external structures?

4. Does litter size have any bearing on rate of postnatal developments?

5. What is the relation of genetic constitution of animals and time of appearance of specific characters?

6. What are the multiple effects of genes?

It is regretable that the observations were not made

more frequently. The author has decided that twenty-four-hour intervals are too long for the observation of the developing young. The growth and maturation of the mouse are too rapid to be accurately studied unless one observes the animals more frequently. A particular litter may have been born five minutes before the time of the observation or five minutes after the previous day's study. This in itself would create a difference of almost a day. In this study there is the advantage that observations were made at the same hour on consecutive days. More frequent investigations should be the rule for future study.

The author wishes to give a brief discussion of possibilities for this topic for future investigation. The present work is an introduction to what can be an interesting and profitable field of study. It would be advantageous to be able to work out the genetics of the postnatal development of the mouse. Great numbers of animals with varied genetic constitutions should be studied. Tests should be made to find out if the age of parents has any bearing on development. It would be of interest to know whether the order of litter is a factor influencing maturation.

A large group of animals should be placed under observation with all variables kept as constant as possible except the one being studied. The records of healthy animals should be the only ones tallied.

The solution of a few problems in connection with the postnatal development of mice will lend weight in solving many similar problems in the human race. It is a very common practice for parents to compare their offspring with the standard mean of the social group. The questions still unsolved in this study of mouse development would suggest themselves with interest and practicality to a similar investigation of the human race.

Conclusions

1. As far as the author knows, an introduction has been made to a new field of investigation.

2. Methods for future studies on postnatal development have been elaborated in this paper.

3. A timetable has been constructed from which one is able to determine approximately the age of a mouse up to about fourteen days.

4. The sex of the mouse can be determined at birth and reaffirmed at approximately the tenth day; the females develop nipples of mammary glands about that time.

5. An interesting correlation was observed between the individual's activity and the time of the opening of the eyes and ears. The young mice at this time began to leave the nest and explore their surroundings. The incisors are well enough developed for them to attempt to get food by themselves, although no experimentation was performed to determine whether they were yet independent of the mother. There seemed to be a complete correlation between pelage and leaving the nest. The time of departure from the nest was not ascertained, but no animal was ever found outside the nest until it was fairly well-covered with hair.

6. There was a continuous growth and a gradual increase in activity of the mouse during the time of ob-

servation.

7. There was a period from the first to approximately the third day of the life of a mouse during which time no observed character made its appearance.

8. Animals of small litters seem to grow faster than animals of large litters. This condition is probably caused by the available food supply.

9. The fourth day in the life of a mouse is important in that the mode of four characteristics appeared as on this day. The modes for the remaining six traits were scattered fairly uniformly through the remainder of the infantile period.

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PART VI

TABLES AND FIGURES

LIST OF THE SIX STRAINS INCLUDED IN TOTALS

I WHITE BELLIED BLACK AGOUTI

II CHOCOLATE

III DARK BELLIED BLACK AGOUTI

IV GATES' PINK-EYED DILUTE BROWN SHORT-EARED

V LITTLE'S DILUTE BROWN

VI LEADENS INBRED STOCK

TABLE I

Totals of the Six Strains

CHARACTERS	Total No. of animals	Day of appearance Mean P.E.	Mode	No. in modal class	% in modal class
Pigment of skin	298	4.00±.036	4	125	41
Hair appearance	370	3.75±.021	4	226	61
Ear flaps open	358	4.10±.020	4	255	71
Palpebral groove	362	4.56±.031	4	168	46
Disapp. of web of toes	325	6.76±.109	7	125	38
Hair color	327	8.06±.030	8	168	51
Mammary glands	142	10.30±.039	10	82	57
Incisors	340	10.54±.032	10	150	44
Opening of eyes	336	13.76±.032	14	134	39
Opening of ears	330	13.54±.031	13	147	44

TABLE II

TOTALS OF THE SIX STRAINS

CHARACTERS	White Bellied Black Agouti	Chocolate	Dark Bellied Black Agouti	Pink-Eyed Dil. Brown	Little's Dil. Brown	Leadens	TOTALS
Pigment of skin	3-42 4-17	4-24 5-20	3-18 4-36		3-24 4-44 5-28 6-26	3-15 4-4	3-99 4-125 5-48 6-26
Hair appearance	3-34 4-27	3-42 4-10	3-28 4-36	3-5 4-10	3-6 4-128 5-22	3-2 4-15 5-4	3-117 4-226 5-27
Ear flaps	4-47 5-14	4-30 5-11	4-46 5-20	3-3 4-11	3-30 4-104 5-18	3-2 4-17 5-2	3-35 4-255 5-68
Palpebral groove	4-9 5-47 6-5	4-5 5-14 6-24	4-6 5-30 6-30	3-8 4-9	3-16 4-118 5-20	4-21	3-24 4-168 5-111 6-59
Disappearance of web of toes	5-4 6-29 7-28	6-22 7-6	5-8 6-36 7-16	7-8 8-7 9-2	6-24 7-62 8-54 9-4	5-6 6-3 7-5 8-1	5-18 6-114 7-125 8-62 9-6
	Days # Animals	Days # Animals	Days # Animals	Days # Animals	Days # Animals	Days # Animals	Days # Animals

TABLE II (Continued)

TOTALS OF THE SIX STRAINS

CHARACTERS	White Bellied Black Agouti	Chocolate	Dark Bellied Black Agouti	Pink-Eyed Dil. Brown	Little's Dil. Brown	Leadens	TOTALS
Hair color	7-13 8-25 9-23	7-9 8-19 9-15	7-10 8-36 9-18		6-3 7-30 8-79 9-26	7-3 8-9 9-7 10-2	6-3 7-65 8-168 9-89 10-2
Mammary glands	9-6 10-6	10-5 11-4	10-20	10-4 11-4	9-6 10-44 11-14 12-4	10-3 11-7 12-1	9-12 10-82 11-41 12-7
Incisors	10-9 11-24 12-26	9-9 10-5 11-14 12-10	10-26 11-16 12-20	8-1 9-7 10-8 11-1	9-20 10-96 11-30 12-4	9-3 10-6 11-12	8-1 9-32 10-150 11-97 12-60
Opening of eyes	12-5 13-18 14-31	14-10 15-24 16-1	13-24 14-36	13-1 14-13 15-3	12-10 13-77 14-30 15-30 16-3	14-14 15-2	12-15 13-120 14-134 15-64 16-3
Opening of ears	13-43 14-15	14-30 15-11	12-8 13-46	14-9 15-8	12-20 13-52 14-42 15-30	13-6 14-8 15-2	12-28 13-147 14-104 15-51
	Days # Animals	Days # Animals	Days # Animals	Days # Animals	Days # Animals	Days # Animals	Days # Animals

WHITE BELLIED BLACK AGOUTI

The foundation animals of White Bellied Black Agouti; ($A^wA^wBBCCDD$) were received from Little's A. W. Stock. The animals received were from male B58213; and females B58214, B58215, and B58216.

These animals were from stock inbred for sixteen generations.

TABLE III

I. WHITE BELLIED BLACK AGOUTI

CHARACTERS	Total No. of animals	Day of appearance Mean P.E.	Mode	No. in modal class	% in modal class
Pigment of skin	59	3.28±.045	3	44	74.5
Hair appearance	61	3.44±.096	3	34	55.7
Ear flaps open	61	4.22±.043	4	47	76.8
Palpebral groove	61	4.93±.045	5	47	76.8
Disapp. of web of toes	61	6.39±.224	6	29	47.5
Hair color	61	8.16±.068	8	25	40.9
Mammary glands	12	9.50±.177	10	6	50.
Incisors	59	11.28±.073	12	26	44.
Opening of eyes	54	13.48±.629	14	31	52.5
Opening of ears	58	13.25±.056	13	43	74.1

CHOCOLATE

The foundation animals of Chocolate Inbred Stock or Dark-Eyed Brown were derived from Kel799 female, Kel800 male, Kel801 male, and Kel802 female. They did not carry albinism.

TABLE IV

II. CHOCOLATE

CHARACTERS	Total No. of animals	Day of appearance Mean	P.E.	Mode	No. in modal class	% in modal class
Pigment of skin	44	4.45	±.055	4	24	54.5
Hair appearance	52	3.19	±.039	3	42	80.7
Ear flaps open	41	4.27	±.045	4	30	73.1
Palpebral groove	43	5.44	±.073	6	24	55.8
Disapp. of web of toes	28	6.21	±.060	6	22	78.5
Hair color	43	8.14	±.075	8	19	44.1
Mammary glands	9	10.60	±.131	10	5	50.
Incisors	38	10.66	±.119	11	14	36.8
Opening of eyes	35	14.74	±.066	15	24	68.5
Opening of ears	41	14.27	±.040	14	30	73.1

BLACK AGOUTI

The foundation animals of Dark Bellied Black Agouti (AABBCCDD) were received from Little's Stock C_{3H}. The animals received 3/4/37 were from the males B58220 and B58221 and females B58222 and B58223. These animals were from stock inbred for thirty-seven generations.

TABLE V

III. BLACK AGOUTI

CHARACTERS	Total No. of animals	Day of appearance Mean	P.E.	Mode	No. in modal class	% in modal class
Pigment of skin	54	3.67	±.041	4	36	66.6
Hair appearance	64	3.56	±.043	4	36	56.2
Ear flaps open	66	4.30	±.040	4	46	69.6
Palpebral groove	66	5.36	±.056	5&6	30	45.4
Disapp. of web of toes	60	6.13	±.057	6	36	60.
Hair color	64	8.12	±.060	8	36	56.2
Mammary glands	20	10.00	±.000	10	20	100.
Incisors	62	10.90	±.077	10	26	41.9
Opening of eyes	60	13.60	±.043	14	36	60.
Opening of ears	54	12.85	±.038	13	46	85.1

PINK-EYED DILUTE BROWN SHORT-EARED INBRED STOCK

This stock came from Gates in February, 1934. It had been inbred by brother-sister matings since the fall of 1926. After receiving these animals, brother-sister matings were not practiced until August 6, 1934, when a single pregnant female was isolated whose litter is to constitute the beginning of inbreeding for this experiment.

TABLE VI

IV. GATES' PINK-EYED DILUTE BROWN

CHARACTERS	Total No. of animals	Day of appearance Mean	P.E.	Mode	No. in modal class	% in modal class
Pigment of skin						
Hair appearance	15	3.67	±.078	4	10	62.5
Ear flaps open	14	3.79	±.067	4	11	64.7
Palpebral groove	17	3.53	±.081	4	9	52.9
Disapp. of web of toes	17	7.65	±.106	7	8	47.
Hair color						
Mammary glands	8	10.50	±.119	10	4	50.
Incisors	17	9.53	±.113	10	8	47.
Opening of eyes	17	14.12	±.064	14	13	76.4
Opening of ears	17	14.47	±.084	14	9	52.9

LITTLE'S INBRED DILUTE BROWN

The foundation Inbred Dilute Browns were received from W. S. Murray in March, 1934. The animals were male 10131, female 10132, male 10133, and female 10134. All of them were born on January 28, 1934 and all of them were siblings. Inbreeding of brother-sister matings continued during this experiment.

TABLE VII

V. LITTLE'S DILUTE BROWN

CHARACTERS	Total No. of animals	Day of appearance Mean P.E.	Mode	No. in modal class	% in modal class
Pigment in skin	122	4.46±.063	4	44	36.
Hair appearance	156	4.10±.024	4	128	82.
Ear flaps open	152	3.92±.031	4	104	68.4
Palpebral groove	154	4.03±.024	4	116	75.3
Disapp. of web of toes	144	7.26±.045	7	62	43.
Hair color	138	7.93±.038	8	78	56.5
Mammary glands	68	10.24±.050	10	44	64.7
Incisors	150	10.12±.036	10	96	64.
Opening of eyes	150	13.59±.055	13	78	52.
Opening of ears	144	13.57±.054	13	52	36.1

LEADENS INBRED STOCK

The foundation animals for this stock were received from J. M. Murray on February 8, 1934. They were the offspring of Murray's 32111 and 32110 (Six toes, left posterior foot). These were from a line throwing six toes on the posterior feet. J. M. Murray's records showed that these animals had a pedigree of seven generations straight of brother-sister matings.

TABLE VIII

VI. LEADENS INBRED STOCK

CHARACTERS	Total No. of animals	Day of appearance Mean P.E.	Mode	No. in modal class	% in modal class
Pigment of skin	19	3.21±.064	3	15	78.9
Hair appearance	21	4.10±.072	4	15	71.4
Ear flaps open	21	4.00±.064	4	17	80.9
Palpebral groove	21	4.00±.000	4	21	100.
Disapp. of web of toes	15	6.07±.170	5	6	40.
Hair color	21	8.38±.126	8	9	42.8
Mammary glands	11	10.82±.110	11	7	63.6
Incisors	21	10.43±.105	11	12	57.1
Opening of eyes	16	14.12±.085	14	14	87.5
Opening of ears	16	13.75±.057	14	8	50.

TABLE IX

COMPARISON OF BLACK AGOUTI AND GATES' PINK-EYED DILUTE BROWN

		Mean	P.E.	Difference
Pigment of skin	Black Agouti	3.67	± .041	
	Gates'	None observed		
Hair appearance	Black Agouti	3.56	± .043	1.23
	Gates'	3.67	± .078	
Ear flaps	Black Agouti	4.30	± .040	6.54**
	Gates'	3.79	± .067	
Palpebral groove	Black Agouti	5.36	± .056	19.67**
	Gates'	3.53	± .081	
Disappearance of web	Black Agouti	6.13	± .057	12.66**
	Gates'	7.65	± .106	
Mammary glands	Black Agouti	10.00	± .000	4.20**
	Gates'	10.50	± .119	
Incisors	Black Agouti	10.90	± .077	7.56**
	Gates'	9.53	± .113	
Opening of eyes	Black Agouti	13.60	± .043	6.75**
	Gates'	14.12	± .064	
Opening of ears	Black Agouti	12.85	± .038	17.60**
	Gates'	14.47	± .084	

TABLE X

COMPARISON OF BLACK AGOUTI AND WHITE BELLIED BLACK AGOUTI

		Mean		P.E.	Difference
Pigment of skin	Black Agouti	3.67	±	.041	6.50
	W.B. Black Agouti	3.28	±	.045	
Hair appearance	Black Agouti	3.56	±	.043	.011
	W.B. Black Agouti	3.44	±	.096	
Ear pinna open	Black Agouti	4.30	±	.042	1.37
	W.B. Black Agouti	4.22	±	.043	
Palpebral groove	Black Agouti	6.13	±	.056	6.05
	W.B. Black Agouti	4.93	±	.045	
Disappearance of web	Black Agouti	6.13	±	.057	1.02
	W.B. Black Agouti	6.39	±	.224	
Hair color	Black Agouti	8.12	±	.060	.440
	W.B. Black Agouti	8.16	±	.068	
Mammary glands	Black Agouti	10.0	±	.000	2.82
	W.B. Black Agouti	9.50	±	.177	
Incisors	Black Agouti	10.9	±	.077	3.61
	W.B. Black Agouti	11.2	±	.073	
Opening of eyes	Black Agouti	13.6	±	.043	0.18
	W.B. Black Agouti	13.4	±	.629	
Opening of ears	Black Agouti	12.8	±	.038	5.88
	W.B. Black Agouti	13.2	±	.056	

TABLE XII

COMPARISON OF BLACK AGOUTI AND CHOCOLATE

		Mean		P.E.	Difference
Pigment of skin	Black Agouti	3.67	±	.041	11.47**
	Chocolate	4.45	±	.055	
Hair appearance	Black Agouti	3.56	±	.043	6.37**
	Chocolate	3.19	±	.039	
Ear flaps	Black Agouti	4.30	±	.040	.50
	Chocolate	4.27	±	.045	
Palpebral groove	Black Agouti	5.36	±	.056	.91
	Chocolate	5.44	±	.073	
Disappearance of web of toes	Black Agouti	6.13	±	.057	.97
	Chocolate	6.21	±	.060	
Hair color	Black Agouti	8.12	±	.060	.20
	Chocolate	8.14	±	.075	
Mammary glands	Black Agouti	10.00	±	.000	4.58**
	Chocolate	10.60	±	.131	
Incisors	Black Agouti	10.90	±	.077	1.61
	Chocolate	10.66	±	.119	
Opening of eyes	Black Agouti	13.60	±	.043	14.61**
	Chocolate	14.74	±	.066	
Opening of ears	Black Agouti	12.85	±	.038	25.81**
	Chocolate	14.27	±	.040	

TABLE XIV

COMPARISON OF LARGE AND SMALL ANIMALS OF LITTLE'S DILUTE BROWN

CHARACTERS	Total No. of animals	Day of appearance Mean P.E.		Mode	% in modal class
Pigment of skin	30	3.36±.013	t=2.971*	4	40 large
	9	3.88±.175		4	44 small
Hair appearance	41	4.21±.576	t= .357*	4	73 large
	10	4.00±.135		4	60 small
Ear flaps open	38	3.50±.065	t=4.39*	3	55 large
	10	3.90±.064		4	90 small
Palpebral groove	41	4.12±.055	t=10.74**	4	73 large
	10	3.40±.105		3	60 small
Disapp. of web of toes	34	6.94±.188	t=2.00	7	58 large
	8	6.50±.119		7	50 small
Hair color	34	8.14±.123	t=4.00*	8	50 large
	10	7.50±.107		8	50 small
Mammary glands	16	10.12±.129	t=3.53*	10	50 large
	3	9.66±.000		9	66 small
Incisors	39	10.02±.079	t=2.62*	10	73 large
	10	9.60±.141		9	50 small
Opening of eyes	41	13.02±.073	t=3.77*	13	70 large
	10	13.70±.167		13	50 small
Opening of ears	39	12.84±.103	t=3.30*	12	38 large
	10	13.70±.213		14	50 small

TABLE XV

COMPARISON OF LARGE AND SMALL ANIMALS

CHARACTERS	Large animals	Small animals	CHARACTERS	Large animals	Small animals
Pigment of skin	2-5 3-11 4-12 5-2	3-3 4-4 5-2	Hair color	6-1 7-7 8-17 9-4 10-5	7-5 8-5
Hair appearance	3-1 4-30 5-10	3-2 4-6 5-2	Mammary glands	9-3 10-8 11-5	9-2 10-0 11-1
Ear flaps	3-21 4-15 5-2	3-1 4-9	Incisors	9-8 10-22 11-9	9-5 10-4 11-1
Palpebral groove	3-3 4-30 5-8	3-6 4-4	Opening of eyes	11-1 12-4 13-29 14-7	13-5 14-3 15-2
Disappearance of web of toes	6-8 7-20 8-6	6-4 7-4	Opening of ears	11-1 12-15 13-12 14-11	12-1 13-3 14-5 15-0 16-1
	Days # Animals	Days # Animals		Days # Animals	Days # Animals

TABLE XVI

COMPARISON OF LARGE AND SMALL LITTERS

CHARACTERS	Large litters	Small litters	CHARACTERS	Large litters	Small litters
Pigment of skin	3-6 4-22 5-22 6-7 7-6	3-4 4-4 5-4 6-11 7-3	Hair color	7-15 8-44 9-11 10-1	6-1 7-4 8-14 9-2 10-4
Hair appearance	3-1 4-62 5-1 6-6	4-25 5-0 6-4	Mammary glands	10-23 11-9 12-3	8-1 9-3 10-9
Ear flaps	3-9 4-48 5-12	3-5 4-20 5-1 6-2	Incisors	9-2 10-50 11-14 12-5	9-4 10-21 11-1
Palpebral groove	3-6 4-53 5-12	4-27	Opening of eyes	13-24 14-16 15-25 16-2	11-1 12-3 13-13 14-6 15-2
Disappearance of web of toes	6-12 7-33 8-30	6-5 7-9 8-11 9-1	Opening of ears	12-2 13-25 14-17 15-23 16-1	11-1 12-5 13-12 14-6 15-2
	Days # Animals	Days # Animals		Days # Animals	Days # Animals

Figure I

Individual Data Sheet

Mouse No._____Cage No._____Sex_____

Order of Litter_____Size of Litter_____Reduced to_____

Mother No._____Mother age_____Mother food_____

Genetic Constitution_____

Time of weaning_____Room temperature_____

Characters		Date															
Eyes:	appearance of Color																
	appearance of Palpebral Groove																
	opening of Eyes																
Ears:	opening of Flaps (Pinna)																
	opening of Ears																
Teeth:	appearance of Incisors																
	appearance of Molars																
Hair:	appearance of																
	appearance of Color																
Weight																	
Mammary Glands																	
Nest:	1st leaving																
Disappearance of web of toes																	
Pigment in the skin																	

Figure II

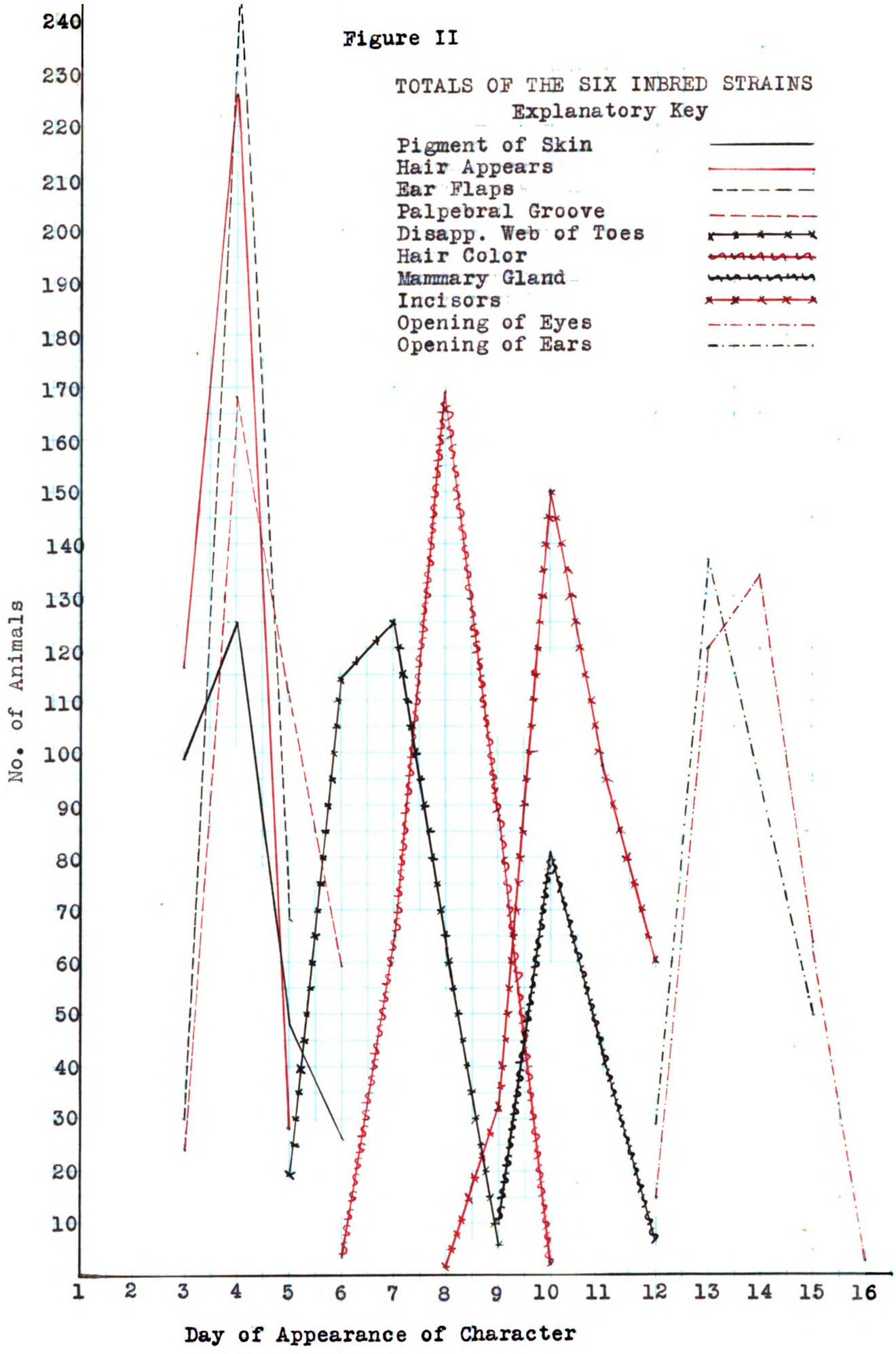

TOTALS OF THE SIX INBRED STRAINS
Explanatory Key
Pigment of Skin
Hair Appears
Ear Flaps
Palpebral Groove
Disapp. Web of Toes
Hair Color
Mammary Gland
Incisors
Opening of Eyes
Opening of Ears
No. of Animals
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Day of Appearance of Character

Figure III

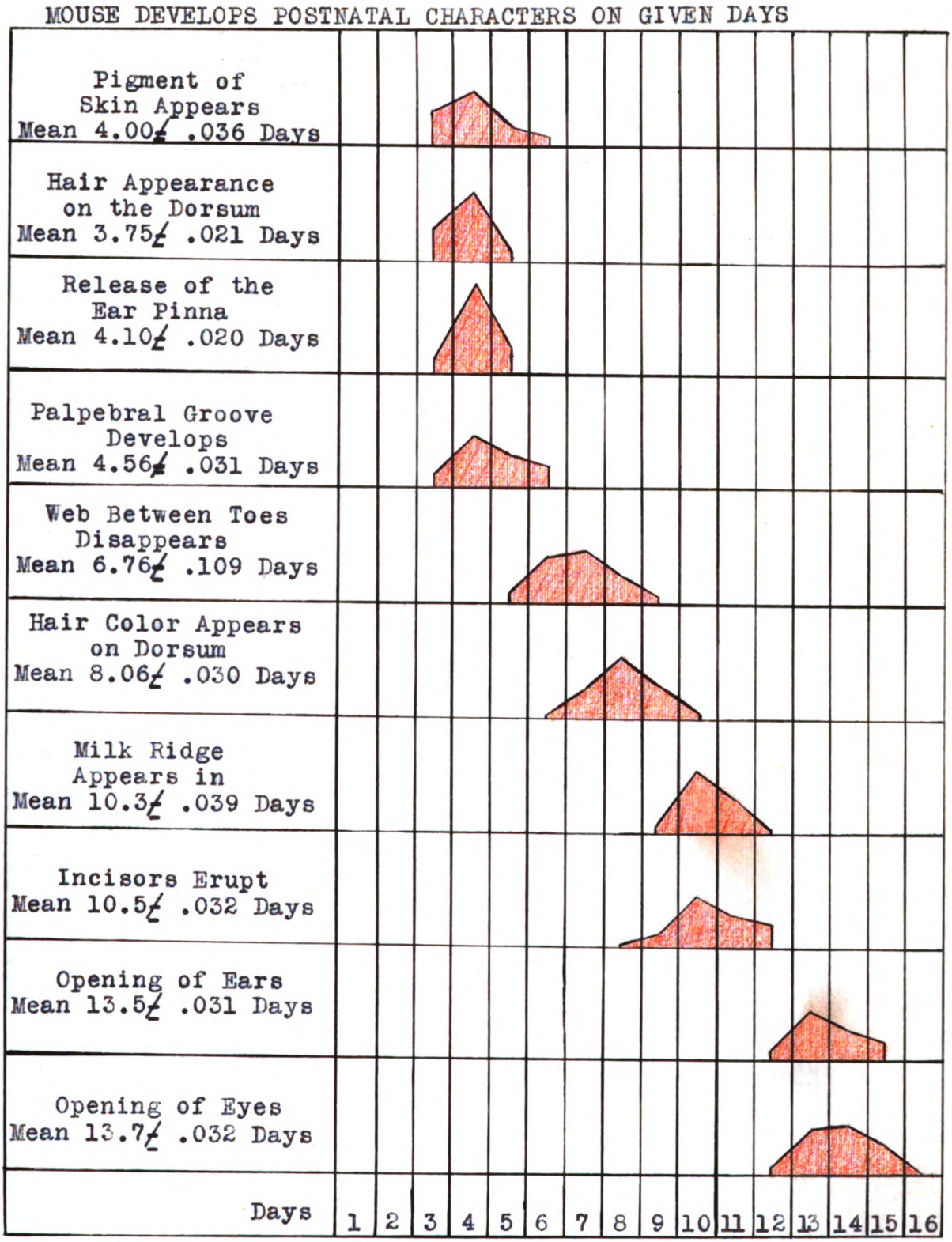
Timetable

MOUSE DEVELOPS POSTNATAL CHARACTERS ON GIVEN DAYS

Days	Pigment of Skin Appears	Mean 4.00±.036 Days	Hair Appearance on the Dorsum	Mean 3.75±.021 Days	Release of the Ear Pinna	Mean 4.10±.020 Days	Palpebral Groove Develops	Mean 4.56±.031 Days	Web Between Toes Disappears	Mean 6.76±.109 Days	Hair Color Appears on Dorsum	Mean 8.06±.030 Days	Milk Ridge Appears in ♀	Mean 10.34±.039 Days	Incisors Erupt	Mean 10.54±.032 Days	Opening of Ears	Mean 13.54±.031 Days	Opening of Eyes	Mean 13.74±.039
1																				
2																				
3	33.2	31.6		9.7		6.6														
4	41.9X	61.0X		71.4X		46.6X														
5	16.1	7.2		19.0		30.6		5.5												
6	8.7					16.3		35.0		0.9										
7								38.4X		19.8										
8								19.0		51.3X				0.3						
9								1.8		27.2		8.4		9.4						
10										0.6		57.7X		44.1X						
11	Key											28.8		28.5						
12	Numbers Represent % of Animals											4.9		17.6		8.5		4.5		
13	Developing Characters on Given Days															44.5X		35.7		
14	X Stands for Mode															31.5		39.8X		
15																15.4		19.0		
16																		0.8		

Figure IV

Timetable



Note - Graphs indicate % of animals developing characters on following days. Size is an index of age during 1st 3 days.

Figure V

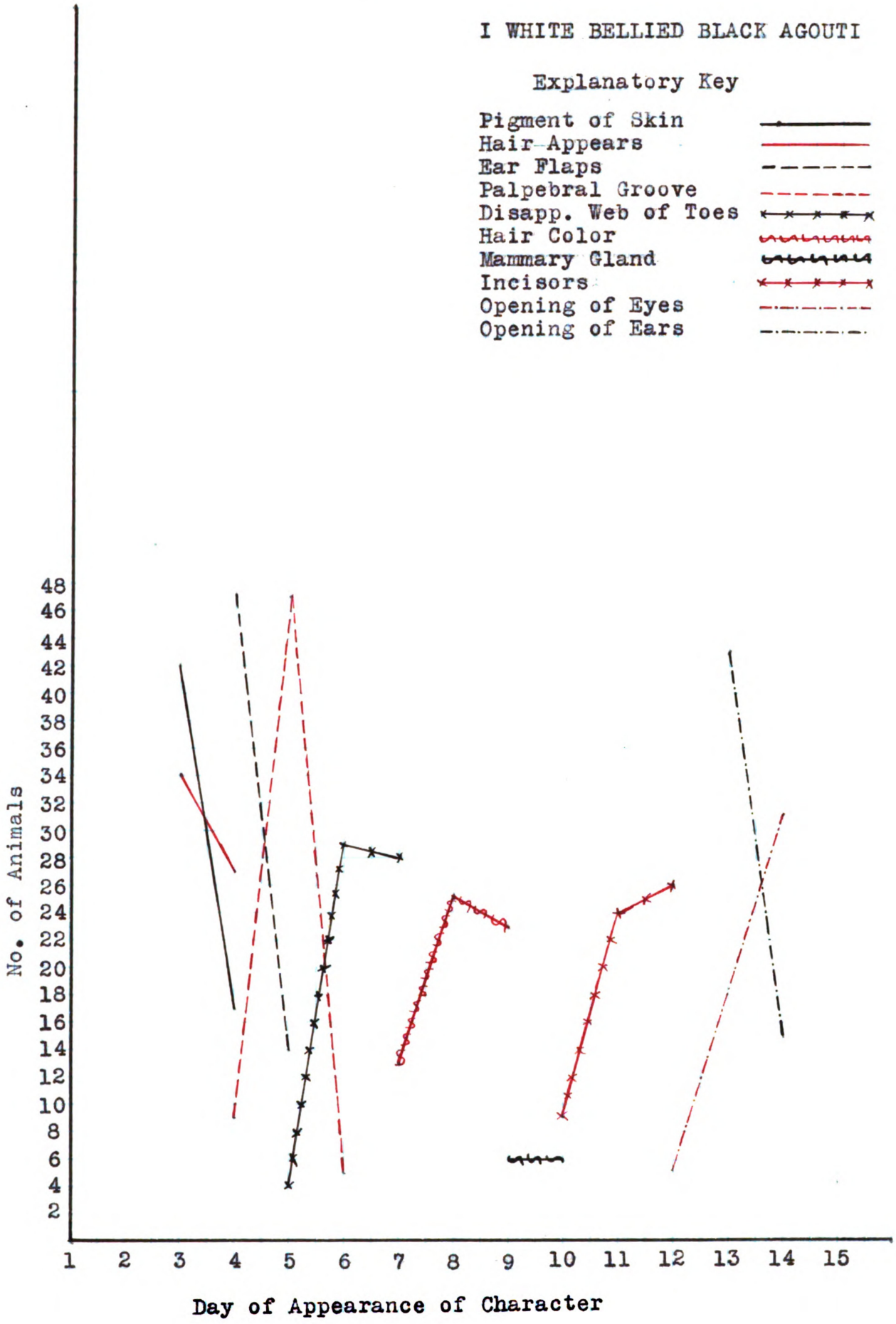

I WHITE BELLIED BLACK AGOUTI
Explanatory Key
Pigment of Skin
Hair Appears
Ear Flaps
Palpebral Groove
Disapp. Web of Toes
Hair Color
Mammary Gland
Incisors
Opening of Eyes
Opening of Ears
No. of Animals
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Day of Appearance of Character

Figure VI

II CHOCOLATE

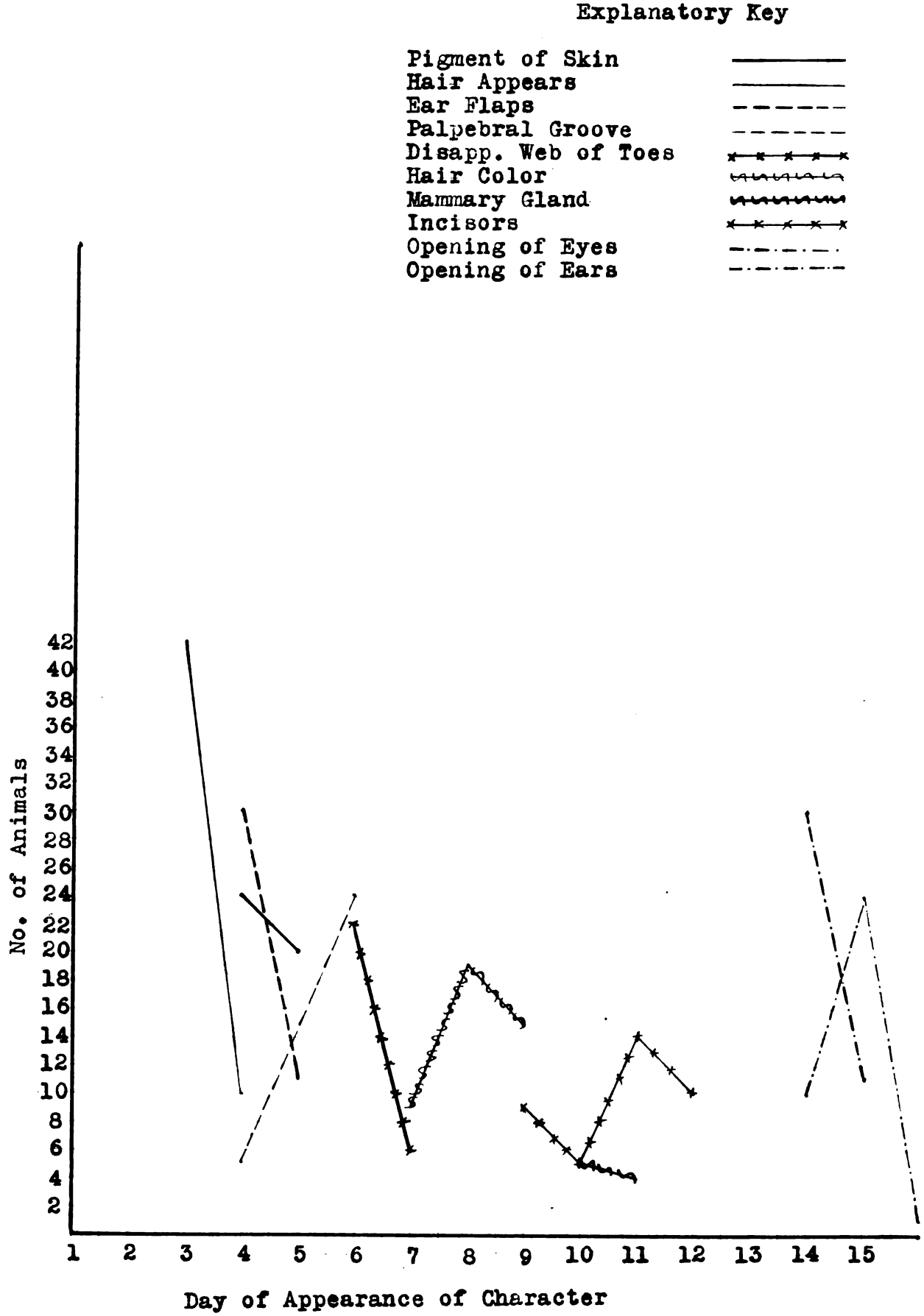


Figure VII

III DARK BELLIED BLACK AGOUTI

Explanatory Key

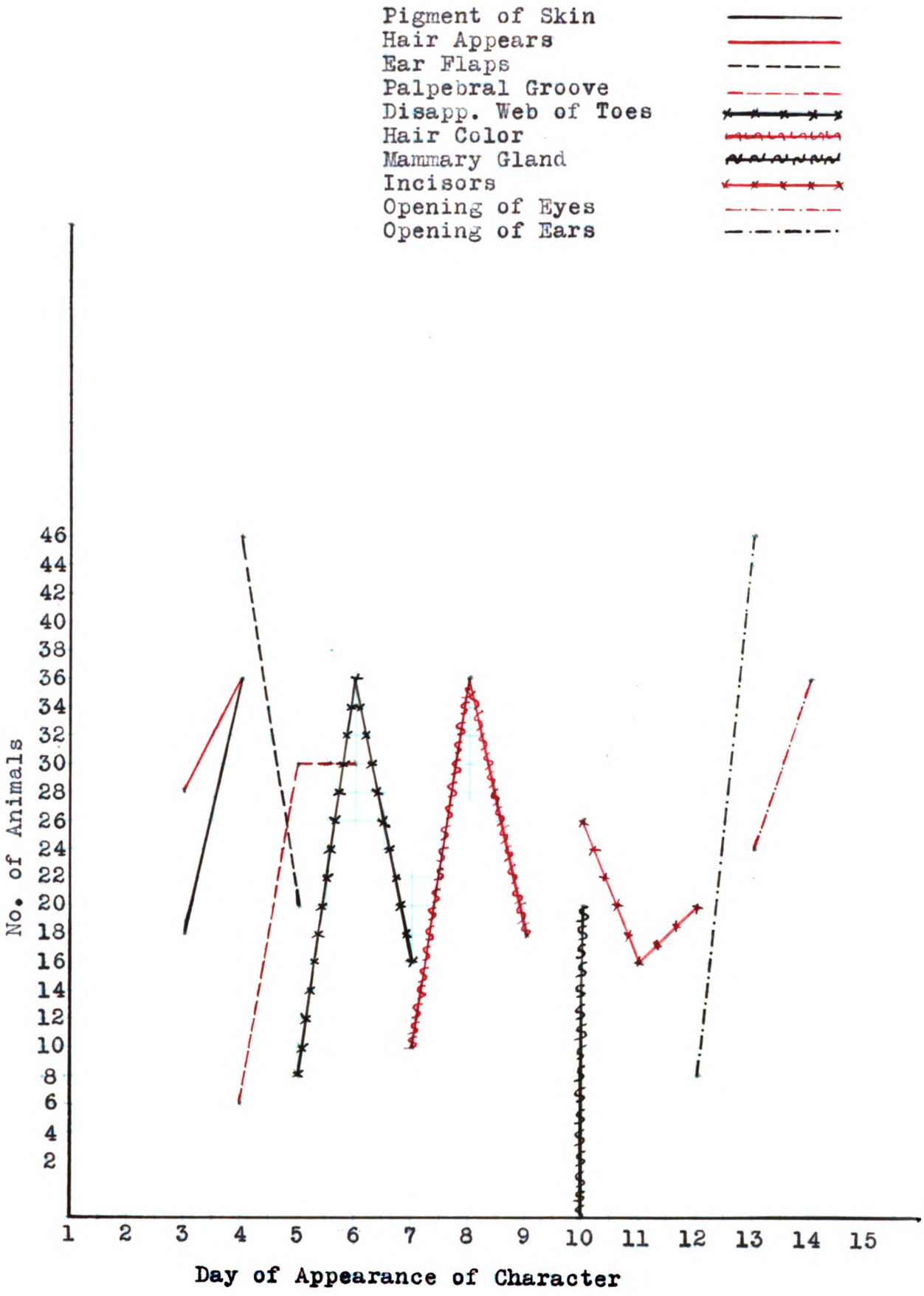


Figure VIII

IV GATE'S PINK-EYED DILUTE BROWN

Explanatory key

Pigment of Skin
Hair Appears
Ear Flaps
Palpebral Groove
Disapp. Web of Toes
Hair Color
Mammary Gland
Incisors
Opening of Eyes
Opening of Ears

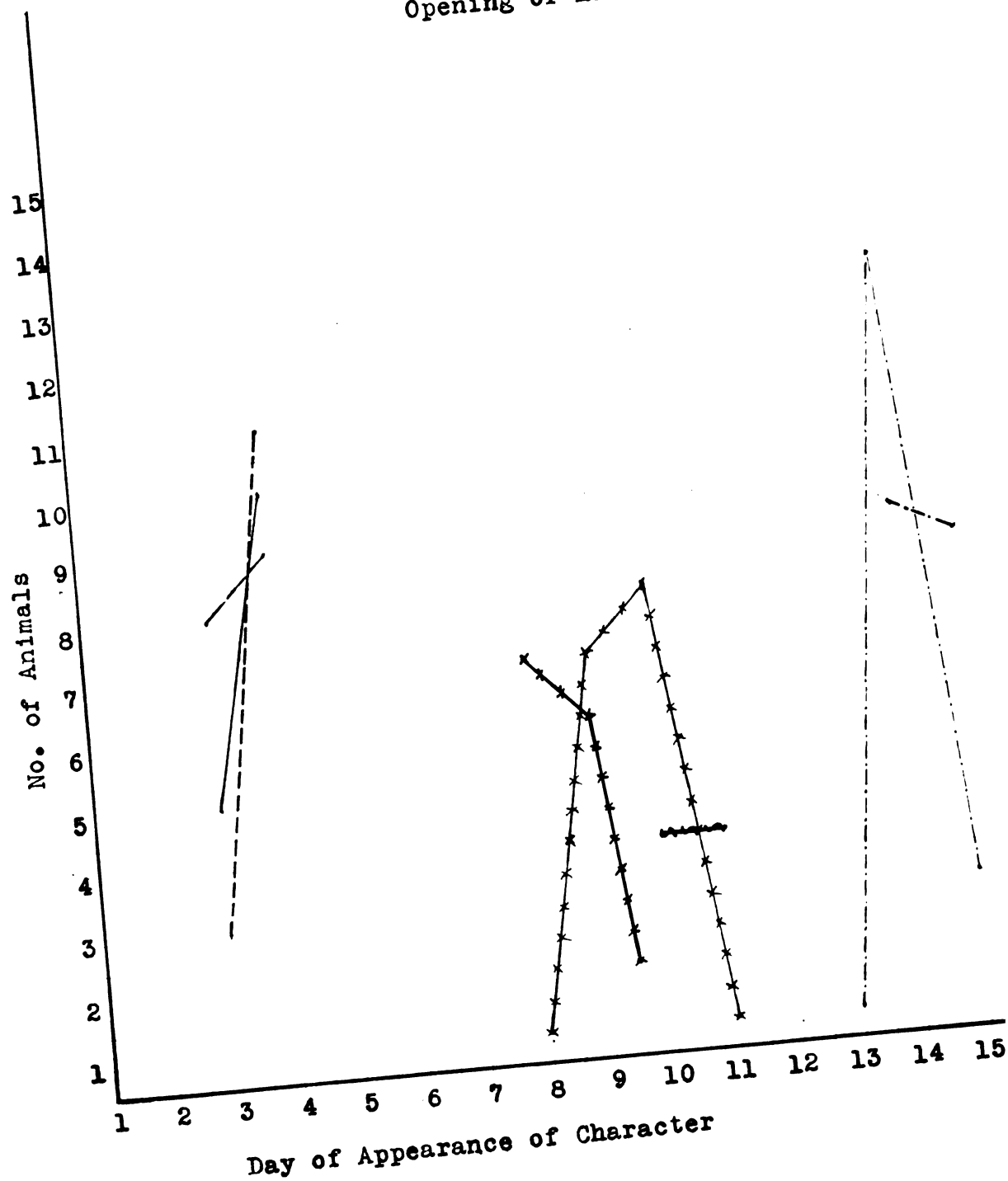


Figure IX

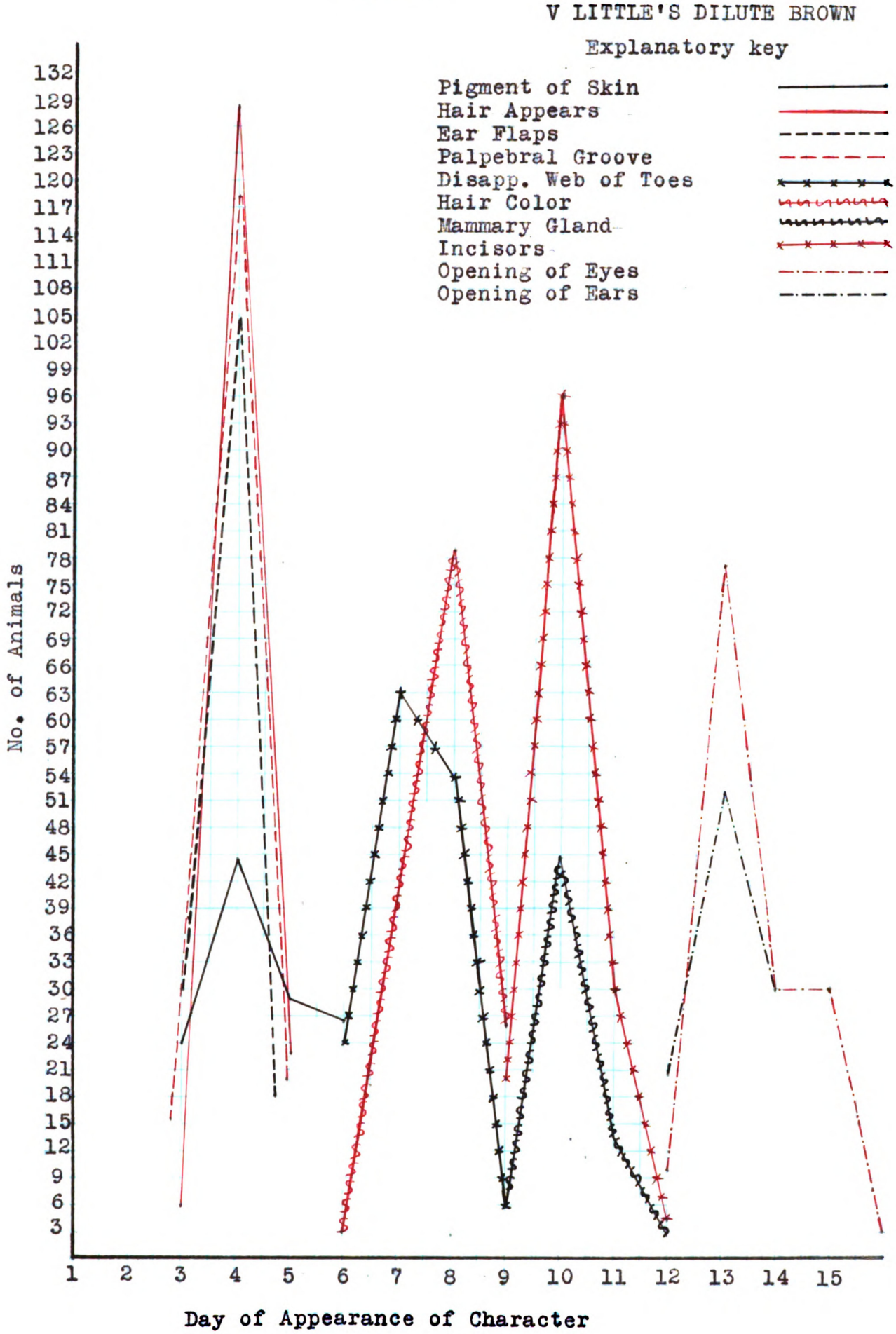

V LITTLE'S DILUTE BROWN
Explanatory key
Pigment of Skin
Hair Appears
Ear Flaps
Palpebral Groove
Disapp. Web of Toes
Hair Color
Mammary Gland
Incisors
Opening of Eyes
Opening of Ears
No. of Animals
132
129
126
123
120
117
114
111
108
105
102
99
96
93
90
87
84
81
78
75
72
69
66
63
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Day of Appearance of Character

Figure X

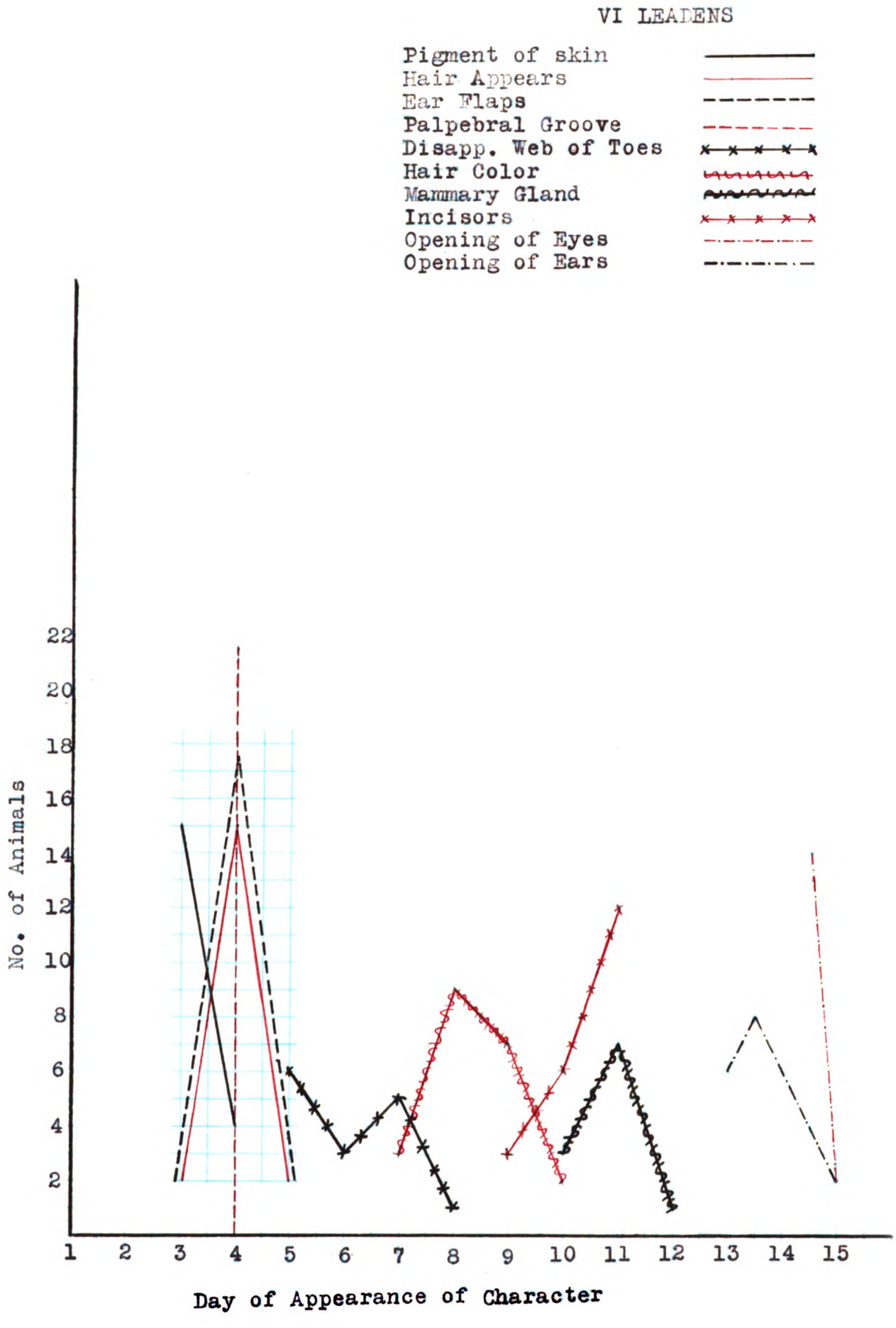

VI LEADENS
Pigment of skin
Hair Appears
Ear Flaps
Palpebral Groove
Disapp. Web of Toes
Hair Color
Mammary Gland
Incisors
Opening of Eyes
Opening of Ears
No. of Animals
22
20
18
16
14
12
10
8
6
4
2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Day of Appearance of Character

Figure XI

COMPARISON OF MEANS OF DIFFERENT STRAINS

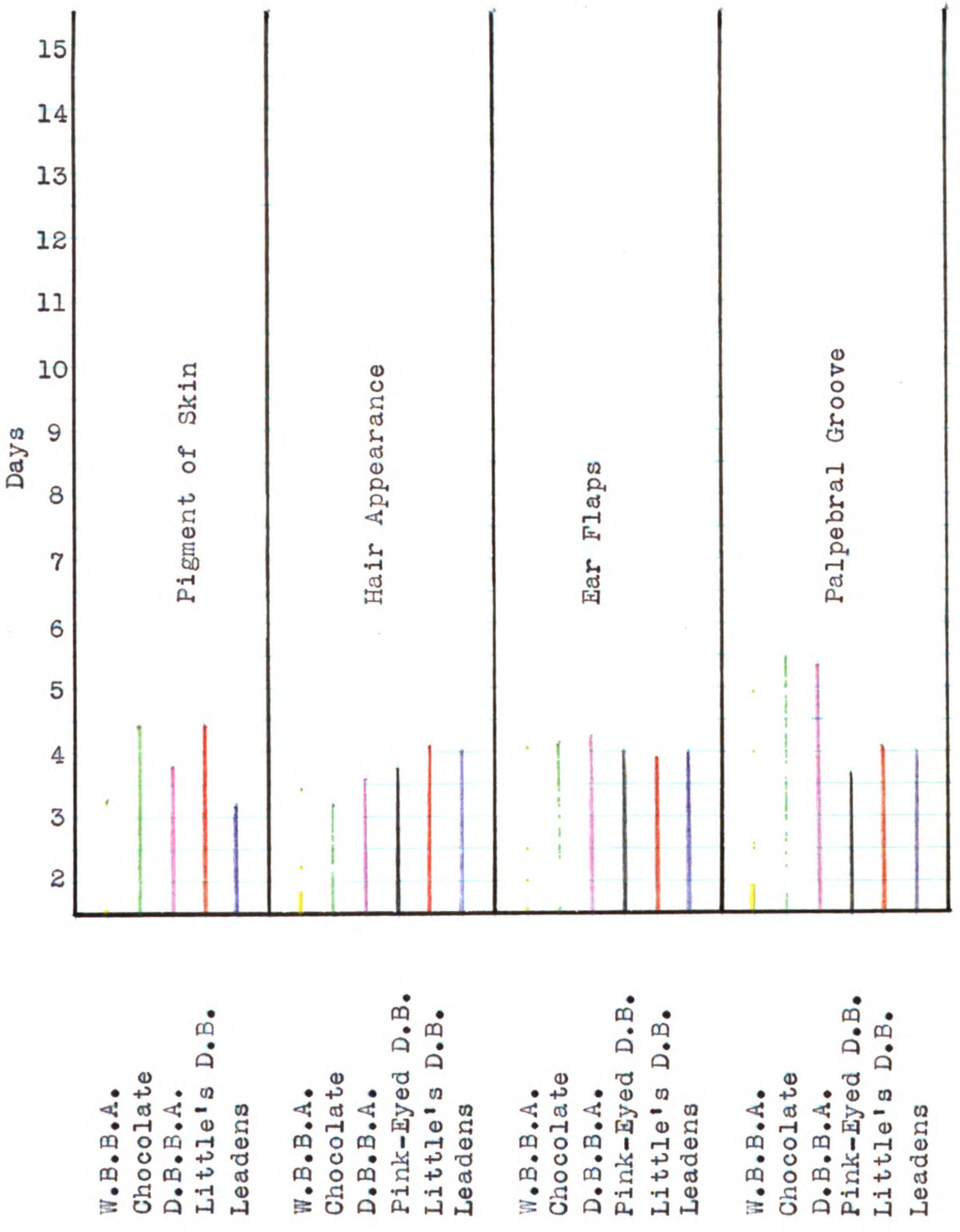


Figure XI Continued

COMPARISON OF MEANS OF DIFFERENT STRAINS

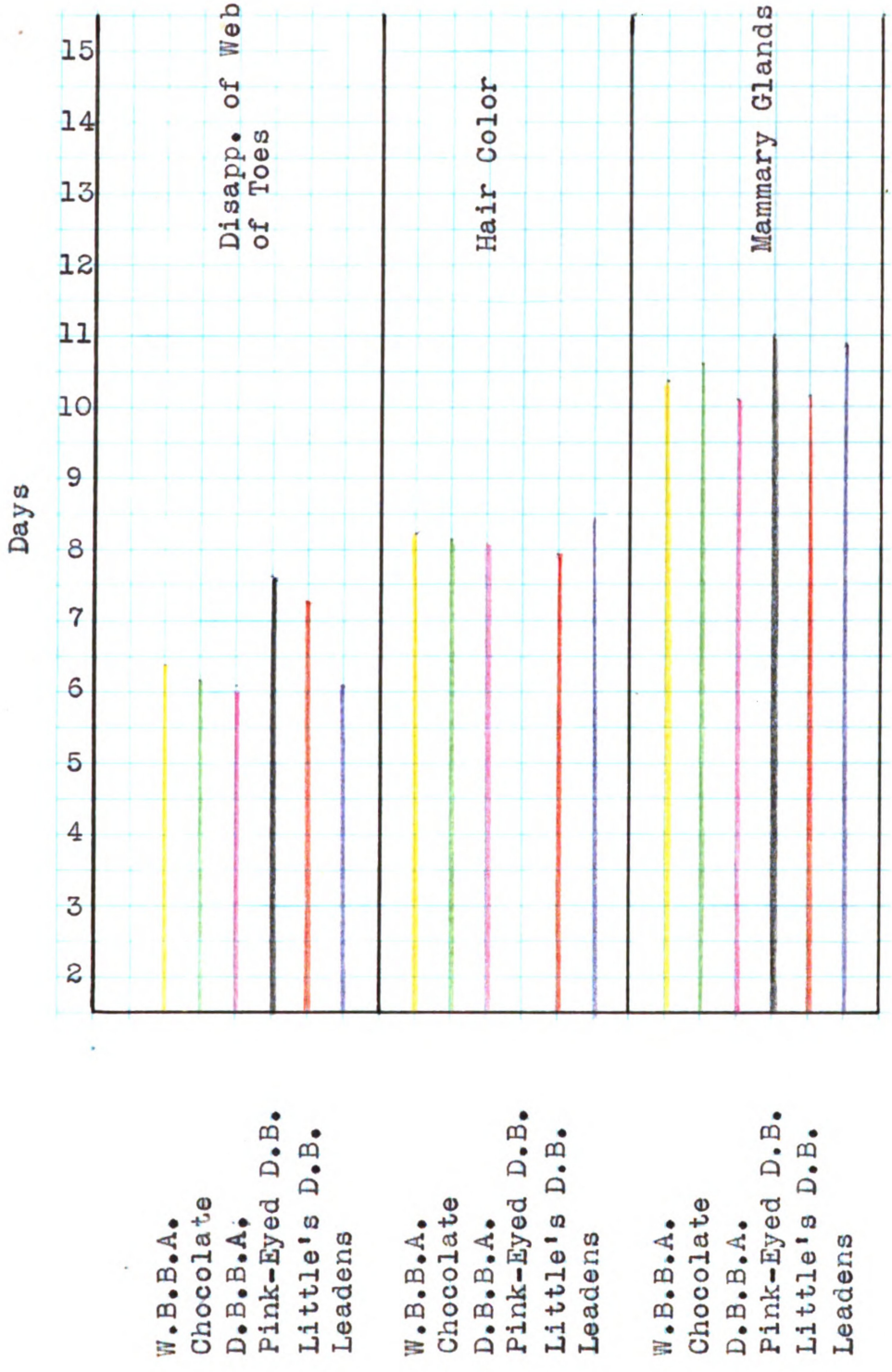


Figure XI Continued

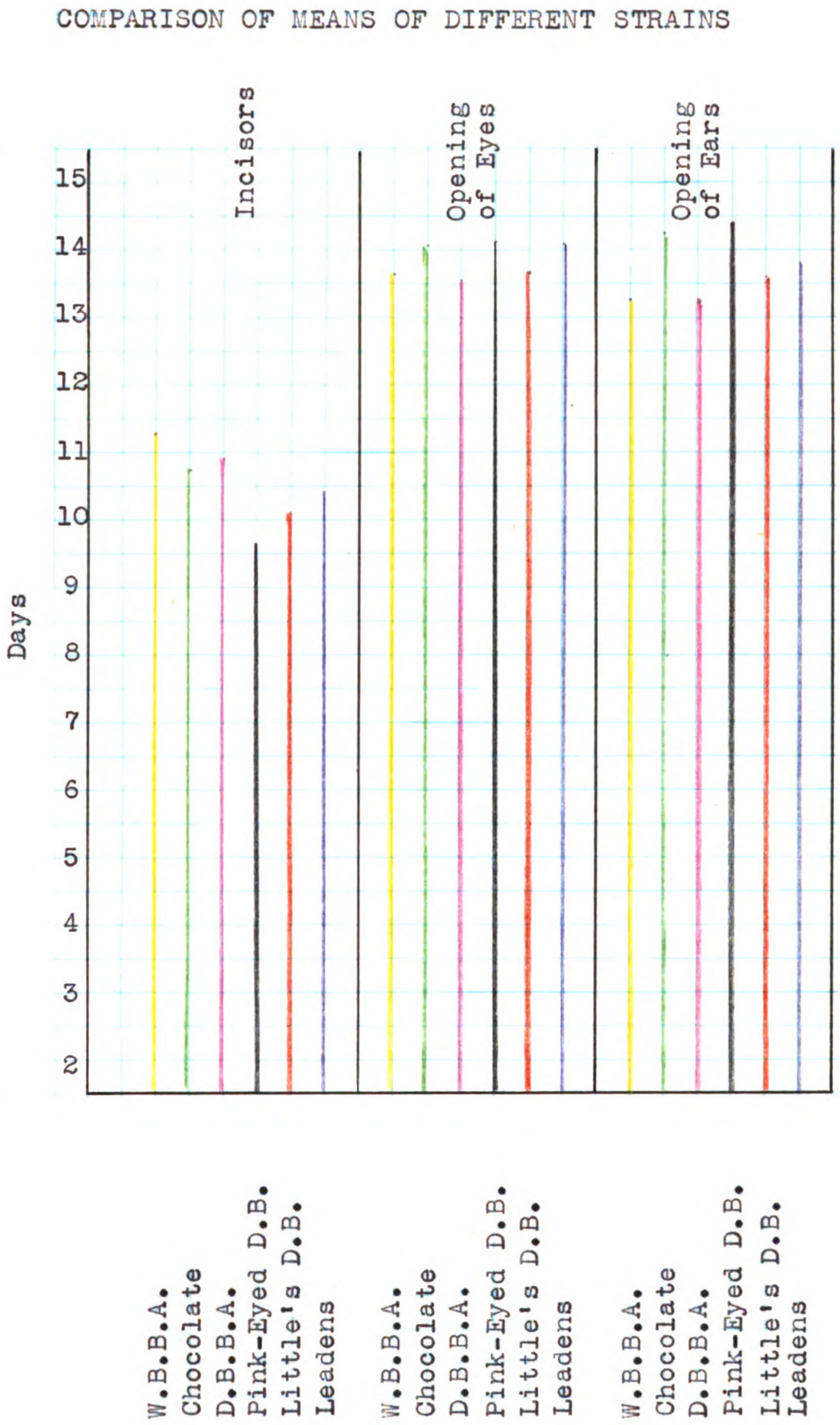


Figure XII

COMPARISON OF LARGE AND SMALL ANIMALS

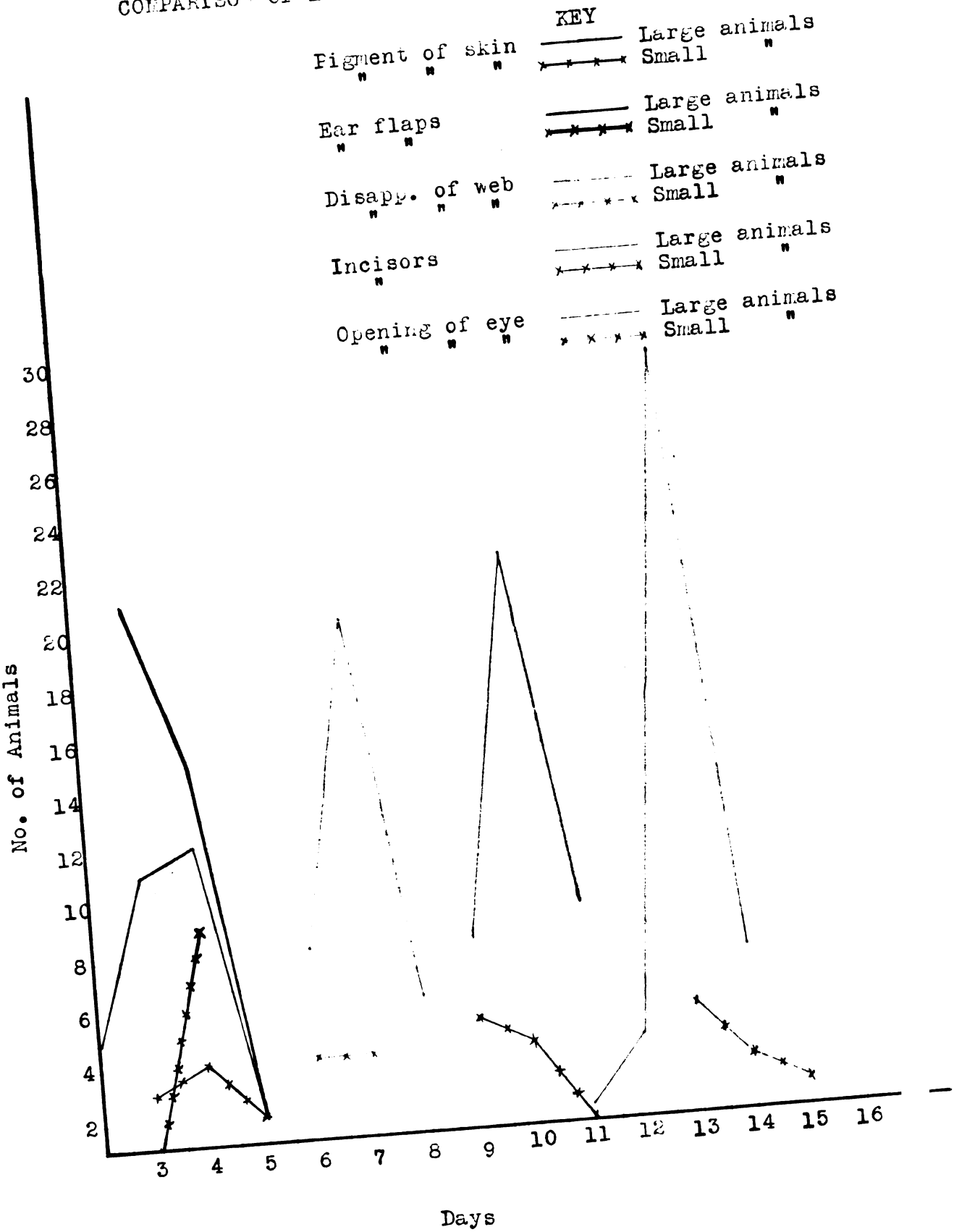


Figure XII Continued

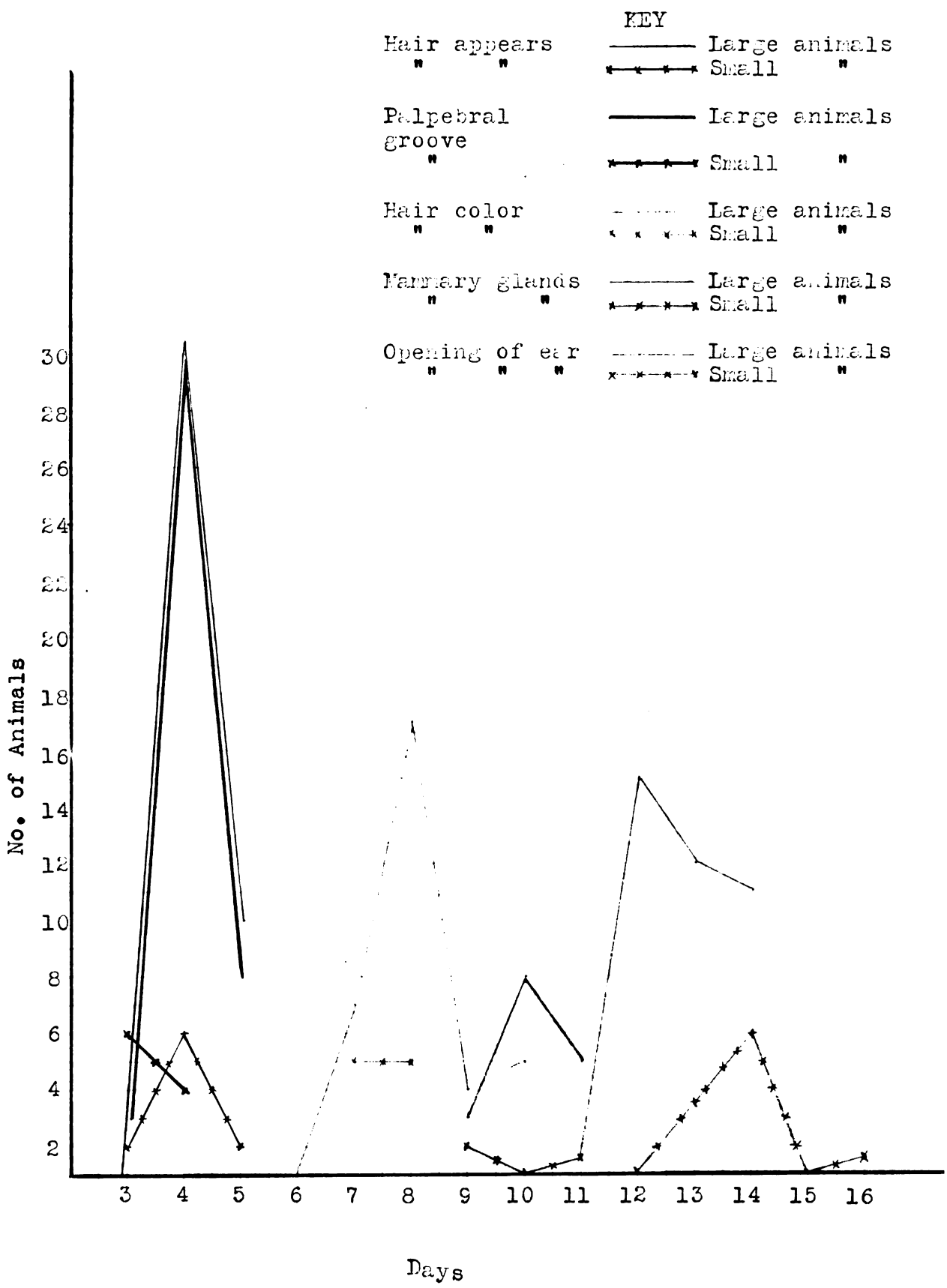


Figure XIII

COMPARISON OF LARGE AND SMALL LITTERS

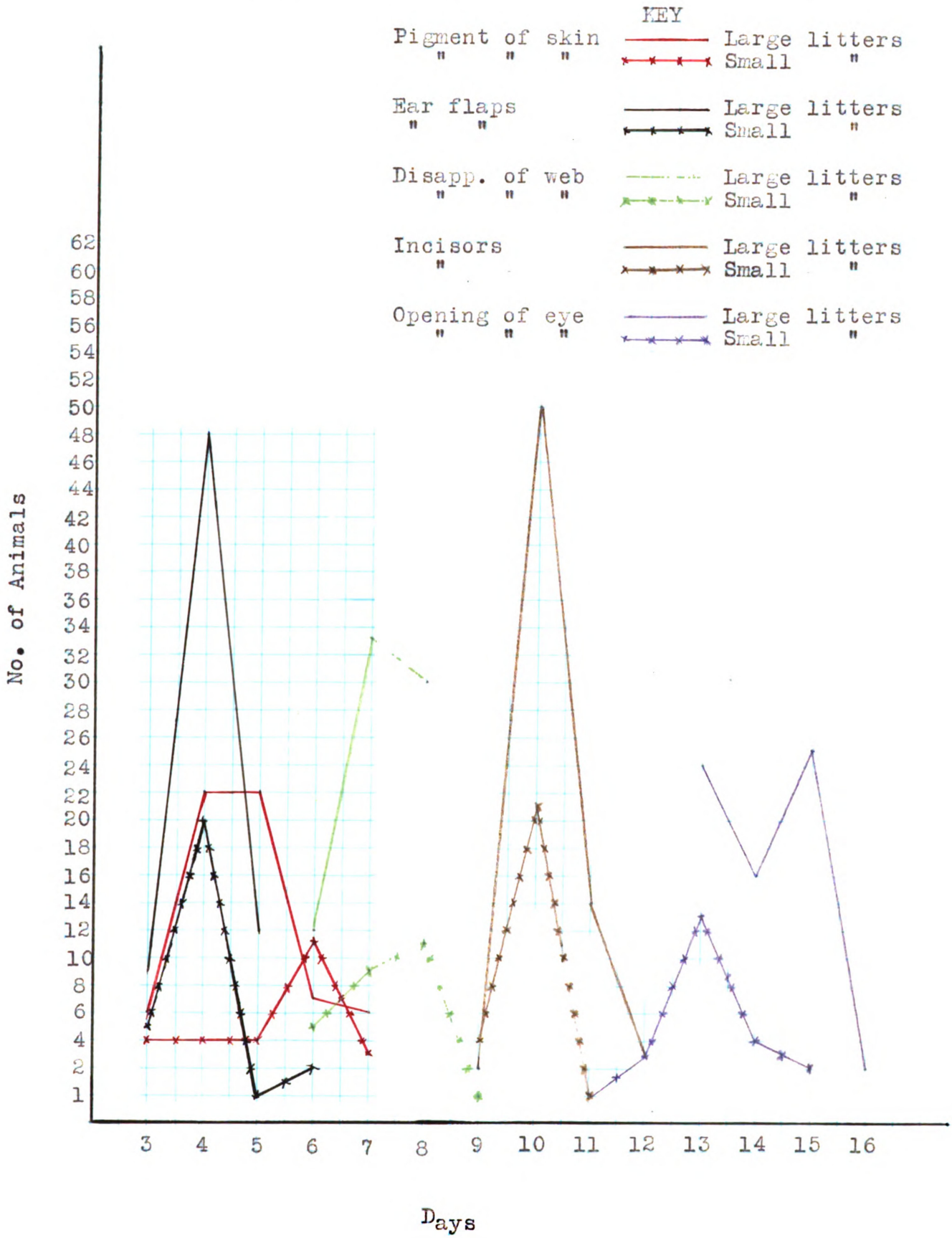


Figure XIII Continued