A STUDY OF A LABORATORY ANIMAL COLONY

by

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A B S T R A C T

This Thesis is a study of the small animal colonies operated by the Animal Nutrition Laboratory in the Department of Animal Husbandry. The four animal units studied are the albino rat, albino mouse, guinea pig and rabbit. The management practices used for each species are described fully. They include the housing, feeding, breeding and control of disease methods utilized. The factors discussed in the housing of the animals are the space utilization per animal and the type of cages. In addition, scale drawings and illustrations of the cages and cage racks are included. The method of feeding and the formula of each ration for each species is reported. The system of breeding used in each of the colonies is described. Control of disease is discussed with reference to the sanitation procedures practised. Growth and production data are reported for each species and a comparison made with the data published in the literature for other colonies. The number of animals involved in the study are 1,700 rats, 258 mice, 73 guinea pigs and 85 rabbits. The growth data includes size of litter, birth weights and weekly weights thereafter until weaning age. The production data comprises the percentage fertility and percentage weaned. In addition the results of a cost survey is reported. The cost per animal for each species includes the cost of housing, feeding and labour. The results reported here are comparable to those reported elsewhere.

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I

Introduction

The extensive use of the laboratory animal in research and the major contribution it has made to our knowledge of the biological sciences can hardly be questioned. Even though the knowledge and the skill of an investigator and the quality of his chemical reagents and apparatus may be beyond question, the experimental data he obtains will be of limited value, if the animals he uses are of poor or of uncertain origin.

An estimate of the relative utilization of the various laboratory animals in biological research can be obtained by scrutinizing the pertinent literature. As a matter of interest such a literature survey has been made using the following six scientific periodicals selected as being representative of the literature as a whole

(1) Journal of Nutrition

(2) Journal of Immunology

(3) Journal of Pathology and Bacteriology

Table 1 - THE UTILIZATION OF LABORATORY ANIMALS DURING THE PERIOD 1918 - 1948

PERIODICAL	YEAR	TOTAL NO. OF ARTICLES	RAT %	MOUSE %	GUINEA PIG %	RABBIT %
Journal of Nutrition	1928	35	54.2			
	1938	49	55.1		6.1	4.0
	1948	130	48.4	2.3	0.7	3.8
Journal of Immunology	1918	38	2.6	2.6	47.3	39.4
	1928	53	0	1.8	33.9	37.7
	1938	72	9.7	9.7	20.8	41.7
	1948	129	3.8	24.8	14.7	20.1
Journal of Pathology & Bacter-iology	1928	71	4.2	2.8	9.8	26.7
	1938	123	5.7	10.5	6.5	14.6
	1948	82	9.7	6.1	3.6	4.9
Journal of Laboratory & Clinical Medicine	1918	84	0		8.3	5.9
	1928	83	0		3.6	3.6
	1938	127	9.4	1.6	4.7	5.5
	1948	117	6.8	0.8	2.5	3.4
Journal of Biological Chemistry	1918	218	16	0	3.5	11.0
	1928	334	13.1	0.3	0.9	4.1
	1938	377	35.8	0.79	0.79	1.6
	1948	317	21.4	1.2	0.9	1.2
Biochemical Journal	1918	36	5.5	5.5	16.6	2.7
	1928	193	11.9		3.1	5.2
	1938	185	12.4	1.6	1.1	4.3
	1948	228	8.3	0.87	2.1	6.1

(4) Journal of Laboratory and Clinical Medicine

(5) Journal of Biological Chemistry

(6) Biochemical Journal

All of the papers published in these journals in the years 1918, 1928, 1938 and 1948 were carefully examined and a record was made of the species of laboratory animal used in the experimental work reported. The results of this survey are presented in Table 1. Farris (1950) records a similar survey of animals used by American investigators in the year 1947. He used the papers presented at the annual meetings of three representative scientific organizations - The American Association of Anatomists, The American Society of Zoologists and the Federation of American Societies for Experimental Biology. This survey revealed that the species employed had the following frequency of use:

TABLE 2 - FARRIS' SURVEY OF LABORATORY ANIMAL UTILIZATION IN THE UNITED STATES DURING 1947.

MAMMALS	No.Used	Per Cent By Group	Distribution of Total
Man	334	24.4	20.0
Rat	317	23.2	19.0
Dog	258	18.8	15.4
Rabbit	110	8.0	6.7
Mouse	108	7.9	6.5
Cat	81	5.9	4.8
Guinea Pig	49	3.6	2.9
Monkey	41	3.0	2.4
Cow	25	1.8	1.5
Hamster	9	0.6	0.5
Sheep	9	0.6	0.5
Pig	8	0.6	0.5
Horse	4	0.3	0.2
Others	16	1.3	0.9
TOTAL	1369	100.0	81.8
AVES			
Chicken	58	82.8	3.5
Other Fowl	12	17.2	0.7
TOTAL	70	100.0	4.2
AMPHIBIA	59	25.4	3.5
REPTILES	2	0.9	0.2
FISH	21	9.0	1.3
INVERTEBRATES	118	51.0	7.0
NOT STATED	32	13.8	1.9
TOTAL	232	100.0	13.9
GRAND TOTAL	1671		100.0

The proof of the importance of the laboratory animal is in modern biological research. Such surveys do not however indicate the extent of the emphasis being placed on the quality and standardization of the animals used. Some indication of the present trend in this respect, is evidenced by the publication within the last five years of no less than four complete reference works on the subject of laboratory animal maintenance and production. See Appendix (1). This greater emphasis on the quality of the laboratory animal has undoubtedly arisen from the desire on the part of investigators to obtain quantitative rather than qualitative data. This change in approach is particularly evident in nutritional research where the requirement has altered from the establishment of the essentiality of nutritional factors to the need for a quantitative statement of the preceise amount of the factor required for each animal species. While it is realized that it is not always possible to obtain the same purity in animal stocks as can be expected from laboratory chemicals, it is nevertheless becoming possible to secure a relatively well standardized animal, if proper production conditions are met. The degree of variability or uniformity in a group of animals is in large measure determined by their genetic constitution and by their environment.

The biologist has long been concerned with the genetic purity and history of his laboratory animals. The now famous Wistar albino rat provides an excellent example of this concern. Indeed the King "A" strain of the Wistar Institute is now in its 135th generation of brother-sister mating. This would correspond to man for a period of approximately 4000 years. It seems safe to conclude in the light of these studies that in the case of the Wistar rat at least, variability from heredity has been minimized.

It seems obvious then that the variability arising from environmental influences should receive greatest consideration. The biologist is usually familiar in general terms at least with the genetic history of his laboratory animals. He is not, however, sufficiently familiar with their previous nutritional and environmental history.

Few workers appear to give sufficient recognition to the marked metabolic changes which are known to occur in the growing animal. For example, Kibler et al (1942) have shown that the metabolic rate of the rat rises from 400 calories per square meter per day near birth to

1200 at the age of 40 days or a body weight of 100 grams and then drops to a level of 800 calories per square meter per day at a body weight of 300 grams. It is obvious that the response of the rat to dietary supplementation with various addenda will depend upon the position of the particular animal on Kibler's heat-age curve shown in Figure 1. The situation in this respect would be most accentuated if the particular study dealt with a nutritional entity required by the body relative to body weight raised to the 0.7 power - for example the pyridoxine requirement. The importance of knowing the previous growth history of an animal can be illustrated in another way. Consider the case of two male rats of weight 5.5 grams at birth. Their growth as measured at weekly intervals by weight criteria is shown in Table 3. Assuming such factors as number in the litter, sex ratio and age of the dam are the same in each case, then the rate of growth of each should be a function characteristic of the individual rat.

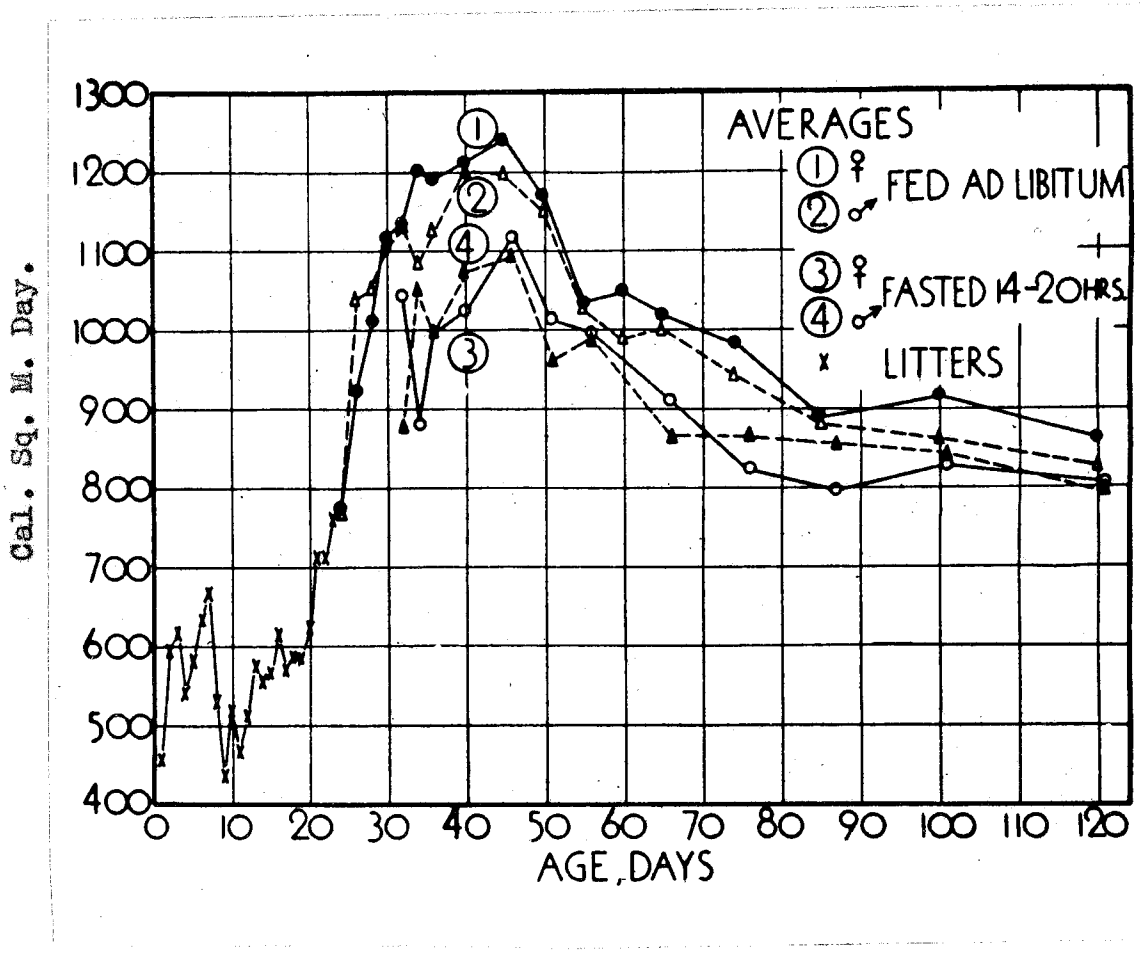

Fig. 1. Metabolism per unit surface area in rats as a function of age.

Table 3 - Growth Rate of Two Rats from Birth to Twenty-one Days Having Equal Birth Weights

Rat No.	Weight at age			
	Birth	7 Days	14 days	21 days
1	5.5	11.6	22.3	32
2	5.5	15.0	24.0	40

The data presented in Table 3 can be expressed as a series of growth constants using the expression (Brody 1947)

$$k = \frac{\ln W_2 - \ln W_1}{t_2 - t_1}$$

in which

W_2 = weight at age two

W_1 = weight at age one

t_2 = age at W_2

t_1 = age at W_1

k = growth constant

When the data of Table 3 are computed in this way the growth constants given in Table 4 are obtained.

Table 4 - GROWTH CONSTANTS FROM DATA IN TABLE 3

$$\text{Growth constant } k = \frac{\ln W_2 - \ln W_1}{t_2 - t_1}$$

Age	Rat 1	Rat 2	Rat 1 / Rat 2
Birth) 7 days)	0.094	0.143	0.66
7 days) 14 days)	0.093	0.066	1.41
14 days) 21 days)	0.051	0.073	0.70
Birth) 21 days)	0.084	0.094	0.90

Examination of the growth constants given in Table 4 show that the rate of growth of the two rats is nearly identical if the birth weight and 21 day weight only are considered. On the other hand, it is evident that the rate of growth as between the two animals is not at all comparable when the gain made during seven day intervals is considered. Obviously, if these animals were used experimentally, after weaning at 21 days there would be a definite advantage of knowing the pre-weaning history as an aid to the interpretation of subsequent data obtained using these animals.

In some experiments, not directly concerned with the desire for quantitative data this point of growth rate is partially overcome by the fact that both control and experimental groups of animals will have equal numbers of the different age and weight categories. The difference in growth rates becomes extremely important, if experiments on the same subject are carried out at different institutions. It is possible that the rats (Wistar strain) at one institution could be growing at the faster growth rate of k=0.094 when placed on the experiment, whereas the rats at the second institution could be growing at the slower growth rate, k=0.084. In such a case, the results obtained in this hypothetical experiment, if measured by rate of growth, would be different between the two institutions and the difference may not be a true reflection of the imposed experimental condition.

From what has been discussed in the preceding paragraphs, it is evident that successful animal research must be dependent upon satisfactory sources of supply for the animals under study. The present study of the small animal colonies of the Department of Animal Husbandry was undertaken to provide a compendium recording the position

of these colonies and to compare their output with that of other laboratories elsewhere. It was felt that such a study would have added value in that most of the biological departments within the University as well as others in other parts of Canada are using the animals produced in these colonies.

II

Experimental - Animal Units

Before beginning to describe each animal unit separately, it might be well to make a few general remarks about the colonies, so that they will not be repetitive with the discussion of each species.

The building which contains the Animal Nutrition Laboratory and its adjunct animal colonies is a converted army hut which for practical purposes, can be considered to be divided into two equal sized sections. The front part consists of actual laboratory facilities, with the rear section housing three of the animal units, namely mice, rats and guinea pigs. The rabbit unit is located in a separate building. These four units are commonly referred to as the stock colonies, since experimental animals are never housed in these particular quarters. These colonies are utilized solely as production units. The temperature of the animal rooms in the laboratory is thermostatically regulated at 72°F with a radiator situated in each room. An electrically operated fan is located in

the attic above the animal rooms. It is controlled by an electric time switch, which can be set for any cycle of operation within one hour. It is normally set to operate for twenty minutes out of each hour. See appendix (2). Each of the three animal rooms has a louvre, about 1.5 square feet in area, connecting to the attic above. In this way, the air in the animal rooms is changed frequently and the animal odour kept at a minimum.

This laboratory prefers to use painted wooden cages for the stock colonies. On failure of the heating system, it has been the experience of this laboratory that the wooden cages tend to not only hold the heat, but also permit the animal to build a nest with the bedding, by pushing it all into a corner of the cage. Wire cages are used for experimental animals.

The water bottles used in these three units are all fitted with rubber stoppers and 9 mm. glass tubing for delivering the water to the animal. The licking end of the tube is fire polished to an inside dimension of 4 - 5 mm. A surface tension membrane forms as a result of this constriction thus permitting the animal to drink, without the water running into the cage.

As a policy of disease control, all new animals arriving for the stock colonies must remain in isolation for a period of three weeks. Occasionally it has not been possible to maintain this policy because of lack of cage facilities. However it still remains as an excellent fundamental of good management.

A. Animal Nutrition Laboratory Rat Unit

(1) Origin

The rat unit of the Animal Nutrition Laboratory originated from a group of Wistar strain rats received from the Pacific Fisheries Experimental Station. In addition, a group of Sherman strain rats were purchased from Rockland Farms in October 1950. Descendants from that original group of Wistar rats and the Sherman strain rats form the basis for this study of the rat colony.

(2) Housing

The rat colony is located in a room which is 11 feet 2 inches long, 9 feet 8 inches wide and 10 feet in height, giving a floor area of 107.9 square feet and a room volume of 1079 cubic feet. Based on a maximum capacity of 432 rats, the volume utilization is 2.5 cubic feet

per rat. The rat cage racks, which hold 54 cages are arranged in three parallel rows. One rack measures 8 feet 7¾ inches long, 1 foot 9¾ inches deep and 6 feet 2¼ inches high. The second rack measures 5 feet 9 inches long, 1 foot 7 inches deep and 7 feet 7½ inches high. The third one measures 7 feet 2¾ inches long, 1 foot 9¾ inches deep and 7 feet 7½ inches high. These racks occupy 37.7 square feet or 34.9 per cent of the floor area of the room. A cold water tap and sink are situated in one corner of the room next to one of the racks. The farthest cage from the sink is about eleven feet away or roughly five steps distant. One of the racks is pictured in Fig. 2 with a scale drawing shown in Fig. 3.

The rats are housed in white painted wooden cages constructed from ½ inch plywood, one of which is illustrated in Figs. 4, 5 and 6. Bedding is furnished by wood shavings approximately ¼ an inch in depth. This amount of bedding represents a volume of 1500 cc. or a weight of approximately 150 grams. The recommended capacity of this size cage is about 8 mature rats. This

Fig. 2. Rat cage rack showing tiers of cages.

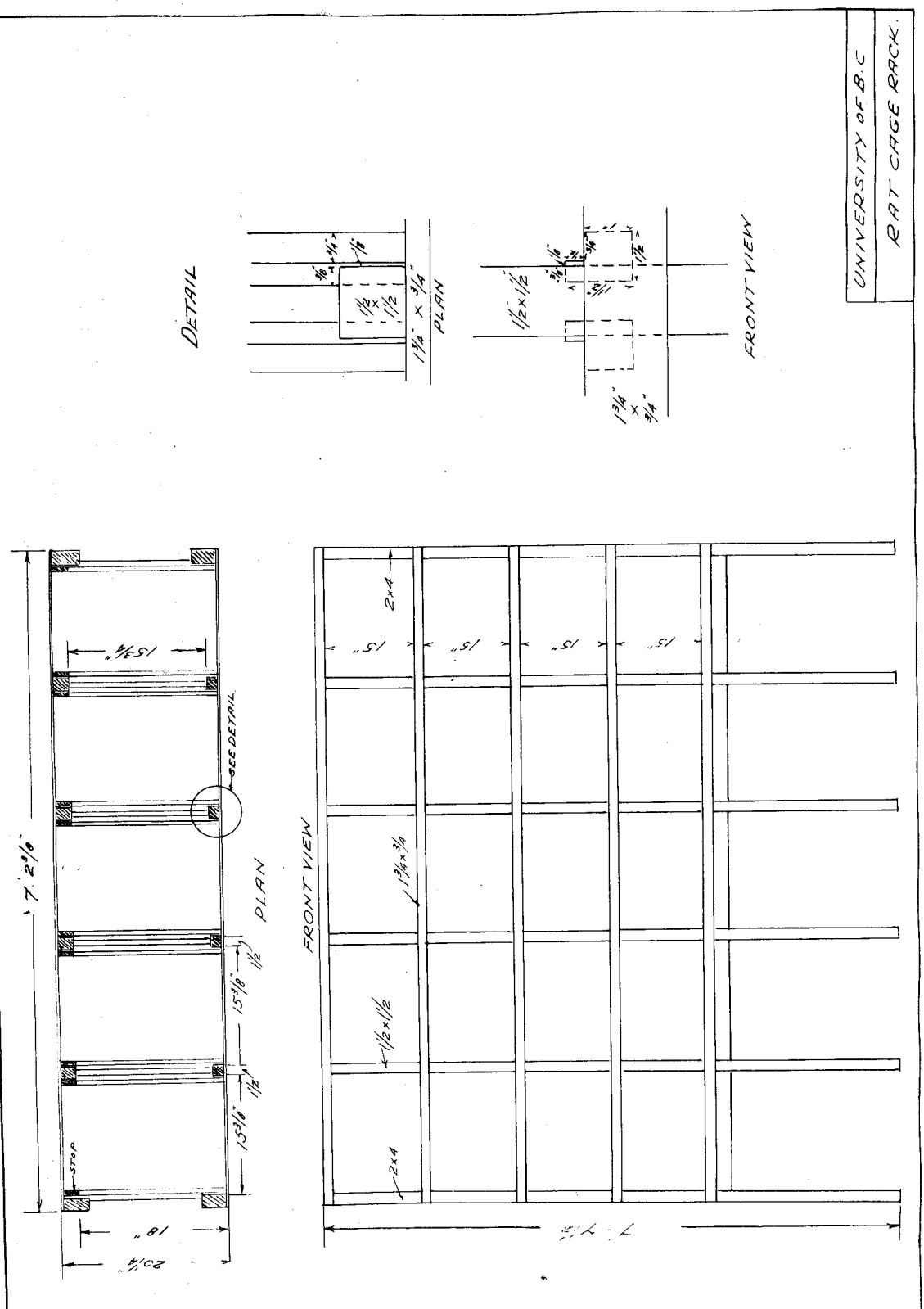
UNIVERSITY OF B.C.
RAT CAGE RACK
DETAIL
PLAN
FRONT VIEW
SEE DETAIL
STOP
PLAN
FRONT VIEW
2×4
1½×1½
1¾×¾
7'-7½"

FIG. 3

Fig. 4. Standard Rat Cage Showing Data Card Bracket and Water Bottle.

Fig. 5. Standard Rat Cage Showing Animals and Bedding.

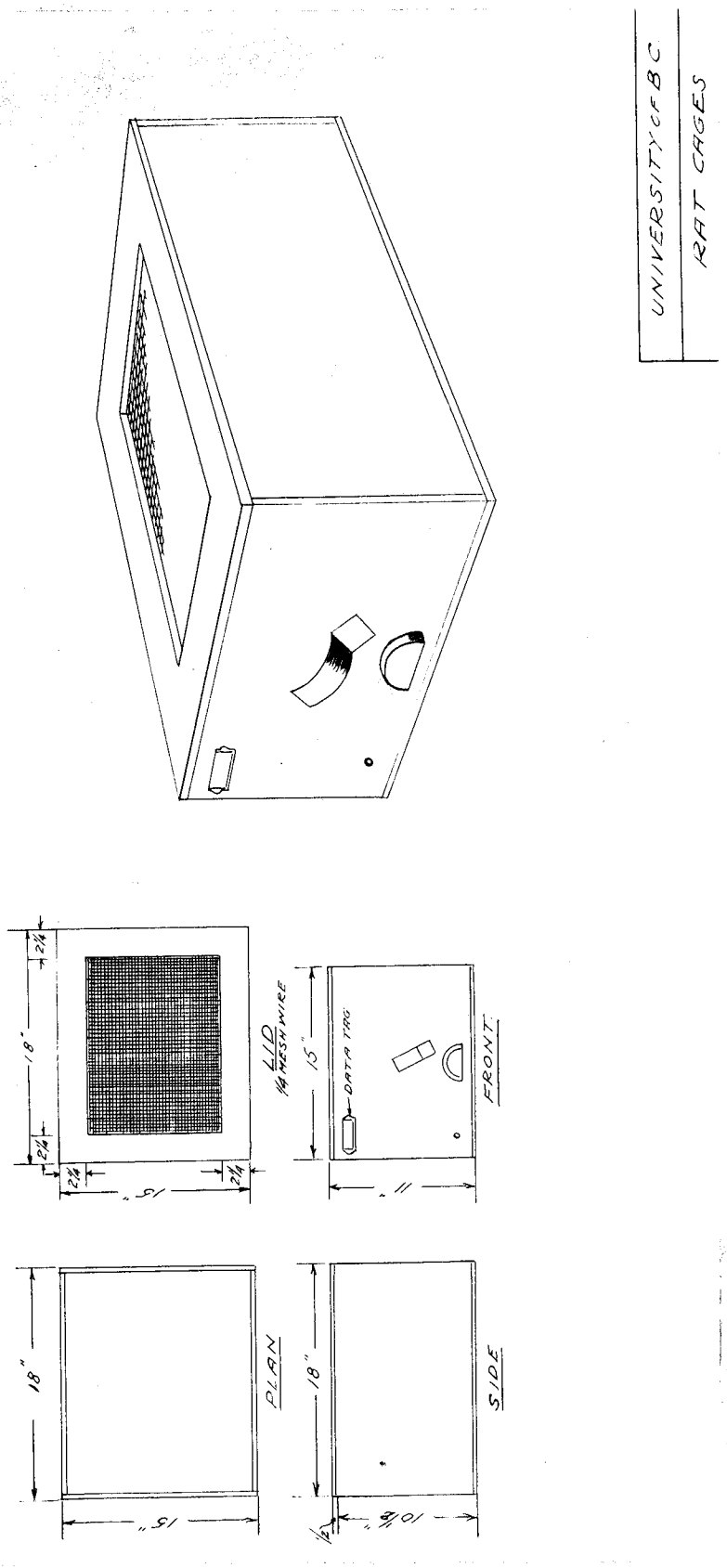

Fig. 6. Scale drawing showing specifications of rat cage.

represents a space utilization of 36 square inches per rat on a room basis, 13 square inches per rat on a cage plus rack basis, and 29 square inches per rat on a cage basis. The cages are kept clean by a rotational system of cleaning cages. Each day the rats which are considered to be in dirty cages are transferred to clean cages. The dirty cages are then carried to the wash-up room where the soiled bedding is scraped into garbage cans. The cages are then scrubbed and washed with hot water and ammoniated soap and allowed to dry overnight. The following day they are returned to the rat room as clean cages.

(3) Feeding and Watering

The rats and mice are fed the same pelleted concentrate ration, (see Appendix III). The pellets weigh approximately five grams each. The rats are fed by placing the pellets loose on top of the bedding. Each animal received a daily feed allowance of about 13 grams. Although this method of feeding is not strictly ad libitum, a small amount of feed is always present in the cage from day to day. Twice a week the rat colony is supplemented

with green feed, usually kale, which serves as an additional source of vitamin A. Half pint milk bottles are used as water bottles. The water is changed daily and the bottles are washed weekly. The bottles are supported by a metal bracket on the front of the cage as shown in Fig. 4.

(4) Breeding

The breeding program followed is one of full brother and sister matings. All breeding stock is identified by ear nicking and each animal's breeding history is card indexed. Each breeding rat has a small record card which fits in a bracket on the cage housing the rat. A breeding unit, when originally set up with new stock, usually consists of a maximum of five females and one male as sire. The male rat is allowed to run with the females for two weeks. The male rat is removed from the breeding cage and each pregnant female is moved to a separate cage to whelp by herself. When the litter is born, the number born and the date of birth are marked on the small record card. All young rats are weaned at 21 days of age. After the female has weaned her litter, she is given two weeks' rest before being bred again.

Rats are selected as replacement breeding stock on the basis of a high weaning weight and a large number in the litter of origin. All the females and the largest male rat are retained to make up the family or breeding unit, thus continuing the brother and sister mating. The young stock is now allowed to breed until it is over 100 days old. Rats which are not selected for future breeding stock but are to be used for experiments are pooled according to age and sex. The female rats which form a breeding unit are caged together when in between breeding periods. The males of each group are also pooled when not in service.

(5) Control of disease.

As yet, there has not been an outbreak of disease in the rat colony. There has been the occasional death, caused by the common respiratory trouble which seems to affect old rats. These deaths have been so insignificant in number, that they are never recorded. Post-mortem examination of the dead rat has usually revealed a pneumonic condition of the lungs. By maintaining a high degree of sanitation in the colony, it is hoped that disease is prevented. The cages are washed with a disinfectant soap and

the water bottles are cleaned weekly. Any animal which does not appear normal is destroyed immediately and autopsied.

(6) Literature Review on the Laboratory Rat.

It would appear from the literature that at the beginning of the twentieth century, the use of the albino rat as a laboratory animal received a tremendous stimulus. The classical nutrition experiments of Osborne and Mendel (1914) (1915) and the extensive work of King (1915) (1919) on inbred strains of albino rats are just a few of the many examples. It was in 1915, that Donaldson published his first memoir titled, "The Rat".

In 1913, Jackson published some of the earliest growth data on the Wistar strain of rats and compared his results with those of Donaldson.

Table 5 - Jackson's and Donaldson's Growth Data on the Wistar Strain Rat - 1913

	Jackson's Larger Series				Donaldson's Series			
	Males		Females		Males		Females	
Age	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Birth	63	5.13	66	4.89	40	5.4	17	5.2
7 days	56	10.53	64	10.29	11	9.2	8	8.7
21 days	53	23.99	59	21.5	19	21.2	17	22.6
42 days	45	63.72	50	64.25	19	46.3	17	47.9
70 days	23	130.4	25	108.9	19	106.6	11	99.8

Jackson's ration is outlined in Appendix III. The 21 - 24 gram weights at 21 days are interesting in contrast to the average weight now of 30 grams at the same age.

King, in 1915, reported average birth weights of stock and inbred albino rats as being 4.54 grams for males and 4.27 grams for females. These data were for 85 litters. She also reported in 1915, that based on the results of 1089 litters, the average size of the litter was 7.0 young.

In 1919 King published a paper on the inbreeding of rats through a number of generations. This paper, although the subject of which was inbreeding, actually rightly predicted a trend or effect on the growth of the albino rat in the future. This idea is put forth in her discussion on

the variability of body weights of animals in the sixteenth to the twenty-fifth generations of inbreeding. She states, "During the past three years, when most of the weighings were taken, it was not possible to rear the animals under environmental and nutritive conditions that were as favorable to growth and to fertility as those existing previously. The 'scrap' food (carefully sorted table refuse)on which the animals of the earlier generations seemed to thrive exceedingly well, had to be replaced by a ration that consisted, for the most part, of oats and corn with occasional additions of various kinds of vegetables and a little meat". King, in commenting on the variability in the later generations, states that, "... the variability was greatly influenced by environmental and nutritive conditions". "Until these latter factors can be controlled, it will not be possible to draw any definite conclusions regarding the effects of inbreeding per se on variability in body weights". It would seem likely that similar reasoning could be applied to the other laboratory and domestic animals.

Sherman and Muhlfield (1922) published a paper on the subject of influence of diet on growth and reproduction. Their ration (see Appendix III) is the basis for other rat rations used since that time.

Table 6 - Sherman and Muhlfield's Growth Data on the Albino Rat.

Diet	No. of Young Born to		No. of Young Reared to		% Young Reared
	All Fem.	Per Fem.	All Fem.	Per Fem.	
A	299	29.9	145	14.5	48
B	498	49.8	310	31.0	62

	No. of Animals	Ave. Wt. at 28 days
A	299	34.2
B	493	42.2

The interesting feature shown by their data is the low percentage of young reared in comparison to that of other investigators. It is the opinion of this writer that a contributing cause to this mortality was the fact that the litters were whelped in wire cages and also that bedding or nesting material was not supplied until the young were born.

Osborne and Mendel (1926) reported an increased rate of growth on a ration which contained 15 per cent lard and nine per cent butterfat. See(Appendix III). This high fat percentage in the ration meant that it was a high energy

ration because of the relatively large proportion of calories furnished by the fat. They reported that it took about 27 days for twenty of their best growing rats to grow from 60 to 200 grams. This rate of growth was much more rapid than the 79 days for males and 129 days for females reported by Donaldson, cited by Mendel and Cannon (1927).

Macy et al (1927) reported growth data using the same ration as Sherman and Muhlfield (1922). (See Appendix III). Their data as shown in Table 7 were taken from graphs of growth data for the Wistar strain.

Table 7 - Macy's Growth Data using the Sherman and Muhlfield Ration.

Age in Days	Ave. Wt.	
	Males	Females
28	35	32
56	92	81
84	154	140
224	310	215

Mendel and Cannon (1927) published data on the relation of rate of growth and diet. They compared the gains in weight made by their albino rats compared to those of Donaldson.

Table 8 - Mendel and Connon's Growth Data on the Albino Rat

	Average Daily Gain in Weight over Range 60 - 200 Grams	
	Males	Females
Donaldson	1.77 Gms.	1.09 Gms.
Mendel and Cannon	5.0	3.0

They concluded from this comparison that, "... the published records and compilations of 'norms' fail to furnish an adequate idea of the rate of growth of which the rat is capable".

Smith and Big (1928) using essentially Sherman's normal diet B reported growth data on stock albino rats. (See Appendix III).

Table 9 - Smith and Big's Growth Data on the Albino Rat

Age in days	Average Weight	
	Males	Females
21	40	39
27	63	60

In evaluating Smith and Bing's data, it should be mentioned that all litters of rats were reduced to eight at birth, a practice which would have an effect on the growth rate and subsequent weaning weight.

Maynard (1930) published a paper proposing a stock diet for rats. (See Appendix III). The foundation rats for his colony had been obtained from the stock of Osborne and Mendel. The breeding program outlined, was to breed one male per three females for 5 days. His results showed that of 52 female rats bred, 65 per cent produced litters. He claimed a high percentage fertility for these experiments. He also stated that 90 per cent of the young were reared to 23 days of age, which would appear to be excellent post-partum production.

Freudenberger (1932) using a somewhat modified Sherman B diet, (See Appendix III) published growth data on the Wistar strain. In this experiment, the litters were reduced to six at birth. In tabulating the growth records for body weight, the method of weighted means was used. He reported the average size of 226 Wistar litters as being 8.57, and the average birth weight of a Wistar litter to be 46.8 grams.

Table 10 - Freudenberger's Growth Data on Wistar Strain Rats

Age	Males (850)	Females (927)
Birth	5.63	5.3
20 days	41	38

Anderson and Smith (1932) published a paper which reported exceptionally rapid growth in albino rats. The rats were weaned at 21 days of age and were fed on the ration outlined in Appendix III.

Table 11 - Anderson and Smith's Growth Data on Male Albino Rats. (21 Rats)

Weaning Weight	60 to 200 Gms. Time Required	60 to 200 Gms. Ave. Daily Gain	60 to 300 Time Required	60 to 300 Ave. Daily Gain	60 to 400 Time Required	60 to 400 Ave. Daily Gain	60 to 500 Time Required	60 to 500 Ave. Daily Gain
48.6	23.3	6.1	41.1	6.0	69.1	5.2	102.4	4.5

A large proportion of the young from which these males were selected weighed from 40 to 55 grams at weaning. In this rapid growth study, individuals were selected from the lower as well as the higher ranges in body weight.

The ration used was not stated.

Table 12 - Mendel and Hubbell's Summary of Reproductive Performance at Connecticut Agricultural Experiment Station

	% of Fertile Matings	No. Born	Wt.at Birth Gm.		% Weaned	Wt.at Weaning Males.	Fem.	Daily Gain to 100 days Males	Fem.
1912	86	7.2			71	23	26	1.8	1.2
1919	65	6.3			67	31	31	2.0	1.4
1925	68	6.4			76	31	30	2.1	1.6
1935	93	9.6		5.8	90	48	47	4.0	2.5

The years tabulated were selected because they represented the different times at which major increases were noted in the growth rate.

Thomson (1936) reported on the albino rat growth results obtained on a stock diet at the Rowett Research Institute. They also reduced number per litter to eight at birth and weaned them at 21 - 23 days of age.

Table 13 - Thomson's Growth Data on the Albino Rat.

Age in days	Weight Males	Females
23	43	41.5

Pickens et al (1940) repeated in part the experiment of Anderson and Smith (1932). To a rapidly growing group, they fed the same ration as that of Anderson and Smith (1932). In addition, they set up a normal growing group, considered to be normal for their colony, and two retarded growing groups. The gains recorded for the rapidly growing group closely approximated the gains made by the Anderson and Smith animals. They required 25 days instead of 23.3 days to increase from 60 to 200 grams in body weight. Eight animals were killed from each dietary group at 42, 110 and 230 days of age as well as at the beginning of the experiment before being placed on the four different diets. These animals were used for analysis for water, fat, nitrogen and ash. The data on the gains showed the tendency of the rapidly growing animals to accumulate greater proportions of fat and smaller proportions of water than the animals of any other groups. These results raise the question of the exact definition of growth. Is it gain in body weight or is it the gain in body weight of non-fat substances?

In 1941, Zucker et al, recorded weanings weights of 61 grams for males and 51.4 grams for females at 28

days of age for albino rats. (For ration see Appendix III).

Maynard and Rasmussen (1942) published a paper on the influence of dietary fat on lactation performance of the rat as measured by the gain in weight of the litter. In this experiment, a diet of natural foods containing approximately 4.5% fat was compared with a similar diet containing approximately 9% fat. Preliminary procedures were necessary before starting the experiment in order to minimize sources of variation. After birth of the young, pairs of mothers were chosen which were equal in weight, and from whose litters six young for paired groups of nearly equal body weight could be selected. Whenever possible these paired groups were equalized as to sex. One mother was then fed the high-fat diet, and the other, the low-fat diet equalizing the caloric intake in accordance with the appetite of the one consuming the least amount. The weight changes in mothers were also recorded. The data for litter gains showed that in 13 out of 15 comparisons they were larger for the high-fat diet. They averaged 126 grams as compared to 112 grams for the low-fat diet over the experimental period, birth to 17 days of age.

Vinson and Cerecedo (1943) reported growth data on Wistar strain rats using Purina laboratory chow as the ration. (See Appendix III).

Table 14 - Vinson and Cerecedo Growth Data on Wistar Strain Rats.

No. of Females	Litters Born	Litters Weaned	Young Weaned	Litter Size	Average Weaning Weight 21 days
15	14	11	79	7.0	34.5

Deuel et al (1944) supported the theory of Maynard and Rasmussen (1942), that the lactation period was a better index period for testing the adequacy of a diet, than the growth or reproduction period.

Loosli et al (1944) likewise experimented with the effect of dietory fat on lactation performance. They used the same technique that Maynard and Rasmussen (1942) used. They measured the gains of the litters relative to varying percentages of fat when corn oil provided the only source of fat. (See Appendix III).

Table 15 - Effect of Varying Ration Percentage of Fat on Lactation in the Rat. (loosli).

Per Cent Fat	Gain of Litter Birth to 17 days
5.5	152.1
11.3	161.2
19.2	150.1

The results outlined in Table 15 showed that the ration with 11.3 per cent fat stimulated the highest lactation rate as measured by growth of the litter.

Deuel et al (1945) published a paper on the production efficiency of a modified diet B used by Sherman (1922) in which the butterfat was replaced by margarine fat. (See Appendix III).

Table 16 - Deuel's Data on the Influence of Margarine Fat in Growth and Reproduction in the Rat.

Gen.	Litters Born	Ave. Age of mother at birth	Ave. No. per Litter	Ave. Weight Per Rat Birth	Ave. Weight Per Rat 21 days	Fertility in Per Cent
0	7		10.7	5.0	31.1[1]	89
1	8	108	11.5	5.22	29.3	
2	8	115.5	9.0	5.57		
3	13	112.7	11.9	5.0	28.4	
4	7	122.7	9.9	4.87	27.6	
5	8	120.4	11.2		32.4	
6	7	148.7	11.2		31.3	
7	6	149.0	9.8		39.3	
8	5	145.5	10.6		36.6	
9	12	149.8	8.4		39.2	
10	13	152.8	8.4		36.6	
			Second Litter Rats			
2[2]	8	176.5	7.8		31.2	91
3	8	171.5	12.1		28.5	
4	8	191.3	10.4		27.3	
5	5	185.2	10.4	6.76	31.6	
6	6	216.9	7.4	7.89	35.2	
7	7	197.5	8.7	7.83	34.1	
8	10	213.5	9.1	8.04	36.4	

1 Only those litters where there were 7 in a litter at 21 days.

2 Second litter of first litter parents. The other rats in this group are from second litters of second litter parents.

Weight

Age in Days	10th. Generation, First Litter Rats. Males	Females	9th Generation, Second Litter Rats Males	Females
90	330	216	267.5	182

Deuel et al (1947) reported production data for albino rats on a stock diet (See Appendix III). All litters were reduced to seven animals 3 days after birth.

Table 17 - Deuel's Data on Albino Rats on Stock Ration

Per Cent Fertility	Ave. No. Per Litter	Ave. Weight Weaning	Per Cent Weaned
90.0	7.8	30.7	77

7. Animal Nutrition Laboratory Growth Data.

The growth data accumulated on the rat colony in the course of this study are tabulated in Appendix IVA and summarized in Table 18. The Wistar outbred group were rats which had not been selected as breeding stock and consequently were not part of the planned line-breeding program. To compensate for an increased demand for weaner rats beyond the possible output of the regular stock colony, this group of females were put into production. They were bred to unselected males. Their production was recorded because it was felt that any additional data would be of assistance in this study. The Wistar inbred group were second and third generation progeny of brother and sister matings which were of comparable age. Both the inbred and outbred Wistar groups were fed U.B.C. ration No. 6. The following groups were fed U.B.C. ration No. 10. (See Appendix III). The groups designated IIA, IIB and IIC were Wistar strain rats of the third and fourth generations of inbreeding in this colony and descendants of the Wistar inbred group. Records were not kept on the per cent fertility of this

group. The Sherman I group consisted of females which had been mated at Rockland Farms but whelped at the Animal Nutrition Laboratory. Sherman II represent a second group of females received from Rockland Farms which were bred to Sherman males at the Animal Nutrition Laboratory. The Wistar x Sherman group represent production resulting from the mating of Sherman I females and Wistar males. These data might also be referred to as the second litter results of the Sherman I females. Sherman III are the third litter growth data of the Sherman I females. As this study progressed, it was found desirable to record more detailed data on the litters, such as the sex ratio and the weight of males and females at birth. Some of the data on the Sherman strain is so tabulated. (See Appendix IVA).

There are several important features to be noted in Table 18. The average percentage fertility exclusive of the unrecorded groups was 73.1 per cent. This is not as high a percentage fertility as would be desired and yet it is not considered to be too low.

Table 18 - Animal Nutrition Laboratory, Growth Data on Rats

	Wister Outbred	Wistar Inbred	Wistar IIA	Wistar IIB	Wistar IIC	Sherman I	Sherman II
No. Females bred	15	18				52	19
No. Litters Born	14	14	10	7	6	38	15
Per cent Fertility	93.3	77.7				73.0	78.9
No. Young Born	158	176	97	58	40	360	125
Ave. Size Litter	11.3	12.5	9.7	8.2	6.6	9.4	8.3
No. Young Weaned	149	164	97	54	32	354	121
Per Cent Weaned			100	93.1	80	98.3	97.5
Birth Weight	5.55	5.48	5.9	5.79	5.85	-	5.24
Weaning Weight	32.4	31.7	32.3	35.7	34.4	36.6	28.6
Males at Weaning	77	85	56	25	101	170	57
Females at Weaning	72	76	41	29	82	184	64

Wistar x Sherman I	Sherman III	Total Rat Colony
55	53	212
41	33	155
74.5	62.2	73.1
418	334	1766
10.2	10.1	9.9
394	307	1672
94.2	91.9	94.6
5.54	5.44	
34.5	32.2	
222	166	959
172	141	861

TABLE 19

COMPARISON OF OTHER INVESTIGOR'S AND ANIMAL NUTRITION LABORATORY GROWTH DATA ON THE RAT

	Jackson (1913)	Donaldson (1913)	Sherman and Muhlfield (1922) Diet A	Diet B	Macy et al (1927)	Smith and Bing (1928)	Maynard (1930)	Freudenberger Wistar (1932)
No. Females Bred							52	
No. Litters Born								
Per Cent Fertility							65	
No. Young Born								
Ave. Size Litter								
No. Young Weaned								
Per Cent Weaned			48	62			90	
Average Birth Weight)M.	5.13	5.4						5.63
Average Birth Weight)F.	4.89	5.2						5.3
Average Birth Weight)L.								
Average Weaning Weight)M.	23.9	21.2			35[1]	40		41.0
Average Weaning Weight)F.	21.5	22.6			32[1]	39		38.0
Average Weaning Weight)L.			34.2[1]	42.2[1]				

1 Weaned at 28 days
2 Weaned at 23 days
3 Male and Female birth weights and weaning weights are from Sherman III

TABLE 19 (Continued)

Anderson and Smith (1932)	Mendel and Hubbell (1935)	Thomson (1936)	Zucker et al (1941)	Vinson and Cereceda (1943)	Devel et al (1945) 8th Generation 2nd Litter	Devel et al (1943)	U.B.C. Wistar	U.B.C. Sherman[3]	U.B.C. Sherman Wistar Cross	U.B.C. Total
				15				126	55	212
				14			51	86	41	155
	93			93.3		90.0		68	74.5	73.1
				98			529	819	418	1766
	9.6			7.0	9.1	7.8	10.4	9.5	10.2	9.9
				79		77	493	782	394	1672
	90			80.6			93.1	95.4	94.2	94.6
								5.41		
								5.50		
					8.04			5.44	5.54	
48.6	48.0	43.0[2]	61.0[1]					33.4	35.4	
	47.0	41.5[2]	51.4[1]					31.6	33.3	
				34.5	36.4	30.7	32.8	33.6	34.5	

The average litter size at birth would be considered as above average. The percentage weaned is definitely high and because of its consistency within the groups, it can be attributed, in a large measure, to the high standard of management and partly to the adequate nutrition of the colony. The weaning weights are satisfactory considering the size of litter nursed and weaned.

Table 19 summarizes as far as possible the data reported by other investigators discussed in the literature review. The methods of reporting data and the conditions under which they were gathered were so varied, that to attempt to make an accurate comparison between their results and those of the Animal Nutrition Laboratory is deemed unwise. The fact that a great variety of rations were fed, that some colonies reduce the litters at birth and that different strains of albino rats were used only adds to the difficulty of comparison. Generally speaking, however, the Animal Nutrition Laboratory rat colony does appear to excel in such factors as average size of litter and percentage weaned. The weaning weights appear to be reasonably high, when it is remembered that the litters

TABLE 20

COMPARISON OF OTHER INVESTIGOR'S AND ANIMAL NUTRITION LABORATORY POST-WEANING GROWTH DATA ON THE RAT

Date and Reference	No.Born M	No.Born F	No.Born T	Average Weight of Litter at 21 days M	21 days F	21 days Ave	28 days M	28 days F	28 days Ave	35 days M	35 days F	35 days Ave	42 days M	42 days F	42 days Ave
1950,An. Nut.Lab.	6	5	11			36			57			82			113
1950,An. Nut.Lab.	6	5	11			34			54			80			113
1946,F.R. L. Data[1]									61						110
1927,Macy 1928,Smith and Bing[2]													126	110	118
1932,Freudengerger[3]													120	94	107
1941,Zucker							61.0	51.4	56.2	87.6	72.8	80.2	115.4	92.4	104

1 F.R.L.Data - Food Research Laboratories data taken from graph in Hawk,Oser, Summerson, p. 1272.

2 Smith and Bing's data was actually recorded at 55,65, and 75 days but is tabulated under 56,63, and 77 days respectively.

3 Freudenberger's data was actually recorded at 45,60,and 75 days but is tabulated under 42,56, and 77 days respectively.

Average Weight of Litter at

Date and Reference	No.Born M	F	T	49 days M	F	Ave	56 days M	F	Ave	63 days M	F	Ave	70 days M	F	Ave
1950,An. Nut.Lab.	6	5	11			137			162	206	146	179	222	161	195
1950,An. Nut.Lab.	6	5	11			139			163	212	145	182	233	161	200
1946,F.R. L.Data									149				215	150	182
1927,Macy							92	81	86.5						
1928,Smith and Bing							157	150	153.5	221	162	191.5			
1932,Freudenberger							170	130	150						
1941,Zucker				139	107	118	164	119	141	186	130	158	205	140	172

Average Weight of Litter at

Date and Reference	No.Born M	F	T	77 days M	F	Ave	84 days M	F	Ave	91 days M	F	Ave
1950,An.Nut.Lab.	6	5	11	238	171	208	251	177	217	261	183	226
1950,An.Nut.Lab.	6	5	11	249	173	214	262	180	225	276	188	236
1946,F.R.L.Data							248	172	210			
1927,Macy							154	140	147			
1928,Smith and Bing				268	178	223						
1932,Freudenberger				198	155	176.5						
1941, Zucker				221	149	185	237	160	198			

are reduced in size at some of the other institutions. However, these weights do not approach those of Anderson and Smith (1932) or Mendel and Hubbell (1935). The percentage fertility has been excelled by other rat colonies.

Table 19 represents a summary of post-weaning growth data reported by several other workers compared with results of the Animal Nutrition Laboratory Colony. The two litters used in this study from this laboratory were selected because they were large litters and the sex ratio was nearly equal. They represent the progeny from the Wistar inbred group. As can be seen from Table 20, the post-weaning growth results of the Animal Nutrition Laboratory compare favourably with those results of other colonies.

8. Cost Survey on Rat Colony

The costs of labour, feed and housing were calculated in order to determine the average cost per rat per day. Appendix V shows the results of this survey. The labour cost was determined by two different animal attendants who were thoroughly familiar with the colony, in order to compute a more legitimate value. It involved recording the time spent each day to manage the colony, the number of animals and the number of cages occupied. In addition, the amount of feed utilized each day by the colony was recorded so that the cost of feed per rat per day could be calculated. A housing cost was charged, based on the value of the cage and the 'life' of the cage. The labour cost of recording breeding data and identifying rats was not included. The average daily cost per rat would be as follows:

Labour	$0.003
Feed	0.002
Housing	0.0006
Total Cost	$ .0056

B. Animal Nutrition Laboratory Mouse Unit.

(1) Origin

The mouse unit of the Animal Nutrition Laboratory originated from a shipment of 15 mice received from the Suffield Experimental Station, Suffield, Alberta. The mice in the colony at the present time, and used for the purpose of this study, are descendants of that original foundation stock.

(2) Housing

The mouse colony is located in a room which is 9 feet 8½ inches long and 7 feet 9½ inches wide, giving a floor area of 75.2 square feet. It's height is 10 feet giving a room volume of 752 cubic feet. Based on a maximum room capacity of 975 mice, the volume utilization is 1330 cubic inches per mouse. The mouse cage rack, which holds 65 cages is situated along three of the walls of the room. Two of the racks measure 4 feet 8¼ inches in length with the third one measuring 5 feet 10 inches. All three racks are 1 foot 7¼ inches deep and 6 feet 7½ inches high. They occupy 21.9 square feet of floor space or

Fig. 7. Mouse cage rack showing tiers of cages.

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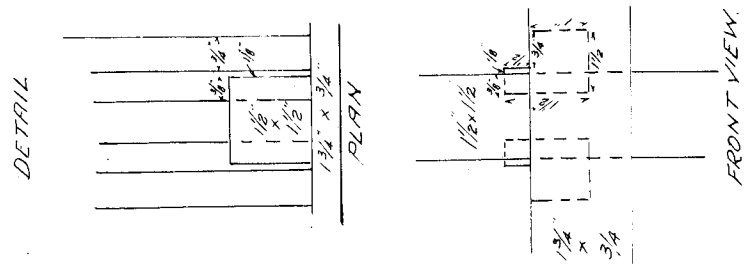
MOUSE CAGE RACK.



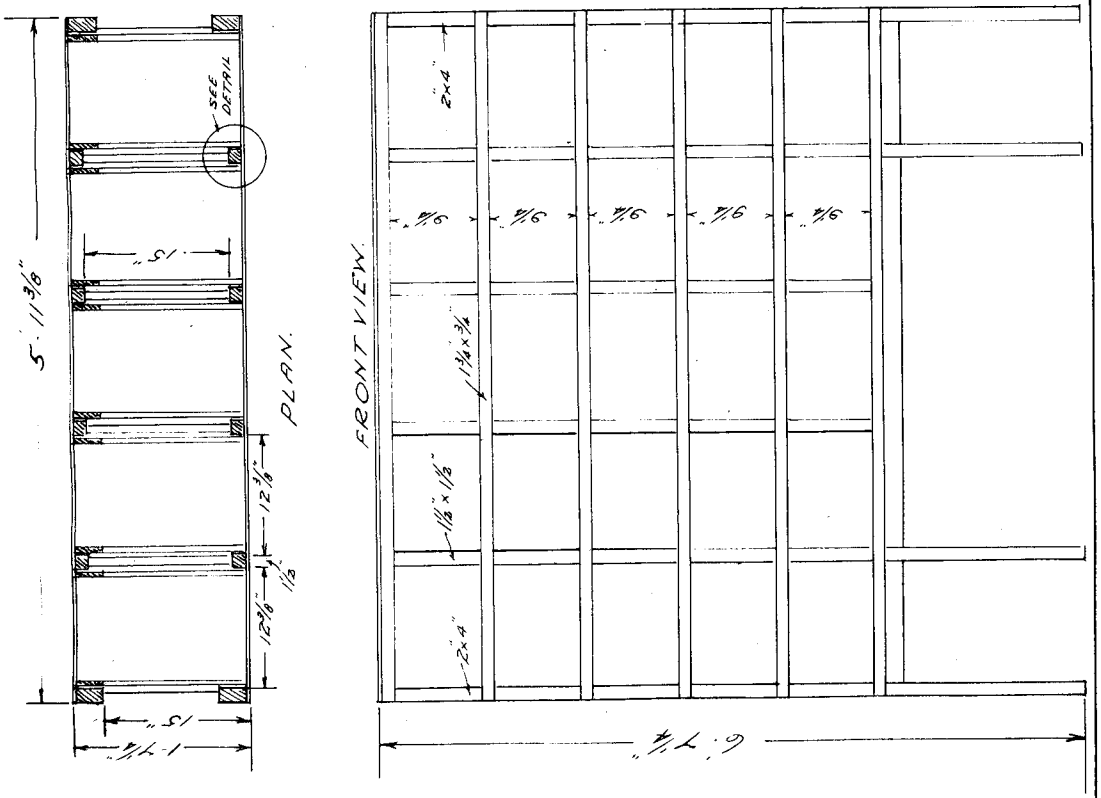


FIG. 8

Fig. 9. Standard mouse cage showing data card bracket and water bottle.

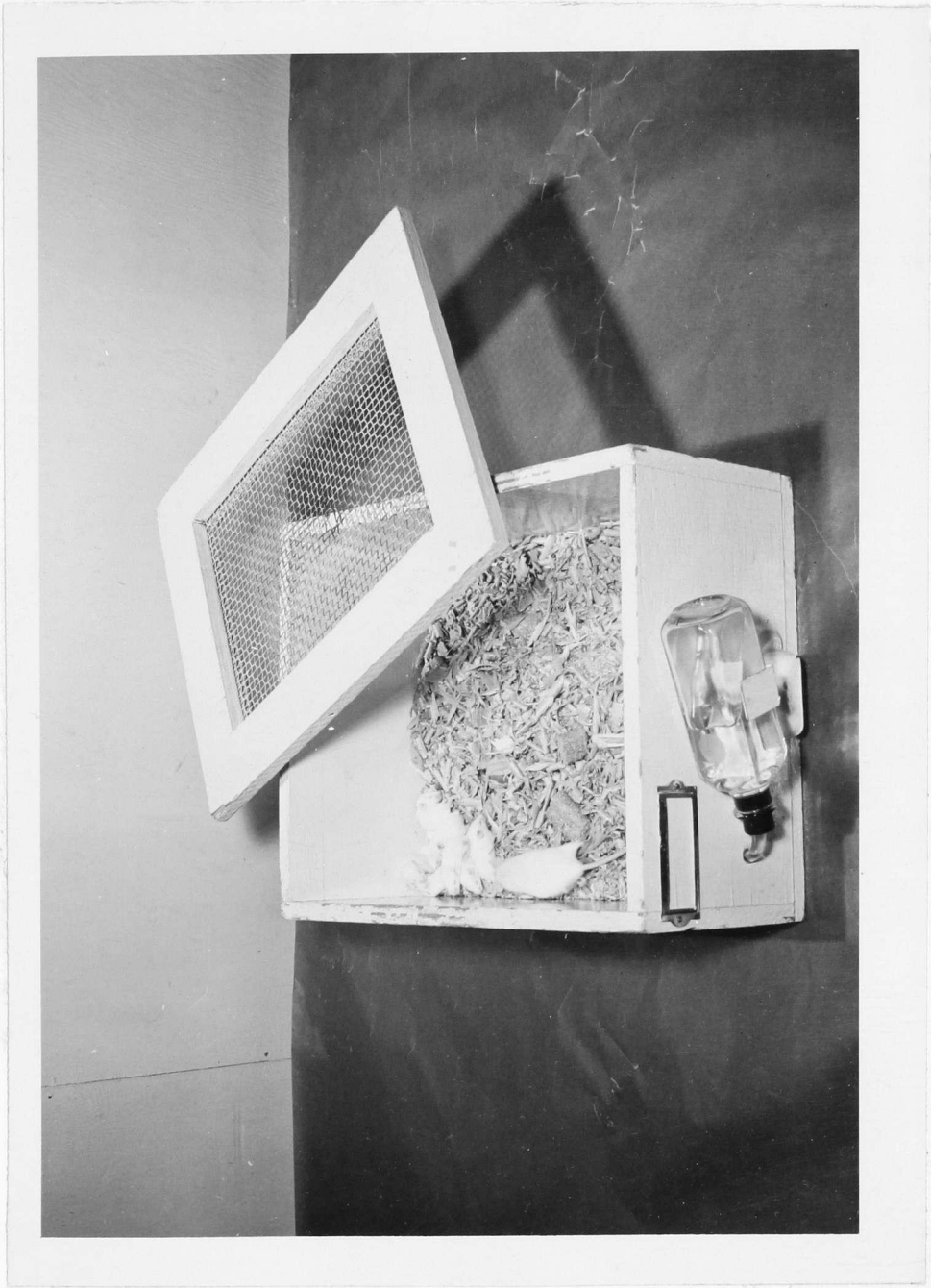


Fig. 10. Standard mouse cage showing animals and bedding.

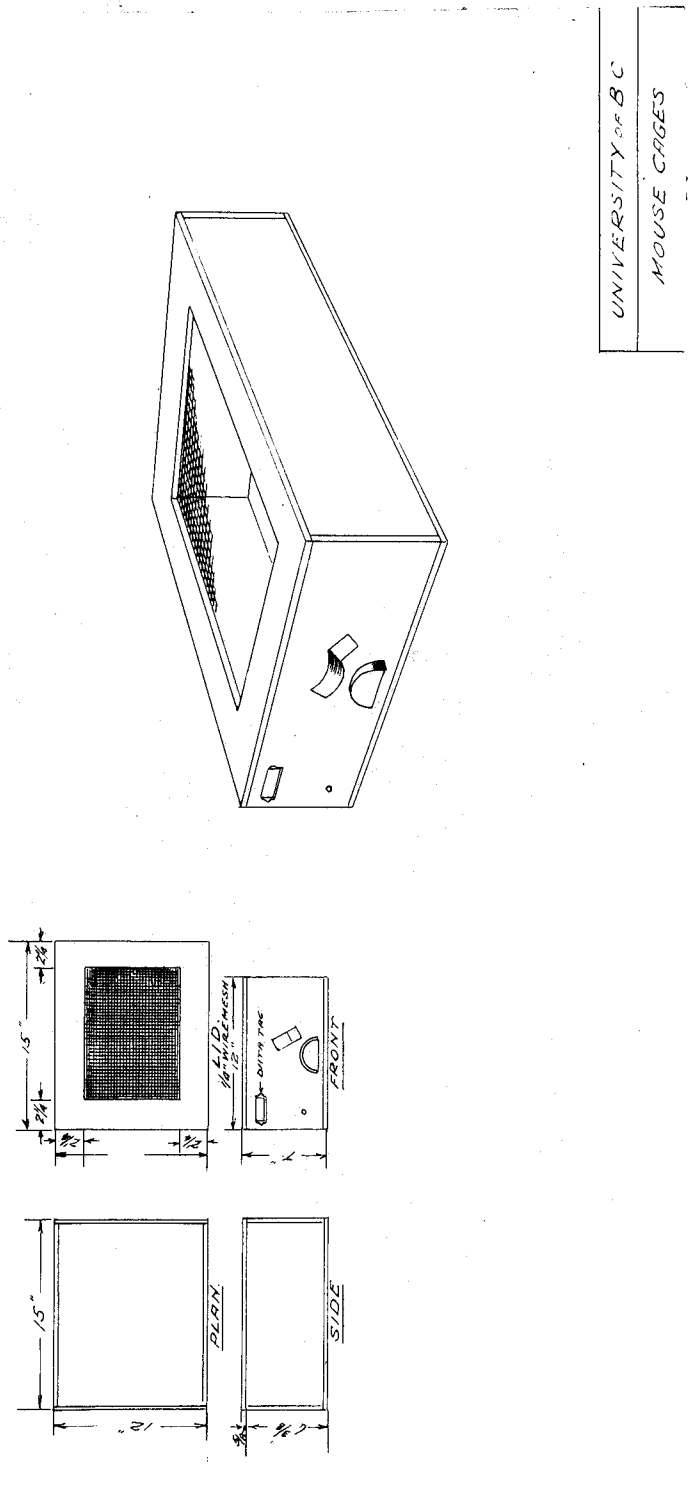


Fig. 11. Scale drawing showing specifications of mouse cage.

approximately 33.9 per cent of the floor area. The room is provided with a cold water tap and sink adjacent to the largest rack, with the farthest cage just over six feet away from the sink, or in terms of motion, three steps distant. The lay-out of the room is well illustrated in Figure 7. A drawing of the rack appears in Figure 8.

The mice are housed in white painted 1/2 inch plywood cages, one of which is pictured in Figures 9 and 10. Figure 11 is a drawing of this cage. Bedding is provided by using a layer of wood shavings approximately 1/2 inch deep which represents a weight of 120 grams or a volume of approximately 1180 cc. The recommended maximum capacity of this cage is 15 mature mice. This represents a floor area utilization including the area of passageways of 11.1 square inches per mouse. On the basis of the area occupied by cages and racks, it represents 3.2 square inches per mouse. On the basis of the area of the cage, it represents 10.2 square inches per mouse. A rotational system of cleaning cages is used. A certain number of cages are changed daily by transferring the mice from the dirty cage to a clean cage. The number of cages

changed daily naturally will depend on the total number of mice in the colony and the number of mice per cage. The dirty cages are then moved to the wash-up room where they are scraped free of the soiled bedding. Next, they are scrubbed and washed with hot water and ammoniated soap and allowed to dry overnight preparatory to being taken back to the mouse room as clean cages.

(3) Feeding and Watering

The mice are fed the same pelleted ration and in the same manner as the rat colony. Each mouse receives approximately seven grams of feed per day. Green feed, usually kale, is fed twice weekly. Milk dilution bottles, with a volume of 160 cc., serve as water bottles. The water is changed daily and the bottles washed weekly. The bottles are held in position on the front of the cage by a metal bracket as shown in Fig. 9.

(4) Breeding

Full brother and sister matings are used in the breeding program. Replacement breeding stock is selected

on the basis of the highest weaning weight and size of litter. The weaning age is 21 days and any litter of seven and over is considered large. If a litter is selected at weaning for breeding stock, the largest male mouse by weight is selected as a sire, and all the females are retained to make up an integral breeding unit or family. The male and his sisters are then identified by ear nicking and their breeding background as to sire and dam card indexed. They are kept in separate cages until they are 60 - 70 days old, when they are allowed to breed. It has been the procedure in this laboratory, to allow the male to run and breed with no more than four female mice at one time. The male is allowed to run with the females for 10 days, then is separated or removed back to his stud cage. Each female mouse which shows external signs of pregnancy is removed to a clean cage. Young mice at weaning which are not saved for breeding purposes are separated according to sex and pooled with mice from other litters of the same age. Female mice which are full sisters and belong to a family, having weaned their litters are regrouped again ready to be re-

bred. A two week rest period is usually allowed breeding females, after they have weaned a litter, before being rebred. Breeding males are always kept in separate cages, because of the natural tendency to destroy one another when pooled.

(5) Control of disease

The same control measures which are exercised in the rat colony are used in the mouse colony. A sick animal is destroyed as soon as it has been observed and an autopsy performed. In the four years of operation, the mouse colony has yet to experience a serious infection.

(6) Literature Review on the Laboratory Mouse.

Some of first growth data of the white mouse were reported by Robertson in 1916. Table 21 shows his results and the ration fed appears in Appendix III.

Table 21 - Robertson's Growth Data on the White Mouse

Normal White Mice

Age in Days	Wt. of Male	No. Weighed	Wt. of Female	No. Weighed	
Birth	1.23	56	1.23	56	Males and Females not Separated
7	3.31	45	3.31	45	
14	5.14	24	4.91	17	
23	9.32	45	8.45	37	
28	12.38	65	10.39	39	
35	12.45	117	11.81	77	

In 1917 Robertson and Delprat reported on the influence of tethelin upon early growth. The growth data for the mice used as control animals are recorded here. The sex is not designated and it is assumed to be the average of both males and females. The ration fed was the same as the one reported by Robertson in 1916.

Table 22 - Robertson and Delprat's Growth Data on the White Mouse

Age in days	No. Weighed	Average Weight
Birth	118	1.47
7	91	3.35
14	82	4.44
21	74	5.89
28	74	8.55
35	65	11.08

Thompson and Mendel in 1918, made a study of growth in the albino mouse and reported the following data in comparison with those of Judson. The composition of the stock ration was not given, possibly because these mice were control animals and part of a larger experiment.

Table 23 - Thompson and Mendel's Growth Data.

Body Weights of Mice on Stock Ration

Age in Days	Males (15) Judson	Males (15) Thompson	Females (11) Judson	Females (11) Thompson	
Birth	1.5	1.5	1.5	1.5	)
5	3.0	3.3	3.0	3.3	) x
12	6.0	6.7	6.0	6.7	
22	9.0	9.9	8.2	9.4	
26	12.0	12.4	10.0	12.2	

x Males and Females not weighed separately

Gates, in 1925, published a paper on the early growth rate of mice. His data resulted from studies on 106 litters containing over 700 mice. The average size of litter was 7.14. His data is recorded in Table 24.

Table 24 - Gates Growth Data on the White Mouse

Age in Days	Weight
Birth	1.36
7 days	3.21
14 days	5.34
21 days	6.89

Parkes, in 1926, published a rather comprehensive study on the growth of the mouse. It involved 66 litters comprising 407 young, which was an average litter size of 6.2. He illustrated quite clearly the effect of size of litter on birth weight and weaning weight as recorded at 21 days of age.

Table 25 - Parke's Growth Data - Effect of Litter Size on Birth and Weaning Weight.

Weight at Birth and Weaning According to Litter Size

Size of Litters	No. of Litters	Birth Sum of Litter Aves.	Birth General Average	Weaning Sum of Litter Aves.	Weaning General Average
1	1	1.8	1.80	16.0	16.0
2	2	3.2	1.60	23.5	11.75
3	5	7.7	1.54	44.1	8.82
4	7	10.9	1.56	57.6	8.23
5	9	13.2	1.47	69.5	7.72
6	8	11.2	1.40	55.5	6.94
7	15	20.7	1.38	98.8	6.58
8	12	15.8	1.32	71.9	5.99
9	5	6.0	1.20	25.8	5.16
10	2	2.4	1.20	8.9	4.45
Total	66	92.9	1.41	471.6	7.14

Table 26 - Parkes Effect of Litter Size on Birth and Weaning Weight.

Age in days	Weight For Ave. of all Animals	Weight for litter of 1
Birth	1.41	1.8
7 days	3.54	7.0
14 days	5.20	13.0
21 days	7.14	16.0

With reference to the litter of one mouse in Table 26, Parkes points out that since only one litter of this size was recorded, it is not possible to unequivocably state that the growth shown is probably normal for that size of litter. However, he does make two interesting observations. He states, "In the first place, this mouse shows clearly the relatively enormous size to which a young animal can grow when there is available the whole of the natural milk which for one suckling offspring is a practically unlimited supply of nourishment."

Parkes (1926) data on the optimal rate of growth of the mouse was later supported by the work of MacDowell

et al (1930). He demonstrated the influence of the plane of nutrition upon the growth of the suckling mouse. In this experiment the number in the litter was reduced to four at birth and later to one. The average weights of the six females in all experiments, that were heaviest on the 14th day, are recorded here from his data.

Table 27 - MacDowell's Data - Optimal Growth of the Mouse

Age in days	Weight Female
Birth	1.53
7	6.97
14	15.4

Enzmann (1933) conducted several experiments on these phases of growth. In 1933, he stated that "Total milk production is increased with increasing litter size for litters of from four to thirteen young, but not in direct proportion to the number of young, with the result that as litter size increases the amount of milk available for each individual is reduced.

Enzmann and Crozier (1935) also reported on the relation between average birth weight and litter size in

1935. They formulated an equation to express the negative correlation between number of young in a new-born litter and the birth weight of the young.

$$\Delta W/W = K(\Delta N/N)$$

$$W = N^{K} + C$$

In 1935 Crozier and Enzmann (1935) published more data on the relation of litter size and birth weight, which is shown in Table 28. They also show the effect of litter size on growth as evidenced by the data in Table 29.

Table 28 - Crozier and Enzmann - Effect of Litter Size on Birth Weight

No. in Litter N	Ave. Weight of newborn w
1	1.63
2	1.53
3	1.49
4	1.41
5	1.35
6	1.33
7	1.31
8	1.26
9	1.23
10	1.20
11	1.18
12	1.20
13	1.14

Table 29 - Crozier and Enzmann - Effect of Litter Size on Growth
Average Weight of 1 individual (= W/N) GM.

No. in Litter	No. of Litters	Age, Days After Birth. 1	7	14
2	2	1.57	5.15	9.62
3	2	1.63	4.43	8.49
4	6	1.49	4.13	7.80
5	8	1.49	4.06	7.31
6	7	1.44	3.82	6.70
7	10	1.40	3.70	6.34
8	3	1.37	3.57	6.03
9	4	1.33	3.48	5.73
10	3	1.26	3.30	5.27
11	3	1.22	3.21	5.05
12	2	1.24	3.05	4.80

In discussing the data in Table 29, Crozier (1935) notes the decline in growth rate beginning with the second week of life. Crozier agrees with the theory of Enzmann that the decline in part is due to a great extent to the decline in the milk secreting capacity of the mother.

He adds emphasis to this idea by his statement that, "A mother suckling 10 or more young would have to produce almost her own body weight in milk every day." He concludes that the mother is unable to produce milk at this capacity.

Morris published data in 1944 on the growth of brown coloured strain of mice from his stock colony which was designated C3H. His data appears worthy of comparison. (See Table 32). The ration fed is outlined in Appendix III.

Bruce in 1947 also reported on the growth and efficiency of a stock colony of white mice. The ration composition is given in Appendix III.

(7) Animal Nutrition Laboratory Growth Data.

For purposes of this study, a breeding program was initiated with one male and one female mouse designated X31 - 31 - 1. Data were not recorded on the first litter from these parents, although the brother and sister mating was continued with the largest male and all the females of that litter. For purposes of reference, this litter will be designated F1 - litter 1. The original parents produced a second and third litter, which shall be referred to as F_1 - litter 2 and F1 - litter 3 respectively. Growth data were recorded on both of these litters. The females of all these three litters were bred by the heaviest male in each litter, and the production data, along with that of the original parents, are tabulated in Appendix IVB. The F_2 litter 1 females tracing from the F1 litter 1 mating were bred by their heaviest brother and their production data are recorded in Appendix IVB.

The growth data were accumulated by weighing the whole litter at birth and at weekly intervals thereafter.

Table 30 - Animal Nutrition Laboratory Data on The White Mouse

Parent Female(s)	No. Born	No. Weaned	% Weaned	Ave. Size Litter	Ave. Birth Weight	Ave. Wean. Weight	M. at Weaning	F. at Weaning
X31-31-1	19	19	100	9.5	1.78	12.67	9	10
F1-Litter 1 4 daughters	37	37	100	9.2	1.33	11.16	18	19
F1-Litter 2 4 daughters	37	34	92	9.25	1.35	9.12	21	13
F1-Litter 3 5 daughters	41	41	100	8.25	1.44	10.24	23	18
Total or Ave. 13 daughters	115	112	97.3	8.9	1.37	10.2	62	50
F2-Litter 1A 6 daughters	44	38	86.3	7.3	1.27	9.0	21	17
F2-Litter 1B 3 daughters	22	18	81.8	7.3	1.39	11.2	8	10
F2-Litter 1C 5 daughters	40	40	100	8.0	1.31	8.8	17.	23
F2-Litter 1D 2 daughters	18	16	88.8	9.0	1.29	9.2	9	7
Total or Ave. 17 daughters	124	112	90.3	7.75	1.31	9.2	55	57

Sex was determined in the parent and F1-litter 1 litters at 21 days of age, but in the other litters it was determined at birth. In order to obtain more detailed growth data, the males and females in the F1 litter 2, F1 litter 3 and the four F2 litter 1 groups were recorded and weighed separately at birth and weekly intervals until 28 days of age. These data are tabulated in Appendix IVB. All litters were weaned at 21 days, but the litters were weighed until they were 28 days of age. The litters were not reduced in size at birth. In order to facilitate interpretation of these results, summaries of the data appearing in Appendix IVB are shown in Table 30. In scrutinizing the data in Table 30, it becomes evident that none of the daughters or granddaughters equalled the parent female in all the production factors. It would almost appear that there was a decline in this respect with succeeding generations. Any statement however, that this trend is absolutely true would not be in order at this time because of the short duration of this study. The average birth and weaning weights of the Animal Nutrition Laboratory mice, when compared with those reported in the literature review and outlined in Table 31, appear to be average.

The results listed with respect to U. B. C. (25 litters) were so arranged because these 25 litters were whelped within a 10 day period and were the final litters born which were studied. They were the progeny of the following females tabulated in Table 30.

Group	No. of Females
F1-Litter 2	4
F1-Litter 3	5
F2-Litter 1A	6
F2-Litter 1B	3
F2-Litter 1C	5
F2-Litter 1D	2

It is the opinion of this writer, that the condition of the young mice produced by these females was not normal during the pre-weaning growth period. The coats were somewhat stary and lacked the characteristic sheen. This observation was made before examining the growth data which

TABLE 31

A COMPARISON OF OTHER INVESTIGATOR'S AND THE ANIMAL NUTRITION LABORATORY'S GROWTH DATA ON THE MOUSE

	Ave. Size of Litter	Weight at Age in Days: Birth M	F	Ave	7 days M	F	Ave	14 days M	F	Ave	21 days M	F	Ave	23 days M	F	Ave
Robertson(1916)				1.23			3.31	5.14	4.91	5.02				9.3	8.45	8.88
Robertson and Delprat (1917)				1.47			3.35			4.44			5.89			
Judson(1918)[1]				1.5			3.0			6.0	9.0	8.2	8.6			
Thompson(1918)[1]				1.5			3.3			6.7	9.9	9.4	9.6			
Gates (1925)	7.4			1.36			3.21			5.34			6.89			
Parkes (1926)	6.2			1.41			3.54			5.20			7.14			
Parkes(1926)[3]	1.0			1.8			7.0			13.0			16.0			
MacDowell(1930)			1.53			6.97			15.4							
Crozier and Enzmann(1935)	6.66			1.38			3.65			6.25			10.5			
Morris(1944)		1.44			5.1			7.9								
Bruce(1947)	6.4												10.3			
U.B.C.Parents	9.5			1.78			5.47			7.89			12.67			
U.B.C.F$_1$Litter 1[4]	9.2			1.33			4.7			6.87			11.16			
U.B.C.(25Litters)[4]	8.0			1.34			4.22			6.63			9.13			
U.B.C.Ave	7.16			1.38			4.38			6.76			10.3			

1 Weights tabulated are actually for 5, 12, and 22 days.
2 Weight of Litter of one mouse.
3 Weights of six selected females.
4 Group of 25 litters born in 10 day period.

would appear to confirm this opinion. It is difficult to say whether this condition was nutritional, but after the mice were weaned they did appear to look more normal. Table 32 is a summary of the production efficiency of colonies reported by other investigators compared to the Animal Nutrition Laboratory unit. This colony, similar to the rat colony, excels in the percentage weaned. It also compares favourably on fertility and average size of litter.

Table 32 - A Production Efficiency Comparison of Various Mouse Colonies

	Foster et al (1943)	Cereceda & Vinson (1944)[2]	Bruce (1947)	U.B.C. (1950)
No. Females Bred	71	25	24	36
No. Litters Born	69	20		32
Per Cent Fertility	97	80		88
No. Young Born	512		306	258
Ave. Size Litter	7.4	6.4	6.4	7.16
No. Young Weaned	435			242
Per Cent Weaned	85	75[1]	83	94.5
Birth Weight				1.38
Weaning Weight		11[3]	10.3	10.3

[1] Figure represents per cent litters weaned.

[2] For ration see Appendix III

[3] This is an approximate weight, since it was taken from a graph.

(8) Cost Survey on Mouse Colony.

A cost survey of the mouse colony was made similar to the one made on the rat colony. (See Appendix V). The average daily cost per mouse is as follows:

Labour - $ 0.0018

Feed - 0.001

Housing - 0.0003

Total Cost -$0.0031 per day

C. Animal Nutrition Laboratory Guinea Pig Unit

(1) Origin

The guinea pig unit of the Animal Nutrition Laboratory was started with foundation stock received from the Suffield Experimental Station, Suffield, Alberta. The guinea pigs in the colony at the present time, and used in this study, are descendants of that original shipment.

(2) Housing

The guinea pig colony is located in a room which is 9 feet 8 inches long and 6 feet 5 inches wide, giving a floor area of 62 square feet. It is 10 feet in height, giving a room volume of 620 cubic feet. This represents a volume utilization of 6.2 cubic feet per guinea pig, assuming a maximum capacity of 100 guinea pigs for the room. The guinea pig cage rack which holds 20 cages measures 7 feet 1¾ inches long, 3 feet 4 inches wide and 6 feet 4 inches high. It occupies 23.8 square feet or about 38 per cent of the floor space. It is illustrated in Figs. 12 and 13.

UNIVERSITY OF B.C.
ISOMETRIC DIAGRAM FOR ALL RACKS.

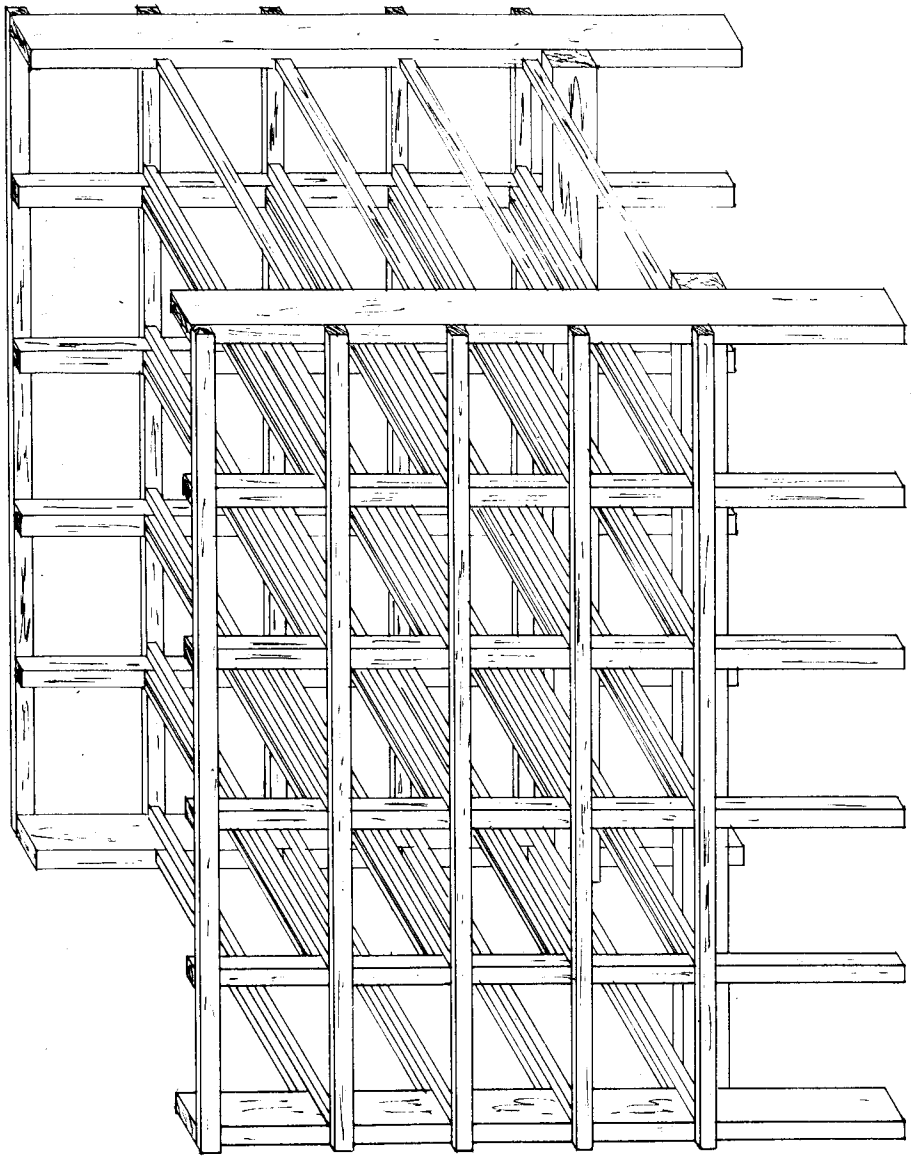


FIG. 12

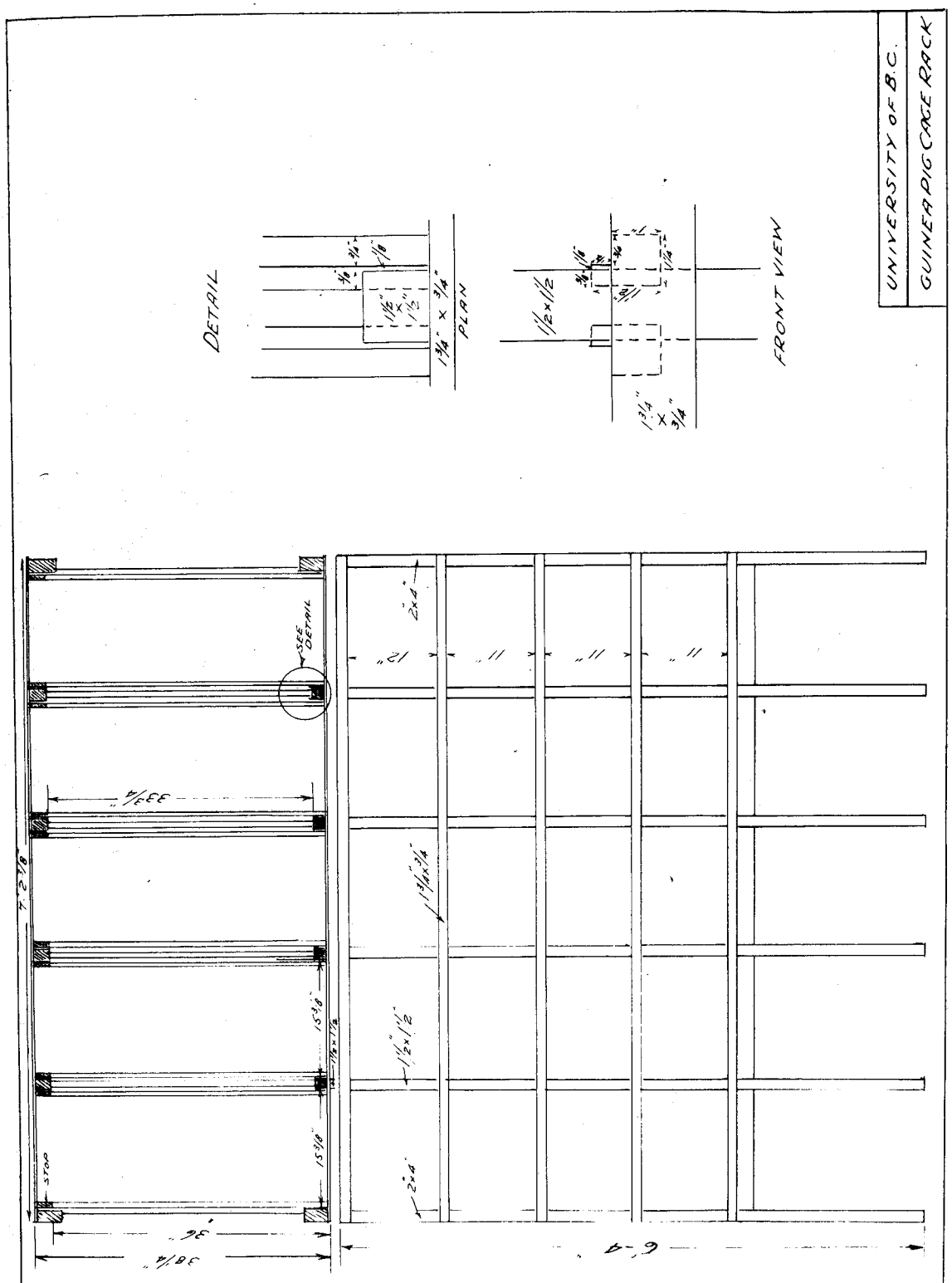

UNIVERSITY OF B.C.
GUINEA PIG CAGE RACK
DETAIL
PLAN
FRONT VIEW
SEE DETAIL
2x4
12"
11"
33 3/4"
15 3/8"
STOP
36"
38 1/4"
6'-9"

FIG. 13

The room is provided with a cold water tap and sink adjacent to the rack. They are situated approximately 9 feet from the farthest row of cages or about 5 steps away, thus enabling the attendant to change the water bottles with a minimum of effort.

The guinea pigs are housed in white painted wooden cages, constructed of 1/2 inch plywood. A layer of wood shavings approximately one inch deep serves as bedding. This amount of bedding averages in weight about 680 grams with an approximate volume of 6000 cc. This cage is illustrated in Figs. 14 and 15 and the dimensions shown in Fig. 16. The maximum capacity recommended per cage is five mature guinea pigs or eight young growing animals. This represents an area utilization per guinea pig of 89 square inches on a room basis, 34 square inches on rack plus cage basis and 98 square inches on cage basis. This type of cage has several features which have proved to be advantageous in the operation of the unit. First of all, the small door or slot at the front of the cage permits the animal attendant to remove the soiled bedding from the cage by means of a scraper while the animals are still in the cage. This procedure is illustrated fairly clearly in Fig.

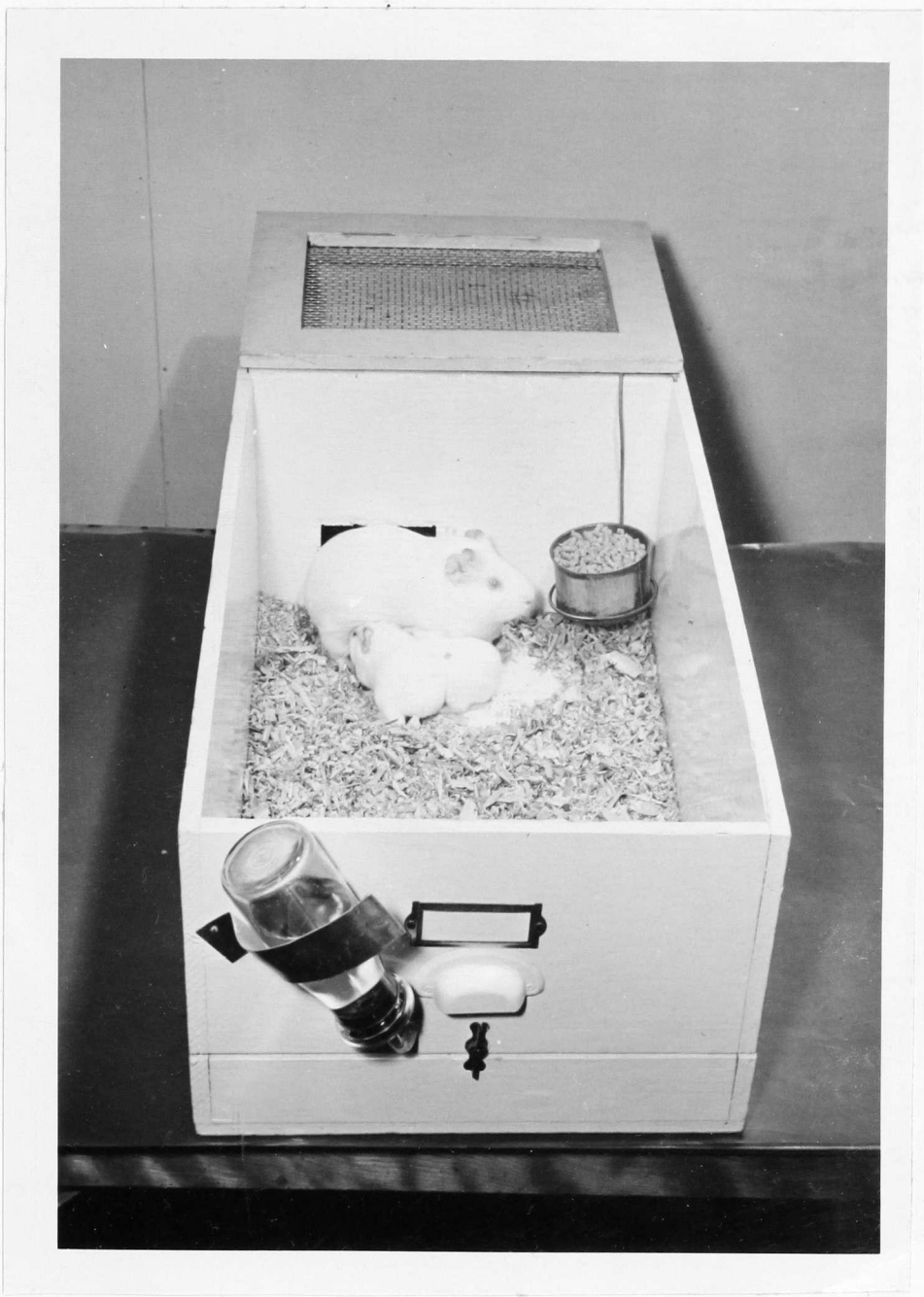


Fig. 14. Standard guinea pig cages showing data card bracket and water bottle.

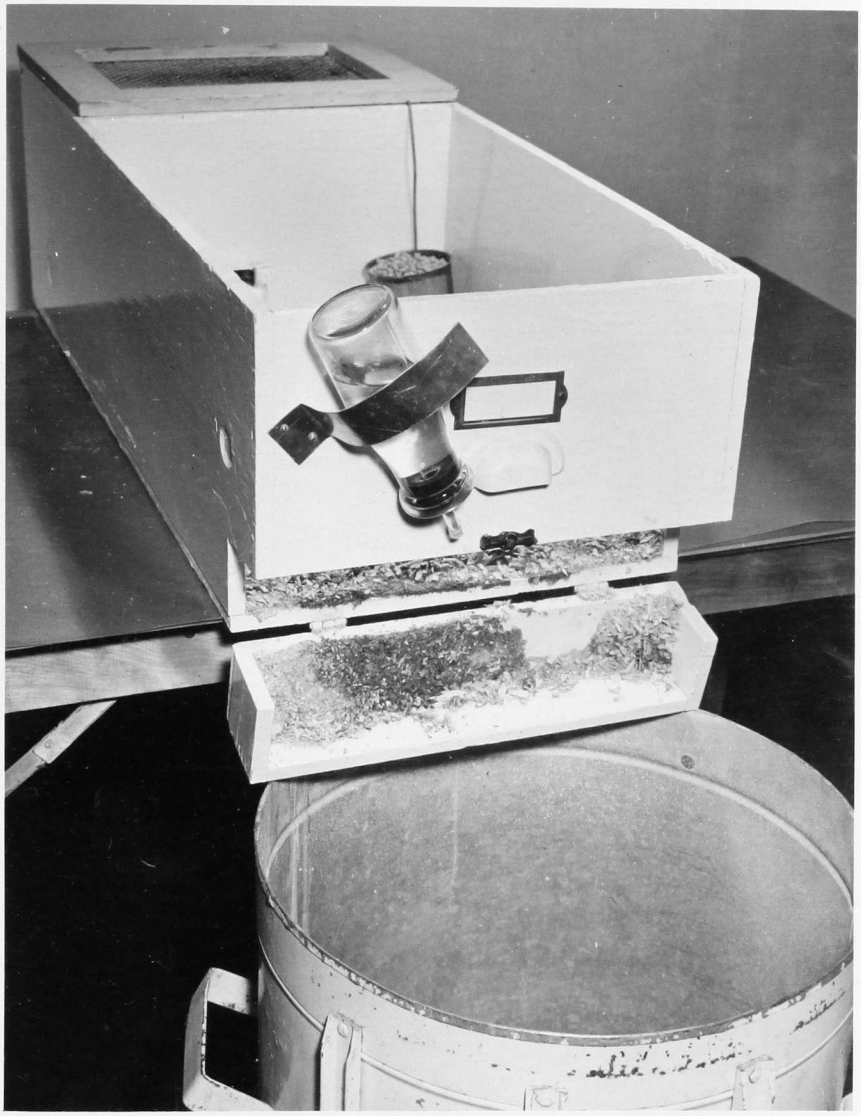


Fig. 15. Standard guinea pig cage showing method of cleaning.

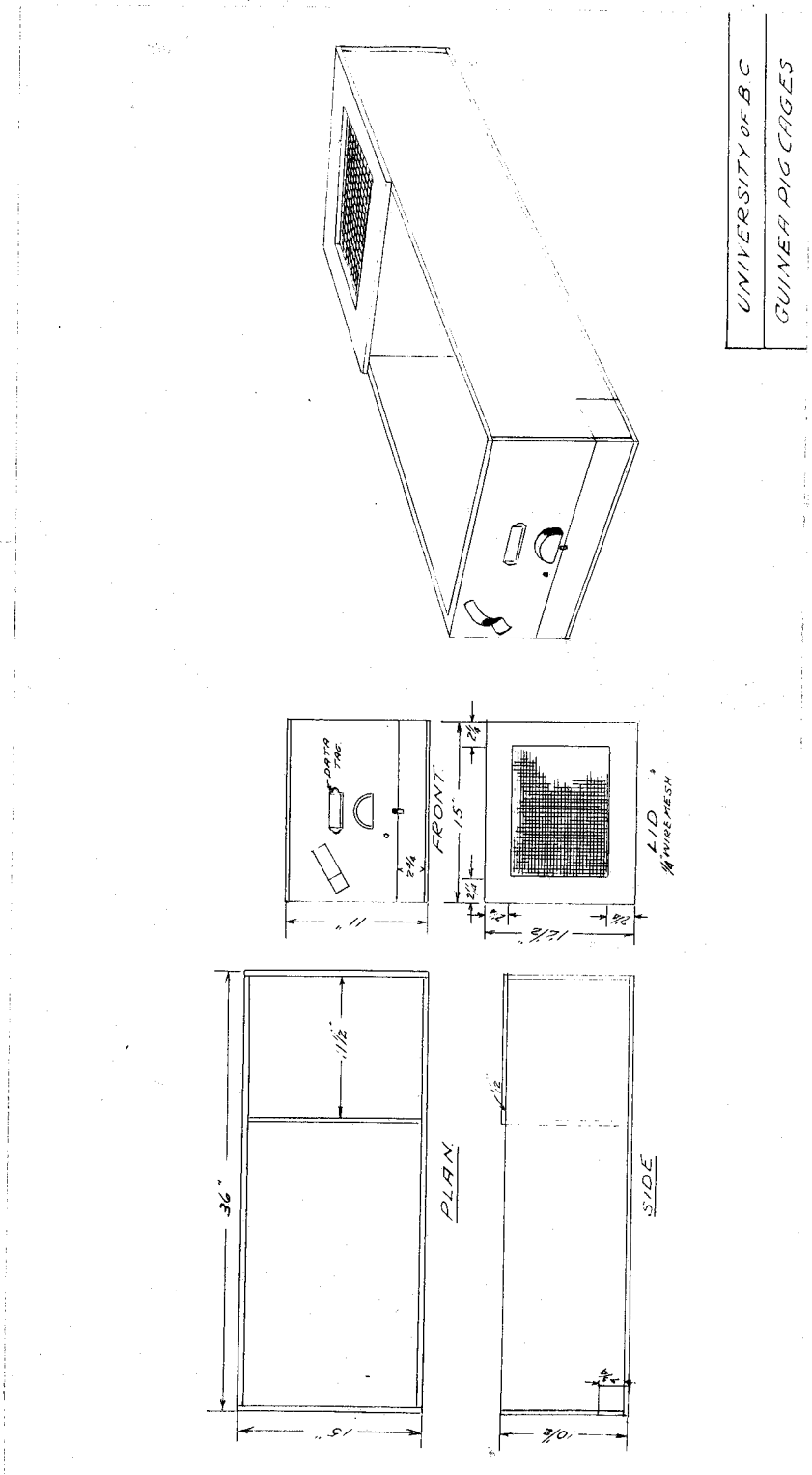


Fig. 16. Scale drawing showing specifications of guinea pig cage.

16. After the cage has been cleaned, fresh shavings are then placed in the cage. Once a week, the guinea pigs are transferred from the dirty cages to clean cages, instead of using the previously described method of removing dirty bedding. The dirty cage is then cleaned and washed with hot water and ammoniated soap and allowed to dry overnight. A second feature of this cage is the partition closing off the part of the cage which permits the guinea pig, particularly a sow with a litter, a place of seclusion. These cages have been in constant use for four years and during that time have been repainted twice. To date, the cages show no signs of deterioration. This type of unit may be open to criticism, on the grounds that it is only possible because it is small. However, the fact that the Suffield Experimental Station successfully operates a unit numbering 4000 sows and their progeny with much the same type of caging, would seem to answer any criticism. The rack and cage they use are illustrated in Figs. 17A and 17B respectively. The important modifications used in this cage are that the floor is sheeted with aluminum and the front wall of the cage acts as a vertically sliding door.

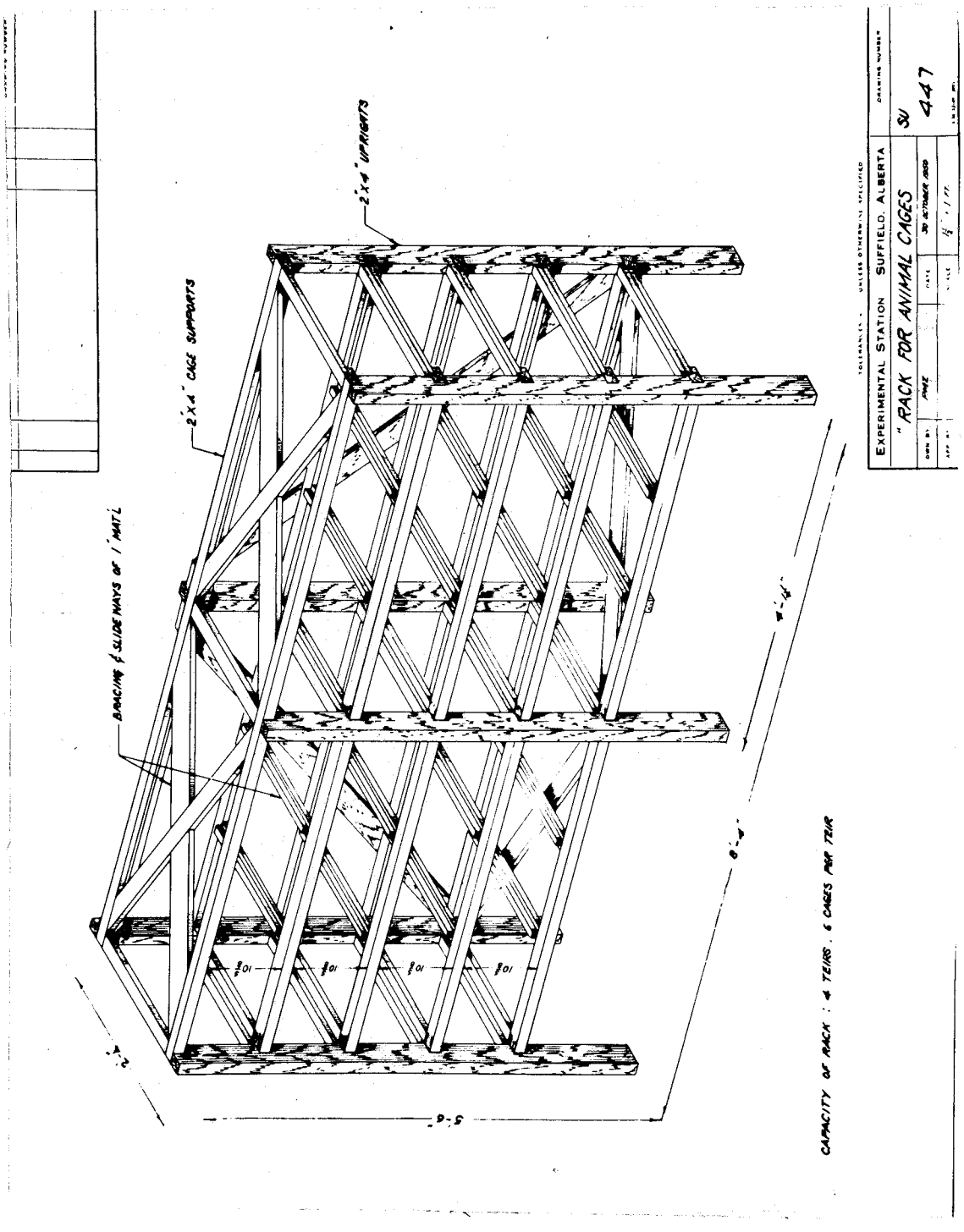
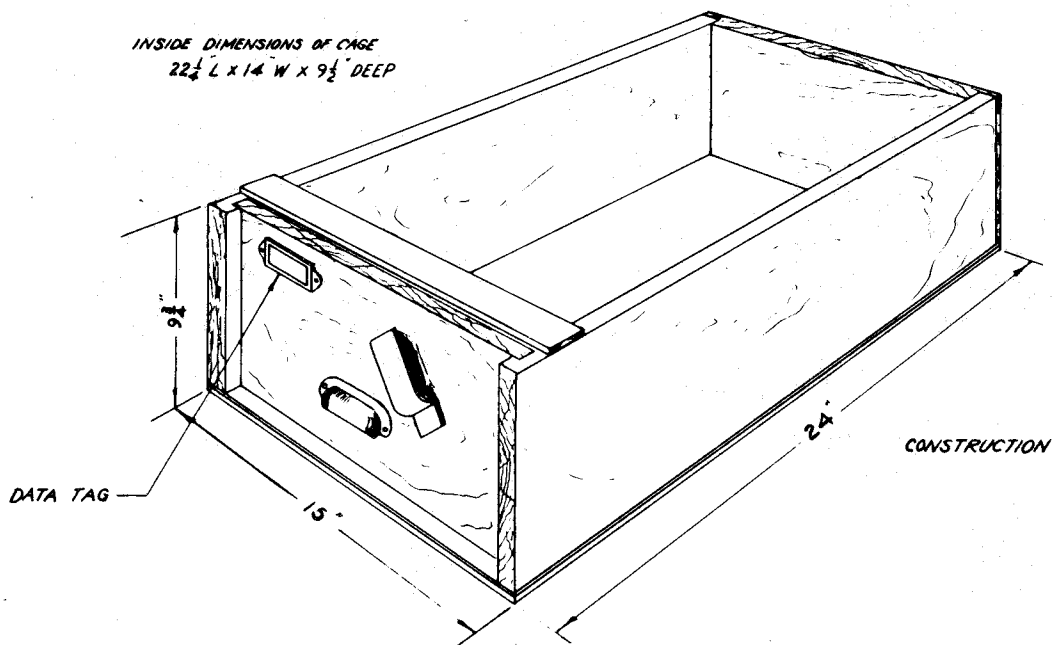


Fig. 17A. Suffield Experimental Station - guinea pig cage rack.

NO.	DATE	REVISION	BY	APP	DRAWING NUMBER



TOLERANCES ± UNLESS OTHERWISE SPECIFIED

EXPERIMENTAL STATION — SUFFIELD, ALBERTA				DRAWING NUMBER
ANIMAL CAGE				SU 448
DWN. BY	PMZ	DATE	31 OCTOBER 1960	
APP. BY		SCALE	¼ IN. = 1 IN.	

Fig. 17B. Suffield Experimental Station - guinea pig cage.

(3) Feeding and Watering

The ration is fed as pellets which are about 1/4 of an inch long and 3/16 of an inch in diameter. (See Appendix III). Small half pound salmon cans serve as feed containers and are hung on the inside of the cage with a piece of stiff wire. The colony is fed and watered daily, feeding being ad libitum. Half pint bottles are used as water containers. They are changed daily and cleaned weekly. In addition to the pelleted ration, the guinea pigs receive fresh green feed every second day about eight months of the year. In the winter months, it is fed less frequently, usually twice a week. The green feed serves as a source of the necessary vitamin C and also as an additional source of vitamin A. The major portion of the green feed consists of kale produced a short distance from the laboratory.

(4) Breeding

All breeding stock are ear-nicked for identification purposes and the breeding history card indexed. In the breeding program practised, a boar is allowed to run with four sows until a sow has farrowed. The sow is not removed from the breeding cage when she appears to be pregnant but is allowed to farrow here with the other mature guinea pigs present in the cage. It has been the experience of this laboratory that by following this procedure, the other sows in the cage assist the sow farrowing, by helping remove the placental membranes from the newborn guinea pigs, thus reducing losses through suffocation. Experience has shown that a sow farrowing in isolation sometimes does not remove the placental membranes in time. This applies particularly when large litters are born. About 12 hours after the guinea pig has farrowed she and her litter are removed to a clean cage and kept in isolation until the litter is weaned at 21 days of age. The female guinea pig comes into estrus a few hours after parturition, consequently by leaving her in the breeding cage for 12 hours after farrowing, it is usually possible

to get her rebred at that time and thus save 21 days, since she will not again come into estrus until her litter has been weaned. When the sow has weaned her litter she is then returned to the breeding cage and the procedure repeated. This system of breeding facilitates continuous production in the guinea pig unit. There has been no evidence to indicate any undesirable effects on the breeding stock or the vigor and growth of the litters resulting from this procedure. The litters are weaned at 21 days and the sexes separated. Future breeding animals are selected on the basis of rapid growth as evidenced by a high weaning weight, and on the ability of the sire and dam to produce large litters. This replacement breeding stock is not used for breeding until they are about two months old.

(5) Control of disease.

Control of disease is directly related to the management practised in the every day husbanding of the colony. This policy includes, keeping the cages clean, washing them with ammoniated soap and washing the water bottles once a week. If an animal appears to be below normal it is destroyed and a post mortem performed to determine the cause of its poor condition. In the four years that the guinea pig colony has been in operation, there has been one serious outbreak of an infection. At that time, approximately half of the total colony population of 40 guinea pigs died. Prior to this outbreak, the colony had been receiving only a limited supplement of green feed and it is felt that this deficiency contributed to the outbreak. Some of the animals were beginning to show signs of a typical vitamin C deficiency, but lack of funds prevented the purchase of green feed.

During the course of the growth study, extending over a period of the last year, one mature guinea pig died at parturition, and a second animal was destroyed because

of poor condition, with the total number of guinea pigs in the unit averaging about 55. It should be stated, that in evaluating this low rate of mortality, very few animals became old, because of the constant demand for guinea pigs for experimental purposes. As a matter of interest approximately 700 guinea pigs have been shipped from this unit to Suffield, Alberta, with no losses. Wood (personal communication) has reported, as a result of experience in the purchase of some 30,000 guinea pigs, that the shipping mortality in this species is largely predetermined by the pre-shipping management of the production unit from which the guinea pigs are purchased. Smith (1951) has reported similar conclusions.

(6) Animal Nutrition Laboratory Growth Data

In order to evaluate the standard of this guinea pig colony, a growth study was conducted. The procedure followed was to weigh the litters at birth and at 21 days of age. After sex determination, each guinea pig in the litter was weighed. The complete data are tabulated in Appendix IVC with a summary of the data recorded in Table 33 along with the data of other investigators.

Table 33 - A Comparison of other Investigator's and the Animal Nutrition Laboratory's Growth Data.

Colony	Litters	Animals	Ave. Lit. Size	Ave. Birth Wt.	Ave. Wean. Wt.	Young Born Alive	Young Raised to Weaning
U.B.C.	24	73	3.0	97.4	250.7[xx]	94%	97.2%
Crampton			3.4	102.			
Eaton	2,241	6,023	2.69	93.4	260.1[x]	92%	81.2%
Haines	-	-	2.58				

x Weaned at 33 days. xx Weaned at 21 days.

The data for Eaton are for non inbred animals used as controls in a breeding experiment. Crampton's data were for animals on a basal diet receiving green feed. He

records the two week gain to be 92 grams. The two week gain for this guinea pig colony is 101 grams. The ration outlined by Crampton will be found in Appendix III.

Table 34 represents a somewhat more detailed summary of the growth data from the Animal Nutrition Laboratory Colony.

Table 34 - Growth Data on Animal Nutrition Laboratory Guinea Pig Unit.

Age in Days	Weight in Grams Heaviest Male	Lightest Male	Ave. Male	Heaviest Female	Lightest Female	Average Female
Birth	147	61	99.6	119	73	95.7
7 days	192	99	143.4	172	108	135.7
14	282	156	205.6	244	151	192.2
21	367	204	256.5	315	194	245.8
33 (Haines)			228.2			220.4

Table 35 - Frequency of Litter Size at Birth

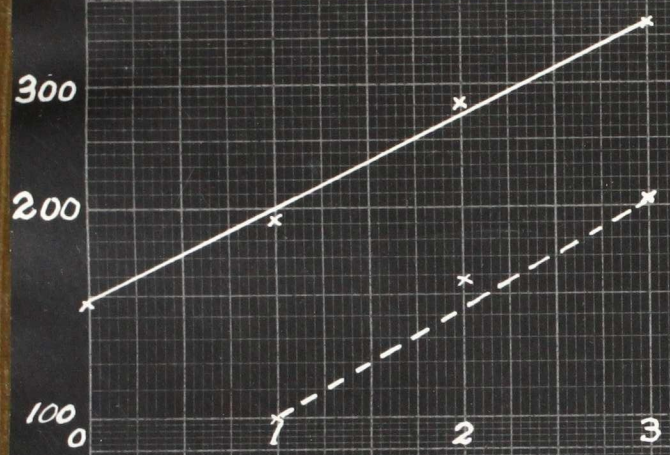
No. in Litter	Distribution of Number of Young in Litter No. of Litter	Per Cent
1	1	1.3
2	5	6.8
3	9	12.3
4	8	10.9
5	nil	
6	nil	
7	1	1.3

The data in Tables 34 and 35 are plotted as shown in Figs. 18 and 19.

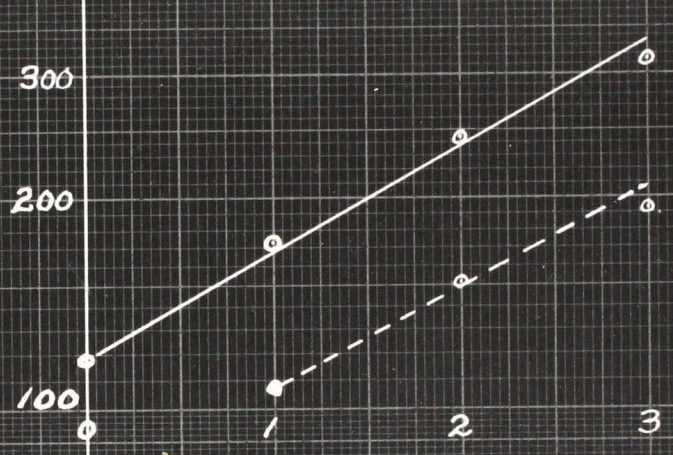
FIG 18 GUINEA PIG – ANIMAL NUTRITION LABORATORY COLONY

TABLE 34 GROWTH DATA

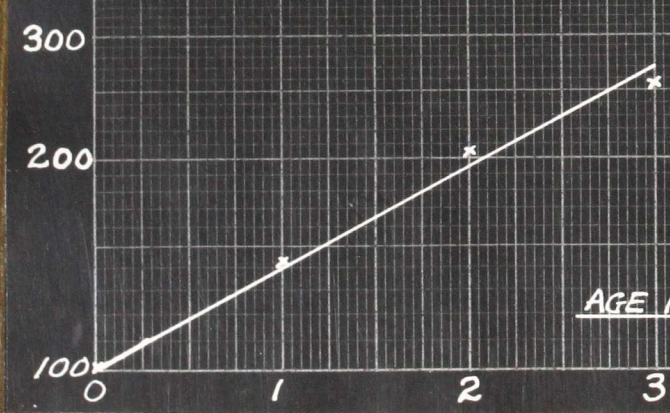
LARGEST AND SMALLEST MALE



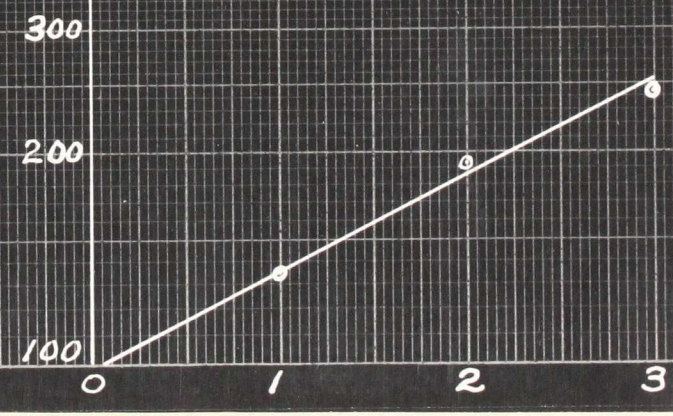
LARGEST AND SMALLEST FEMALE



MEAN OF ALL MALES



MEAN OF ALL FEMALES

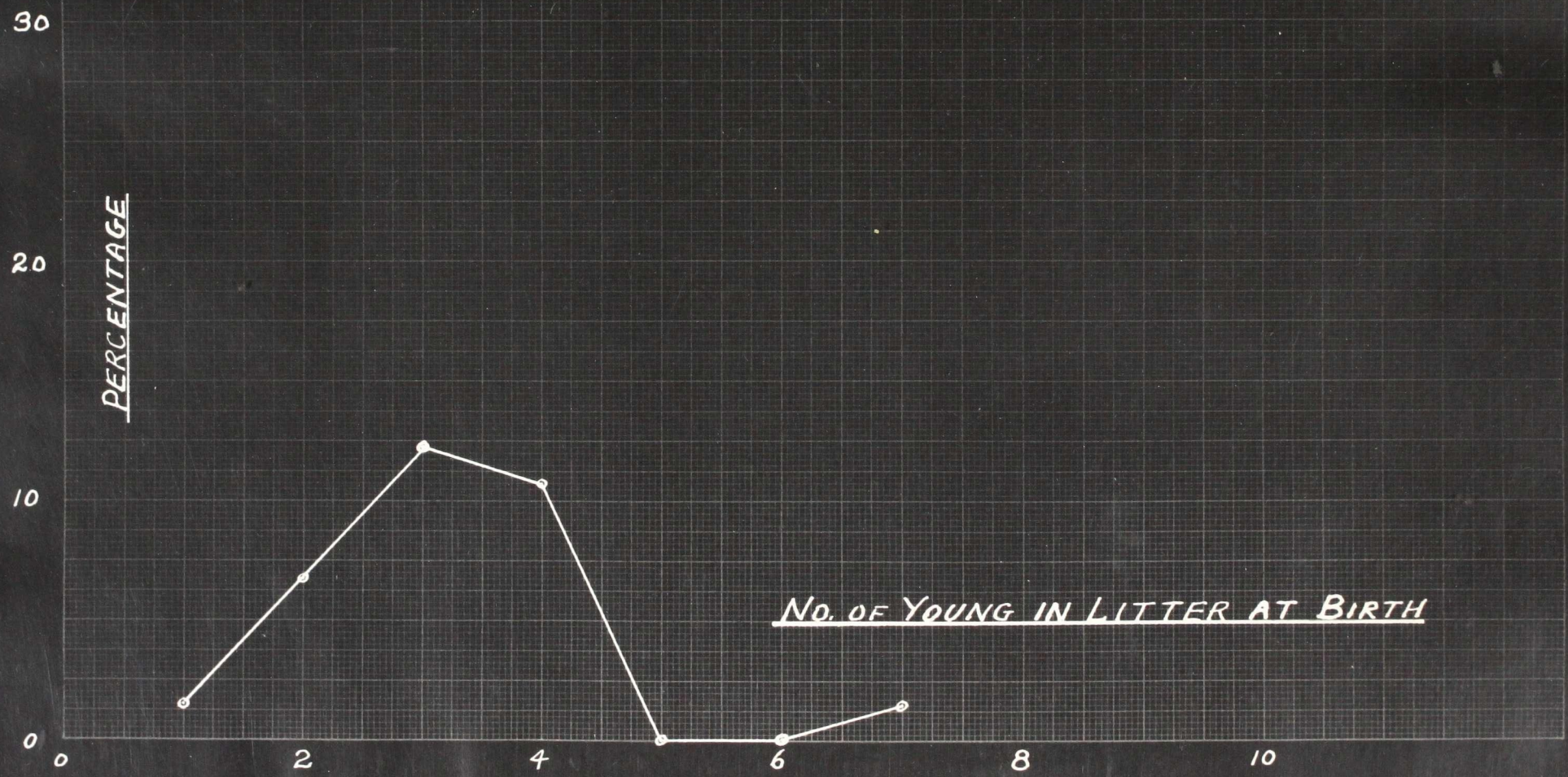


AGE IN WEEKS

BODY WEIGHT IN GRAMS

FIG. 19 GUINEA PIG - ANIMAL NUTRITION LABORATORY

FREQUENCY OF LITTER SIZE AT BIRTH



In order to obtain some post-weaning growth data, four males and seven females selected randomly from four litters were weighed weekly until they were 56 days of age. The complete data are found in Appendix IVC and a summary in Table 36.

Table 36 - Post Weaning Growth Data on the Guinea Pig.

	Age in Days							
	Birth	7 days	14 days	21 days	28 days	35 days	42 days	49 days	56 days
Weight Male	101	141	195	247	310	374	430	502	546
Weight Female	103	136	194	247	303	343	376	441	483

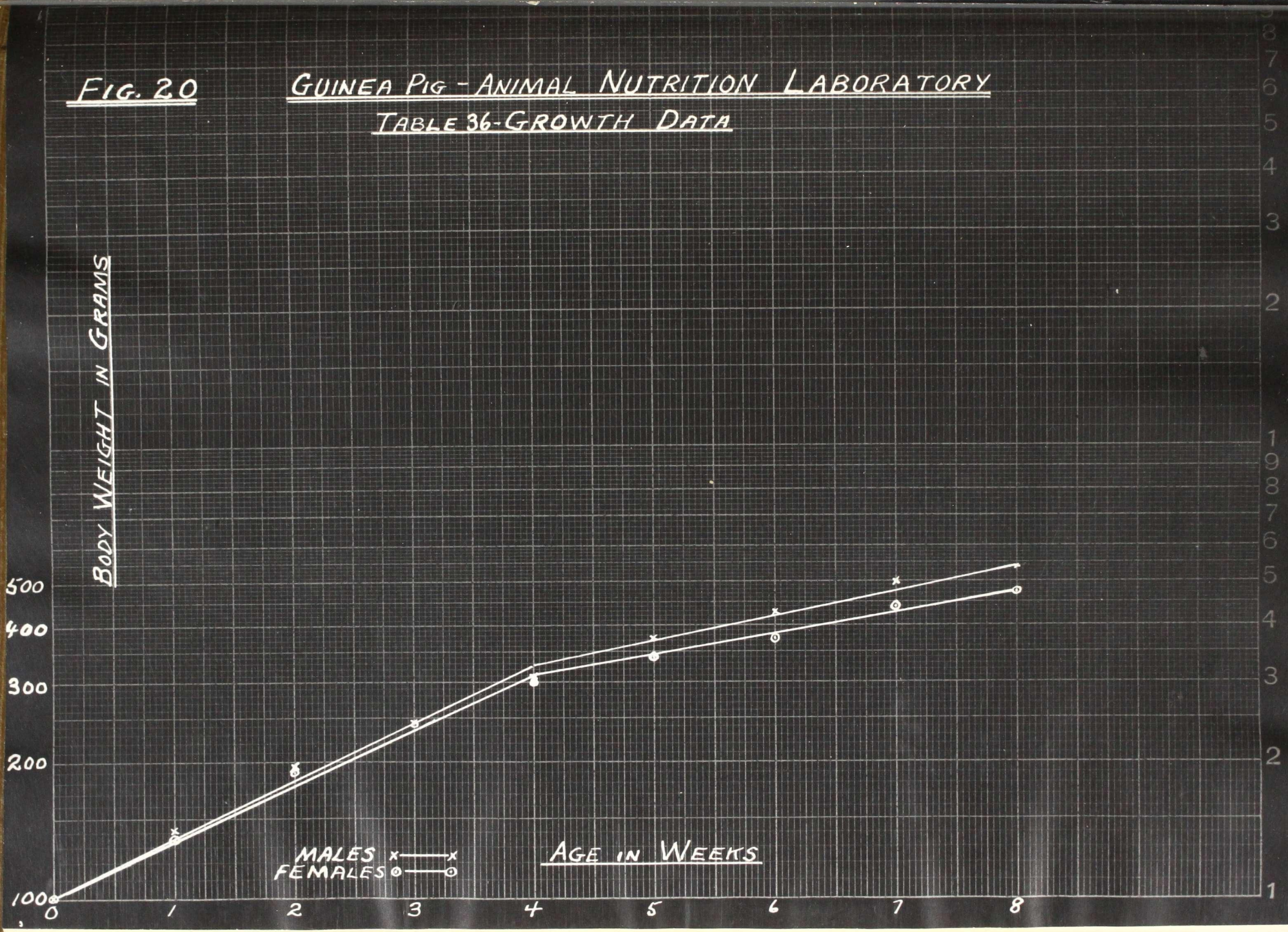
Figure 20 is a plot of the data in Table 36.

It would appear from the data, that the guinea pig unit operated by the United States Department of Agriculture is not up to the standard of the U. B. C. unit if Eaton's data is used as a criterion. The birth weight, average litter size, relative weaning weight and the per cent weaned that are born alive are the factors in which the U. B. C. unit excels the U. S. D. A. unit. Eaton refers to a weaning weight of 260 grams at 33 days of age. The limited data beyond the 21 day weaning age show that the U. B. C. animals are approximately 350 grams at 33 days of age.

FIG. 20

GUINEA PIG - ANIMAL NUTRITION LABORATORY

TABLE 36 - GROWTH DATA



(7) Cost Survey on Guinea Pig Colony.

A cost survey was conducted on the colony similar to those on the mouse and rat. See Appendix V. The cost of greens was so small that it was not included. The average cost per guinea pig per day is as follows:

Labour -	$0.005
Feed -	0.003
Housing -	0.001
Total Cost -	$0.009 per day

D. Animal Nutrition Laboratory Rabbit Unit

(1) Origin

The rabbit unit consists of two breeds, namely the Flemish Giant and the New Zealand White. Because of the rapid turn-over of the rabbits for experimental purposes, it has not been possible to set up a separate breeding colony. As a result, rabbits have been purchased periodically for use as breeding stock or experimental animals. Therefore a breeding program with any definite objectives has not been put into practice. The primary objective in the operation of the colony has been to maintain the animals in optimum condition.

(2) Housing

The rabbits are housed in an unheated barn. Wire cages with expanded metal floors are suspended from two inch pipe supports bolted to the ceiling of the room. This type of caging is well illustrated in Fig. 21. A cage unit consists of two separate cages with a hay feeder. dividing them. The cage unit measures 8 feet long, 2 feet wide and

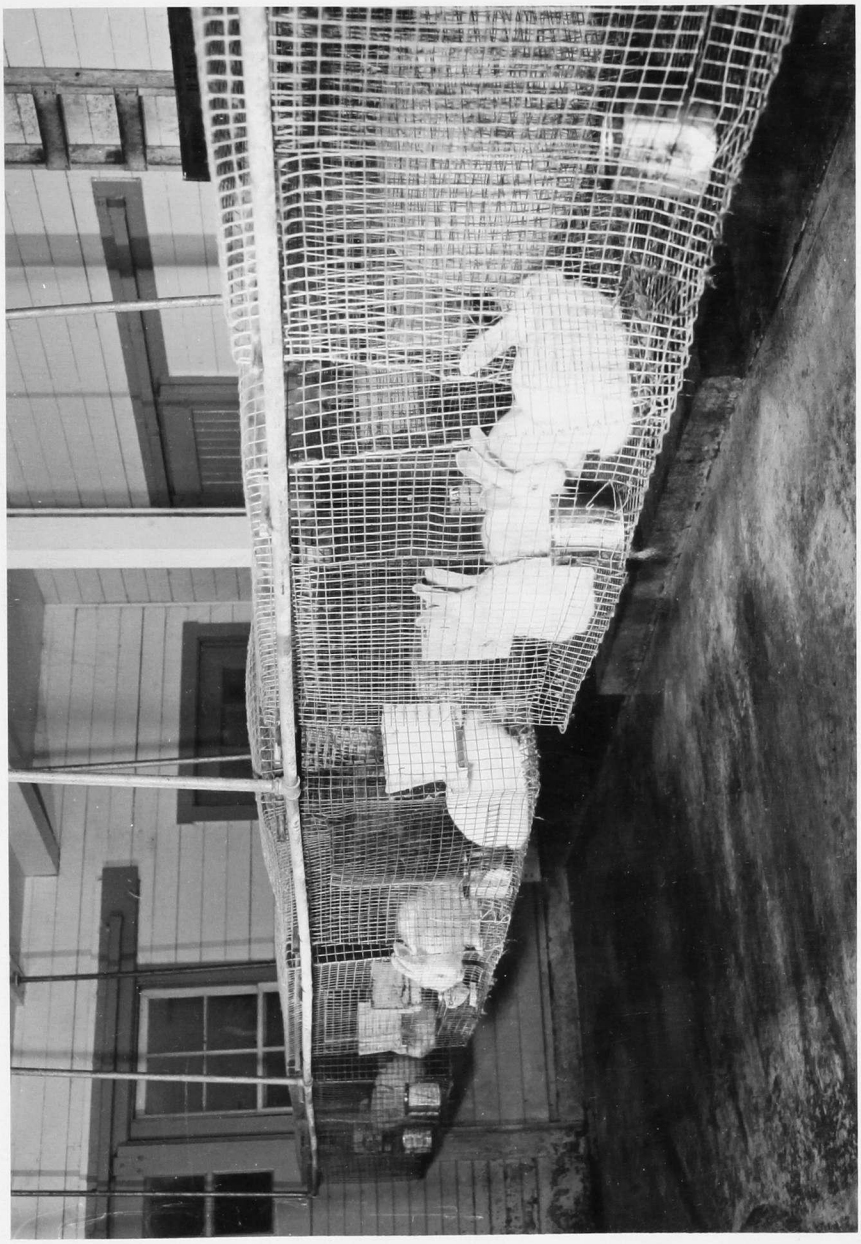


Fig. 21. Standard rabbit cages.

2 feet high, with each compartment being 4 feet long but the same width and height. The maximum capacity recommended is 4 rabbits per section. The breeding does and bucks are provided with small nail kegs as nest boxes. They measure 1 foot, 8 inches long and 1 foot two inches in diameter. The floor of the barn is constructed of concrete, which facilitates the daily removal of droppings passed through the wire floor of the cage. After the floor has been cleaned, it is hosed and the water allowed to drain off the sloping floor through an outlet.

(3) Feeding and Watering

The rabbits are fed and watered daily. They are fed a pelleted ration similar in size to that of the guinea pig. The composition of the ration is given in Appendix III. Every fifth day the rabbits were fed pellets to which sulfaquinoxaline had been added at the o.ol per cent level. One gallon open top jam tins which have a volume capacity of approximately 1500 cc. are utilized as water containers.

(4) Breeding

A planned breeding program is not followed in the rabbit colony, mainly because of the large demand and rapid turn-over of animals. As a result, line breeding is

not practised and there are no attempts to establish a particular family or raise breeding stock. Instead, whenever new or more animals are needed for breeding purposes, they are purchased from other breeders. It is the objective of this laboratory to keep the unit in continuous production throughout the year. Sometimes this is not always possible. For example, during the last three months of 1950, the eleven litters born during that period were destroyed by the does. No reasonable explanation can be offered for these losses, since from the beginning of February, production has been excellent under identical conditions of feeding and management.

Each breeding doe is kept in a separate cage and the litter is not disturbed until they are a week old. At that time, the litter size is recorded and fresh bedding, usually hay, is placed in the nest. The young are weaned at six to eight weeks of age, depending upon the size of the litter. Each breeding buck is housed in a separate cage.

(5) Control of disease.

It is considered, that by the use of the cages with wire floors and good management, disease in the colony is kept to a minimum. While no accurate figures on rate of mortality have been recorded, it is a known fact that the greatest losses occur in the pre-weaning age group, suggesting that the causes are more nutritional than pathological. In fact, the losses of mature animals are extremely rare. It is recognized, however, that the rabbit unit has relatively the highest rate of mortality of the four animal units. Possibly three of the more common troubles of rabbit units are coccidiosis, so called "snuffles" and ear mange. In this colony, coccidiosis does not present a problem, because of the use of the wire-bottomed cage and sulphaquinoxaline. There has been the odd case of "snuffles", but to date no serious outbreak. It is caused by the organism Pasteurella cuniculicida. Ear mange has been the most bothersome problem to keep under control in the colony. It is caused by Psoroptes cuniculi and Choroptes cuniculi, two species of ear-mites. Although

it is not a particularly dangerous infection, it is extremely irritating to the rabbit. The treatment used to eradicate the mite, is to pour a light oil, such as olive oil into the ears of the rabbits, so that the affected areas are well saturated. This control measure needs to be repeated frequently in order to effect a complete cure.

(6) Animal Nutrition Laboratory Growth Data.

Since all the litters in the latter part of 1950 were destroyed, it has not been possible to accumulate as much data as was desired. In addition, all the litters were not weighed until they were a week old, because it was felt that any attempts to secure birth weights might disturb the doe and risk destruction of the litter. The litters were weighed at weekly intervals after the initial weighing and no sex determinations were made. For these reasons, the limited growth data in Table 37 are not to be taken as a standard but more as a guide. If Table 37 does nothing else, it does serve to substantiate the already well known knowledge of the effect of the size of litter on birth weight and subsequent gain in weight with time.

Table 37 - Animal Nutrition Laboratory Growth Data on the Rabbit

No. in Litter	No. of Litters	Average Weight at 7 days	14 days	21 days	28 days	35 days	42 days
3	1	200	413				
4	1	235					
5	1	132	334	496	697	1015	
6	2	188	311	453	781	1096	
7	1	177					
8	1	137	282	568			
9	1	114	219				
12	2	110	182	196[1]	343[2]	441	635
13	1	106	228[3]				

[1] - 11 alive

[2] - 10 alive

[3] - 10 alive

Cost Survey of Rabbit Colony

A cost survey of the colony was made, the detailed results of which appear in Appendix V. The housing cost was not calculated because of the difficulty in estimating the "life" of the wire cages. The average cost per rabbit per day is as follows:

Labour -	$0.017
Feed -	0.007
Total cost -	$ .024 per day

III

Summary and Conclusions

A study has been made of the small animal units of the Animal Nutrition Laboratory of the Department of Animal Husbandry. These units included the rat, the mouse, the guinea pig and the rabbit. The study was undertaken to ascertain if the animals produced in these units are comparable, with respect to productivity and growth rate, to the animals produced by similar laboratories elsewhere. In addition, details of the housing and management practices followed have been described. This has not always been done by other investigators. Such a description seemed justified for two reasons:

(1) The productivity of any animal unit, laboratory or domestic, is in a large measure determined by the management practices followed in its operation. They have been included in the present work, so that the production and growth data may be more readily assessed.

(2) In the writer's experience, the establishment of a small animal colony is attended by many minor difficul-

ties associated with its day to day operation. The methods used in this colony were recorded in detail, in the hope that others might resolve their minor problems at the outset.

Table 38 - Optimum Growth Data of Other Investigators Compared to Animal Nutrition Laboratory Mean Growth Data.

	RAT		MOUSE		GUINEA PIG	
	Others[1]	A.N.L.[2] Ave	Others[1]	A.N.L. Ave.	Others[1]	A.N.L. Ave
Per Cent Fertility	93.3	73.1	97	88		Not Recorded
No. Young Born		1766	512	258	6,025[4]	73
Ave. Size Litter	9.6	9.9	7.4	7.2	3.4[5]	3.0
No. Young Weaned		1672	435	242		
Per Cent Weaned	90	94.6	85	94.5	81.2[4]	97.2
Average Birth Weight)M	5.6	5.4[3]				99.6
Average Birth Weight)F	5.3	5.5				95.7
Average Birth Weight)L		5.44	1.38	1.38	102[5]	97.4
Average Weaning Weight)M	48.0	33.4				256.5
Average Weaning Weight)F	47.0	31.6				245.8
Average Weaning Weight)L		33.6	10.5	10.3	260	250.7

[1] Represents the optimum results reported in the literature by other investigators.

[2] Abbreviation for Animal Nutrition Laboratory

[3] Birth and weaning weights are for Sherman strain rats

[4] Represents Crampton's data

[5] Represents Eaton's data - weaned at 33 days

Table 38 represents a summary of the optimum data reported by all other investigators compared to the results recorded in this laboratory.

From the data presented, it is concluded that the Animal Nutrition Laboratory rat colony excels in litter size at birth and percentage weaned but is slightly lower in percentage fertility and overage weaning weight.

The mouse colony also excels in litter size and percentage weaned, but is only average in fertility and weaning weight when compared with other mouse colonies.

On the basis of the limited production and growth data reported in the literature, the Animal Nutrition Laboratory guinea pig colony recorded nearly comparable birth weights and a heavier weaning weights. The percentage weaned was also higher than that reported.

The growth data of this rabbit colony was not considered to be representative enough to make possible valid conclusions with respect to its efficiency. It is evident that much improvement is needed in this unit.

The present work may be criticized on the grounds that a statistical interpretation has not been applied to

the results recorded. This point was recognized, but it was felt that much more data should be accumulated over a more extended period of time before such an analysis is carried out. Future studies should be conducted on the post-natal nutrition of the mouse and the nutritional aspects of fertility in the rat and mouse as produced in this colony.

APPENDIX I

Some of recent texts published within

period 1945 - 1950 inclusive

Farris, E. J., (1950) "The care and breeding of laboratory animals", John Wiley and Sons, New York.

Farris, E. J., and Griffith, jr, J. Q., (1949) "The rat in laboratory investigation". J. B. Lippincott Co., Philadelphia.

Snell, G. D., (1941) "Biology of the laboratory mouse". The Blakiston Co., Philadelphia.

Worden, A. N., (1947) The U.F.A.W. Handbook, the care and management of laboratory animals, Bailliere, Tindall and Cox, London.

APPENDIX II

SPECIFICATIONS OF ELECTRIC FAN

Manufacturer of Fan - Canadian Sirocco Co.
Windsor, Ont.

Cat. 118H
No. C26132B

Size 17 Vent Free Air - 2400 C.F.M.

Since the fan is operated for 15 minutes of every hour, the volume of air changed equals 36,000 cubic feet per hour. The volume of the three animal rooms and a stock room is as follows:

Room	Volume - Cu.Ft.
Rat	1079
Mouse	752
Guinea Pig	620
Stock	1079
Total	3530 cu. ft.

The total room volume of 3530 cubic feet and a volume air change of 36000 cubic feet represent 10 air changes in all rooms every hour.

Manufacturer of Electric Motor - General Electric Co.

Model 11F840 Type K8
Fr. - 47 A 3.6
Cy. 60 R.P.M. 1725 V.110
P.H. 1 H.P. 1/4

APPENDIX III A - RAT RATIONS

U. B. C. Ration 6 - Rats and Mice

	POUNDS
Ground Wheat	653
Rolled Groats	200
Corn Meal	300
Wheat Flakes	400
Soyabean meal	25
Pilchard Oil	7
Dog Meal Pre-Mix	415
	2000

Dog Meal Pre-Mix	Pounds
Iodized Salt	10
Meat Scraps	685
Fish Meal (71%)	360
Powdered Skim Milk	100
Carragrass	120
Wheat Germ Meal	60
Rice Feed	250
	1585

U. B. C. Ration 10 - Rats and Mice

	Pounds.
Wheat Flakes	450
Wheat Bran	45
Fish Meal (70%)	50
Wheat Germ Meal	75
Powdered Skim Milk	50
Dried Yeast	10
Apple pomace	30
Beet pulp	30
Oats ground	40
Meat scrap	75
Soya meal	75
Liver meal	50
Bone meal	10
Carragrass	5
Salt	5
	1000

Computed Analysis	
Protein	25%
Fat	6%
Fibre	4%

DONALDSON

Milk soaked bread plus corn as staple.

JACKSON (1913)

A supply of chopped corn was kept constantly in cages. A liberal amount of wheat bread soaked in whole milk was supplied daily, and fresh meat (beef) once a week.

SHERMAN AND MUHFIELD (1922)

	Diet A	Diet B
Whole Milk	1/6	1/3
Ground Whole Wheat	5/6	2/3

NaCl 2% of weight of wheat in each case.

OSBORNE AND MENDEL (1926)

	Per Cent
Casein	35
Salt Mixture	4
Starch	37
Butterfat	9
Lard	15

Yeast 0.2 grams daily

Lettuce 40 grams daily

MACY, OUTHOUSE, LONG and GRAHAM (1927)

Whole Wheat 2/3

Whole Milk Powder 1/3

MaCl to the amount of 2% of the wheat

Fresh cabbage or lettuce six days a week

Lactating rat - augmented by fresh cow's milk ad libitum.

SMITH and BING (1928)

Ground Whole Wheat 2/3

Dried Whole Milk 1/3

NaCl to the amount of 2% of the wheat

They found it advantageous to replace half of the added sodium shloride with an equal weight of calcium carbonate giving a Ca to P ratio of 1:1.16

Fresh lettuce fed daily

Lactating rats receive 9 grams of dried yeast per week.

MAYNARD (1930)

G. L. F. Calf Meal

	Pounds
Linseed oil meal	300
Ground malted barley	200
Wheat red dog flour	440
Dried skim milk	300
Oat flour	300
Yellow corn meal	400
Steamed bone meal	20
Ground limestone	20
Salt	20
	2000

Cod liver oil is fed twice a week, mixed in as 3 per cent of the days food. No green feed is supplied.

FREUDENBERGER (1932)

Casein	15%
Whole Milk Powder	10%
Sodium Shloride	0.8
Calcium Carbonate	1.5
Butter (unsalted)	5.2
Whole Ground Wheat	67.5
	100.

5% dried yeast is also added to diet of mother rats while nursing.

ANDERSON and SMITH (1932)

The following dry ration (97%) was mixed with 3% cod liver oil.

	Per cent
Linseed oil meal	15
Corn meal	20
Barley-ground malted	10
Red dog flour	22
Dried skim milk	12
Oat flour	15
Soluble blood meal	3
Sodium chloride	1
Ground limestone	1
Steamed bonemeal	1

Moisture content of air dry mixture - 57%
Protein - 22.1%
Calcium - 0.92%

In addition a paste food containing

Whole milk powder	25%
Casein	25%
Wheat embryo	20%
Lard	30%

was freely available at all times.

Moisture	2.2%
Protein	34.9%
Calcium	0.27%

Each rat received 20 grams lettuce per diem and 3 grams of dried yeast twice a week.

MENDEL and HUBBELL (1935)

G. L. F. Calf Meal - 97%

Cod Liver Oil - 3%

Nursing mothers and young rats under 6 weeks of age receive in addition a "paste food" consisting of:

	per cent
Casein	25
Whole Milk Powder	25
Wheat Embryo	20
Lard	30

Each rat receives 1 gm. of dried yeast daily except Sunday.

THOMSON - STOCK DIET (1936)

	per cent
Wheat offal (fine middlings No.2.)	19.2
Ground wheat	19.2
Ground oats	19.2
Ground barley	9.5
Ground maize	9.5
Meat and bone meal (45% protein)	9.5
Dried skim milk	7.0
White fish meal (60% protein)	4.7
Dried yeast (40% protein)	1.2
Sodium chloride	0.5
Cod liver oil	0.5

Dig. Protein	14.9 per cent
Calcium	1.18
Phosphorous	0.99
or Ca:P ratio	1.19

The colony is fed the stock ration plus 5 grams of green feed usually kale. In addition 10 ml. of separated milk fed per growing rat.

ZUCKER (1942)

	per cent
Ground yellow corn	15
Ground hulled barley	15
Ground shelled oats	15
Ground whole wheat	15
Soyabean meal	15
Meat scrap	10
Whole milk powder	10
Alfalfa leaf meal	2
Sodium chloride	2
Calcium carbonate	0.8
Molasses (as binder)	0.5
	100.

MAYNARD and RASMUSSEN (1942)

	Low Fat Stock Ration per cent	High Fat Stock Ration per cent
Linseed meal	15	15
Yellow corn meal	20.875	12.86
Ground malted barley	10	10
Wheat red dog flour	22	22
Oat flour	15	15
Dried skim milk	12	12
Soluble blood flour	3	3
Salt	1	1
Steamed bone meal	1	1
Cod liver oil	0.125	0.14
Casein		1
Corn oil		7

	Per Cent	
Protein	23.83	Cal. per gram 3.30
Fat	4.50	

The cod liver oil used contained 800 A.O.A.C. chick units of vitamin D and 6000 I. U. of vitamin A per gram.

VINSON AND CERECEDO (1943)

Purina Dog Chow	per cent
Protein	26.86
Fat	6.28
Fiber	4.44
Ash	7.33
Calcium	1.38
Phosphorous	0.96

LOOSLI (1944)

	Grams		
Casein	20	20	20
Yeast (extracted)	5	5	5
Corn Starch	25	30	35
Sucrose	11.3	17	23.4
Bone meal (extracted)	2	2	2
Salts (Hawk and Oser)	3	3	3
Choline	0.1	0.1	0.1
Cystine	0.2	0.2	0.2
Fat (in form of Corn Oil)	15	10	5
	81.6	87.3	93.7
Per Cent			
Protein	23.3	21.6	20.4
Fat	19.2	11.3	5.5
Ash	5.4	5.8	4.6

DEUEL (1945) - Modified Sherman Diet

	per cent
Skim milk powder	23.76
Margarine fat	9.24
Ground whole wheat	66.0
Sodium chloride	1.0

The skim milk powder contained 1.1% lipid. An assay showed the margarine to have between 12,000 - 15,000 I.U. vitamin A per pound. Adequate quantities of vitamins D and E were present in the fat. This proportion of added margarine fat gives the fat content equivalent to that which would be present if 33% whole milk powder containing (28% fat) were used. Five grams of lean meat and lettuce once weekly were fed to each rat after weaning.

DEUEL (1947)

	per cent
Ground whole wheat	34
Ground steel cut oats	34
Skim milk powder	15
Cottonseed oil containing 1600 I.U. vitamin A 160 I.U. vitamin D	10
Alfalfa leaf meal	4
Dry yeast (Anheuser-Busch strain G)	2
Sodium Chloride	0.5
Calcium carbonate	0.5
Fat	14%

IIIB MOUSE RATIONS

Robertson Mouse Ration. (1916)

Rolled barley

Mixed white and yolks of eggs are supplied daily.

Fresh leaves of lettuce were supplied twice weekly.

Sundays - thoroughly dried bread.

The whites and yolks of eggs are beaten together and strained, 5 cc. of mixture being supplied to six mice.

Parkes Mouse Ration (1926)

Bread and Milk)
Crushed Oats) plus periodic vegetable food.
Millet)

MacDowell (1930)

Fresh milk

Spratts Cod Liver Oil Dog Food

Bread soaked in water

Oats

Hemp

Canary seed.

Cerecedo and Vinson (1944)

Stock Diet A - Purina Dog Chow

Stock Diet B

Ground oats	50
Brewers yeast	10
Whole milk powder (Klim)	15
Sodium chloride	1.2

They were also fed lettuce and fresh liver once a week.

Constituents of Diet	Stock Diet No.77 Morris	Stock Diet (Thompson & Mendel)
Skim-Milk Powder	22.75 Grams	20 grams
Casein		24
Ground Whole Wheat	61.52	
Brewers Yeast (Dried)	4.00	2
Starch		20
Salt Mixture		4
Butterfat		32
Cod Liver Oil	2.00	
Salt	1.40	
Ferric Citrate	.13	
Corn Oil	8.20	
	100	102

Calculated Composition

Protein	19.6%	31.3%
Fat	11.7	29.3
Carbohydrate	62.7	30.2
Ash	4.8	4.5
Water		4.6

Bruce Ration

	Per Cent
Wholemeal Flour	50
Dried Full-Cream Milk	27
Dried Yeast	12
Meat and Bone Meal	6
Cod Liver Oil	3
Sodium Chloride	1
Calcium Carbonate	1

Calculated Composition

Dig. Prot.	19.3%
Dig. Fat	11.6
Dig. Fibre	0.5

III GUINEA PIG RATIONS

U.B.C. Ration 8 - Guinea Pigs

	Pounds
Rolled Oat flour	450
Flaked Wheat	140
Flaked Barley	200
Wheat Bran	350
Carragrass	100
Beet Pulp	80
Cocoanut Meal	200
Soyabean Oil Meal	175
Oil Cake Meal	250
Mineral Pre-mix	50
Sodium Chloride	20
Vitamin D_2 Pre-mix	.25
	2010.25

Computed Analysis

	Per cent
Protein	20
Fat	3
Fibre	8

Guinea Pig Ration by Crampton

The basal diet fed, known as the MacDonald V diet.

Constituent	Per Cent
Oats	15.0
Wheat	13.0
Beet pulp	25.0
Oilmeal	12.5
Skim milk	15.0
Fish meal	5.0
Brewers dried yeast	10.0
Bone char	4.0
Salt (o.1% KI)	0.5
	100.0

IIID Rabbit Ration

U.B.C. Ration 12 - Rabbits

	Pounds
Oats	400
Wheat	175
Barley	200
Bran	350
Dried Grass	100
Beet Pulp	80
Copra meal	200
Soya meal	175
Oil Cake meal	250
Irradiated Yeast	2
Colony minerals	50
Salt	18
	2000

This ration has been pelleted with sulphaquinoxaline for coccidiosis control.

APPENDIX IV A

GROWTH DATA ON ANIMAL NUTRITION LABORATORY RATS

Female No.	Age of Female	Number Born	Stillborn	Number in Litter at 7 days	14 days	21 days	28 days
Wistar Outbred							
C1	181	16		15	14	14	14
C3	183	10		10	10	9	9
C4	181	10		9	9	9	9
C5	182	10		10	10	10	10
C6	184	14		12	12	12	12
C7	180	7	3	7	7	7	7
C8	180	12		12	12	12	12
C9	182	8		8	8	8	8
C10	182	17	1	15	15	15	15
C11	184	7	1	7	7	7	7
C12	184	12		12	12	12	12
C13	185	11	1	10	10	10	10
C14	186	12		12	12	12	12
C15	186	12		12	12	12	12
Total		158	6	151	150	149	149
Ave.		11.3		10.0	10.0	9.9	9.9
Wistar Inbred							
P.F.XII-11-1	177	11		11	11	11	11
P.F.XII-11-2	179	13		12	11	11	11
P.F.XII-11-3	177	12		12	12	12	12
P.F.XIII-11-5	178	15		15	15	14	14
P.F.XII-1A-1	106	12	3	11	10	10	10
P.F.XII-1A-2	107	13		13	12	12	12
P.F.XII-1A-3	112	13	1	12	12	12	9
P.F.XII-1A-4	112	16		16	15	13	13
P.F.32-41-21-2	140	10		10	10	10	10
P.F.32-41-21-3	143	11		11	11	11	11
P.F.32-41-21-4	144	13		13	13	13	13
P.F.32-41-21-5	143	15		15	15	13	13
P.F.32-41-3x-3	177	11	1	11	11	11	11
P.F.32-41-3x-4	182	11		11	11	11	11
Total		176	5	173	169	164	161
Ave.		12.5		12.3	12.0	11.7	11.5
Overall Total		334	11	324	319	313	31.0
Overall Ave.		11.9		11.6	11.4	11.2	11.1

APPENDIX IV A - Continued

Weight of Litter at					Sex Ratio at 21 Days	
Birth	7 days	14 days	21 days	28 days	M	F
81	135	212	348	538	10	4
62	120	185	295	515	4	5
60	111	212	356	562	4	5
55	115	208	317	520	4	6
76	134	238	382	664	6	6
47	109	204	333	541	3	4
69	151	273	417	659	8	4
51	116	212	332	529	2	6
91	135	253	381	576	8	7
42	93	186	292	490	3	4
63	124	231	390	677	4	8
55	87	177	298	513	5	5
65	124	208	314	538	8	4
60	126	242	384	645	8	4
877	1680	3041	4839	7967	77	72
5.55	11.1	20.3	32.4	53.4		
59	104	204	329	536	8	3
76	131	224	357	591	6	5
68	130	241	376	516	7	5
74	134	253	345	590	5	9
60	108	200	316	523	4	6
67	116	195	296	496	5	7
68	120	210	254	455	3	6
86	179	299	440	704	7	6
60	118	216	339	589	5	5
64	138	254	424	712	6	5
71	149	280	461	754	10	3
85	167	279	405	662	8	5
58	110	195	317	535	5	6
63	136	255	415	701	6	5
956	1840	3305	5074	8364	85	76
5.34	10.6	19.55	30.9	51.9		
1833	3520	6396	9913	16331	162	148
5.48	10.86	20.0	31.7	57.7		

Wistar IIA

Female No.	Age of Female	Number Born	Number Still-born	Number in Litter at 7 days	14 days	21 days
P.F.XII-11-51-4	330	6		6	6	6
P.F.XII-11-51-5	332	9		9	9	9
P.F.32-41-21-21-1	272	11		11	11	11
P.F.32-41-21-21-3	270	8		8	8	8
P.F.32-41-21-31-5	331	6		6	6	6
P.F.32-41-3x-31-2	364	13		13	13	13
P.F.32-41-3x-31-4	363	10		10	10	10
P.F.32-41-3x-31-5	364	11		11	11	11
P.F.32-41-3x-41-1	267	11		11	11	11
P.F.32-41-3x-41-5	267	12		12	12	12
Total		97		97	97	97
Average		9.7				

Wistar IIB

P.F.32-41-21-21-4	301	10		10	10	10
P.F.32-41-21-31-1	363	9		7	7	7
P.F.32-41-21-31-4	362	4		4	4	4
P.F.32-41-3x-31-4	402	13		13	13	13
P.F.32-41-3x-31-5	404	8		7	7	7
P.F.32-41-3x-41-2	296	11	1	10	10	10
P.F.32-41-3x-41-3	300	3	1	3	3	3
Total		58		54	54	54
Average		8.2				

Wistar IIC

P.F.XII-11-51-5	408	6		6	6	6
P.F.32-41-21-21-1	347	6		6	6	6
P.F.32-41-21-31-4	409	7		6	6	6
P.F.32-41-21-31-3A	345	4		3	3	3
P.F.32-41-3x-31-3	443	8		6	4	4
P.F.32-41-3x-41-4	344	9		7	7	7
Total		40		34	32	32
Average		6.6				
Overall Total		195		185	183	183
Overall Average		8.47				

Weight of Litter at				Sex Ratio 21 days	
Birth	7 days	14 days	21 days	M	F
39	89	177	294	4	2
49	111	202	318	7	2
70	132	219	346	9	2
49	102	184	249	4	4
37	83	138	232	3	3
72	142	232	314	5	8
55	94	191	267	7	3
63	136	247	357	7	4
60	114	214	329	5	6
79	162	258	426	5	7
573	1165	2062	3132	56	41
5.9	12.0	21.2	32.2		
56	107	200	303	3	7
46	80	135	217	5	2
26	69	125	210	2	2
71	137	226	330	5	8
58	123	203	321	6	1
61	135	243	385	4	6
18	57	106	161	-	3
336	708	1238	1927	25	29
5.7	13.1	22.9	35.7		
42	90	167	258	3	3
38	83	141	223	5	1
38	96	177	243	4	2
21	31	50	88	1	2
41	64	97	156	3	1
53	114	179	266	4	3
233	478	811	1234	20	12
5.8	14.0	25.3	38.6		
1142	2351	4111	6293	101	82
5.85	12.7	22.5	34.4		

Sherman I — Appendix IV A -Continued

Female No.	Female's Age (days)	Number Born	Number Weaners (21days) M	F	T	Weight at Weaning M	F	T
Gp.I W1	Age	9	3	6	9	113	192	305
W2	Unknown	7	2	4	6	61	105	166
W3		13	9	4	13	370	161	531
W4		9	4	5	9	161	188	349
W5		1		1	1		31	31
Gp.II W1		9	6	3	9	202	90	292
W2		11	6	5	11	210	150	360
W3		7	2	5	7	104	253	357
W4		9	4	5	9	149	181	330
W5		9	6	3	9	234	109	343
Gp.III W1		7	4	3	7	137	104	241
W2		9	5	4	9	173	143	316
W3		11	5	6	11	146	164	310
W4		6	1	5	6	42	211	253
W5		14	8	6	14	320	236	556
Gp.IV W1		7	4	3	7	170	122	292
W2		11	6	5	11	207	158	365
W3		10	4	6	10	143	209	352
W4		10	6	4	10	211	168	379
W5		12	3	9	12	102	286	388
Gp.V W1		10	5	5	10	188	177	365
W2		7	3	4	7	136	164	300
W3		9	4	5	9	176	197	373
W4		13	7	6	13	223	185	408
W5		10	3	7	10	95	220	315
Gp.VI W1		10	2	6	8	57	210	267
W2		10	4	6	10	166	242	408
W3		14	6	7	13	192	216	408
W4		4	1	3	4	46	130	176
W5		13	7	6	13	211	169	380
Gp.VII W1		8	3	5	8	116	218	334
W2		8	3	5	8	128	199	327
W3		9	6	3	9	258	128	386
W4		12	5	6	11	175	206	381
W5		9	5	3	8	232	135	367
GP.VIII W1		11	6	5	11	264	194	458
W3		12	7	5	12	247	174	421
W4		10	5	5	10	177	179	356
Total		360	170	184	354	6342	6604	12946
Average		9.4				37.3	35.8	36.58

Sherman II — Appendix IV A - Continued

Female No.	Number Born	Stillborn	7 days	14 days	21 days M.	F.	T.
Gp. XII W1	8		8	8	3	5	8
Gp. XVI W5	10		10	10	5	5	10
Gp. XII W4	11		11	11	5	6	11
Gp. XIV W2	8		8	8	2	6	8
Gp. XIII W2	11		11	11	4	6	10
Gp. XIV W1	3		3	3	1	2	3
Gp. XII W3	10		10	10	5	5	10
Gp. XIII W3	9		9	9	6	3	9
Gp. XIV W4	8		7	7	3	4	7
Gp. XVI W3	2		2	2	1	1	2
Gp. XIII W5	11		11	11	6	5	11
Gp. XV W2	10		10	10	5	4	9
Gp. XIV W5	9		9	9	2	7	9
Gp. XII W2	8		8	7	5	2	7
Gp. XIII W1	7		7	7	4	3	7
Total	125		124	123	51	64	121
Average	8.33						

Weight of Males, Females and Total Litter Weight

Birth	7 days	14 days	21 days
40	88	151	215
50	125	230	327
60	128	218	310
39	85	147	223
62	121	222	294
15	33	69	95
57	124	207	281
43	114	191	266
39	74	121	159
11	31	64	100
58	113	197	276
48	106	192	261
49	105	180	247
42	87	148	178
42	93	162	230
655	1427	2499	3462
5.24	11.5	20.31	28.61

Wistar X Sherman I Appendix IV A Continued

Female No.	Number Born	Stillborn	Number Alive at 7 days	14 days	21 days M	F	T
Gp. I W4	9		9	9	4	5	9
Gp. I W5	13		13	12	8	4	12
Gp.II W1	11		10	10	5	5	10
Gp.II W2	11		11	11	10	1	11
Gp.II W3	14		13	0	0	0	0
Gp.II W4	6		5	5	4	1	5
Gp.III W1	10		10	10	5	5	10
Gp.III W2	13		13	12	3	9	12
GP.III W3	12		12	12	6	6	12
Gp.III W5	12		12	12	7	5	12
Gp. IV W1	9		9	9	6	3	9
Gp. IV W2	12		12	12	8	4	12
Gp. IV W3	11		11	11	5	6	11
Gp. IV W4	11		11	11	6	5	11
Gp. IV W5	12		12	12	8	4	12
Gp. V W1	10		10	10	6	4	10
Gp. V W3	12		12	12	6	6	12
Gp. V W4	11		11	10	8	2	10
Gp. V W5	12		12	12	6	6	12
Gp. VI W1	8		8	8	4	4	8
Gp. VI W4	2		2	2	1	1	2
Gp.VII W1	10		10	10	5	5	10
Gp.VII W2	12		12	12	5	7	12
Gp.VII W5	11		11	11	7	4	11
Gp.VIIIW1	10	1	10	10	5	5	10
Gp.VIIIW2	13		13	12	7	5	12
Gp.VIIIW4	11		11	11	4	7	11
Gp.VIIIW5	11		10	10	7	3	10
Gp.IX W1	11		9	9	4	5	9
Gp.IX W2	10		10	10	8	2	10
Gp.IX W3	11		11	11	5	6	11
Gp.IX W4	4		4	4	2	2	4
Gp.IX W5	12		12	12	7	5	12
Gp. X W4	10		10	10	7	3	10
Gp. X W5	12		12	12	6	6	12
Gp.XI W1	11		11	11	7	4	11
Gp.XI W2	7		7	7	4	3	7
Gp.XI W3	3	3	3	3	1	2	3
Gp.XI W4	10		9	9	3	6	9
Gp.XI W5	10		10	10	6	4	10
Gp.XI W6	8	1	8	8	6	2	8
Total	418	5	411	394	222	172	394
Average	10.19						

Weekly Weights of Litters, Weights of Males, and Litter at Weaning					
Birth	7 days	14 days	21 days M	21 days F	21 days T
53	119	218	148	185	333
68	159	271	267	126	393
60	127	229	162	153	315
62	131	231	303	30	333
70	118	-	-	-	-
32	74	132	176	43	219
63	133	251	190	180	370
77	155	262	91	242	333
60	155	255	175	166	341
63	170	286	269	178	447
51	124	221	217	109	326
69	156	273	248	119	367
58	152	267	181	212	393
64	169	281	258	195	453
57	135	257	254	125	379
56	151	249	228	148	376
69	153	250	183	176	359
64	171	264	318	73	391
64	133	246	204	177	381
41	105	199	148	143	291
15	25	45	33	30	63
55	133	249	178	170	348
67	160	280	175	237	412
58	133	254	255	131	386
59	141	242	168	154	322
65	143	268	234	157	391
59	125	260	134	230	364
57	145	256	293	113	406
60	125	187	127	160	287
51	117	216	294	68	362
65	149	259	182	190	372
24	75	148	110	108	218
68	142	255	211	155	366
52	123	229	218	98	316
63	138	239	178	165	343
63	143	255	247	133	380
47	119	204	196	128	324
16	34	79	40	87	127
67	141	265	146	264	410
56	133	219	212	111	323
51	99	176	209	63	272
2319	5333	9227	7860	5732	13592
5.54	12.97	23.41	35.40	33.32	34.49

Sherman III — Appendix IV A - Continued

Female No.		Number Born	Still-Birth			Number in Litter 7 days			14 days			21 days		
			born	M	F	T	M	F	T	M	F	T	M	F	T
Gp.I	W1	13		8	5	13	6	4	10	6	4	10	6	4	10
	W2	12		10	2	12	1	1	2	Died					
	W4	11		5	6	11	5	6	11	5	6	11	5	6	11
Gp.II	W1	12		6	6	12	6	5	11	6	5	11	6	5	11
	W2	10		6	4	10	5	4	9	5	4	9	5	4	9
	W3	15		7	8	15	6	8	14	6	8	14	5	8	13
Gp.III	W1	9		3	6	9	3	6	9	3	6	9	3	6	9
	W2	14		5	9	14	5	9	14	5	9	14	5	9	14
	W3	15		10	5	15	8	5	13	8	5	13	8	5	13
	W4	7		5	2	7	4	2	6	4	2	6	4	2	6
	W5	12		9	3	12	9	3	12	9	3	12	9	3	12
Gp.IV	W1	14		7	7	14	7	7	14	6	7	13	6	7	13
	W3	12		5	7	12	5	7	12	5	7	12	5	7	12
	W4	11		6	5	11	6	5	11	6	5	11	6	5	11
	W5	7		2	5	7	2	4	6	2	4	6	2	4	6
Gp.V	W3	11		7	4	11	7	4	11	7	4	11	7	4	11
Gp.VI	W1	10		5	5	10	4	5	9	4	5	9	4	5	9
	W2	5		2	3	5	2	3	5	2	3	5	2	3	5
	W3	6		2	4	6	2	4	6	2	4	6	2	4	6
Gp.VII	W1	9	1	5	4	9	5	4	9	5	4	9	5	4	9
	W2	12		7	5	12	7	5	12	7	5	12	7	5	12
	W4	13		7	6	13	7	6	13	7	6	13	7	6	13
Gp.VIII	W1	9		6	3	9	6	3	9	6	3	9	6	3	9
	W4	11	1	7	4	11	7	4	11	7	4	11	7	4	11
	W5	12		5	7	12	5	7	12	5	7	12	5	7	12
Gp.IX	W1	8		1	7	8	1	7	8	1	7	8	1	7	8
	W3	9		8	1	9	8	0	8	8	0	8	8	0	8
	W5	10		7	3	10	7	3	10	7	3	10	7	3	10
	W6	10		7	3	10	7	3	10	7	3	10	7	3	10
Gp.X	W3	7		6	1	7	5	1	6	5	1	6	5	1	6
	W5	9		5	4	9	5	4	9	5	4	9	5	4	9
Gp.XI	W3	2	1	2	0	2	2	-	2	2	-	2	2	-	2
	W5	7	1	4	3	7	4	3	7	4	3	7	4	3	7
Total		334	4	187	147	334	169	142	311	167	141	308	166	141	307

Average 10.2

Weight of Males, Females, and Total Litter											
Birth			7 days			14 days			21 days		
M	F	T	M	F	T	M	F	T	M	F	T
39	25	64	75	50	125	133	82	215	202	124	326
47	10	57	4	4	8	Died					
33	31	64	75	87	162	118	129	247	180	190	370
31	32	63	65	60	125	114	95	209	161	144	305
29	22	51	70	55	125	113	85	198	186	134	320
33	38	71	55	70	125	83	120	203	112	181	293
19	36	55	44	86	130	72	137	209	113	212	325
31	55	86	63	113	176	103	171	274	141	238	379
43	23	66	79	46	125	145	80	225	194	113	307
30	13	43	66	32	98	114	54	168	185	86	271
52	15	67	116	38	154	182	57	239	256	87	343
42	41	83	80	79	159	113	122	235	162	181	343
25	38	63	62	89	151	113	150	263	171	223	394
36	29	65	78	59	137	133	99	232	207	152	359
7	33	40	26	53	79	54	102	156	84	155	239
45	23	68	100	52	152	173	88	261	225	114	339
28	26	54	45	57	102	88	110	198	120	160	280
12	20	32	35	51	86	63	89	152	105	150	255
13	24	37	30	58	88	54	107	161	87	158	245
26	21	47	62	52	114	117	95	212	187	142	329
39	28	67	87	64	151	142	96	238	219	154	373
39	32	71	79	69	148	131	104	235	195	160	388
33	16	49	81	43	124	132	68	200	213	107	320
37	22	59	82	47	129	156	85	241	333	141	374
26	35	61	60	87	147	111	143	254	157	205	362
5	34	39	15	96	111	24	169	193	40	273	313
45	5	50	93	-	93	179	-	179	251	-	257
37	17	54	83	36	119	143	59	202	204	84	288
39	18	57	85	37	122	139	60	199	235	105	340
35	7	42	75	15	125	134	26	160	223	43	266
25	22	47	60	49	109	110	86	196	161	122	283
9		9	17		17	33		33	68		68
21	18	39	61	48	109	101	76	177	161	121	282
1011	809	1820	2108	1782	3890	3620	2944	6564	5544	4459	9903
5.4	5.5	5.4	12.4	12.5	12.5	21.6	20.8	21.3	33.3	31.6	32.2

APPENDIX IV B

GROWTH DATA ON ANIMAL NUTRITION LABORATORY MICE

Female No.	Female's Age	Number Born	Still-born	7 days	14 days	21 days M	21 days F	21 days T
Parents								
X31-3-1	75	10		10	10	5	5	10
X31-3-1	123	9		9	9	4	5	9
Total		19		19	19	9	10	19
Average		9.5		9.5	9.5	4.5	5	9.5
F1 Litter 1								
X31-31-11-3	83	11		11	11	4	7	11
X31-31-11-2	85	8		8	8	5	3	8
X31-31-11-4	113	9	1	9	9	6	3	9
X31-31-11-1	115	9		9	9	3	6	9
Total		37		37	37	18	19	37
Average		9.2		9.2	9.2	4.5	4.7	9.2
F1 Litter 2	149	11		9	8	5	3	8
X31-31-11-1A								
X31-31-11-3A	147	9		9	9	4	5	9
X31-31-11-4A	149	9		9	9	6	3	9
X31-31-11-5A	148	8		8	8	6	2	8
Total		37		35	34	21	13	34
Average		9.25		8.75	8.5	5.25	3.25	8.5
F1 Litter 3								
X31-31-11-1B	94	7		7	7	4	3	7
X31-31-11-2B	89	11		11	11	5	6	11
X31-31-11-3B	91	5		5	5	3	2	5
X31-31-11-4B	93	9		9	9	8	1	9
X31-31-11-5B	97	9		9	9	3	6	9
Total		41		41	41	23	18	41
Average		8.25		8.25	8.25	4.6	3.6	8.25

APPENDIX IV B

WEEKLY WEIGHTS OF LITTERS

Female No.	Birth	7 days	14 days	21 days	28 days	35 days M	35 days F	35 days T
Parents								
X31-3-1	14	49	77	127	193	134	99	233
X31-3-1	20	55	73	124	187	104	98	202
Total	34	104	150	251	380	238	197	435
Average	17	52	75	125.5	190	119	98.5	217.5
Average	1.78	5.4	7.8	12.6	20.0	26.4	19.7	22.8
F1 Litter 1								
X31-31-11-3	15	49	68	114	184	97	136	233
X31-31-11-2	11	37	52	85	118	111	59	170
X31-31-11-4	11	43	69	108	177	156	58	214
X31-31-11-1	12	44	64	104	160	66	111	179
Total	49	173	253	411	639	432	364	796
Average	12.2	43.2	63.2	102.7	159.7	108	91	199
Average	1.3	4.7	6.8	11.1	17.3	24.0	19.3	21.6
F1 Litter 2								
X31-31-11-1A	14.2	29.8	40.2	64.9	108.7			
X31-31-11-3A	11.7	36.8	53.9	81.8	112.3			
X31-31-11-4A	12.1	35.6	53.5	79.1	126.0			
X31-31-11-5A	12.1	38.1	56.7	84.6	114.5			
Total	50.1	140.3	204.3	310.4	461.5			
Average	12.5	35.7	51.7	77.6	115.3			
Average	1.3	4.1	6.1	9.1	13.5			
F1 Litter 3								
X31-31-11-1B	9.6	34.5	53.6	78.0	118.0			
X31-31-11-2B	15.1	45.0	69.4	104.4	159.0			
X31-31-11-3B	7.6	25.3	37.8	54.8	84.8			
X31-31-11-4B	13.4	46.1	70.2	97.1	141.5			
X31-31-11-5B	13.8	38.7	64.8	88.3	123.8			
Total	59.5	189.6	295.8	422.6	627.1			
Average	11.9	37.9	59.1	84.5	125.4			
Average	1.4	4.5	7.2	10.2	15.2			

APPENDIX IV B

Weekly Weights of Litters

42 days			49 days			56 days			63 days		
M	F	T	M	F	T	M	F	T	M	F	T
143	105	248	150	108	258	158	115	273	162	116	278
109	104	213	116	106	222	122	113	235	122	113	235
252	209	461	266	214	480	280	228	508	284	229	513
126	104.5	230.5	133	107	240	140	114	254	142	114.5	256
28.0	20.9	24.2	29.5	21.4	25.2	31.1	22.8	26.7	31.5	22.9	26.9
107	142	249	114	156	270	117	159	276	123	160	283
127	61	188	138	71	209	143	73	216	153	74	227
161	61	222	162	64	226	167	66	233	177	69	246
72	122	194	75	123	198	76	127	203	80	131	211
467	386	853	489	414	903	503	425	928	533	434	967
116.7	96.5	213.2	122	103.5	225.7	125.7	106.2	232	133.2	108.5	241.7
25.9	20.5	23.1	27.1	22.0	24.5	27.9	22.6	25.2	29.6	23.0	26.2

Female No.	Female's Age	Number Born	Still-born	7 days	14 days	21 days M	21 days F	21 days T
F2 Litter 1								
X31-31-11-11-1	89	10		10	10	6	3	9
X31-31-11-11-2	88	9		8	8	4	4	8
X31-31-11-11-3	89	6		6	3	1	2	3
X31-31-11-11-4	94	7		7	7	4	3	7
X31-31-11-11-5	92	5		5	5	3	2	5
X31-31-11-11-6	92	7		6	6	3	3	6
Total		44		42	39	21	17	38
Average		7.3		7.0	6.5	3.5	2.8	6.3
Average								
F2 Litter 1								
X31-31-11-21-1	114	9		8	8	3	5	8
X31-31-11-21-2	114	5		5	5	5	-	5
X31-31-11-21-3	112	8		6	6	-	5	5
Total		22		19	19	8	10	18
Average		7.3		6.9	6.9	2.6	3.3	6
Average								
F2 Litter 1								
X31-31-11-31-1	115	8		8	8	3	5	8
X31-31-11-31-2	117	8		8	8	3	5	8
X31-31-11-31-3	117	7		7	7	3	4	7
X31-31-11-31-5	124	10		10	10	4	6	10
X31-31-11-31-6	124	7		7	7	4	3	7
Total		40		40	40	17	23	40
Average		8.0		8.0	8.0	3.4	4.6	8.0
Average								
F2 Litter 1								
X31-31-11-41-1	89	9		7	7	5	2	7
X31-31-11-41-3	86	9		9	9	4	5	9
Total		18		16	16	9	7	16
Average		9		8	8	4.5	3.5	8
Average								
Overall Total		124		117	114	55	57	112
Overall Average		7.75		7.31	7.12	3.43	3.56	7.0

Weekly Weights of Litters

Birth	7 days	14 days	21 days	28 days
12.6	35.1	52.5	65.1	106.0
10.5	32.7	54.1	74.7	112.1
7.6	21.8	15.9	24.0	36.5
8.8	31.3	46.5	69.7	109.4
7.1	23.4	40.3	51.6	82.0
9.1	27.4	48.2	55.4	84.9
55.7	171.7	257.5	340.5	530.9
9.3	28.6	42.9	56.7	88.4
1.2	4.1	6.6	9.0	14.5
11.9	37.4	54.6	84.8	119.6
8.3	26.9	41.4	60.3	88.0
10.4	28.1	45.2	56.5	82.2
30.6	92.4	141.2	201.6	289.8
10.2	30.8	47.0	67.2	96.6
1.3	4.9	7.4	11.2	16.1
10.5	33.2	43.3	66.6	106.1
11.1	34.7	51.4	79.9	120.5
9.3	26.0	43.4	63.8	101.5
13.0	40.4	66.0	80.1	136.5
9.0	30.8	45.9	63.0	103.1
52.9	165.1	250.0	353.4	569.7
10.5	33.0	50.0	70.6	113.9
1.31	4.1	6.2	8.8	14.2
11.4	19.1	33.5	60.4	99.8
11.8	37.4	53.5	79.8	120.0
23.2	56.5	87.0	140.2	219.8
11.6	28.2	43.5	70.1	109.9
1.2	3.5	5.4	8.7	13.7
162.4	485.7	753.7	1035.7	1610.2
10.1	30.3	47.1	64.7	100.6
1.31	4.1	6.6	9.2	14.3

APPENDIX IV B

Female No.	Female's Age	Number Born			Number Still-born	Number Alive at 7 days			14 days			21 days			28 days		
		M	F	T		M	F	T	M	F	T	M	F	T	M	F	T
F1 Litter 2																	
X31-31-11-1A	149	7	4	11		5	4	9	5	3	8	5	3	8	5	3	8
X31-31-11-3A	147	4	5	9		4	5	9	4	5	9	4	5	9	4	5	9
X31-31-11-4A	149	6	3	9		6	3	9	6	3	9	6	3	9	6	3	9
X31-31-11-5A	148	6	2	8		6	2	8	6	2	8	6	2	8	6	2	8
Total		23	14	37		21	14	35	21	13	34	21	13	34	21	13	34
Average		5.75	3.5	9.5		5.25	3.5	8.75	5.25	3.25	8.5	5.25	3.25	8.5	5.25	3.25	8.5
F1 Litter 3																	
X31-31-11-1B	94	4	3	7		4	3	7	4	3	7	4	3	7	4	3	7
X31-31-11-2B	89	5	6	11		5	6	11	5	6	11	5	6	11	5	6	11
X31-31-11-3B	91	3	2	5		3	2	5	3	2	5	3	2	5	3	2	5
X31-31-11-4B	93	8	1	9		8	1	9	8	1	9	8	1	9	8	1	9
X31-31-11-5B	97	3	6	9		3	6	9	3	6	9	3	6	9	3	6	9
Total		23	18	41		23	18	41	23	18	41	23	18	41	23	18	41
Average		4.6	3.6	8.2		4.6	3.6	8.2	4.6	3.6	8.2	4.6	3.6	8.2	4.6	3.6	8.2
F2 Litter 1																	
X31-31-11-11-1	89	6	4	10		6	4	10	6	4	10	6	3	9	6	3	9
X31-31-11-11-2	88	5	4	9		4	4	8	4	4	8	4	4	8	4	4	8
X31-31-11-11-3	89	2	4	6		2	4	6	1	2	3	1	2	3	1	2	3
X31-31-11-11-4	94	4	3	7		4	3	7	4	3	7	4	3	7	4	3	7
X31-31-11-11-5	92	3	2	5		3	2	5	3	2	5	3	2	5	3	2	5
X31-31-11-11-6	92	3	4	7		3	3	6	3	3	6	3	3	6	3	2	5
Total		23	21	44		22	20	42	21	18	39	21	17	38	21	16	37
Average		3.8	3.5	7.3		3.6	3.3	7.0	3.5	3.0	6.5	3.2	2.8	6.3	3.5	2.6	6.16

F2 Litter 1

Female No.	Female's Age	Born M	Born F	Born T	Still-Born	Number Alive at 7 days M	7 days F	7 days T	14 days M	14 days F	14 days T	21 days M	21 days F	21 days T	28 days M	28 days F	28 days T
X31-31-11-21-1	114	4	5	9		3	5	8	3	5	8	3	5	8	3	5	8
X31-31-11-21-2	114	5	-	5		5	-	5	5	-	5	5	-	5	5	-	5
X31-31-11-21-3	112	3	5	8		1	5	6	1	5	6	-	5	5	-	5	5
Total		12	10	22		9	10	19	9	10	19	8	10	18	8	10	18
Average		4	5	7.3		3	5	6.3	3	5	6.3	4	5	6	4	5	6
F2 Litter 1																	
X31-31-11-31-1	115	3	5	8		3	5	8	3	5	8	3	5	8	3	5	8
X31-31-11-31-2	117	3	5	8		3	5	8	3	5	8	3	5	8	3	5	8
X31-31-11-31-3	117	3	4	7		3	4	7	3	4	7	3	4	7	3	4	7
X31-31-11-31-5	124	4	6	10		4	6	10	4	6	10	4	6	10	4	6	10
X31-31-11-31-6	124	4	3	7		4	3	7	4	3	7	4	3	7	4	3	7
Total		17	23	40		17	23	40	17	23	40	17	23	40	17	23	40
Average		3.4	4.6	8		3.4	4.6	8	3.4	4.6	8.0	3.4	4.6	8.0	3.4	4.6	8.0
F2 Litter 1																	
X31-31-11-41-1	89	7	2	9		5	2	7	5	2	7	5	2	7	5	2	7
X31-31-11-41-3	86	4	5	9		4	5	9	4	5	9	4	5	9	4	5	9
Total		11	7	18		9	7	16	9	7	16	9	7	16	9	7	16
		5.5	3.5	9		4.5	3.5	8	4.5	3.5	8	4.5	3.5	8	4.5	3.5	8

APPENDIX IV B

Female No.	Weekly Weights of Litters Birth M	F	T	7 days M	F	T
F1 Litter 2						
X-31-31-11-1A	9.2	5.0	14.2	17.1	12.7	29.8
X-31-31-11-3A	5.3	6.4	11.7	16.8	20.0	36.8
X31- 31-11-4A	8.1	4.0	12.1	24.0	11.6	35.6
X31- 31-11-5A	9.1	3.0	12.1	28.4	9.7	38.1
Total	31.7	18.4	50.1	86.3	54.0	140.3
Average	7.9	4.6	12.5	21.5	13.5	35.0
Average	1.4	1.3	1.3	4.1	3.8	4.0
F1 Litter 3						
X31-31-11-1B	5.3	4.3	9.6	18.8	15.7	34.5
X31-31-11-2B	6.9	8.2	15.1	20.5	24.5	45.0
X31-31-11-3B	4.7	2.9	7.6	15.4	9.9	25.3
X31-31-11-4B	12.0	1.4	13.4	40.9	5.2	46.1
X31-31-11-5B	5.0	8.8	13.8	13.3	25.4	38.7
Total	33.9	25.6	59.5	108.9	80.7	189.6
Average	8.4	6.4	14.8	27.2	20.1	47.4
Average	1.8	1.8	1.8	5.9	5.6	5.8
F2 Litter 1						
X31-31-11-11-1	7.6	5.0	12.6	20.8	14.3	35.1
X31-31-11-11-2	6.1	4.4	10.5	17.0	15.7	32.7
X31-31-11-11-3	2.7	4.9	7.6	7.5	14.3	21.8
X31-31-11-11-4	5.0	3.8	8.8	18.1	13.2	31.3
X31-31-11-11-5	4.2	2.9	7.1	13.7	9.7	23.4
X31-31-11-11-6	4.1	5.0	9.1	14.2	13.2	27.4
Total	29.7	26.0	55.7	91.3	80.4	171.7
Average	4.9	4.3	9.2	15.2	13.4	28.6
Average	1.3	1.2	1.2	4.2	4.1	4.1
F2 Litter 1						
X31-31-11-21-1	5.2	6.7	11.9	14.6	22.8	37.4
X31-31-11-21-2	8.3		8.3	26.9		26.9
X31-31-11-21-3	3.5	6.9	10.4	4.8	23.3	28.1
Total	17.0	13.6	30.6	46.3	46.1	92.4
Average	5.6	6.8	10.2	15.4	23.0	30.8
Average	1.4	1.4	1.3	5.1	4.6	4.9
F2 Litter 1						
X31-31-11-31-1	4.3	6.2	10.5	13.1	20.1	33.2
X31-31-11-31-2	4.3	6.8	11.1	13.1	21.6	34.7
X31-31-11-31-3	4.1	5.2	9.3	11.3	14.7	26.0
X31-31-11-31-5	5.1	7.9	13.0	16.0	24.3	40.4
X31-31-11-31-6	5.1	3.9	9.0	17.9	12.9	30.8
Total	22.9	30.0	52.9	71.5	93.6	165.1
Average	4.5	6.0	10.5	14.3	18.7	33.0
Average	1.3	1.3	1.3	4.2	4.1	4.1
F2 Litter 1						
X31-31-11-41-1	9.0	2.4	11.4	13.4	5.7	19.1
X31-31-11-41-3	5.3	6.5	11.8	16.6	20.8	37.4
Total	14.3	8.9	23.2	30.0	26.5	56.5
Average	7.1	4.4	11.6	15.0	13.2	28.2
Average	1.3	1.2	1.28	3.3	3.8	3.5

APPENDIX IV B

Weekly Weights of Litters

14 days			21 days			28 days		
M	F	T	M	F	T	M	F	T
25.5	14.7	40.2	41.4	23.5	64.9	71.6	37.1	108.7
24.7	29.2	53.9	37.3	44.5	81.8	52.5	59.8	112.3
36.4	17.1	53.5	54.1	25.0	79.1	87.8	38.2	126.0
42.6	14.1	56.7	63.8	20.8	84.6	86.0	28.5	114.5
129.2	75.1	204.3	196.6	113.8	310.4	297.9	163.6	461.5
32.3	18.7	51.0	49.1	28.4	77.6	74.4	40.9	115.3
6.1	5.1	6.0	9.3	6.7	9.1	14.2	12.6	13.6
29.8	23.8	53.6	43.2	33.8	78.0	67.5	50.5	118.0
31.5	37.9	69.4	47.8	5.66	104.4	77.3	81.7	159.0
22.8	15.0	37.8	34.4	20.4	54.8	54.6	30.2	84.8
62.2	8.0	70.2	86.7	10.4	97.1	127.5	14.0	141.5
21.6	43.2	64.8	29.2	59.1	88.3	44.6	79.2	123.8
167.9	127.9	295.6	241.3	180.3	422.6	371.5	255.6	627.7
41.9	31.9	73.9	60.3	45.0	105.6	74.3	51.1	125.4
9.1	8.9	9.1	13.1	12.5	12.9	15.2	14.2	15.3
31.4	21.1	52.5	41.5	23.6	65.1	67.5	38.5	106.0
27.8	26.3	54.1	39.8	34.9	74.7	59.5	52.6	112.1
5.4	10.5	15.9	8.8	15.2	24.0	14.3	22.2	36.5
26.7	19.8	46.5	40.6	29.1	69.7	65.4	44.0	109.4
23.5	16.8	40.3	30.6	21.0	51.6	49.8	32.2	82.0
24.8	23.4	48.2	29.3	26.1	55.4	54.4	30.5	84.9
139.6	117.9	257.5	190.6	149.9	340.5	310.9	220.0	530.9
23.2	19.6	42.9	31.7	24.9	56.7	51.8	36.6	88.5
6.6	6.5	6.6	9.0	8.9	9.0	14.8	14.1	14.5
21.1	33.5	54.6	33.6	51.2	84.8	48.1	71.5	119.6
41.4		41.4	60.3		60.3	88.0		88.0
7.7	37.5	45.2	-	56.5	56.5	-	82.2	82.2
70.2	71.0	141.2	93.9	107.7	201.6	136.1	153.7	289.8
23.4	35.5	47.0	46.9	53.8	67.2	68.0	76.8	96.6
7.8	7.1	7.5	11.7	10.8	11.2	17.0	15.4	16.1
16.9	26.4	43.3	27.1	39.5	66.6	43.8	64.3	108.1
19.4	32.0	51.4	31.1	48.8	79.9	48.7	71.8	120.5
19.3	24.1	43.4	27.7	36.1	63.8	46.0	55.5	101.5
25.7	40.3	66.0	31.8	48.3	80.1	57.8	78.7	136.5
27.0	18.9	45.9	37.7	25.3	63.0	34.5	38.6	103.1
108.3	141.7	250.0	155.4	198.0	353.4	230.8	308.9	569.7
21.6	28.3	50.0	31.0	39.6	70.6	52.1	61.7	113.9
6.3	6.1	6.2	9.1	8.6	8.8	5.3	13.4	14.2
20.8	12.7	33.5	43.7	16.7	60.4	73.8	26.0	99.8
23.7	29.8	53.5	35.7	44.1	79.8	55.9	64.1	120.0
44.5	42.5	87.0	79.4	60.8	140.2	129.7	90.1	219.8
22.2	21.2	43.5	39.7	30.4	70.1	64.8	45.0	109.9
4.9	6.0	5.43	8.8	8.7	8.7	4.4	12.8	13.7

APPENDIX IV C

GROWTH DATA ON ANIMAL NUTRITION LABORATORY GUINEA PIG COLONY (MALES)

No. of Male	No. in Litter	Weight of Animal			
		Birth	7 days	14 days	21 days
1	2	114	160	228	278
2	3	87	123	185	251
3	2	118	151	219	269
4	3	101	153	225	282
5	4	97	131	170	226
6	4	92	120	159	202
7	3	95	152	229	276
8	4	85	124	180	264
9	4	86	126	192	251
10	4	61	99	156	204
11	4	66	105	167	238
12	4	84	140	179	226
13	3	107	149	207	260
14	3	95	128	199	241
15	3	85	128	170	235
16	3	88	170	235	325
17	2	132	202	291	370
18	7	81	92	144	202
19	7	86	115	174	240
20	7	91	128	190	261
21	2	117	179	251	331
22	1	147	192	282	367
23	3	100	131	199	265
24	3	99	135	193	259
25	4	107	139	203	254
26	3	116	162	233	285
27	3	108	154	205	244
28	3	111	159	225	280
29	3	115	159	230	291
30	3	105	147	212	267
31	2	113	163	231	299
32	4	101	143	218	265
Total 32		3190	4559	6581	8208
Ave.		99.6	143.4	205.6	256.5

APPENDIX IV C

GROWTH DATA ON ANIMAL NUTRITION LABORATORY GUINEA PIG COLONY (FEMALE)

No. of Female	No.in Litter	Weight of Animal Birth	7 days	14 days	21 days
1	2	104	145	212	261
2	3	89	128	188	244
3	3	91	126	188	259
4	2	109	147	205	240
5	4	114	153	218	276
6	4	112	117	171	218
7	4	78	115	Died	
8	4	84	97	159	205
9	3	107	158	226	290
10	3	119	172	244	315
11	4	94	129	170	212
12	4	91	129	169	216
13	3	76	126	183	
14	3	90	144	214	
15	4	90	133	180	251
16	4	88	133	181	251
17	4	92	136	189	252
18	4	80	121	176	203
19	4	82	133	175	209
20	4	96	151	183	232
21	4	94	147	177	223
22	3	95	126	190	250
23	3	73	108	151	194
24	4	92	134	188	233
25	2	121	186	247	300
26	7	107	152	219	281
27	7	96	129	185	248
28	7	98	126	175	236
29	2	117	177	235	307
30	3	65	99	155	211
31	3	100	135	189	243
32	4	116	155	227	271
33	3	97	122	176	223
34	3	100	123	181	227
35	4	102	133	194	254
36	4	93	131	190	249
37	3	98	144	202	268
38	2	122	167	229	292
39	4	75	115	179	219
40	4	85	130	197	233
41	4	93	133	201	245
Total 41		3925	5565	7712	9341
Ave.		95.7	135.7	192.2	245.8

APPENDIX IV C

Number of Male	Number in Litter	Weight of Animal								
		Birth	7 days	14 days	21 days	28 days	35 days	42 days	49 days	56 days
1	2	114	160	228	278	329	390	468	539	593
4	4	101	153	225	282	325	384	444	516	574
5	4	97	131	170	226	321	395	439	513	528
6	4	92	120	159	202	265	327	369	440	488
		404	564	782	988	1240	1496	1720	2008	2183
		101	141	195	247	310	374	430	502	545.7
Number of Female										
5	4	114	153	218	276	310	355	388	449	508
6	4	112	117	171	218	266	293	309	376	426
8	4	84	97	159	205	239	267	282	326	379
9	3	107	158	226	290	329	378	424	495	552
10	3	119	172	244	315	371	428	449	531	577
11	4	94	129	170	212	297	348	382	438	455
12	4	91	129	169	216	310	335	404	472	487
		721	955	1357	1732	2122	2404	2638	3087	3384
		103	136.4	193.9	247.4	303.1	343.4	376.8	441	483.4

APPENDIX V

COST OF LABOUR, FEED and HOUSING PER SPECIES PER ANIMAL

Labour

The labour cost was based on an annual salary of $2160, and a 47 hour week, which is equivalent to $0.88 per hour.

Feed

Pelleted Ration	Price	
U.B.C.No. 10 (Rats and Mice)	$ 120.00	per ton
U.B.C.No. 8 (Guinea,Pig)	90.00	per ton
U.B.C.No. 12 (Rabbit)	78.00	per ton

Green Feed - Kale.

The cost of green feed is only an approximateion.

Cost of planting 20 hours at $1.00 per hour	$ 20.00
Cost of seed	3.00
Cost of harvesting	15.00
	$ 38.00

Estimated Yield - 10 tons from half acre plot
Therefore cost per pound $0.002

Housing

"Life" of Cage - 5 years
Yearly repainting cost - $0.50 per year per cage
= $2.50 for five year period.

Value of Cage	Repaint Cost	Total Cost	Cost Per Day Per Cage	Cost Per Day Per Animal Based on Average Capacity	
Mouse	$3.50	$2.50 $ 6.00	$ 0.0032	$ 0.0003	(10 mice per cage
Rat	4.50	2.50 7.00	0.0038	0.0006	(6 Rats "
Guinea Pig	5.50	2.50 8.00	0.0043	0.001	(4 Guinea Pigs per Cage)

LABOUR COST STUDY

RAT COLONY

Days	No. of Animals	No. Cages	Total Time in Minutes
1	76	12	33
2	"	"	10
3	"	"	25
4	"	"	13
5	"	"	15
6	"	"	85
7	"	"	35
8	"	"	15
9	"	"	20
10	"	"	15
11	"	"	18
12	"	"	15
13	"	"	40
14	"	"	30
15	"	"	15
16	"	"	25
17	"	"	20
18	"	"	15
19	"	"	10
20	"	"	27
Total 20	1520	240	481
Average 1	76	12	24.0

Average Time Per Cage = 2.0 Minutes
Average Time Per Rat = 0.31 "

1	86	14	35
2	86	14	37
3	48	11	25
Total 3	220	39	97
Ave. 1	73	13	32

Average Time Per Cage = 2.7 Minutes
" " " Rat = 0.43 "

Complete " per Cage = 2.07 "
" " " Rat = 0.33 "
Cost per Cage =$ 0.03
" " Rat =$ 0.003

LABOUR COST STUDY

MOUSE COLONY

Days	No. of Animals	No. Cages	Total Time in Minutes
1	112	12	20
2	"	"	5
3	"	"	20
4	"	"	5
5	"	"	50
6	"	"	15
7	"	"	18
8	"	"	8
9	"	"	10
10	"	"	15
11	"	"	10
12	"	"	10
13	"	"	40
14	"	"	15
15	"	"	5
16	"	"	15
17	"	"	10
18	"	"	10
19	"	"	7
20	"	"	27
20 Total	2240	144	315
1 Average	112	12	15.75

Ave. Time Per Cage = 1.31 minutes
Ave. Time Per Mouse = 0.14 "

1	174	39	60
2	174	49	50
3	174	49	65
Total 3	522	137	175
Ave 1	174	45	58

Ave. Time Per Cage = 1.28 Minutes
Ave. Time Per Mouse = 0.33 "
Complete Ave. " " Cage = 1.3 "
Complete Ave. " " Mouse = 0.2 "

Cost Per Cage = $ 0.019
Cost Per Mouse = $ 0.0018

LABOUR COST STUDY

Guinea Pig Colony

Days	No. of Animals	No. Cages	Total Time in Minutes
1	132	33	130
2	"	"	30
3	"	"	110
4	"	"	50
5	"	"	100
6	"	"	40
7	"	"	105
8	"	"	125
9	"	"	40
10	"	"	85
11	"	"	30
12	"	"	95
13	"	"	20
14	"	"	70
15	"	"	105
16	"	"	45
17	"	"	105
18	"	"	35
19	"	"	90
20	"	"	40
21	"	"	60
Total 21	2772	693	1510
Ave. 1	132	33	71.9

Ave. Time Per Cage = 2.17 Minutes
Ave. Time Per Guinea Pig = 0.54 Minutes

1	24	9	25
2	24	9	10
3	24	9	20
Total 3	72	27	55
Ave. 1	24	9	18

Ave.Time Per Cage = 2.03 Minutes
Ave.Time Per Guinea Pig = 0.75 "
Complete Ave.Time Per Cage = 2.2 "
" " " " Guinea Pig = 0.58 "
Cost Per Cage = $ 0.018
Cost Per Guinea Pig = $ 0.005

LABOUR COST STUDY

RABBIT COLONY

	Days	No. of Animals	Total Time in Minutes
	1	29	40
	2	"	10
	3	"	45
	4	"	15
	5	"	30
	6	"	30
	7	"	15
	8	"	45
	9	"	25
	10	"	45
	11	"	20
	12	"	45
	13	"	20
	14	"	15
	15	"	120
	16	"	25
	17	"	35
	18	"	20
	19	"	10
	20	"	60
Total	20	580	670
Ave	1	29	33

Ave. Time Per Rabbit = 1.15 Minutes

Cost per Rabbit Per Day = $ 0.017

FEED CONSUMPTION AND COST

Rat Colony

	Day	Number of Animals	Total Feed Consumed Gms.	Ave. Feed Consumed per Animal Gms.
	1	371	5072	13
	2	333	4397	13.2
	3	371	5186	14
Total	3	1075	14655	40.2
Average	1	358	4885	13.4

Average Feed Cost Per Rat - $0.0017 or 0.002 Per Day

Mouse Colony

	1	174	1241	7
	2	174	1118	6.4
	3	174	1197	6.8
Total	3	592	3556	20.2
Average	1	174	1185	6.7

Average Feed Cost Per Mouse = $0.0008 or 0.001 Per Day

Guinea Pig Colony

	1	24	716	29.8
	2	24	738	30.7
	3	24	704	29.3
Total	3	72	2158	89.8
Average	1	24	719	29.6

Average Feed Cost Per Guinea Pig = $ 0.003 Per Day

Rabbit Colony

Total	20	580	100 lbs. Pellets and 35 lbs. Kale
Average	1	29	0.17 lbs. pellets and 0.06 lbs. Kale

Average Feed Cost per Rabbit = $0.006
0.001
0.007 per day.

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