1973-04-12

# Growth and development of the western harvest mouse, Reithrodontomys megalotis megalotis

Gary H. Richins
*Brigham Young University - Provo*

# GROWTH AND DEVELOPMENT OF THE WESTERN HARVEST MOUSE,

*REITHRODONTOMYS MEGALOTIS MEGALOTIS*

A Thesis

Presented to the

Department of Zoology

Brigham Young University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Gary H. Richins

August 1973

This thesis by Gary H. Richins, is accepted in its present form by the Department of Zoology of Brigham Young University as satisfying the thesis requirement for the degree of Master of Science.

12 April '73
Date

Typed by: Marla Joye Lay

## ACKNOWLEDGEMENTS

Appreciation is extended to Brigham Young University, Department of Zoology, for providing laboratory space and equipment.

I am grateful to Dr. Clive D. Jorgensen for advice and help with the analyses, and to Drs. Herbert H. Frost and Odell Julander who assisted in the preparation of this manuscript.

I am especially thankful to Dr. H. Duane Smith, friend and teacher, who spent innumerable hours helping with the preparation of this manuscript and offered thoughtful advice and timely encouragement throughout my graduate studies.

TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

Figure | Page

# INTRODUCTION

The western harvest mouse, *Reithrodontomys megalotis*, is a small cricetine found throughout much of North America. It has a wide variety of habitats ranging from deserts to pine and oak forests. It is highly adaptable to areas disturbed by man, attains high population densities, and is important in the dynamics of the biotic community (Bancroft, 1966).

In estimating populations of rodents and their relationship to the biotic community it is difficult, if not impossible, to accurately measure the impact of animals below trappable age, especially when litter size, gestation period, reproductive age, sex ratios, and biomass are not known. Little research in these areas has been concerned with the western harvest mouse. This study will help define the growth and development of *Reithrodontomys megalotis megalotis*. The objectives are: 1) to characterize growth by measurements of body weight, total length, tail length, ear length, hind foot length, skull total length, nasal length, cranium width, zygomatic breadth, mastoidal breadth, foramen magnum height, and dried eye lens weight; and 2) to determine gestation period, litter size, reproductive age, sex ratios, and development and behavioral sequences.

In the genus *Reithrodontomys*, the life histories of the species *R. humulis*, *R. montanus*, *R. fulvescens*, and *R. megalotis* have been studied. Holding and Royal (1952), Layne (1959), and Kaye (1961) studied development and behavior in the eastern harvest mouse, *R.*

*humulis*. Svihla (1930) published brief notes on the behavior of *R. fulvescens* and Leraas (1938), studied growth and behavior of *R. montanus*. Several workers have studied aspects of the life history of *R. megalotis*. Svihla (1931), Smith (1936), and Brummel (1961) made observations on growth, development, and reproduction in *R. megalotis* but their studies were made on small sample sizes and need validation. Bancroft (1966) studied reproduction, development, and behavior of a large sample of *R. megalotis dychei* from Kansas, but no correlation of age with growth was made.

## MATERIALS AND METHODS

The observations on reproduction, growth, and development of *Reithrodontomys megalotis megalotis* in this study have been made on a large number of individuals. Wherever possible the data have been compared with data reported by previous workers.

All of the animals used in this study were the progeny of 20 pairs of *R. m. megalotis* captured live approximately 19 km SE of Benmore Guard Station, Tooele Co., Utah from September 1-8, 1971. The colony was housed in the small mammal research laboratory at Brigham Young University. The animals were caged in galvanized metal cages 25.5 cm long, 18 cm wide, and 16.5 cm tall with covers of 8.35 mm wire mesh. Wood shavings 6-8 cm deep were provided as a substrate, and cotton was provided as nesting material. Water bottles were provided and unlimited food consisted of Purina mouse breeder chow. The temperature was held constant at 22$^{\circ}$ C and the photoperiod artificially maintained at 12 hr. light and 12 hr. dark with varying intensities simulating dawn and dusk.

When the animals were brought into the laboratory, they were sexed and paired, one pair to a cage. Each cage was checked daily for food and water and inspected for the presence of a litter.

When a litter was born each member of the litter was marked by sequential toe clipping. The following measurements were taken daily from days 1-22 and then weekly to 10 weeks on a sample of 100 animals: (1) body weight, (2) total length, (3) tail length, (4) ear length, and

(5) hind foot length. Body weight was determined to the nearest .05 g on an Ohaus triple beam balance; total and tail lengths were measured to the nearest 0.5 mm with a clear plastic metric rule; and ear and hind foot lengths were measured to the nearest 0.01 mm with a Mitutoyo dial caliper. After the eyes had opened and the individuals became more active, they were anesthetized with Penthrane to facilitate handling and obtaining accurate measurements. Daily observations were recorded on each litter to determine development and behavior sequences.

The instantaneous relative growth rate (IGR) described by Brody (1945) and Lackey (1967) was calculated to express growth as a rate between times of measurements and percentage of adult size. The instantaneous relative growth rate described by Brody (1945) is expressed as $(dW/dt)/W$, where W is the parameter measured at the instant the rate of change $dW/dt$ is measured. Since it is not entirely possible to develop the "instantaneous" rate of growth, it was necessary to integrate the infinite number of growth rates to derive:

$$W = Ae^{kt}$$

This is conveniently written as:

$$\ln W = \ln A + kt$$

where lnW is the natural logarithm of the variable measured (W) at time $t$, lnA is the natural logarithm of the variable measured (W) at $t = 0$, and $k$ represents the instantaneous relative growth rate (when multipled by 100, $k$ = percentage growth rate). For comparative purposes, the instantaneous relative growth rate ($k$) is determined with:

$$k_n = \frac{\ln W - \ln W_{-1}}{t_n - t_{n-1}}$$

thus, $k$ is definite and can be used to compare differences in rates of growth.

Additional studies on skull measurements and eye lens weights were also made to correlate age with the previously mentioned measurements. Ten individuals were sacrificed each day from 1-22 days and weekly from 4-10 weeks. In addition 29 animals were sacrificed from 42-64 weeks.

On the day that an animal was sacrificed, it was removed from the nest and killed with an overdose of Penthrane. The standard body measurements were taken and then the carcass was placed into a 10% formalin solution to fix the eye lenses. After a minimum of four days the animals was removed from the formalin solution; the head was removed, skinned, and the lenses extracted by making a slit in the cornea with a hooked insect pin and applying pressure to the sides of the eyeball with a curved forceps. The lenses were then stored in vials of 10% formalin. After a number of lenses had accumulated, they were removed from the formalin, placed on spotting plates, and dried at $100^{o}$ C for one week. After drying, they were removed from the oven and weighed individually to the nearest .0001 g on a Mettler laboratory balance.

After the lenses had been extracted, the skull was placed into a labeled paper cup, frozen, and later stained and measured. The skull staining followed basically the methods described by Humason (1967), but differed in the amount of alizarine stock solution used, since the present work required 10 times as much as Humason (1967) reported. The skulls were thawed, placed into a compartmentalized tray, and covered with a 2% KOH solution. After two days this solution was replaced for two days with a solution consisting of 3 l. of 2% KOH and 30 ml. of alizarine stock solution. The skulls were then rinsed wtth water and again covered with 2% KOH for two days, after which the skulls were rinsed with water and allowed to dry for measuring. The (1) total length, (2) zygomatic breadth, (3) foramen magnum height, (4) mastoidal breadth, (5) nasal length, and (6) cranium width were taken with dial calipers to the nearest 0.01 mm on each skull.

Reproductive efficiency, defined as the weight of the litter multiplied by 100 and divided by the weight of the mother (Kaye, 1961), was determined for 19 adult female *R. m. megalotis*. Both measurements were taken immediately after birth in all instances.

All data were keypunched on IBM cards for subsequent computer analysis.

## RESULTS AND DISCUSSION

### Growth Rates

Growth rates ($k$) for body weight, total length, tail length, ear length, and hind foot length were initially determined for a sample size of 100 *Reithrodontomys megalotis megalotis* each day from 1-22 days and then weekly from 4-10 weeks (Table 1). Random sampling subsequently showed that a sample size of 10 animals each day gave significant results. Growth rates ($k$) were also calculated for dried eye lens weight, skull total length, zygomatic breadth, foramen magnum height, mastoidal breadth, nasal length, and cranium width in addition to the previously mentioned parameters (Table 2).

The $R^2$ values (Tables 1, 2) indicate how much variation is accounted for in the analyses due to the growth of the particular parameter. When $R^2$ values are converted to $r$ values they can be used to determine statistical significance ($\alpha$=.05). A significant $r$ suggests a significant correlation between the appropriate LnW (log of the variable) and the age of the growing animals when time is partitioned into intervals of 1-3, 4-12, 13-22, and 23-70 days (Smith and Jorgensen, 1972). Tail length, ear length, and dried eye lens weight provided the best correlations of growth with age, since $r$ was significant during all four growth phases (Table 1). Total length, hind foot length, and nasal length were significantly correlated with age from 1-22 days. Body weight had a significant $r$ from 4-22 days. All other parameters studied were significantly correlated with age only during the 4-12 day growth phase.

Table 1. Growth Data Analyses for *Reithrodontomys megalotis megalotis*, n=100.

| Parameter | lnA | $k$ | Age in Days ($t=t-1$) | $R^2$ | $r$ |
|---|---|---|---|---|---|
| Body Weight | 0.2482 | .1271 | 1-3 | .2813 | .5303* |
| | 0.4029 | .0845 | 4-12 | .4963 | .7044* |
| | 0.8676 | .0411 | 13-22 | .2555 | .5055* |
| | 1.8053 | .0157 | 23-70 | .2092 | .4573* |
| Total Length | 3.7609 | .0647 | 1-3 | .3550 | .5958* |
| | 3.7895 | .0537 | 4-12 | .6862 | .8283* |
| | 4.0837 | .0303 | 13-22 | .5089 | .7133* |
| | 4.7579 | .0044 | 23-70 | .2299 | .4794* |
| Tail Length | 2.3960 | .1055 | 1-3 | .4327 | .6577* |
| | 2.4496 | .0945 | 4-12 | .7285 | .8535* |
| | 3.0958 | .0414 | 13-22 | .5220 | .7224* |
| | 4.0245 | .0038 | 23-70 | .1931 | .4394* |
| Ear Length | 0.3730 | .2835 | 1-3 | .4612 | .6791* |
| | 1.0368 | .0837 | 4-12 | .7426 | .8617* |
| | 1.4669 | .0530 | 13-22 | .6001 | .7746* |
| | 2.5732 | .0030 | 23-70 | .1970 | .4438* |
| Hind Foot Length | 1.8136 | .0887 | 1-3 | .4904 | .7002* |
| | 1.9031 | .0638 | 4-12 | .7205 | .8488* |
| | 2.4023 | .0194 | 13-22 | .4368 | .6609* |
| | 2.8252 | .0009 | 23-70 | .0453 | .2128* |

*significant at $\alpha$=.05

Table 2. Growth Data Analyses for *Reithrodontomys megalotis megalotis*, n=10.

| Parameter | lnA | $k$ | Age in Days ($t$=$t$-1) | $R^2$ | $r$ |
|---|---|---|---|---|---|
| Body Weight | 0.4087 | .1300 | 1-3 | .3195 | .5563 |
| | 0.6668 | .0848 | 4-12 | .6079 | .7796* |
| | 0.9555 | .0487 | 13-22 | .4854 | .6967* |
| | 1.9007 | .0084 | 23-70 | .2799 | .5290 |
| Total Length | 3.7444 | .0862 | 1-3 | .6732 | .8204* |
| | 3.8684 | .0614 | 4-12 | .8251 | .9083* |
| | 4.1701 | .0329 | 13-22 | .7061 | .8402* |
| | 4.8253 | .0020 | 23-70 | .2392 | .4890 |
| Tail Length | 2.3621 | .1329 | 1-3 | .5156 | .7180* |
| | 2.5983 | .1051 | 4-12 | .8171 | .9048* |
| | 3.2106 | .0467 | 13-22 | .7109 | .8431* |
| | 4.1493 | .0015 | 23-70 | .6780 | .8234* |
| Ear Length | 0.3022 | .3401 | 1-3 | .5496 | .7413* |
| | 1.1064 | .0888 | 4-12 | .8458 | .9196* |
| | 1.5477 | .0539 | 13-22 | .7394 | .8598* |
| | 2.6303 | .0010 | 23-70 | .9162 | .9571* |
| Hind Foot Length | 1.8138 | .0929 | 1-3 | .5784 | .7605* |
| | 2.0453 | .0577 | 4-12 | .7914 | .8896* |
| | 2.4590 | .0194 | 13-22 | .6268 | .7917* |
| | 2.8773 | .0004 | 23-70 | .1776 | .4214 |
| Dried Eye Lens Weight | -9.6263 | .4867 | 1-3 | .4323 | .6574* |
| | -8.6014 | .1820 | 4-12 | .9322 | .9655* |
| | -6.9336 | .0337 | 13-22 | .6200 | .7874* |
| | -6.7643 | .0159 | 23-70 | .9804 | .9901* |
| Skull Total Length | 2.2411 | .0683 | 1-3 | .2656 | .5153 |
| | 2.3662 | .3713 | 4-12 | .6839 | .8269* |
| | 2.6658 | .0113 | 13-22 | .1985 | .4455 |
| | 2.8731 | .0017 | 23-70 | .2810 | .5300 |
| Zygomatic Breadth | 1.6980 | .0496 | 1-3 | .1116 | .3340 |
| | 1.8599 | .0266 | 4-12 | .5816 | .7626* |
| | 2.0332 | .0106 | 13-22 | .1004 | .3168 |
| | 2.2512 | .0006 | 23-70 | .0293 | .1711 |
| Foramen Magnum Height | 0.7337 | .5703 | 1-3 | .0517 | .2273 |
| | 0.8292 | .0297 | 4-12 | .4024 | .6343* |
| | 1.0644 | .0090 | 13-22 | .0835 | .2889 |
| | 1.2950 | .0008 | 23-70 | .0136 | .1166 |

Table 2 (continued)

| Parameter | lnA | $k$ | Age in Days ($t$=$t$-1) | $R^2$ | $r$ |
|---|---|---|---|---|---|
| Mastoidal Breadth | 1.5132 | .0326 | 1-3 | .0457 | .2138 |
| | 1.7198 | .0346 | 4-12 | .5563 | .7458* |
| | 2.0563 | .0033 | 13-22 | .0454 | .2130 |
| | 2.1200 | .0002 | 23-70 | .0040 | .0632 |
| Nasal Length | 0.8588 | .0994 | 1-3 | .4501 | .6708* |
| | 1.0450 | .0572 | 4-12 | .7338 | .8566* |
| | 1.4497 | .0216 | 13-22 | .6049 | .8005* |
| | 1.8263 | .0033 | 23-70 | .1613 | .4016 |
| Cranium Width | 1.7787 | .0461 | 1-3 | .2434 | .4933 |
| | 1.9281 | .0268 | 4-12 | .6096 | .7807* |
| | 2.1876 | .0044 | 13-22 | .1397 | .3737 |
| | 2.2845 | .0001 | 23-70 | .0014 | .0374 |

*significant at $\alpha$=.05

The growth rate (*k*) is the slope of the LnW values for a given time interval. The close correlation of *k* with the actual data means indicates that the *k* values for each of the four growth phases accurately characterize the growth of *R. m. megalotis*. Layne (1959) found two growth phases in *R. humulis*--0-3 weeks and 3-7 weeks. Bancroft (1966) found three growth phases in *R. m. dychei*--0-3 weeks, 3-7 weeks, and 7-10 weeks.

Graphical representations of means, standard errors, and growth rates (*k*) were prepared the four most significant growth parameters for *R. m. megalotis*: body weight (Figure 1), tail length (Figures 2), ear length (Figure 3), and dried eye lens weight (Figure 4). The growth rates (*k*) correlated closely with the actual data means. This indicated that growth rates accurately characterized the actual growth of *R. m. megalotis*.

## Gestation Period

The gestation period of the western harvest mouse in this study was shorter than previously reported. The gestation period for *R. m. megalotis* as determined by the minimum interval between successive litters was 22 days, however one litter was born after only 20 days but because all four young died within a few hours, it was determined to be premature. A 23-day gestation period is the shortest gestation period previously reported for *R. megalotis*. Svihla (1931) listed a 23-day gestation period for *R. m. megalotis* while EcoDynamics (1971) reported 25-28 days. Bancroft (1967) also reported 23 days as the gestation period for *R. m. dychei*. Layne (1959) lists a 24-day gestation period for *R. humulis*, but Kaye (1961) reported 21 days. Leraas (1938) reported 21 days as the gestation period for *R. montanus*.

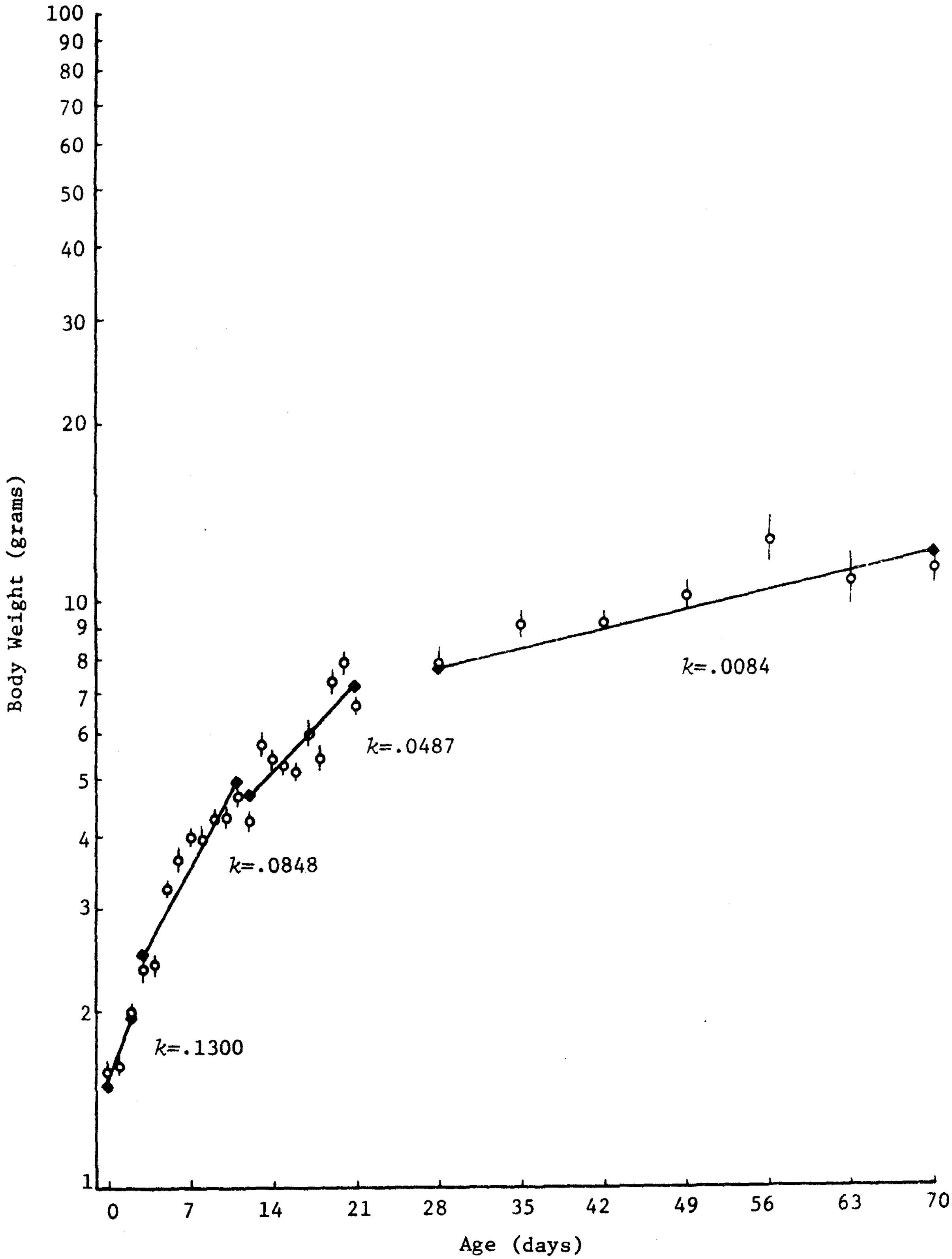


Figure 1. Means, standard errors (p=.95), and growth rates for body weight of *Reithrodontomys megalotis megalotis*.

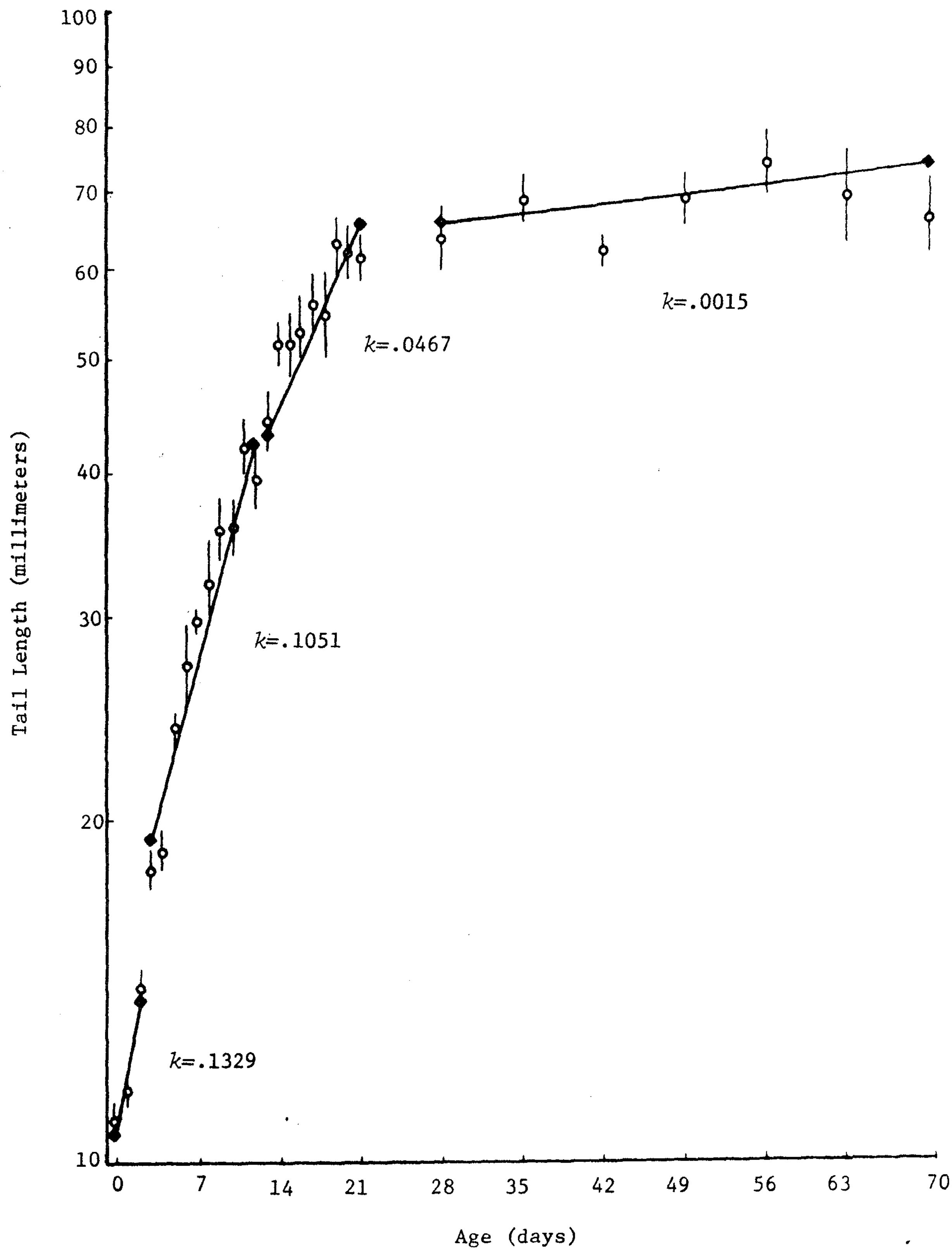


Figure 2. Means, standard errors (p=.95), and growth rates for tail length of *Reithrodontomys megalotis megalotis*.

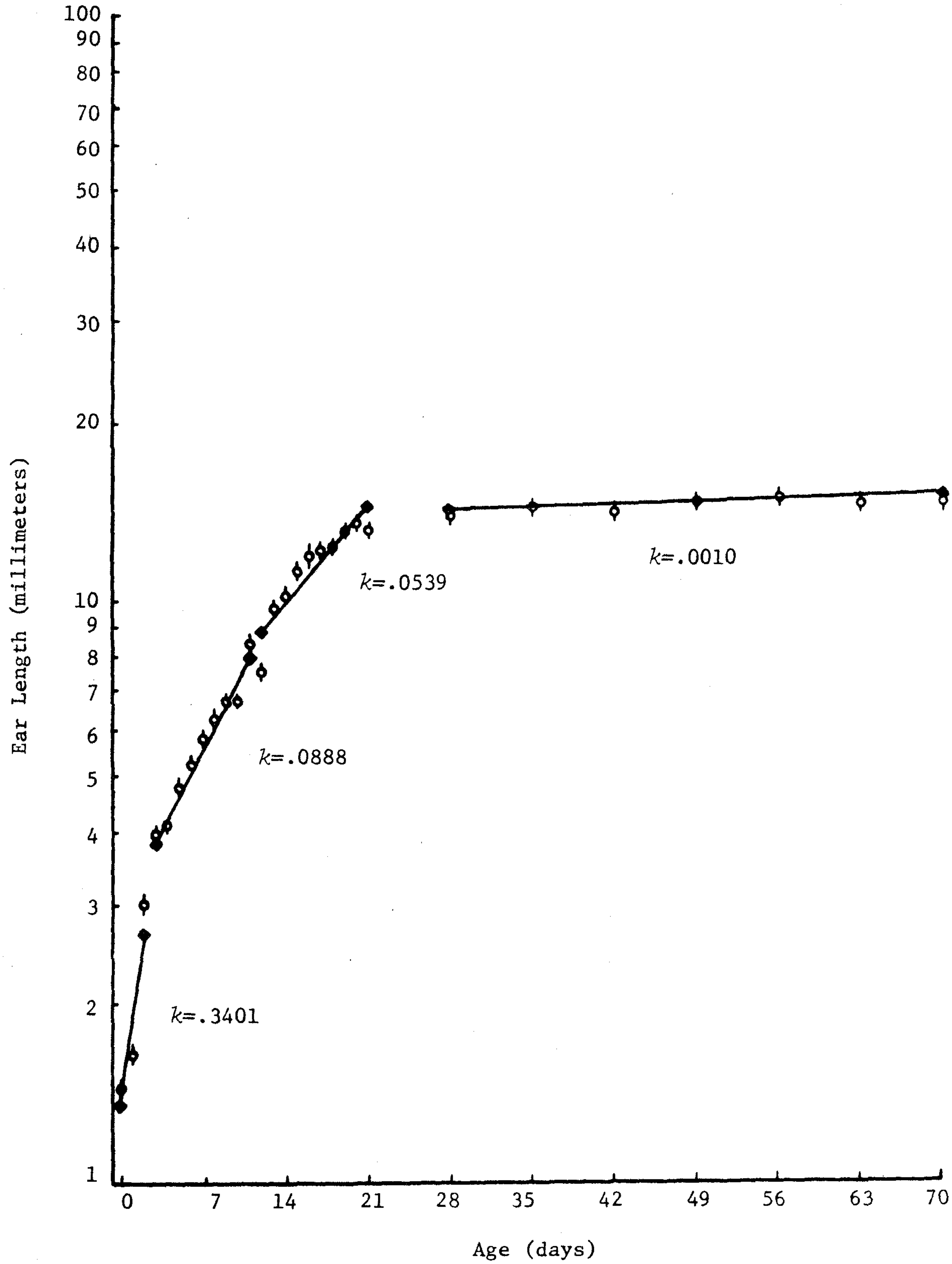


Figure 3. Means, standard errors (p=.95), and growth rates for ear length of *Reithrodontomys megalotis megalotis*.

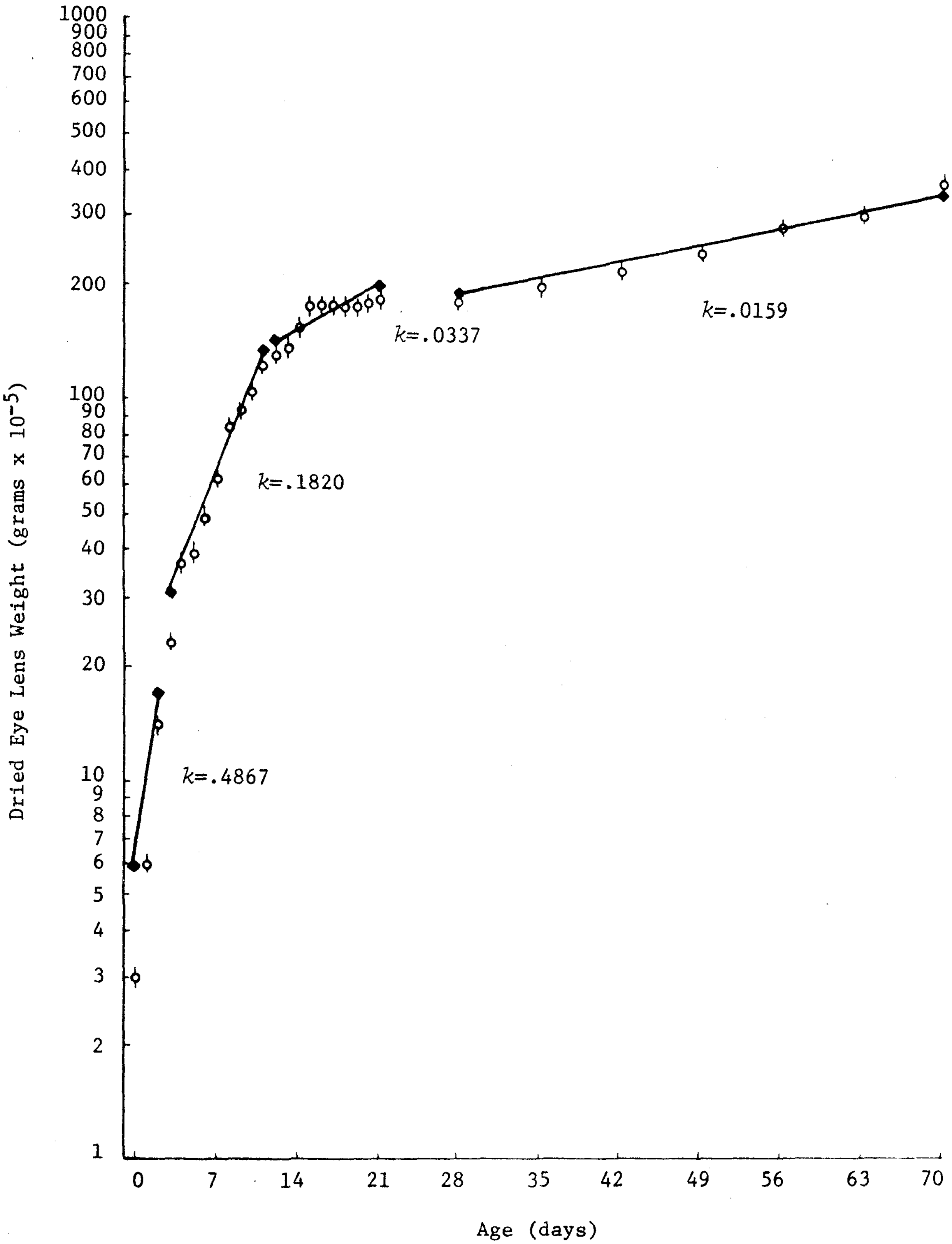


**Figure 4.** Means, standard errors (p=.95), and growth rates for dried eye lens weight of *Reithrodontomys megalotis megalotis*.

Litter Size

Litter size of 198 litters of *R. m. megalotis* varied (Table 3). Mean litter size was 3.83 with a range of 1-7 which is essentially identical with Bancroft's (1966) listing of an average litter size of 3.84 with a range of 1-7 for 114 litters of *R. m. dychei* but differs from that of other workers. Svihla (1931) studied *R. m. nigrescens* and *R. m. megalotis* and reported an average litter size of 2.60 with a range of 1-7 for 25 litters. Bailey (1936) reported litter size as ranging from 4-6 for *R. m. megalotis* in Oregon. Zukerman (1953) reported a mean of 2.0 with a range of 1-4 for *R. m. megalotis* in South Dakota. Egoscue, Bittmenn, and Petrovich (1970) reported that out of 1056 litters of *R. m. megalotis* examined, the maximum litter size was eight. Egoscue (1972) listed 4.27 as the average litter size with a range of 1-7 for 211 captive-bred litters of *R. m. megalotis*. Long (1962) reported on two *R. m. dychei* containing 8 and 9 embryos. Egoscue (1972) listed 4.64 as the average litter size with a range of 3-6 based upon embryo counts of 56 female *R. m. megalotis* wildtrapped from Tooele Co., Utah.

Litter size varied with the number of litters a female produced. In the present study, mean litter size of 69 first litters of *R. m. megalotis* was 3.29. Mean litter size increased to a high of 4.71 for 17 fourth litters, and decreased to 3.60 for five ninth litters (Table 3). Bancroft (1966) states that mean litter size of three *R. m. dychei* was 4.30 for first litters, increased to a maximum of 6.00 for fifth litters, and decreased to a low of 3.30 for eleventh litters.

Sex Ratio

The sex ratio at birth of 751 *R. m. megalotis* was 53.49% males

Table 3. Mean Number of Young *Reithrodontomys megalotis megalotis* Born in the Laboratory Per Successive Litter.

| Successive Litter Number | Number of Litters | Average | | | Percent | |
|---|---|---|---|---|---|---|
| | | Litter Size | Males | Females | Males | Females |
| 1 | 69 | 3.29 | 1.90 | 1.39 | 52.7 | 42.3 |
| 2 | 37 | 3.86 | 2.24 | 1.62 | 58.0 | 42.0 |
| 3 | 30 | 4.23 | 1.90 | 2.33 | 44.9 | 55.1 |
| 4 | 17 | 4.71 | 2.76 | 1.94 | 58.8 | 41.2 |
| 5 | 12 | 4.25 | 2.17 | 2.08 | 50.9 | 49.1 |
| 6 | 10 | 4.10 | 1.80 | 2.30 | 43.9 | 56.1 |
| 7 | 9 | 4.00 | 2.00 | 2.00 | 50.0 | 50.0 |
| 8 | 8 | 3.88 | 2.00 | 1.88 | 51.6 | 48.4 |
| 9 | 5 | 3.60 | 1.60 | 2.00 | 44.4 | 55.6 |
| 10 | 1 | 5.00 | 2.00 | 3.00 | 40.0 | 60.0 |
| 1 through 10 | 198 | 3.83 | 2.05 | 1.78 | 53.49 | 46.51 |

to 46.51% females (Table 3). This sex ratio varies from those previously reported. Bancroft (1966) reports a sex ratio at birth of 51% males to 49% females for 438 *R. m. dychei*. Egoscue (1972) lists a sex ratio of 50.99% males to 49.01% females for 901 *R. m. megalotis*. Layne (1959) found an even sex ratio at birth in *R. humulis*, but Kaye (1961) found a ratio of 33.3% males to 66.6% females for 27 *R. humulis*.

Reproductive Age

Svihla (1931) reported 128 days as the youngest age at which a male or female *R. m. megalotis* had been found to breed. Leraas (1938) found that female *R. montanus albescens* gave birth as early as 90 days. Layne (1959) reported that one female *R. humulis humulis* became pregnant at 77 days and males had enlarged testes as early as 49-56 days. Bancroft (1966) listed one female *R. megalotis dychei* as giving birth at 72 days, while males reached sexual maturity from 56-70 days.

During this study of *R. m. megalotis* a female 29 days old was paired with a male of 50 days old. This pairing resulted in a litter of four young born when the female and male parents were 62 and 83 days of age respectively. A 22-day gestation period evidenced that *R. m. megalotis* can become reproductively active as early as 38 and 59 days for females and males respectively, which supports the 35 days reported but unpublished by EcoDynamics (1971), but supplants previously published data.

Reproductive Efficiency

*R. megalotis* has the highest reproductive efficiency reported for any mammal. Table 4 lists reproductive efficiencies for 19 adult female *R. m. megalotis*. The highest reproductive efficiency reported

Table 4. Reproductive Efficiency for *Reithrodontomys megalotis megalotis*.

| | Weight (grams) | Litter Size | Litter Weight (grams) | Reproductive Efficiency |
|---|---|---|---|---|
| | 14.10 | 4 | 4.70 | 33.33 |
| | 12.90 | 5 | 5.70 | 44.19 |
| | 13.10 | 5 | 6.40 | 48.85 |
| | 13.40 | 4 | 6.95 | 51.87 |
| | 14.80 | 5 | 6.35 | 42.91 |
| | 14.00 | 5 | 6.70 | 47.86 |
| | 15.50 | 4 | 5.95 | 38.39 |
| | 14.20 | 4 | 5.00 | 35.21 |
| | 11.20 | 4 | 4.75 | 42.41 |
| | 14.30 | 5 | 7.10 | 49.65 |
| | 15.75 | 6 | 8.40 | 53.33 |
| | 15.00 | 6 | 7.80 | 52.00 |
| | 16.90 | 6 | 7.85 | 46.45 |
| | 11.75 | 3 | 3.70 | 31.48 |
| | 11.50 | 4 | 5.80 | 50.43 |
| | 12.30 | 4 | 5.80 | 47.15 |
| | 9.70 | 3 | 3.40 | 34.74 |
| | 12.50 | 4 | 5.65 | 45.20 |
| | 11.65 | 3 | 4.65 | 39.91 |
| Mean | 13.3973 | 4.4210 | 5.9289 | 43.4410 |
| Standard Error (p=.95) | ±0.7942 | ±.4203 | ±.5982 | ±2.9054 |

in this study was 53.33% for a litter of six young. The mean reproductive efficiency of the 19 animals listed (Table 4) was 43.44%. Frank (1956) listed *Microtus arvalis* as having the highest reproductive efficiency of any mammal, the litter weight amounting to 53.2% of the mother's weight, but Bancroft (1966) reported a high reproductive efficiency of 62.5% for a litter of five *R. m. dychei*. Kaye (1961) reported a high reproductive efficiency of 50.5% for *R. humulis*. Dunaway (1962) listed 77.7% as the reproductive efficiency of a litter of eight *R. humulis*, but since the measurements were taken some 10-50 hours after birth, they are probably not representative.

Reproductive Potential

Several factors contribute to the high reproductive potential of *R. megalotis:* early breeding, post-partum estrous, year-round breeding, high reproductive efficiency, and a short gestation period. Early breeding allows for a longer reproductive life. Post-partum estrous which was evidenced during this study enables *R. m. megalotis* to maximize the number of litters born during a single season. Bancroft (1966) also reported post-partum estrous in *R. m. dychei*. Although the harvest mice in this laboratory study bred year-round, this is not likely to occur in wild *R. m. megalotis* in Utah. The potential exists, however, and they may do so in the southern part of their range. Bancroft (1966) has expressed similar thoughts on *R. m. dychei*. A high reproductive efficiency allows a greater percentage of the energy intake to go for breeding purposes, thus maximizing reproductive potential. A short gestation period is also advantageous since it minimizes the time between successive litters.

Development

Birth. *R. m. megalotis* examined at birth were smooth, pink and naked, except for natal vibrissae. The ribs and viscera were visible through the semi-transparent skin of the venter. Eyes were closed and covered with a transparent membrane. The clear pupil in the center and the darker iris around the outside of the eye could be seen. A crease marking the fusion of the upper and lower eyelids was present above the pupil. The ear pinnae were folded and appressed to the head, the toes were fused and the nails were not present. The young vocalized faintly when handled. *R. m. megalotis* appear to be identical at birth with *R. m. dychei* as described by Bancroft (1966).

One day old. There was little change in appearance, but the ear pinnae were unfolded in some. A gray dorsal stripe was visible and the skin had lost its new-born transparency. No hair was evident, although Bancroft (1966) reported fine hair visible upon close examination of the dorsum in *R. m. dychei*. Layne (1959) reported abundant short and long hair on the dorsum of day-old *R. humulis*.

Two days old. Young *R. m. megalotis* moved the feet rapidly and vocalized sharply when handled. The dorsal pigmentation was darker, and dorsal hairs were visible when the young were held to the light. The toes were about one-third separated and the toenails were present. The ear pinnae were unfolded in all.

Three days old. The young clung to the female's nipple when she was disturbed and were often dragged around the nest several times before falling off. Vocalization was a high pitched squeak, 2-8/second. The toes were about one-half separated. The eye slits were visible.

The dorsal pigmentation was almost black and a white scaly epidermal material was also present on the dorsum. Epidermal scaling was also observed by Bancroft (1966) in *R. m. dychei* and by Layne (1959) in *R. humulis*.

Four days old. The toes were almost completely separated. The hair on the head was thicker and colored a pale gray-brown. Bancroft (1966) reported that *R. m. dychei* had claws approximately 5 mm. long, and that the ears were only fleshy lobes.

Five days old. Dorsal furring extended about one-third of the way along the back. The upper and lower incisors had erupted in some. Bancroft (1966) stated that the lower incisors had erupted in *R. m. dychei*. Layne (1959) also reported that the lower incisors were visible in *R. humulis*. Egoscue (1972) reported that a few hairs were visible on the venter in *R. m. megalotis*.

Six days old. There was little external change evident. Bancroft (1966) found that hair appeared on the dorsal side of the tail in *R. m. dychei*. Smith (1936) reported that the eyes first opened in *R. megalotis* but were of little use for 48 hours.

Seven days old. The dorsum was completely furred and the ventral hair was more pronounced. The mammae were visible in females. Bancroft (1966) found that the eyes were beginning to open in *R. m. dychei* but were not yet fully functional. Svihla (1931) found that the eyes opened on days 11-12 in *R. m. megalotis*, as did Brummel (1961). Leraas (1938) observed that the eyes opened on the eighth day in *R. montanus*. Layne (1959) reported that the eyes opened from days 7-10 in *R. humulis*. In the present study, the eyes of *R. megalotis megalotis* opened from days 9-13.

Eight days old. The external auditory meatus was open. The young were very active and vocal. In this study it was found that the opening of the external auditory meatus almost always preceded the opening of the eyes by one day.

Nine days old. The eyes were beginning to open. The venter, feet, and pinnae of ear were completely furred.

Ten days old. The eyes were open and fully functional in the majority of the young.

Fourteen days old. Face washing was observed. There was very little vocalization. Observations of the feces suggested that the young had taken some solid food.

Sixteen days old. Although nursing was observed until the sixteenth day, the majority of the young were completely weaned.

## Age Prediction

Since the correlation of growth parameters with age is significant (i.e. dried eye lens weight) one might consider using these parameters to predict age. Although the process seems evident at first, since it would simply involve reading the predicting age from a graph, the results are not meaningful because of the lack of variation among days. Calculation of confidence limits about the regression line presents special problems, because the X axis (age) is a non-random variable, selected arbitrarily by the investigator. Only the regression of Y on X (growth parameter on age) can be estimated accurately. Consequently, the regression of X on Y is not valid when found by the method of least squares, and the correlation coefficient cannot be determined. When the regression equation is used in predicting the age of unknown animals, age is a random variable (Dapson and Irland, 1972; Smith and Jorgensen, 1972). The analyses of these data to provide age determination awaits non-parametric procedures which should provide much better results and will be included in a later publication.

# SUMMARY AND CONCLUSIONS

The growth rate of *Reithrodontomys megalotis megalotis* can be divided into four distinct phases: 1-3, 4-12, 13-22, and 23-70 days; whereas *R. m. dychei* and *R. humulis humulis* have three and two growth phases respectively (Bancroft, 1966; Layne, 1959). Growth of *R. m. megalotis* through all four phases is most accurately characterized by tail length, ear length, and dried eye lens weight measurements.

*R. m. megalotis* had a 22-day gestation period, one day shorter than previously reported. Litter size varied from 1-7, and sex ratios at birth were approximately even.

Western harvest mice became reproductively active much earlier than previously reported. One *R. m. megalotis* became pregnant at 38 days of age.

A higher reproductive efficiency has been evidenced in *R. m. megalotis* than reported for any other mammal. Reproductive efficiencies of 53.33% and 62.5% listed in the present study and in Bancroft (1966) respectively, supplant the 53.2% previously reported by Frank (1956) for *Microtus arvalis*.

*R. m. megalotis* has a high reproductive potential due to early breeding, post-partum estrous, year-round breeding, high reproductive efficiency, and a short gestation period.

The development of *R. m. megalotis* closely followed that of *R. m. dychei* as reported by Bancroft (1966), but differed slightly in that the eyes opened from days 9-13 in *R. m. megalotis* while in *R. m. dychei* the eyes opened from days 7-11.

In the laboratory *R. m. megalotis* grows faster, has a shorter gestation period, has larger litters, breeds earlier, and has a higher reproductive efficiency than previously reported.

## LITERATURE CITED

Bailey, V. 1936. The mammals and life zones of Oregon. N. Amer. Fauna 55:1-416.

Bancroft, William L. 1966. Reproduction, development and behavior of the western harvest mouse, *Reithrodontomys megalotis*. Unpubl. Masters Thesis, U. of Kansas. 80 pp.

________. 1967. Record fecundity for *Reithrodontomys megalotis*. J. Mammal. 48:306-308.

Brody, Samuel. 1945. Time relations of growth of individuals and populations. *In:* Bioenergetics and Growth, Reinhold, N. Y. 1023 pp.

Brummel, C. N. 1961. Some aspects of the life history and ecology of the western harvest mouse in southeastern South Dakota. Proc. South Dakota Acad. Sci. 40:85-92.

Dapson, Richard W. and Jacquiline M. Irland. 1972. An accurate method of determining age in small mammals. J. Mammal. 53(1):100-106.

Dunaway, Paul B. 1962. Litter size record of eastern harvest mouse. J. Mammal. 43(3):428-429.

EcoDynamics, 1971. Ecological studies in western Utah, Annual Report. EcoDynamics Inc., Salt Lake City, Utah. 116 pp.

Egoscue, H. J., J. G. Bittmenn, and J. A. Petrovich. 1970. Some fecundity and longevity records for captive small mammals. J. Mammal. 51(3):622-623.

Egoscue, H. J. 1972. Personal communication, 20 December, 1972.

Frank, Fritz. 1957. The causalty of microtine cycles in Germany. J. Wildl. Mgmt. 21(2):113-121.

Holding, B. F. and O. L. Royal. 1952. The development of a young harvest mouse, *Reithrodontomys*. J. Mammal. 33:388.

Humason, G. L. 1967. Animal Tissue Techniques. 2 ed., W. H. Freeman and Co., San Francisco. pp. 179-181.

Kaye, S. V. 1961. Laboratory life history of the eastern harvest mouse. Am. Midl. Nat. 66:439-451.

Lackey, James A. 1967. Growth and development of *Dipodomys stephensi*. J. Mammal. 48:624-632.

Layne, J. N. 1959. Growth and development of the eastern harvest mouse, *Reithrodontomys humulis*. Bull. Florida State Mus., Biol. Sci. 4(2):61-82.

Leraas, H. J. 1938. Observations on the growth and behavior of harvest mice. J. Mammal. 19:441-444.

Long, C. A. 1962. Records of reproduction for harvest mice. J. Mammal. 43:103-104.

Smith, Clarence F. 1936. Notes on the habits of the long-tailed harvest mouse. J. Mammal. 17(3):276-278.

Smith, H. D. and C. D. Jorgensen. 1972. Demographic and individual growth studies for *Dipodomys ordii* and *Peromyscus maniculatus*. Desert Biome IBP. Progress Rpt. December 31, 1972.

Svihla, Ruth Dowell. 1930. Notes on the golden harvest mouse. J. Mammal. 11(1):53-54.

_______. 1931. Notes on the desert and dusky harvest mouse (*Reithrodontomys megalotis megalotis* and *R. m. nigrescens*). J. Mammal. 12:363-365.

Zukerman, S. 1953. The breeding seasons of mammals in captivity. Proc. Zool. Soc. London 122:827-950.

# VITA

Gary H. Richins

GROWTH AND DEVELOPMENT OF THE WESTERN HARVEST MOUSE,

*REITHRODONTOMYS MEGALOTIS MEGALOTIS*

Gary H. Richins

Department of Zoology

M. S. Degree, August 1973

ABSTRACT

Growth rates, gestation period, litter size, reproductive age, sex ratios, and development were studied on 198 litters of *Reithrodontomys megalotis megalotis*. Growth was characterized by several standard skull and body measurements, and was partitioned into four phases of 1-3, 4-12, 13-22, and 23-70 days. Growth was best described by measurements of tail length, ear length, and dried eye lens weight.

Reproductive activity began as early as 38 days for females and 59 days for males. Gestation period was 22 days and mean litter size was 3.83 (range 1-7). Sex ratio was 53.49% males to 46.51% females. Reproductive efficiency was 53.53%. The development of *R. m. megalotis* was very similar to that of *R. m. dychei*.

Early breeding, post-partum estrous, year-round breeding, high reproductive efficiency, and a short gestation period contribute to a high reproductive potential in *R. m. megalotis*.

COMMITTEE APPROVAL: