A STUDY OF A GRAY SQUIRREL (SCIURUS CAROLINENSIS) POPULATION LOCATED IN MONTGOMERY COUNTY, TENNESSEE

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An Abstract

Presented to

the Graduate Council of

Austin Peay State University

In Partial Fulfillment

of the Requirements of the Degree

Master of Science

in Biology

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by

Charles Carroll Woolwine IV

August, 1977

ABSTRACT

The gray squirrel (Sciurus carolinensis) is an important Tennessee game species and information concerning the management of this small mammal is always of importance to wildlife managers.

Many population studies have been made of this small game animal. However, no research prior to the present study has been conducted concerning a gray squirrel population in Montgomery County, Tennessee.

From 5 August 1976 to 4 August 1977, a gray squirrel population located in Greenwood Cemetery was studied. Data were collected concerning minimum home range, annual reproductive cycle, annual and seasonal body weight, annual changes in adult male genital anatomy and reproductive activity, and social hierarchy.

The following are some general conclusions derived from this study:

1. The mean minimum home range of adult males was significantly larger than all other age/sex categories. The minimum home range of juvenile males was significantly larger than that of juvenile females.
2. The gray squirrel population utilized a biannual reproductive cycle.

3. The seasonal body weights of the various age/sex categories did not vary significantly. This was probably due to the abundance of food and water.

4. The testes of adult males probably follow an annual photoperiodic cycle. However, the individuals are not necessarily sexually active when the testes are in the scrotal position.

5. Social hierarchy is established within the gray squirrel population. Adult males were dominant over all age/sex categories. However, exceptions to the established hierarchy occurred during various phases of the reproductive cycle.

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August, 1977

To the Graduate Council:

I am submitting herewith a thesis written by Charles Carroll Woolwine IV entitled "A Study of a Gray Squirrel (Sciurus carolinensis) Population Located in Montgomery County, Tennessee." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Biology.

Marvin D. Stone
Major Professor

We have read this thesis and recommend its acceptance:

Second Committee Member

Third Committee Member

Accepted for the Council:

William H. Ellis

ACKNOWLEDGEMENTS

Few works represent the work of one man. This study, in turn, is the result of the support, cooperation, and assistance of several organizations and individuals, and it is a pleasure to recognize their contributions.

The author wishes to express appreciation to Dr. Marvin M. Provo, Professor of Biology, Austin Peay State University, who made many valuable suggestions during the course of research and writing of the manuscript; to Dr. Diane I. Findley, Associate Professor of Biology, and Mr. Floyd L. Brown, Associate Professor of Biology, for their suggestions and constructive criticisms of the manuscript.

I am deeply indebted to my parents for the inspiration given me as a child and for their unstinting financial help and encouragement given me as an undergraduate.

Special thanks is extended to the staff of Greenwood Cemetery for allowing this study to take place, and for aiding in the collection of data.

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CHAPTER I

INTRODUCTION

The gray squirrel (Sciurus carolinensis) is one of the most loved animals in the United States. It holds a great degree of interest for casual city park visitors, hunters, naturalists and the nature hobbyist. As is the case with many small mammals, little is known concerning minimum home range, the reproductive cycle or social hierarchy of the gray squirrel in Tennessee.

These three concepts are fundamental to a basic understanding of the life cycle of mammals. A familiarity with these factors could prove to be a valuable tool for the game manager or perhaps the manager of a city park. They could be utilized in setting up the proper number of winter feeding stations placed at the most effective number per acre, erecting effective nesting boxes and establishing the most desirable hunting seasons which would help maintain a well-balanced gray squirrel population.

In the past two decades, there have been various studies in several states concerning not only gray squirrels, but many other game animals. This interest in life history studies may be due to the continuing rise in the popularity of hunting or perhaps it is due to the fairly new awakening to the fact that we as a nation must become more con-

servation and ecology minded. As the human population grows and participation in hunting increases, it will become more and more difficult to maintain our natural populations of sought-after game animals. That is why as much sound information as possible should be accumulated now to insure a more complete understanding of the population dynamics of both game and non-game animals. Already, in many urban areas, the only location a student can go to observe gray squirrels and other animals first-hand is to a city park. Perhaps, especially in these urban areas, a full understanding of the organism is required for proper management and preservation of the already delicately balanced populations.

Surprisingly, the state of Tennessee has had relatively little work done concerning the life history of gray squirrels. This may be due to the great abundance of the animal throughout the state which creates a lack of immediate concern for its welfare. Whatever the reason, the author has selected to study this organism due to a personal interest based upon many years of observing and hunting. The writer was fortunate in locating a site that provided an excellent opportunity to conduct a study of a relatively undisturbed population.

The major objectives of the study were:

1. To determine the minimum home range for various age/sex categories.
2. To establish the annual reproductive cycle, as well as record the changes in reproductive organs which may occur during the various phases of the reproductive cycle.

3. To investigate any existing social hierarchy or "pecking order" which may exist.

It is the author's hope that the results will be a contribution to wise game management and responsible establishment of hunting seasons. Also, it is desired that future studies will be compared to this one to gain a fuller understanding of the gray squirrel in Tennessee. Since factors affecting populations continually change, it is only through continual study that an up-to-date and meaningful game management program can be maintained. In the absence of adverse climatic conditions which could result in mast failure, there is practically no reason why the citizens of Tennessee cannot enjoy a balanced and adequate gray squirrel population for many future generations.

CHAPTER II

LITERATURE REVIEW

Sciurus carolinensis has been studied extensively. Flyger's (1951) bibliography of squirrel literature emphasizes the enormous amount of literature which has been produced concerning the gray squirrel since 1865.

In 1929 Seton published a general overview of game animals which included gray squirrels. This work is still fairly accurate and is valuable in studies dealing with game animals.

Many states have had thorough population probes done concerning various gray squirrel populations. Goodrum (1940) conducted a population study of the gray squirrel in eastern Texas. His study included habitat preference, population size, and other ecological factors affecting population dynamics and the economic status of the gray squirrel. A similar study was published by Brown and Yeager in 1945 concerning the gray squirrels in Illinois. This paper was extremely thorough and comprehensive in its presentation. Another state, California, had a study conducted in Ingles (1947) concerning their gray squirrel populations; Indiana, likewise, had a comprehensive study conducted by Allen in 1952. Also, in 1952 Wingart produced a short but accurate description of S. carolinensis in his state of Pennsylvania. Uhlig (1955c) published

his findings dealing with a population in West Virginia, and Alabama had a publication distributed in 1958 by Colin and Kyle which aided in the understanding of that state's gray squirrels.

Perhaps some of the most interesting literature comes from studies conducted in the British Isles. Around 1830 gray squirrels were imported from the United States to England. Since that time, the squirrels have virtually taken over the country. Many population studies have been conducted to see if there is any way of controlling the spread of this intruder. The acknowledged leader of these studies in the 1930's was A. D. Middleton who wrote extensively concerning his work with this animal (Middleton, 1930, 1931).

In Tennessee there appears to have been very little research conducted concerning this popular game animal. The studies which have been accomplished deal mainly with the effect of hunting upon the gray squirrel populations. Specifically, the effect of the 1949 hunting season upon the 1950-51 season was examined by Marsh (1951), and in 1957 Schultz studied the overall status of the gray and fox squirrel in Tennessee.

Although most squirrel population studies deal little with capturing and tagging, the following articles are exceptions. Baumgartner (1940) discussed the use of wooden traps and wire handling cages, as well as the marking of squirrels. Fitzwater (1943) described techniques of color marking squirrels which have not been greatly improved upon

since his study. In 1972 Hadow introduced a method of freeze branding which would be of tremendous value if the necessary equipment was readily available. Donohoe and Beal (1972) presented results in which they described an effective radiotelemetry system for use with gray squirrels.

A subject of which one must be aware before working with squirrels is the phenomenon of fear-stress and trap shock in captured gray squirrels. Both of these have been adequately described by Guthrie (1965) and Hanson (1966). In both these studies, it was found that shock resulting from confinement was characterized by convulsions and subsequently unconsciousness, leading to death. Therefore, it is important that frequent trap visitation and efficient handling of the animals be established to insure success.

Gardner (1930) gave a brief but useful description of hand-reared squirrels which could be utilized in the aging of young gray squirrel nestlings. A comprehensive description of the aging of nestling and sub-adult gray squirrels was also prepared by Uhlig (1955a) for West Virginia populations. His inquest techniques make it rather easy to age squirrels if one has the necessary data. Aging by the use of tail pelage became rather accurate after Sharp (1958) published his work. In 1967 Barrier and Barkalow published a paper in which a method of aging gray squirrels which were in winter pelage was established. When used together, the author feels that these three methods provide a rather accurate method of determining the age of gray squirrels. The next

method appears to be rather accurate, but requires the sacrificing of the animal, and therefore was never utilized by the author. It concerns the estimating of age by eye lens weight as presented by Fisher and Perry (1970).

Uhlig (1955b) published work in which the weights of adult gray squirrels were examined. These data concerned natural populations and can be favorably compared with the work of Short and Duke (1971) in which weight limits of captive tree squirrels were determined.

The literature concerning home range and territoriality is rather extensive. In 1934 Goodwin investigated the phenomenon of gray squirrel migrations and was followed in 1936 by Gordon who reported on the territoriality of this animal in Colorado and Oregon. A general study of concepts of home range as applied to mammals was presented by Burt in 1943, and another such article was published by Hayne in 1949. A critical and valuable piece of work was done by Davis in 1953, in which he studied home range as determined from recapture data.

A very much needed work was published in 1954 by Lucille F. Stickle. In her work, she explained and compared the existing methods of determining mammalian home range.

In 1956 Hibbard did work concerning the range and spread of gray squirrels in North Dakota. Harrison (1958), investigating the home range of Malayan rats, utilized a statistical system in which probability zones were utilized to determine a center of activity. From

this the probability of an animal being in various rings around this center could be determined. Taylor (1966), while studying the destructive habits of gray squirrels in relation to the stripping of bark from trees, took a close look at the home range of gray squirrels. In 1973 Cordes and Barkalow examined the home range of a North Carolina gray squirrel population.

The transportation of nestling squirrels by the parents to new locations has been documented in the past. This activity has a tendency to either change the size of or alter the center of activity of the home range. This litter movement has been reported on by Hatt (1927), Packard (1954), and again by Nichols in 1958.

Fairly recently home range and movement have been explored through the use of small radio transmitters attached to individual squirrels. Beal (1967) produced a rather effective radio transmitter collar for squirrels, and Nixon, Beal, and Donohoe (1968) studied litter movements through the use of radiotelemetry. Donohoe and Beal (1972) obtained useful but limited home range information through radiotelemetry while working with squirrels in Ohio.

In several of the population studies previously referred to, reproductive cycles were investigated. However, there have been specific studies which should be noted. In England such a study came forth in 1933 in which the oestrous cycle of the gray squirrel was described in great detail by Deanesly and Parkes. The breeding seasons of a population in Edmonson County, Kentucky were reported on by

Hibbard (1935), and a similar study was conducted concerning gray squirrels living in Maryland and Pennsylvania by Flyger (1952). This was the beginning of a tremendous number of squirrel studies produced by Vagn Flyger. Barber (1953) described the behavior and breeding seasons of gray squirrels in Kentucky, and in 1955 Kirkpatrick described the phases of the testes of the fox squirrel in relation to age and breeding seasons. In Ohio the breeding seasons of the gray squirrel, as well as the fecundity of the female, was probed by Nixon and McClain in 1975. Also, in 1975 Barkalow and Soots studied and published concerning the reproductive longevity of the gray squirrel in Wake County, North Carolina. In this study, it was found that females lived at least 12.52 years, and males lived at least 8.99 years. In regard to reproductive activity, it was shown that females were reproductively active for 7.96 years and possibly up to 12.52 years. Males were active for 6.61 years and possibly up to 8.99 years.

The social behavior of gray squirrels in Maryland was investigated by Flyger in 1955, and a summary of work concerning the social behavior of gray squirrels was presented by Bakken (1959) at the 13th Annual Conference of the Southeast Association of Game and Fish Commissions. The results of a thorough investigation of the complete ontogeny of social behavior in gray squirrels was published in 1972 by Horwich. The writer found this article most helpful in his research, and it should be useful in similar future studies.

In addition to social behavior, social dominance or a type of "pecking order" has also been dealt with through various studies. The social hierarchy of gray squirrels in Virginia was dealt with by Pack, Mosby, and Siegel in 1967. This hierarchy was again studied in North Carolina by Ackerman and Weigl in 1970. In their study, not only was interspecific hierarchy examined, but also intraspecific hierarchy between gray and red squirrels (Tamiasciurus hudsonicus).

This brief literature survey reveals that the number of gray squirrel studies which have been performed are indeed numerous. However, research dealing with gray squirrels in Tennessee is surprisingly lacking, and almost every facet of the life history and ecology of the gray squirrel needs further in-depth study.

CHAPTER III

METHODS AND MATERIALS

Study Area

The study area consists of a portion of Greenwood Cemetery located in Montgomery County, Tennessee. The cemetery is located .7 of a mile north of the Cumberland River which is the southern city limits of the city of Clarksville. The area is bounded on the east and south by a deciduous forest, to the north by other portions of the cemetery, and to the west by a paved city street and beyond this is a housing development (Figure 1).

The study area consists of 13.94 acres which are divided by access roads into seven sections which were labeled A, B, C, D, E1, E2, and F. All of the areas are level except area B which descends gradually from west to east, and area F which is a circular sinkhole. The acreage and overstories of each area are described in Tables I and II.

Traps and Trap Sites

The trees utilized in each area as trap sites were permanently labeled with numbered metal corner fasteners, thus providing permanent capture sites (Figure 2). Trees were utilized as capture sites due to the ease with which traps could be secured with chain.

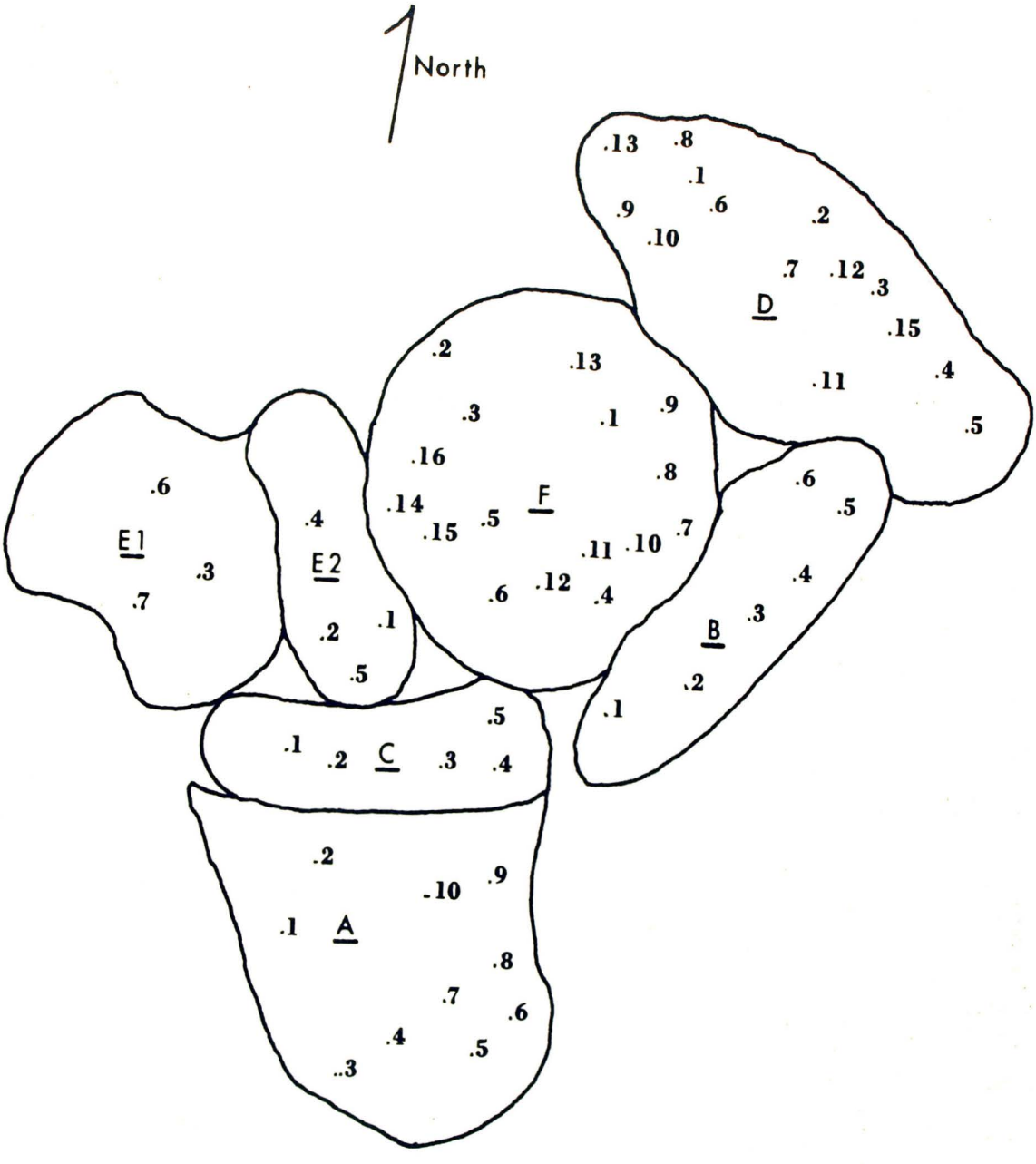

FIGURE 1

Study Area (1" = 183')
and Trap Sites

TABLE I

Acreage Per Area

Area	Acreage
A	2.62
B	1.41
C	1.16
D	2.95
E1	1.58
E2	.89
F	3.33
TOTAL	13.94

TABLE II

Overstory Composition

TREES	AREA							TOTAL
	A	B	C	D	E1	E2	F	
Tsuga canadensis (Eastern Hemlock)	2	2	1	3	3	1	1	13
Albizia julibrissin (Mimosa)					2			2
Quercus velutina (Black Oak)	3						1	4
Chamaecyparis thyoides (Atlantic White Cedar)	5							5
Quercus alba (White Oak)	1	4	1	3		1	1	11
Acer saccharum (Sugar Maple)	2	7	5	17	8	5	16	60
Cornus florida (Flowering Dogwood)	2		2	10	9	1	4	28
Juglans nigra (Black Walnut)	1						19	20
Carya ovata (Shagbark Hickory)	1							1
Picea mariana (Norway Spruce)						1	3	4
Carya tomentosa (Mockernut Hickory)	2							2

TABLE II (Continued)

TREES	AREA							TOTAL
	A	B	C	D	E1	E2	F	
Aesculus glabra (Ohio Buckeye)							1	1
Prunus serotina (Black Cherry)	1				1		3	5
Carya glabra (Pignut Hickory)	1	1	1	1	1			5
Acer platanoides (Norway Maple)							1	1
Oxydendrum arboreum (Sourwood)	3		1	2			2	8
Fraxinus americana (White Ash)	2	1			1		1	5
Morus alba (White Mulberry)							1	1
Ulmus americana (American Elm)	1	1		1				3
Thuja occidentalis (Northern White Cedar)				4				4
Fagus sp. (Beech)		1		1				2
Carya cordiformis (Bitternut Hickory)		1				1	3	5
Cercis canadensis (Redbud)			3	2	1		5	11
Ilex opaca (American Holly)			1		3		1	5

TABLE II (Continued)

TREES	AREA							TOTAL
	A	B	C	D	E1	E2	F	
Tilia americana (American Basswood)			1	1				2
Magnolia virginiana (Sweetbay Magnolia)				1	1	1		3
Ginkgo biloba (Ginkgo)				2	1	1	1	5
Liquidambar styraciflua (Sweetgum)				2				2
Ulmus alata (Winged Elm)				1				1
Larix laricina (American Larch)				1				1
Picea glauca (White Spruce)				1				1
Celtis occidentalis (American Hackberry)				2			7	9
Taxodium distichum (Bald Cypress)					1			1

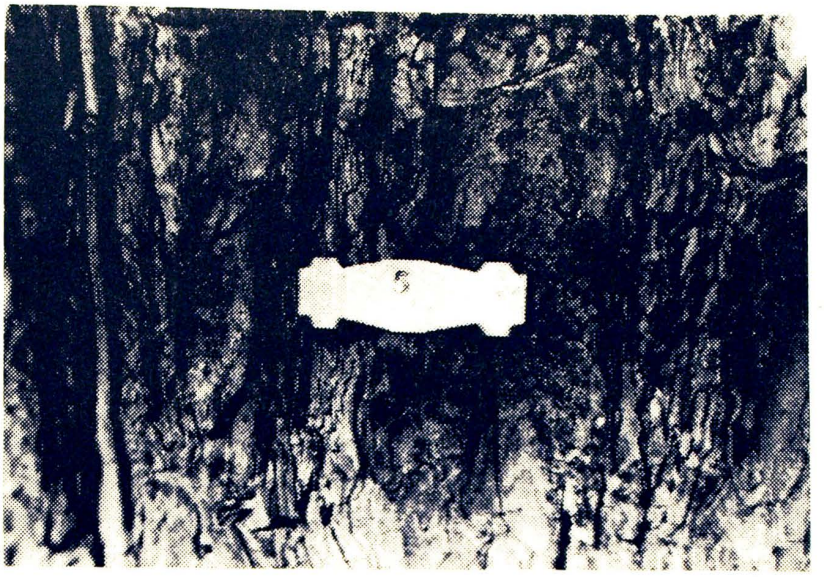

FIGURE 2

Trap Site Tag

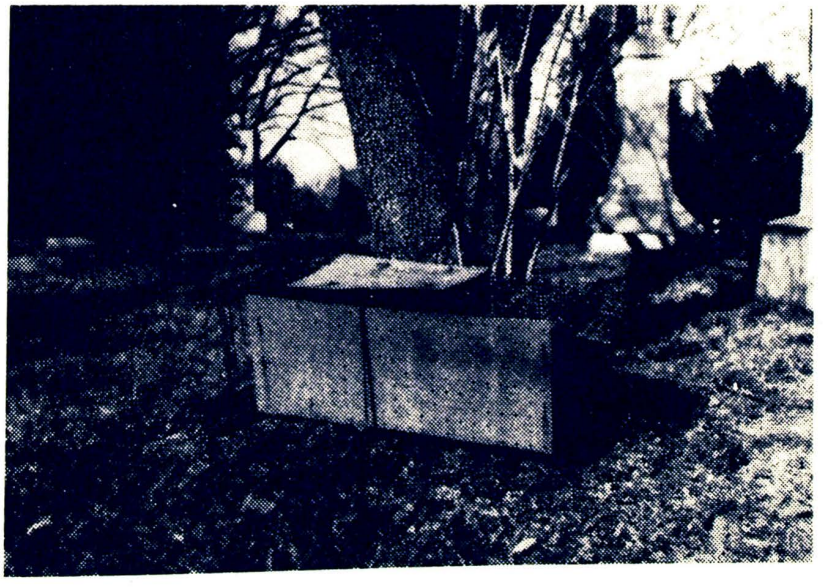

FIGURE 3

Modified Treadle Trap

The squirrels were live-trapped in 9" X 9" X 24" treadle-type wire traps. The traps were modified with 1/8th inch masonite pegboard. This was found to inhibit trap-shock and harassment by dogs (Figure 3).

Handling Box

Initially, the entire trap was placed in a wooden box with a plexiglass front, and ether was directly applied to subdue the animal (Figure 4). This worked fairly well; however, it was rather time-consuming and required a lot of ether. Therefore, a holding box with a sliding-door was constructed of clear 1/8" plexiglass. The squirrel was transferred from the trap to the "knock-out" box where it was anaesthetized (Figure 5).

The squirrel was determined to be unconscious by a lack of body movement and rapid, uncontrolled eye movement. As soon as these signs were noticed, the squirrel was immediately removed for processing. Usually, 2 teaspoons of ether was sufficient to subdue a squirrel for approximately 3 minutes. The amount of ether utilized was not as important as watching for the critical signs of unconsciousness. By using this method, only one squirrel was killed due to an overdose.

Data Collection

Each squirrel was sexed by external observation. The age was determined by a combination of three methods. These were: tail-pelage patterns as described by Sharp (1958), weight categories as defined by Uhlig (1955a, 1955b), and during the winter months rump-pelage was

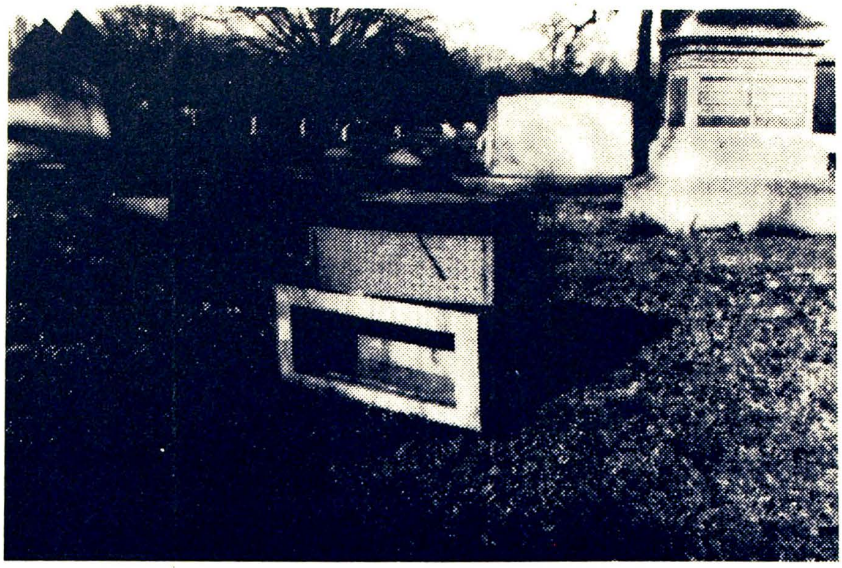

FIGURE 4

Wooden Knockout Box

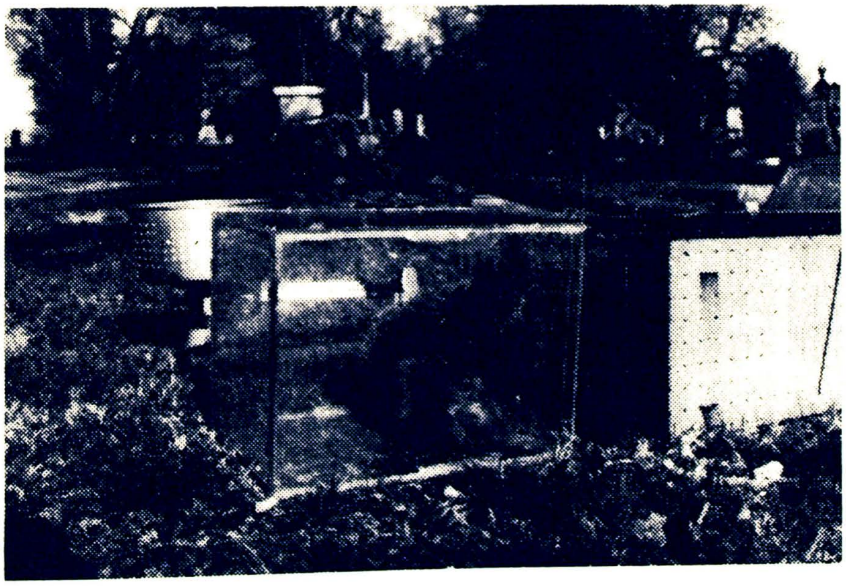

FIGURE 5

Plexiglass Knockout Box

utilized as described by Barrier and Barkalow (1967). A total of six age/sex categories were established for the squirrels: Adult Male, Juvenile Male, Nestling Male, and the female equivalents. A nestling was defined as that individual which had not yet initially left the den tree, and was usually no more than 10 weeks old. This is very similar to the nestling category described by Uhlig (1955a). The term juvenile referred to the individual which had left the den tree but was not sexually mature, and an adult was sexually mature (Brown and Yeager, 1945). Nestlings were only trapped under unusual conditions such as during a litter movement or perhaps following parental abandonment which forced the young onto the ground earlier than normal.

Once sexed and placed in the proper age category, the squirrel was weighed in grams on a triple-beam balance. Next, the animal was ear tagged with an individually numbered aluminum tag. The tags utilized were Rabbit Ear Tags (4-41) obtained from the National Band and Tag Company (Newport, KY.). Colored plastic washers (4-42) were affixed to the opposite side of the metal tag to aid in categorizing the individual squirrel for field recognition. Males were tagged in the right ear and females the left ear. Adults received red washers, juveniles orange, and nestlings received white washers (Figure 6).

In the latter stages of the study, squirrels were marked with an individual identifying pattern of Jamar D fur dye. Jamar D produces a blackened area of fur which is highly visible (Figure 7). A sample of the

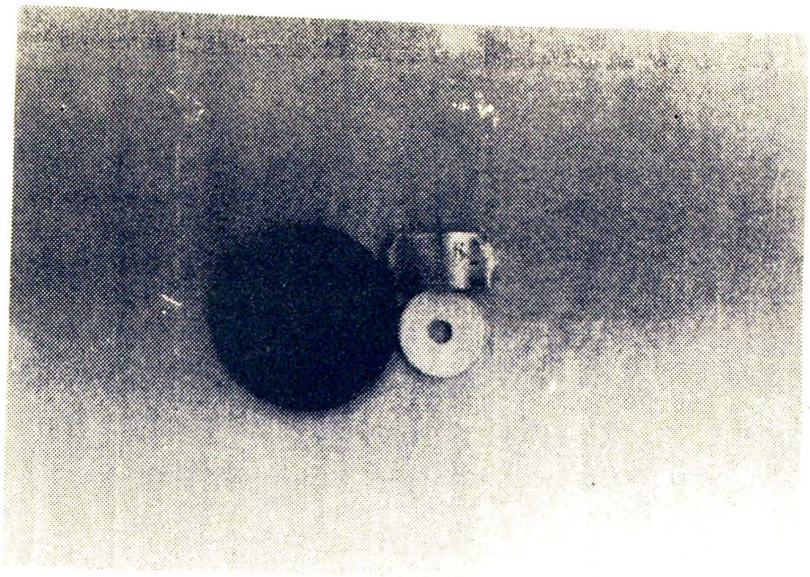

FIGURE 6a

Ear Tag System

FIGURE 6b

Ear Tag Attached

FIGURE 7

Jamar D Marking

patterns utilized is shown in Figure 8. This dye is commercially available from the Jamar Chemical Company, North Andover, Maine.

The reproductive status of the squirrels was determined in the following manner: A female was considered lactating if the nipples were enlarged and milk could be produced by gentle kneading. Also, if birth had taken place, the hair surrounding the nipple was often pushed down or absent due to the nursing of the young. On young female squirrels, there was often no visible indication of mammary glands (Brown and Yeager, 1945). Male squirrels were classified as to testicular position and scrotal condition. The three testicular categories utilized were abdominal, inguinal and scrotal. A darkly pigmented scrotum relatively free from hair and containing testes was usually indicative of an individual that was sexually mature and in breeding condition. A scrotum covered with hair and rather shrunken indicated sexual quiescence (Brauer and Dusing, 1961).

Minimum home range was determined by a method similar to that described by Flyger (1960). An aerial photograph of the study area on a scale of 1:100 was obtained from Atlantic Aerial Surveys, Huntsville, Alabama. An overlay was constructed on clear acetate, and all trap sites labeled. The outermost points of capture and dye sightings were connected for those animals with a minimum of four points of known home range. A polar planimeter was then employed to determine the minimum home range area which was then converted to acres. Initially a grid system was to be utilized. This was abandoned due to a high

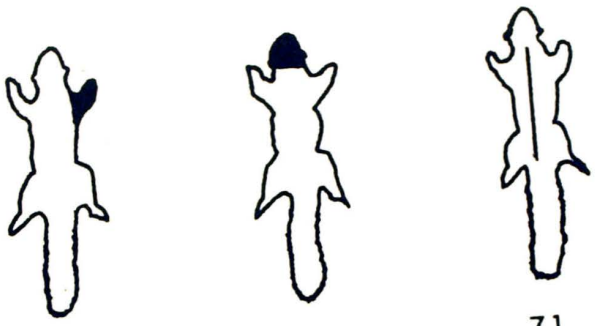

FIGURE 8

Sample Marking Patterns

incidence of theft which forced the traps to be chained to trees. The initial 25 traps were concentrated in designated areas and were rotated every two to three weeks depending upon the weather. The theft and destruction of traps forced a reduction in area saturation until eventually only one area could be trapped at a time.

The annual reproductive cycle was established by a cross-check of three systems. The condition of the reproductive organs was one factor. A second indicator was direct observation of sexual behavior among squirrels as described by Horwich in 1972. The third system was the trapping or location of nestlings or juveniles which had recently left the den tree. In this instance, extrapolation based upon weights and gestation period was employed to arrive at copulation and birth dates. The work of Brauer and Dusing (1961) and Uhlig (1955a) was utilized as a guide for this phase of the study.

Social behavior was determined by a code developed from the paper presented by Horwich (1972). The code utilized is shown in Figure 9. Observation of tagged and dyed squirrels was utilized exclusively for this portion of the study.

The social hierarchy for age/sex categories was established by the utilization of an encounter-submission code (Figure 10) used while observing squirrels. When two squirrels encountered one another, the result was noted as a number which represented one individual showing dominance over another. Submission was indicated by the acquisition of

FIGURE 9

Social Code

A. Play
   1. Locomotory
   2. Other; including sexual play

B. Defensive Behavior
   1. Retreat
   2. Growling from den hole
   3. Jumping at

C. Aggressive Behavior
   1. Jumping at aggressively
   2. Chasing
   3. Running at
   4. Pawing

D. Comfort Behavior
   1. Social grooming
   2. Wash-Groom-Comb sequence

E. Reproductive Behavior
   1. Female intolerant of male advances
   2. Sniff/lick vaginal area
   3. Males gang up on "by-standing" male
   4. Males become very aggressive towards each other, and female runs to hole of den, or turns to face leading male
   5. Lead male maintains prime position near female
   6. Male approaches female very carefully
   7. If female leaves, males follow or search for her emitting a "stifled sneeze" vocalization which only occurs at this stage of mating
   8. Female approaches a male of her choice
   9. Copulation
   10. Male grooms penis

FIGURE 10

Social Hierarchy Code

*1. AM/AM
2. AM/AF
3. AM/JM
4. AM/JF
5. AF/AF
6. AF/AM
7. AF/JF
8. AF/JM
9. JF/AF
10. JF/JF
11. JF/AM
12. JF/JM
13. JM/AF
14. JM/JF
15. JM/AM
16. JM/JM

* #1 indicates Adult Male demonstrated dominance over another Adult Male.

the posture or actions as described by Pack, Mosby, and Siegel (1967) and Horwich (1972).

CHAPTER IV

RESULTS

During the period of 5 August 1976 to 4 August 1977, a total of 468 hours was spent in the field managing traps or observing gray squirrel behavior. During this time interval, 3,008 trap days were recorded.

Minimum Home Range

The total capture data is summarized in the Appendix. The minimum home range of the squirrels with a minimum of four recapture/dye sightings is summarized in Figure 11. Using Duncan's Multiple Range and the Student-t test both at the .05 level of significance, it was determined that the adult male's minimum home range was significantly larger than all other age/sex categories. The only other category which was significantly different from another was that of the juvenile male's as opposed to the juvenile female's category.

The minimum home range of dyed individuals as opposed to the tagged-only individuals is summarized in Table III. At the .05 level of significance, every age/sex category of dyed squirrels was larger than their tagged-only counterparts. The Student-t test was utilized for this analysis.

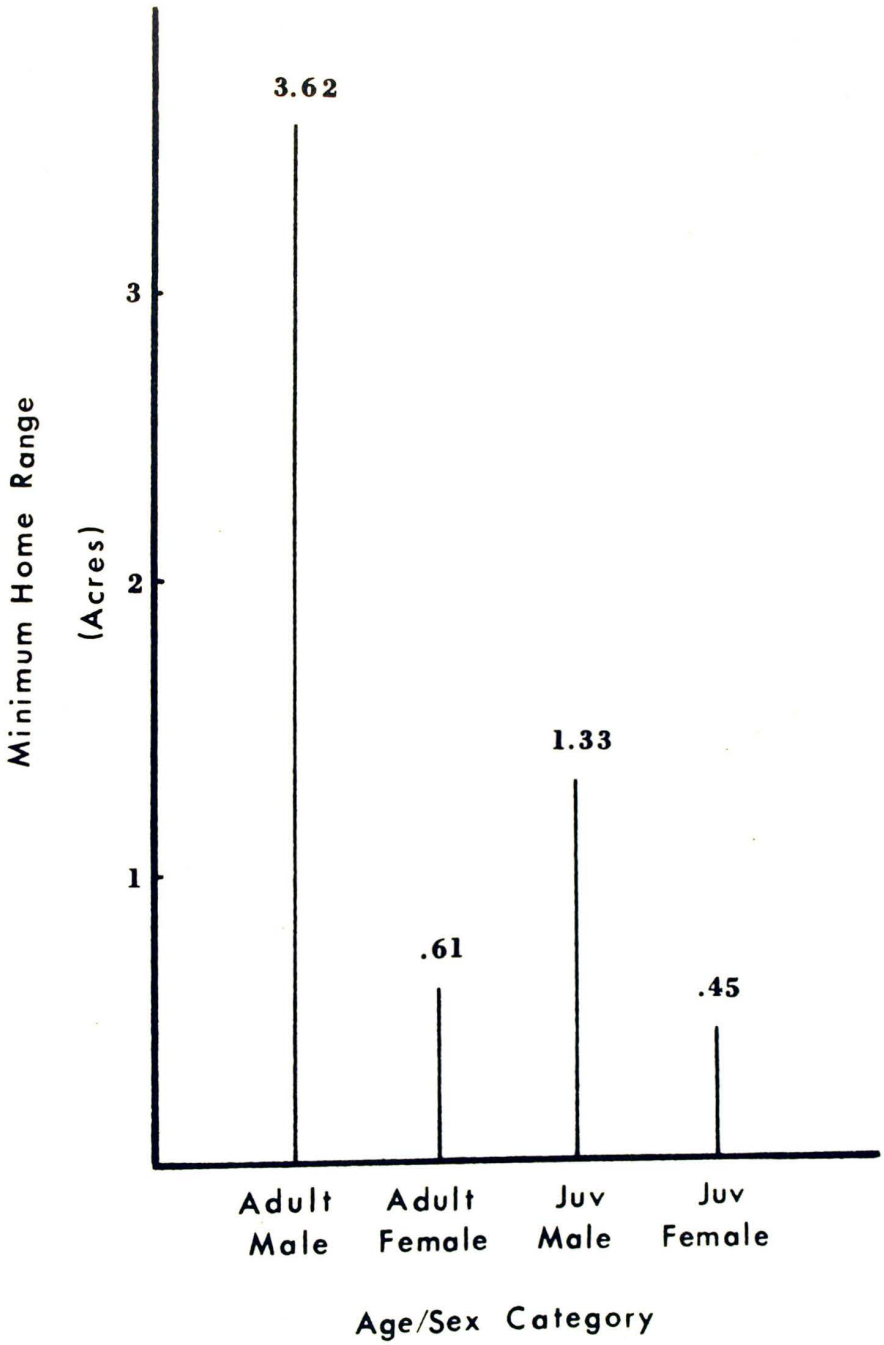

FIGURE 11

Mean Minimum Home Range

TABLE III

Mean Minimum Home Range of Dyed Versus Tagged Squirrels

	Acres			
	AM	AF	JM	JF
Dyed	4.02	1.18	1.38	.64
Tagged	2.90	.38	.79	.44

Annual Reproductive Cycle

The determination of the annual reproductive cycle was based upon five factors. These are summarized in Tables IV-VIII. The indicators utilized were: observed reproductive activity with emphasis on dates of copulation, the determination of age of captured nestlings and newly turned juveniles, the occurrence of lactating females, the status of adult male genitals, and the sighting of young squirrels which had recently ventured forth from the den tree onto the ground. The presented reproductive cycle is not meant to be a firm and unchanging set of occurrence dates. Therefore, Table IX represents a minimum time period for this particular year.

Annual and Seasonal Body Weight

The mean annual body weight for the age categories and age/sex categories is summarized in Table X. Due to the inherently large standard deviation, no significant difference was realized. The reason for this will be discussed further in Chapter V.

The seasonal weight fluctuation for the various age/sex categories has been summarized in Figures 12-15. A much clearer picture of the seasonal weight variation can be achieved by studying the individual cases as presented in the Appendix.

TABLE IV

Observed Reproductive Activity

Date	Activity
8 Aug 76	Copulation
5 Jan 77	Copulation/Male Grooms Penis
21 Jan 77	Complete Mating Sequence
11 Feb 77	Copulation/Male Grooms Penis
18 Jul 77	Copulation/Male Grooms Penis

TABLE V

Birth Dates of Young Squirrels

Date of Capture	Weight (gms)	Determined Age	Birth Date
7 Sep 76	21.2	2 Days	5 Sep 76
15 Oct 76	106	41 Days	4 Sep 76
1 Nov 76	219	70 Days	24 Aug 76
4 Nov 76	213	73 Days	24 Aug 76
5 Nov 76	220	70 Days	28 Aug 76
25 Mar 77	120	48 Days	8 Feb 77
20 Apr 77	195	66 Days	15 Feb 77
23 Apr 77	201	69 Days	15 Feb 77
12 May 77	296	93 Days	10 Feb 77
27 May 77	245	78 Days	11 Mar 77
3 Jun 77	220	75 Days	21 Mar 77
3 Jun 77	213	71 Days	25 Mar 77
16 Jun 77	269	84 Days	25 Mar 77
26 Jun 77	296	94 Days	25 Mar 77

TABLE VI

Percent Lactating Adult Females During the Proposed Cycle

Period	Percent Lactating
24 Aug-21 Sep	83.3
22 Sep- 2 Nov	87.0
3 Nov-30 Nov	0.0
1 Dec-31 Dec	0.0
1 Jan-11 Feb	*NA
13 Feb-25 Mar	85.7
26 Mar-22 Apr	78.6
23 Apr- 3 Jun	33.3
4 Jun-10 Jul	0.0
11 Jul- 8 Aug	**NA
9 Aug-23 Aug	**NA

*Squirrels not trapped due to inclement weather conditions.

**Not enough captures for a meaningful percentile.

TABLE VII

Percent of Sexually Active Adult Male Genitals
During Proposed Cycle

Period	Percent Sexually Active
24 Aug-21 Sep	100
22 Sep- 2 Nov	16.7
3 Nov-30 Nov	0.0
1 Dec-31 Dec	0.0
1 Jan-11 Feb	*NA
13 Feb-25 Mar	87.5
26 Mar-22 Apr	88.9
23 Apr- 3 Jun	26.7
4 Jun-10 Jul	67.0
11 Jul- 8 Aug	100
9 Aug-23 Aug	100

*Squirrels not trapped due to inclement weather conditions.

TABLE VIII

Sightings of Young Which Had Recently Left Den Tree

Dates of Sightings
3 Nov 76
11 Nov 76
30 Nov 76
20 Apr 77
21 Apr 77
23 Apr 77
9 May 77
3 Jun 77

TABLE IX

Annual Reproductive Cycle

Dates	Occurrence
24 Aug-21 Sep	Birth
2 Nov-30 Nov	Nestlings Leave Den Tree
1 Jan-11 Feb	Mating (Copulation)
13 Feb-25 Mar	Birth
23 Apr- 4 Jun	Nestlings Leave Den Tree
11 Jul- 8 Aug	Mating (Copulation)

TABLE X

Mean Annual Body Weight

Age/Sex Category	Mean Weight (gms)
Adult	482.2
Juvenile	389.1
Adult Female	486.8
Adult Male	477.5
Juvenile Male	395.4
Juvenile Female	387.2

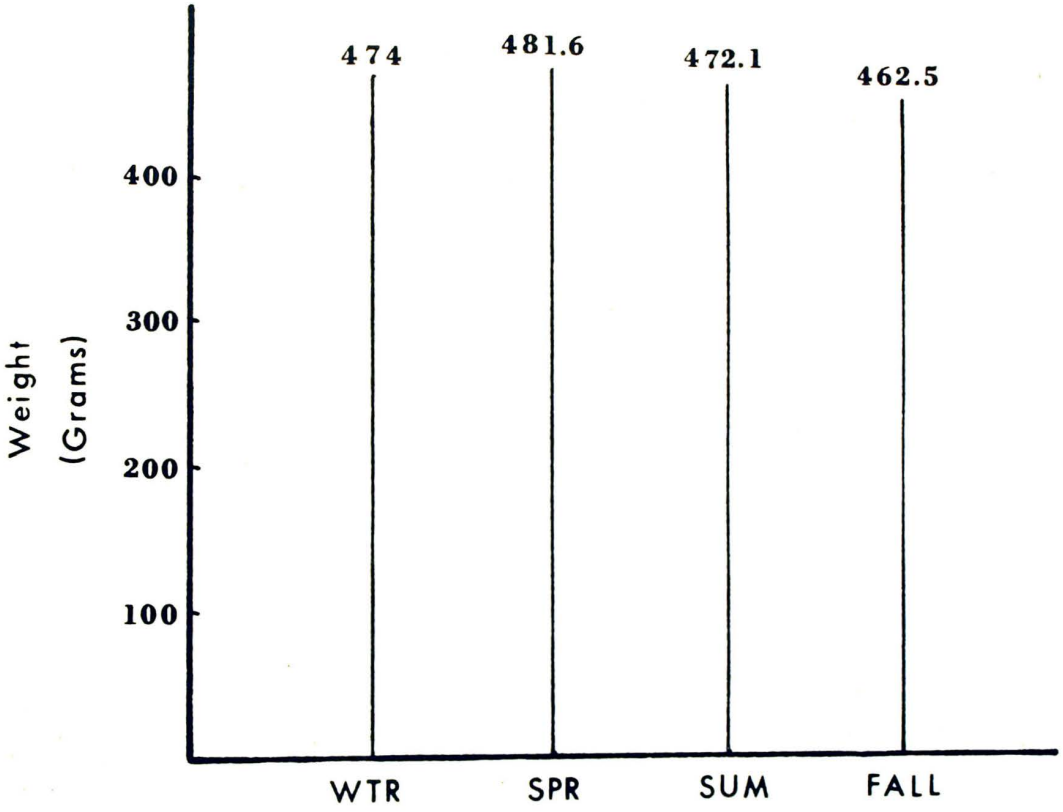

FIGURE 12

Adult Male Seasonal Weight Fluctuation
(Mean)

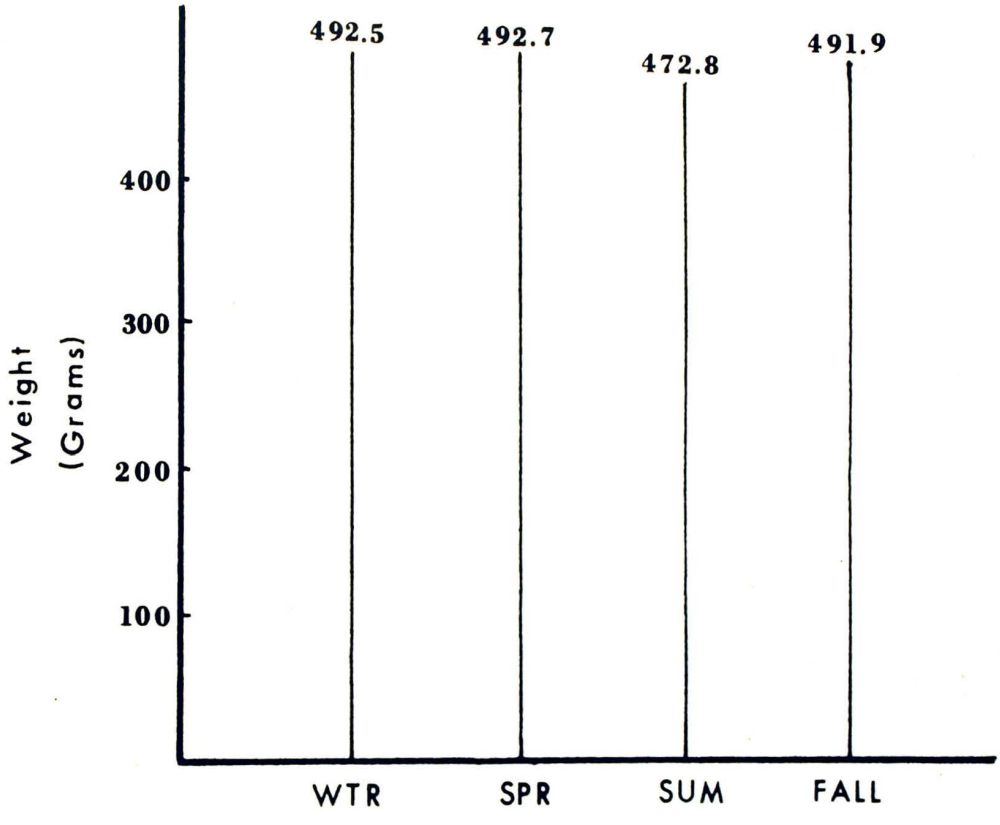

FIGURE 13

Adult Female Seasonal Weight Fluctuation
(Mean)

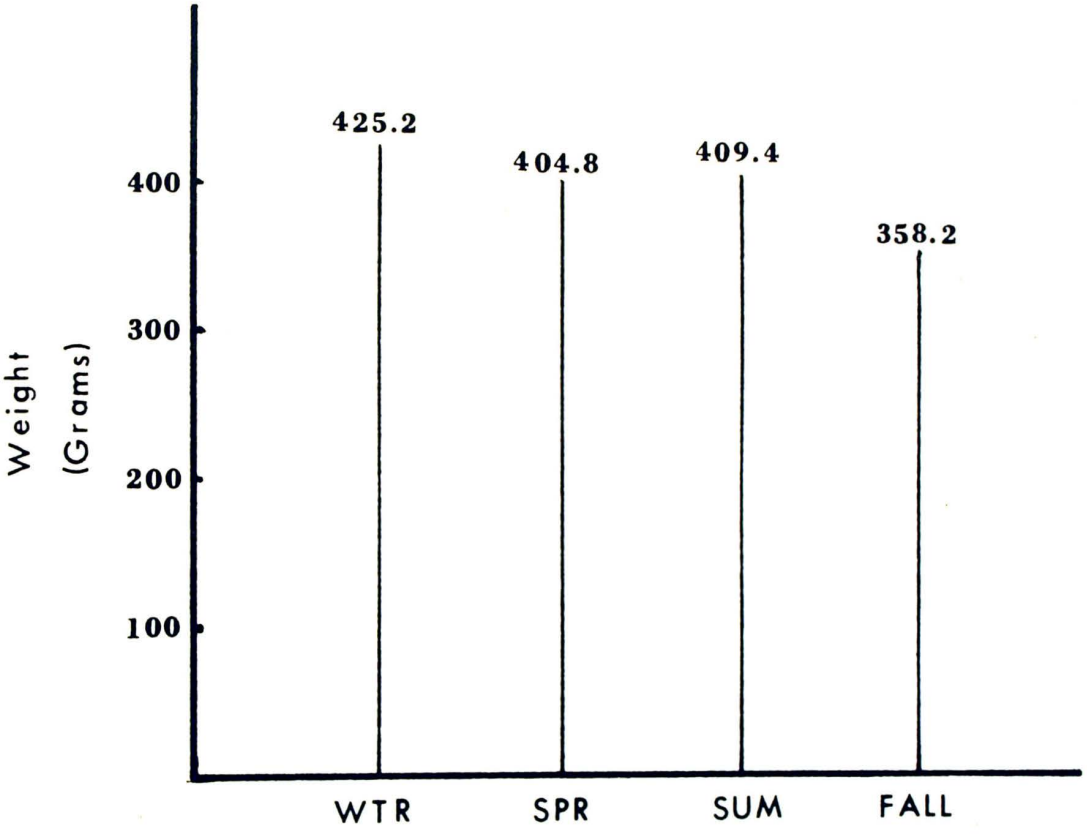

FIGURE 14

Juvenile Male Seasonal Weight Fluctuation
(Mean)

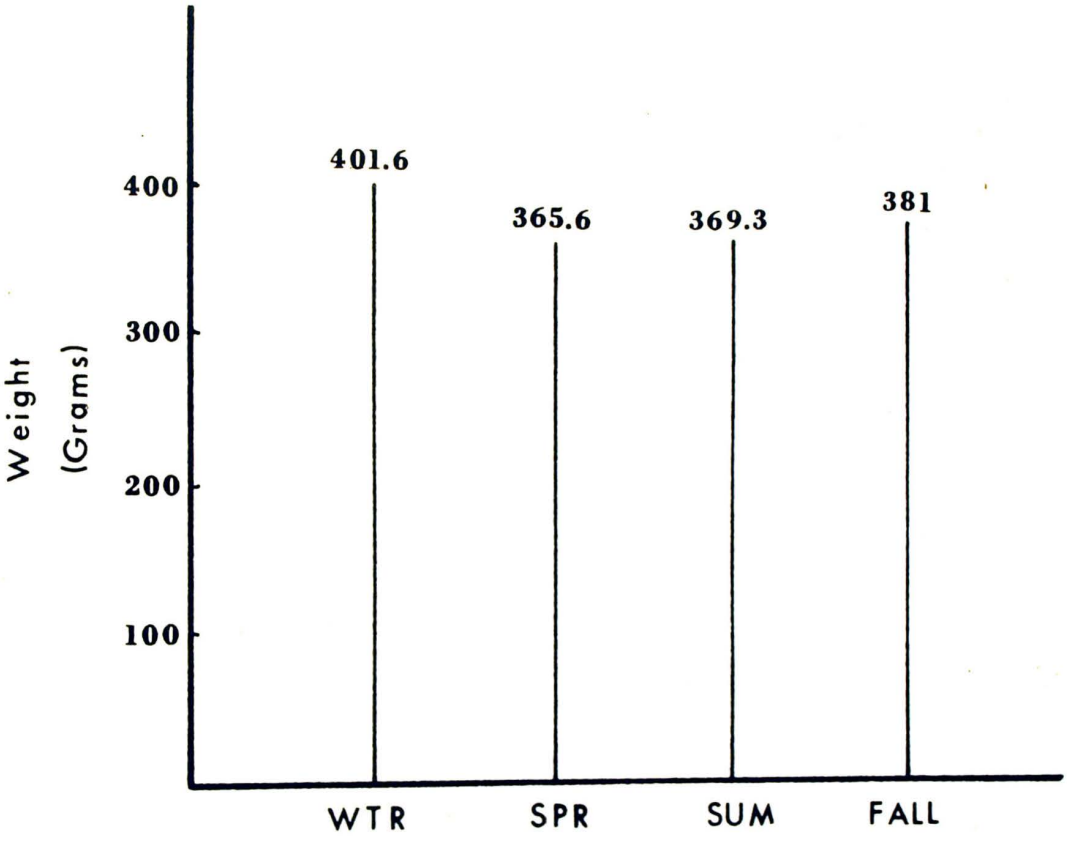

FIGURE 15

Juvenile Female Seasonal Weight Fluctuation
(Mean)

Annual Male Reproductive Activity

The annual movement of the male testes from the abdominal to the scrotal position was investigated. Also, the change of the scrotum from the quiescent to the active condition was examined. The results are summarized in Table XI. A complete discussion follows in the related section.

Social Hierarchy

The social hierarchy within the population was examined as to its possible existence. Considered along with this, was its structure and method of function. The results are presented in Table XII.

TABLE XI

Annual Cyclic Condition of the
Adult Male Genitalia

	Testes			Scrotum	
Month	Abdominal	Inguinal	Scrotal	Inactive	Active
*Jan		NA		NA	
Feb			**100%		100%
Mar		7.7	92.3	23.1	76.9
Apr	6.3	12.5	81.3	62.5	37.5
May	9.1	9.1	81.8	90.9	9.1
Jun			100	42.9	57.1
Jul			100		100
Aug			100		100
Sep			100	25	75
Oct	33.3	66.7		100	
Nov	100			100	
Dec	100			100	

*Squirrels not trapped due to inclement weather conditions.
**Indicates percent of total adult males examined.

TABLE XII

Social Hierarchy Data

Season	Total # of Observed Encounters	Adult M (AM) Encounters	Adult F (AF) Encounters	Juvenile M (JM) Encounters	Juvenile F (JF) Encounters	# Of AM Wins	# Of AF Wins	# Of JM Wins	# Of JF Wins
Winter	144	61	31	73	62	50	17	50	21
Spring	133	48	15	69	71	44	4	40	40
Summer	129	43	28	79	51	26	24	55	16
Fall	154	48	10	84	66	46	9	60	40

TABLE XII (Continued)

Social Hierarchy Data

Season	# Of Juv/Juv Wins	# Of AM/AF Encounters	# Of AM/Juv Wins	# Of AF/Juv Wins	% Encounters AM Wins	% Encounters AF Wins	% Encounters JM Wins	% Encounters JF Wins
Winter	59	22	91.3	61.5	82.0	54.8	68.5	33.9
Spring	74	15	91.7	75.0	91.7	26.7	58.0	56.7
Summer	65	18	94.4	93.3	60.5	89.3	69.6	31.4
Fall	85	14	88.9	66.7	95.8	90.0	71.4	60.6

CHAPTER V

DISCUSSION

Minimum Home Range

The minimum home range varies from location to location. In Ohio it was reported that the mean minimum home range for adult male gray squirrels was 16.9 acres and that of adult females was 8.0 acres (Donohoe and Beal, 1972). In Maryland it was found that the adult male roamed over a mean of 1.9 acres and the females existed on an average of 1.2 acres (Flyger, 1960). For the present study, it can be seen in Figure 11 that the mean minimum home range for adult males was 3.62 acres and that of adult females .61 acres. These tremendous variations between studies are probably due to how well the particular habitat meets the needs of the individual animal. In Greenwood Cemetery, the food is abundant at all times of the year. Water is also available in the form of city water dispensers located at random throughout the cemetery.

The relatively large minimum home range of the adult males can be attributed to the fact that they typically search out the adult females for reproductive purposes. The adult female's range is extremely small due to the probable inclination to stay near the respective den trees.

The juvenile males show a significant increase over the juvenile females at the .05 level of significance. This may indicate an inherent tendency to roam in males even before they become sexually mature.

This also indicates the tendency of the juvenile female to remain near the den tree as her adult counterpart does.

The minimum home range of dyed individuals was significantly greater than that of the undyed individuals. This was true for all age/sex categories. This occurs due to the ability to obtain with certainty more location coordinates for the dyed individuals. Donohoe and Beal (1972) determined that the more fixes one has for an individual, the closer one comes to approaching the true home range. This is essentially what occurred during the present study.

Annual Reproductive Cycle

The annual reproductive cycle tends to vary from state to state. In fact it often varies considerably depending upon the specific location in the state in which a study takes place. In Ohio Chapman (1939) reported that there was only one mating season which lasted from January thru February. However, he noted that in the southern portion of the state there was a possibility of biannual breeding seasons occurring. In 1975 Nixon and McClain showed a definite biannual breeding season for gray squirrels in southeastern Ohio. They reported that breeding occurred from 2 January to 25 January and from 19 May to 18 June. In Kentucky it was demonstrated in 1961 by Brauer and Dusing that this state had a biannual gray squirrel breeding season. The breeding dates were December through January and mid-June through July. With this in mind, the author was not surprised to find a biannual breeding season

in Tennessee. The first breeding season of the year lasts approximately from 1 January to 11 February (Table IX). The second breeding season extends from approximately 11 July to 8 August. The initial season may be longer due to a tendency toward longer periods of daylight which contributes to a continual scrotal position of the male testes. With the second breeding season, the hours of daylight are fewer per day, and the testes have a tendency to move to the abdominal position and therefore become quiescent.

The proposed cycle offers suggestions for gray squirrel management in Montgomery County, Tennessee. The present (1977-1978) Tennessee gray squirrel hunting season begins 27 August and extends until 31 January. This implies that for every adult female killed from 27 August until 1 November, when the nestlings begin leaving the den trees, that a litter is left to starve. Although cruel, this practice does not seriously affect the Montgomery County gray squirrel population at the present time. However, as hunting grows in popularity, there may come a time when the gray squirrel population seriously declines. The decline could possibly be avoided by altering the hunting season to begin the first of November and continuing until mid-February.

Annual and Seasonal Body Weight

The average annual and seasonal body weights of the various age/sex categories have been summarized in Table X and Figures 12-15. The mean weights for the various categories compared favorably with

those of other studies such as Brown and Yeager's 1945 Illinois study. In the current study, the mean annual adult male weight was 477.5 grams and the adult female's mean annual weight was 486.4 grams. Although a trend is demonstrated, the two are not significantly different. This particular difference may possibly be attributed to the extra weight some adult females maintain during certain phases of the reproductive cycle. However, this lack of a significant weight difference holds true when comparing any combination of the various age or age/sex categories. This phenomenon is believed to be due to the broad categories of sex and age. For example, an adult female may weigh only 390 grams while a juvenile female may weight 440 grams. Instances such as this create large standard deviations within the population.

Seasonally, the weights for each category do not vary significantly. This is due to the abundance of food which is available throughout the year. The storage of large quantities of white oak acorns, hickory nuts, walnuts, plus the availability of tree bark, maple seeds, magnolia seeds, various fungi, and a great number of grubs make it easy for the gray squirrels to maintain fairly constant annual body weights. Winter feeding stations have also been established by the cemetery employees to aid the population through the harsh season. All of the previously mentioned types of food have been consumed in the presence of the author and the results of such food abundance is clearly shown in Figure 12-15.

Annual Cyclic Conditions of the Adult Male Genitalia

The movement of the adult male testes from the scrotal to the abdominal position has been the cause for long standing folklore. It is believed by many people that the adult female gray squirrel will castrate males under varying conditions. At first sight, this is a logical conclusion since during the winter months many adult males will be harvested which apparently have no testes. This phenomenon has been studied and partially explained in Kentucky by Brauer and Dusing during a 1961 study. They found that the testes maintain three positions throughout the year. These were described as the abdominal, inguinal, and scrotal positions. In conjunction with this, Brauer and Dusing examined and described the scrotum as to active and quiescent conditions.

By examining Table XI, it can be seen that the testicular positions are probably photoperiodic in origin as reported by Allanson in 1933. During both breeding seasons, the testes are in the scrotal position and the scrotum is in the active condition. As the summer season passes and the daylight hours lessen, the testes move to the inguinal and then the abdominal condition. In September 100 percent of the testes were scrotal with 75 percent of the scrotums in the active condition. By October 66.7 percent were inguinal and 33.3 percent abdominal and both November and December show 100 percent abdominal testes. This is during the height of the hunting season, and therefore explains the tale of castration. As December passes and the daylight hours lengthen, the testes begin moving to the scrotal position. By February the testes

are scrotal and active in time for the breeding season. Due to heavy snow and high risk of trap death due to exposure, no squirrels were examined during January. By deduction January would probably produce a significant number of inguinal positioned testes. This can be logically deduced since in December 100 percent were abdominal and in February 100 percent were scrotal.

During the summer season, possibly due to long periods of daylight, the testes do not retract to the abdominal position as a rule. However, during May and June 90.0 percent and 42.9 percent of the scrotums are in the quiescent condition. However, by August, 100 percent are again active in preparation for the breeding season.

This occurrence requires more study as indicated by the lack of literature. Why the scrotum becomes quiescent while the testes are scrotal is another area which needs further investigation.

Social Hierarchy

Although social hierarchy is a very subtle factor in a gray squirrel population, it nonetheless exists. It is not a blatant phenomenon as with the "pecking-order" in chickens in which violence can erupt with fights in order to establish the new dominant individual. The author witnessed many squirrels often feeding at the same station without a sign of violence or harsh territorial behavior occurring. The only sign of aggression occurred during the mating season, and when the adult female would "guard" her den tree entrance from intruders. Table XII

is based upon those usually nonviolent encounters which were described by Horwich in 1972.

Out of an annual total of 200 observed adult male encounters, the adult male showed dominance in 83.0 percent. Adult females showed dominance in 64.3 percent of their annual observed encounters. It becomes immediately apparent that the adult males are the dominant figures in the social hierarchy. However, a lot of the dominance depends upon the status of the population in relation to the breeding season. For example, the adult female only "wins" an overall 64.3 percent of her encounters. But during the fall when nestlings are present, the adult female wins 90.0 percent of her encounters. Encounters are few during this time, but the adult female is usually dominant.

Juveniles consistently have more encounters than adults, but a majority of these are juvenile-juvenile play encounters. When juveniles encounter adults, they submit 91.6 percent of the time to males, and 74.1 percent of the time to females. Adult females often run from or submit to juveniles, but this is due to the fact that they would rather return to the den rather than interact with other individuals.

The results obtained are in keeping with those obtained by Pack, Mosby and Siegel in 1961. In their study, however, individuals were observed for social dominance. Adult males were found to be dominant with adult females following. The remainder of the population was classified depending upon sex and age. The younger the individual, the lower it was found to be in social ranking.

Concerning juvenile males as opposed to juvenile females, the males win 66.9 percent of their encounters and the females only win 45.7 percent. Even at the juvenile stage of development, males show a tendency towards twice the social dominance as females.

CHAPTER VI

SUMMARY

A study was conducted utilizing a gray squirrel population located at Greenwood Cemetery in Montgomery County, Tennessee. Trapping and observation began 5 August 1976 and continued until 4 August 1977. In this study 104 squirrels were tagged. These were utilized for recapture and observation. Data concerning 421 recaptures or dye sightings were collected along with the observing of 560 social encounters.

The following are conclusions concerning this gray squirrel population based on the data obtained in the present study and comparisons with other studies:

1. The mean minimum home range for adult males was 3.62 acres. This showed a significant difference when compared to .61 acres for adult females, 1.33 acres for juvenile males, and .45 acres for juvenile females. The juvenile male's minimum home range showed a significant difference over juvenile female's.
2. The mean minimum home range of dyed individuals was significantly larger than that of tagged individuals for the various age/sex categories.
3. This gray squirrel population utilized a biannual reproductive cycle. The first breeding season lasted from 1 January

to 11 February, and the second from 11 July to 8 August. The latter breeding season coincides with the Tennessee gray squirrel hunting season and should be considered in game management of the species.

4. The seasonal weights of each age/sex category did not fluctuate significantly. This is probably due to the great abundance of both natural and winter feeding station foods.

5. The testes of adult males followed an annual photoperiodic cycle. During the shorter days, the testes moved to and remained in the abdominal position. As the period of daylight lengthened, the testes moved to and remained in the scrotal position. However, the scrotal position did not automatically indicate that the animal was in the breeding condition. The scrotum was often in the quiescent condition as described by Brauer and Dusing in 1961. With the advent of the breeding season, the scrotum would maintain the active condition.

6. Social hierarchy study indicated the following dominance pattern. Adult males were dominant over all age/sex categories. Adult females showed dominance over all age/sex categories except for the adult male category. Juvenile males showed dominance over juvenile females only. Exceptions to this pattern occurred during various phases of the reproductive cycle.

APPENDIX

Capture/Recapture Data

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
0	AF	10/1/76 1720	D-2	512	Lactating	NO
3	JM	8/10/76 1900	B-6	423	Abdominal Quiescent	NO
4	JM	3/7/77 1720	A-7	383	Abdominal Quiescent	YES
		4/3/77 1600	B-1	401	Inguinal Quiescent	YES
		4/26/77 1700	F-6	409	Inguinal Quiescent	YES
		5/15/77 1830	A-1	412	Inguinal Quiescent	NO
		7/28/77 1830	A-1	429	Inguinal Quiescent	NO
5	JM	4/25/77 1800	E-6	445	Abdominal Quiescent	NO
		5/3/77 1800	E-7	460	Inguinal Quiescent	NO
6	AF	3/11/77 1700	D-8	519	Lactating	YES
		4/3/77 1600	F-2	NA	NA	YES
		4/7/77 0715	E-4	NA	NA	YES

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
6	AF	4/26/77 1830	E-1	505	Non-Lactating	YES
		5/18/77 0945	F-2	NA	NA	YES
		7/3/77 1930	E-2	446	Non-Lactating	YES
8	JM	3/29/77 0900	B-3	440	Inguinal Quiescent	YES
		4/1/77 1630	B-4	NA	NA	YES
		4/5/77 1630	B-2	NA	NA	YES
		4/9/77 0830	F-9	NA	NA	YES
		4/12/77	B-2	NA	NA	YES
9	AM	11/14/76 0830	F-16	420	Abdominal Quiescent	NO
		6/10/77 0830	D-13	490	Scrotal Active	NO
		6/15/77 0700	D-14	502	Scrotal Active	NO
		6/19/77 1930	C-5	506	Scrotal Active	NO
		6/28/77 1930	D-5	507	Scrotal Active	NO
		7/1/77 0700	D-4	505	Scrotal Active	NO

TAG #	AGE SEX	DATE TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
10	AF	8/8/76 0915	A-4	474	Non-Lactating	NO
		8/29/76 0800	A-2	455	Non-Lactating	NO
		8/31/76 1900	A-2	NA	Lactating	NO
		9/2/76 1900	A-4	NA	Lactating	NO
		9/8/76 1745	C-1	NA	Lactating	NO
		2/15/77	A-7	465	Lactating	NO
11	AF	10/4/76 1830	D-7	448	Lactating	NO
		10/12/76 1835	D-3	400	Lactating	NO
		10/13/76 0830	D-11	420	Lactating	NO
		2/20/77	D-5	470	Lactating	NO
12	JF	11/4/76 0800	E-2	213	Non-Lactating	YES
		3/22/77 1700	B-1	412	Non-Lactating	YES
		4/1/77 0800	C-2	418	Non-Lactating	YES
		4/6/77 0700	C-3	NA	NA	YES

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
12	JF	4/6/77 1630	E-4	NA	NA	YES
		4/7/77 0715	C-2	393	Non-Lactating	YES
		4/7/77 1700	E-4	NA	NA	YES
		4/10/77 0930	E-4	NA	NA	YES
		4/13/77	C-2	NA	NA	YES
13	AF	8/28/76 1840	A-5	525	Non-Lactating	NO
		8/30/76 0820	A-2	504	Non-Lactating	NO
		2/26/77 1 900	A-10	517	Lactating	NO
		3/12/77 1630	A-7	520	Lactating	NO
		6/13/77 1900	A-1	512	Non-Lactating	NO
15	AM	2/17/77 1730	D-8	410	Scrotal Active	NO
		3/3/77	A-5	435	Scrotal Inactive	NO
		6/10/77 1930	D-12	499	Scrotal Active	NO
17	JF	11/25/76 0900	F-8	312	Non-Lactating	NO

TAG #	AGE SEX	DATE TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
17	JF	12/16/76 0830	F-1	340	Non-Lactating	NO
		3/11/77 1700	D-10	380	Non-Lactating	NO
		4/20/77 1530	F-2	392	Non-Lactating	NO
18	JF	2/20/77 0730	A-7	365	Non-Lactating	NO
		5/15/77 1830	A-3	380	Non-Lactating	NO
		7/26/77 0930	A-1	378	Non-Lactating	NO
19	AF	3/7/77 1800	D-8	470	Non-Lactating	YES
		3/14/77 1700	D-8	NA	Lactating	YES
		3/15/77 1700	D-1	475	Lactating	YES
		3/31/77 1630	D-9	NA	NA	YES
		4/4/77 1630	D-13	NA	NA	YES
		4/7/77 1700	F-13	NA	NA	YES
		4/9/77 0830	F-9	NA	NA	YES
		4/10/77 0930	C-2	420	Non-Lactating	YES
20	AM	9/16/76 1800	B-1	451	Scrotal Active	NO
		10/21/76 0900	E-4	445	Inguinal Quiescent	NO

TAG #	AGE SEX	DATE TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
20	AM	12/12/76 1615	F-13	442	Abdominal Quiescent	NO
		2/23/77 1600	A-7	450	Scrotal Active	NO
21	JF	3/23/77 1100	B-3	412	Non-Lactating	YES
		4/1/77 1630	B-2	418	Non-Lactating	YES
		4/12/77 1730	B-4	NA	NA	YES
		4/16/77 1745	F-7	NA	NA	YES
22	JF	3/23/77 1100	B-5	414	Non-Lactating	YES
		4/12/77 1730	F-4	NA	NA	YES
		4/13/77 1730	B-3	417	Non-Lactating	YES
		5/10/77 1820	B-2	405	Non-Lactating	NO
23	AM	8/9/76 1400	A-4	462	Scrotal Active	NO
		9/11/76 1900	B-4	440	Scrotal Active	NO
		12/12/76 1620	F-15	451	Abdominal Quiescent	NO
		4/14/77 0700	C-1	481	Scrotal Active	NO
		5/31/77 0630	B-3	460	Scrotal Active	NO

TAG #	AGE SEX	DATE TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
25	JM	9/3/76 1900	A-3	405	Abdominal Quiescent	NO
		9/6/76 0730	A-3	404	Abdominal Quiescent	NO
26	JM	10/21/76 0900	B-4	460	Inguinal Quiescent	NO
	AM	3/23/77 1100	B-6	499	Scrotal Active	NO
		4/11/77 1720	B-1	500	Scrotal Active	NO
		4/12/77 1730	B-3	462	Scrotal Active	NO
27	JM	11/2/76 0800	B-3	350	Abdominal Quiescent	NO
		11/20/76 0800	F-8	370	Abdominal Quiescent	NO
		12/5/76 1630	F-10	NA	Abdominal Quiescent	NO
		12/9/76 0800	F-7	360	Abdominal Quiescent	NO
	AM	3/29/77 0900	B-4	458	Scrotal Active	NO
		6/12/77 0930	D-4	497	Scrotal Quiescent	NO
28	AF	10/12/76 1830	E-3	514	Lactating	NO
		10/14/76 0900	E-4	510	Lactating	NO
		10/19/76 1600	E-1	515	Lactating	NO
		12/6/76 1620	F-14	509	Non-Lactating	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
29	JM	10/21/76 1800	E-3	390	Abdominal Quiescent	NO
30	AM	3/9/77 1700	D-7	464	Scrotal Active	YES
		3/10/77 1700	E-2	NA	NA	YES
		3/16/77 1630	A-3	471	Scrotal Active	YES
		4/26/77 1830	F-1	470	Scrotal Quiescent	YES
31	AF	4/17/77 0830	B-3	460	Lactating	YES
32	AF	10/5/76 0930	D-7	464	Lactating	NO
		10/11/76 0900	D-7	470	Lactating	NO
		10/18/76 1800	D-3	456	Lactating	NO
		11/5/76 0740	D-3	449	Lactating	NO
33	AF	3/8/77 1715	D-5	440	Lactating	YES
		4/8/77 0800	F-1	NA	NA	YES
		6/10/77 1930	B-2	NA	NA	YES
		6/23/77 0830	D-11	517	Non-Lactating	YES
34	AM	2/19/77 0930	A-7	459	Scrotal Active	YES
		3/5/77 1100	D-4	445	Scrotal Active	YES

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
34	AM	3/12/77 1630	D-10	NA	Scrotal Active	YES
		4/7/77 0715	B-3	494	Scrotal Active	YES
		5/10/77 1800	A-4	525	Scrotal Quiescent	YES
		6/9/77 1700	D-4	472	Scrotal Quiescent	YES
		6/13/77 1900	D-6	462	Scrotal Active	YES
		6/24/77 1730	D-8	450	Scrotal Active	YES
		7/10/77 0730	E-4	NA	NA	YES
36	JM	4/23/77 1800	E-6	439	Inguinal Quiescent	NO
		7/9/77 1920	E-6	440	Inguinal Quiescent	NO
37	AF	8/9/76 0800	A-3	476	Non-Lactating	NO
		8/10/76 1400	A-6	457	Non-Lactating	NO
38	AF	10/4/76 1830	B-2	490	Non-Lactating	NO
39	AM	10/22/76 0900	E-4	444	Inguinal Quiescent	NO
		12/6/76 0945	F-9	NA	Abdominal Quiescent	NO
		12/8/76 1700	F-6	435	Abdominal Quiescent	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
39	AM	2/27/77 1700	D-8	460	Scrotal Active	NO
		3/27/77 1630	C-1	481	Scrotal Active	NO
41	AF	4/25/77 1800	E-7	544	Lactating	NO
		5/9/77 1900	A-2	578	Lactating	NO
		6/3/77 1900	A-3	520	Non-Lactating	NO
42	AF	8/10/76 1900	A-3	470	Non-Lactating	NO
		2/26/77 0630	A-1	475	Non-Lactating	NO
43	JM	11/1/76 1630	E-4	219	Abdominal Quiescent	NO
		11/6/76 1800	E-4	NA	Abdominal Quiescent	NO
		11/15/76 0830	E-4	NA	Abdominal Quiescent	NO
		12/6/76 0940	F-14	307	Abdominal Quiescent	NO
		12/14/76 1630	F-15	325	Abdominal Quiescent	NO
		4/4/77 1000	C-3	446	Inguinal Quiescent	NO
46	JM	10/5/76 1530	D-3	412	Inguinal Quiescent	NO
	AM	2/22/77 1630	D-15	480	Scrotal Active	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
46	AM	4/28/77 1730	F-13	480	Scrotal Quiescent	NO
		4/29/77 1900	F-8	NA	Scrotal Quiescent	NO
		5/31/77 1900	A-1	491	Scrotal Quiescent	NO
48	AM	8/10/76 1900	A-3	457	Scrotal Active	NO
		10/22/76 1600	E-4	440	Abdominal Quiescent	NO
		2/19/77 0930	D-9	501	Scrotal Active	NO
		4/5/77	B-1	452	Scrotal Quiescent	NO
49	NF	10/15/76 1000	D-14	106	Non-Lactating	NO
		10/19/76 1900	D-14	NA	Non-Lactating	NO
50	AF	10/19/76 0900	E-1	515	Lactating	NO
		10/20/76 1300	E-3	519	Lactating	NO
		11/5/76 0730	E-6	510	Non-Lactating	NO
		12/6/76 1630	F-15	505	Non-Lactating	NO
		3/31/77 0730	C-1	490	Lactating	NO
53	AF	8/9/76 1830	A-6	502	Non-Lactating	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
53	AF	9/2/76 1800	A-1	493	Lactating	NO
		3/15/77 1700	A-2	516	Lactating	NO
		5/10/77 1800	A-3	493	Non-Lactating	NO
54	JF	3/21/77 1645	A-10	356	Non-Lactating	NO
		5/15/77 1830	A-5	381	Non-Lactating	NO
		5/16/77 1845	A-1	385	Non-Lactating	NO
		7/25/77 0915	A-2	387	Non-Lactating	NO
		8/4/77 0730	A-3	385	Non-Lactating	NO
55	AF	4/20/77 1030	E-7	595	Lactating	YES
		4/23/77 1030	C-1	NA	NA	YES
		5/14/77 1930	C-1	NA	NA	YES
		5/16/77 1845	A-1	NA	NA	YES
		5/18/77	C-5	NA	NA	YES
56	AF	9/2/76 0800	A-1	505	Non-Lactating	NO
		9/3/76 1800	A-1	485	Non-Lactating	NO
57	AM	3/6/77 0930	D-4	470	Scrotal Active	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
58	JF	10/10/76 1730	A-3	434	Non-Lactating	NO
		10/20/76 1800	E-4	430	Non-Lactating	NO
		3/5/77 1125	A-2	440	Non-Lactating	NO
	AF	4/6/77 0900	C-2	451	Lactating	NO
		4/14/77 0700	C-2	441	Lactating	NO
		4/18/77 1100	E-2	452	Lactating	NO
		5/23/77 1830	A-1	483	Non-Lactating	NO
		5/28/77 0920	A-7	490	Non-Lactating	NO
60	AF	10/12/76 0900	B-1	543	Lactating	NO
		12/10/76 1630	F-6	545	Non-Lactating	NO
		12/16/76 0800	F-4	NA	Non-Lactating	NO
		12/16/76 1830	F-10	551	Non-Lactating	NO
		3/31/77 0730	B-2	501	Lactating	NO
61	AM	8/11/76 0800	B-5	495	Scrotal Active	NO
		9/16/76 1000	D-5	490	Scrotal Active	NO
		12/8/76 1700	F-3	500	Abdominal Quiescent	NO

TAG #	AGE SEX	DATE TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
61	AM	4/20/77 1030	F-14	483	Inguinal Quiescent	NO
62	AM	9/23/76 1430	A-3	505	Scrotal Quiescent	NO
		2/16/77 1600	D-5	520	Scrotal Active	NO
		2/26/77 1830	A-1	495	Scrotal Active	NO
		4/29/77 1900	E-6	500	Scrotal Quiescent	NO
63	JM	8/9/76 0800	B-2	380	Abdominal Quiescent	NO
	AM	5/24/77 1830	A-9	489	Scrotal Quiescent	NO
		5/26/77	A-1	490	Scrotal Quiescent	NO
65	JM	3/2/77 1720	A-4	407	Abdominal Quiescent	NO
		6/3/77 0840	A-2	411	Inguinal Quiescent	NO
66	JM	8/10/76 0800	B-3	423	Abdominal Quiescent	NO
		3/31/77 1630	B-2	470	Inguinal Quiescent	NO
		4/11/77 1015	B-6	480	Inguinal Quiescent	NO
		6/1/77 1930	B-1	450	Inguinal Quiescent	NO
67	AF	9/17/76 1800	A-1	515	Lactating	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
67	AF	9/23/76 1430	A-1	503	Lactating	NO
		5/31/77 1900	A-3	517	Non-Lactating	NO
69	JM	10/13/76 0830	E-2	410	Abdominal Quiescent	NO
		10/14/76 0900	E-1	405	Abdominal Quiescent	NO
		3/1/77 0630	A-1	435	Abdominal Quiescent	NO
		4/24/77 1630	F-14	420	Abdominal Quiescent	NO
70	JF	10/22/76 0910	E-1	424	Non-Lactating	NO
		7/8/77 2020	E-5	460	Non-Lactating	NO
71	JF	3/23/77 1100	B-4	383	Non-Lactating	YES
		3/28/77 0900	B-3	NA	NA	YES
		4/2/77 0900	B-2	NA	NA	YES
		4/10/77 0930	B-5	NA	NA	YES
		4/12/77 0700	B-6	NA	NA	YES
72	AF	9/7/76 1900	B-3	390	Lactating w/young	NO
		4/6/77 0900	B-2	440	Lactating	NO
		5/25/77 1930	A-8	NA	Non-Lactating	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
73	AF	9/8/76 1800	A-1	502	Lactating	NO
		9/13/76 0800	C-1	521	Lactating	NO
		2/22/77 1630	A-10	515	Lactating	NO
		3/16/77 1630	A-9	525	Lactating	NO
		3/30/77 1600	C-2	470	Lactating	NO
74	JM	11/12/76 1700	E-4	408	Abdominal Quiescent	NO
		11/13/76 0900	E-7	NA	Abdominal Quiescent	NO
		11/19/76 1620	F-11	NA	Abdominal Quiescent	NO
		3/10/77 1700	A-9	430	Abdominal Quiescent	NO
75	AF	9/6/76 0730	B-1	507	Lactating	NO
		10/12/76 1300	B-1	510	Lactating	NO
77	AM	2/25/77 1700	A-3	497	Scrotal Active	NO
		3/13/77 0630	D-8	499	Scrotal Quiescent	NO
		4/11/77 1015	B-1	502	Scrotal Quiescent	NO
		4/16/77 1745	C-3	501	Scrotal Quiescent	NO
		7/8/77 1940	E-4	500	Scrotal Active	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
78	JM	10/15/76 1200	E-3	308	Abdominal Quiescent	NO
79	AM	2/21/77 1645	A-2	462	Scrotal Active	NO
		3/21/77 1700	B-3	459	Scrotal Active	NO
		4/26/77 0530	E-7	461	Abdominal Quiescent	NO
		5/17/77	A-3	459	Scrotal Quiescent	NO
82	AM	4/12/77 0700	B-4	482	Scrotal Active	YES
		4/28/77	F-2	NA	NA	YES
		5/16/77 1845	A-4	491	Inguinal Quiescent	YES
		5/24/77 1800	B-3	490	Scrotal Quiescent	YES
		6/12/77 0800	D-2	491	Scrotal Active	YES
		6/19/77 0700	D-9	499	Scrotal Active	YES
		6/25/77 0830	C-1	430	Scrotal Active	YES
		7/7/77 0820	E-6	493	Scrotal Active	YES
		7/12/77 1945	E-1	NA	NA	YES
		7/13/77 0900	E-4	449	Scrotal Active	YES
		7/15/77 0830	E-1	NA	NA	YES

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
82	AM	7/28/77 1045	A-9	447	Scrotal Active	YES
		8/1/77 0730	A-8	NA	NA	YES
83	AM	8/10/76 1400	B-2	467	Scrotal Active	NO
84	AF	11/14/76 0900	B-4	524	Non-Lactating	NO
		11/23/76 0820	F-11	NA	Non-Lactating	NO
		11/24/76 1600	F-4	NA	Non-Lactating	NO
		4/13/77	B-2	495	Lactating	NO
85	AM	4/8/77 0830	B-1	487	Scrotal Active	YES
		5/5/77 1900	E-1	NA	NA	YES
		5/15/77 1830	A-2	491	Abdominal Quiescent	YES
		6/22/77 0800	D-6	491	Scrotal Active	YES
88	JF	8/10/76 1900	A-5	464	Non-Lactating	NO
		10/11/76 0915	A-3	440	Non-Lactating	NO
		3/13/77 1930	A-7	452	Non-Lactating	NO
		5/23/77 1830	A-1	425	Non-Lactating	NO

TAG #	AGE SEX	DATE TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
89	AF	9/2/76 1900	A-3	439	Lactating	NO
		9/7/76 1900	A-1	404	Lactating	NO
		9/10/76 0915	A-2	419	Lactating	NO
		9/11/76 0800	C-2	438	Lactating	NO
		9/12/76 0800	C-1	422	Lactating	NO
		9/15/76 0800	C-1	384	Lactating	NO
90	JF	4/18/77 1115	E-2	460	Non-Lactating	YES
		4/23/77 1030	E-7	NA	NA	YES
		4/25/77 1100	E-6	449	Non-Lactating	YES
		4/28/77 1730	F-15	456	Non-Lactating	YES
		5/14/77 1930	E-6	NA	NA	YES
		5/16/77 1830	C-1	NA	NA	YES
		7/9/77 1915	E-7	487	Non-Lactating	YES
91	AM	2/17/77 1700	A-9	563	Scrotal Active	NO
		2/28/77 1730	A-4	503	Scrotal Active	NO
		3/3/77 1745	D-2	NA	Scrotal Active	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
91	AM	6/26/77 0900	D-5	452	Scrotal Active	NO
92	AM	11/2/76 1310	E-7	511	Abdominal Quiescent	NO
		11/12/76 1700	E-6	501	Abdominal Quiescent	NO
		12/10/76 1640	F-10	498	Abdominal Quiescent	NO
		2/14/77 1715	D-3	486	Scrotal Active	NO
		2/27/77 1715	D-5	510	Scrotal Active	NO
93	AF	11/1/76 0820	E-7	461	Non-Lactating	NO
		3/30/77 1600	C-1	495	Lactating	NO
		4/9/77 1630	C-3	480	Lactating	NO
		4/11/77 1720	C-2	482	Lactating	NO
94	AM	2/20/77 1045	D-7	420	Scrotal Active	NO
		2/24/77 1600	A-9	426	Scrotal Active	NO
		2/26/77 0700	A-2	NA	Scrotal Active	NO
		3/10/77 1700	A-1	NA	Inguinal Quiescent	NO
95	JF	5/24/77 1830	A-2	400	Non-Lactating	YES

TAG #	AGE SEX	DATE TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
95	JF	5/27/77 1900	A-4	389	Non-Lactating	YES
		5/28/77 1900	A-7	NA	NA	YES
		6/2/77 1900	A-9	NA	NA	YES
96	JM	11/1/76 0810	E-4	325	Abdominal Quiescent	NO
		12/9/76 1640	F-14	332	Abdominal Quiescent	NO
		12/14/76 0830	F-14	417	Abdominal Quiescent	NO
		12/16/76 0800	F-15	NA	Abdominal Quiescent	NO
		3/7/77 0700	A-2	403	Abdominal Quiescent	YES
		3/8/77 1630	A-6	NA	Abdominal Quiescent	YES
		3/28/77 0900	C-1	433	Inguinal Quiescent	YES
		3/31/77 0730	C-2	436	Inguinal Quiescent	YES
		4/8/77 0800	E-3	NA	NA	YES
		4/8/77 1630	C-2	423	Inguinal Quiescent	YES
		4/13/77 0545	C-2	NA	NA	YES
		4/18/77 1100	E-3	NA	NA	YES
		4/23/77 1030	F-14	NA	NA	YES

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
96	JM	4/23/77 1830	F-15	464	Abdominal Quiescent	YES
		4/25/77 1800	E-2	NA	NA	YES
		5/2/77 1800	F-15	468	Inguinal Quiescent	YES
		6/2/77 0730	A-8	478	Inguinal Quiescent	YES
		7/23/77 0900	F-1	NA	NA	YES
98	JM	11/5/76 0720	E-7	220	Abdominal Quiescent	NO
		6/14/77 1830	C-1	460	Inguinal Quiescent	NO
		6/19/77 0700	D-13	504	Inguinal Quiescent	NO
		6/27/77 1830	C-4	500	Inguinal Quiescent	NO
99	AF	9/18/76 1820	D-1	531	Lactating	NO
		9/22/76 1430	D-1	467	Lactating	NO
		9/25/76 0830	D-6	501	Lactating	NO
		10/8/76 0830	D-8	466	Lactating	NO
		11/4/76 0830	D-9	NA	Lactating	NO
		2/17/77 1700	D-10	510	Lactating	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
100	JM	3/23/77 1100	B-1	421	Abdominal Quiescent	YES
		3/27/77 1630	B-2	419	Abdominal Quiescent	YES
		3/28/77 0900	B-1	NA	NA	YES
		4/17/77 0830	B-2	NA	NA	YES
		5/5/77 1900	F-4	NA	NA	YES
		5/13/77 1900	A-3	409	Abdominal Quiescent	YES
		5/22/77 0930	C-1	NA	NA	YES
		6/3/77 0845	A-7	383	Abdominal Quiescent	NO
105	AM	4/23/77 1800	E-3	443	Inguinal Quiescent	YES
		7/31/77 1900	B-1	NA	NA	YES
106	JM	6/3/77 1900	A-4	220	Abdominal Quiescent	NO
113	JF	4/20/77 1000	E-6	195	Non-Lactating	NO
		5/17/77 0700	E-3	NA	Non-Lactating	NO
120	AF	5/14/77 0630	A-3	489	Non-Lactating	NO
		5/17/77 1900	A-2	485	Non-Lactating	NO
		5/27/77 1920	B-4	491	Non-Lactating	NO

TAG #	AGE SEX	DATE TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
120	AF	5/30/77 0700	A-1	510	Non-Lactating	NO
121	JM	4/27/77 1000	E-7	443	Inguinal Quiescent	NO
		5/4/77 0900	E-6	450	Inguinal Quiescent	NO
		7/4/77 1830	E-6	452	Inguinal Quiescent	NO
		7/6/77 0730	E-1	451	Inguinal Quiescent	NO
		7/13/77 1845	E-6	437	Inguinal Quiescent	NO
125	JF	5/22/77 1930	A-1	245	Non-Lactating	YES
		5/29/77 1900	A-8	NA	NA	YES
		5/30/77 1900	A-4	NA	NA	YES
		6/9/77 1700	A-2	NA	NA	YES
		7/19/77 2015	A-2	340	Non-Lactating	NO
127	JF	5/27/77 1925	A-7	354	Non-Lactating	YES
		5/29/77 0700	A-1	NA	NA	YES
		5/28/77 0920	A-2	NA	NA	YES
		6/10/77 0830	C-4	NA	NA	YES
		7/11/77 0800	C-2	NA	NA	YES

TAG #	AGE SEX	DATE TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
127	JF	7/21/77 0740	A-1	380	Non-Lactating	YES
130	AM	6/8/77 0900	A-3	430	Scrotal Active	NO
		6/20/77 0830	D-2	435	Scrotal Active	NO
		6/26/77 1920	D-8	441	Scrotal Active	NO
		7/17/77 0830	E-4	441	Scrotal Active	NO
		7/20/77 0730	B-2	440	Scrotal Active	NO
132	JF	6/23/77 1915	C-1	424	Non-Lactating	NO
138	AF	6/2/77 0830	B-1	509	Non-Lactating	YES
		6/3/77	A-9	NA	NA	YES
		6/20/77 1900	A-5	NA	NA	YES
		7/10/77 2030	A-6	489	Non-Lactating	YES
142	AM	5/21/77 1745	A-8	520	Scrotal Quiescent	NO
		6/14/77 0730	D-13	524	Scrotal Active	NO
		6/22/77 0800	C-2	522	Scrotal Active	NO
		6/24/77 0830	D-7	521	Scrotal Active	NO
144	AF	6/8/77 0900	A-2	480	Non-Lactating	NO

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
144	AF	6/10/77 0830	C-5	482	Non-Lactating	NO
		6/30/77 0730	C-1	485	Non-Lactating	NO
147	JF	5/16/77 0700	B-3	382	Non-Lactating	YES
		5/17/77 0700	F-7	NA	NA	YES
		5/20/77 0730	B-2	NA	NA	YES
		5/25/77 0700	B-4	NA	NA	YES
151	JM	5/12/77 0700	B-4	296	Abdominal Quiescent	NO
		5/20/77 1900	B-1	301	Abdominal Quiescent	NO
		5/22/77 1900	B-2	316	Abdominal Quiescent	NO
156	JF	5/18/77 0940	A-3	409	Non-Lactating	YES
		5/20/77 0730	A-7	NA	NA	YES
		5/22/77 1900	A-2	408	Non-Lactating	YES
		5/25/77 0700	A-1	412	Non-Lactating	YES
169	JF	6/16/77 1730	D-6	269	Non-Lactating	NO
		6/29/77 1935	D-4	263	Non-Lactating	NO

TAG #	AGE SEX	DATE TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
171	JM	5/28/77 0940	B-2	430	Inguinal Quiescent	NO
		5/29/77 0700	B-5	425	Inguinal Quiescent	NO
172	JF	4/23/77 1030	F-14	201	Non-Lactating	NO
		5/20/77 1900	E-2	212	Non-Lactating	NO
		7/6/77 1930	E-4	320	Non-Lactating	NO
181	JM	7/4/77 1836	E-4	320	Abdominal Quiescent	NO
184	AM	8/3/77	B-2	471	Scrotal Active	NO
185	AM	6/2/77 0820	B-1	490	Scrotal Quiescent	NO
187	AM	5/25/77 1015	A-1	499	Scrotal Quiescent	NO
		6/21/77 0845	D-4	482	Scrotal Active	NO
		6/30/77 1740	D-5	472	Scrotal Active	NO
		7/16/77 0900	E-7	486	Scrotal Active	NO
190	JF	5/29/77 0915	A-7	372	Non-Lactating	YES
		5/31/77 0630	A-2	NA	NA	YES
		6/1/77 1930	A-3	NA	NA	YES

TAG #	AGE / SEX	DATE / TIME	TRAP SITE	WEIGHT (gms)	STATUS OF GENITALIA	JAMAR-D MARKING
191	JF	6/3/77 0830	A-1	213	Non-Lactating	NO
		7/19/77 0800	A-2	315	Non-Lactating	NO
		7/29/77 0730	A-5	280	Non-Lactating	NO
194	JM	6/26/77 0745	C-1	296	Abdominal Quiescent	NO
		7/5/77 0800	E-4	250	Abdominal Quiescent	NO

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