

FINAL REPORT

STUDY TITLE

Laboratory Evaluation of the Efficacy of the
Pest-A-Cator/Riddex System to Exclude Wild Mice

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EXECUTIVE SUMMARY

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TEST SPECIES: 1. House Mouse, wild type (*Mus musculus*)
2. White-footed Mouse, colony bred (*Peromyscus leucopus*)

TEST DEVICE: PEST-A-CATOR /RIDDEX Rodent and Insect Repeller

TEST APPARATUS: Two clear acrylic nesting/feeding/drinking chambers, approximately 18 in. X 18 in. x 8 in. (LxWxH). Each chamber is placed on the floor inside a 4 ft X 4 ft. replica of a standard house closet. The closet replicas with acrylic cages are placed 12 feet apart, center to center distance. Acrylic chambers are joined by a 4inch diameter, opaque PVC drain pipe. Two-four same sex mice are placed in the apparatus with pelleted laboratory rodent chow and water available in each chamber at all times (*ad libitum*). Nesting cans and paper toweling for bedding are provided in each chamber. Mice have freedom to move between chambers and use the connecting tunnel at will. The walls of the closet replicas are wired with standard 12 ga. electrical cable.

TEST DESIGN: Mice are allowed to acclimate to the apparatus, followed by a test phase I in which one of the boxes is selected at random and the electrical circuit activated by installation of a PEST-ACATOR or RIDDEX device. Test phase II involves switching the PEST-A-CATOR/RIDDEX device to the alternate chamber.

TEST PHASE PERIODS: House Mice: 8 days acclimation.
14 days Phase I.
7 days extended Phase I with signal moved closer to acrylic chambers via extension cord.
7 days Phase II. Signal moved closer via extension cord.

White-footed Mice: 3 days acclimation.
5 days Phase I.

CHAMBER USAGE MEASURES: 1. Daily feed consumption in each chamber.
2. Video taping of time occupy each chamber.

Summary.

This study was conducted to assess the response of mice to an electromagnetic signal generated by the Pest-A-Cator device. We introduced two rodent species, wild house mice (*Mus musculus*), and white-footed mice (*Peromyscus leucopus*), into a complex of chambers simulating a home setting. Chambers were connected with PVC pipe tunnels. After groups of rodents were acclimated to the housing complexes, various chambers were activated with the Pest-a Cator device for one to three weeks at a time. Food, water and shelter were provided *ad libitum* (available in surplus) at all times in all chambers. Feed consumption in each chamber was measured daily as an indirect index of chamber usage. Video cameras were used at times as well as a direct measure of the usage of chambers by the mice. Behavioral patterns of interest were the rate of onset of a response to the device, the extent and duration of any response, and the rate of extinction of avoidance behavior after the system is turned off in one location.

The study results illustrate the difficulty in isolating a single behavior or behavioral response in higher animals. The study design and test apparatus were designed both to allow data to be collected and to provide a setting in which the mice behavior would be representative of what might occur in the wild. We attempted to limit "background noise" which interferes with the observations of interest. However, even in a controlled setting other factors including the behavioral adaptability of mice are operating at all times.

Feeding location preference was observed to change in conjunction with introduction of the signal into one end of the test apparatus. The female wild house mice in particular changed behavior patterns in association with the signal, with moderate avoidance behavior at first, followed by apparent gradual habituation after about a week. Moving the signal closer to the housing chambers resulted in the reinstatement of avoidance behavior.

The response of both sexes of mice when the signal location was reversed also suggests the mice were aware of the signal. The feeding behavior pattern clearly changed in conjunction with the signal relocation. The mice alternately took most of their diet for one chamber one day, and the other the next during this seven day period. This behavior is consistent with an interpretation that the mice had developed an aversion to the first chamber which remained intact for at least a week after the signal was removed. While the previously established behavior had yet to become extinct, the newly activated chamber was may have been eliciting the same response during this period.

The study results were not designed to establish a cause and effect relationship, but do demonstrate that changes in behavior of wild house mice correspond with changes in the Pest-A-Cator device placement and activation.

Preliminary study of white-footed mice behavior in the test apparatus demonstrated a significant preference for the non-activated chamber among both sexes.

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I. INTRODUCTION

Wild house mice (*Mus musculus*) are found in association with humans and human dwellings throughout the world. They damage structures, consume and contaminate food stuffs, and spread a variety of diseases (3).

Another group of wild mice, *Peromyscus* spp. constitute a large, widespread genus of New World rodents. While not as likely to enter human habitations as house mice, they will do so, particularly during the winter months and if foodstuffs are available (5). Members of the genus such as the deer mouse (*Peromyscus maniculatus*) have been identified as vectors or hosts of micro-organisms causing the human disease hanta pulmonary syndrome, caused by the Sin Nombre virus (popularly referred to as Hantavirus). This public health problem came to national attention when a cluster of deaths occurred in the southwest U.S. in 1993. Lyme disease is associated with the white-footed mice (*Peromyscus leucopus*), which is the eastern counterpart to the deer mouse. Lyme disease is caused by a *Borrelia* spirochete and carried by deer ticks. Infected ticks spread the disease to white-footed mice, which then serve as a reservoir of infection for future generations of ticks. The ticks will bite and spread the disease to humans as well. Figures 1 and 2 on the following page show the distribution of deer mice and white-footed mice. While the ranges overlap, *P. maniculatus* is the predominant species in the western U.S., while *P. leucopus* is most common in the east.

As more and more residences are being built at the suburban-rural interface in many areas of the U.S., the incidence of rodent-borne diseases is increasing. Devices which repel rodents from structures offer an environmentally benign method of reducing or eliminating rodent damage and potential disease exposure. As with any rodent management technique, no one method is completely effective, and a program of integrated management involving a variety of techniques and practices is most likely to provide the desired results. The goal of pest management is not to kill pests, but to reduce the problem(s) caused by the pests to acceptable levels.

This study was conducted at Genesis Laboratories, Inc., in Wellington, Colorado. The objective of the study was to evaluate whether the Pest-A-Cator/Riddex electronic device will repel rodents from a treated area. This device is designed to be plugged into a standard two or three-prong 110V AC wall outlet and generates a pulsating electromagnetic signal which flows through from the building's wiring system and potentially annoys rodents, eventually inducing them to leave the treated area. The manufacturer, Global Instruments Ltd., Trenton, MO, instruct consumers to use the devices as part of an integrated rodent management program including exclusion and sanitation.

To conduct this study we introduced two rodent species, wild house mice (*Mus musculus*), and white-footed mice (*Peromyscus leucopus*), into a complex of chambers simulating a home setting. Chambers were connected with PVC pipe tunnels. After groups of rodents were acclimated to the housing complexes, various chambers were activated with the Pest-A-Cator device for two to three weeks at a time. Food, water and

shelter were provided *ad libitum* (available in surplus) at all times in all chambers. Feed consumption in each chamber was measured daily as an indirect index of chamber usage. Video cameras were used at times as well as a direct measure of the usage of chambers by the mice. Behavioral patterns of interest were the rate of onset of a response to the device, the extent and duration of any response, and the rate of extinction of avoidance behavior after the system is turned off.

Figure 1. Range map of White-footed mouse distribution in North America (number 1 on map). (Adapted from King, 1968)

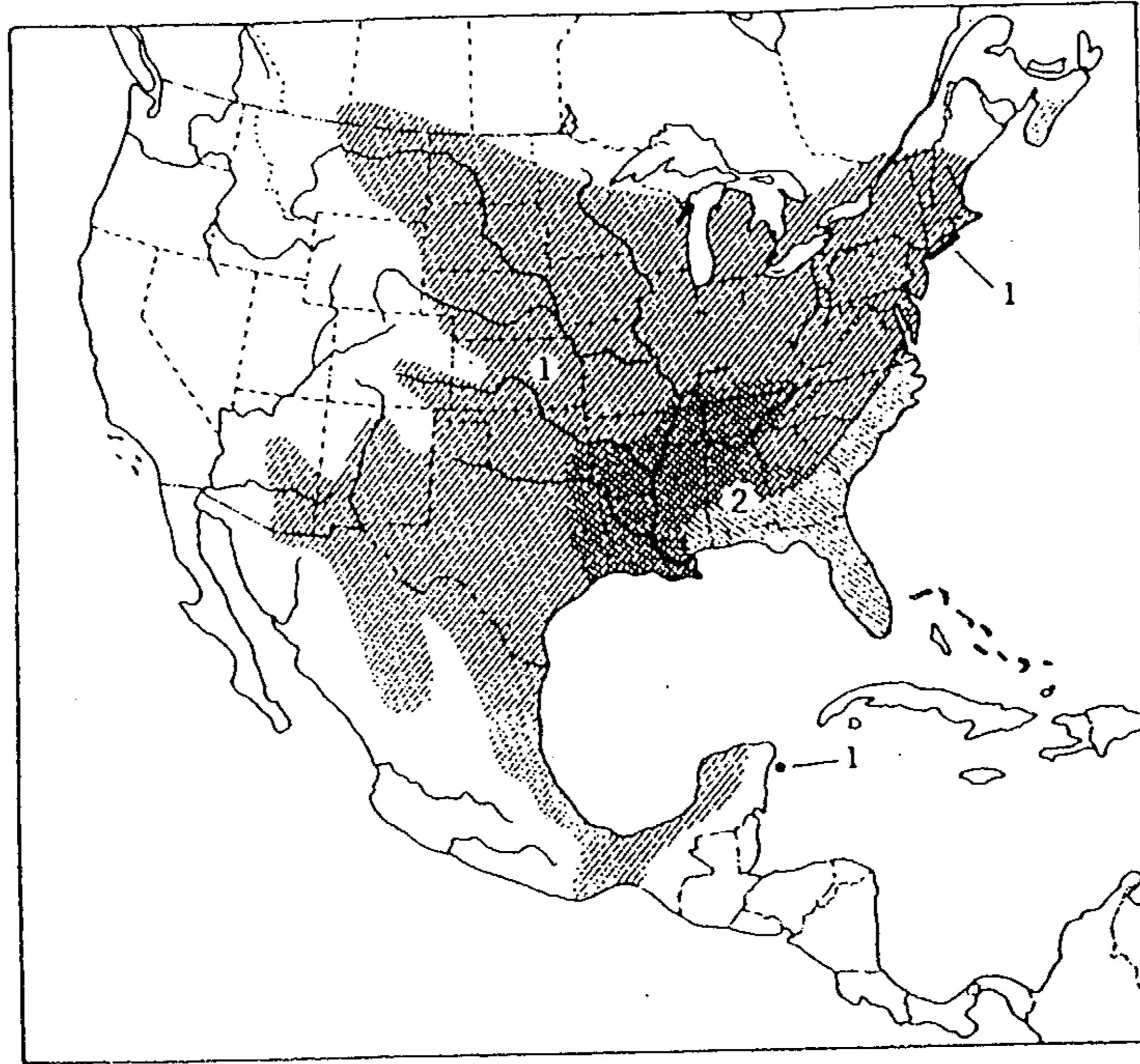
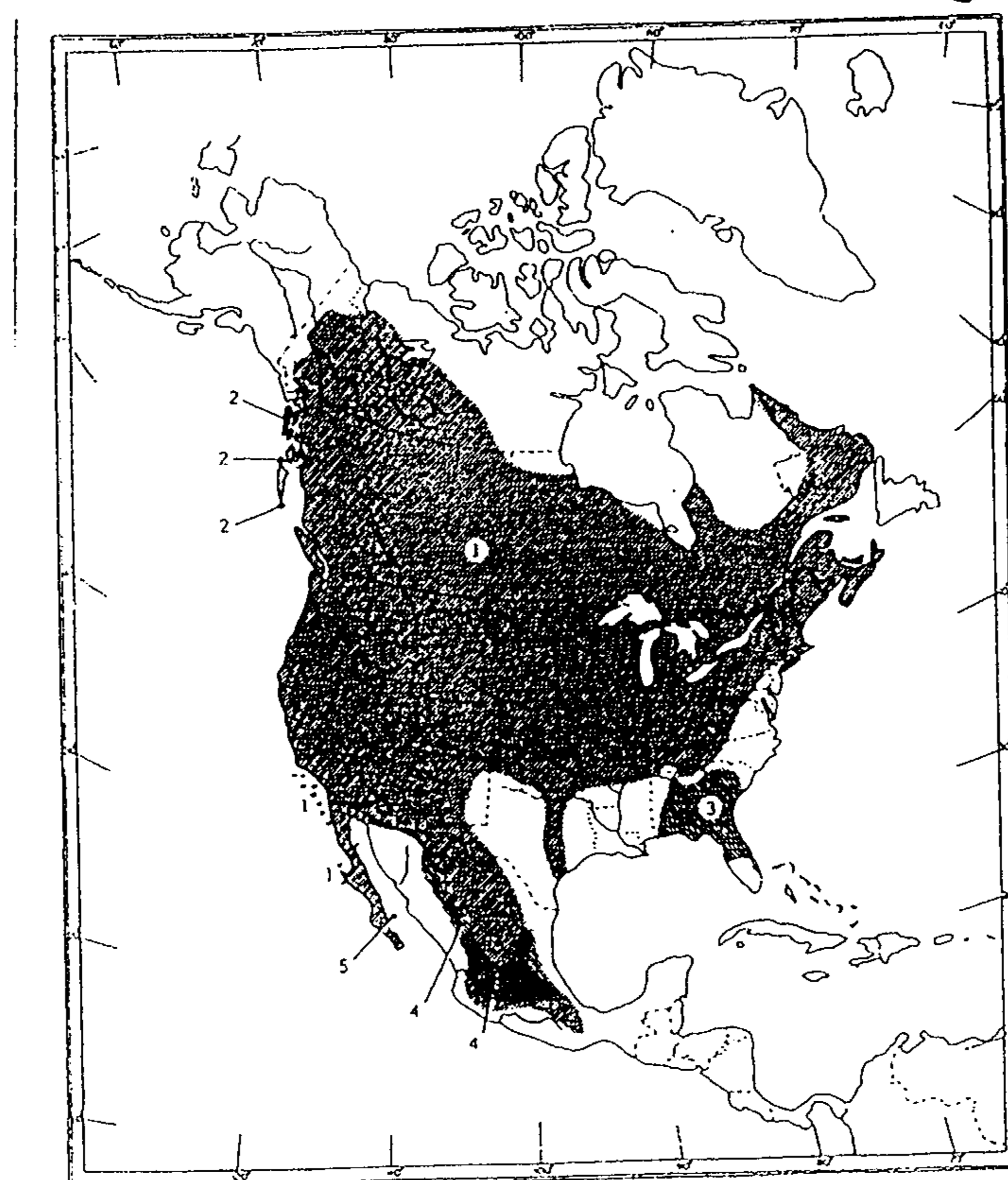


Figure 2. Range map of Deer Mouse (*Peromyscus leucopus*) distribution in North America (number 1 on map). (Adapted from King, 1968).



II. MATERIALS AND METHODS

A. **Experimental Design**

The experimental design involved placing rodents into an apparatus which simulated two small rooms in a typical wood framed structure, with standard electrical wiring in the walls. Chambers were connected by a tube so that mice could move freely from one chamber to the other. Food, water and shelter were available in both chambers. The starting assumption was that mice would show no preference for either chamber and would use each approximately equally. The test period was divided into phases. Phase I was an acclimation period to allow the mice to become accustomed to the setting and to establish baseline data regarding chamber usage. Phase II involved activating one of the chambers with the Pest-A-Cator device for a period of two weeks. The expectation was that, if the device had a repellent effect, chamber usage would shift away from the activated chamber. Daily monitoring of chamber usage would also allow any habituation to the signal, or gradual extinction of response, to be detected. Phase III involved switching the device to the opposite chamber. The response of interest was if the mice would switch their chamber preference accordingly, and how long would such a switch take. The extinction rate of avoidance of the previously activated chamber could be also be detected.

With the wild house mice, the original experimental design was altered during the course of the study. After two weeks of exposure to the device in one chamber, we determined that the "chamber within a chamber" apparatus differed from a home situation in one important respect. The mice were not able to come closer than about 15 inches to the outer chamber wall which contained the activated wires. The inner chamber restricted them to an area which was comparable to being out in the open of a room in a house or office. Mice typically run along walls, and prefer to maintain contact with the wall with their vibrissae (whiskers). To correct this design problem as much as possible we moved the Pest-A-Cator signal closer to the inner plexiglas housing chambers via an extension cord laid around the outside of the base of the unit. Phase I was extended for one week with the adjusted signal placement. Consequently, Phase II, when the signal placement was reversed, lasted only nine days rather than 14 days.

The white-footed mice study was done as an adjunct to the house mouse study, and the study period was only one week. The mice were allowed to acclimate for three days, followed by a four day period (Phase I) in which one of the chambers was activated with a Pest-A-Cator.

B. **Pest-A-Cator and Riddex Device**

The Pest-A-Cator device is a plastic encased module measuring about 2.5" x 1.25" x 4.5" (LxWxH), with two prongs that allow it to be plugged into any standard two or three prong, 110V AC electrical outlet. "Riddex" is an alternate marketing name for the same device. According to manufacturer specifications, a single device produces a signal adequate to cover about 2000 square feet. Larger structures require an additional device per 2000 square feet area to maintain signal strength. In large buildings, several devices

are to be plugged in at different locations to assure adequate signal strength as well as distribution, rather than multiple units being activated at a single location. The signals produced by the device are carried through the structural wiring, and thus are distributed to all wired areas. The literature accompanying the device claims the signal is able to penetrate walls and cabinet areas, although the attenuation rate of the signal when passing through various materials is not known.

To assure adequate signal distribution at the activated chambers, one device was plugged into each activated chamber, for a total of two per test room. In addition, three other devices were installed in the building at other sites at all times. The building consists of animal care rooms and office spaces and totals 4500 square feet. All wiring is distributed through a two breaker panels, one piggy-backed on the other to provide additional circuits. The use of five devices in the building was considered adequate by the manufacturer to maintain full signal strength in the test chambers. The units provided by the sponsor appeared to be standard commercial devices, and were not manufactured specifically for this study.

C. Test Dates

Wild house mice were tested from November 8 to December 14, 2001. White-footed mice were tested from December 8 to December 16, 2001.

The white-footed mice were not part of the original test plan, but since the performing laboratory had laboratory space and a source of pathogen – free animals available, it was decided late in the study to generate some preliminary data on the effect of the Pest-A-Cator on this species as well.

D. Test Animals

Wild House Mice - Wild house mice (WHM) were live-trapped from local farms, using Sherman live-traps baited with peanut butter and oats. Mice were dusted with a pyrethrin-based flea powder upon capture, separated by sex, and placed into the test apparatus as soon as possible. Five male mice were placed in one apparatus and two female mice were used in a second apparatus. All mice were from the same site and were likely related. This was important to minimize aggressive behavior. Nonetheless, one male mouse was found dead on the third day in the chamber, with wounds suggesting he was a victim of fighting. No further signs of agonistic behavior were noted during the study.

White-footed Mice - White-footed mice (WFM) came directly from a colony maintained at Genesis Laboratories. The founders of the colony were obtained from the Peromyscus Stock Center at the University of South Carolina. The mice are a pathogen-free, out-bred, wild type. They are derived from wild stock captured in 1946 and kept in captivity for about 60 generations. Three young adult males and three young adult females were placed in each of two test apparatuses, grouped by sex. The mice are accustomed to human activity and a captive environment, but cannot be considered “domesticated.”

E. Housing and Maintenance of the Test Animals

1. Housing. Wild house mice were housed in Room A5. White-footed mice were housed in Room A2. See Figure 3 for the floor plan of the building.

Each test apparatus was designed to represent two closet-sized rooms in a standard wood frame house, with insulated walls and a single run of 12-2 electrical wire in each wall. In order to confine the movements of the mice, to be able to make observations, and to have access to the food and water supplies, an inner housing chamber was built and placed in the center of each "room" or secondary enclosure.

The inner, primary housing chambers consisted of plexiglas boxes measuring 18 inches X 18 inches X 10 inches (L x W x H). Each chamber had a solid, hinged lid, and a ¼ inch hardware cloth bottom suspended over a bedding pan. The sides of the chambers were drilled with approximately 20, ¼ inch diameter ventilation holes. A four inch diameter opening in one side provided access to a 4 inch diameter, 10 foot long PVC drain pipe which will lead to another, identical chamber. A food cup, water bottle with stainless steel sipper tube, and a shelter consisting of a single, slightly flattened soup can were provided in each plexiglas chamber. Paper toweling was provided for nesting material.

Each plexiglas chamber was placed on the floor in the center of a secondary enclosure measuring 48" x 48" x 39" (L x W x H). The secondary enclosures were constructed of 2" x 4" lumber framed walls with 1/2" oriented strand board sheathing on the outside, and 1/2" sheetrock on the inside. The interior of the walls were insulated with fiberglass batting, and a single run of 12-2 Romex™ household electrical wire was installed horizontally around all four walls of the secondary enclosure. The wire was installed at a standard height off the floor of 15 inches. The wire run commenced and terminated at a two-gang outlet box fitted with two wall outlets. This allowed the secondary enclosure to be connected by an extension cord to an outlet in the test room, using a male-male adapter. When connected thus, the wire circuit in the box was live. To activate the secondary enclosure circuit a single Pest-A-Cator or Riddex device was plugged in to the adjacent outlet in the two-gang box.

Once a week, pine shaving bedding below the plexiglas chambers was replaced with fresh material.

See Figure 4 for a diagram of the test apparatus. There were two apparatuses (four chambers) in each test room. One was used for the females and one for the males.

2. Environment

Environmental monitoring was performed daily during the test periods. The temperature and humidity in the test rooms were monitored with a digital hygro-thermo unit. Temperature was maintained between 12.4 and 31.0°C. Relative humidity was ambient, and ranged from 16-41 %.

Lighting was provided by full spectrum fluorescent lights, which were illuminated 12 hours per day. Light intensity one meter above the floor was adjusted to between 130 – 325 lux. According to the *Guide for the Care and Use of Laboratory Animals (1996)* this light level is safe for the animals and still is sufficient for animal care activities. Two 25 watt incandescent red bulb table lamps were used in each room at all times. One was plugged into the Pest-A-Cator activated chamber to simulate a home setting where a lamp might typically be on the same circuit as a Pest-A-Cator device. The second lamp was plugged into a room outlet on the opposite side of the room to provide consistent light levels near each chamber at night. The lamp near the non-activated chamber was placed 5-6 feet from the chamber so as not to influence the chamber with the Pest-a-Cator signal.

This provided sufficient illumination for filming during the dark cycle. The red light wavelength and low intensity does not disturb the day:night cycle of the mice (1,6). A Paragon Electric Model P101 timer was used to maintain the light cycle in each room.

Room ventilation was maintained at approximately 10-15 air exchanges per hour in the study room during the test periods.

3. Basal Diet and Water

Harlan Teklad 8664 commercial rodent chow was available *ad libitum* at all times in all chambers. The pelleted feed was presented in aluminum feed cups. Tap water in inverted bottles with steel sipper tubes was available at all times in all chambers.

4. Video Recording

Video surveillance of mouse activity in the clear plexiglas chambers was performed using PC-100 microvideo cameras (Supercircuits, Liberty Hill, TX) mounted above each chamber. The cameras are capable of imaging in low-light conditions (0.5 lux). Power was supplied to each unit by a 12V converter plugged into a test room outlet. The power supply and video output lines were shielded in flexible plastic conduit to minimize emission of electronic pulses generated by the Pest-A-Cator devices into non-activated chambers via the camera power cord.

All four cameras used in each test room (one per chamber) were connected to a black and white EP-100 quad processor (Supercircuits, Liberty Hill, TX), which allows four cameras to be monitored simultaneously, and recorded simultaneously on a VCR tape.

Taping was conducted during the first and last weeks the wild house mice were in the chambers. White-footed mice were taped during most of the one week they were on the test. However, one camera malfunctioned and only three chambers were taped for part of the period. Taping on most days was conducted for 16 hours, which included about 11 hours of daylight activity and five hours of nocturnal activity.

F. Parameters Investigated

1. Daily Observations

Observations were performed once daily in all phases of the test. The house mice typically hid in the tunnels when people were in the room and so were rarely observed directly. The white-footed mice were accustomed to human activity and would often stay in the plexiglas chambers when people were in the room. Human activity in the rooms was minimized so as not to alter the activity and behavior patterns of the mice. Daily food, water, and environmental monitoring took about 20 minutes.

2. Feed Consumption

Feed consumption was measured daily in each plexiglas chamber. Any spilled feed was retrieved and the combined weight of the feed cup and diet were measured to the nearest gram.

3. Video Recording

Video tapes of mouse activity in the plexiglas chambers was quantified by reviewing the tapes and noting with a stopwatch the time spent in each chamber by one or more mice. Since mice were not individually identifiable, no attempt was made to determine individual rodent activity patterns. Whenever at least one mouse from a group was in a chamber, the chamber was logged as being in use.

G. Data Analysis and Statistical Procedures

The daily feed consumption was evaluated in three ways.

First, the daily consumption for males and females was plotted in line graph format. The data was entered into the graphs such that the area above the 50% grid line always represents the chamber with the Pest-A-Cator activated wiring, except during the acclimation or baseline period when neither chamber was activated. Thus data points above the 50th percentile represent a majority of the diet coming from the activated chamber. Data points below the 50th percentile represent a majority of the diet on that day coming from the control chamber. When reading Figures 5 and 6, realize that the source data for the plots were reversed when the Pest-a-Cator location was reversed in Phase II, so that the upper half of the plot still represents use of the activated box. This data presentation may illustrate behavioral trends suggesting, for example, avoidance or habituation to the Pest-A-Cator signal. This type of presentation may suggest correlations between variable being measured, however it does not establish a cause and effect relationship. The same data, percent feed taken from each chamber each day, is presented in bar graph form in Figures 7 and 8. In this case, plotting for the activated box was not adjusted, so the line graph patterns in Phase II of Figures 5 and 6 represent a mirror image of the bar graph patterns for that period (days 30-36).

Second, the number of days in each phase that the mice took a majority of their diet from the blank or activated chamber is presented. This format provides another means of identifying any correlation between stimulus (Pest-A-Cator) and behavioral response by the WHM.

Third, the percent of diet taken from each chamber for each phase was analyzed statistically, using the chi-square goodness-of-fit procedure to test the fixed ratio hypothesis. The null hypothesis tested is that the Pest-A-Cator device has no effect, leading to a ratio of activity (feeding or presence) in activated and non-activated chambers of 1:1, or 50%:50%. A statistically significant deviation from this ratio suggests an effect by the device, since all other variables are presumably equal in either chamber. The chi-square statistic will identify statistically significant and consistent feeding chamber preferences for each period. This procedure has limitations in that the data for each phase is tested in the aggregate, so that trends that only persisted for part of each phase are not tested in the analysis. Furthermore, when the number of replications is small, as in this case, there is a potential for committing a statistical Type II error, which is to say that the null hypothesis (no differences, or no effect) is accepted when in fact it is false. Quantifying the probability of a Type II error in this situation, however, is very difficult (5).

Video recordings of activity provided further evidence of relative use of the alternate chambers. Summaries of the time spent in the activated chambers vs. time spent away from the activated chambers are presented.

The white-footed mouse data is summarized with graphs of daily feed consumption and tabulation of time in chambers derived from video recordings. The test period was so short that the results must be considered preliminary. Nonetheless, interesting behavioral habits of the WFM that are quite different from the wild house mice emerged from the brief study.

Despite attempts to simulate a natural setting and isolate any effects of the device on rodent behavior, it is recognized that this was an artificial setting. The individual and group rodent responses to the physical setting, the social dynamics inherent in the situation, and potential reactions to the stimulus introduced by the Pest-A-Cator device cannot be entirely separated. However, behaviors in this setting can give an indication of how rodents might respond in a natural setting.

III. RESULTS – WILD HOUSE MICE

A. Feed Consumption

Daily feed consumption in each chamber is presented in Appendix I. The chart shows both daily grams consumed per box and percent of daily total taken from each chamber

Data is missing for the males for days 5 and 6, during the acclimation period, due to a recording error that was impossible to reconstruct later. The same occurred on day 5 of acclimation for the females.

1. Percent Daily Feed Consumption Patterns

a.. Male Wild House Mice.

Figure 5 indicates the male mice were using both chambers with no clear pattern established during the baseline period. Following activation of the Pest-A-Cator, the male WHM concentrated most of their feeding activity in the control box for the first five days. Thereafter they took the majority of their diet from either chamber on different days. Overall, for the first 14 days the Pest-A-Cator was activated, the male WHM obtained most of their food from the control box on 10 days.

The plot does not show a change in pattern when the signal was moved closer. However, the WHM took the majority of their diet from the control box on four of the seven days after the signal was moved closer.

Following the reversal of the Pest-A-Cator location on day 22, the male WHM did not display a clear response, but nonetheless took most of their diet from the new control chamber on three of seven days, and ate a majority of the diet from the former control chamber (now activated) 4 of 7 days.

b. Female Wild House Mice.

Figure 6 indicates the female mice were using both chambers with no apparent pattern established during the baseline period. Following activation of the Pest-A-Cator, the female WHM concentrated most of their feeding activity in the non-activated, or control box. This was true for seven of the next eight days. On day 16 they took most of their feed from the activated box, reverted to the control box on day 17, then obtained an equal amount or a majority of their diet from the activated box until the signal location was switched. On day 23, the day after the signal was moved closer, they took most of their feed from the activated box. However, the following day and for the next five days, they ate most of their feed from the control box.

On day 29, the Pest-A-Cator was switched from chamber C to chamber D of the female WHM apparatus. In viewing the graph, Figure 4, recall that majority use of the activated chamber is always represented by the top 50% of the chart. During the seven days following the reversal, the mice alternated between chambers and took a majority of their food from the activated (formerly control) chamber four of seven days. No clear use pattern emerged during this period.

Figures 7 and 8 present the same data for male and female WHM in bar graph format.

2. Percent Daily Feed Consumption Chamber Usage by Days

Table 1 summarizes the number of days male and female WHM took a majority of their feed from the activated or inactivated chambers.

a. Male Wild House Mice

The male WHM took half or more of their daily diet from the control chamber 17 out of 21 days during Phase I, or 67% of the days. However, during the last seven days of Phase I, even though the signal was moved closer, this measure of activity balanced out between chambers, with each chamber receiving a majority of the diet take on 3/7 days, with one day a even. When the Pest-A-Cator signal was switched in Phase II, they took a majority of their diet from the control chamber for 3 of 7 days, or 43% of the days. These data are consistent with an interpretation of moderate repellency during the first 14 days, followed by a period of indifference, or habituation, in spite of a closer, presumably stronger signal during the last seven days of Phase I. There was no consistent use of either chamber during Phase II, again suggesting that the abrupt reversal of the site of signal disrupted previously established patterns. Overall, half or more of the diet was taken from the control chamber 17/28 days, or 61% of the time.

b. Female Wild House Mice

The female WHM took half or more of their daily diet from the control chamber 17 out of 21 days during Phase I, or 81% of the days. Following a lag of one day after the relocating of the signal, the females used the control chamber 50% or more for each of the next six days. In a pattern that followed that of the males, when the Pest-A-Cator signal was switched in Phase II, the females took a majority of their diet from the control chamber for 3 of 7 days, or 43% of the days. These data, combined with the patterns show in Figure 4, reinforce an interpretation of some aversion to the Pest-a-Cator signal during the first 7 days, followed by a period of habituation for the next seven days. When the signal was moved closer, in contrast to the males, the females obtained most of their food from the non-activated chamber until the signal location was reversed. The pattern of switching between chambers for the week mirrors the reaction of the male WHM during Phase II. Overall, half or more of the diet was taken from the control chamber 20/28 days, or 71% of the time.

3. Chi-Square Analysis of Feed Consumption per Chamber by Phase.

Table 2 shows the amount of diet taken from each chamber during each phase, in both grams and in terms of percentage. The percentage data were analyzed using the chi-square statistic. The tabular value of the chi-square statistic at the 0.05% level of probability is 3.84. A test result which exceeds 3.84 indicates a significant difference between the actual response and the expected response of a 1:1 ratio. Testing at the 0.05% level means that the result would only be expected to occur by chance one out of 20 times the experiment is repeated. Phrased another way, a significant response is

probably due to a treatment effect 19 of 20 times. The 0.05% level of probability is considered to be a reasonable level for detecting treatment effects in the life sciences.

As shown in Table 2, when the data are analyzed in this manner, there is no apparent preference for either chamber during the acclimation or Phase I periods. Going back to Figures 3 and 4, however, it becomes apparent that the analyzing the summarized data obscures patterns within each phase. However, a very strong and/or consistent response would likely have shown a significant difference in this analysis.

The only significant deviations from a 1:1 ratio in feed consumption from alternate chambers occurred in Phase II for both female and male WHM. Interestingly, with both sexes a significant majority of diet was taken from the activated chamber during this phase. The activated chambers, however had been inactive for the entire preceding four weeks, and both groups of mice had been obtaining a majority of their diet from these chambers in the preceding week. While the data do not indicate an *aversive* response to the relocated Pest-A-Cator, the shift from no significant differences in the previous phases to a very significant difference in Phase II, taken along with the alternating pattern of use that emerged during this phase (illustrated in Figures 5 and 6), strongly suggests the abrupt relocation of the device had an impact on their behavior. Again, the reversing of the Pest-A-Cator location was associated with a disruption of their previously established feeding behavior patterns.

B. Video Recording of Activity in Chambers

Video recordings of activity were only tabulated for the last week of the test. The results are presented in Table 3 and Table 4.

Table 3 shows the comparative times spent in each chamber during Phase II when the Pest-A-Cator signal location was reversed. The males spent a slightly greater proportion of the time in the activated chamber than the control chamber. The opposite was true of the females. Recall that during this period feed consumption data indicated the mice had abandoned earlier established patterns and were alternating between chambers for food supplies.

Table 4 shows a breakdown of time in the chambers and tubes. The time in tubes was derived by subtracting the time in either chamber from the eight hours (28,800 seconds) recorded on each tape. The percentage of time spent in either chamber is shown to be a small proportion of each eight-hour period.

IV. DISCUSSION – WILD HOUSE MICE

This study illustrates the difficulty in isolating a single behavior or behavioral response in higher animals. The study design and test apparatus were designed both to allow data to be collected and to provide a setting in which the mice behavior would be representative of what might occur in the wild. The two goals were not entirely compatible. The study attempted to simulate a real home or office situation within a controlled setting that

allowed various parameters to be measured that might indicate the existence, strength and duration of response to the Pest-A-Cator device. The extent to which we succeeded in the experimental design is difficult to quantify. Clearly social behaviors, survival instincts, and stress were uncontrolled variables that were influencing the behavior of the mice in addition to any responses to the Pest-A-Cator. These elements and others, unidentified factors all contribute to "background noise" which interferes with the observations of interest.

The feed consumption patterns offer the strongest indication that the wild house mice were in fact reacting to the device. The females in particular displayed feeding patterns consistent with a hypothesis that they were avoiding the signal initially, and that after about seven days they began to habituate to it. Moving the signal closer was associated with a rapid shift of food source preference back to the non-activated chamber. This suggests that the signal may be attenuated by building materials. In the original configuration, the signal was about 18 inches from the tube and plexiglas chambers, separated by wood, sheetrock and fiberglass insulation. The female mice feeding behavior clearly shifted back to the control chamber when the extension cord was used to bring the signal within a few inches of the plexiglas chamber and there were no other obstructions.

The male mice showed a similar reaction when viewed from the perspective of the number of days they took a majority of their diet from the control chamber during Phase I. However, they never displayed as clear a pattern as the female mice. This could be due to the fact that there were four male mice and only two females. Social factors may have played a larger role in the male mouse apparatus, interacting with and perhaps at times perhaps over-riding other influences.

The responses of both sexes of mice when the signal location was reversed in Phase II also suggests the mice were aware of the signal. The feeding behavior pattern clearly changed in conjunction with the signal relocation.

The results shed light on the three questions of interest: rate of response, extent and duration of response, and rate of extinction of response. While the study was not designed to establish a cause and effect relationship, both sexes of WHM, and particularly the females, exhibited behavioral changes within 24-48 hours of the activation of the Pest-A-Cator/Riddex device in a particular chamber. The magnitude and duration of behavioral changes in the male mice varied more than that of the females. The females showed a feeding preference for the non-activated chamber for seven days after the other chamber was activated, then shifted preference for most the next seven days to the activated chamber. Moving the signal closer was associated with a reversal of preference again within 48 hours. This preference followed for the next 6 days. When the signal location was reversed, a pattern of alternating preferences prevailed for the next seven days. Alternating preferences between the formerly activated chamber and the newly activated chamber could be an indication that an avoidance response to the initial chamber was still intact during this period, while the

new location of the signal was causing avoidance as well. If this was the case, the extinction period for the response is more than seven days.

The video recording illustrated that there were really *three* choices of sites for the mice in the test. The tube represents a different, and as we learned, a preferred "habitat" for the mice. It is not valid to sum time in the tube with time in the in-active chamber as "time away from the Pest-A-Cator signal." However, the question remains, if the apparatus had consisted of only a single "habitat" and two location choices, activated and non-activated, how would the mice have partitioned their time?

A final observation associated with the time budget analysis is that when the apparatuses were dismantled at the end of the test, both male and female mice were found to have built nests near the center of their respective tubes. Video tape recordings made in the acclimation period also showed the WHM spent the great majority of their time in the tubes rather than the chambers.

V. RESULTS AND DISCUSSION – WHITE-FOOTED MICE

The white-footed mouse study was a preliminary look at how another species might respond to the Pest-A-Cator. The same apparatus and study design were used as with the WHM, but the test period was compressed into three days acclimation and five days of exposure to the Pest-A-Cator signal.

A. Feed Consumption

Daily feed consumption in each chamber is presented in Figures 9 and 10 for the male and female WFM, respectively. The same data is shown in bar graph format in Figures 11 and 12. With such a short acclimation period and exposure period it is difficult to discern any clear patterns. Perhaps the most interesting observation to emerge was that the female WFM were found to be transporting feed pellets from the activated chamber to the control chamber on days 5 and 6 of the test. This was learned by feed weight measurements, in which the active chamber feed cup lost weight on these days while the control cup gained weight. Thus, although the activated chamber lost feed weight on some days, only the amount not traced to gained weight in the control chamber is tallied as consumption.

B. Video Recording of Activity in Chambers

Video recordings of activity were only tabulated for the last week of the test. The results are presented in Table 5 and Table 6.

Table 5 shows the comparative times spent in each chamber during the last four days of Phase I when the Pest-A-Cator signal location was reversed. In contrast to the WHM, both sexes of the WFM spent a very significantly majority of the total time in chambers in the non-activated chambers. They also spent much more time in the chambers relative

to the time spent in the tubes (Table 6). This was probably due to the fact that the WFM used were much more accustomed to captivity than the WHM.

V. CONCLUSIONS

A. Wild House Mice

The patterns exhibited by the female WHM suggest there may be an aversive response to the Pest-A-Cator, which persists for 6-7 days, after which habituation seemed to occur. The change in behavior upon moving the signal closer indicates the signal is attenuated by building materials. Reversing the signal location was associated with another change in behavior of the female mice, that of alternating, or oscillating, chamber preference. If the mice were in fact repelled by the device signal, this behavior in Phase II suggests that more than seven days is needed for extinction of the association of the signal with a particular site.

The behavior of the male mice was not as clearly associated with operation and location of the Pest-A-Cator. The influence of other factors, such as dominance hierarchies (pecking order) may have been stronger with the male mice than the females and therefore interfered with any response to the devices.

Still, the results clearly demonstrate that wild house mouse behavior changes in conjunction with the introduction of the device and signal into their immediate environment.

B. White-footed Mice

Although the results are preliminary, the hugely disproportionate amount of time spent in the non-activated chambers by the WFM may indicate a greater sensitivity to the Pest-A-Cator signal than house mice. The same pattern of behavior was seen in both males and females whereas with the house mice, females displayed a more pronounced behavioral change in association with the Pest-a-Cator activation than did the males. The caching behavior of the female mice may have been in response to the Pest-A-Cator signal and bears further research.

Overall, the results indicate that the rodent species studied here change their behavior in association with the activation and placement of the Pest-A-Cator/Riddex devices. If the same responses occur in home and office settings, the devices should have applications as part of integrated rodent management programs.

VII. LITERATURE CITED

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Figure 3.

Floor Plan of Test Facility, showing locations of test rooms A2 (white-footed mice) and A5 (wild house mice).

Genesis Laboratories, Inc.
10122 N. E. Frontage Road
Wellington Colorado

Building No. 1: Toxicology
Facility Layout: Emergency Evacuation Routes
June 1, 2001

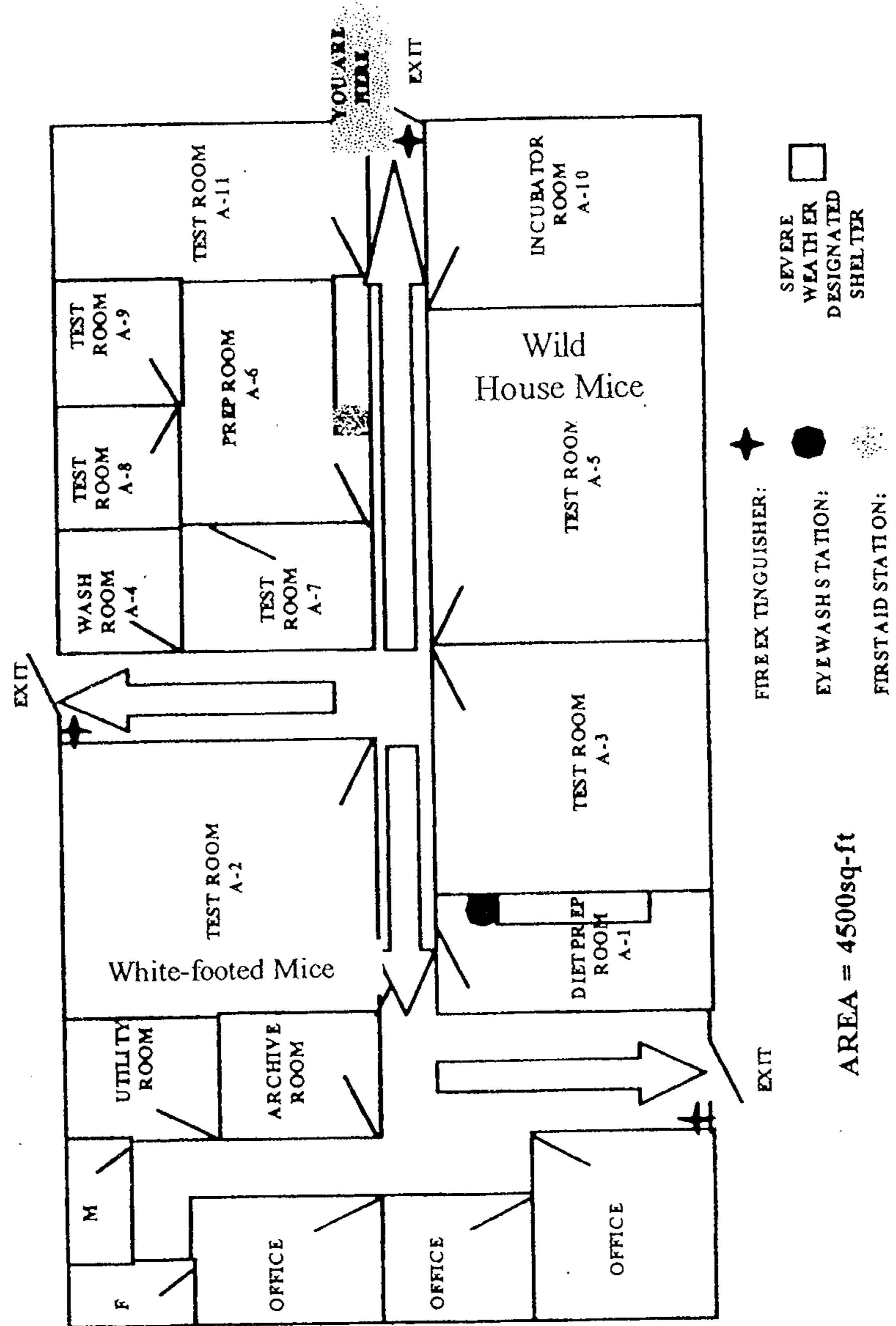


Figure 4.

Diagram of Test Apparatus.

There were two parallel apparatuses in each test room, one for males and one for females.

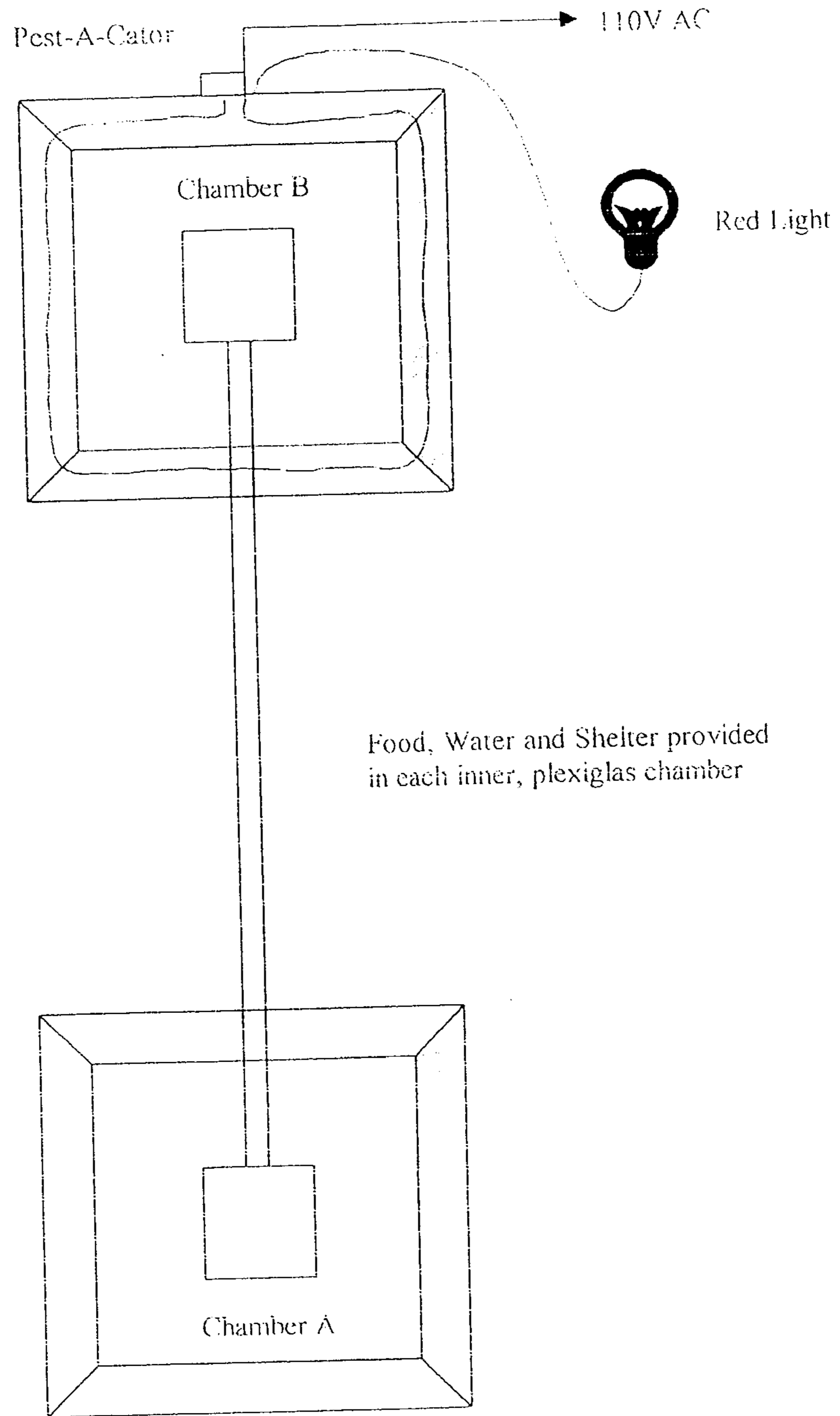


Figure 5.

Percent of Diet Taken From Each Chamber, Male Wild House Mice.
 The upper 50% always represents use of the Pest-a-Cator activated chamber, except during the acclimation, or baseline phase, when neither chamber was activated.

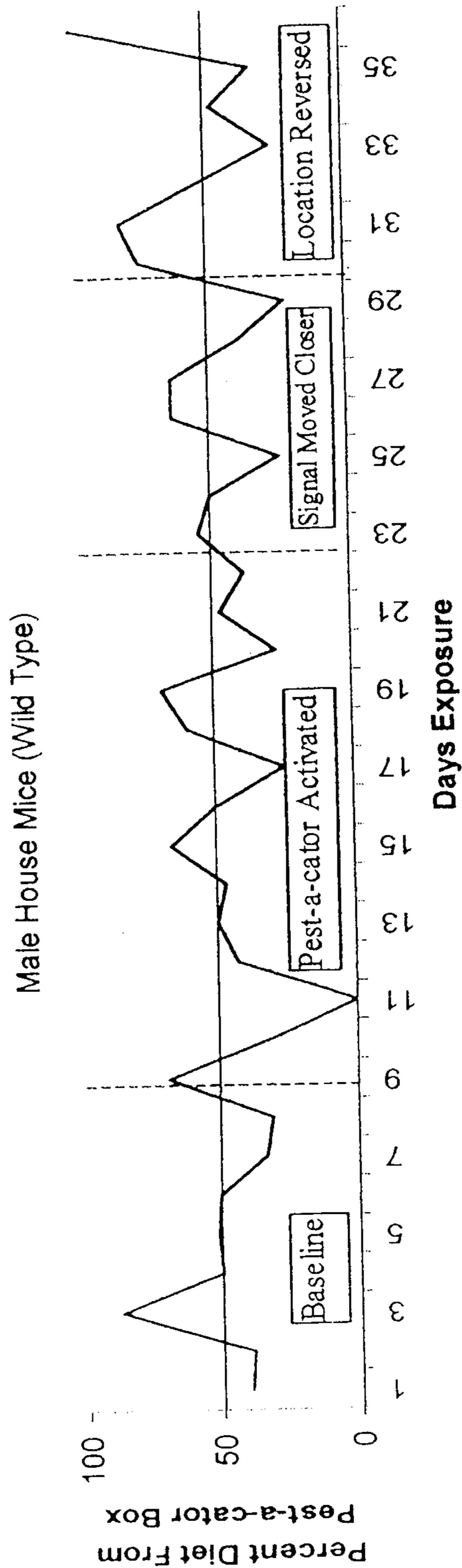


Figure 6.

Percent of Diet Taken From Each Chamber, Female Wild House Mice.
 The upper 50% always represents use of the Pest-a-Cator activated chamber, except during the acclimation, or baseline phase, when neither chamber was activated.

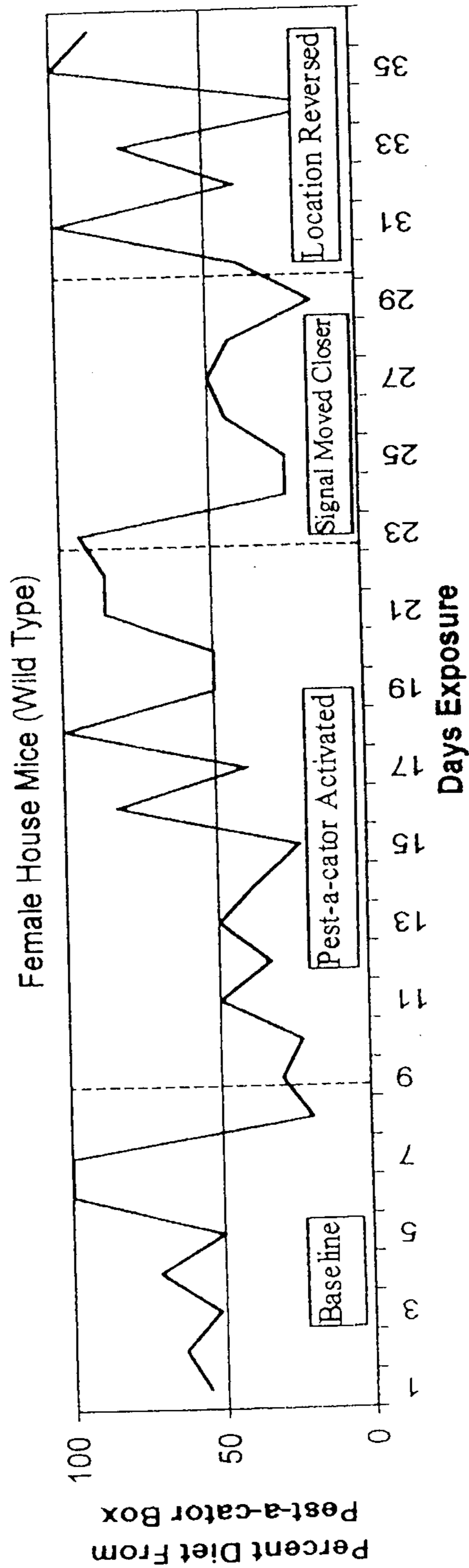


Figure 7.

Percent of Diet Taken From Each Chamber, Male Wild House Mice.
Bar Graph Representation

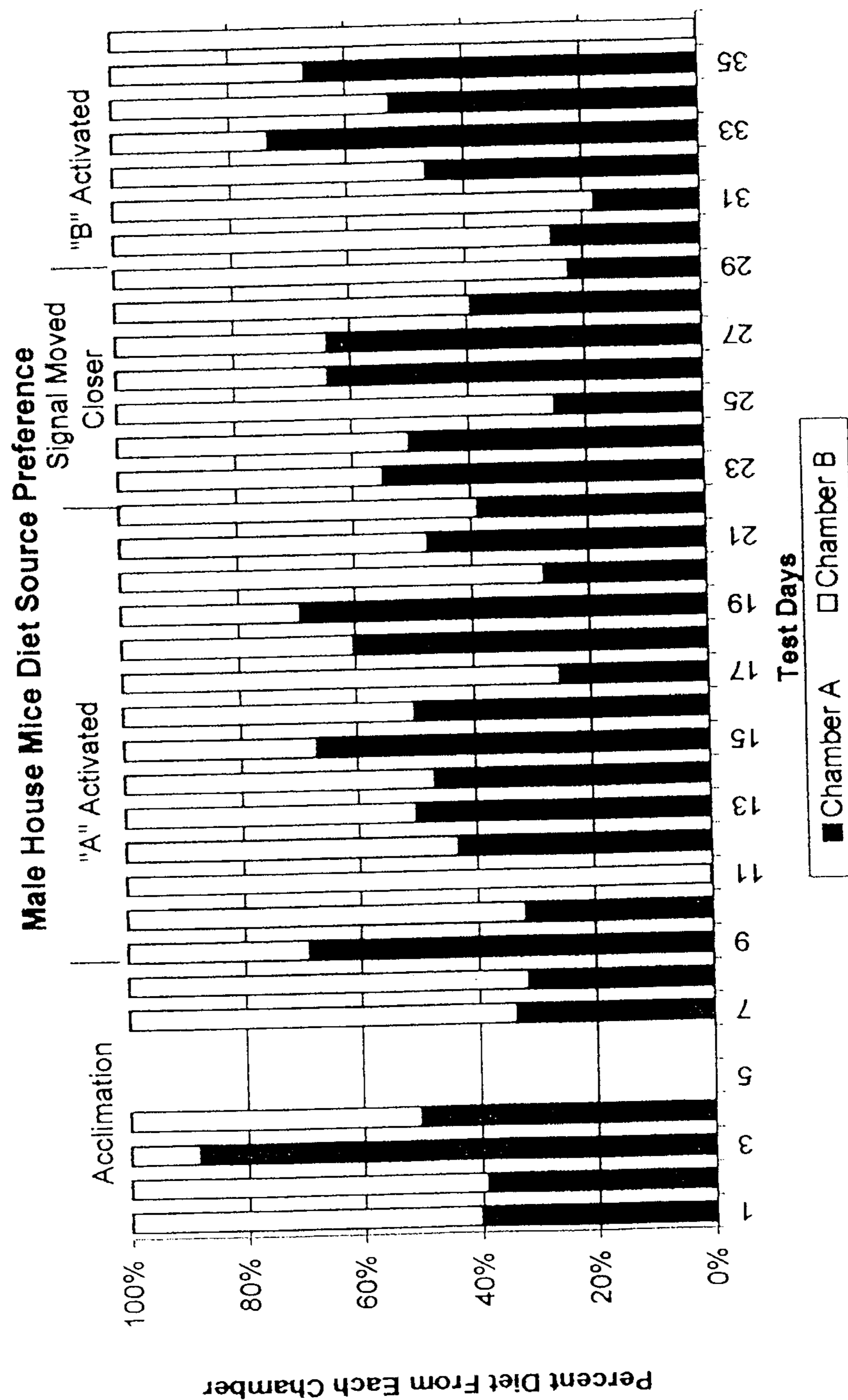


Figure 8.

Percent of Diet Taken From Each Chamber, Female Wild House Mice.
Bar Graph Representation

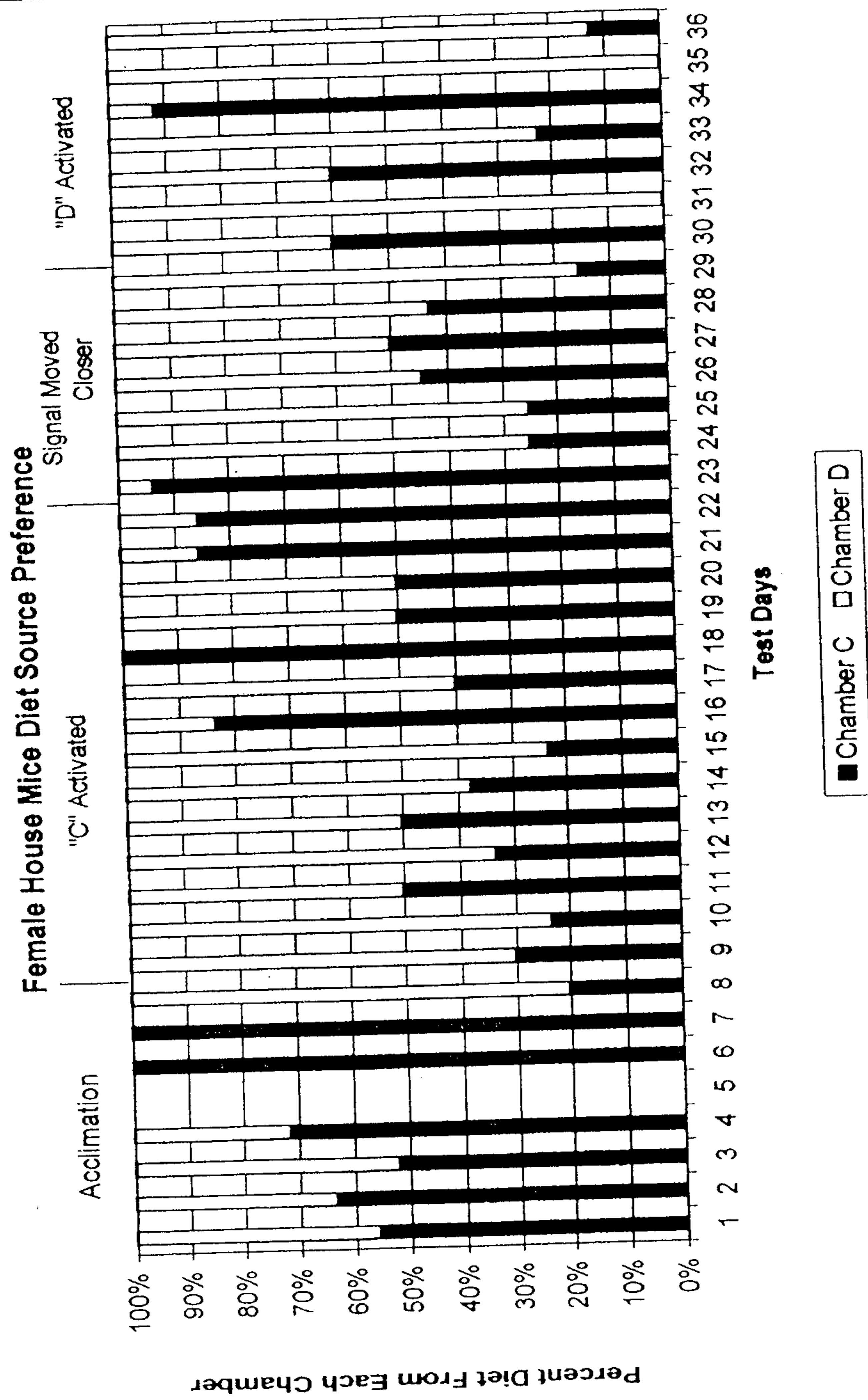


Table 1.

Number of Days a Majority of Diet Was Taken From Each Chamber

Pest-A-Cator Activated Chamber Appears in **Bold Type**

Days on which consumption was equal from both chambers are excluded from the counts.

| Male – Acclimation ¹ | | Female – Acclimation ² | |
|---------------------------------|------|-----------------------------------|------|
| | Days | | Days |
| Chamber A | 1/8 | Chamber C | 6/8 |
| Chamber B | 4/8 | Chamber D | 1/8 |
| 50:50 Tie | 1/8 | 50:50 Tie | 0/8 |

| Male- Phase I | | Female – Phase I | |
|------------------|-------------|------------------|-------------|
| | Days | | Days |
| Chamber A | 4/14 | Chamber C | 3/14 |
| Chamber B | 8/14 | Chamber D | 7/14 |
| 50:50 Tie | 2/14 | 50:50 Tie | 4/14 |

| Male – Phase I, Signal Closer | | Female – Phase I, Signal Closer | |
|-------------------------------|------------|---------------------------------|------------|
| | Days | | Days |
| Chamber A | 3/7 | Chamber C | 1/7 |
| Chamber B | 3/7 | Chamber D | 5/7 |
| 50:50 Tie | 1/7 | 50:50 Tie | 1/7 |

| Male – Phase II | | Female – Phase II | |
|------------------|------------|-------------------|------------|
| | Days | | Days |
| Chamber A | 3/7 | Chamber C | 3/7 |
| Chamber B | 4/7 | Chamber D | 4/7 |
| 50:50 Tie | 0/7 | 50:50 Tie | 0/7 |

¹ On days 5 and 6, data records contain an error, therefore those two days are considered missing data. The acclimation period was actually 8 days long.

² On one day during this period, data consumption was recorded as zero for both chambers. The mice may have used food pellets taken previously and moved into the tube. Regardless, this is considered missing data.

Table 2.

Wild House Mice.
 Mean Daily Grams and Percent of Diet Obtained from Each Chamber
 During Each Phase, With Chi-Square Analysis

| Male - Acclimation | | | |
|--|-------|---------|----------------------|
| | Grams | Percent | Chi-Square |
| Chamber A | 9.5 | 50.4 | 3.84 0.0004 No |
| Chamber B | 9.3 | 49.6 | |
| Tabular x-2 Value - 0.05 Calculated x-2 Value Significant | | | |

| Female - Acclimation | | | |
|--|-------|---------|--------------------|
| | Grams | Percent | Chi-Square |
| Chamber C | 7.6 | 59.2 | 3.84 3.03 No |
| Chamber D | 5.3 | 40.8 | |
| Tabular x-2 Value - 0.05 Calculated x-2 Value Significant | | | |

| Male - Phase I | | | |
|--|-------|---------|--------------------|
| | Grams | Percent | Chi-Square |
| Chamber A | 6.2 | 45.3 | 3.84 0.71 No |
| Chamber B | 7.5 | 54.7 | |
| Tabular x-2 Value - 0.05 Calculated x-2 Value Significant | | | |

| Female - Phase I | | | |
|--|-------|---------|--------------------|
| | Grams | Percent | Chi-Square |
| Chamber C | 4.1 | 48.3 | 3.84 0.06 No |
| Chamber D | 4.4 | 51.7 | |
| Tabular x-2 Value - 0.05 Calculated x-2 Value Significant | | | |

| Male - Phase I, Signal Closer | | | |
|--|-------|---------|--------------------|
| | Grams | Percent | Chi-Square |
| Chamber A | 5.4 | 45.2 | 3.84 0.74 No |
| Chamber B | 6.6 | 54.8 | |
| Tabular x-2 Value - 0.05 Calculated x-2 Value Significant | | | |

| Female - Phase I, Signal Closer | | | |
|--|-------|---------|----------------------|
| | Grams | Percent | Chi-Square |
| Chamber C | 4.3 | 49.2 | 3.84 0.0036 No |
| Chamber D | 4.4 | 50.8 | |
| Tabular x-2 Value - 0.05 Calculated x-2 Value Significant | | | |

| Male - Phase II | | | |
|--|-------|---------|---------------------|
| | Grams | Percent | Chi-Square |
| Chamber A | 6.1 | 34.1 | 3.84 9.49 Yes |
| Chamber B | 11.9 | 65.9 | |
| Tabular x-2 Value - 0.05 Calculated x-2 Value Significant | | | |

| Female - Phase II | | | |
|--|-------|---------|---------------------|
| | Grams | Percent | Chi-Square |
| Chamber C | 2.9 | 37.7 | 3.84 5.57 Yes |
| Chamber D | 4.7 | 62.3 | |
| Tabular x-2 Value - 0.05 Calculated x-2 Value Significant | | | |

Table 3.

Wild House Mice

Summary of Time Spent in Plexi-glas Chambers
During Phase II
(minutes:seconds)

| Date | Male Mice (n=4) | | | | Female Mice (n=2) | | | |
|------------------------------------|-----------------|---------|--------------|---------|-------------------|---------|--------------|---------|
| | Chamber A | | Chamber B | | Chamber C | | Chamber D | |
| | Control | | Pest-a-Cator | | Control | | Pest-a-Cator | |
| | minutes | seconds | Minutes | seconds | minutes | seconds | minutes | seconds |
| 12/10/2001 | 13 | 15 | 14 | 16 | 1 | 43 | 2 | 19 |
| 12/11/2001 | 18 | 19 | 18 | 4 | 8 | 10 | 2 | 25 |
| 12/11/2001 | 93 | 54 | 118 | 22 | 55 | 2 | 64 | 6 |
| 12/12/2001 | 4 | 24 | 4 | 27 | 1 | 52 | 1 | 11 |
| 12/12/2001 | 130 | 44 | 164 | 57 | 55 | 51 | 42 | 9 |
| 12/13/2001 | 9 | 17 | 10 | 30 | 4 | 27 | 2 | 52 |
| 12/13/2001 | 206 | 16 | 231 | 36 | 110 | 14 | 60 | 54 |
| 12/14/2001 | 10 | 16 | 13 | 50 | 8 | 47 | 9 | 23 |
| Total Minutes | 483 | | 572 | | 242 | | 182 | |
| Total Seconds | 205 | | 242 | | 246 | | 199 | |
| Total Time (seconds) | 29185 | | 34562 | | 14766 | | 11119 | |
| Division of Chamber Time (percent) | 45.8 | | 54.2 | | 57.0 | | 43.0 | |

Table 4.

Wild House Mice

Summary of Time Spent in Plexiglas Chambers
and Tubes During Phase II

Time in tube is derived by subtracting chamber time from 8 hours per tape

| Date | Male Mice (n=4) | | | Female Mice (n=2) | | |
|-------------------------|----------------------|---------|---------------------------|----------------------|---------|---------------------------|
| | Chamber A Control | Tube | Chamber B Pest-a-Cator | Chamber C Control | Tube | Chamber D Pest-A-Cator |
| | seconds | seconds | seconds | seconds | seconds | seconds |
| 12/10/2001 | 795 | 27149 | 856 | 103 | 28558 | 139 |
| 12/11/2001 | 1099 | 26617 | 1084 | 490 | 28165 | 145 |
| 12/11/2001 | 5634 | 16064 | 7102 | 3302 | 21652 | 3846 |
| 12/12/2001 | 294 | 28239 | 267 | 112 | 28617 | 71 |
| 12/12/2001 | 7844 | 11059 | 9897 | 3351 | 22920 | 2529 |
| 12/13/2001 | 557 | 27613 | 630 | 267 | 28361 | 172 |
| 12/13/2001 | 12376 | 2528 | 13896 | 6614 | 18532 | 3654 |
| 12/14/2001 | 616 | 27354 | 830 | 527 | 27731 | 542 |
| Total Time (seconds) | 29215 | 166623 | 34562 | 14766 | 204536 | 11098 |
| Percent per Location | 12.7 | 72.3 | 15.0 | 6.4 | 88.8 | 4.8 |

Figure 9.

Percent of Diet Taken From Each Chamber, Male White-footed Mice.
 The upper 50% always represents use of the Pest-a-Cator activated chamber, except during the acclimation, or baseline phase, when neither chamber was activated.

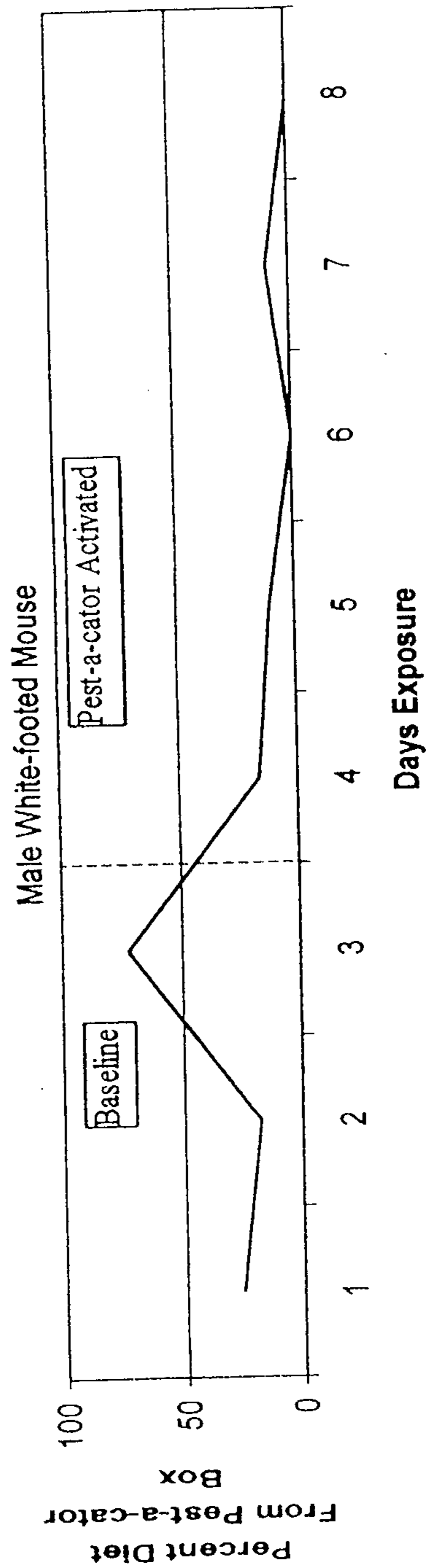


Figure 10.

Percent of Diet Taken From Each Chamber, Female White-footed Mice.
 The upper 50% always represents use of the Pest-a-Cator activated chamber, except during the acclimation, or baseline phase, when neither chamber was activated.

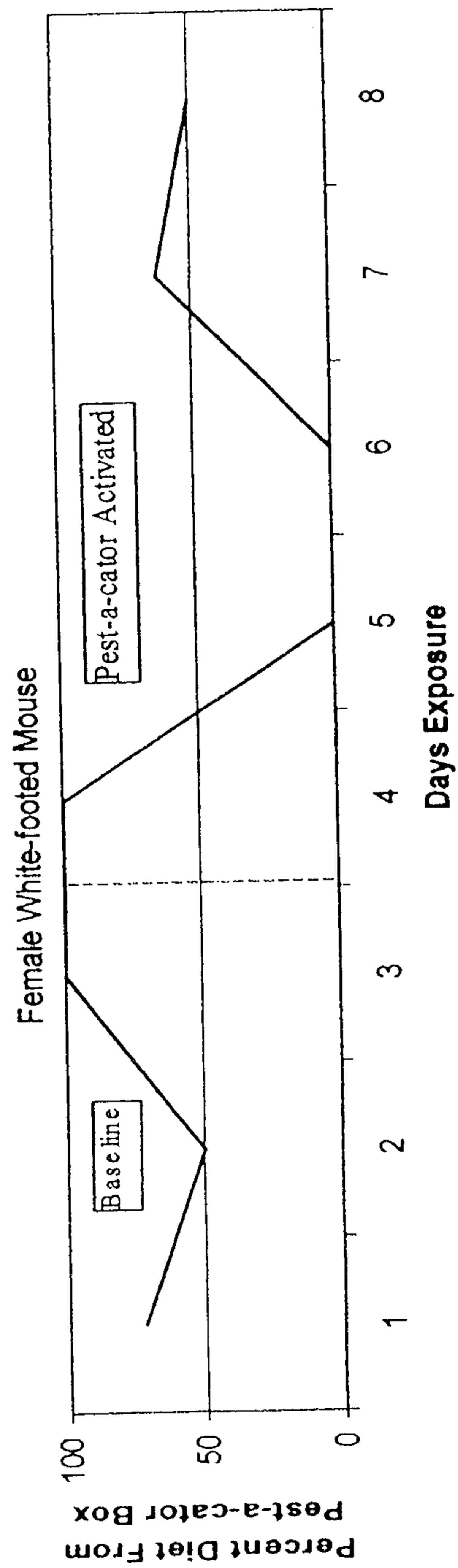


Figure 11.

Percent of Diet Taken From Each Chamber, Male White-footed Mice.

The upper 50% always represents use of the Pest-a-Cator activated chamber, except during the acclimation, or baseline phase, when neither chamber was activated.

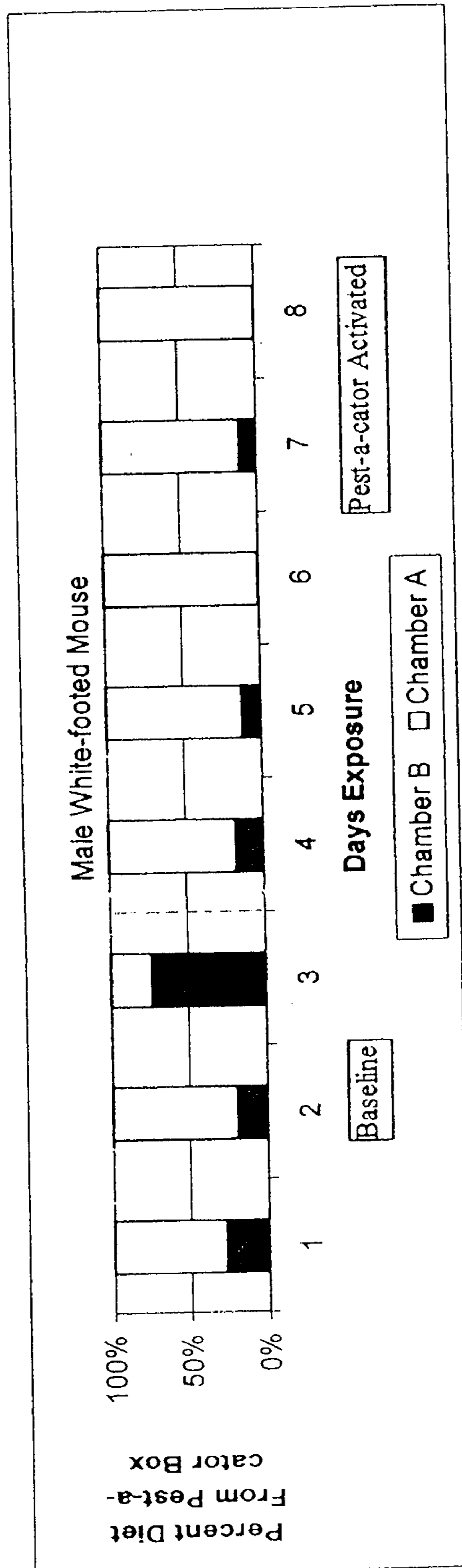


Figure 12.

Percent of Diet Taken From Each Chamber, Female White-footed Mice.
 The upper 50% always represents use of the Pest-a-Cator activated chamber, except during the acclimation, or baseline phase, when neither chamber was activated.

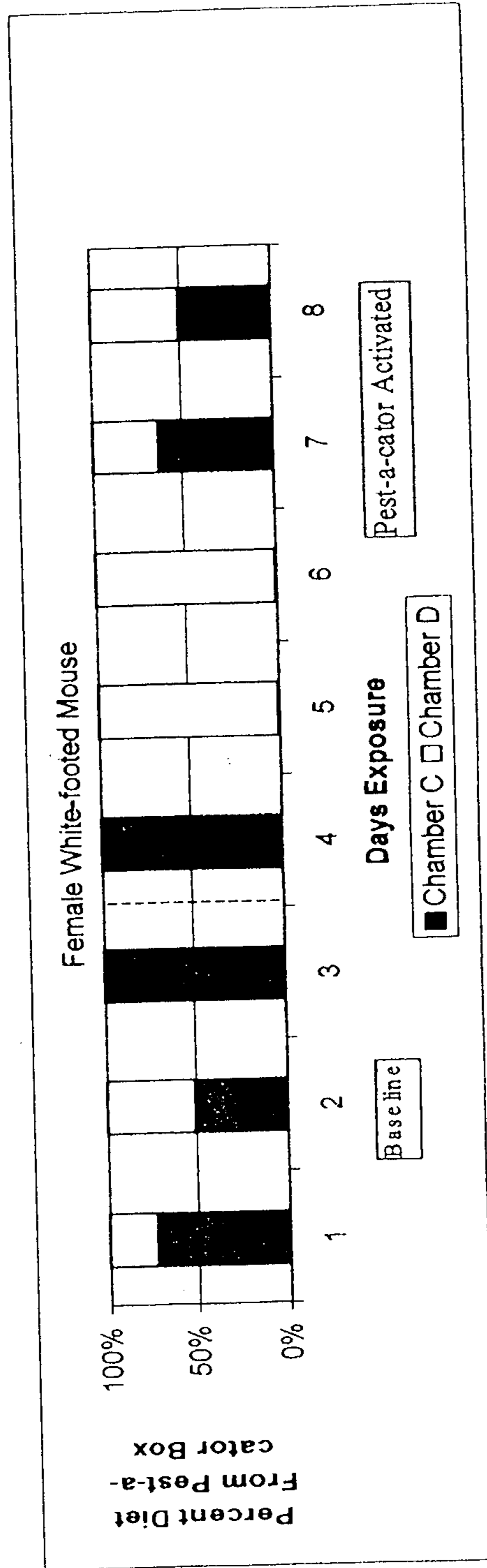


Table 5.

White-footed Mice.

Summary of Time Spent in Plexiglas Chambers
During Phase I
(minutes:seconds)

| Date | Male Mice (n=3) | | | | Female Mice (n=3) | | | |
|-----------------------------|-----------------|---------|--------------|---------|-------------------|---------|--------------|---------|
| | Chamber A | | Chamber B | | Chamber C | | Chamber D | |
| | Control | | Pest-a-Cator | | Control | | Pest-a-Cator | |
| | minutes | seconds | Minutes | seconds | minutes | seconds | minutes | seconds |
| 12/13/2001 | - | - | - | - | 50 | 28 | 20 | 33 |
| 12/13/2001 | - | - | - | - | 360 | 39 | 11 | 38 |
| 12/14/2001 | - | - | - | - | 239 | 54 | 5 | 26 |
| 12/15/2001 | 384 | 51 | 11 | 17 | 354 | 12 | 9 | 20 |
| 12/16/2001 | 179 | 50 | 16 | 19 | 276 | 59 | 17 | 12 |
| Total Minutes | 563 | --- | 27 | --- | 1279 | --- | 62 | --- |
| Total Seconds | | 101 | --- | 36 | --- | 192 | --- | 129 |
| Total Time (seconds) | 33881 | | 1656 | | 76932 | | 3849 | |
| Percent of Time per Chamber | 95.3 | | 4.7 | | 95.2 | | 4.8 | |

Table 6.

White-footed Mice

Summary of Time Spent in Plexiglas Chambers
and Tubes, Phase I

Time in tube is derived by subtracting chamber time from 8 hours per tape.

Data is missing for first three days for male mice
due to mechanical technical difficulties with video..

| Date | Male Mice (n=3) | | | Female Mice (n=3) | | |
|-------------------------|---------------------------------|-----------------|--------------------------------------|---------------------------------|-----------------|--------------------------------------|
| | Chamber A Control seconds | Tube Seconds | Chamber B Pest-a-Cator seconds | Chamber C Control seconds | Tube seconds | Chamber D Pest-A-Cator seconds |
| 12/13/2001 | - | - | - | 3028 | 24539 | 1233 |
| 12/13/2001 | - | - | - | 21639 | 6463 | 698 |
| 12/14/2001 | - | - | - | 14394 | 14080 | 326 |
| 12/15/2001 | 23091 | 5083 | 677 | 21252 | 6988 | 560 |
| 12/16/2001 | 10790 | 17081 | 979 | 16619 | 11149 | 1032 |
| Total Time (seconds) | 33881 | 22164 | 1656 | 76932 | 63219 | 3849 |
| Percent per Location | 58.7 | 38.4 | 2.9 | 53.4 | 43.9 | 2.7 |

Appendix 1.

Wild House Mice
Daily Feed Consumption

| Group | Day 0 | | Day 1 | | Day 2 | | Day 3 | | Day 4 | | Day 5 | | Day 6 | |
|-----------------|---------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|
| | Chamber | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present |
| Male | A | 610 | 604 | 604 | 597 | 597 | 575 | 650 | 638 | 638 | 526 | 526 | 619 | 619 |
| | grams | | 6 | | 7 | | 22 | | 12 | | NA | | NA | |
| | % | | 40.0 | | 38.9 | | 88.0 | | 50.0 | | NA | | NA | |
| | B | 592 | 583 | 583 | 572 | 572 | 568 | 651 | 639 | 639 | 533 | 533 | 625 | 625 |
| grams | | 9 | | 11 | | 3 | | 12 | | NA | | NA | | |
| % | | 60.0 | | 61.1 | | 12.0 | | 50.0 | | NA | | NA | | |
| Female | C | 619 | 614 | 614 | 585 | 595 | 581 | 650 | 635 | 635 | 635 | 635 | 633 | 633 |
| | grams | | 5 | | 19 | | 14 | | 15 | | 0 | | 2 | |
| | % | | 55.6 | | 63.3 | | 51.9 | | 71.4 | | 0.0 | | 100.0 | |
| | D | 620 | 616 | 616 | 605 | 605 | 592 | 650 | 644 | 644 | 644 | 644 | 644 | 644 |
| grams | | 4 | | 11 | | 13 | | 6 | | 0 | | 0 | | |
| % | | 44.4 | | 36.7 | | 48.1 | | 28.6 | | 0.0 | | 0.0 | | |
| Wild House Mice | Remove | 614 | 609 | 609 | 598 | 598 | 592 | 592 | 592 | 592 | 586 | 586 | 579 | 579 |
| | 614 | 609 | 609 | 598 | 598 | 592 | 592 | 592 | 592 | 586 | 586 | 579 | 579 | |
| | 5 | 5 | 5 | 11 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | |
| | 33.3 | 31.3 | 31.3 | 68.8 | 31.6 | 31.6 | 0.0 | 0.0 | 0.0 | 42.9 | 42.9 | 50.0 | 50.0 | |
| | 615 | 604 | 604 | 599 | 599 | 586 | 586 | 578 | 578 | 570 | 570 | 563 | 563 | |
| | 615 | 604 | 604 | 599 | 599 | 586 | 586 | 578 | 578 | 570 | 570 | 563 | 563 | |
| | 10 | 11 | 11 | 5 | 13 | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 7 | |
| | 66.7 | 68.8 | 68.8 | 31.3 | 68.4 | 68.4 | 100.0 | 100.0 | 57.1 | 57.1 | 57.1 | 50.0 | 50.0 | |
| | 629 | 627 | 627 | 624 | 624 | 621 | 621 | 615 | 615 | 613 | 613 | 609 | 609 | |
| | 629 | 627 | 627 | 624 | 624 | 621 | 621 | 615 | 615 | 613 | 613 | 609 | 609 | |
| | 4 | 2 | 2 | 3 | 3 | 3 | 3 | 6 | 6 | 2 | 2 | 4 | 4 | |
| | 100.0 | 20.0 | 20.0 | 30.0 | 23.1 | 23.1 | 50.0 | 50.0 | 33.3 | 33.3 | 33.3 | 50.0 | 50.0 | |
| | 644 | 636 | 636 | 629 | 629 | 619 | 619 | 613 | 613 | 609 | 609 | 605 | 605 | |
| 644 | 636 | 636 | 629 | 629 | 619 | 619 | 613 | 613 | 609 | 609 | 605 | 605 | | |
| 0 | 8 | 8 | 7 | 10 | 10 | 8 | 8 | 4 | 4 | 4 | 4 | 4 | | |
| 0.0 | 80.0 | 80.0 | 70.0 | 76.9 | 76.9 | 50.0 | 50.0 | 66.7 | 66.7 | 66.7 | 50.0 | 50.0 | | |

Appendix 1. (continued)

Wild House Mice
Daily Feed Consumption

| Day 14 | | Day 15 | | Day 16 | | Day 17 | | Day 18 | | Day 19 | | Day 20 | | Day 21 | |
|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present |
| 572 | 572 | 566 | 644 | 638 | 638 | 634 | 634 | 625 | 625 | 616 | 616 | 613 | 613 | 605 | 653 |
| 7 | 6 | 6 | 6 | 6 | 4 | 4 | 9 | 9 | 9 | 3 | 3 | 3 | 3 | 8 | 8 |
| 46.7 | 66.7 | 50.0 | 50.0 | 25.0 | 25.0 | 60.0 | 60.0 | 69.2 | 69.2 | 27.3 | 27.3 | 47.1 | 47.1 | 585 | 845 |
| 555 | 555 | 552 | 630 | 624 | 624 | 612 | 612 | 608 | 608 | 602 | 602 | 594 | 594 | 585 | 845 |
| 8 | 3 | 6 | 6 | 6 | 12 | 6 | 4 | 4 | 4 | 8 | 8 | 9 | 9 | 9 | 9 |
| 53.3 | 33.3 | 50.0 | 50.0 | 75.0 | 75.0 | 40.0 | 40.0 | 30.8 | 30.8 | 72.7 | 72.7 | 52.9 | 52.9 | | |
| 606 | 606 | 603 | 646 | 641 | 641 | 637 | 637 | 631 | 631 | 627 | 627 | 624 | 624 | 618 | 658 |
| 3 | 3 | 5 | 5 | 4 | 4 | 6 | 6 | 4 | 4 | 3 | 3 | 6 | 6 | 6 | 6 |
| 37.5 | 23.1 | 83.3 | 83.3 | 40.0 | 40.0 | 100.0 | 100.0 | 50.0 | 50.0 | 50.0 | 50.0 | 85.7 | 85.7 | | |
| 600 | 600 | 590 | 636 | 635 | 635 | 629 | 629 | 629 | 629 | 625 | 625 | 622 | 622 | 621 | 621 |
| 5 | 10 | 1 | 6 | 6 | 6 | 0 | 4 | 4 | 4 | 3 | 3 | 1 | 1 | 1 | 1 |
| 62.5 | 78.9 | 16.7 | 16.7 | 60.0 | 60.0 | 0.0 | 0.0 | 50.0 | 50.0 | 50.0 | 50.0 | 14.3 | 14.3 | | |
| | | | | | | | | | | | | | | | |
| Day 22 | | Day 23 | | Day 24 | | Day 25 | | Day 26 | | Day 27 | | Day 28 | | Day 29 | |
| Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present |
| 648 | 648 | 642 | 642 | 636 | 636 | 633 | 633 | 626 | 626 | 674 | 667 | 660 | 660 | 668 | 668 |
| 5 | 6 | 6 | 6 | 3 | 3 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 2 | 2 |
| 38.5 | 54.5 | 50.0 | 50.0 | 25.0 | 25.0 | 63.6 | 63.6 | 63.6 | 63.6 | 63.6 | 63.6 | 38.9 | 38.9 | 22.2 | 22.2 |
| 637 | 637 | 632 | 632 | 626 | 638 | 629 | 629 | 625 | 666 | 662 | 662 | 651 | 692 | 685 | 685 |
| 8 | 5 | 6 | 6 | 9 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 11 | 7 | 7 | 7 |
| 61.5 | 45.5 | 50.0 | 50.0 | 75.0 | 75.0 | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 | 61.1 | 61.1 | 77.8 | 77.8 |
| 652 | 652 | 637 | 637 | 636 | 636 | 635 | 635 | 631 | 682 | 678 | 678 | 675 | 675 | 673 | 673 |
| 6 | 15 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 2 | 2 |
| 85.7 | 93.8 | 25.0 | 25.0 | 25.0 | 44.4 | 44.4 | 44.4 | 50.0 | 50.0 | 50.0 | 50.0 | 42.9 | 42.9 | 15.4 | 15.4 |
| 620 | 620 | 619 | 619 | 616 | 642 | 639 | 639 | 634 | 676 | 672 | 672 | 688 | 688 | 677 | 677 |
| 1 | 1 | 3 | 3 | 3 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 11 | 11 |
| 14.3 | 6.3 | 75.0 | 75.0 | 75.0 | 55.6 | 55.6 | 55.6 | 50.0 | 50.0 | 50.0 | 50.0 | 57.1 | 57.1 | 84.6 | 84.6 |

Appendix 1. (continued)

Wild House Mice
Daily Feed Consumption

| Day 30 | | Day 31 | | Day 32 | | Day 33 | | Day 34 | | Day 35 | | Day 36 | |
|-------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present | Remove | Present |
| 665 | 662 | 662 | 662 | 656 | 656 | 645 | 645 | 633 | 633 | 625 | 625 | 625 | 625 |
| 3 | 3 | 6 | 6 | 11 | 11 | 12 | 12 | 8 | 8 | 0 | 0 | 0 | 0 |
| 25.0 | 17.6 | 46.2 | 46.2 | 73.3 | 73.3 | 52.2 | 52.2 | 66.7 | 66.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 676 | 662 | 662 | 662 | 655 | 655 | 651 | 651 | 640 | 640 | 636 | 636 | 636 | 636 |
| 9 | 14 | 7 | 7 | 4 | 4 | 11 | 11 | 4 | 4 | 34 | 34 | 34 | 34 |
| 75.0 | 82.4 | 53.8 | 53.8 | 26.7 | 26.7 | 47.8 | 47.8 | 33.3 | 33.3 | 100.0 | 100.0 | 100.0 | 100.0 |
| 670 | 670 | 670 | 670 | 667 | 667 | 665 | 665 | 654 | 654 | 654 | 654 | 654 | 654 |
| 3 | 0 | 3 | 3 | 2 | 2 | 11 | 11 | 0 | 0 | 1 | 1 | 1 | 1 |
| 60.0 | 0.0 | 60.0 | 60.0 | 22.2 | 22.2 | 91.7 | 91.7 | 0.0 | 0.0 | 12.5 | 12.5 | 12.5 | 12.5 |
| 675 | 664 | 664 | 664 | 662 | 662 | 655 | 655 | 654 | 654 | 651 | 651 | 651 | 651 |
| 2 | 11 | 2 | 2 | 7 | 7 | 1 | 1 | 3 | 3 | 7 | 7 | 7 | 7 |
| 40.0 | 100.0 | 40.0 | 40.0 | 77.8 | 77.8 | 8.3 | 8.3 | 100.0 | 100.0 | 87.5 | 87.5 | 87.5 | 87.5 |

Appendix 2.

Genesis Laboratories Capabilities and Staff Qualifications



GENESIS
Laboratories

P.O. Box 1195 Wellington CO, 80549 USA

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Genesis Laboratories, Inc. is a world leader in wildlife management with experience in the laboratory and field. Our scientists have developed their expertise in over 60 countries, and Genesis maintains an office in Montevideo, Uruguay. Genesis has the experience and resources to assist in developing and implementing management plans.

The following are areas where we hope we can be of service to you:

VERTEBRATE PEST MANAGEMENT

Genesis has been performing vertebrate pest research for over 30 years. Product stewardship and developing integrated pest management strategies is our specialty.

RODENTS

- Acute Toxicology
- Secondary and Non-target Toxicity
- Laboratory and Field Studies
- Regulatory Consultation
- Anticoagulant Resistance Testing
- Radio Telemetry
- Rodent Breeding Colonies
- Island Restoration
- Training

BIRDS

- Repellent Development and Testing
- Damage Assessment
- Crop Protection
- Population Studies

VECTOR-BORNE DISEASE MANAGEMENT

Genesis has experience with the vectors that carry disease, including Hantavirus. Our laboratories are equipped to test for many diseases.

- Lyme Disease Surveillance
- Plague Surveillance
- Development and Testing of Preventative and Control Products
- Biosafety Level 2 Laboratory Facilities
- Training

OTHER VERTEBRATE PESTS

- Management of many species including carnivores and large and small mammals

NATURAL RESOURCE MANAGEMENT

Genesis biologists can assist in the design and implementation of projects to preserve or improve habitats and wildlife populations, or to mitigate negative impacts of natural and human disturbances.

- Park Management
- Big Game, Mammal, Bird Surveys
- Exotic Species Removal
- Management Plans
- Population Dynamics
- Habitat Assessment
- Browse Protection
- Radio-Telemetry

OTHER SERVICES

- Analytical Support Laboratory
 - HPLC and GC/MS
 - Product Chemistry
 - Residue Analysis
- Avian Toxicology
 - Acute Studies
 - Long-term Reproduction
 - Secondary Hazards
- Ecological Risk Assessment
- QA Consultation, Support and Training
OECD, FDA and EPA GLPs

KEY SCIENTIFIC PERSONNEL

February 2002

Richard M. Poché

President

Mr. Poché has over 25 years of experience in wildlife management, toxicology, and vertebrate pest management from over 40 countries around the globe. He has extensive experience in laboratory and field product testing and related environmental studies. Currently he manages Genesis and directs projects adhering to Good Laboratory Practice (GLP) standards as required under FIFRA as promulgated by the EPA. The research work includes wildlife toxicology and risk assessments, product chemistry and residue studies, analytical method development and validation, various field studies, and animal metabolism. He serves as a Director for the Rocky Mountain Regional Chapter of the Society of Quality Assurance. Prior to Genesis Mr. Poché operated another business that did natural resource management work, including reforestation and forestry surveys. He developed pesticide formulations that were EPA registered for use in urban and agricultural areas.

Mr. Poché served as Technical Director for a major chemical company and directed research projects for pesticide product registrations, which included contracting research with outside facilities, serving as EPA regulatory liaison, development of new product formulations, establishment of a new analytical laboratory, and assisted with laboratory testing.

He served four years in Niger, Africa, conducting wildlife research in a national park and directing agricultural and forestry projects. Mr. Poché spent two years in Bangladesh where he helped establish a National Vertebrate Pest Research Center for the agricultural ministry. There he recruited and trained personnel, and conducted research on vertebrates and developed methods and products to curtail crop and food losses inflicted by pests such as rodents, birds, and jackals.

Mr. Poché has extensive experience in environmental impact studies and conducted work in the U.S. and abroad on projects involving coal fired power plants and power transmission. He managed a multimillion dollar environmental project involving power plant and coal slurry pipeline development in Utah, Arizona, and Nevada.

Mr. Poché has over 50 scientific publications in journals around the world covering a variety of topics such as elephant management in Africa and secondary toxicity to birds of prey when exposed to pesticide killed rodents. His educational background includes a B.S. from the University of Southwestern Louisiana, M.S. from Texas A&M University., and PhD work at the University of California, Berkeley in natural resource management.

John A. Baroch
Senior Scientist

Mr. Baroch has 20 years of experience in wildlife biology, with a focus in the area of agricultural rodent pest management. He has conducted studies on field and commensal rodents throughout the United States as well as in Africa.

At Genesis Laboratories, Mr. Baroch currently serves Senior Scientist. He has participated in or directed over 60 pesticide registration studies (FIFRA) conducted under US Environmental Protection Agency (EPA) Good Laboratory Practice (GLP) Standards. Mr. Baroch has experience in the development and assessment of baits and repellents, as well as animal and plant tissue residue studies.

Mr. Baroch worked in West Africa for two years, on a project funded by USAID, to study agricultural rodents pests and develop methods to mitigate crop losses. He studied the population ecology of rodents pests, conducted field efficacy trials, developed baits using locally available ingredients, and trained extension agents in crop protection methods. He also assisted in annual big game censuses at the national park.

Mr. Baroch has a B.S. degree in Biology from Fort Lewis College, Durango, Colorado, and conducted graduate research at Colorado State University, Fort Collins, Colorado. His Master's thesis involved study of the effects of ecological and genetic processes on population dynamics. Professional affiliations include the Wildlife Society and the Rocky Mountain Chapter of the Society of Quality Assurance. He currently serves as chairman of the USDA Western Coordinating Committee on Vertebrate Pests of Forests and Public Lands, and is the Southwest Regional Director of the National Animal Damage Control Association.

Jeff J. Mach
Supervisor for Ecotoxicology

Mr. Mach graduated from the University of Nebraska-Lincoln with a B.S. degree in wildlife management in 1993. The degree included a semester abroad at the University of South Australia in Adelaide studying field biology and habitat assessment in the Dangali Conservation Park. Mr. Mach graduated from the University of Nebraska-Lincoln in 1998 with a M. S. degree in natural resources sciences. His research focused on evaluating rodenticide performance on the black-tailed prairie dogs and its associated secondary risks to domestic ferrets as a model for wild mustelids.

Mr. Mach joined Genesis Laboratories to aid in field research and laboratory toxicology studies. He has participated in or directed pesticide registration studies (FIFRA) conducted under US Environmental Protection Agency (EPA) Good Laboratory Practice (GLP) Standards. The range of tests performed have included acute and chronic toxicity testing of compounds to a variety of avian and mammalian models in the laboratory, field efficacy tests of rodenticides, avian field pen studies, and secondary hazard assessments to birds and mammals. Mr. Mach has experience in the development and assessment of baits and repellents, and animal tissue residue studies.