MORPHOLOGICAL, PHYSIOLOGICAL AND BEHAVIORAL CHANGES OCCURRING IN THE PRAIRIE DEER MOUSE, PEROMYSCUS MANICULATUS BAIRDII, DURING THE PROCESS OF DOMESTICATION

Thesis for the Degree of M. S.

MICHIGAN STATE UNIVERSITY

Edward O. Price

1963

ABSTRACT

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Body of Abstract

AN ABSTRACT OF A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Zoology

1963

Edward O. Price

Three groups of Peromyscus maniculatus bairdii were employed to determine some of the morphological, physiological and behavioral changes that have occurred in the prairie deer mouse during twenty or more generations of laboratory breeding. Wild caught mice, the offspring of pregnant wild caught females born and reared in the laboratory and a semi-domesticated group were compared in regard to certain body and organ measurements, adrenal corticosterone output under stress and three behavioral tests measuring activity, gnawing and sand digging.

Few definite trends were observed in the morphology of the three experimental groups other than that of body weight. In each of four cases, body weight was proportional to time spent in the laboratory with the laboratory mice exhibiting the largest mean body weight. These basic differences in body weights were partly responsible for certain differences observed in organ-body weight ratios.

Almost a two to one ratio was observed for the relative adrenal corticosterone output of wild caught and first generation wild mice, respectively, under three hours of cold stress. The greater timidity and emotionality of mice with early experience in the wild was discussed as a possible explanation for this phenomenon.

Wild caught mice showed significantly less activity in three behavioral tests measuring activity, gnawing and

sand digging. The similarity in performance of first generation wild and laboratory mice pointed to environmental factors as responsible for the relative inactivity of the wild group.

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ACKNOWLEDGMENTS

The author is extremely grateful to Dr. John King for instituting this study and for his advice and encouragement throughout its tenure and in the preparation of the manuscript. Appreciation is also expressed to Doctors Rollin Baker and Herman Slatis for their careful appraisal of this dissertation and to Dr. Phillip Clark for his advice concerning the statistical treatment of the data. Thanks also go to my wife, Mabell, who so willingly gave of her time to assist in collecting the morphological data and in typing the rough draft of this paper. The assistance of Mrs. B. Henderson in obtaining various materials for this study was also greatly appreciated.

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Literature Review

The practice of domesticating wild animals dates back to the time man began cultivating the soil (Dyson, 1953; Zeuner, 1956). Since that time a great variety of animals have been bred and reared in captivity for religious sacrifices, food, draft purposes, pets, decoy hunting and more recently for scientific investigation.

During the process of domestication, changes have occurred in the morphology, physiology and behavior of those animals involved. Breeding for size as in dogs and beef cattle has produced gross changes in the morphology of these animals when compared with their wild ancestors. Selection for the most gentle and productive females has resulted in as increase in fertility in many of our domesticated species (King, 1939; Richter, 1959; Castle, 1947). Another change is the general lack of fear shown by domesticated species toward human beings (Hediger, 1954). Although tameness is essentially acquired, the process of domestication is basically a genetic alteration (Hale, 1962; Hediger, 1954; Richter, 1954) affecting the genotype and phenotype of organisms by way of evolutionary processes. Much is known concerning the genotype and phenotype response of animals to specified types of artificial selection (Lerner, 1958), but the effects of relaxed selections

have been examined only in captive groups far removed from their wild counterparts.

A change in selective pressure occurs when a species is removed from its natural habitat and placed in an artificial environment. From the species standpoint this transfer is detrimental in that the stability attained by natural selection in the wild is broken down changing both the population structure and ultimately the genetic constitution of the species. Spurway (1955) has stated that in an artificial environment three types of selection pressures exist which are essentially unalterable: (1) selection exerted on the population by unstabilized patterns of development, (2) selection exerted by a reduced number of intraspecific mating partners, and (3) purposeful or unconscious selection exerted by man. Selective advantage will go to those individuals which show the greatest "fitness" to their new environment and only as the species approaches a new adaptive peak will stability again be attained.

Without variation new adaptive peaks could not be achieved and it was Darwin (1875) who first wrote concerning the variation prevalent among domestic plants and animals. He ascribed the variability to: (1) changed conditions of life, (2) crosses between already existing breeds, and (3) selection by man, and concluded that variation and selection alone were responsible for the changes seen in domestic animals over their wild counterparts.

Darwin was a pioneer in the study of the anatomical

differences between domestic animals and their wild counterparts. He stated (1875) that domestic rabbits have smaller brains per unit body size than wild species. In comparing wild and domestic Norway rats, C. P. Richter (1959), Donaldson and Hatai (1931), and King and Donaldson (1929), found that the relative brain weights of domestic rats are one-tenth to one-eighth smaller than those of their wild counterparts. Herr (1955), in examining wild and domestic ducks found that the domestic strains invariably have the smaller brains, attributable to smaller cerebrums. Leopold (1944), reported that the brain of the wild turkey is 37% larger than that of the domestic bird. Agreement is found concerning the fact that domestic animals are usually larger in body size than their wild relatives, probably resulting from better living conditions and selection for size by humans. Darwin (1875) reports a smaller body size for wild rabbits and Richter (1954), and King and Donaldson (1929) found that wild Norway rats also tend to be smaller than the domestic strains. Leopold (1944) observed that domestic turkeys are considerably heavier than either wild or hybrid birds. However, Zeuner (1954) reports a reduction in size of large and hard to manage domestic animals because of selection for tractable characteristics. He further states that changes in the skeleton of both body and limbs are generally species-specific and that changes in the soft body parts occur mainly in the skin and in the length and texture of the hair. Another point which Zeuner makes is that domestication generally involves a reduction in

musculature, such as chewing muscles in domesticated carnivores, and an accumulation of body fat which may partially account for the greater size of domestic animals.

Relative size of adrenal glands in wild and domestic animals has received much attention in the literature and all reports agree that the wild strain has larger adrenals. Watson (1907) was the first to observe this difference and reported a three to one ratio in adrenal weight. King and Donaldson (1929) observed a 21% and 32% decrease in adrenal weight of male and female Norway rats, respectively, during ten generations of laboratory breeding. Donaldson (1928) and Richter (1954) found that the adrenal weights of domestic Norway rats were from one-half to one-fifth smaller than those of their wild counterparts and that most of this reduction occurred in adrenal cortical tissue. That the wild rat adrenal is superior in secretory activity has been shown by Mosier (1957) who found a greater concentration of lipid, aldehyde, ketonic carbonyl groups and a richer blood supply in the wild rat adrenal. Woods (1957) also demonstrated that metabolic depletion of the adrenal cortex was lacking in wild rats under conditions of acute stress which regularly produced a depletion of adrenal ascorbic acid and sudanophilic lipid in domestic rats. Leopold (1944) observed that the adrenals of wild turkeys were twice the size of those of domestic turkeys. Crile (1941) reported 25% larger adrenals in wild lions as compared with those of captive lions of the same body weight.

In regard to other morphological features, King and Donaldson (1929) found that in ten generations of laboratory breeding of the wild rat the thyroid decreased in weight while the hypophysis weight increased. Richter (1954) made similar observations when comparing wild caught Norway rats with a captive albino strain. They disagree, however, concerning the gonads in that King and Donaldson report 17% larger testes and 101% larger ovaries in wild rats when compared with albinos many generations removed from the wild while Richter failed to find any differences.

Richter (1954) also demonstrated that the wild rat possesses the larger spleen, heart, kidneys, liver, pancreas, seminal vescicles, prostate and preputials while the domestic rat has the larger thymus and uterus. No differences were found in regard to the lungs. Leopold (1944) noted that the pituitary of the wild turkey is 50% larger than that of the domestic fowl, an observation supported by Richter (1959) in the Norway rat.

Certain changes in the physiology of the adrenal gland due to domestication have been mentioned previously (Mosier, 1957; Woods, 1957). Nichols (1950) found twice as much cholesterol per unit of adrenal tissue in wild rats as in domestic rats. Immediately after capture, the adrenal of the wild rat undergoes hypertrophy with a loss of cholesterol. After 24 hours, the cholesterol content has returned to normal but there is more cholesterol per unit body weight in domestic rats than in wild ones. The gland finally returns to normal size after ten weeks of captivity. Mosier and Richter (1958)

observed that whereas both wild and domestic Norway rats remained in good health when fed sodium chloride diets from .5% to 25%, both groups died on salt concentrations above 35% due to their inability to ingest sufficient food and water. On a low salt diet, the adrenals of the domestic rats showed a definite hyperplasia while no change was observed in the adrenals of wild rats, possibly because only low salt diets were available to rats in the wild state.

A high salt diet resulted in atrophy of the zona glomerulosa in the adrenals of both strains. The loss of lipids and aldehydes was complete in domestic rats while wild rats showed only a partial loss. However, no differential response to a high salt diet occurred in the zona fasiculata and zona reticularis, both showing an increase in lipids and aldehydes in both strains. Richter, Rogers and Hall (1950) noted that the response to adrenalectomy in both groups on "salt poor" diets was the same; both groups survived for only eight or nine days. With salt replacement after adrenalectomy 87% of the domestic rats survived and all but 2% of the wild group died. The authors were in agreement that the wild rat is much more dependent on adrenal secretion than its domestic counterpart. Woods (1957) found that the adrenals of wild rats showed no hypertrophy when exposed to 26 days of freezing temperatures while the adrenals of the domestic group increased 35% in weight. No change was observed in the ascorbic acid content of either strain.

A differential response to gonadectomy was observed in wild and domestic Norway rats by Richter and Uhlenhuth

(1954). The domestic group exhibited a decrease in food and water consumption and an increase in body weight (due to inactivity) while little or no change occurred in the wild strain. Gonadectomy also produced a rise in the adrenal weights of the wild males and a decrease in the adrenals of the domestic females while the adrenals of the domestic males and wild females remained constant. The experimenters further noted that gonadectomy brought about almost total inactivity in the domestic rats but had little effect on the running activity of wild Norways. This they attributed to a greater dependence of the domestic rats on gonadal secretions.

Griffiths (1944, 1947) and Richter (1954) point out that domestic Norway rats are more likely to show convulsive seizures when exposed to auditory stimulation than are wild rats. Furthermore, both wild and domestic strains show fits when on a magnesium deficient diet but the wild group do not die as a result.

In regard to the heart rates of gentled and non-gentled albino rats, Marcuse and Moore (1943) found that the non-gentled group had a significantly faster heart rate than the gentled group in three out of four cases. Richter (1954), however, observed a marked slowing of the heart beat of wild rats when restrained while domestic rats showed little or no change.

Richter (1954) also points out that the domestic Norway rat has a lower metabolic rate than the wild rat as shown by its lower food and water intake per unit body size.

Hatai (1945), studying the effect of long continued

exercise on certain body organs of the albino rat, found that the following organs were heavier in the exercised group, relative to body length: heart - 23.5%; kidney - 19%; liver - 17.5%; testes - 12.5%; ovaries - 84.5%; and brain - 4.02%. The spleen, thyroids and eyeballs were heavier in the non-exercised group while no change in size was observed in body weight and length, alimentary tract and spinal cord. Hatai's findings agree closely with those of Richter (1954) in regard to the morphology of wild and domestic Norway rats. Wild rats presumably exercise more in their natural habitat than do strains in captivity. The fact that the various organ weights of wild rats closely parallel the weights obtained for the exercised group relative to corresponding values for the domestic and non-exercised groups, respectively, may represent a possible clue to the factors responsible for certain changes in the domestication process.

A study by Richter and Rice (1954) on a closely related problem indicated that fasting produced a 142% increase in activity of wild rats on an activity wheel while the activity of the domestic group increased only 32%. From the standpoint of survival, these findings are quite pertinent in that selection would favor the more active wild rat (under conditions of low food supply) since it would be the most likely to locate food.

In regard to the effects of domestication on the processes concerned with reproduction, Donaldson and Hatai (1911) state that the wild Norway rat breeds later, has larger litters and a longer sex life than the domestic albino rat.

King (1939), however, found that after 25 generations of laboratory breeding the average reproductive period for the Norway rat was increased 8 months due to earlier breeding and a continuation of reproductive activities to an older age. Furthermore, fertility gradually increased from 3.5 young per litter by the first generation females to 10.18 young per litter by females of the 19th generation. In support of these findings, Richter (1959) points out that the reproductive tract of the domestic rat begins to function earlier, the vagina opens earlier and the estrous cycles are more regular in the females. This increase in fertility is no doubt favored by an either conscious or unconscious selection for the most gentle and productive females. Castle (1947) regards these changes as the consequences of mutations affecting behavior either directly or by way of changes in the endocrine system.

Many wild animals are difficult to breed in captivity if breeding is accomplished at all. The failure of wild pintail ducks to breed in captivity led Phillips and Van Tienhoven (1960) to study the gonadal development of ducks caught in the wild when young and those reared from the eggs of wild parents. The arresting of gonadal development in the wild caught birds was found to be due to a lack of gonadotrophic hormones from the pituitary. This was confirmed by the fact that injections of chicken pituitaries produced normal ovarian development. Furthermore, gonadal development and pituitary gonadotrophin content was greater in birds hand reared from eggs of wild parents than in the wild caught birds,

indicating that early behavioral experiences may be involved in the reproductive failure of the captives.

Leopold (1944) found that wild turkeys seldom breed their first year while first-year domestic birds were considered the most vigorous breeders. Furthermore, domestic turkeys started breeding activities two months before the wild birds in spring while hybrids followed domestic turkeys by only a month. Although no significant differences were found between the three strains in regard to clutch size, egg fertility or hatching success, the wild turkeys were more successful in rearing young in the wild. Wild females showed a greater ability to conceal their young, their young froze upon the approach of danger while hybrid young fled, and wild birds nested during more favorable weather than did domestic birds.

The act of removing an animal from its natural habitat and placing it in a strange artificial environment invariably results in some form of psychological stress. The effect of this stress upon the physiology and behavior of the animal will depend on its ability to adapt to its new environment. The hyperexcitability of most wild creatures in captivity is evidenced by their wildness and timidity (Hediger, 1954).

The Norway rat is no exception to this rule. Richter (1954) mentions that while domestic rats show only a mild reaction to handling, wild rats become extremely emotional often resulting in death. Wild rats were found to be much more cautious than domestic rats in accepting a change in diet and would often starve to death than eat poisoned food.

He goes on to state that when two wild rats are shocked they will immediately attack one another, while shocking two domestic rats results only in escape behaviour.

Richter (1954) and Barnett (1960) found that wild rats attack and kill strange rats and mice introduced into their cages while albino rats show little aggression toward strange animals. Barnett also pointed out that hybrid rats, obtained from an albino-wild cross also showed conflict under similar conditions but of a lesser intensity. The albino rats appeared to lack the repertoire of aggressive and "amicable" social signals common to the wild rats.

Hediger (1954) points out that the process of domestication necessarily involves hereditary factors while tameness is merely an acquired behavioral trait. By a series of behavioral tests Yerkes (1913) and Coburn (1922) were able to demonstrate in rats and mice, respectively, that savageness, wildness and timidity are heritable behavior complexes. In each successive generation these characteristics showed a definite drop in intensity. A decrease in savageness, wildness and timidity also accompanied repetition of the tests administered, but rearing by a wild mother and tame father or vice versa had little effect on the inheritance of these traits. Furthermore, if both parents were wild, the majority of the offspring would be wild while the majority of offspring born to tame mice would be tame. King (1939) pointed out that rats did not lose their high nervous tension and fear of man until the 25th generation removed from the wild. Dawson (1932), experimenting with wild and domestic mice, found that

the wild mice traversed a given runway in the shortest amount of time. He further observed that the offspring of a wild and tame cross were nearly as fast as the wild mice, suggesting that he was dealing with a heritable behavioral response.

Leopold (1944) found the wild turkey extremely wary and much less tolerant of disturbances than either hybrid or domestic birds. He also discovered that in the process of domestication, hybrid and domestic juveniles lost their tendency to "freeze" or hide in the face of natural enemies, a response indicative of relaxed selection pressures.

Introduction

A review of the literature pointed out that certain changes in the morphology, physiology and behavior of animals occurs during the process of domestication. The purpose of the present study was to determine what changes have occurred during approximately 20 generations of laboratory breeding of the prairie deer mouse, Peromyscus maniculatus bairdii. Comparison was made between wild caught mice, first generation laboratory mice (the laboratory raised offspring of pregnant wild caught females), and semi-domestic mice about 20 generations from the wild. The first generation laboratory group was employed as a measure of the relative importance of genetic versus experiential factors contributing to the differences observed.

Methods

Subjects

Wild Caught. Seventeen male and twelve female deer mice were

live-trapped in October and November, 1962, four miles south of East Lansing in Ingham County, Michigan. In January and March, 1963, ten male and ten female P.m. bairdii were kill-trapped five miles south of Okemos, Michigan, also in Ingham County.

First Generation Laboratory. Twenty male and twenty-four female offspring of pregnant wild caught females were born in the laboratory and raised by their wild mothers until weaning at 21 days of age. The parent mice were caught in live-traps during April, 1962, about four and seven miles south of East Lansing, Michigan. The mice in this group were chosen from approximately ten different litters.

Semi-Domestic. The ancestors of the semi-domestic group were caught in the vicinity of Ann Arbor, Michigan, in 1948. Forty-nine descendents of each sex were obtained from the colony of Dr. John King and employed in the present study (Harris, 1954). Having been reared in the laboratory for nearly fifteen years, these mice were estimated to be about 20 generations removed from the wild. Seventy-eight of the mice used in the morphological study were sacrificed as part of a mating experiment.

Care and Handling

The mice were housed individually in clear plastic cages (5" by 11" by 6" deep) from the time of weaning (21 days) or capture, as in the case of the wild caught group. Wood-shavings were used to cover the bottom of the cages and cotton

was provided for nesting material. A surplus of food and water was on hand at all times. The mice remained undisturbed except when being tested or for cage cleaning about every three weeks. Handling was accomplished by means of 12" metal forceps with rubber-covered tips.

Morphology

Table 1 summarizes the numbers and approximate ages of the mice used in collecting the morphological data.

TABLE 1

MORPHOLOGICAL MEASUREMENTS COLLECTED (INDICATED BY X) ACCORDING TO GROUP, SEX, AND AGE IN MONTHS

Measurement	Wild Caught				1st Gen. Lab.				Semi-Domestic			
	6		10-12		8-9		16		6-12	7-8	12-14	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Body Weight	X	X	X	X	X	X	X	X	X	X	X	X
Skull Length	X	X	X	X	X	X	X	X	X	X		
Brain	X	X	X	X	X	X	X	X	X	X		
Eyeball	X	X	X	X	X	X	X	X	X	X		
Lens	X	X	X	X	X	X	X	X	X	X		
Heart			X	X			X	X			X	X
Kidney			X	X			X	X			X	X
Spleen			X	X			X	X			X	X
Testis			X				X				X	
Adrenals					X	X			X	X		
Total No.	10	10	17	12	10	10	10	14	39	39	10	10

Dissections were performed on ten wild caught (snap-trapped), ten first generation laboratory and 39 semi-domestic mice of each sex. The following measurements were obtained: (1) body weight, (2) skull length, (3) brain weight, (4) eyeball weight, (5) lens diameter and weight, and (6) adrenal

weights. All weight measures were from fresh tissues weighed on a "Federal Pacific" precision balance. While the brain was being removed the various organs were placed in saline solution until they could be cleaned and weighed.

Since the wild mice were caught during the months of March and April, their average age was estimated at six months since Howard (1949) found that over 75 per cent of all early spring-caught P.m. bairdii are born the previous September and October. The first generation laboratory mice were eight to nine months of age when sacrificed. The age of the semi-domestic males ranged from six to twelve months with the majority falling in the seven, ten and eleven month categories while the majority of the females were seven or eight months of age.

In several cases the snap-traps damaged parts of the wild caught mice and certain measurements could not be made. If a mouse was tail-caught the adrenals were discarded and when part of the body was consumed by shrews a body weight measurement was not taken. When pregnant females were obtained, the adrenals were discarded and body weight was obtained by subtracting the weight of the fetuses from the total weight.

Subsequent to this study an additional 73 mice were sacrificed to obtain blood plasma for the corticosterone analysis discussed shortly. These mice were also dissected to increase the sample size and gather additional morphological data. Seventeen male and twelve female wild caught mice, kept in the laboratory for nine months and estimated to be ten to

twelve months of age, were examined in regard to: (1) body weight, (2) skull length, (3) brain weight, (4) heart weight, (5) left kidney weight, (6) spleen weight, (7) left testis weight in males, (8) right eyeball weight, and (9) right lens diameter and weight. The same measurements were obtained from ten male and fourteen female first generation laboratory mice at an age of 16 months. In addition, ten semi-domestic mice of each sex were sacrificed at 12 to 14 months of age and data was obtained on the following: (1) body weight, (2) heart weight, (3) kidney weight, (4) spleen weight, (5) left testis weight in males.

Differences due to sex, age and treatment groups were tested by means of analysis of variance techniques. In most cases, the ratios of organ weight to body weight were used as the criterion for comparison except for the eye measurements where skull length was more closely correlated.

Physiology

A biochemical analysis of the relative corticosterone levels in the blood plasma of the three treatment groups under cold stress was made for a physiological measure. Recent work (Schaporo, Geller and Eiduson, 1962; Timmer, 1962; Hyde and Skelton, 1961) has shown that in animals where corticosterone is the principle adrenal steroid, its concentration in the blood plasma of the animal concerned is proportional to the amount of stress the animal is experiencing. Halberg, Peterson and Silber (1959) have demonstrated that corticosterone is the principle adrenal steroid in mice and

Eleftheriou (person. comm.) has confirmed this finding for the prairie deer mouse.

Seventeen male and twelve female wild caught P.m. bairdii, ten male and fourteen female first generation laboratory mice and ten semi-domestic mice of each sex were subjected to a 45°F temperature for three hours. On the day preceding their sacrifice, the animals were individually marked and weighed. Each mouse was put in an empty cage the following morning and placed in the cold room at 9:00 a.m. At 12:00 noon, three hours later, they were removed and placed in an isolated room for one hour. The purpose of the hour waiting period was to facilitate blood removal by permitting expansion of the blood vessels following a contraction period during the cold exposure. At 1:00 p.m., after the waiting period, the animals were individually removed from the isolated room and decapitated in less than 45 seconds. The blood was collected by means of a powder funnel coated with "Anti-foam A" silicone spray to facilitate blood flow and a 50 ml. test tube containing heparin to prevent coagulation. Following collection, the blood was immediately centrifuged and the plasma removed and frozen. The pooled blood from the complete N of each group was necessary to make one determination. Plasma aliquots were varied depending on the amount of plasma available.

The technique employed for measuring the plasma corticosterone was one established by Silber, Busch and Oslapas (1958) and modified by Peron and Dorfman (1959). Briefly, it

consists of: (1) washing a blank, two standards of known corticosterone concentration and four plasma aliquots (made up to two ml. with 13% EtOH) with five ml. of ligroin; (2) extracting the corticosterone with five ml. of dichloromethane; (3) washing the latter with 1.0 ml. of ice cold .1N NaOH; and (4) re-extracting the corticosterone with three ml. of 30N H_2SO_4, and reading the fluorescence after 45 minutes. Each washing or extracting step involved shaking the tubes vigorously for one minute, centrifuging for five minutes at 0°-5° C. and aspiration of the topmost layer. The sulfuric acid acts on the corticosterone molecule (McGowan and Sandler, 1961) inducing a fluorescence that is maximal in light with a wave length of 455 to 460 mμ (Sweat, 1954), 30-90 minutes after addition of the sulfuric acid (Silber, Busch and Oslapas, 1958).

Fluorescence was read on a fluorimeter after adjusting the blank reading to zero. Aliquots containing .1 and .2 μg of corticosterone were used to establish the standard curve for each determination while four aliquots of plasma up to .8 ml. were used to establish the plasma curve. The corticosterone concentration in μgs/100 ml. of plasma was then determined by extrapolation.

To achieve absolute cleanliness and absence of cations, the glassware was soaked in concentrated nitric acid overnight and then rinsed in de-ionized and double distilled water. Only the purest chemicals available were used to avoid possible errors.

Reagents:

- 30 N H_2SO_4 (DuPont's Reagent Grade) - 8 vol. H_2SO_4 mixed with 2 vol. distilled water.
- 0.1 N NaOH - .1 mol. weight in 1000 mls. water
- 13% ethyl alcohol - distilled from 95% EtOH and 2,4 dinitrophenylhydrazine and redistilled (95% pure); make up 13% by volume.
- Dichloromethane (Spectro Grade - Eastman Kodak) - washed with equal volume of water, dried with anhydrous Na_2SO_4, kept over NaOH flakes for 24 hours and distilled (b.p. 40-41°C.) (Saffran, 1955).
- Ligroin (b.p. 60°C. Eastman Kodak) - purified by permanganate.
- Standard Corticosterone (U-4460, Upjohn, Kalamazoo, Michigan) - 10 mg. weighted out and dissolved in EtOH and diluted with water to desired concentration.

Behavior

The behavioral tests employed were concerned with the areas of activity, gnawing and sand digging. The numbers and ages of the mice used are summarized in Table 2.

TABLE 2

NUMBERS AND AGES (IN MONTHS) OF MICE EMPLOYED IN THREE BEHAVIORAL TESTS

	Wild Caught			1st Gen. Lab.			Semi-Domestic		
Test	N		Age	N		Age	N		Age
	♂	♀	♂ε♀	♂	♀	♂ε♀	♂	♀	♂ε♀
Activity	10	10	1-6	10	10	7-10	10	10	5-9
Gnawing	7	3	4-7	5	5	10	5	4	8-10
Sand Digging	7	3	4-7	5	5	10	6	4	8-10

Activity. Activity tests began on wild caught mice from one week to two months after being brought into the laboratory. Nearly three months laboratory experience had elapsed before they were tested for gnawing and sand digging.

Activity was measured by means of a tilt box consisting of a 5" by 11" by 4" deep plastic container covered with 1/4" wire mesh that was free to rock on a wire shaft running through the center of the box. Each time the animal moved away from the cage's center the rocking of the box depressed a microswitch connected to a counter (Figure 1).

Sixty mice, ten of each sex and group were tested in the apparatus. A red neon light served as the dark cycle during all but the 6:00 a.m. to 8:00 a.m. period when incandescent lights were on. The temperature in the experimental room averaged slightly over 70°F. Each mouse was placed in the tilt box 16 hours (4:00 p.m. to 8:00 a.m.) for five nights without food, water or nesting material. The first test period allowed the animal to explore the apparatus and become accustomed to the test situation. Each night thereafter a mouse was placed in a different tilt box and its mean score for the four test nights was computed. The rotation to a different box each night was designed to eliminate any errors due to differences in sensitivity of the four experimental apparatuses. The Mann Whitney U-Test was applied to the mean scores after the sexes were combined for each group.

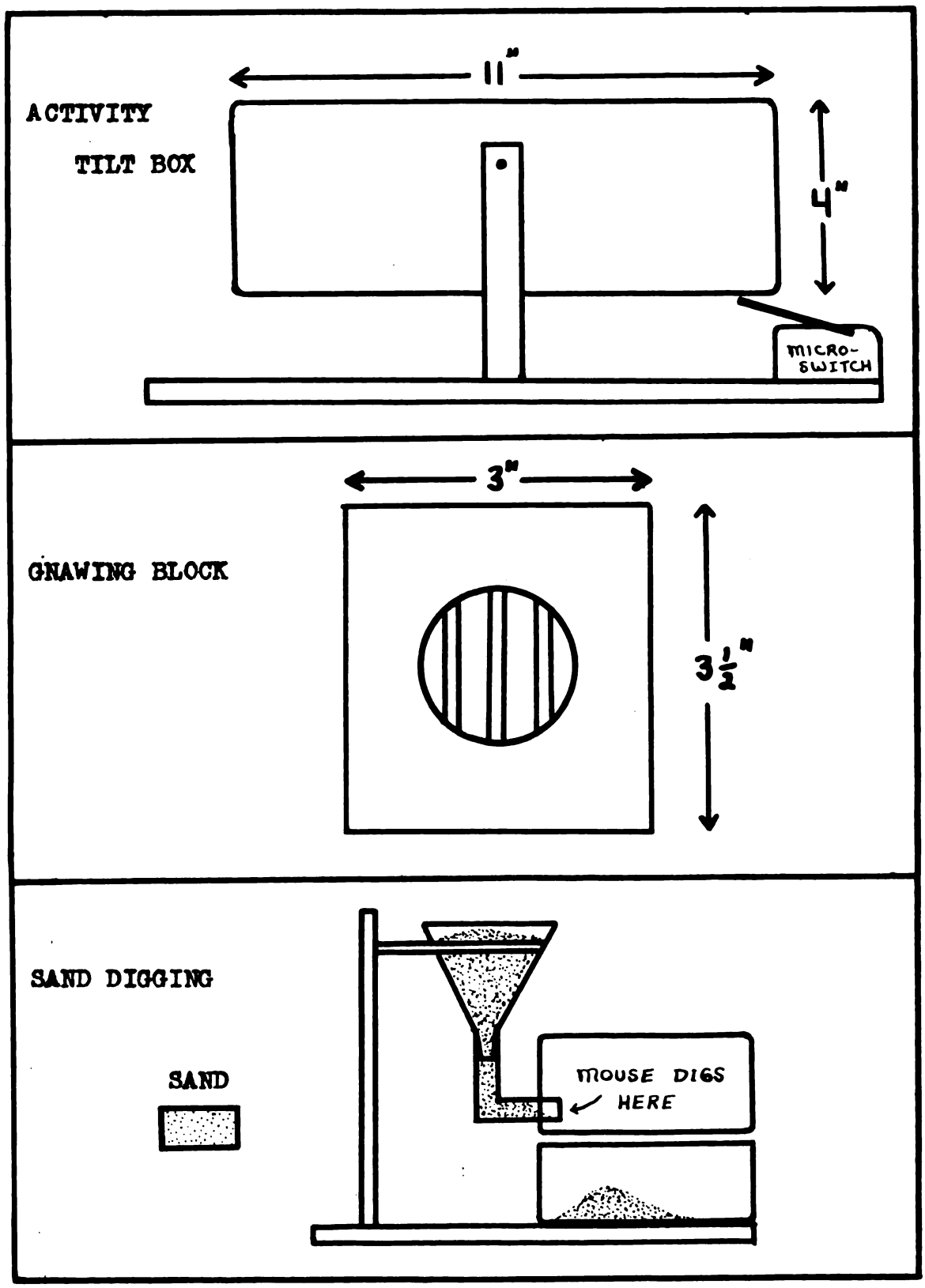
Gnawing. A second behavioral measure was concerned with the gnawing activity of ten wild caught, ten first

generation laboratory and nine semi-domestic mice. The apparatus consisted of a plywood frame divided into five runways 22 1/2" long, 3" wide and 4" deep. With no floor, it was possible to remove all feces, odors, etc., after each run by cleaning the surface on which the apparatus was placed. The top was covered with clear Plexiglas to admit the limited amount of light given off by the red neon light in the test room. Four 2" by 4" blocks 3 inches wide and spaced 4" apart were placed in each runway. In the center of each block a 1 1/4" diameter hole was drilled and a series of fourteen one-eighth inch holes were drilled from top to bottom of each block passing through the 1 1/4" hole. Balsa sticks one-eighth inch by one-eighth inch were inserted into the fourteen holes and passing through the large opening provided a barrier to reaching the next compartment. The number of gnawed sticks that had to be replaced from a 30-minute testing trial were recorded and the mean scores for two consecutive daily test periods were computed and applied to a Mann Whitney U-Test for significance.

Sand Digging. The sand digging apparatus consisted of a clear plastic cage (5" by 11" by 6") connected by an L-shaped section of 1 1/4" diameter plastic tubing to a funnel filled with dry sifted sand. The bottom of the cage was cut out and covered with a section of 1/4" wire mesh through which sand could easily pass when dug out of the tubing. The same mice as used in the gnawing test, with one additional male semi-domestic mouse, were tested for 30 minutes on two

FIGURE 1

APPARATUSES USED IN THREE TESTS OF BEHAVIOR



consecutive days. Group differences in the mean ounces of sand dug per day per individual were tested with the Mann Whitney U-Test.

Results

Morphology

Means and standard deviations for the various body and organ measurements are presented in Table 3.

TABLE 3

MEANS AND STANDARD DEVIATIONS FOR BODY AND ORGAN MEASUREMENTS

		Wild Caught		1st Gen. Lab.		Semi-Domestic	
Age (mo.)		6	10-12	8-9	16	6-12	12-14
Body Weight ♂	$\bar{X}$	15.50	17.53	16.06	17.31	18.11	18.45
	S.D.	3.00	1.75	1.99	1.35	1.75	2.83
Body Weight ♀	$\bar{X}$	14.92	15.58	16.19	15.94	16.50	18.55
	S.D.	3.21	3.20	1.85	2.00	1.80	2.09
Skull Length ♂	$\bar{X}$	22.78	23.37	23.21	23.27	23.30	
	S.D.	1.07	0.65	0.43	0.48	0.53	
Skull Length ♀	$\bar{X}$	22.40	23.35	23.40	23.50	23.32	
	S.D.	0.64	0.73	0.75	0.57	0.57	
Brain Weight ♂	$\bar{X}$	524.90	507.71	542.60	511.00	520.02	
	S.D.	46.09	27.92	38.51	36.87	30.06	
Brain Weight ♀	$\bar{X}$	516.94	499.82	545.45	524.61	519.13	
	S.D.	28.27	16.18	44.28	36.80	27.55	
Brain Wt. / Body Wt. ♂	$\bar{X}$	35.03	29.17	34.19	29.62	28.91	
	S.D.	5.45	2.58	4.09	2.38	2.62	
Brain Wt. / Body Wt. ♀	$\bar{X}$	36.49	32.86	34.44	32.48	31.74	
	S.D.	8.62	4.48	4.78	4.67	3.08	
Eye Weight ♂	$\bar{X}$	39.94	47.99	49.37	49.67	50.10	
	S.D.	4.75	2.84	2.11	3.33	3.71	
Eye Weight ♀	$\bar{X}$	40.77	49.70	49.92	46.65	49.72	
	S.D.	3.83	3.38	2.72	2.99	4.79	

TABLE 3--Continued

		Wild Caught		1st Gen. Lab.		Semi-Domestic	
Age (mo.)		6	10-12	8-9	16	6-12	12-14
Eye Wt. / Skull Lgth ♂	$\bar{X}$	1.76	2.13	2.13	2.11	2.15	
	S.D.	0.21	0.20	0.10	0.14	0.15	
♀	$\bar{X}$	1.82	2.13	2.21	1.98	2.13	
	S.D.	0.18	0.12	0.27	0.12	0.19	
Lens Weight ♂	$\bar{X}$	15.92	18.92	18.55	19.37	18.35	
	S.D.	2.82	1.05	0.95	1.37	1.95	
♀	$\bar{X}$	15.14	19.08	18.80	18.83	17.86	
	S.D.	2.14	1.54	1.26	1.18	1.84	
Lens Wt. / Skull Lgth ♂	$\bar{X}$	0.67	0.81	0.80	0.83	0.79	
	S.D.	0.10	0.04	0.04	0.05	0.08	
♀	$\bar{X}$	0.67	0.82	0.80	0.80	0.77	
	S.D.	0.09	0.06	0.06	0.04	0.08	
Heart Weight ♂	$\bar{X}$		111.55		107.16		106.63
	S.D.		10.64		15.68		17.75
♀	$\bar{X}$		100.96		108.11		106.89
	S.D.		15.83		20.37		13.04
Heart Wt. / Body Wt. ♂	$\bar{X}$		6.38		6.22		5.79
	S.D.		0.53		0.80		0.50
♀	$\bar{X}$		6.55		6.75		5.77
	S.D.		0.71		0.65		0.38
Kidney Weight ♂	$\bar{X}$		114.14		111.14		121.08
	S.D.		16.30		14.40		20.10
♀	$\bar{X}$		113.50		114.14		116.99
	S.D.		19.26		21.62		15.68
Kidney Wt. / Body Wt. ♂	$\bar{X}$		6.50		6.41		6.58
	S.D.		0.57		0.57		0.78
♀	$\bar{X}$		7.38		7.15		6.31
	S.D.		1.14		0.98		0.57
Spleen Weight ♂	$\bar{X}$		23.52		18.08		21.79
	S.D.		9.63		4.33		7.27
♀	$\bar{X}$		19.67		22.05		22.92
	S.D.		4.20		7.64		9.39

TABLE 3--Continued

		Wild Caught		1st Gen. Lab.		Semi-Domestic	
Age (mo.)		6	10-12	8-9	16	6-12	12-14
Spleen Wt. / Body Wt.	$\bar{X}$		1.33		1.05		1.13
	S.D.		0.44		0.28		0.38
	$\bar{X}$		1.28		1.36		1.20
	S.D.		0.26		0.35		0.38
Testis Weight	$\bar{X}$		123.92		132.36		108.56
	S.D.		38.47		40.64		32.95
Testis Wt. / Body Wt.	$\bar{X}$		7.07		9.71		5.91
	S.D.		2.32		4.96		1.74
Combined Adrenal Weight	$\bar{X}$			2.80		3.74	
	S.D.			0.54		1.09	
	$\bar{X}$			2.53		3.32	
	S.D.			0.83		1.25	

Sex differences for the various body and organ measurements were examined by an analysis of variance with a two-tailed test of significance. The results are summarized in Table 4.

TABLE 4

SEX DIFFERENCES WITHIN TREATMENT GROUPS FOR BODY AND ORGAN MEASUREMENTS. ("F" RATIOS)

	Wild Caught		1st Gen. Lab.		Semi-Domestic	
Age (mo.)	6	10-12	8-9	16	6-12	12-14
Body Weight	.238	4.453	.024	3.039	13.228**	.008
Skull Length	1.161	.021	.514	.993	.033	
Brain Weight	.309	.544	.026	.796	.019	
Brain Weight/ Body Weight	.259	7.950*	.017	3.130	19.070**	
Eye Weight	.149	2.040	.255	5.180	.149	

*P $<$.05 **P $<$.01

TABLE 4--Continued

	Wild Caught p		1st Gen. Lab.		Semi-Domestic	
Age (mo.)	6	10-12	8-9	16	6-12	12-14
Eye Weight/ Skull Length	.267	0.00	.714	4.706	.333	
Lens Weight	.667	.111	.252	.920	1.290	
Lens Weight/ Skull Length	0.00	0.000	.500	1.250	2,544	
Heart Weight		4.670		.015		.001
Heart Weight/ Body Weight		.535		3.287		.015
Kidney Weight		.009		.146		.257
Kidney Weight/ Body Weight		7.542		4.575		.760
Spleen Weight		1.680		2.180		.091
Spleen Weight/ Body Weight		.089		5.330		.196
Comb. Adrenal Wt.			.795		2.500	

Significant sex differences were found in only three instances: (1) body weight for the youngest semi-domestic mice ($F = 13.228$), (2) brain weight - body weight ratio for older wild caught mice ($F = 7.95$), and (3) brain weight - body weight ratio for youngest semi-domestic group ($F = 19.07$). The only trend noted was that in four out of six cases the male mice exhibited heavier body weights than did the females. In the two cases that the females showed the heaviest mean body weights the sex differences were very small.

Age differences for the various body and organ measurements were examined by an analysis of variance. A one-tailed

test of significance was used since the various morphological measurements were predicted to be larger in the older animals. The results are summarized in Table 5.

TABLE 5

AGE DIFFERENCES WITHIN TREATMENT GROUPS FOR BODY AND ORGAN MEASUREMENTS ("F" RATIOS)

	Wild Caught		1st Gen. Lab.		Semi=Domestic	
	♂	♀	♂	♀	♂	♀
Body Weight	5.72*	0.25	2.85	0.09	0.22	9.65**
Skull Length	3.36	12.40**	0.10	0.14		
Brain Weight	1.60	25.47	3.82	1.58		
Brain/Body Wt.	15.35	1.67	9.64	0.95		
Eye Weight	30.40**	27.02**	0.05	7.30		
Eye Weight/ Skull Length	18.00**	17.62**	0.00	6.95		
Lens Weight	16.66**	27.47**	2.56	0.00		
Lens Weight/ Skull Length	25.76**	21.67**	2.00	0.40		

*P<.05 **P<.01

Significant age differences were found in slightly less than half the data compared. An increase in body weight with age was found in five out of six cases but the difference was significant in only the wild caught males and the semi-domestic females. Skull length was significantly larger in the wild caught females. In wild caught mice of both sexes, all eye and lens-of-eye measurements were significantly larger (<.01) with age.

A decrease in absolute brain weight was observed in all wild caught and first generation laboratory mice. This difference was significant ($<.01$) for only the wild caught females. Brain weight-body weight ratios also showed a decrease with age. These differences were significant ($<.01$) among the males of both groups. Absolute and relative eyeball weight also showed a significant ($<.05$) decrease with age in the first generation laboratory females. No feasible explanation can be given for these observed deviations from the expected norms.

An analysis of variance was used in comparing the three groups of deer mice, treating the sexes separately. In cases where a prediction could be made, based on the available literature, a one-tailed test for significance was employed. It was hypothesized that the semi-domestic group would show the larger mean body weight, skull length and testis-body weight ratios while the wild animals (wild caught and first generation laboratory mice) were predicted to exhibit the larger brain, heart, kidney, spleen and adrenal weight-body weight ratios. Since no predictions were made on the eye measurements a two-tailed significance test was used on this data. The "F" ratios obtained are given in Table 6.

In each of four cases, body weight was greater in the semi-domestic group. This difference, however, was significant in only the young males ($<.01$) and old females ($<.05$). Skull length also tended to be greater in the semi-domestic mice but only among the young females was the difference significant ($<.01$). Brain weight-body weight ratios were significantly

different in the expected direction in both the young males ($<.01$) and young females ($<.05$). The eye measurements-skull length ratios of the semi-domestic group were significantly greater ($<.01$) among the young mice of both sexes. The heart-body weight ratios were significantly larger in the predicted direction for the older females but the semi-domestic females showed significantly larger ($<.05$) kidney weight-body weight ratios, contrary to predictions. Combined adrenal weights were significantly heavier ($<.05$) in the semi-domestic group than in the first generation laboratory mice. This also was contrary to the original hypothesis.

TABLE 6

DIFFERENCES BETWEEN TREATMENT GROUPS, KEEPING AGES AND SEXES SEPARATE

	Younger Groups		Older Groups	
	Male	Female	Male	Female
Body Weight	10.19**	2.48	0.94	4.57*
Skull Length	2.93	12.47**		
Brain Weight/ Body Weight	19.15**	4.74*		
Eye Wt./Skull Length	22.83**	7.11**		
Lens Wt./Skull Length	11.59**	9.28**		
Heart Wt./ Body Wt.			2.96	8.23**
Kidney Wt./Body Wt.			0.18	3.76
Spleen Wt./Body Wt.			1.78	0.65
Testis Wt./Body Wt.			3.86	
Combined Adrenal Wt.	7.52	3.54		

*P $<.05$ **P $<.01$

In cases where a significant "F" ratio was obtained among the three groups in Table 6, the data were reanalyzed to parcel out inter-group differences. These "F" values are represented in Table 7.

It was noted that in the skull length and eye-lens comparisons the first generation laboratory group as well as the semi-domestic mice differed significantly from the wild caught group. In the body, brain, heart and kidney weight comparisons the first generation laboratory group differed from the semi-domestic mice, as did the wild caught group.

TABLE 7

INTERGROUP DIFFERENCES FOR THOSE MEASUREMENTS HAVING SIGNIFICANT "F" RATIOS IN TABLE 6

		Young Males		Young Females		Old Females
		1st Gen.	S-Dom.	1st Gen	S-Dom	S-Dom.
Body Weight	Wild		16.33**			6.32*
	1st Gen.		11.84**			9.56*
Skull Length	Wild			12.34**	24.55**	
	1st Gen.					
Brain Body Weight	Wild		29.67**		8.61**	
	1st Gen.		28.18**		4.52**	
Eye Weight Skull Length	Wild	27.67**	39.32**	9.30**	13.71**	
	1st Gen.					
Lens Weight Skull Length	Wild	14.80**	18.63**	16.13**	12.37**	
	1st Gen.					
Heart Weight Body Weight	Wild					9.84**
	1st Gen.					19.19**
Kidney Weight Body Weight	Wild					7.21*
	1st Gen.					5.84*

*P $<$ .05 **P $<$ .01

Physiological Analysis

The results of the corticosterone analysis are described in Table 8. Due to an experimental error, results obtained for the semi-domestic mice were discarded.

TABLE 8

CONCENTRATION OF CORTICOSTERONE IN BLOOD PLASMA OF WILD CAUGHT AND FIRST GENERATION LABORATORY STOCKS OF P.M. BAIRDII

	Concentration per 100 ml. blood plasma		Average for group
Wild Caught	Males	68 μg.	62 μg.
	Females	56 μg.	
First Gen. Lab.	Males	42 μg.	35 μg.
	Females	28 μg.	

The results indicate that the corticosterone output, under the conditions described previously, is nearly twice as high for the wild caught P.m. bairdii as for their offspring reared under laboratory conditions.

Behavior

Activity. Considerable individual variation was observed within the three treatment groups. The mean and standard deviation for each group (sexes combined) along with the range in mean number of counts per night are given in Table 9.

The wild caught group was significantly less active than both the first generation laboratory and semi-domestic groups below the .001 level of significance (Mann-Whitney U-Test). The difference in activity between the first generation

laboratory and semi-domestic mice was not significant. These results indicate that the previous experience of wild caught mice in nature inhibits activity in a laboratory test situation.

TABLE 9

RANGES, MEANS AND STANDARD DEVIATIONS FOR SCORES OBTAINED IN A TILT-BOX TEST FOR ACTIVITY

	Range ($\bar{X}$ counts/night)	X	S.D.
Wild Caught	17.25 to 366.75	73.29	84.37
First Gen. Lab.	24.67 to 22,125.75	6,159.93	31,061.53
Semi-Domestic	40.50 to 21,634.00	4,760.52	6,672.01

Gnawing. The results of the gnawing test are summarized in Table 10.

TABLE 10

MEAN NUMBER OF STICKS GNAWED BY THREE TREATMENT GROUPS

Wild Caught	First Gen. Lab.	Semi-Domestic
0.0	0.0	0.0
0.0	0.0	3.5
0.0	0.0	4.5
0.0	0.0	5.5
0.0	4.0	7.0
1.0	5.0	14.0
2.0	9.5	20.0
8.5	12.0	20.5
12.0	14.0	21.5
16.5	17.0	

A greater percentage of semi-domestic mice gnawed (88.0) than wild caught (50.0) or first generation laboratory animals (60.0). The differences in gnawing activity as

measured by mean sticks gnawed and tested by the Mann-Whitney U-Test, were significant between wild caught and semi-domestic mice below the .05 level of probability, but the scores of the first generation wild strain were not significantly different from either the wild caught or semi-domestic groups.

Sand Digging. The results of the sand digging test are given in Table 11.

TABLE 11

MEAN OUNCES OF SAND DUG BY THREE TREATMENT GROUPS

Wild Caught	First Gen. Lab.	Semi-Domestic
0.00	0.00	0.00
0.00	0.50	0.00
0.00	0.50	0.75
0.00	0.75	2.50
0.25	3.50	7.50
0.25	4.00	20.50
0.25	4.50	26.50
1.00	27.25	42.50
1.50	36.50	76.00
82.50	66.00	88.50

Again the wild caught mice had the lowest mean test scores followed by the first generation laboratory and semi-domestic mice. Employing the Mann-Whitney U-Test it was found that the wild caught group dug significantly less sand than either the first generation laboratory group ($<.05$) or the semi-domestic mice ($<.05$). However, the difference between the first generation laboratory and semi-domestic mice was not significant. As in the gnawing test, the results point to the differential effects of early experience in the wild and laboratory raised mice.

Discussion

Morphology

In regard to sex differences, it was noted that the body weights of male mice tended to surpass those of females. However, this relationship generally holds true for most mammalian species. Of greater interest, perhaps, is the fact that in two out of five cases, the ratio of brain weight to body weight was significantly different between sexes below the .02 level of probability. In both cases the females exhibited the greater ratios, partly because the females were considerably smaller in body weight than the males.

Significant differences due to age were more numerous. Body weight and skull length showed consistent increases with age but the increment was found significant in only about one-third of the cases. Brain weight and brain-body weight ratios, however, decreased in every case. The fact that the brain has a sharp growth curve which levels off at an early age (15-20 days in P.M. bairdii) while body weight shows marked increases for a longer period of time (King and Elefteriou, 1960) could account for the decrease in brain-body weight ratios found but the loss in absolute brain weight is unexplained. Increases in eye measurements with age below the .01 level of significance were found in each case for the wild caught mice. This may be explained by the fact that the young mice were caught in the field at an early age. Howard (1949), Snyder (1956) and Blair (1948) estimate the average life span of Peromyscus in central Michigan to be approximately five months

regardless of the season. It is, therefore, estimated that most of the younger group of wild caught mice range from five to six months of age since the majority were caught in March and early April. A few individuals trapped in late December and early January were probably much younger, however, and tended to lower the means. Body and eye weights obtained from these young mice support this assumption. In many mammals, lens weight has been used to determine age (Lord, 1959, 1961; Beale, 1962; Edwards, 1962; Kolenosky and Miller, 1962). These studies have pointed out that the greatest increment in lens weight occurs early in life and that growth decreases with age. The lack of significance between "young" and "old" groups of first generation laboratory mice may then be explained by the fact that the eye growth of young mice, which averaged eight months of age when sacrificed, would be fairly complete and little gain could be expected thereafter.

Comparison of certain morphological characteristics between wild caught, first generation laboratory and semi-domestic P.m. bairdii pointed out that twenty generations or more of laboratory breeding has resulted in a slight increase in body weight. The increase is significant only among young males and old females, but the trend is evident in all classes. A significant brain-body weight interaction was found for both young males and females but because of the differences in body weight this measure may not represent true differences in brain size. In regard to eye measurements, the young wild mice differed significantly from both first generation laboratory and semi-domestic groups in every case. As discussed previously,

this difference is probably due to the young age at which the wild mice were caught. Had a true genetic difference existed between the eyes of wild and domestic P.m. bairdii, a significant difference between the wild and first generation laboratory groups would not have been likely. As noted in Tables 6 and 7, the heart-body weight and kidney-body weight values were significantly lower in the old semi-domestic females than in either old wild or first generation females. Again this difference may be due, at least in part, to body weight relationships.

Physiology

Sulfuric acid-induced fluorescence was used to measure the output of adrenal corticosterone after a three hour stress period. The data obtained for the semi-domestic mice were discarded due to an experimental error but the values obtained for the wild caught mice were nearly twice those of the first generation laboratory group. The stress factors involved were handling the mice initially, placing them in empty cages without food or water and subjecting them to a 45°F. temperature for three hours. The stress value of these three situations is unknown and unimportant to the present study since the investigation was primarily concerned with relative corticosterone outputs. Eleftheriou (person. comm.) has found the "resting level" (no stress) of corticosterone for P.m. bairdii to be about 25 μg/100 ml. of plasma. Using this as a base level the values of 35 and 62 μg/100 ml. obtained for the first generation laboratory and wild caught mice, respectively, would indicate that the two groups of

mice had undergone stress of a differing degree.

Foster (1959) describes the prairie deer mouse as being "tense" and "timid" and by means of these traits explains the "freezing" tendency of P.m. bairdii when startled or confronted with a strange situation. In its natural environment (primarily grassland), this behavior is probably adaptive. A crude measure of emotionality or timidity was obtained by recording the number of times a mouse would attack the experimenter's rubber-tipped forceps when picked up by the tail. Out of 24 first generation laboratory mice, 72 per cent attacked the forceps while only 38 per cent of 29 wild caught mice exhibited this behavior. Furthermore, the wild mice used in this experiment had been in the laboratory for ten or more months and had received the same treatment as the first generation laboratory group. The only difference in their rearing histories was the fact that the wild caught mice had been born and reared in the wild for a period of about two months.

In any case, the differential effect of stress on the relative corticosterone output of these two groups was probably due to: (1) an age factor, since the wild caught group was three or four months younger than the first generation laboratory group; or (2) environmental factors including early experience, affecting the emotionality or temperament of the animals. Because of the genetic similarity of these two groups, heritable factors were disregarded.

Behavior

In three tests of behavior the wild caught group

exhibited significantly less activity than the semi-domestic mice and in all but the gnawing test the wild mice were significantly less active than the first generation laboratory group. This general inactivity or inhibition was also observed when the mice were placed in a strange environment offering no concealment or escape, such as an empty cage. The wild mice would soon settle down, often assuming a crouching position as if hiding, while the mice reared in the laboratory from birth would remain active, investigating the new environment and often showing such stereotyped behavior as backflipping. Compared to such related species as P.m. gracilis and P. polionotus, P.M. bairdii shows a greater latency to enter strange surroundings (Dice and Clark, 1962) but the unusual inactivity and timidity of wild caught mice in the laboratory is probably due to more than heritable factors.

Similar behavior among first generation laboratory and semi-domestic mice in all three tests indicate that their similar early environment was responsible. Since all groups received similar treatment in the laboratory the behavioral differences exhibited by the wild mice may then be attributable to their early experience under natural conditions. At this point the investigator would encourage further research to determine what factors in the early experience of P.m. bairdii could be responsible for their subsequent behavior in the laboratory and whether or not these differences will extinguish with time (Wecker, 1963). Problems related to learning and emotionality would probably be most pertinent.

The degree of stress accompanying the transfer of

wild mice to laboratory cages is not known. Whether the initial adjustment takes place in a week or a year is purely hypothetical at this point. It would have been enlightening to have repeated the behavioral tests described previously six months or more after the initial testing. If the corticosterone study and the observations made on handling with forceps are related to the basic behavioral differences observed shortly after transfer to the laboratory we may conclude that these differences had not dissipated after ten months in the laboratory situation.

In conclusion, the original hypothesis that an increase in body weight accompanies the domestication process was given good support. Other relative differences observed in regard to body and organ measurements between the three groups were probably due to body weight phenomena in that in most cases the latter was used as the only indicator of body size.

The physiological measurement pointed out that the wild caught mice are more easily stressed than those lacking early experience in the wild, even after ten months in the laboratory. Whether this greater susceptibility to stress is characteristic of wild mice in general or a product of the change in environments is a problem for future research.

The differential early experience is also believed responsible for the observed differences between the wild caught and laboratory raised mice in three behavioral tests. The fact that the wild caught group showed significantly less activity, gnawing and sand digging indicates that an inhibitory

mechanism may be operating in the wild group possibly due to their greater emotionality.

Summary

Three groups of Peromyscus maniculatus bairdii were employed to determine some of the morphological, physiological and behavioral changes that have occurred in the prairie deer mouse during twenty or more generations of laboratory breeding. Wild caught mice, the offspring of pregnant wild caught females born and reared in the laboratory and a semi-domesticated group were compared in regard to certain body and organ measurements, adrenal corticosterone output under stress and three behavioral tests measuring activity, gnawing and sand digging.

Few definite trends were observed in the morphology of the three experimental groups other than that of body weight. In each of four cases, body weight was proportional to time spent in the laboratory with the laboratory mice exhibiting the largest mean body weight. These basic differences in body weights were partly responsible for certain differences observed in organ-body weight ratios.

Almost a two to one ratio was observed for the relative adrenal corticosterone output of wild caught and first generation wild mice, respectively, under three hours of cold stress. The greater timidity and emotionality of mice with early experience in the wild was discussed as a possible explanation for this phenomenon.

Wild caught mice showed significantly less activity

in three behavioral tests measuring activity, gnawing and sand digging. The similarity in performance of first generation wild and laboratory mice pointed to environmental factors as responsible for the relative inactivity of the wild group.

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