An Unusual Animal Model

Deer Mice As Laboratory Animals

Charlotte P. Joyner, Lisa C. Myrick, Janet P. Crossland, and Wallace D. Dawson

The laboratory mouse (Mus domesticus) and rat (Rattus norvegicus) remain the most widely used species of research rodents. Nevertheless, other rodent species (albeit in smaller numbers) are also consistently employed in laboratory research and teaching (Jackson 1997). One species used increasingly in toxicological and epidemiological research, as well as in ecological, behavioral, and genetic studies, is the deer mouse (Peromyscus maniculatus) (Figure 1) (Barry 1975).

Wild deer mice are among the most abundant small mammals in North America. They range from Alaska to central Mexico, from Newfoundland to Virginia, and from Atlantic to Pacific oceans (Hall 1981). Deer mice are absent only in the southeasternmost states, where they are replaced by related species. More than 60 formally described subspecies of deer mice occupy a wide variety of forest, prairie, and desert habitats from sea level to elevations of 14,000 ft or more. In nature, deer mice nest in logs and stumps or in shallow burrows beneath rocks and clumps of vegetation. They subsist on seeds supplemented with occasional crickets or other insects. Owls, snakes, foxes, weasels, and other small carnivores find these rodents a staple food source, and thus they play an important role in natural ecosystems (King 1968; Kirkland and Layne 1989).

Deer mice were first bred in captivity about 1916 by Francis Sumner at the Scripps Institution at La Jolla, California (Sumner 1917). For the next half-century, a handful of investigators continued to collect and establish breeding stocks of these animals, which were used primarily to study genetic structure of small mammal populations. A particularly noteworthy large colony was maintained from about 1925 until 1975 by Lee R. Dice and his proteges at the University of Michigan. Several existing lines of deer mice trace to this Michigan colony. It was also during this time that many of the distinctive coat color mutants were originally isolated (Rasmussen 1968).

In 1962, the deer mouse colony at the University of South Carolina was established. Over the next 3 decades, more than 30 distinct “wild-type” and mutant genetic stocks were acquired, forming the nucleus of the Peromyscus Genetic Stock Center (PGSC). The PGSC, formally initiated in 1985, is supported in part by the National Science Foundation as a biological resource. At the time of this writing, approximately 3000 animals are maintained. The function of the PGSC is to provide the scientific community with genetically defined animals and to improve the deer mouse as a model for biological research.

The deer mouse has distinct advantages for certain kinds of studies. Many of the advantages stem from the fact that this native species can be used as a laboratory standard for contrasting wild counterparts. For example, deer mice can be utilized to monitor environmental pollution using exposed wild animals compared with laboratory-bred controls (Kucera 1988). A representative study is that of Schauber and others (1997), in which effects of insecticide ingestion were assayed in deer mice. Because deer mice are native, laboratory observations can be extrapolated to natural populations for ecological investigations. The existence of numerous deer mouse races and more than 50 closely related Peromyscus species, all in North America, also make the deer mouse a favorite subject for fine scale systematics studies in this country. Because many genetic variants in deer mice occur at loci homologous with those in the laboratory house mouse and rat, they are useful in parallel studies with more conventional laboratory species. Deer mice are appealing, alert creatures with large eyes and ears. The wild-

FIGURE 1 Laboratory-bred wild-type deer mouse (Peromyscus maniculatus) of the Bairdii Washtenaw (BW) stock.
type animal is sharply bicolored with a rich brown-gray above and white below. Handled properly by experienced persons, even with bare hands, the majority bite only rarely. Additionally, they are slightly smaller than most laboratory mice, and odor is negligible. Another major advantage is the ample genetic polymorphism in natural *Peromyscus* populations and various laboratory stocks that can be screened for specific variants of interest. For example, an outbred stock of deer mice was the source of the alcohol dehydrogenase “null” variant extensively employed in ethanol metabolism research (Alderman and others 1987; Bradford and others 1991; Felder 1975).

Two major disadvantages of deer mice as laboratory animals are the unavailability of highly inbred, genetically homogeneous strains and difficulty in handling due to their quickness and jumping ability. Both of these problems are being approached through controlled breeding. Because outbred stocks retain significant genetic polymorphism, they are not preferred when consistency of response is required, such as in dosage studies. However, as noted above, this same polymorphism provides a rich source of biochemical and molecular variation that can be tapped for genetic analysis. Development of highly inbred strains of *Peromyscus* has met with limited success. Although a number of lines of both deer mice and white-footed mice (*Peromyscus leucopus*) have been inbred by sib-sib and/or parent-offspring mating for more than 20 generations, inbred animals tend to have reduced fertility and viability. Selection for greater docility in deer mice has proved effective in the double recessive brown and silver coat color stock. A related species maintained in the PGSC, *Peromyscus azte cus* from Mexico, is easily handled and stands in marked contrast to *Peromyscus melanophrys*, also from southern Mexico. *P. melanophrys* is among the more aggressive species.

**SOURCES OF INFORMATION**

Many aspects of the biology of the deer mouse and other *Peromyscus* species have been amply explored. Two general reference volumes, *Biology of Peromyscus* (King 1968) and *Advances in the Study of Peromyscus* (Kirkland and Layne 1989), are devoted exclusively to rodents of this genus. Literally thousands of laboratory and field studies have been conducted. Thus, these are laboratory animals whose natural ecology is very well documented. Particularly the physiology, reproduction, genetics, and behavior of deer mice have been extensively investigated (see citations in the 2 volumes referenced above). Butter (1988) compiled a *Peromyscus* literature data base with more than 6000 citations, including 1380 titles between 1980 and 1987. A semiannual *PEROMYSCUS NEWSLETTER* is published by the PGSC and distributed to more than 600 individuals active in research with these rodents. This newsletter includes informal research accounts, summary information on genetics of deermice, recent literature citations, and other information of interest to subscribers.

At the time of this writing, the Internet-accessible data bank PeroBase is under development. When completed, this data base will contain a large body of detailed information concerning all aspects of *Peromyscus* biology.

**RESEARCH USE**

The most active research areas utilizing deer mice and related species are ecology and epidemiology (Table 1). *Peromyscus* have been implicated in 2 human diseases of current interest: (1) Deer mice (*P. maniculatus*) are carriers of the pathogen producing the recent hantaviral pulmonary syndrome (Four Corners disease) outbreak in the southwestern United States. (2) The deer mouse and the congeneric white-footed mouse are known hosts for the larval stage of the tick (*Ixodes*), which transmits the Lyme disease spirochaet (*Borrelia*) (Burgess and Patrican 1987; Ubico and others 1996). These species are extensively employed in laboratory studies of the conditions described. *Peromyscus* are also used in aging research, since they are often long lived compared with house mice (*Mus*) (Sacher and Hart 1978; Smith and others 1990).

**TABLE 1 Research with Peromyscus based on 284 articles in the 1993 to 1997 scientific literature**

<table>
<thead>
<tr>
<th>Discipline</th>
<th>No. of articles</th>
<th>(% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular biology and cell/organism geneticsa</td>
<td>17</td>
<td>(6.0)</td>
</tr>
<tr>
<td>Reproduction, growth, development, and aging</td>
<td>14</td>
<td>(4.9)</td>
</tr>
<tr>
<td>Physiology and metabolism</td>
<td>37</td>
<td>(13.0)</td>
</tr>
<tr>
<td>Behavior and social organization</td>
<td>27</td>
<td>(9.5)</td>
</tr>
<tr>
<td>Systematics, population genetics, and evolutionb</td>
<td>35</td>
<td>(12.3)</td>
</tr>
<tr>
<td>Community ecology, species interaction, and natural history</td>
<td>68</td>
<td>(23.9)</td>
</tr>
<tr>
<td>Applied ecology, toxicology, and environmental monitoring</td>
<td>20</td>
<td>(7.1)</td>
</tr>
<tr>
<td>Parasitology and infectious disease</td>
<td>66</td>
<td>(23.2)</td>
</tr>
</tbody>
</table>

a Does not include molecular systematics or population genetics.
b Includes molecular systematics.
However, less than 25% of research activity with deer mice and their allies is for strictly “biomedical” research, in which more traditional laboratory animals are usually preferred. Deer mice and other *Peromyscus* have long been considered ideal for evolutionary research at the morphological (Blair 1950; Dice 1940; Sumner 1932), biochemical (Zimmerman and others 1978), cytogenetic (Alfand and Honeycutt 1991; Stangl and Baker 1984), and molecular levels (Cassavant and others 1996; Kass and others 1992; Lansman and others 1983). Deer mice are a frequent species of choice for studies of biological rhythms (Demas and others 1997; Nelson and Blom 1994), torpor (Hulihan-Giblin and others 1997; Nelson and Blom 1994), and neurochemistry (Hunt and Hooper 1993; Kavaliers and Innes 1993).

**CLASSIFICATION AND MORPHOLOGY**

The genus *Peromyscus* comprises approximately 55 existing and several extinct species of mouse-like rodents of the family Muridae (sensu lato), subfamily Sigmodontinae. Representatives of the genus first appear in the fossil record during the late Pliocene about 4 million years ago (MYA) and represent the North American phylogenetic branch of sigmodontine rodents that also includes wood rats, grasshopper mice, and American harvest mice (Hibbard 1968; Hooper and Musser 1964). The evolutionary lines leading respectively to *Peromyscus* and murine rodents (*Rattus, Mus*) diverged from a common ancestral stock 17 to 30 MYA, probably in Asia, and deer mouse progenitors invaded North America from Siberia perhaps 20 MYA (Catzeflis and others 1993; Sarich 1985).

The systematics of *Peromyscus* is well studied, but some aspects remain controversial (Carleton 1989; Hooper 1968; Osgood 1909; Stangl and Baker 1984). The genus traditionally is divided into subgenera and species groups (Hall 1981). Different species vary greatly in size: The largest, *Peromyscus thomasi* and *Peromyscus pirrensis*, weighing 100 g or more, and the smallest, as little as 14 g as adults. However, of the numerous forms, only a few are widespread. *P. maniculatus* (deer mice) and *P. leucopus* (white-footed mice) are the most familiar and biologically best known species.

Mature deer mice weight ranges from 16 to 35 g, depending on the subspecies. The tail is shorter than the head-body length in the prairie and desert races, but longer in the forest forms. Adult animals of the most frequently used laboratory stock (*P. m. bairdii*) typically weigh 18 to 21 g, with 85- to 90-mm head-body length and a tail length of 50 to 55 mm. Deer mice have distinctly bicolored tails.

White-footed mice, also used extensively in research, are similar in size and other features to the deer mouse. The white-footed mouse is the most common wild *Peromyscus* species in the eastern United States. In some wild populations, white-footed mice are difficult to distinguish readily from deer mice, but they usually have a less distinct tail stripe and a narrower eye set. Nevertheless, these are distinct species and cannot be hybridized (Dice 1933; Maddock and Dawson 1974). Mature white-footed mice maintained at the PGSC average 25 to 28 g in weight, 90 to 95 mm in head-body length, and approximately 70 mm in tail length. The reproductive biology of the 2 species in the laboratory is similar, except that the birth interval in white-footed mice averages about 2 days longer than the 27 days typical of deer mice.

The California mouse (*Peromyscus californicus*), another species maintained at the PGSC, is larger than either the deer mouse or white-footed mouse. California mice are noteworthy because of their monogamous mating behavior and paternal participation in nurturing young (Gubernick and others 1993; Ribble 1991). This species has received considerable attention from behavioral biologists.

**GENETICS**

Approximately 50 loci representing coat color and morphological, behavioral, and biochemical variants have been described in the deer mouse from formal genetic crosses. Approximately 24 additional presumptive enzyme loci are known from variation in wild populations. A linkage map based on recombination data contains 8 recognized groups and 22 markers (Dawson and Rogers 1993). The population and evolutionary genetics of allozyme variation are particularly well studied (Avise and others 1979; Baccus and Wolff 1989; Gill 1976; Loudenslager 1978; Zimmerman and others 1975; among others). The deer mouse, like all *Peromyscus*, has a diploid chromosome number of 48 (Hsu and Arrighi 1968). In contrast to murine rodents, centric fusion has never been observed in *Peromyscus*. At least 3 pericentric inversions have been detected in deer mouse (Greenbaum and others 1978), and there is considerable variation in constitutive heterochromatin within the species (Pathak and others 1973; Stangl and Baker 1984). The karyotype has been standardized (Greenbaum and others 1994), but only 2 of the linkage groups have been assigned to chromosomes. Genomic and cDNA libraries exist for *P. maniculatus, P. leucopus,* and *P. californicus*. Restriction maps and DNA sequences have been generated for several genes and elements (for example, Crew and others 1994; Kass and others 1997; Padgett and others 1987; Zheng and others 1993). Many restriction enzyme site and sequence variants are known for mitochondrial DNA of deer mice (Ashley and Wills 1987, 1989; Lansman and others 1983; Morzunov and others 1998). *Peromyscus*-specific molecular probes exist for several individual genes and elements. Biotinylated DNA probes have been hybridized in situ to *Peromyscus* chromosomes (Baker and Wichman 1990; Bowers and others 1998; Wang and others 1995). Several *Peromyscus* molecular probes and libraries are available through the PGSC (*Peromyscus* Stock Center 1998).
REPRODUCTION IN CAPTIVITY

Abundant information is available on the reproductive biology of *Peromyscus*, in both the laboratory and field (Millar 1989). Representative are studies by Clark (1936), Terman (1968), Maddock and Chang (1979), Modi (1984), Roth and Klein (1986), Millar and Millar (1989), Nelson (1993), and Demas and others (1996). Many species of *Peromyscus* breed satisfactorily in captivity (Dice 1933). Captive breeding of *P. maniculatus* has been examined by Williams and others (1965), Rood (1966), Price (1967), Millar and Threadgill (1987), and Burger and Gochfeld (1992), among others. Dewsbury (1979, 1988) extensively investigated variables in breeding behavior of deer mice and other *Peromyscus* species.

At the PGSC, reproductive characteristics of both wild-type and most mutant deer mouse stocks are consistent (Table 2). Animals are sexually mature by 50 days of age. The estrous cycle of the deer mouse is 5 days (Clark 1936) and gestation is 22 days, except in lactating mothers for which it is delayed between 4 to 5 days and is 26 to 27 days. Breeding is optimized when animals are continuously retained in breeding pairs. Like many other small murid rodents, females enter postpartum estrus about 12 hr after parturition and will remate at this time (Bradley and Terman 1979). Thus, serial litters are born at 26- to 28-day intervals. About 80% of the mated pairs are productive within 3 mo or less. Breeding may lag in midwinter under natural lighting. The mean number born per litter is 4.8, of which 80% or more are expected to survive to weaning. The usual number born per litter ranges from 3 to 6 and rarely exceeds 8. Mean weight for neonates is 1.6 g.

For breeding, pairs are established individually and remain together indefinitely as long as they are productive. Breeder cages should be observed regularly for pregnancies and newborn litters. Copulatory plugs are not conspicuous in *Peromyscus* and are not a reliable indication of mating. Litters are normally born during midday. A proper lighting cycle is essential, and a 16:8 light to dark cycle is satisfactory. Continuous light will produce anestrus. Breeding difficulties are sometimes overcome by reducing the light cycle to 12:12 and then advancing it in increments to 16:8 over a 3-wk interval. The male should be retained with the female throughout. In some *Peromyscus*, the male may contribute significantly to care of the young (Gubernick and others 1994; Wolff and Cicirello 1991). Introduction of a strange male to a pregnant female may block the pregnancy (Bronson and Eleftheriou 1963; Dewsbury 1985). Litters should be removed from the breeding cage when they are 25 days old. Although they may cease nursing (self-wean) as early as 20 days after birth, parental care for another several days contributes to viability and growth. It is generally convenient to earmark the young at this time. The juvenile animals are caged 6 to 7 per cage, separated by sex, until ready for use. It is convenient to tag each mating cage with a card to maintain a record of breeding performance. Pairs of deer mice infertile for 3 mo may be remated to other partners. Occasional females exhibit the “bad mother” syndrome in which case a mated female may regularly produce litters but consistently fails to nurse or raise them. The syndrome is evident when the mother fails to build a nest, soaks and flattens the bedding material at the nest site, and scatters the neonates about the cage, and when there is no evidence of milk in the stomach of the young. The young are

<table>
<thead>
<tr>
<th>Stock</th>
<th>Litter size at birth (X)a</th>
<th>Litter size at weaning (X)b</th>
<th>F:M sex ratio at weaning</th>
<th>Productiveb matings (%)</th>
<th>Gestation lengthc (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. maniculatus</em> (BWd stock) (28)</td>
<td>4.79±0.43 (20)</td>
<td>4.03±0.47 (20)</td>
<td>0.986±1.014</td>
<td>83.1 (124)</td>
<td>24.61±1.24</td>
</tr>
<tr>
<td><em>P. polionotus</em> (POd stock) (38)</td>
<td>4.11±0.27 (20)</td>
<td>3.80±0.35 (20)</td>
<td>0.978±1.022</td>
<td>77.2 (101)</td>
<td>27.29±1.34</td>
</tr>
<tr>
<td><em>P. leucopus</em> (Lld stock) (31)</td>
<td>4.16±0.42 (20)</td>
<td>3.62±0.45 (20)</td>
<td>0.962±1.038</td>
<td>66.5 (179)</td>
<td>29.45±0.90</td>
</tr>
</tbody>
</table>

aBased on 20 mated pairs that produced 6 or more consecutive liveborn litters for each stock.
bMated pairs that produced 1 or more weaned offspring from among 100 or more pairs established for each stock.
cBetween litter interval minus 1 day when successive litters are conceived at postpartum estrus.
dBW, Baird's Washtenaw; PO, Polionotus Ocala; LL, Leucopus Linville.
typically cannibalized within approximately 1 day of birth. Individuals showing this condition do not succeed as breeders. However, occasionally a normally productive female will lose and cannibalize a litter, particularly when stressed, but successfully wean subsequent offspring. It is important to distinguish between these 2 situations.

HUSBANDRY

Deer mice and similar-sized Peromyscus are easily maintained using standard laboratory mouse protocols. A maximum of 6 adult animals are housed in 7 x 10-in plastic cages. Feed and water are presented ad libitum. Nutritional complete commercial laboratory rodent feed is advised by the PGSC. Rabbit or guinea pig feed should never be used, and high lipid “breeder” chows should be avoided. Supplements of fresh vegetables, raisins, sunflower seed, and so forth are unnecessary and may be detrimental. Except for breeding, sexes should be housed separately. Deer mice are reasonably cold-tolerant, but ambient temperatures should never exceed 33°C. The optimal temperature is 22 to 25°C. Bedding of aspen shavings or other nontoxic fibrous material may be used. A small amount of cotton may be provided as nesting material but is not essential and probably improves breeding only minimally. Woolen materials should never be used for bedding since some animals will consume wool and die from gastrointestinal blockage. Clean cages and bedding should be provided weekly.

PATHOLOGY

Deer mice and other Peromyscus species are typically healthy and disease resistant in captivity. They consistently test negative for 15 common murine viruses. During 40 years of experience working with large colonies of deer mice, we have experienced only 1 serious episode that resulted in substantial mortality. In 1968, approximately 140 deer mice (among 1200 in the colony) died during a 3-day interval. A group of 60 random-bred albino laboratory rats (Rattus norvegicus) in an adjacent animal room experienced 100% mortality during this same period. Male P. maniculatus were primarily affected and showed nasal and urethral bleeding. Fewer females were affected. Although the pathogen was never definitively identified, it was assumed to be “rat pneumonia” (Mycoplasma or possibly Pasteurella), accidentally introduced from rats obtained from an unsanitary source. With greatly improved animal health protocols and separation of Peromyscus from other rodents, there has never been another major disease problem at the PGSC.

Weanling deer mice, particularly when stressed, occasionally experience self-limiting diarrhea. When this condition is noted, the animals should be isolated and tetracycline added to the drinking water until the symptoms subside. Pinworms, which sometimes occur in laboratory-reared deer mice, can be controlled with Ivermectin. Mites and other ectoparasites are rarely a problem in a well-tended animal facility; however, if they do occur, treatment of the bedding with 5% Sevin dust should alleviate the problem.

Wild Peromyscus mice are notorious as carriers of hantaviruses, ehrlichiosis, and the larval tick vectors of Lyme disease and other human diseases. Wild-caught animals should always be kept in isolation and totally removed from laboratory-reared animals. Wild Peromyscus should be handled with utmost caution. The Centers for Disease Control and Prevention has established proper procedures for handling wild-caught rodents (Mills and others 1995). Deer mice infected with hantavirus exhibit no overt symptoms and remain healthy. The mode of mouse-to-mouse transmission of hantaviruses is not clear but may be by biting. Peromyscus introduced from other colonies should be isolated until tested to confirm that no hantavirus seropositive animals are present. Captive-reared deer mice from well-maintained facilities approved by the Association for Assessment and Accreditation of Laboratory Animal Care pose little risk of infectious disease to researchers and handlers. However, some technicians and researchers develop allergies to deer mice and must discontinue working with them.

BEHAVIOR AND HANDLING

Deer mice are considerably more active than laboratory house mice and will readily escape if not properly guarded. A handling table with a 10-in-high barricade is recommended. Although the animals will bite if handled improperly, they rarely bite without provocation. Gentle handling with surgical gloves, rather than with tongs, is advised. The animals become accustomed to regular mild handling. The skin at the neck is loose, and the animals may be held by the scruff of the neck. Deer mice may also be restrained by cupping the palm of the hand over the animal, without applying pressure, and lifting the animal by the tail. For injections or other invasive procedures, the animals can be essentially immobilized by holding the animal by the scruff of the neck between the thumb and forefinger of the left hand (opposite for left-handed persons) and securing the tail between the fourth and fifth fingers of the same hand. The right hand is then free to hold a syringe or other instrument, or to record information.

Most technical procedures used for laboratory mice work equally well for deer mice. Anesthetics and dosages are essentially the same. At the PGSC, Avertin is customarily used with good results. Blood is conveniently obtained by suborbital puncture using capillites.

Although Peromyscus do not technically qualify as “rats” or “mice” under federal animal welfare legislation, animal use protocols are basically those applicable to laboratory Mus and Rattus. Peromyscus colonies are subject to inspection by the US Department of Agriculture at regular intervals.

Peromyscus are much more active at night than during the day. Their repertoire of behavior is greater than that of laboratory mice (Kavanau 1967), and they exhibit many ac-
tivities and routines of circling, leaping, climbing, and exploring, all of which are normal. Most individuals will readily run exercise wheels.

**BASELINE DATA**

An immense amount of information is available in the literature on the physiology of deer mice and other *Peromyscus* species. Published body masses, basal metabolism rates, and indices of evaporative water loss are summarized by MacMillan and Garland (1989). Adult body masses reported in 7 independent studies for 7 subspecies of deer mouse average 19.6 g. The mean basal metabolic rate based on these studies for the deer mouse is 2.07 mL (range 1.67 to 2.56) of \( \text{O}_2 \) uptake/g of weight/hr. Evaporative water regulatory efficiency averages 10.2 (index) for 6 subspecies of *P. maniculatus*, a value lower than that in various species endemic to xeric environments. Some metabolic values for laboratory stocks of *Peromyscus* are given in Table 3.

Considerable endocrinological information is also available for the deer mouse. Unfortunately, no recent comprehensive reviews have been published. Representative studies of reproductive hormones are those of Bradley and Terman (1981), Clemens and Pomerantz (1981), Colosi and others (1983), Demas and others (1996), Desjardins and Lopez (1983), and Finlay (1974). Thyroid function (Hulbert and others 1985; Levy and others 1965), adrenal effects on metabolism (Andrews and Belknap 1988; Garwood and Rose 1995), and melatonin and other neurohormones (Fail and Whitsett 1988; Hayssen and others 1994; Lin and Pivorun 1990) are examined in the cited publications and in many others. Extensive literature also exists on thermoregulation, oxygen consumption, alcohol metabolism, sensitivity to environmental contaminants, pheromones, and other aspects of metabolism and physiology in deer mice and related *Peromyscus* species.

**CURRENT STATUS OF THE *PEROMYSCUS* GENETIC STOCK CENTER**

The program at the PGSC has established several goals. Among these are (1) to further characterize the genetics, physiology, and reproduction of the most widely used standard deer mouse stocks; (2) to develop special multiple mutant strains for further developing the species’ genetic linkage map by using combinations of morphological and biochemical traits; (3) to develop inbred strains of *Peromyscus*. These endeavors are under way at the University of South Carolina and elsewhere at the time of this writing.

One widely used stock, Bairdii Washtenaw or “BW,” has existed in captivity for 50 yr. In 1947, a breeding stock was initiated from 41 wild deer mice of the prairie subspecies (*P. m. bairdii*) captured in Washtenaw County, Michigan. This stock proved to be vigorous and to breed well in captivity. It has been maintained as a closed stock at several institutions since its inception with a complete pedigree dating to the original wild-caught ancestors. The BW stock continues to exhibit the phenotypic characteristics of the original animals, thus serving as a convenient standard reference. This stock has been utilized in numerous physiological, behavioral, reproductive, and genetic studies. Because of its high fertility and vigor, it also sometimes is crossed out to improve reproduction of various mutant stocks. The reproductive characteristics of this and 2 other “wild-type” stocks of *Peromyscus* are given in Table 2.

At the time of this writing, 25 single factor visible mutant types of deer mice are maintained in the PGSC (Table 4). Most of these types represent distinctive coat color varieties and patterns, but other morphological variants, including 2 hairless (hypotrichosis) mutants, are represented in the collection. Additionally, several neurosensory mutants are kept that exhibit epileptic and ataxic behaviors. The “cataract-webbed” and “spherocytosis” variants have potential biomedical research applications.

**TABLE 3 Physiological standards for laboratory stocks of *Peromyscus***

<table>
<thead>
<tr>
<th>Stock</th>
<th>Hematocrit %</th>
<th>Serum glucose mg/DL</th>
<th>Basal metabolic rate ( 3 \text{O}_2 ) uptake/g/hr in resting animals</th>
<th>Thyroid secretion rate (( \mu g/100g ) body wt)</th>
<th>Protein bound iodine (( \mu g/% ))</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. maniculatus</em> (BW&lt;sup&gt;b&lt;/sup&gt; stock)</td>
<td>48.27±0.90 (15)</td>
<td>84.75±4.32 (4)</td>
<td>1.96±0.18 (17)</td>
<td>1.61±0.70 (9)</td>
<td>21±0.22 (20)</td>
</tr>
<tr>
<td><em>P. polionotus</em> (PO&lt;sup&gt;b&lt;/sup&gt; stock)</td>
<td>47.84±1.28 (23)</td>
<td>64.74±1.72 (21)</td>
<td>1.84±0.16 (26)</td>
<td>1.96±0.66 (13)</td>
<td>2.75±0.32 (20)</td>
</tr>
<tr>
<td><em>P. leucopus</em> (LL&lt;sup&gt;b&lt;/sup&gt; stock)</td>
<td>47.81±0.91 (30)</td>
<td>81.81±1.27 (33)</td>
<td>NA&lt;sup&gt;b&lt;/sup&gt;</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

<sup>a</sup>O<sub>2</sub> uptake/g/hr in resting animals.

<sup>b</sup>BW, Bairdii Washtenaw, PO, Polionotus Ocala; LL, Leucopus Linville; NA, not applicable.
The deer mouse will hybridize in captivity to the oldfield mouse (Peromyscus polionotus), a smaller, paler, more fossorial allopatic species from the southeastern United States, to produce fertile hybrids (Dawson 1965). However, this interspecific cross is fully fertile only when the deer mouse is used as the mother. F1 hybrids of both sexes are nearly as fertile in either direction as either parent form. These hybrids have proved useful in studies of development (Bell and others 1983; Rogers and Dawson 1970) and size inheritance (Dawson 1965; Dawson and others 1993) and for genetic linkage analysis (Dawson and others 1983).

**SUMMARY**

Deer mice and their allies (genus Peromyscus) are a widespread and diverse group of rodents in North America. Captive bred stocks of normal and variant members of the genus have increasing utility in both academic and applied research. The PGSC at the University of South Carolina has an active program to breed these animals as a research resource for the scientific community at large.

**ACKNOWLEDGMENTS**

The Peromyscus Genetic Stock Center is supported in part by National Science Foundation (NSF) grant BIR 9600960. The Peromyscus Genetic Database Project is supported in part by NSF grant BIR 9600960. We also thank our colleagues and the numerous investigators who, through the years since its inception, have assisted with the Stock Center.

**REFERENCES**


**TABLE 4 Monogenic variants of deer mouse maintained by the Peromyscus Genetic Stock Center**

<table>
<thead>
<tr>
<th>Coat colors</th>
<th>Anomalies/pathologies</th>
<th>Behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashy ahy/ahy</td>
<td>Platinum pht/pht</td>
<td>Boggler bg/bg</td>
</tr>
<tr>
<td>Black (non-agouti) a/a</td>
<td>Silver sil/sil [1]</td>
<td>Flexed tail t/t [1]</td>
</tr>
<tr>
<td>Blonde bln/bln</td>
<td>Tan streak ins/ins</td>
<td>Hairless-1 hr-1/hr-1</td>
</tr>
<tr>
<td>Brown b/b [II]</td>
<td>Variable white</td>
<td>Hairless-2 hr-2/hr-2</td>
</tr>
<tr>
<td>California blonde cb/cb</td>
<td>White-belly nonagouti aw/aw [IV]</td>
<td>Vw/Sphechromatosis sph/sph</td>
</tr>
<tr>
<td>Dominant white spotting S/+</td>
<td>Wide-band agouti A[a]/A[a] [IV]</td>
<td>Alcohol DH8 deficient</td>
</tr>
<tr>
<td>Gray g/g</td>
<td>Yellowish yel/yel</td>
<td>Adh8/Adh8</td>
</tr>
<tr>
<td>Ivory i/i</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Chromosome or linkage group, where known, in brackets.

8DH, dehydrogenase.


Barr WJ. 1975. Bringing the deer mouse from the field to the lab. Lab Anim 14:20-23.


Dicke LR. 1933. Fertility relationships between some of the species and subspecies of mice in the genus Peromyscus. J Mamm 14:298-305.


