

PEROMYSCUS NEWSLETTER

NUMBER THIRTY-EIGHT



AUTUMN 2004

Cover: A Deer Mouse (*Peromyscus maniculatus rufinus*)
with a striking "blazed" head pattern. See entry
by Katy Mirowsky and Brian Hjelle pp. 22 this issue.

PN 38 -

This issue of *PEROMYSCUS NEWSLETTER* follows soon after the mailing of the triennial "Genetics and Genomics" issue, and includes correspondents' entries received earlier in 2004 that we did not have space for in that previous issue. And we thank those who kindly responded to our request for information about activities in their research programs. *PN* is published twice annually by the Peromyscus Genetic Stock Center at the University of South Carolina.

Please notice that **effective January 2005 that charges for many of our stocks and materials have been increased** due to greater costs of maintenance and shipping.

In this issue we report progress in developing a phylogenetic tree for peromyscine rodents. We intend the tree to serve as a useful reference for all with interest in any aspect of peromyscine biology, and not specifically for systematic and evolutionary biologists (See p. 7).

The Stock Center had an excellent year in 2004 supplying a record number of animals and materials for research and education to institutions around the world. Stock Center utilization over the nineteen years of its existence in numbers of animals and specimens supplied is shown in the graph on page 7. The Stock Center also provides numerous animals and related materials for in-house research at the University of South Carolina. The Stock Center is funded by grants from NSF and NIH, user fees (sales), University in-house funds and donations.

Information and informal research contributions to be published in the Spring 2005 issue of *PN* should be submitted to the Editor not later than June 15.

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with support, in part, from
National Science Foundation Grant # DBI-0130348
National Institutes of Health Grant # P40 RR14279
The Stock Center sponsors *PeroBase*, a comprehensive database for
peromyscine rodents.

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NEWS, COMMENTS and ANNOUNCEMENTS:

Unexpected Visitors to the Stock Center: The Endangered Perdido Key Beach Mice

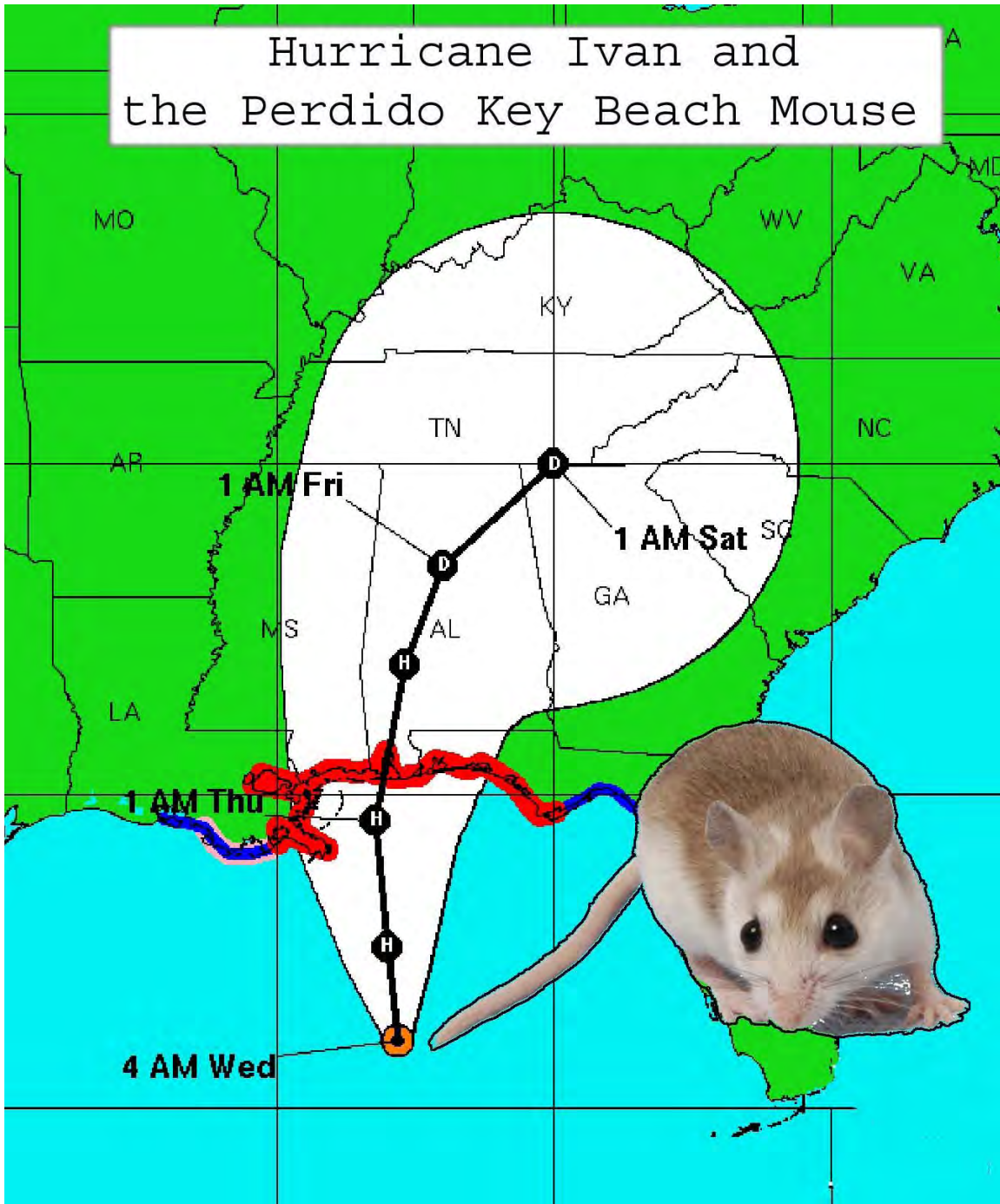
Peromyscus polionotus trissyllepsis, otherwise known as the Perdido Key beach mouse, has been listed as endangered since the mid-'80s. It shares this status with a number of other *P polionotus* subspecies that inhabit mainland and barrier island beaches on the Atlantic and Gulf coasts of Florida. Included among these are Choctawhatchee beach mice (*P p allophrys*), Alabama beach mice (*P p ammobates*), Southwestern beach mice (*P p niveiventris*), St Andrew beach mice (*P p peninsularis*), and Anastasia Island beach mice (*P p phasma*). The situation is critical for some of them. In analyses based on field data collected by Michael Wooten (Auburn University) in the '80s and '90s Oli et al (1) concluded there to be a >50% chance of extinction of some subspecies within the next 50 years. Naturally, habitat loss due to coastal development constitutes a major factor threatening the survivability of beach mouse populations. State and federal conservation officials have been in continuing conflict with developers regarding the preservation and improvement of beach mouse habitat. Even so, an equally serious factor menacing the thin populations of beach mice is the weather, particularly the tropical storms and hurricanes that frequent the region.

Such was the case last October when Ivan, a category 5 hurricane, was making its way across the Caribbean and into the Gulf of Mexico. Ivan's course was set to make landfall in the Florida panhandle and the Perdido Key beach mice were right in the path. Since the beach mice numbered only about a 150 animals, there was major concern about their surviving a direct hit. One strategy adopted, in an effort to save this subspecies, was to capture a number of them and move them out of harms way. Two days before Ivan struck, Karen Lamonte, a biologist for the Florida Fish and Wildlife Conservation Commission, captured eight mice and transported them to Federal facilities in Atlanta. In the meantime arrangements were made for their transport to the Stock Center. Julie Weston, a post doc with the Stock Center, drove to Atlanta and brought them back to Columbia.

The refugees are currently residing in one of the quarantine rooms, and doing well in captivity. One of the females was pregnant and gave birth to four neonates soon after arriving. It was anticipated that the captured mice would be returned to the wild after the hurricane but habitat conditions were considerably worsened by the hurricane, so their repatriation is on hold. Jeff Gore and other officials with the Florida Commission are currently considering the right time for their reintroduction, and whether it would be worthwhile to attempt establishing a longer term captive colony in the Stock Center. In the meantime, the mice have been partitioned into mating pairs in the hopes of expanding the population. Beyond the issue of their endangered status, Perdido Key beach mice are scientifically important. For evolutionary geneticists such as Hopi Hoekstra at UC San Diego they are ideal models for determining the genetic basis of adaptive coloration. The pelage of beach mice differs substantially from that of their mainland counterparts in the degree of pigmentation, its color, and its patterning.

(1) Oli MK, Holler NH, Wooten MC. 2001. Viability analysis of Gulf Coast beach mice (*Peromyscus polionotus*) populations. *Biological Conservation* 97:107-118.

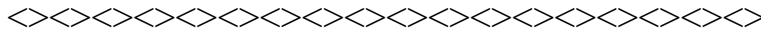
Hurricane Ivan and the Perdido Key Beach Mouse



News, Comments & Announcements (continued)

George Smith, UCLA, generously provided some *Peromyscus* reprints to our extensive collection of reference materials. Dr. Smith served on the Stock Center Advisory Committee for eleven years and was Chairman of the Committee from 1994 until 2002.

Dr. Smith has retired from his faculty position in the School of Medicine at UCLA. The Stock Center continues to maintain two inbred strains of *Peromyscus leucopus* that were developed by Dr. Smith.



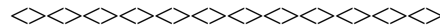
Recent issues of *Journal of Mammalogy* have published several articles relating to peromyscine rodents, including some refinement of phylogeny based on DNA sequence data. In the October issue (*JM* 85:940-947) **Monika A. Havelka** and **John S. Millar** report on the effect of senescence on litter size variability within two populations. They concluded that reproductive senescence plays but a minor role in variation in litter size in the overall population. The same issue of *J. Mammalogy* (pp. 948-958) has a report from **Anthony Stancampiano** and **Gary Schnell** on microhabitat affinities of small mammals, including three species of *Peromyscus*.

The December issue of *J. Mammalogy* contains **five** papers focusing on various aspects of peromyscine biology, three of which are phylogenetic studies based on molecular sequence data. **Robert Bradley** and his associates are authors of these three papers that collectively add much to our understanding the phylogenetics of peromyscine rodents. Of broadest significance is the paper titled "Molecular systematics of Neotomine-Peromyscine rodents based on dentin matrix protein-1 gene by **Serena Reeder** and Robt. Bradley (*JM* 85:1194-1200). There are no particular surprises, except that the volcano mouse (*Neotomodon*) clusters with genus *Peromyscus* (*sensu stricto*), and perhaps should be returned once again to *Peromyscus* proper. Another matter relates to whether *Reithrodontomys* is a "peromyscine" or not. ---- We shall see, as Bradley and associates continue to elucidate these phylogenies (See also *J. Mamm.* 2004, 85:389-395). Another paper from the Bradley-Kilpatrick group (**Nevin Durish et al.** *JM* 85:1160-1169) examines molecular sequence data (cytochrome-*b*) of mitochondrial DNA from six species of the *P. truei* species group as well as other peromyscines. The data supports four principal species in the group: *P. difficilis*, *P. pectoralis*, *P. gratus* and *P. truei*. There may be reason to question whether *P. nasutus* should be considered specifically distinct from *P. difficilis*, a question long debated by *Peromyscus* systematists. A third paper in the recent *J. Mammalogy* (85:1184-1193) from the Bradley group reports a "new" species of *Peromyscus*, *P. schmidlyi*, from western Mexico. This species had previously been considered part of *P. boylii*.

Two additional reports of interest are also in the December issue of *J. Mammalogy*. **Elizabeth McPhee** (*JM* 85:1130-1137) reports morphological changes in *P. polionotus subgriseus* reared for multiple generations in captivity; and **Mike Lucid** and **Joseph Cook** (*JM* 85:1149-1159) analyze the phylogeography of *Peromyscus keeni* populations using cytochrome-*b* sequence data, with reference to the fragmented island landscape of southeastern Alaska.

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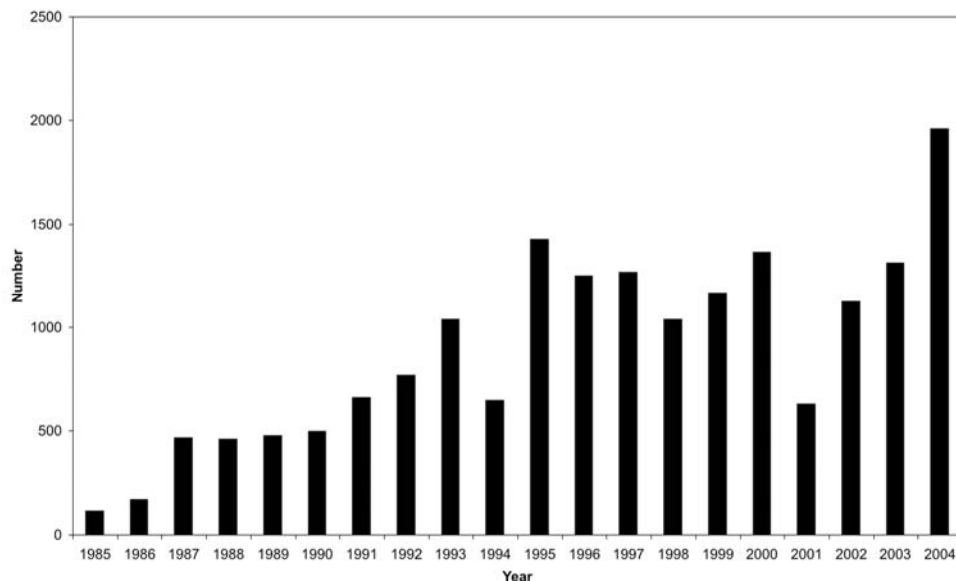
The "Consensus" Phylogenetic Tree. We are pleased to report that a group of knowledgeable individuals have graciously agreed to help develop a useful phylogenetic tree diagram for peromyscines. Thus far **BILL KILPATRICK, DUKE ROGERS, ROBERT BRADLEY, IRA GREENBAUM** and **RON ADKINS** have agreed to participate and others are expected to join the effort in some capacity. It is hoped that this tree will be most useful to researchers, teachers and others who need a ready frame of reference for relationships among peromyscine rodents, but who are not necessarily directly concerned with systematics or phylogenetics. We envision that behavioral biologists, ecologists, toxicologists, developmental biologists and others working with rodents would be best served. Of course, the Tree should periodically be reconsidered and appropriately revised as new information or interpretation requires.



We were belatedly informed of the death in August 2003 of **Dr. John A. Sealand**, professor emeritus, University of Arkansas. John published about a dozen papers on *Peromyscus* physiology, and was most active in this area during the 1950s and 60s. He was a general mammalogist who conducted both field and laboratory research. John authored several field guides to mammals and other vertebrates of Arkansas, and a general zoology textbook. Perhaps his most significant research addressed short-term effects of gamma radiation on old field mice (*P. polionotus*), a project done in collaboration with Savannah River Ecology Lab.



New Record for the Stock Center. The *Peromyscus* Genetic Stock Center established a new record in 2004 for the number of specimens provided to external users. Nineteen hundred and fifty live deer mice and other peromyscine mice, tissue samples, and other biological materials were distributed to fifty-three users in the United States and four other countries during 2004. This surpassed the record for any previous year in Stock Center history (See graph below). The record for the number of individual orders was tied for with the previous high - 1995.



Number of individual mice and other items provided

THE PEROMYSCUS GENETIC STOCK CENTER

General

The University of South Carolina has maintained a genetic stock center for *Peromyscus* (deer mice and congeneric species) since 1985. The center was established under a grant from the Living Stocks Collection Program of the National Science Foundation and continues to be supported by NSF and the NIH Biological Models and Materials Research Program. The Stock Center also receives support from the University of South Carolina and from user fees.

The major function of the Stock Center is to provide genetically characterized types of *Peromyscus* in limited quantities to scientific investigators and educators. Continuation of the center is dependent upon significant external utilization, therefore potential **users are encouraged to take advantage of this resource.**

Policies and Procedures

The Stock Center currently maintains several categories of stocks of living animals: 1) Closed colony random-bred¹ “wild-type” stocks of seven species of *Peromyscus*, 2) Two highly inbred² stocks of “wild-type” *P. leucopus*, 3) Stocks of sixteen coat color mutations, mostly in *P. maniculatus*, 4) Stocks of nine other monogenic traits. The Stock Center operates in strict compliance with the Animal Welfare Act and is located in an AAALAC approved facility. All animal care is performed by certified technicians. Stocks are monitored regularly for presence of disease and parasites and are free of hantavirus and 15 murine viruses.

The Stock Center also provides blood, organs, tissues, fetuses, skins and other biological materials from *Peromyscus*. The Stock Center operates a Molecular Bank where selected genomic libraries and probes are available. Other resources include a reference collection of more than 2,500 reprints of articles on peromyscine rodents, copies of which may be provided. The Stock Center is the primary sponsor of **PeroBase**, an on-line database dedicated to information regarding *Peromyscus* and closely related species.

Sufficient animals of the mutant types generally can be provided to initiate a breeding stock. Somewhat larger numbers, up to about 50 animals, can be provided from the wild-type stocks. Animals requested in greater numbers frequently require a “breed-up” charge and some delay in shipment.

Orders and Pricing

A user fee is charged for animals or materials provided by the Stock Center. A schedule of fees effective 1 January 2005 is shown in the Table below. Fees vary with species and type of services provided. User assumes the cost of all shipment. Animals lost in transit are replaced without charge. Tissues, blood, skins, *etc.* are supplied at a modest fee that includes technician time. Arrangements for special orders will be negotiated. Billing will be submitted upon satisfactory delivery. **Write or call for details or special requirements.**

SCHEDULE OF USER FEES

Item	Academic and Government	Commercial Users
MATURE ANIMALS (each)		
Wild-type Stocks		
Smaller species (<i>P. maniculatus</i> <i>P. polionotus</i> , <i>P. leucopus</i> <i>P. eremicus</i>)	\$ 22.50	35.00
Larger species (<i>P. californicus</i> , <i>P. melanophrys</i> , <i>P. aztecus</i>)	30.00	40.00
Mutant and Inbred Stocks	30.00	40.00
Pregnant females	40.00	50.00
Special Attention (Diet, etc.)	40.00	50.00
F ₁ Species Hybrids	30.00	40.00
TISSUE SAMPLES (Per sample)		
Solid	25.00	
Fluid (Blood, urine, saliva, etc.) per ml	40.00	
Flat skins (each)	35.00	
MOLECULAR MATERIALS		
Extracted DNA, 20 µg	100.00	
PCR Primers (500 µl @ 10 µM)	10.00	
Genomic & cDNA libraries	300.00	
OTHER CHARGES		
Shipping costs = actual shipper's charges plus cost of mouse containers, packaging.		
Lab fee for sample preparation.		
Breed-up fees (for orders exceeding 50 animals) = <i>per diem</i> cage charges X cages required.		

Stocks Available

WILD TYPE STOCKS

ORIGIN

P. maniculatus bairdii
(BW Stock)
Deer Mouse

Closed colony bred in captivity since 1948.
Descended from 40 ancestors wild-caught near Ann Arbor MI.

P. maniculatus sonoriensis
(SM2 Stock)
Sonoran Deer Mouse

Derived from about 50 animals wild-caught by Jack Hayes in 1995 near White Mountain Research Station CA

P. polionotus subgriseus
(PO Stock)
Oldfield Mouse

Closed colony since 1952. Derived from 21 ancestors wild-caught in Ocala Nat'l. Forest FL. High inbreeding coefficient.

P. polionotus leucocephalus
(LS Stock)
Beach Mouse

Derived from beach mice wild-caught on Santa Rosa Island FL and bred by R. Lacy.

P. leucopus
(LL Stock)
White-footed Mouse

Derived from 38 wild ancestors captured between 1982 and 1985 near Linville NC.

P. californicus insignis
(IS Stock)
California Mouse

Derived from about 60 ancestors collected between 1979 and 1987 in Santa Monica Mts. CA.

P. aztecus
(AM Stock)
Aztec Mouse

Derived from animals collected on Sierra Chincua Michoacan, Mexico in 1986.

P. melanophrys
(XZ Stock)
Plateau Mouse

Derived from animals collected between 1970 and 1978 from Zacatecas, Mexico and bred by R. Hill.

P. eremicus
(EP Stock)
Cactus Mouse

Originated from 10-12 animals collected at Tucson AZ in 1993.

INTERSPECIFIC HYBRIDS

P. maniculatus X *P. polionotus* Bred by special order.
F₁ Hybrids

P. leucopus X *P. gossypinus* Sometimes available by special arrangement.
F₁ Hybrids

³COAT COLORS

ORIGINAL SOURCE

Blonde <i>bln/bln</i>	Mich. State U. colony (Pratt and Robbins, 1982)
Albino <i>c/c</i>	Sumner's albino deer mice (Sumner, 1922)
Ashy <i>ahy/ahy</i>	Wild-caught in Oregon ~ 1960 (Teed et al., 1990)
Black (Non-agouti) <i>a/a</i>	Horner's black mutant (Horner et al., 1980)
⁴ Brown <i>b/b</i>	Huestis stocks (Huestis and Barto, 1934)
California blonde <i>cfb/cfb</i>	Santa Cruz I., Calif., stock (Roth and Dawson, 1996)
Dominant spotting <i>S/+</i>	Wild caught in Illinois (Feldman, 1936)
Golden nugget <i>b^{gn}/b^{gn}</i>	Wild caught <i>P. leucopus</i> (Horner and Dawson, 1993)
Ivory <i>i/i</i>	Wild caught in Oregon (Huestis, 1938)
⁵ Pink-eyed dilution <i>p/p</i>	Sumner's "pallid" deer mice (Sumner, 1917)
Platinum <i>plt/plt</i>	Barto stock at U. Mich. (Dodson et al., 1987)
⁴ Silver <i>sil/sil</i>	Huestis stock (Huestis and Barto, 1934)
Tan streak <i>tns/tns</i>	Clemson U. stock from N.C. (Wang et al., 1993)
Variable white <i>Vw/+</i>	Michigan State U. colony (Cowling et al., 1994)
White-belly non-agouti <i>a^w/a^w</i>	Egoscue's "non-agouti" (Egoscue, 1971)
Wide-band agouti <i>A^{Nb}/a</i>	Natural polymorphism U. Mich. (McIntosh, 1954)

OTHER MUTATIONS AND VARIANTS

Alcohol dehydrogenase negative <i>Adh⁰/Adh⁰</i>	South Carolina BW stock (Felder, 1975)
Alcohol dehydrogenase positive <i>Adh^f/Adh^f</i>	South Carolina BW stock (Felder, 1975)
Boggler <i>bgl/bgl</i>	Blair's <i>P. m. blandus</i> stock (Barto, 1955)
Cataract-webbed <i>cwb/cwb</i>	From Huestis stocks (Anderson and Burns, 1979)
Epilepsy <i>epl/epl</i>	U. Michigan <i>P. m. artemisiae</i> stock (Dice, 1935)
⁵ Flexed-tail <i>ff/ff</i>	Probably derived from Huestis flexed-tail (Huestis and Barto, 1936)
Hairless-1 <i>hr-1/hr-1</i>	Sumner's hairless mutant (Sumner, 1924)
Hairless-2 <i>hr-2/hr-2</i>	Egoscue's hairless mutant (Egoscue, 1962)
Juvenile ataxia <i>ja/ja</i>	U. Michigan stock (Van Ooteghem, 1983)
Enzyme variants	Wild type stocks provide a reservoir (Dawson, 1983)

¹ "Random bred" without deliberate selection, sib-sib matings avoided. ² Inbred lines bred by sib-sib and/or parent-offspring mating for 21 generations or more. ³ Unless otherwise noted, mutations are in *P. maniculatus*. ⁴ Available only as silver/brown double recessive. ⁵ Available only as pink-eye dilution/flexed tail double recessive.

Other Resources of the *Peromyscus* Stock Center

Highly inbred *P. leucopus* (I₃₀₊) are available as live animals or as frozen tissues.

Two lines developed by George Smith (UCLA) are currently maintained by the Stock Center.

Preserved or frozen specimens of types given in the above tables.

Flat skins of mutant or wild-type coat colors of any of the stocks listed above.

Reference library of more than 2500 reprints of research papers, articles and reports on *Peromyscus*. Single copies of individual articles can be photocopied and mailed. Please limit requests to not more than five articles at any given time. There will be a charge of 10 cents per photocopied page after the initial 20 pages.

Photocopies of back issues of *Peromyscus* Newsletter (\$5 ea.) or single original back copies, when still available, without charge.

Materials are available through the *Peromyscus* Molecular Bank of the Stock Center. Allow two weeks for delivery. Included is purified DNA or frozen tissues of any of the stocks listed above. Several genomic libraries and a variety of molecular probes are available. (Inquire for more information)

For additional information or details about any of these mutants, stocks or other materials contact: Janet Crossland, Colony Manager, Peromyscus Stock Center, (803) 777-3107, e-mail crosslan@biol.sc.edu

PLEASE CALL WITH INQUIRIES

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PO Stock of *Peromyscus polionotus subgriseus* (Old Field Mouse)

[This is the third in a series featuring a particular stock of *Peromyscus* maintained by the Peromyscus Genetic Stock Center.]

The PO ("polionotus Ocala") stock originated from 21 ancestral mice wild caught in 1952 by Paul G. Pearson at Ocala National Forest, Florida, and thence shipped to L.R. Dice at the Laboratory of Vertebrate Biology at the University of Michigan. At the LVB a breeding stock was established and maintained for several years as a closed colony. About 1956 a sub-colony was established by W. B. McIntosh at Ohio State University and from this colony the stock presently at the Peromyscus Genetic Stock Center was established in 1962 with a founder population of 19 individuals. All breeding of captive animals at all three institutions used individually ear-marked animals and breeding records were meticulously maintained. Animals were bred without deliberate selection except to avoid sib-sib and parent-offspring mating. A bottleneck in the breeding program about 1978-1980 reduced the founders of the current stock to 13 individuals. Hence, the stock has a relatively high inbreeding coefficient estimated at $\sim .30$. It is about 35-40 generations into captivity. The stock is wild-type in coat color and exhibits no abnormalities, and is essentially like the wild ancestral animals. About 75-80% of mated pairs produce weaned young. Litter size is 1 - 6, typically 3. Young are removed from the parental cages (weaned) at 25-28 days. Litters are born at about 28-30 day intervals in continuously paired matings. Females may be productive for up to five years. Old field mice are easily handled and survive well in standard animal care facilities with temperature maintained at 22-25° C.

Peromyscus polionotus is the smallest species of the genus with an average adult weight of 16 ± 2 g. Its range is limited to the five southeastern-most states of the US. Fourteen subspecies are recognized based primarily upon intensity of pigmentation. This species prefers sandy soils and beach dunes where the mice construct an elaborate burrow with a distinctive pattern of tunnel and nest chamber features (Dawson *et al.* 1988). Coat coloration varies with the predominant soil color. Inland populations are darker and beach forms are pale, and in the case of the Santa Rosa Island FL form, nearly white (Sumner, 1929). The pale forms are often called "beach mice" to distinguish them from the darker inland subspecies. *P. polionotus* is mostly a monogamous breeder. *P. polionotus* is interfertile in captivity to a limited extent with the larger and darker deer mouse, *P. maniculatus*. The two species are allopatric in distribution. Since the 1920s experimental hybridization between oldfield mice and deer mice has been used in investigations of natural selection, speciation and genetic isolating mechanisms. Reciprocal hybrids exhibit about a 12-gram difference in mean adult weight and a six-fold difference in placental size. Most recently, the demonstration of genomic imprinting in *P. maniculatus* X *P. polionotus* hybrids is of considerable interest (Vrana *et al.* 1998, 2000).

About 13% of mice supplied by the Stock Center during the past 5 years have been *P. polionotus*, mostly PO stock and PO stock hybrids, and the remainder being *P. polionotus leucocephalus* of the LS stock. The LS stock was initiated from animals captured on Santa Rosa Island about 1985.

P. polionotus are easily handled, attractive animals that do well in captivity and are about 50-60% fertile in captivity. The PO stock is typical of the inland sand hills old-field mice, and the LS stock exhibits the palest wild-type of any species of peromyscines.

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TO FIND REFERENCES CITED AND OTHERS:

Google: **PeroBase**. Select "Enter". Select "Buttler Bibliography". Find reference by author name.

Species Descriptions Online

Detailed descriptions of the following 18 species are now accessible through **PeroBase** as pdf files of *Mammalian Species* accounts courtesy of the American Society of Mammalogists and Allen Press. Brief summary species descriptions are also available in **PeroBase** for 15 of these species. (<http://woton.cse.sc.edu/perobase/species.htm>)

Peromyscus (=Neotomodon) alstoni - Volcano Mouse

Peromyscus attwateri - Texas Mouse

Peromyscus californicus - California Mouse

Peromyscus caniceps - Monserrat Island Canyon Mouse

Peromyscus crinitus - Canyon Mouse

Peromyscus eremicus - Cactus Mouse

Peromyscus gossypinus - Cotton Mouse

Peromyscus leucopus - White-footed Mouse

Peromyscus melanocarpus - Black-wristed Deer Mouse

Peromyscus pectoralis - White-ankled Mouse

Peromyscus pseudocrinitus - Coronados Island Canyon Mouse

Peromyscus spicilegus - Gleaning Mouse

Peromyscus stirtoni - Stirton's Deer Mouse

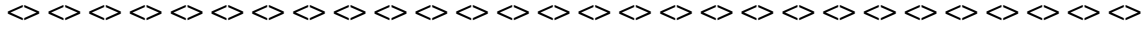
Peromyscus truei - Pinyon Mouse

Peromyscus yucatanicus - Yucatan Deer Mouse

Peromyscus zarhynchus - Long-nosed Mouse

Onychomys leucogaster - Northern Grasshopper Mouse

Onychomys torridus - Southern Grasshopper Mouse



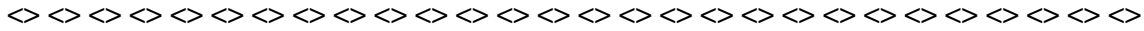
NOTICE

PEROMYSCUS NEWSLETTER IS NOT A FORMAL SCIENTIFIC PUBLICATION.

Therefore ...

INFORMATION AND DATA IN THE CONTRIBUTIONS SECTION SHOULD NOT BE CITED
OR USED WITHOUT PERMISSION OF THE CONTRIBUTOR.

THANK YOU!



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Does infection by bot flies affect mating behavior in *Peromyscus leucopus*?

One common parasite of *Peromyscus leucopus* is the bot fly, *Cuterebra fontinella*. Although this interaction has been intensively studied, it is not clear that there is a cost to the host. *Peromyscus leucopus* has a polygynous mating system, with males mating with several females. The mating system is determined by use of space, with males defending large territories to gain access to females. In this system, there is great potential for parasite-mediated sexual selection. Males parasitized by bot flies may be compromised in either of two ways: (1) infected males may not be as effective at territory defense, and (2) females may show preference for uninfected males. If either of these scenarios are true, there would be a clear fitness cost of bot fly parasitism, in terms of lost mating opportunities. The goal of the current study was to determine if infection by bot flies affected intrasexual aggression and mate choice. We hypothesized that if bot fly parasitism represented a significant cost to hosts, infected males would demonstrate lower aggression levels when paired with uninfected males, and reproductive females would spend more time associating with infected than uninfected males.

Aggression was assessed using dyadic pairs of males. Two males, one infected with at least one bot fly larva, were observed in a neutral arena. Interactions were scored based on published ethograms of *Peromyscus* behavior. Two indices of aggression were analyzed; one based on the number of aggressive behaviors relative to the number of submissive behaviors, and another based on a principal components analysis of frequency of behaviors. Contrary to expectations, both analyses indicated that infected animals were more aggressive than their uninfected counterparts. This result was independent of differences in body weight or reproductive condition of contestants. Higher levels of aggression by infected mice may represent a cost if infected animals are aggressive toward all other individuals, including potential mates.

Female mate choice was assessed with a three-chamber apparatus. Females were placed in the central chamber with males placed in separate chambers on each side. One of the males was infected with a bot fly, and the other was uninfected. Females were able to see and smell the males, but a screen prevented physical contact between the mice. All animals used in the trials were reproductively active. Mate choice was determined by measuring the amount of time the female spent with each male. Analyses revealed that females spent more time with infected than uninfected males, indicating that females would be more likely to mate with infected males. However, this experimental design did not address the question of whether male mice would actually attempt to mate with the female. Furthermore, females spent more time with larger males, and the difference in their response was positively related to the difference in size. In addition, infected mice were significantly larger than uninfected mice. Thus, the preference by females for infected males may be the result of a sensory bias for larger males. Further study must be conducted to see if the preference for large males is independent of body size. In addition, female mate choice is only the first part of reproductive behavior, and other factors, such as increased aggression of males, may prevent females from mating with infected males.

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The effect of weather on deer mouse (*Peromyscus maniculatus*) activity in enclosures and in the wild

Monitoring the nests of small mammals is difficult when nest sites are inaccessible. One solution to this problem is to use enclosures where nests are accessible, but the value of enclosures is contingent upon a consistency of behaviour between confined and wild animals. Several studies have investigated the response of small mammals to environmental conditions in enclosures. In these studies, it was assumed that animals respond similarly to changes in environmental conditions as they would in the wild. However, the applicability of this research has not been tested.

The activity levels of several small mammal species are affected by precipitation and temperature. We monitored activity of deer mice (*Peromyscus maniculatus*) in outdoor enclosures using infrared video cameras and in the wild using radiotelemetry. Activity showed a great deal of individual variation. However, variation in activity was best explained by a combination of ambient temperature, soil temperature and gender. Whether measurements were made in enclosures or in the wild affected the extent to which soil temperature, ambient temperature and gender influenced start of nightly activity, the number and length of activity bouts and nest attendance periods, and total time active. Start of nightly activity was not affected by weather in the wild, but mice in enclosures started activity later with cold ambient temperatures and warm soil temperatures. Length of nest attendance periods and activity bouts showed a negative relationship to soil temperature and number of activity bouts showed a positive relationship to soil temperature in both enclosures and the wild. However, this relationship was only significant in enclosures, likely because of the low power of statistical tests performed on data from the wild. Changes in activity in response to temperature are likely mediated by an individual's ability to behaviourally minimize exposure to cold temperatures. Total time active was greater in females than in males, and this difference was greater in the wild than in enclosures. Differences in activity between the sexes were potentially a result of innate differences in the amount of time devoted to foraging, mate-searching, parental care and exploratory behaviour, all of which may have been affected by enclosure conditions.

There was no difference in total length of nest attendance or end of nightly activity between enclosures and the wild. Total nest attendance was higher in males than females, and when ambient temperatures were cold and soil temperatures were warm. Nightly activity ended later when ambient temperatures were warm.

Precipitation may be more important than shown in this study because there were very few nights with precipitation events and most of these events resulted in very little accumulation of moisture.

Differences in the effect of weather and gender on activity between enclosures and the wild were a matter of strength of effect rather than direction of observed influence. Thus, enclosures can still be used to give an indication of the direction of an effect, if not necessarily the magnitude of that effect. It is imperative that enclosure results be validated against wild data if enclosure studies are going to be used to mimic wild results. The use of enclosures is still preferable to lab measurements for activity and metabolism when studies in the wild prove too difficult to conduct. Additionally, closer concordance of activity between enclosures and the wild might be gained by adjusting other conditions such as food availability, density and enclosure size.

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Rapid changes in the distribution of *Peromyscus* species in the Great Lakes region

Prior to the 1980's, trapping records and museum collections indicate that *Peromyscus maniculatus gracilis* was the predominant mouse in the northern Great Lakes region. It was the sole *Peromyscus* present in most of the Upper Peninsula of Michigan, northern Minnesota and northwestern Wisconsin, and it co-occurred in roughly equal numbers with *Peromyscus leucopus noveboracensis* in the southwest corner of Michigan's UP and throughout the northern half of the Lower Peninsula (Baker 1983). Recently, however, *P. m. gracilis* has disappeared from most of its historical sites in the LP of Michigan, and *P. l. noveboracensis* is now the only *Peromyscus* found at these sites (Myers et al.). *P. m. gracilis* is currently found only in a very limited area of the LP, centered in the Pigeon River State Forest. In the Upper Peninsula, *P. l. noveboracensis* appears to be expanding its range eastward at a remarkably rapid rate, but so far no populations of *P. m. gracilis* are known to have disappeared.

Some of the changes in the distribution of *P. l. noveboracensis* correlate with one measure of climate change, the date of spring ice break-up on Lake Michigan (Myers et al.). Taken together with limited evidence for the superior overwintering ability of *P. m. gracilis*, this indicates that the recent warming trend in the Great Lakes region may have allowed *P. l. noveboracensis* to increase its range at the expense of *P. m. gracilis*.

We are continuing to monitor range changes of both *Peromyscus* species in the Great Lakes region. Tissues will be preserved for genetic analyses of the changing populations, more detailed weather and vegetation data will be collected, and more widespread trapping will be undertaken. These data will be used to test whether climate change or other factors can account for the rapid ongoing shifts in the distributions of *Peromyscus* in the region.

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Chromosome homologies between *Mus musculus* and *Peromyscus maniculatus*

Cytogenetic analyses of karyotypic evolution and diversity within peromyscines have uncovered an interesting chromosomal history within this group of mammals. Chromosomal variation among *Peromyscus* species ($2n=48$) predominantly involves pericentric inversions, resulting in an extensive variation in fundamental number (FN, number of chromosome arms) of 52 to 96. Concomitant with the high number of chromosomal inversions that characterize this genus, heterochromatic repatterning through additions, deletions and translocations has occurred at an elevated rate (1-3). It has been estimated that at least 34 additions have occurred in this genus (4) although intraspecific variation is also found. This type of chromosomal diversity lies in stark contrast to that found in *Mus*, in which centric (Robertsonian) fusions are the most common karyotypic change among species (5-7)

Given the karyotypic diversity within *Peromyscus* and the increased use of species within this genus as genetic model organisms, a detailed map of the genome is essential. This map should be based on a reference species in which detailed genomic information with regard to syntenic gene order is available, i.e. *Mus musculus*. The cytogenetic fluorescence *in situ* hybridization technique of comparative (i.e. cross species) chromosome painting has proven useful in the determination of homologous segments of chromosomes between both closely-related and distantly-related species. Over the past several years, comparative genome analysis has evolved as a separate field of research having practical applications in many different types of genetic research. Most important is the ability to infer relationships between species based on chromosomal homology and determine the conservation of breaks of synteny and gene content within syntenic blocks.

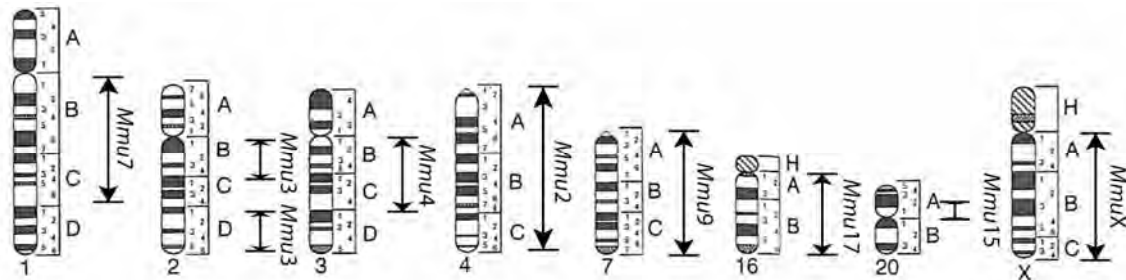
Using cross-species chromosome painting, several chromosome homologies have been identified between *Mus musculus* (*Mmu*) and *Peromyscus maniculatus* (*Pma*). Fluorescent-labeled DNA probes derived from whole *Mmu* chromosomes hybridized to *Pma* metaphase spreads show conservation of large homologous blocks between the two species (Fig 1). Previously, Dawson et al (8) utilized three flow-sorted *M. musculus* whole chromosome paints (WCP) to identify conserved chromosome segments and to aid in the determination of linkage groups between these species (marked in the data below with *). We have subsequently analyzed five additional *M. musculus* WCPs on *Pma* metaphase spreads. These experiments have allowed us to delineate the genomic relationship between these distantly related species and to identify syntenic blocks and gene order as well as the chromosome rearrangements that define the *Peromyscus* karyotype.

Results of these hybridization studies are as follows: *Mmu* WCP 2 hybridized to *Pma* chromosome 4, regions A-C; *Mmu* WCP 3* hybridized primarily to *Pma* chromosome 2, region B and D, with region C lacking hybridization signal. A small

amount of WCP 3 also hybridized to a yet unidentified, small to medium bi-armed chromosome. *Mmu* WCP 4 consistently showed hybridization to the q arm of *Pma* chromosome 3 in the B and C regions. *Mmu* WCP 7* hybridized to the B and C regions of *Pma* chromosome 1. Chromosome paint 9* of the mouse hybridized entirely to *Pma* chromosome 7. *Mmu* 15 WCP consistently hybridized to the A region of *Pma* chromosome 20, along with additional hybridization to as yet unidentified chromosomes. *Mmu* WCP 17 hybridized to the entire length of *Pma* chromosome 16. Finally, *Mmu* X WCP hybridized to the entire q arm of *Pma* chromosome X.

Preliminary hybridizations with several other *Mmu* chromosomes (namely 1,5,6 and 8) indicate the syntenic regions for these chromosomes reside as smaller syntenic blocks spread across several chromosomes within *Pma*. This type of spread requires refinement of the *in situ* hybridization technique in use, chromosome identification for positive signals and statistical analyses of the mapping data. We hope to complete the data set for this species, as well as several others in this genus, in the near future.

Figure 1. Modified ideogram of *Peromyscus maniculatus* showing chromosome homologies with *Mus musculus* whole chromosome paints. The *P. maniculatus* chromosome is listed at the bottom and the region of homology is indicated to the right of each chromosome.



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**A deer mouse (*Peromyscus maniculatus rufinus*)
with a striking "blazed" head pattern**

Some deer mice from this colony show a blazed face (see cover). The captive breeding colony was established from wild-caught mice (sub-species *rufinus*, locality Manzano Mts., Central NM), there are other blaze faced mice ranging from a few white hairs on the forehead to the mouse in the photo, which has been the most extreme blaze so far. We have not identified a pattern of heredity for the quirk. The mice are mostly F₅, F₆ and F₇ in our colony.

The Hjelle laboratory at the University of New Mexico Health Sciences Center is using deer mice to conduct studies of the natural history of infection with Sin Nombre hantavirus (SNV) in its native host, *P. maniculatus rufinus*. Presently theirs is the only laboratory that is carrying out experimental infections of deer mice with SNV. In addition to their natural history experiments, they have also undertaken inbreeding of deer mice while using genetic markers to develop deer mouse lines that are homozygous at the MHC, and have also been using the deer mouse-SNV infection model to test antivirals and immunotherapeutics.

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***Cuterebra fontinella* (Botfly) Infestations in *P. gossypinus* in S. Carolina**

The cotton mouse, *Peromyscus gossypinus*, is known to inhabit undisturbed riparian woodlands and swamps of the southeastern coastal plain (Hamilton, 1943; McCarley, 1963; Hoffmeister, 1989). Previous studies on the incidence of botfly parasitism on white-footed mice in eastern forests have shown variability depending on season, preliminary site evaluations, and year the study was conducted. (Wecker 1962; Dunaway et al. 1967; Miller and Getz 1969).

We undertook a study of botfly infestation affecting *P. gossypinus* at Poinsett State Park, a relatively undisturbed habitat, 30 miles from the University of South Carolina. *Peromyscus* species were captured with small Sherman live traps baited with peanut butter in year 2002 and 2003. In year 2002 we captured and visually inspected mice for the presence of bots and found infestation to be prevalent during summer months when the temperature was the highest and accompanied with high humidity. All mice captured had infestations in the inguinal region. Mice captured with botfly infestations in year 2003, were brought back to the laboratory and temporarily, examined for areas of localization of botfly infestation and monitored to detect time of emergence of the adult botfly from the pupal stage. Again infestation was highest during the summer months from May- July when local temperatures were between 85- 90⁰ F. We captured 13 mice from March to August and found infestation in five of the thirteen mice captured. All mice had infestations in the inguinal region, with one mouse having two simultaneous infestations in the inguinal region. Emergence of adult botfly from the pupae varied from 92-116 days with average incubation time of 99.2 days. There was significant weight gain, most of which could be attributed to weight gain of larvae in the mice due to the infestation. The mice also seemed lethargic towards the time of emergence of the pupae that may have adaptive significance for parasite and host.

Future studies will focus on weight gain and hematological parameters of erythrocytes, granulocytes and agranulocytes.

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Figure 1. Illustrates the stages of development of the botfly (A) larva with pore (B) two larvae on single mouse (C) emergence of larva (D) pupa (E) pupal case (F) recently emerged adult botfly

A



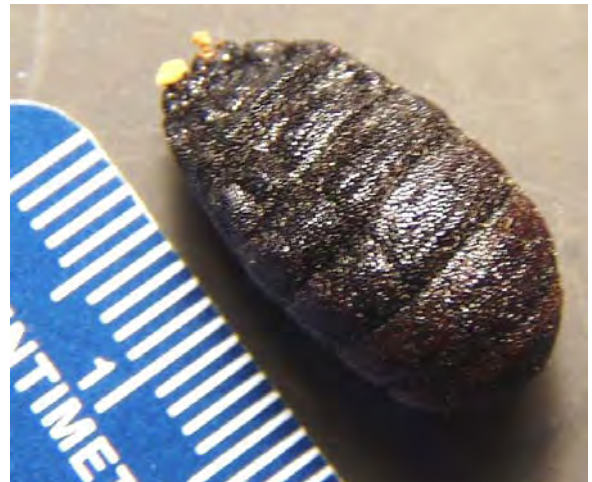
B



C



D



E



F



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