PEROMYSCUS NEWSLETTER

NUMBER THIRTEEN

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Cover: Cataract-webbed mutant deer mouse.
See page 15. (Photo by Clint Cook)

ISSUE 13

PN Number Thirteen features descriptions of the behavior mutant deer mice maintained at the Behavior Genetic Stock Center (p. 10), an updated genetic linkage map for *Peromyscus* (p. 17) and a discussion of the cataract-webbed mutant *P. maniculatus* (p. 15).

Our Peromyscus Pioneer for this issue is B. Elizabeth ("Betty") Horner, Professor Emerita at Smith College. Among her many achievements, Dr. Horner has contributed significantly to our knowledge of behavior in *Peromyscus* and was an early advocate of documenting behavior on film and more recently on videotape. We want to express our sincere thanks to Betty's friends and colleagues, Dorcas MacClintock, Virginia Hayssen and John Burk, for providing essential background information for our biographical sketch.

The "Recent Publications" section is brought up to date with citations from 1991 and 1992 in the current listing. In each March issue of PN we purge citations more than two years old, thus most citations will appear in two or three consecutive issues before being removed. Please call our attention to any recent citations we failed to list and we will catch them in the next issue.

We want to thank those who send entries for our "Contributions" section. This section, we believe, is the principal function of Peromyscus Newsletter. It is obvious that our own emphasis is on genetics, but genetics constitutes only a fraction of the research conducted with *Peromyscus*. In fact, our recent literature analysis indicates that most research with *Peromyscus* involves ecological or behavioral studies on wild or wild-caught animals. Thus we welcome entries from ecologists, behavioral biologists and systematists since they accurately reflect the use of *Peromyscus* in research. Nevertheless, *Peromyscus* are also used as more conventional "laboratory" animals. For example, the alcohol dehydrogenase negative deer mouse developed by Michael Felder, is widely used in studies of alcohol metabolism with several dozen published articles in the biochemical and pharmacological literature. In this issue we suggest that the cataract-webbed mutant is also a potential model of biomedical significance. As enthusiasts for *Peromyscus*, we like to think that, at least for North American biologists, these rodents are ideal for a wider variety of investigations than the conventional lab animals - you know the ones.

Deadline for **PN** Number 14 is **15 September 1992**. We look forward to hearing from you!

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NEWS, COMMENT and ANNOUNCEMENTS

We want to recognize and **thank** several individuals who recently donated materials to the *Peromyscus* Stock Center:

*** **Sue Hoffman** (Livermore National Lab) and **David Gubernich** (University of Wisconsin) have each donated *P. californicus* which will be used to found breeding stocks at the center.

*** **George Smith** (UCLA Med School) who provided the Stock Center a video tape showing activity of captive *Peromyscus* and several mutant and inbred types.

*** **Betty Horner** (Smith College) who gave us a tape showing whirling (waltzing) behavior in non-agouti *P. maniculatus*.

*** **Mark Crew** (UCLA Med School) who dontated a *P. leucopus* genomic library to the Molecular Bank. Dr. Crew will be providing us with additional materials (See his entry this issue).

*** **John Glendinning** (Univ. Arizona) who supplied the Center with some *P. melanotis* and *P. aztecus*.

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J. Bruce Falls (University of Toronto) reports that he hopes to write up data based on 36 years of trapping experience with Peromyscus. Readers may recall Dr. Falls as author of the chapter on "Activity" in King's BIOLOGY OF PEROMYSCUS. One of his students, **Gordon Fehringer**, recently conducted a feeding experiment on Peromyscus in the field.

* * * *

Robert Robbins is featured (in a distinguished pose) in the current issue of *Scientific American* (*p.* 137). He has moved from NSF to Johns Hopkins where he is Director of the Informatic Core for Genome Data Base (GDB). GDB is the project for computer-archiving human gene mapping data. This data base will interface with other genetic reference sources, including Genbank. Bob writes that he misses the "nostalgic smell of a mouse room".

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A letter from Michael Wooten (Auburn Univ.) reports that he has a M.S. student working on Cytochrome B sequences for specimens of P. polionotus *from eight locations and Mike has generated mtDNA D-loop sequences for several of these locations. He has some tissues and whole DNA preps from several of these locations which may be of interest to some investigators. Inquiries can be directed to Dr. Wooten or through the Stock Center.*

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Walter E. Howard wrote in response to our September "Peromyscus Pioneer" sketch, in which he was featured. He states that his major activity now is "writing and lecturing to defend society's ethical and moral right to study peros and to use animals for research, food, game, fur and recreation." He still thinks that "*Peromyscus* are probably the most delightful species of mammal known" and wishes he was still studying them.

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NEEDED

Peromyscus eremicus and *P. crinitus*

At least 10 adult male and 10 adult female of each species

Will cover all expenses.

Contact: Dr. David Gubernich
Dept. Psychology
University of Wisconsin
Madison, WI 53706

Phone (608) 262-3918
or Bitnet:
DJGUBE@VMS.MACC.WISC.EDU

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News from the Peromyscus Stock Center

A Record Year for the Stock Center. During 1991 the *Peromyscus* Stock Center supplied the largest number of live animals and other specimens and filled the greatest number of requests of any year to date. We delivered 661 specimens, mostly live *Peromyscus*, to to fill 26 requests. This represents about a 22% increase over the previous year.

Molecular Bank Opens. The Peromyscus Molecular Bank is now open and accepting libraries and probes derived from *Peromyscus* and other peromyscine rodents. Individuals holding these materials are encouraged to share them with the Molecular Bank.

The Bad News - User Fee Increases Coming. To help offset the tremendous cost of animal care we will be increasing the user fees charged. The new fee schedule is ....

Per live animal in stock (wild-types)	$ 7.50 after 1 July 1992 10.00 after 1 Jan. 1993
Per live mutant animal in stock	$ 10.00 after 1 July 1992
Other materials or special requests	Negotiated

These increases are made reluctantly upon recommendation of the Advisory Committee. Our *per diem* cost of animal care service through our Animal Resource Facility has increased dramatically during the past three years. Even with the increases, the user fees recover only about 15% of the cost involved per animal supplied. We are a non-profit organization in a big way!

Legitimate investigators with little or no grant or institutional funding may be furnished discard or excess animals at reduced rates. Please contact the *Peromyscus* Stock Center for more information (803) 777-3107.

Inbred *Peromyscus maniculatus* Soon to be Available. The Stock Center expects to be able to begin supplying a small number of highly inbred deer mice in the near future. The lines formerly maintained at Jackson Laboratory have been transferred to the *Peromyscus* Stock Center. (See p. 9)

PEROMYSCUS STOCK CENTER

What is the Stock Center? The deer mouse colony at the University of South Carolina has been designated a genetic stock center under a grant from the Special Projects Program of the National Science Foundation. The major function of the Stock Center is to provide genetically characterized types of **Peromyscus** in limited quantities to scientific investigators. Continuation of the center is dependent upon significant external utilization, therefore potential **users are encouraged to take advantage of this resource.** 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.

A user fee of **$5 per animal** is charged and the user assumes the cost of air shipment. Animals lost in transit are replaced without charge. **User fees will increase after 1 July 1992.** Tissues, blood, skins, etc. can also be supplied at a modest fee. Arrangements for special orders will be negotiated. Write or call for details.

Stocks Available in the Peromyscus Stock Center:

WILD TYPES	ORIGIN
P. maniculatus bairdii (BW Stock)	Closed colony bred in captivity since 1948. Descended from 40 ancestors wild-caught near Ann Arbor MI
P. polionotus subgriseus (PO Stock)	Closed colony since 1952. Derived from 21 ancestors wild-caught in Ocala Nat'l. Forest FL. High inbreeding coefficient.
P. polionotus leucocephalus (LS Stock)	Derived from beachmice wild-caught on Santa Rosa I., FL. and bred by R. Lacy. Third to sixth generation in captivity.
P. leucopus (LL Stock)	Derived from 38 wild ancestors captured between 1982 and 85 near Linville NC. Seventh to ninth generations in captivity.
P. maniculatus X *P. polionotus* F_1 Hybrids	Sometimes available.

MUTATIONS AVAILABLE FROM THE STOCK CENTER

Coat Colors	**ORIGINAL SOURCE**
Albino *c/c*	Sumner's albino deer mice (Sumner, 1922)
Ashy *ahy/ahy*	Wild-caught in Oregon ~ 1960 (Teed *et al.*, 1990)
Black (Non-agouti) *a/a*	Horner's black mutant (Horner *et al.*, 1980)
Blonde *bl/bl*	Mich. State colony (Pratt and Robbins, 1982)
Brown *b/b*	Huestis stocks (Huestis and Barto, 1934)
Dominant spotting *S/-*	Wild caught in Illinois (Feldman, 1936)
Gray *g/g*	Natural polymorphism From Dice stocks (Dice, 1933)
Ivory *i/i*	Wild caught in Oregon (Huestis, 1938)
Pink-eyed dilution *p/p*	Sumner's "pallid" deer mice (Sumner, 1917)
Platinum *pt/pt*	Barto stock at U. Mich. (Dodson *et al.*, 1987)
Silver *si/si*	Huestis stock (Huestis and Barto, 1934)
White-belly non-agouti a^{W}/a^{W}	Egoscue's "non-agouti" (Egoscue, 1971)
Wide-band agouti $A^{Nb/-}$	Natural polymorphism Univ. Michigan stock (McIntosh, 1954)
Yellow *y/y*	Sumner's original mutant (Sumner, 1917)

Note: Some of the coat color mutations are immediately available only in combination with others. For example, silver and brown are maintained as a single "silver-brown" double recessive stock. Write the Stock Center or call (803) 777-3107 for details.

MUTATIONS AVAILABLE FROM THE STOCK CENTER (continued)

Other Mutations and Variants	**ORIGIN**
Alcohol dehydrogenase negative *Adh^{o}/Adh^{o}*	South Carolina BW stock (Felder, 1975)
Alcohol dehydrogenase positive *Adh^{f}/Adh^{f}*	South Carolina BW stock (Felder, 1975)
**Boggler *bg/bg*	Blair's *P. m. blandus* stock (Barto, 1955)
Cataract-webbed *cwb/cwb*	From Huestis stocks. (Anderson and Burns, 1979)
**Epilepsy *ep/ep*	U. Michigan *artemisiae* stock (Dice, 1935)
Flexed-tail* *f/f*	Probably derived from Huestis flexed-tail (Huestis and Barto, 1936)
Hairless-1 *hr-1/hr-1*	Sumner's hairless mutant Sumner (1924)
Hairless-2 *hr-2/hr-2*	Egoscue's hairless mutant (Egoscue, 1962)
**Juvenile ataxia *ja/ja*	U. Michigan stock (Van Ooteghem, 1983)

Enzyme variants. Wild type stocks given above provide a reservoir for several enzyme and other protein variants. See Dawson *et al.* (1983).

*Available only on pink-eye dilution background.

**Available from Behavior Mutant Center (See p. 10)

Other Resouces of the *Peromyscus* Genetic Stock Center:

Preserved or frozen specimens of types given above.

Tissues, whole blood or serum of types given above.

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

Reference library of more than 1700 reprints of research articles and reports on *Peromyscus*. Copies can be xeroxed and mailed.

Limited numbers of other stocks, species, mutants and variants are on hand, or under development, but are not currently available for distribution. For additional information or details about any of these mutants or stocks contact: Janet Crossland, Colony Manager, Peromyscus Stock Center, (803) 777-3107.

INBRED PEROMYSCUS

The Stock Center has acquired the inbred lines of *P. maniculatus bairdii* developed by Muriel Davisson and others at Jackson Laboratory. These lines are closely related and each is derived from more than twenty sib-mated generations, hence they are "highly" inbred. Two of the lines were separated at the 15th sib-mated generation and represent closely related, but separate lines, and are currently designated PmH1 and PmH8. Lines of H8 were split subsequent to generation I_{20} and, hence, constitute sublines of H8. The Stock Center is in the process of further development of these lines. Small numbers (*c.* 5) of either of the two distinct lines (H1 and H8) are available from the stock center on a limited basis. We suggest that these animals may be useful in molecular or other genetic investigations where a uniform genome is desirable. It is anticipated that greater numbers will be available in the future as production stocks are established. Please contact the Stock Center for more information.

PEROMYSCUS MOLECULAR BANK

Materials are now available through the *Peromyscus* Molecular Bank of the Stock Center. Allow two weeks for delivery.

Purified DNA from fresh and/or frozen tissues of following species:

P. maniculatus	*P. leucopus*	*P. aztecus*	*P. californicus*
P. polionotus	*P. gossypinus*		
P. melanotis			

Genomic DNA libraries:

P. maniculatus (Source: M. Felder)
P. leucopus (Source: M. Crew)

cDNA libraries:

P. maniculatus liver (Source: M. Felder)

DNA Probes:

LINE1 element probes pDK55 and pDK62
(Source: D. Kass from *P. maniculatus* genomic library)

Adh-1 (cADHF72) and Adh-3 (cADHF65) probes
(Source: M. Felder from *P. maniculatus* cDNA library)

Additional materials soon to be acquired. Please call with inquiries.

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THE AIKEN BEHAVIOR MUTANT CENTER

Suellen A. Van Ooteghem, Ph.D.

One of the main objectives of the Behavior Mutant Center is to maintain and breed behaviorally relevant mutant stocks to use:

a. For internal and external developmental use.
b. In improving these stocks.
c. To promote their development by interested investigators as animal models for biomedical use.

This colony is supported by NSF to provide a national resource for use by the scientific community. In accord with this mission, behavioral mutant animals and wild-type controls are being supplied to interested investigators to allow preliminary studies designed to assess and develop the usefulness of these animals. The following types of preliminary studies are being conducted.

Boggler (*bg*) -- These animals have been provided to interested investigators to allow preliminary comparisons between boggler and wild-type homozygotes. Both wild-type and boggler homozygotes show neuroanatomical lesions similar to the "flame cells" that show the neurofibrillary tangles seen in aged humans and Alzheimer's patients. As in man, the frequency of these lesions is greater in boggler deermice than in wild-type animals. Boggler deermice show these lesions primarily in the cortex,hippocampus, amygdala, and basal forebrain. Animals needed to conduct these studies are being provided to Marija B. Wise, University of South Carolina, Columbia, South Carolina.

Both wild-type and boggler deermice also show axonal dystrophy. Boggler deermice consistently show a higher incidence of dystrophic axons than do wild-type deermice of the same age and sex. Recent findings show that dystrophic axons are also seen in man, with a higher incidence of axonal dystrophy in Alzheimer's patients than in unaffected individuals. These findings were made by Elizabeth Barto, Ph.D. and J. Vandermeer.

Currently, boggler and wild-type deermice are also being provided to determine if heat-shock protein levels are elevated in these animals. Increased levels of heat-shock proteins (particularly ubiquitin and heat shock protein 70) have been detected in neurofibrillary inclusion-bearing neurons in Alzheimer's disease. Elevated levels of heat-shock proteins are hypothesized to be associated with chronic oxidative stress. Animals needed to conduct these studies are being provided to Rawhi A. Omar, M.D., Ph.D. West Virginia University School of Medicine, Morgantown, W.V.

Juvenile Ataxia (*ja*) -- These animals have been provided to interested investigators so that preliminary biochemical studies could be conducted demonstrating that both acetylcholine and acetylcholine esterase levels are reduced in homozygotes compared with controls. A similar reduction was not noted in boggler (*bg*), a second age-related behavior mutant. Animals needed to conduct these studies are being provided to J. J. Buccafusco, Ph.D., Medical College of Georgia, Augusta, Georgia.

In addition, there are suggestions that liver glycogen levels are elevated in juvenile ataxia homozygotes. Therefore, animals are being provided to allow routine histological, histochemical and ultrastructural studies. Animals needed to conduct these studies are being provided to Elizabeth R. Walker, Ph.D., West Virginia School of Medicine, Morgantown, W.V.

Thompson Falls Convulsive (*tf*) -- Deermice are being provided to continue preliminary studies suggesting that these animals show elevated serum carnitine levels compared with normal animals of the same age and sex. Elevated serum carnitine levels have also been noted in Leigh's disease in man. Animals needed to conduct these studies are being provided to A. Lee Carter, Ph.D. Medical College of Georgia, Augusta, Georgia.

Epilepsy (*e, ep*), **Chemogenic Convulsive** (*Cn*, CNV) and **Alamogordo Convulsive** (*Alg*, ALG) -- Work continues to develop high expression lines of each of these mutations.

A family of nonagouti *P. maniculatus gracilis* which displays whirling behavior has been identified by Dr. Elizabeth Horner. As part of the mission of both stock centers, this family is currently being maintained by the Aiken Behavior Mutant Center. In concert with Dr. Horner, collaborative studies are being conducted to (1) identify the mode of inheritance of the whirling behavior, and (2) determine if nonagouti and whirling are linked. Another mutant, waltzer (*v*) has previously been identified as linked with wideband (A^{Nb}). Wideband is known to be allelic with nonagouti.

Representatives of these behavior mutants can be made available to all interested investigators. For further information please contact:

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Morgantown, W.V. 26506
(304) 284-5443

B. Elizabeth Horner

B. Elizabeth Horner

Elizabeth "Betty" Horner is another of the illustrious group of "*Peromyscus* pioneers" who emerged from Lee Dice's Michigan group. But like many other former Dice proteges, Betty Horner has established herself as a first rate biologist in her own right. Although her work extends well beyond the realm of *Peromyscus*, it is her work with behavioral adaptations in deer mice and their allies that is probably most familiar to our readers. Indeed, her classic study on arboreal adaptations of *Peromyscus* (1954. *Contrib. Lab. Vert. Biol.*, 62:1-85) remains as a cornerstone and frequently cited reference in any study of climbing behavior. But Dr. Horner's research interests extend well beyond behavior of peromyscines and include biogeography, anatomy and other aspects of the biology of rodents on a world-wide basis.

Elizabeth Horner was born at Merchantville, New Jersey, in April 1916 into a family of Quaker heritage. Here she and her younger brother spent childhood not far from Camden and Philadelphia. She was fascinated by animals from early in life, having a water spaniel and several cats as pets. In an age when female scientists - particularly mammalogists - were rare she chose to pursue the career of an academic biologist. Symbolic of this dedication, she sold the bugle she played at camp as a youth to buy scientific materials. She attended Douglass College, receiving her B.S. degree in 1938, and subsequently enrolled in a master's degree graduate program at Smith College. At Smith she was strongly influenced by Dr. Ernest Driver. Her thesis was a study of craniometric determinations made on carnivores and other mammals conducted under the direction of Dr. Driver. In the process of conducting this work she developed a craniometer which permitted comparisons among different studies utilizing a single standard. This device was described in her first published article (1944. *J. Mamm.*, 25:71ff).

Upon completion of the M.A. degree, she remained at Smith as an instructor in zoology until 1944, when she undertook her Ph.D. program at the University of Michigan. Dice accepted her as a student into his program, which was then in its heyday except that several members of the Dice group were in World War II military service. Most of them had returned by 1946, thus, she was a contemporary of W. Frank Blair, Van T. Harris, Elizabeth Barto, Don Hayne and other Dice associates. Betty initiated a project in which she tested ten species and subspecies of *Peromyscus* for climbing ability, with particular emphasis on the use of the tail as a prop or balancing organ. With the help of Dice, she documented these behaviors on motion picture film, and subsequently analyzed the films frame-by-frame to describe the subtle differences in behavior. This was a most innovative approach to animal behavior studies at the time, and a highly noteworthy feature of Horner's study. (Incidentally, she still uses this approach - but now videotape substitutes for movie film!) One distinctive feature of Dr. Horner's career is that she always has been open to technological advances.

She finished her degree requirements in 1948 and returned to Smith College as an assistant professor of zoology, where she held a faculty position for the remainder of her professional career. Her dissertation appeared in publication in 1954. It immediately became a landmark work for studies adaptive behavior in arboreal animals. During the early 1950's, in addition to getting an academic career established at Smith, she participated along with others, in an intensive study of the small mammals of Arcadia Wildlife Refuge for the Massachusetts Audubon Society, published as a series of bulletins, one of which (1954. *Bull. Mass. Aud. Soc.*, 37:341ff) was devoted solely to *Peromyscus*. In 1954 Betty Horner initiated a long-term research program with Australian mammals, and undertook the first of three extended research leaves "down under" (1954-55; 1963-64; 1965). Among the forms she studied were several native Australian murids, as well as small marsupials, under the sponsorship of the University of Sydney and CSIRO. During the third of these visits, she participated in an expedition into the relatively unexplored Coburg Peninsula of the Northern Territory. Much of the Australian work was

accomplished in a long-term collaboration with J. Mary Taylor of the University of British Columbia. The Australian work with Taylor culminated in a comprehensive review of the systematics of native species of *Rattus* (1973. *Bull. Am. Mus. Nat. Hist.*, 150:130p) and a second detailed description of the reproductive biology of Australian members of this genus (1973. *Austr. J. Zool.*, 21:437ff)

Nor have Dr. Horner's travels been limited to Australia. She has also made professionlly related visits to Jordan, Kenya, Panama, the Pribilof Islands, the Alaskan North Slope and, very recently, Madagascar, where she participated in an Earthwatch tour. During this trip she was delighted to observe an aye-aye in its native habitat. She has been involved with the Monarch Butterfly Research Program initiated by Lincoln Brower of the University of Florida, her particular area of interest being predation on the butterflies by *Peromyscus melanotis* at the Mexican wintering sites (1985. *Biotropica*, 17:89ff). She has also travelled and collected extensively within the U.S. Dr. Horner has regularly attended the annual meetings of the American Society of Mammalogists since the 1940's.

Betty Horner has held several research grants and published more than 45 research articles and other professional works, of which eight pertain directly to *Peromyscus*. Included among the latter are a report on her discovery, with Gary Potter, of the first true non-agouti mutant deer mouse (1980. *J. Hered.*, 71:49ff), paternal care of young in deer mice (1947. *J. Mamm.*, 28:31ff) and hairballs in *Peromyscus* (1950. *J. Mamm.*, 31:94ff). She also has numerous published papers on grasshopper mice (*Onychomys*). Her publication record spans nearly 50 years, beginning in 1943 with a laboratory manual co-authored with Dr. Driver, and continuing with a paper currently in preparation describing the "golden nugget" *P. leucopus* coat color mutation.

Dr. Horner is well-liked and respected by her faculty and professional colleagues. She is a devoted teacher with high performance and ethical standards. Her courses in vertebrate zoology, biogeography and animal behavior, a course she established, were consistently popular, and even in retirement she frequently presents guest lectures. At Smith Dr. Horner maintained an animal colony which included *Peromyscus*, and through it she introduced many students to the rewards of studying animals. She has always been a strong advocate of conservation of wildlife and natural resources, and has served conservation groups in various capacities. Betty Horner, as a female scientist of wide reputation, serves as a role model for her students and younger colleagues. While she expresses no strident views on the women's movement, she has always been, by example, a "quiet feminist" who participated, even as a graduate student at Michigan, in organizations promoting women in research, and continuing into the 1980's as a participant in the "Women in Science" traveling exhibit sponsored by the Springfield Mass. Science Museum.

Betty Horner is a member of more than a dozen scientific societies and conservation organizations, including the Australian Mammal Society, the American Behavior Society, AIBS and the Society for the Study of Evolution. She is a Fellow (1954) of the AAAS, and Fellow of the Explorers Club. Dr. Horner has served on several committees of the American Society of Mammalogists, which honored her in 1986 by establishing the B. Elizabeth Horner Grant for research in mammalogy. She served as President (1965-66) of the Smith College chapter of Sigma Xi and held the Myra M. Sampson Chair Professorship at Smith. Following her retirement in 1987, a Horner Fund for Research was established in her honor by the Biological Sciences Department at Smith. This fund provides support student participants in summer research projects.

Betty Horner remains active in official retirement, and continues to conduct modest research projects and to collaborate on others. She participates in the Explorers Club, Earthwatch and other organizations. She reads extensively, but her most significant activity is "collecting friends". She has a wide network of personal and professional associates around the world, and befriends virtually every individual she encounters at professional meetings, in her travels and in association with numerous conservation-related activities. She is a gentle, even modest, individual, but never reluctant to express her views in a direct manner. Among *Peromyscus* biologists there are few who don't know Betty Horner either personally or by reputation, and hold her in greatest respect and affection. Those of us who work with *Peromyscus* are fortunate to count her among our number.

CATARACT-WEBBED DEER MICE - A MODEL FOR DEVELOPMENTAL STUDIES

One of the more interesting mutations in *Peromyscus* is **cataract-webbed**. The mutant was first reported by R.R. Huestis in 1951, but the formal genetics and detailed description was not published until more than two decades later (Burns and Feeney, 1975; Burns and Anderson, 1979). Huestis described the trait as follows:

> "Cataract-webbed" show webbed toes as soon as they show toes, and the webbing involves digits 3=4 or 2=3=4 on the hind foot and 3=4 or 3=4/5 in front with many variations, all presumably genetic. At from three months to never they get lenticular cataract prior to which they may have eye hemorrages or other opthalmic changes. Almost all are cataractous by a year. [Huestis, 1964, pers. comm. to WDD via E. Barto]

Although Huestis had ascertained that cararact-webbed was inherited as an autosomal recessive trait (*cw/cw*), Burns and Anderson (1979) further analyzed the co-inheritance of the two visible manifestations of the mutant. They determined that the syndactyly component, which involves only soft tissues of the toes, is more than 98% penetrant, but variably expressed. The second and third digits of the hind foot are nearly always involved, and syndactyly is much more evident on the hind foot that the front. It is virtually always bilaterally expressed.

About 63% of the known homozygous animals had cataracts by one year of age and an additional 25% exhibited other opthalmic lesions, for a total penetrance of 88%. Although some of the deer mice show developing cataracts by three months of age, more typically they appear between 6 and 12 months, and in a few after one year of age. In some animals the eye condition is unilaterally expressed, but more commonly it is bilateral. Burns and Anderson detected no strong correlation between the degrees of expression of syndactyly versus onset time or severity of cataracts.

Stocks of the deer mice directly derived from Dr. Huestis' animals were maintained by Dr. Ruth Anderson and others, and eventually these were kept at the Oregon Health Sciences University at Portland. At some point in the history of the stock, it was interbred with several other deer mouse mutants (pink-eyed dilution, brown, spherocytosis and possibly others). The *Peromyscus* Genetic Stock Center at the University of South Carolina acquired a number of animals of the spherocytosis (*sph*) stock in 1986 from Dr. Bernard Pirofsky of OHSU. It was soon apparent that the cataract-webbed gene was also present in this group of animals together with the brown and pink-eyed traits. We have initiated a breeding program to separate the cataract-webbed line from spherocytosis, and to select out the coat color traits, in the belief that the anomalies are better characterized independent of one another. This process is currently in progress, but it will likely be another two years before "clean" cataract-webbed deer mice are available from the Stock Center. Meanwhile, some homozygous cataract-webbed can be made available to investigators for exploratory investigations.

Unlike most cataract mutations in laboratory mice (*Mus domesticus*), which are evident by weaning or earlier (Beasley, 1963; Davidorf and Eglitis, 1966; Harata *et al.*, 1978; Kratochvilova, 1981; Paget *et al.*, 1961; Tissot and Cohen, 1972), the *Peromyscus* mutant usually shows a later onset, and therefore may be more analogous to human cataract formation. At a more basic level **the pleiotropic effect of cataract with syndactyly suggests the existence of a fundamental developmental defect with the attendant potential to exploit this as a model in developmental biological research.** Such a model invites biochemical and/or molecular analysis.

Interested investigators should contact the *Peromyscus* Genetic Stock Center.

References relevant to Cataract-webbed *Peromyscus* and inheritance of cataracts in laboratory house mouse:

Anderson, R.S. and R.P. Burns. 1979. Cataract-webbed *Peromyscus*. I. Genetics of cataract in *P. maniculatus*. *J. Hered.*, 70:27-30.

Beasley, A.B. 1963. Inheritance and development of a lens abnormality in the mouse. *J. Morph.*, 112:1-11.

Burns, R.P. and L. Feeney. 1975. Hereditary cataracts in deer mice (*Peromyscus maniculatus*). *Am. J. Opthamal.*, 80:370-378.

Davidorf, F. and I. Eglitis. 1966. A study of a heritary cataract in the mouse. *J. Morph.*, 119:89-100.

Harata, M., R. Shoji and R. Semba. 1978. Genetic background and expressivity of congenital cataract in mice. *Jap. J. Genetics*, 53:147-152.

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GENETIC LINKAGE IN *PEROMYSCUS*. 1992 UPDATE.

All linkage data for *Peromyscus* to date has been generated by formal recombination genetics. No loci, as of January 1992, have been assigned to chromsomes, but partial banding homology between Chromosome 1 of *Rattus* and Chromosome 1 of *Peromyscus* (13) suggests that Linkage Group (LG) I is probably located on Chromosome 1 in deer mouse, as is the homologous group in rat (7). The diploid chromosome number of all *Peromyscus* species is 2N = 48 (6). The standard karyotype is under revision by Greenbaum *et al.* (unpub.)

Linkage data for the deer mouse (*Peromyscus maniculatus*) collected before 1972 are summarized by Robinson (16, 17). The system of assigning linkage groups on the basis of a single marker employed during the 1940's and 50's (2,14) is no longer used. "Group IV" in the earlier system is now Group II, and old Groups "II" and "III" have been abandoned. In the interim since Robinson's review several additional linkages have been added (3, 8, 10, 18). The current status of the linkage map for the deer mouse and its sibling species *P. polionotus* is represented in the accompanying figure. Seven linkage groups are now established by formal genetics and another is tentative.

The order of loci in LG I, reported informally by R.R. Huestis and K. Silliman in an unpublished communication (16, 9), has been recently revised from previously unpublished data of W.B. McIntosh and K. Dodson. Linkage of *Trf* and *Lap* is tentative (8), but is homologous with a similar linkage in *Mus*. The *Pep-2* locus is provisionally assigned to LG VI proximal to *Alb*, but has not been mapped further (10).

Positive, but not significant, lod scores suggesting possible linkage between the gene pairs *Adh - 6Pgd, Adh - Got-1, Adh - Idh, Alb - Pept-1, Alb - Sdh* and *Est-4 - Sdh*, respectively, were reported by Baccus *et al.* (1). Subsequent information indicates that *Adh-1* and *Got-1* are independent, as are the *Alb* and *Sdh-1* loci (10).

The *Hbe* locus is part of the triplicated beta globin site (*Hbb*), according to Snyder (18). Unpublished data from Snyder maps the position of the *Gpi-1* and *Hbe* loci relative to the albino (*c*) and pink-eyed dilution (*p*) loci. Silliman (unpub.) proposed that there is a duplication, f^{l}, closely linked to the *f* locus. The Pm blood group locus, formerly designated "*Pm*", is redesignated *Ea-1*. Linkage of the agouti locus has been tested using the dominant wide-band agouti allele A^{Nb}.

Two significant markers on the *Peromyscus* linkage map, *d* and *v*, are now extinct in laboratory stocks of deermice. The "flexed tail" trait which occurs in a laboratory stock may not be identical by descent with the original trait used in early linkage studies, but it maps to the same location in LG I.

The *c, p, a* and *b* coat color loci are phenotypically essentially identical to their counterparts in *Mus* and *Rattus*, and are assumed to be homologous. Enzyme and other protein loci are assumed to be homologous to counterparts in *Mus*, human and other mammals. Specific homologies between esterases and peptidases are not firm, but two clusters of common esterases in *Peromyscus* LG VIII are probably homologous to the esterase clusters on *Mus* Chromosome 8 and *Rattus* LG V. Erythrocytic esterase (*Es-3*, formerly "*Es-1*") of *Peromyscus* is very likely homologous with *Es-3* of *Mus* and is now known to be independent of the esterase loci in LG 8 (D.L. Covington *et al.*, unpub.)

MAPPED LOCI IN THE DEER MOUSE (*PEROMYSCUS*). 1992.

Arranged by linkage group. Probable mouse and human homologies indicated.

Locus	Name	*Peromyscus* Linkage Group	Mouse (*Mus*) Chromosome	Human Chromosome
c	albino (tyrosinase?)	I	7	11q
f	flexed tail	I	-	-
Gpi-1	glucophosphoisomerase-1	I	7	19q
Hbb	betaglobin complex	I	7	11p
p	pink-eyed dilution	I	7	-
sb	snub nose	I[1]	-	-
si	silver	I	-	-
b	brown	II	4	-
d	dilute	II	-	-
a	agouti	III	2	-
v	waltzing	III	-	-
Ea-1	erythrocytic antigen (Pm blood group)	IV	-	-
Es-3	major erythrocytic esterase (formerly *Es-1*)	IV	11	-
Lap-1	leucine amino peptidase (serum)	V[1]	9?	11q?
Trf	transferrin	V	9	3q

(Continued)

Peromyscus Linkage (Continued):

Locus	Name	*Peromyscus* Linkage Group	Mouse (*Mus*) Chromosome	Human Chromosome
Alb	albumin	VI	5	4q
Adh-1	alcohol dehydrogenase-1	VI	3	4q
Amy-1	salivary amylase	VI	3	1p
Pep-2	peptidase-2	VI[1]	10	12q
P_A	*polionotus* rump pattern A	VII	-	-
P_B	*polionotus* rump pattern B	VII	-	-
Es-4,5	esterase 4,5 cluster	VIII	8	16?
Es-1,6	esterase 1,6 cluster	VIII	8	-

[1] Provisional assignment.

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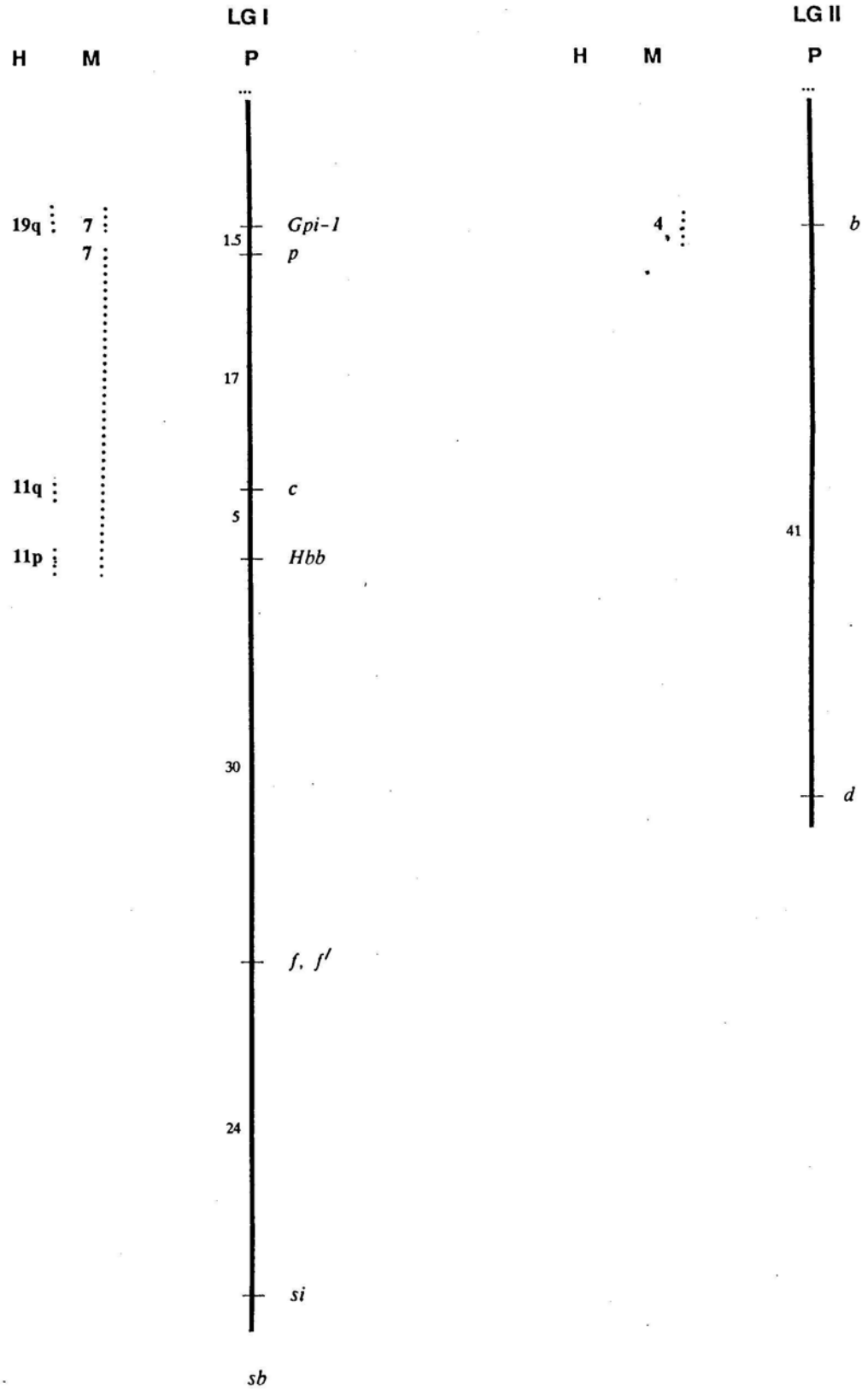
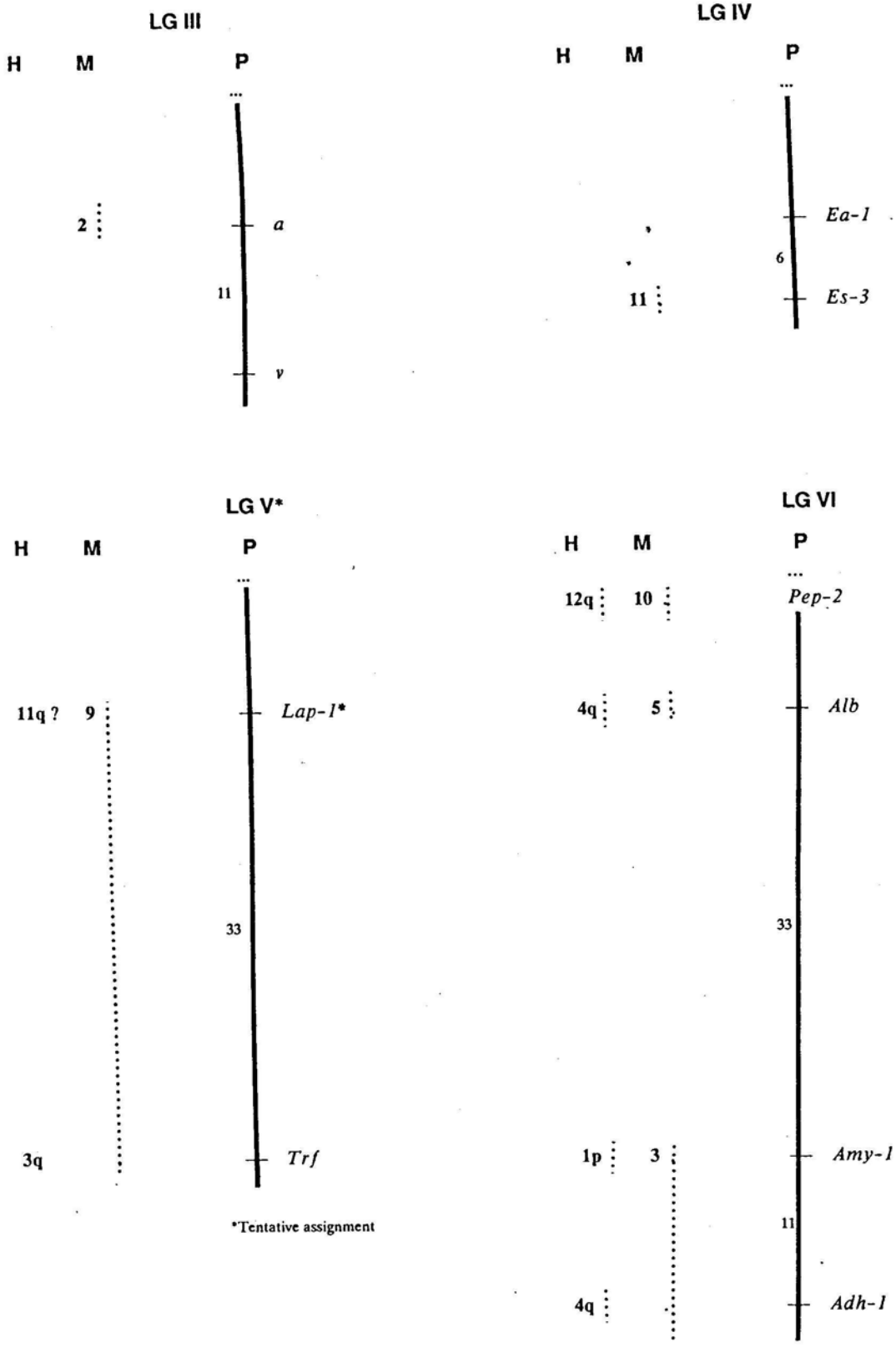
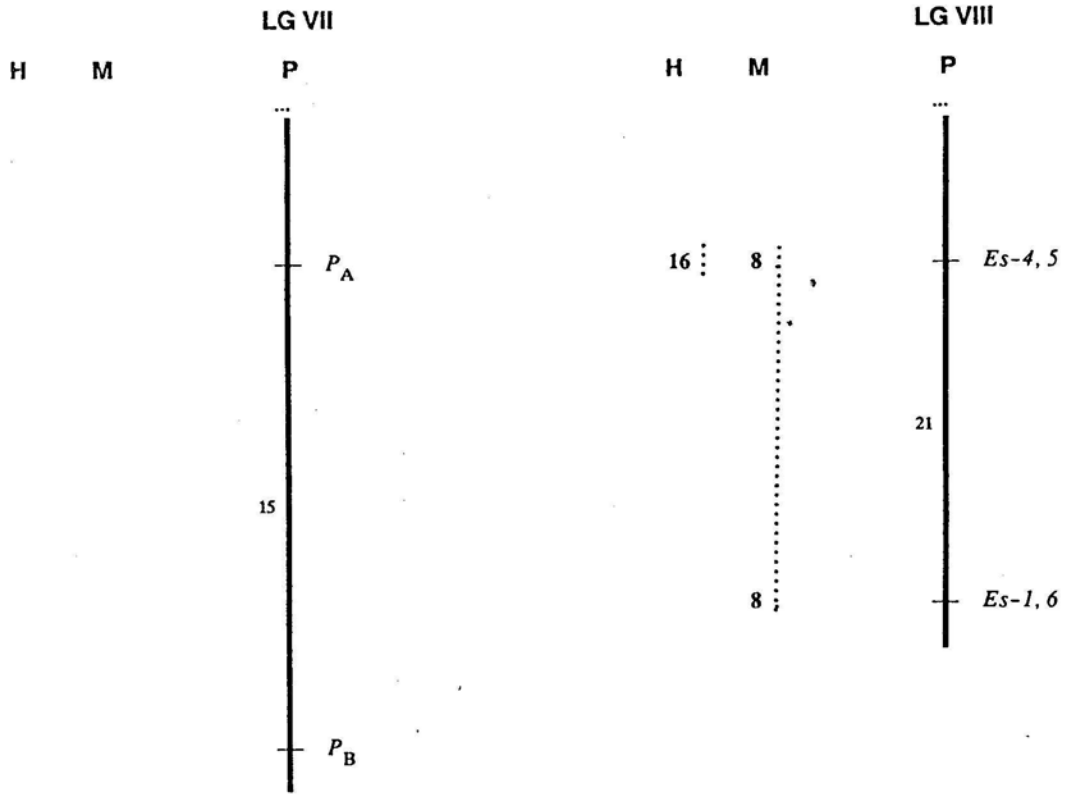
PEROMYSCUS LINKAGE MAP 1992.



Probable homologies with mouse (*Mus*) = **M**; with human = **H**.


LG III
H
M
P
2
a
11
v
LG IV
H
M
P
Ea-1
6
11
Es-3
LG V*
H
M
P
11q ?
9
Lap-1*
33
3q
Trf
*Tentative assignment
LG VI
H
M
P
12q
10
Pep-2
4q
5
Alb
33
1p
3
Amy-1
11
4q
Adh-1


LG VII
H
M
P
P_A
15
P_B
LG VIII
H
M
P
16
8
8
21
Es-4, 5
Es-1, 6

CONTRIBUTIONS

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NOTICE

PEROMYSCUS NEWSLETTER IS <u>NOT</u> 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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Research on *Peromyscus* in our lab over the past several years has dealt with gaining a greater understanding of various aspects within a naturally occurring hybrid zone of *Peromyscus leucopus*.

Shelly M. Witte, a masters student in the lab is currently working to quantify variation in cellular DNA content within individuals across the distribution of *Peromyscus leucopus*. His work also includes a series of laboratory crosses in an attempt to recreate individuals with an elevated coefficient of variation under controlled conditions. Previous studies, show naturally occurring hybrids of *P. leucopus* display an elevated CV from that of at least one of the parental types. We hope that determination of CVs from lab bred F_1s will give insight into factors which give rise to elevated CVs within naturally occurring hybrids.

Identification of population and species subdivisions using DNA probes is another area of interest in our lab. Due to the lack of any morphological or allozymic characters which can distinguish between the two chromosomal races of *P. leucopus*, the white-footed mouse is an ideal candidate for the usefulness of such probes. At present we have found at least one tandemly repeated element which distinguishes the two cytotypes. This work is in cooperation with Holly Wichman of the University of Idaho.

Work on *Peromyscus* chromosomes involves the distribution of LINEs as compared to that of the retrotransposon Mys (Baker and Wichman, 1990). This work is in collaboration with David Kass (currently at M.D. Anderson Hospital, Houston, TX) who isolated these probes while at the University of South Carolina.

Our lab also has also been involved in a collaborative effort with Dr. Mark Crew's lab (UCLA School of Medicine). With a portion of the MHC gene received from Dr. Crew's lab, Madison Powell, is working to chromosomally localize part of the MHC gene complex in *P. leucopus* using *in situ* hybridization.

* * *

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CIRCLING BEHAVIOR BY *PEROMYSCUS LEUCOPUS* OBSERVED IN NATURE

We are reporting a siting of a circling behavior in a wild *Peromyscus leucopus*, suggestive of whirling behavior in captive *Peromyscus* reported in the September, 1991 issue of the *Peromyscus* Newsletter (Van Ooteghem and Brown, 1991). On February 15, 1992 we saw a white-footed mouse in the asphalt drive of a house located on the grounds of the Calder Ecology Center (Fordham University) in Armonk, New York. It caught our attention because of its unusual, circling behavior, which we describe below. We were inside the house at the time and watched from a window about 1.5 to 2 meters away from the mouse. The mouse began by running counterclockwise in a circle of about 0.5 to 0.7 m in diameter, then spiraled inwardly making ever-smaller circles, until it appeared to be chasing its tail in place. It took about one minute to spiral down to a small circle and it continued to "chase its tail" rapidly in place for another 30 to 60 seconds. It stopped abruptly, sat and gnawed its left hind foot for about 10 seconds. The foot did not appear injured. Then it jumped straight up, flipped over in mid-air and fell back down on its feet. After this it meandered for a minute and began the entire routine again. It performed this routine about 6 times within the half hour that we watched it. Since it had rained earlier, there were puddles in the dirve. This did not appear to interfere with the mouse's behavior. It did not avoid the puddles while it circled and spiraled. After a half hour or so, the mouse wandered into the oak wood surrounding the house. This behavior seemed similar enough to reports of whirling behavior in captive *Peromyscus*, that we felt this unusual activity in the wild *Peromyscus* population would interest those studying this behavior.

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The Roles of *Peromyscus leucopus* and *P. maniculatus* in Lyme Disease Transmission in Kansas

Peromyscus leucopus and *P. maniculatus* have both been implicated as reservoirs for the Lyme disease spirochete in the wild. Most research has focused on *P. leucopus* because it is more prevalent in states where there are high numbers of Lyme disease cases in humans. Since both of these species occur in Kansas, I have been interested in determining whether there was a difference in prevalence of infection between the two species. Since the winter of 1989, I have collected serum samples from approximately 155 *P. leucopus* and 100 *P. maniculatus*, across the state. All of the samples have been tested for antibodies against the Lyme disease spirochete by using an IFA (immunofluorescent antibody) test. Since no commercial fluorescinated antibody is available to either species I have had to make a intermediary antibody (rat anti-*Peromyscus*) and then use a fluoresceinated goat anti-rat antibody. The results of the tests show that overall 13.5% of the mice tested were positive for Lyme disease antibodies. Of the *P.leucopus* samples, 16 were positive, with highest prevalences in the eastern third of the state and decreasing westerly. Thirteen of the 100 *P. maniculatus* were found to be positive, again with higher prevalence in the east. However, due to the possibility of false positives the positive IFA samples will now be tested using an enzyme-linked immunosorbent assay (ELISA) because of its greater sensitivity. A known vector tick of Lyme disease, *Ixodes scapularis* also occurs in the eastern third of the state. However, as no larvae or nymphs of this tick species have been found on the mice collected in eastern Kansas, the role of *P. leucopus* and *P. maniculatus* in the transmission of Lyme disease in Kansas still remains a mystery. In the future I would like to focus on the ability of these two species to pass the spirochete to other conspecific individuals in the absence of a vector tick, and their interactions with potential vector ticks.

These studies are part of a M.S. program under the supervision of Steve J. Upton, and funded by a grant from the Kansas State Agricultural Experiment Station.

* * *

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Our molecular analysis of the *Peromyscus leucopus* major histocompatibility complex (MHC) continues (see PN #12). A number of probes derived from the *P. leucopus* MHC are now (or soon will be) available through the *Peromyscus* Molecular Bank:

plasmid probe	region	specificity	polymorphisms detected	sequence known
MHC class I genes				
p38dP2	intron 3 - intron 4	all class I genes (>30)	Y	Y
p52aP6	intron 4 - intron 6	*Pele-A* genes (~20)	Y	Y
p40bBg1	intron 4 - intron 5	*Pele-B* genes (5-10)	Y	Y
p53Pv1	intron 4 - intron 5	*Pele-M1.1* and *Pele-M1.2*	N	Y
p46aX1	intron 5 - intron 6 (EcoRI fragm.)	*Pele-M4.1* and *Pele-M4.2*	Y	Y
MHC class II genes				
pII-3E21	intron 3-3' (StuI/EcoRI Fragm.)	*DQa*-Like gene	Y	N
Other MHC genes				
p17E2	5' - 3' untranslated	TNF	N	Y

* * *

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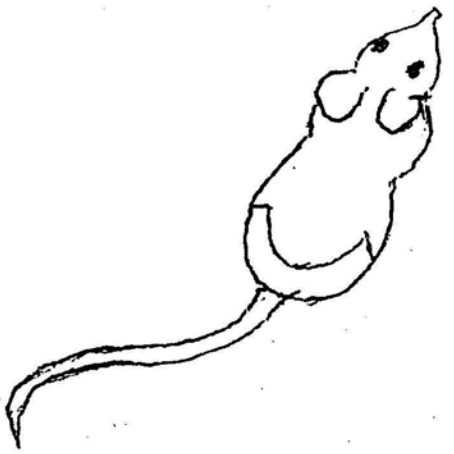
This is an update on my last report of the young *Peromyscus* pups that lost their hair about the time they emerged from their nesting jar at weaning time. Their hair began growing back within about two weeks. They now appear normal. The white that usually is only underneath the body and up a bit on their sides goes very high on their sides, almost forming an inverted white "U" between their front and back legs. Some have white areas on the front of their hips. These larger areas of white are showing up on many of my mice. I am not sure if it is because of the inbreeding, and is a family characteristic, or if it is because of the season. Could this be the winter coat, and that there will be less white with approaching spring and summer?

At one stage three or four of the mutant mice had a strange dark almost black, ring around the hip area with a streak down each side toward the hind legs. It seemed it might have been caused by the dark under-hairs showing at that point. Perhaps it was a form of moult.

These mice have become extremely aggressive and fight with a brutality that is worse than any others I have witnessed in the five years that I have been studying *Peromyscus*. I removed from their cage two adult females and the male that fathered the pups, before this aggression became so fierce.



Later I had to remove one body and a male that was so badly wounded that he died within a day. I removed two more that recovered. They are kept in separate cages now. The rest of them are still together, but do battle occasionally. I had hoped that they might breed. Since they have not, I suspect they may be sterile.

About three weeks ago one female entered a jar and built her nest so that the opening was closed. She stayed in it except to come out for food. When she did come out she was especially vicious and often bit her cagemates until the tank was bloodsplattered. One little female had a hole all the way through her tail.

Because of her behavior I thought the vicious female must have pups. However, none came out of that nest. When I cleaned the nest there were no signs that there had been any.

Afterwards one female (probably the same one) stayed by herself. She looked wet and poorly so I put her in a tank by herself. She has built herself a closed nest, so I wonder if she is pregnant again. Maybe her pups were cannibalized and that is why she had such a foul disposition. There is also the possibility that her pups may not have survived. The group that these mice came from do seem to have a high rate of pup mortality.

At least if she is pregnant she will be by herself this time. If she is just a nest-builder and no pups are born to her, then I must assume that these mutants are sterile, or nearly so, since they are now more than six months old.

* * *

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MATERNAL AGGRESSION TOWARD CONSPECIFIC MALES IN *PEROMYSCUS LEUCOPUS* AS A FUNCTION OF LITTER AGE

I have been studying maternal aggression toward unrelated conspecific males as a function of litter age in wild populations of *Peromyscus leucopus*. It is known that conspecific *P. leucopus* males sometimes commit infanticide, and this may be related to confidence of paternity. Parental investment theory predicts that a mother's defense of her young should increase as her investment in those young increases. However, when the mother's risk to her own future reproductive success is more than her contribution to the pups' likelihood of survival, she would benefit from switching her protective aggression from the current litter to reproductive effort in future offspring (weaning). As pups mature, their ability to defend themselves increases, and her defense (and thus risk) may be unnecessary. I predict that a mother's defense of her pups would be low at the beginning of postnatal development, begin to decline when the pups are old enough to defend themselves against infanticide, and cease altogether at the time of weaning.

Females and their litters were exposed to male intruders over the course of postnatal litter development to determine: 1) the point at which the dam reduces protection of the young, and 2) dam and pup aggressive behavior toward intruders. Exposure days started on day 3 (day 0 = birth) and continued every four days until day 27, by which time the pups would be weaned in the wild. To eliminate the likelihood of relatedness, males were captured at a site 1.6 km away.

Data have been collected for only one of the two proposed years, but analysis to date suggests:

1) Contrary to my prediction, maternal aggression (as determined by the number of attacks on male intruder/10 minute trial) is high at early postnatal days.

2) As predicted, this aggression begins to decline at about postnatal day 15, by which time the pups' eyes are open and they have motor control.

3) The decline in aggression continues to zero at day 27 when the pups are weaned.

4) Pup behavior toward intruders consists almost exclusively of defensive behaviors, mainly boxing and running away. This behavior begins on postnatal day 11, but is most pronounced on days 19 and 23.

* * *

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Nestled in the mountains of Mount Haggin Management Area near Anaconda Montana, several *Peromyscus maniculatus* were collared and harassed for a few summer months in 1991. In all a total of 22 deer mice wore 2-3 gram radio collars for a week at a time. The purpose of course, science.

The summer of 1991 I began the research for my masters degree in biology at Montana State University. The main objectives for my study were the following: 1) To determine the effects of moderate cattle grazing on *Peromyscus* habitat usage; 2) To determine habitat usage of *Peromyscus* in a bitterbrush-agropyron community; 3) To determine the effects *Peromyscus* have on bitterbrush germination ie..how caching behavior effects bitterbrush germination.

Without including the gory details this time ie..data not analyzed yet, I will just mention a few interesting preliminary observations.

First, during the cattle grazing experiment, 130 cattle were grazed on a site approximately 5 acres in size and deer mouse habitat usage been delineated prior to this event. The following observations have been recorded, 1) Deer mice appear to be unconcerned about 130 cattle tromping around for a day mowing down the grass, and continued to utilize the same bushes and area as the previous night; 2) In the following days when cattle scat became relatively dried mice were observed digging in the "pies" and extracting various undigested seeds; 3) Mice appeared to utilize grassy areas mowed by cattlemore frequently in order to move more readily between feeding stations. Preliminary conclusions indicate that moderate grazing does not effect deer mice habitat usage in a negative manner.

Second, during the caching experiment, the following observations were made: 1) When given the opportunity to choose between native (small and less plump) bitterbrush seed and purchased (from Native Seed in Utah, plump and healthy) bitterbrush seed, deer mice would completely clean a plate of purchased seed and return frequently to the plate with native seeds but not consume or remove one seed; 2) When human planted caches were made in various areas around bushes only those caches consisting of purchased bitterbrush seed were excavated and consumed on the spot (288 seed hulls were collected out of 300 seeds planted in caches). Preliminary conclusions indicate mice like healthy purchased seed better then dried shriveled native seeds. Germination will be checked the summer of 1992 both in mouse exclosures and outside. Also cattle grazing will be repeated and more collars worn by the lucky chosen few *Peromyscus*.

* * *

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INBREEDING, GENETIC VARIATION AND PARASITE RESISTANCE

Many authors have claimed that populations without significant genetic variation are more vulnerable to pathogens than genetically varied populations (e.g., Wakelin, 1978, Advances in Parasitology 16:219), but few empirical studies support or refute this supposition (Parker, 1989,Evolution 43:540). To test this hypothesis, I am addressing two questions with *Peromyscus*: First, is there a correlation between levels of genetic variation and levels of parasitism in natural host populations? Second, under controlled laboratory conditions, is there any difference in parasite resistance among hosts drawn from genetically variable and genetically homogenous populations? Deer mice (*Peromyscus maniculatus gracilis*) from Michigan present a unique opportunity to answer these questions: Populations from the mainland and islands in the Beaver Island archipelago in northern Lake Michigan differ substantially in levels of genetic variation. These populations also harbor a liver-inhabiting roundworm, *Capillaria hepatica*, a likely parasite candidate for field and laboratory investigations.

During the summer of 1989, I collected 15-25 deer mice from each of 10 sites: 5 from mainland localities in both of Michigan's peninsulas, and 5 from islands that range in size from 60 to 0.1 mi^2. I have completed a preliminary survey of genetic variation in these 200 mice. In order to estimate genome-wide variability in these animals (Nei, 1978, Genetics 89:583), I am using cellulose acetate electrophoresis to examine variation at 30-40 enzyme-coding genes. I have worked out staining techniques that allow me to evaluate variability in 21 genes. Heterozygosity (H), a standard measure of genetic variability, is higher in mainland than island populations (average $H=0.10$ vs. 0.05). Further, there is a significant nonparametric negative correlation between heterozygosity and the proportion of mice infected (prevalence) with *C. hepatica* (Spearman-rank rho=-0.72, p=0.04). As predicted by theory, populations that contain less genetic variation have a higher proportion of infected individuals. In order to corroborate this pattern, I plan to expand this genetic survey to include at least 10 more loci and also to repeat it on 200 mice, collected in 1991, from 6 localities (4 island, 2 mainland).

I have also observed an additional pattern: Among the sites I have studied, *C. hepatica* prevalence is also positively correlated with mouse population density (rho=0.76, p=0.03), as measured by trap success, and epidemiological considerations predict that transmission rates and prevalence will be higher in crowded situations.

Infection trials under controlled conditions are now required to determine whether differences among localities are due to innate (i.e genetic) or ecological differences among these populations. I have planned such an experiment and will collect the animals for it this spring.

In the final part of this research project, I plan to examine variability in major histocompatibility complex (MHC) genes in these mouse populations (see Mark Crew's contribution in *Peromyscus* Newsletter no. 12, September 1991). In this way, I hope to obtain information about the variability of a particular part of the genome that may be involved in parasite resistance for comparison with my data on potentially neutral allozyme markers.

* * *

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EFFECTS OF EAR-TAGGING ON INFESTATION RATES OF *PEROMYSCUS LEUCOPUS* WITH DEER TICKS (*IXODES DAMMINI*)

In June 1991 we began a long-term study of the effects small mammals on forest ecosystem structure and function. The three primary ways in which small mammals, among which *P. leucopus* is dominant locally, may influence our forests are as predators of gypsy moths (*Lymantria dispar*), as reservoirs for Lyme disease spirochetes (*Borrelia burgdorferi*),and as hosts for their tick vectors (*Ixodes dammini*). *P. leucopus* is perhaps the most competent reservoir for *B. burgdorferi* among all local vertebrates and is probably the primary source of infection of *I. dammini*. Although larval *I. dammini* ticks may acquire the Lyme disease spirochete from other sources, *P. leucopus* has been identified as the predominant reservoir. Thus, the opportunity for larval ticks to attach to *Peromysus* vs. other hosts may have a strong impact on the proportion of ticks infested with Lyme disease spirochetes, and therefore on the risk to humans of contracting Lyme disease. *Peromyscus* themselves obtain the spirochete during blood meals taken by infected nymphal ticks. Therefore, the opportunity for nymphal ticks to attach to *Peromyscus* is likely to affect the proportion of *mice* carrying the disease agent. Infestation rates of mice by both larval and nymphal ticks may be an important factor in the ecology of Lyme disease.

We have been using standard mark-recapture techniques to study population dynamics of small mammals, including marking individuals with numbered, metal eartags. We have found that eartagging substantially increases tick loads on mice. Upon first capture of mice during each trapping session (3 weeks apart) we removed all ticks from the face and ears (the primary sites of attachment). On subsequent captures within each 3-day trapping session we counted, but did not remove, ticks to monitor reinfestation. After both a 1-2 day and a 3 week interval, *Peromyscus* had about twice as many ticks on the tagged right ear as on the untagged left ear. We suspect that the ear tags provided a refugium for the ticks from grooming by mice. An alternative explanation that the inflamation of the tissue surrounding the eartagging injury attracts ticks will be evaluated.

We will be using eartagging as an experimental method to increase tick loads on mice in order to measure the effects of tick infestation on the infection rates of both mice and ticks with *Borrelia*. However, for those investigators studying natural dynamics of ticks and mice related to Lyme disease, we strongly recommend an alternative method of marking individual mice, such as toe-clipping. Preliminary results will be presented in a poster at the 72nd Annual Meeting of the American Society of Mammalogists in June 1992.

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STATUS OF THE SANTA ROSA BEACH MOUSE, *PEROMYSCUS POLIONOTUS LEUCOCEPHALUS*

The Santa Rosa beach mouse, *Peromyscus polionotus leucocephalus*, is one of eight subspecies of the oldfield mouse found in coastal dune habitats of the southeastern United States. Blair (1946, 1951) indicated that the Santa Rosa beach mouse was common within his range which covers all of Santa Rosa Island, Florida. The 75 Km-long island in northwest Florida is largely publicly-owned and remains undeveloped.

The Santa Rosa beach mouse is the only beach subspecies of *P. polionotus* not listed as threatened or endangered by the U. S. Fish and Wildlife Service and remains under review. We are documenting the presence of the mouse across the island and studying the relative use of front dune versus back dune habitat. The limited mammalian fauna and abundance of open sand allows us to determine presence of beach mice from tracks. We are running tracking transects at 1-Km intervals across the island and confirming results with live-trapping. To evaluate habitat use we are live-trapping two replicate sites each month.

Preliminary findings indicate that the Santa Rosa beach mouse occurs throughout the undeveloped portions of the island, including all island habitats except canopied forests. In addition, the mice are as abundant in back dune habitat, even as far as 500 m from the beach, as they are along the front dune.

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RESPONSE OF THE SANTA ROSA BEACH MOUSE (*Peromyscus polionotus leucocephalus*) TO HABITAT DISTURBANCE CAUSED BY HUMAN DEVELOPMENT

Loss of habitat to residential and commercial development has been implicated as a major cause of decline in beach mouse populations on coastal dune communities (Holliman, 1983; Meyers, 1983; Holler and Rave, 1991). Along with the loss of habitat, house cats (*Felis cattus*) and house mice (*Mus musculus*) are often introduced when beach mouse habitat is developed. Holliman (1983) suggests that house cats may be responsible for the absence of beach mice on Ono Island in Alabama. Other authors report competition between beach mice and house mice in disturbed habitats (Hollar, et al., 1989; Humphrey, 1991; Holler and Rave, 1991).

In October, 1991, I began a study of Santa Rosa beach mouse populations in Navarre Beach on Santa Rosa Island, Florida. Undeveloped habitat in Navarre Beach consists of numerous fragments of various sizes, both along the fordune and inland. The development consists primarily of single family and multifamily dwellings with commercial development restricted to the eastern portion of Navarre Beach.

Live-trapping grids have been established on five fragments of undeveloped beach mouse habitat. A control grid has been established approximately 200 meters west of Navarre Beach in undeveloped coastal dunes of the Gulf Islands National Seashore. These grids are being live-trapped monthly through May 1992. Tracking is also being undertaken in areas not being live-trapped wherever the presence of house mice is suspected or where tracks are absent. Data will be analyzed to determine the distribution, abundance, and viability of beach mouse populations within Navarre Beach. Comparisons will be made with trapping data from the nearby undeveloped control habitat.

Preliminary analysis suggest that beach mouse populations are greatly reduced or absent in the undeveloped fragments within Navarre Beach. Only two house mice have been captured (both in the same fragment) indicating little competition between house mice and beach mice. Numerous domestic cat tracks have been found on all fragments.

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I have been studying the population and behavioral ecology of white-footed mice, *Peromyscus leucopus*, and deermice, *P. maniculatus*, for 12 years at the Mountain Lake Biological Station in southwestern Virginia. During 1990 we experienced densities of over 100 animals/ha. During this year and the previous and following year, I made observations and conducted experiments on reproductive suppression and sex-biased juvenile dispersal as it related to density. The following is an excerpt from a paper which has resulted from this work and is currently in review.

Natal dispersal in birds and mammals is hypothesized to be triggered by aggression from same-sex parents and to result in reduced reproductive competition between same-sex adults and juveniles. Numerous laboratory studies on at least 10 species of rodents have demonstrated reproductive suppression and/or delayed sexual maturation of juvenile rodents in the presence of same-sex adults, thus lending support to this hypothesis. Alternatively, sex-biased juvenile dispersal may function to separate juveniles from opposite-sex relatives to avoid incestuous matings. During high population density, juvenile white-footed mice did not disperse from their natal home ranges, but remained and formed extended families with their parents. Reproductive suppression of juveniles occurred if the opposite-sex parent was present in the home range, whereas the presence of the same sex parent did not inhibit sexual maturation. Sex-specific removal of parents resulted in extended residency of the opposite-sex offspring in the natal home range. The results suggest that sex-biased dispersal results from the presence of opposite - and not same - sex parents in the natal home range and that reproductive suppression occurs when juveniles are not able to separate from their opposite-sex parents and does not result from reproductive competition. Conclusions from laboratory studies that have demonstrated sexual inhibition of juvenile females by adult females or their urine products may not represent what occurs in natural populations. The results of this study do, however, support the inbreeding avoidance hypothesis for sex-biased dispersal. Any population regulation that results from this reproductive suppression is likely an artefact of daughters being unable to separate from their fathers.

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