PEROMYSCUS NEWSLETTER

NUMBER TWENTY-SIX

SEPTEMBER 1998

Cover: Colorless hairtip mutant *Peromyscus polionotus*.
One of two existing photographs. See page 11.

ISSUE # 26

In our last issue (March 98) we discussed the future of *Peromyscus Newsletter* and requested input and suggestions from our readers concerning what changes we might institute to appeal to a broader reader base. We thank all of you for your continued interest and support. We were gratified to receive a number of constructive comments and ideas. Below are excerpts from some of these:

"I believe that the need for a newsletter continues ..... I guess I would favor having one copy a year published, and for one or two other bits of PN news to be sent on-line" (Bob Rose, ODU)

"Although out of the Peromyscus business for several years, I enjoy the newsletter. Perhaps adding a few web pages to the database site for contributions, news and comment, etc. would suffice." (John Beidler, FSU)

"We face the same problems with RAT GENOME that you face with P. Newsletter ..... A key point is the support of people who use the animal as a research subject, since they outnumber the geneticists, etc. Printing sequences, chromosomal assignments, etc. is useful to us, since they are ready reference material. This certainly serves a function." (Tom Gill, U. Pittsburgh)

"I believe that a newsletter is still pertinent ..... most research involving Peromyscus is 'non-genetic' in scope ; hence a newsletter provides information that a database cannot ..... Although it may make the best business sense to produce an annual issue, there have been occasions when the information was so timely that I was able to utilize it almost immediately upon receipt ..... of the options presented, I am most in favor of (summarizing) all the genetic info in one issue to be published every two or three years; change the focus of the intervening issues to ecology, reproduction, behavior, etc. (Alice Bard, Fla. Dept. Eviron. Protect.)

"I'd really hate to see PN disappear ..... Instead of having a subscription cost ..., possibly you could require an entry every other year" (Richard Hill, Mich State Univ.) Dr. Hill also bemoans the increasing difficulty in maintaining wild rodent colonies because of prohibitive costs and red tape.

"I'd like to see (PN) continued as a semi-annual publication. I would welcome more space devoted to ecology, reproduction and behavior ..... you could minimize the list of publications that cite Peros since library searching is so commonplace now that most investigators can do the same on a more regular basis. On line is probably the way of the future, but I still like the hard copy ..." (Erick Hofmeister, Mayo Clinic)

"I read PN as a general reader .... in conjunction with my editing for Mammalian Species. I also subscribe to Roy Horst's Bat Research News for the same reason ..... what about having a broader base in PN, similar to what Roy has?" (Barbara Blake, Bennett College)

(Continued next page)

We are taking these suggestions to heart and, beginning with this issue, will gradually incorporate many of your ideas. One consistent theme among your comments was that we should broaden the focus to include more material related to field biology and behavior of *Peromyscus* and reduce the emphasis on genetics that has characterized *PN* until now. In response, we plan to dedicate each fourth issue - March even years - entirely to genetic updates. We will term this our "*Peromyscus* Genome" issue. This bi-annual issue will contain gene lists, the updated linkage maps, accession numbers to GenBank sequences and other information of interest. The other issues will omit this matter except that a catalog of animals and materials available from the *Peromyscus* Genetic Stock Center will continue to be included in each issue. Any particularly noteworthy genetic news will be reported in our "News and Comment" section as it occurs. The "Recent Publications" section, of course, will cite any new published articles relevant to *Peromyscus* regardless of topic. Genetic information will be regularly updated in *Pero***Base** on the Internet.

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PEROMYSCUS NEWSLETTER is produced by the

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NEWS, COMMENT and ANNOUNCEMENTS

Peromyscus continues to make the news. High profile work by **Shirley Tilghman, Paul Vrana** and colleagues at Princeton made the cover of the December issue *NATURE: GENETICS*. This study has also been highlighted inthe September 25Th issue of *SCIENCE* (281:1984-1985) and the December 1st *NEW YORK TIMES* science column. Work by the Princeton group using fetal and placental expression of imprinted genes in *Peromyscus maniculatus X P. polionotus* hybrids tests the a gametic competition hypothesis proposed by David Haig of Harvard University. The hybrids of two species, one monogamous and one not, exhibit size anomalies consistent with the theory, but the results of the Princeton study failed to verify the gametic conflict theory. The implications of imprinting for speciation are discussed.

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The July 6th issue of *USA Today* carried a three full page spread on *Peromyscus* and the 1993 hantavirus outbreak in the Four Corners region. It discusses the Native American cultural aspects of the outbreak and resulting conflicting views concerning conventional public health procedures. The feature includes several photos of deer mice.

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We have a note that Tom Gill is retiring at the end of December. Dr. Gill was editor of Rat Newsletter (now Rat Genome) and for many years has been active in rat genetics.

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Gloria E. Salavarria has written an piece entitled "Mouse in the House" recounting her observations of several *Peromyscus* sp. that she keeps in terraria at her home. We can empathize with her experience with keeping *P. leucopus* from leaping out of the terraria.

X-X-X-X-X-X-X-X-X

Dennis Ruez of the Florida Museum of Natural History has been investigating fossil *Peromyscus*. The fossil record of *Peromyscus* is an overlooked area. Although several species have been described based on fossil material, the record is quite spotty. Let's hope that Dennis will help fill in the fossil history

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For those who ship small mammals (*Peromyscus, Mus, etc.*) an article in *Lab Animal* 27(5):49ff by Terrie Cunliffe-Beamer DVM of Jackson Labs describes how to organize the shipment. It is a useful reference.

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DIRECTOR,
PEROMYSCUS GENETIC STOCK CENTER

Applications are invited for a tenure track appointment as **Associate** or **Full Professor** in the Department of Biological Sciences at the University of South Carolina. Responsibilities of this appointment include directorship of the *Peromyscus* Genetic Stock Center.

The Stock Center (http://stkctr.biol.sc.edu/), supported by NSF since 1985, maintains seven species and 33 mutant strains of deer mice and related species and provides them to investigators in the US and abroad. The Center publishes the *PEROMYSCUS* NEWSLETTER to a circulation of about 750, and is developing the *Peromyscus* database, *Pero***Base**, also funded by NSF. In Spring 1999 the Stock Center will move into new state-of-the-art animal care facilities and research laboratories.

Applicants must possess a highly productive, externally funded research program that may be in any of a number of fields including infectious diseases, comparative mapping, molecular evolution, toxicology, population genetics, physiology, or behavior. Research experience with *Peromyscus* or other rodents, and future use of *Peromyscus* are expected. Directorship of the Stock Center provides a unique opportunity for career development of individuals interested in *Peromyscus* research. The candidate must be willing to promote the Stock Center as a national focal point for *Peromyscus* research.

Applicants should submit curriculum vitae, description of research program, and a letter of intent to: ***Peromyscus* Search Committee, c/o Dr Michael J Dewey, Department of Biological Sciences, 700 Sumter St, University of South Carolina, Columbia SC 29208**

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An editorial in *Science*, co-authored by Jim Bull and **Holly Wichman** addresses the relevance of evolutionary biology to modern science and discuss the implications of resistance its teaching in many high schools.

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Three additional species of *Peromyscus* are the subjects of new issues of *Mammalian Species*:

Alvarez-Castenada, S.T. 1998. *Peromyscus pseudocrinitus.* Mamm. Species 601:1-3.

Alvarez-Castenada, S.T. P. Cortes-Calva and C. Gomez-Machorro. *Peromyscus caniceps.* Mamm. Species 602:1-2.

Roberts, H.R., D.J. Schmidly and R.D. Bradley. 1998. *Peromyscus spicilegus.* Mamm. Species 596:1-4.

Others are "in the works".

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BACK ISSUES. Unfortunately our supply of original back issues of *PEROMYSCUS NEWSLETTER* is becoming depleted. The only issues we still have in adequate supply are Numbers 8, 13, 14, 17, 18, 19, 20, 21, 23 and 24. For others there are either no available copies or fewer than 5 on hand. We have good photocopies of scarce back issues (with covers in the original colors) that can be supplied for $ 5 each. A complete set of *PN* (Numbers 1 thru 25), including some as the photocopied version, will be provided for $ 50 including postage.

Calling attention to a paper in *Ecological Monographs* 68:571*ff* by **Ruth Lewellen** and **Steve Vessey**: This paper summarizes 23 years of field data noting the influences of weather and density on populations of deer mice at Carter Woods in northwest Ohio. The comprehensive reference list is potentially useful to many biologists involved in field work with *Peromyscus*

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MICROSATELLITES

At the Stock Center we frequently receive queries about microsatellite markers useful with *Peromyscus*. In the event that you have or know of microsatellites that work for deer mice and related species, we would like to have the information for our database. We would like to list any primer sequences in a future issue of *PN*, if there is no objection. Please contact us if you can help. Thanks.

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 **$17.50 per wild-type animal** and **$ 25 per mutant or special stock animal** is charged. The user assumes the cost of air shipment. Animals lost in transit are replaced without charge. 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 TYPE SPECIES	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. Approximately ten generations in captivity.
P. leucopus (LL Stock)	Derived from 38 wild ancestors captured between 1982 and 85 near Linville NC. Approximately 20 generations in captivity.
P. californicus insignis (IS Stock)	Derived from about 60 ancestors collected between 1979 and 87 in Santa Monica Mts. CA. Approximately twelve generations in captivity.
P. aztecus (AM Stock)	Derived from animals collected on Sierra Chincua, Michoacan, Mexico in 1986 Approximately ten generations in captivity.
P. melanophrys	Originated from a group of animals collected at Zacatecas Mexico during the 1970's. Formerly maintained by R.W. Hill at Mich. State Univ.
P. maniculatus X *P. polionotus* F_1 Hybrids	Sometimes available.

MUTATIONS AVAILABLE FROM THE STOCK CENTER[1]

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 *bln/bln*	Mich. State U. colony (Pratt and Robbins, 1982)
[2]Brown *b/b*	Huestis stocks (Huestis and Barto, 1934)
California blonde *cfb/cfb*	Santa Cruz I., Calif., stock (Roth and Dawson, 1996)
Dominant spotting *S/+*	Wild caught in Illinois (Feldman, 1936)
Golden nugget b^{gn}/b^{gn} [in *P. leucopus*]	Wild caught in Mass. (Horner and Dawson, 1993)
Gray *g/g*	Natural polymorphism. From Dice stocks (Dice, 1933)
Ivory *i/i*	Wild caught in Oregon (Huestis, 1938)
[3]Pink-eyed dilution *p/p*	Sumner's "pallid" deer mice (Sumner, 1917)
Platinum *plt/plt*	Barto stock at U. Mich. (Dodson *et al.*, 1987)
[2]Silver *sil/sil*	Huestis stock (Huestis and Barto, 1934)
Tan streak *tns/tns*	Clemson U. stock from N.C. (Wang *et al.*, 1993)
Variable white *Vw/+*	Michigan State U. colony (Cowling *et al.*, 1994)
White-belly non-agouti a^w/a^w	Egoscue's "non-agouti" (Egoscue, 1971)
Wide-band agouti A^{Nb}/a	Natural polymorphism. U. Mich. (McIntosh, 1954)
Yellowish *yel/yel*	Sumner's original mutant (Sumner, 1917)

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)
[3]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. (Dawson *et al.*, 1983).

[1]Unless otherwise noted, mutations are in *P. maniculatus*.

[2]Available only as silver/brown double recessive.

[3]Available only as pink-eye dilution/flexed-tail double recessive.

OTHER RESOURCES OF THE *PEROMYSCUS* GENETIC STOCK CENTER:

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NOW. Highly inbred *P. leucopus* (I_{20+}) are available in limited numbers as live animals or as frozen tissues. Several lines developed by George Smith (UCLA) are currently maintained by the Stock Center.

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Limited numbers of other stocks, species, mutants, inbreds and variants are on hand, or under development, but are not available for distribution. Currently we can supply up to 10 each of the species *P. eremicus* and *P. melanophrys*.

Preserved or frozen specimens of types given in tables above.

Tissues, whole blood or serum of types given in tables above.

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

Reference library of more than 2400 reprints of research articles and reports on *Peromyscus*. Copies of individual articles can be photcopied and mailed. Please limit requests to five articles at any given time. There will be a charge of 5 cents per photocopied page after the initial 20 pages.

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

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 or peromyscus@stkctr.biol.sc.edu

PLEASE CALL WITH INQUIRIES.

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Materials on Deposit in the *Peromyscus* Molecular Bank

Accession Number	Item	Description	Species	Donor	Location[1]
Probes and Clones:					
Pr-01	LINE1	pDK62	*P. maniculatus*	D. Kass	C
Pr-02	LINE1	pDK55	*P. maniculatus*	D. Kass	C
Pr-03	ADH1	pADH F72	*P. maniculatus*	M. Felder	B
Pr-04[2]	Mys		*P. leucopus*	(Requested)	
Pr-05[2]	SAT		*P. leucopus*	(Requested)	
Pr-06	6PGD	pB5 clones	*P. californicus*	S. Hoffman	A
Pr-07	MHC *Pele*I	38dp2	*P. leucopus*	M. Crew	A
Pr-08	MHC *Pele*I	52ap6	*P. leucopus*	M. Crew	A
Pr-09	MHC *Pele*I	40Bgl	*P. leucopus*	M. Crew	A
Pr-10	MHC *Pele*I	53Pv1	*P. leucopus*	M. Crew	A
Pr-11	MHC *Pele*I	37B2	*P. leucopus*	M. Crew	A
Pr-12	MHC *Pele*I	37B4	*P. leucopus*	M. Crew	A
Pr-13	MHC *Pele*II	α3E23	*P. leucopus*	M. Crew	A
Pr-14	MHC *Pele*III	17E2	*P. leucopus*	M. Crew	A
Pr-15	MHC *Pema*I	pr44	*P. maniculatus*	M. Crew	A
Libraries:					
Lb-03	lambda genomic	testis	*P. leucopus*	M. Crew	A
Lb-04	cosmid genomic	testis	*P. leucopus*	R. Baker	A
Lb-05	lambda genomic	liver	*P. californicus*	S. Hoffman	A
Frozen Tissue for DNA:					
S-01	bairdii (BW)	liver, tail, other[3]	*P. maniculatus*	Stk. Ctr.	A
S-02	subgriseus (PO)	liver, tail, other	*P. polionotus*	Stk. Ctr.	A
S-03	leucopus (LL)	liver, tail, other	*P. leucopus*	Stk. Ctr.	A
S-04	wild-caught SC	liver, other	*P. gossypinus*	-	A
S-05	aztecus (AM)	liver, tail, other	*P. aztecus*	J. Glendinning	A
S-06	insignis (IS)	liver, tail, other	*P. californicus*	S. Hoffman	A
S-07	inbred PmH1A	liver, other	*P. maniculatus*	Jackson Lab	A
S-08	inbred PmH8	liver, other	*P. maniculatus*	Jackson Lab	A

[1]Location code: **A** = USoCar SAI 01; **B** = USoCar CLS 603; **C** = USoCar CLS 707

[2]Not currently available.

[3]kidney, spleen, testis, carcass.

EXTINCT GENETIC VARIANTS

Since 1917 about 40 distinct, monogenic coat color and other visible mutations have been detected in *Peromyscus*. Most of these have been genetically analyzed and formally described in publications such as *The Journal of Heredity*. Many of these are kept as mutant lines at the *Peromyscus* Genetic Stock Center.

Between 1917 and 1922 F.B. Sumner described several recessive characters (*albino, pinkeyed dilution, yellowing, and hairless-1*). Since then, as new mutations were detected in laboratory or field-caught animals, a published report on the mutant would be accomplished, and a stock of the variant animals retained for potential genetic studies. The most recently reported new mutation is *California blonde* (Roth and Dawson, 1996). Using such traits, Frank Clark, Betty Barto and Bill McIntosh by the 1950's had worked out several linkage groups.

Some of these distinctive variants have been lost. One of these, *colorless hairtip* (*ctp*), is shown on the cover of this issue of *PN*. Most of the pelage color variants are known from *P. maniculatus*, but "colorless" was recovered from *P. polionotus*. Wilfred Bowen (1968) obtained it from a second generation hybrid between two *P. polionotus* subspecies. The pale gray-white trait was inherited as a simple recessive character (Bowen and Dawson, 1969). A stock of these animals were retained at the University of South Carolina until 1978, when the line died out. Other visible traits (*dilute, whiteside, post-juvenile nude*) and several monogenic behavior variants also no longer exist in laboratory stocks, although these were never kept in the South Carolina colony.

At the Stock Center considerable effort is devoted to maintaining the distinctive mutants, primarily as potential markers for gene mapping. Many of the stocks were accepted "in trust" with the assumption that they would be maintained indefinitely. Some of these have homologs in *Mus* and *Rattus* and provide "anchors" for linkage and mapping studies. Nevertheless, the argument is sometimes made that we should "not re-invent the lab mouse" and that there is little value in keeping the color variants for *Peromyscus*. Indeed, there is relatively little demand for these variants, and, when they are requested, the numbers needed are limited. So the question is: "**Should the Stock Center continue to maintain visible mutations???**" Many people at several institutions for many years have invested much money, time and effort in preserving these lines, with the belief that they would "someday" be of scientific value. One alternative that we are considering is cryopreservation, particularly of sperm, a technique not yet perfected for deer mice.

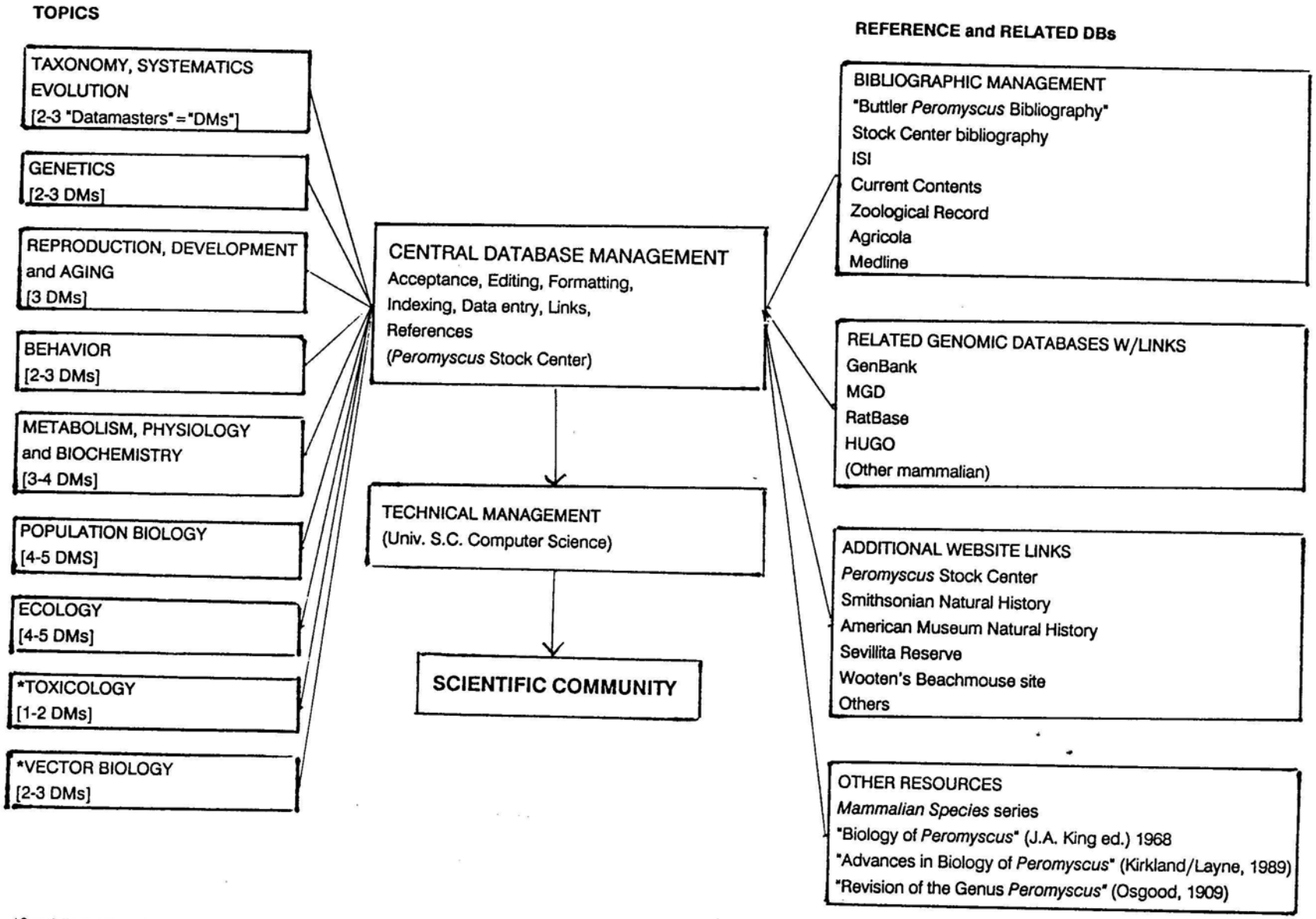
Nevertheless, in our estimation, funding to maintain these variants soon may be in jeopardy. Are they worth the effort to save?

References:

Bowen, W.W. 1968. Variation and evolution of Gulf Coast populations of beach mice, *Peromyscus polionotus*. Bull. Fla. State Mus. 12(1):1-91.

Bowen, W.W. and W.D. Dawson. 1969. Colorless hairtip, a new mutant in *Peromyscus*. J. Hered. 60:170-172.

Roth, V.L. and W.D. Dawson. 1996. Coat color genetics of *Peromyscus*: V. California blonde, a new recessive mutation in the deer mouse. J. Hered. 87:403-406.



*Specialized categories.

Progress on *Pero*Base

The *Peromyscus* database project is now being organized with the support of an NSF database grant. This is a report on the progress and plans, together with a request for input.

*Pero*Base is not strictly a genomic database, but rather encompasses the whole spectrum of *Peromyscus* research areas. We have selected nine general topical areas in our primary classification (Diagram opposite). Seven of these areas are general academic areas, while two ("Toxicology", "Disease Vector Biology") are more applied. There will be overlap with crosslinks among some of these areas. For example, a set of data may be relevant to both "behavior" and "reproduction" and, hence, could be accessed readily from within either topic page. Data to be inserted into *Pero*Base will be reviewed by an appropriate "authority" or "referee" that we tentatively refer to as "datamasters" or DMs. These will be individuals who consent on a voluntary basis to review proposed data entries and, intially, to recommend existing data sets for installation in *Pero*Base. Several such persons at any given time would act as DMs in a particular topic area. We anticipate that many of our readers will assist construction of *Pero*Base in this role.

Proposed entries will then be forwarded to "Central Database Management" for acceptance, editing, formatting for database consistency, identifying appropriate links and references, and formally entering the data. This will be a function of the personnel of the *Peromyscus* Genetic Stock Center. Of course, one advantage of an electronic database compared to print media, is that updating becomes and ongoing process as additional information is developed. Review and revision of information in the database will be accomplished either on recommendation of external DMs, or by central editors. The Stock Center will identify an editor and assistant editors to maintain *Pero*Base, as well as to communicate with the external DMs. A major concern will be to maintain an attractive "look" and easy accessibility. The database will maintain an index to readily access a particular reference or dataset. The index will be an on-line list of topics, or can be reached by a query word.

Bibliographic management will be a major function and will begin by incorporating the extensive 7000+ reference list created by Bruce Buttler, and will be enhanced with recent references in *Peromyscus Newsletter*, and various on-line services (Medline, Agricola, *etc.*). There will be links to various mammalian genomic databases and to GenBank. There will also be ready links to websites particularly relevant to *Peromyscus, e.g.* major American museum collections.

Technical management of *Pero*Base will be accomplished through the Univsersity of South Carolina Computer Science Department. The database will be mounted on a Unix platform using SyBase "commercial-strength" software. Care will be taken that *Pero*Base is accessible through all major internet providers and search engines.

We trust that *Pero*Base will prove a useful resource. We invite your comments and participation. If a *PN* reader would like to serve 2-3years as a datamaster in his/her area of expertise, please contact us.

Wallace Dawson & John Rose

NOTICE

PEROMYSCUS NEWSLETTER IN 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!

CONTRIBUTIONS

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A STANDARD LABORATORY TEST WITH ZINC PHOSPHIDE ON *PEROMYSCUS MANICULATUS*

In 1993, deer mice were implicated as the reservoir for hantavirus which caused an outbreak of adult respiratory distress syndrome, and ultimately, several deaths in the four-corners area of Colorado (Timm and Howard 1994). Douglass and others (1996) found that deer mice are prevalent in a variety of habitats in Montana and that the mice they captured ranged between 0% and 30% seropositive for the hantavirus per sampling grid. Winters (1998) writes that "between 100,000 and 200,000 people are affected (by hantavirus) worldwide every year". Cases of hantavirus are occurring from North America to South America with reports of cases found on the Internet from Alberta, Canada to Argentina, South America (Taggert 1997 and Nickerson 1998). Methods to control deer mouse populations and educational programs about hantavirus and its prevention are ways to alleviate potential outbreaks of hantavirus. Zinc phosphide was tested as a rodenticide to collect efficacy data for the Environmental Protection Agency (EPA) for reregistration and to add deer mice (*Peromyscus spp.*) to the bait label.

The objective of this research was to determine the efficacy of a 1.82% zinc phosphide wheat bait and a 2.0% zinc phosphide oat groat bait for controlling deer mice. The treated wheat bait and the treated oat bait were not tested simultaneously, but were both 3-day, 2-choice tests. The second choice food used in the test was a mixture, recommended by the EPA and their Office of Pesticide Programs (OPP), called rat and mouse challenge diet (EPA 1980).

Table 1: 1.82% Wheat Bait and 2.0% Oat Groat Bait on Deer Mice (*Peromyscus maniculatus*)

A. 1.82% Wheat Bait

Group I Sex	No. dead over sample size	Treated Bait Cons x̄	Group II Sex	No. dead over sample size	Treated Bait Cons x̄	Group III Sex	No. dead over sample	Treated Bait Cons x̄	Total x̄
F	10/10	N/A	F	4/10	0.31	F	8/10	0.46	0.38
M	10/10	N/A	M	6/10	0.31	M	6/10	0.33	0.32

B. 2.0% Oat Groat Bait

Group I Sex	No. dead over sample size	Treated Bait Cons x̄	Group II Sex	No. dead over sample size	Treated Bait Cons x̄	Group III Sex	No. dead over sample	Treated Bait Cons x̄	Total x̄
F	10/10	N/A	F	9/10	0.63	F	8/10	0.62	0.62
M	10/10	N/A	M	9/10	0.91	M	6/10	0.62	0.76

C. Wheat Bait and Oat Groat Bait Comparison

Sex	Wheat Bait Cons x̄	Sex	Oat Treated Bait Cons x̄
F	0.64	F	2.27
M	0.65	M	2.26
Total	0.64		2.26

The study took place at the National Wildlife Research Center's (NWRC) Animal Research Building. A breeding colony was established from 10 breeding pairs purchased from the University of South Carolina, Columbia.

All mice weaned from the breeding pairs used in this test were held, sexes separate, under standard laboratory conditions (i.e., temperature, humidity, lighting, etc.) Comparable to those of the animal testing room until they were of adequate weight for use in tests (15-40 g).

Sixty animals (30 of each sex) were randomly selected from the total population available for each test. The mice were all weighed, ranked by weight using 10 weight classes so that each class contained 3 animals. Each mouse in the 10 weight classes was randomly assigned to one of the two concentrations [control (0.00%) and treatment (1.82% for wheat bait or 2.0% for oat bait)] for a total of 10 animals per sex, per each concentration, or a total of 20 animals per each group. A third group was a repetition of the second group. The animals were acclimated to their assigned group and test conditions for 3-days before exposure to the treated baits and the OPP rat and mouse challenge diet.

Mortality rates from the 1.82% wheat bait test on females were 4/10 = 40% and 8/10 = 80% in groups II and III (Table 1, A.), respectively, taking 1 to 2 days to die. The male group mortality rates were 6/10 = 60% for both groups II and III (Table 1, A.), taking 1 to 3 days to die. The overall mean mortality rate for this test was 60%. No control animals died.

Mortality rates from the 2.0% oat groat bait test on females were 9/10 - 90% and 8/10 = 80% in groups II and III (Table 1,B.), respectively, taking 1 to 3 days to die. The male group mortality rates were 9/10 = 90% and 6/10 = 60% for groups II and III (Table 1, B.), respectively, taking 1 to 4 days to die. The overall mean mortality rate for this test was 80%. No control animals died.

The total consumption from the mice on the wheat grain test was less than the total consumption from the mice on the oat groat test: $\bar{x}$ = 0.38 g of wheat for the females, compared to $\bar{x}$ = 0.62 g of oat groat for females; $\bar{x}$ = 0.32 g of wheat for the males, compared to $\bar{x}$ = 0.76g of oat groats for males (Table 1,A. And B.), respectively. The mortality rate for the wheat bait was below the 70% efficacy rate set by the EPA for laboratory studies (EPA 1982) and would not be adequate for the rodenticide reregistration. Since the mice were thought to be discriminating against the wheat bait, another test was run to determine if *Peromyscus* preferred oat groat baits over wheat baits. The females consumed an average of 2.27 g of oats over 0.64 g of wheat when the two baits were presented side by side. (Males ate 2.26 g of oats over 0.65 g of wheat (Table 1, C.).

LITERATURE CITED

Douglass, R. J., R. Van Horn, K. W. Coffin, and S. N. Zanto. 1996. Hantavirus in Montana Deer Mouse Populations: Preliminary Results. J. Wildl. Dis. 32(3). 527-530pp.

EPA. 1982. Pesticide Assessment Guidelines, Subdivision G: Product Performance. (96-10: Commensal Rodenticides). Pages 307-310 *in* EPA-540/9-82-026, Office of Pesticide Programs, Washington, D. C.

EPA. 1980. Standard Norway Rat Acute Dry Bait Laboratory Test Method, OPP Designation: 1.209. (8-15-80) Revision 9. J. A. McCann, editor. Biological Testing Methods for Pesticides and Devices. 4pp.

Nickerson, C. 1998. Case of Hantavirus Confirmed At Local Farm, Precautions Required. Http://www.westernwheel.com/980909/news-hantavirus.html Western Wheel News Stories. 3pp.

Taggert, K. 1997. Hanta virus Alert in South America - Southern Cone. S. Amer. Expl. Club Home Page. Http://www.samexplo.org/hanat.htm 3pp.

Timm, R. M. and W. E. Howard. 1994. White-Footed and Deer Mice. Prevention and Control of Wildlife Damage. Coop. Ext. Div., Instit. Of Ag. And Nat. Resour., Univ. of Nebraska-Lincoln. B47-B51pp.

Winters, K.(ed.) 1998. Hantavirus: What Is It and What Can Be Done About It? Montguide, MT 9404 Human Resour. Development. Http://www.montana.edu/wwpb/pubs/mt9404.html 6pp.

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PEROMYSCUS LEUCOPUS AS A POSSIBLE BIOINDICATOR OF AROCLOR 1254 CONTAMINATED SITES.

A number of hematological, immunological and biochemical parameters were measured in *Peromyscus leucopus* pups born from dams exposed to a single dose (300 mg/Kg body weight) of Aroclor 1254. In one experiment the pups were weaned at 3 weeks and examined at 6 weeks of age, in a second experiment the pups were kept with their mother for 4 weeks at which time they were examined.

The older pups showed significant decreases in: body weight, ratio of spleen weight to body weight, number of white blood cells and lymphocytes, and number and percentage of monocytes. They also showed significant increases in: stimulation index in response to the mitogen phytohemagglutinin (PHA), percentage of peripheral blood neutrophils and liver EROD induction. Pups sacrificed at 4 weeks of age showed even more significant differences. Their body and liver weights, percentage and number of lymphocytes, and serum antibody titers were lower than those of their controls; while their ratio of spleen weight to body weight, the concentration of the mitogen concanavalinA (ConA) needed to elicit the maximal proliferative response, the percent of neutrophils in their peripheral blood and their liver EROD, PROD and BROD activities were significantly higher than those of the controls.

Should the results prove consistently reproducible, pups could be used as biomonitors of contaminated sites. Females could be captured at the sites, bred in captivity with normal males, the vulnerable parameters identified in this study measured in their offspring and compared with a data base collected from normal pups.

Further studies using decreasing doses of exposure to Aroclor 1254 should define the threshold of sensitivity of this possible biomonitor.

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CONSERVATION EFFORTS FOR ENDANGERED ALABAMA BEACH MICE (*PEROMYSCUS POLIONOTUS AMMOBATES*)

This report is to summarize ongoing research and conservation efforts for the federally endangered Alabama beach mouse (*Peromyscus polionotus ammobates*). This research is aimed at evaluating potential differences in life history variables between the mice found in areas that include designated critical habitat and those occupying the unprotected coastal scrub habitat. Beach mice regularly use both habitats, but the roles of these habitats relative to beach mouse ecology and management are poorly understood.

Capture - recapture data were collected from a series of grids at Bon Secour National wildlife Refuge from December 1994 to February 1997. From these grids, we produced information on survivorship, population density, reproductive output, body mass, and home range size. Telemetry data was collected to provide more detailed information on homerange and habitat use. These variables were compared between the beach dune and scrub habitat. Bimonthly survivorship values for both habitat types were at or above the population maintenance value of 0.52 (Sankaran, 1993). Population density was 25% lower in the scrub than in the beach dunes and there were no differences in mean body mass of adult males between habitats. While the number of subadults captured was much higher in the beach areas, the proportion of subadults recaptured as adults was not different between the habitats. Analyses of homerange sizes between habitats is being completed, however, no significant difference in homerange size between sexes was found.

Detailed microhabitat maps have been digitized in ArcView GIS which will allow homeranges to be overlaid. From this, we will determine habitat use versus availability to elucidate information critical to understanding the microhabitat requirements of this species.

Additional research included characterization of burrow site selection. Radio collared mice were located in their burrow where a suite of biotic and abiotic variables were measured including plant species richness, plant diversity, burrow aspect, dune height, and soil moisture, temperature and compaction. The same variables were measured for 10 randomly selected points within 20 m of the burrow. Multivariate statistical techniques will be used to determine the most important factors influencing burrow site selection. After gathering data on movement patterns, a burrow trap was used to trap exclusively the inhabitants of a burrow to provide information on the social organization of beach mice. Burrows have generally been located within 1 meter of the dune crest and on a slope of 20 degrees.

We also have been actively involved in a cooperative re-establishment effort with the U. S. Fish and Wildlife Service. In March 1998, preparations began to relocate Alabama beach

mice to previously occupied habitat within Gulf State Park, Baldwin County Alabama. House mice (*Mus musculus*) were trapped and removed from the release site, and beach dunes were fertilized to promote vegetative growth. Starting in April 1998, beach mice were captured on private property which was scheduled for development. These mice were released into Gulf State Park, and a supplemental feeding regime was initiated and continued through the summer period of low food availability. Gulf State Park will be trapped in Fall 1998 to assess the status of this new population.

LITERATURE CITED

Sankaran, M. 1993. Population dynamics of the beach mouse (*Peromyscus polionotus trissyllepsis*): A simulation study. M. S. thesis, Auburn University, Auburn University, Alabama. 140p.

* * *

RECENT PUBLICATIONS

Allen, D. L. and D. L. Otis. 1998. Relationship between deer mouse population parameters and dieldrin contamination in the Rocky Mountain Arsenal National Wildlife Refuge. Can. J. Zool, 76:243-250.

Anderson, G. S. and B. J. Danielson. 1997. The effects of landscape composition and physiognomy on metapopulation size: The role of corridors. Landscape Ecol., 12:261-271.

Barger, J.L. and M. G. Tannenbaum. 1998. Consumption of endophyte-infected fescue seeds and osmoregulation in white-footed mice. J. Mammal., 79:464-474.

Bayne, E. M. and K. A. Hobson. 1998. The effects of habitat fragmentation by forestry and agriculture on the abundance of small mammals in the southern boreal mixedwood forest. Can. J. Zool., 76:62-69.

Bickle, C.A., M. A. Cantrell, S. N. Austad, and H. A. Wichman. 1998. Effects of domestication on telomere length in *Mus musculus* and *Peromyscus maniculatus*. FASEB J., 12:1845.

Billitti, J. E., B. L. Lasley, and B. W. Wilson. 1998. Development and validation of a fecal testosterone biomarker in *Mus musculus* and *Peromyscus maniculatus*. Biol. Reprod., 59:1023-1028.

Boone, J. D., E. W. Otteson, K. C. McGwire, P. Villard, J. E. Rowe, and S. C. St. Jeor. 1998. Ecology and demographics of hantavirus infections in rodent populations in the Walker River Basin of Nevada and California. Am. J. Trop. Med. Hyg., 59:445-451.

Bowers, K. L., M. J. Hamilton, S. M. Witte, and R. J. Baker. 1998. Origins of heterochromatic repatterning in white-footed mice, *Peromyscus leucopus*. J. Mammal., 79:725-735.

Brooks, R. T., H. R. Smith, and W. M. Healy. 1998. Small-mammal abundance at three elevations on a mountain in central Vermont, USA: A sixteen-year record. Forest Ecol. Manage., 110:181-193

Bunnell, J. E., J. S. Dumler, J. E. Childs, and G. E. Glass. 1998. Retrospective serosurvey for human granulocytic ehrlichiosis agent in urban white-footed mice from Maryland. J. Wildlife Dis., 34:179-181.

Casavant, N. C., R. N. Lee, A. N. Sherman, and H. A. Wichman. 1998. Molecular evolution of two lineages of L1 (LINE-1) retrotransposons in the California mouse, *Peromyscus californicus*. Genetics, 150:345-357.

Chae, H. E. and P. D. Heideman. 1998. Water-deprived white-footed mice express c-*fos* on a day/night cycle graded according to the duration of deprivation. Brain Res., 791:1-10.

Cole, E. C., W. C. McComb, M. Newton, J. P. Leeming, and C. L. Chambers. 1998. Response of small mammals to clearcutting, burning, and glyphosate application in the Oregon Coast Range. J. Wildlife Manage., 62:1207-1216.

Creekmore, T. E., W. O. Fletcher, and D. E. Stallknecht. 1998. Evaluation of two oral baiting systems for wild rodents. J. Wildlife Dis., 34:369-372.

Crew, M. D., R. B. Effros, R. L. Walford, E. Zeller, H. Cheroutre, and E. Brahn. 1998. Transgenic mice expressing a truncated *Peromyscus leucopus* TNF-alpha gene manifest an arthritis resembling ankylosing spondylitis. J. Interferon Cytokine Res., 18:219-225.

Crosbie, P. R. and W. M. Boyce. 1998. *Dermacentor hunteri* (Acari: Ixodidae): Seasonal variation in questing adults and on-host juvenile stages, and host associations and feeding behavior of larvae and nymphs. J. Med. Entomol., 35:1034-1043.

Cunliffe-Beamer, T. 1998. From here to there: Organizing a shipment of laboratory rodents. Lab Anim., 27:49-55.

Dearing, M. D., A. M. Mangione, W. H. Karasov, S. Morzunov, E. Otteson, and S. St. Jeor. 1998. Prevalence of hantavirus in four species of Neotoma from Arizona and Utah. J. Mammal., 79:1254-1259.

Del Cerro, M. C. R. 1998. Role of the vomeronasal input in maternal behavior. Psychoneuroendocrinol., 23:905-926.

Delker, D. A., S. J. McKnight, and D. W. Rosenberg. 1998. The role of alcohol dehydrogenase in the metabolism of the colon carcinogen methylazoxymethanol. Toxicol. Sci., 45:66-71.

Demas, G. E. and R. J. Nelson. 1998. Exogenous melatonin enhances cell-mediated, but not humoral, immune function in adult male deer mice (*Peromyscus maniculatus*). J. Biol. Rhythms, 13:245-252.

Demas, G. E. and R. J. Nelson. 1998. Photoperiod, ambient temperature, and food availability interact to affect reproductive and immune function in adult male deer mice (*Peromyscus maniculatus*). J. Biol. Rhythms, 13:253-262.

Demas, G. E. and R. J. Nelson. 1998. Short-day enhancement of immune function is independent of steroid hormones in deer mice (*Peromyscus maniculatus*). J. Comp. Physiol. B-Biochem. System. Environ. Physiol., 168:419-426.

Demas, G. E. and R. J. Nelson. 1998. Social, but not photoperiodic, influences on reproductive function in male *Peromyscus aztecus*. Biol. Reprod., 58:385-389.

Dohm, M. R., D. N. Janes, K. A. Hammond, and J. K. Roth. 1998. Effects of altitude and thyroxine supplementation on field metabolism of deer mice (*Peromyscus maniculatus*). FASEB J., 12:4189.

Duquette, L. S. and J. S. Millar. 1998. Litter sex ratios in a food-supplemented population of *Peromyscus mexicanus*. Can J. Zool., 76:623-629.

Ebensperger, L. A. 1998. Strategies and counterstrategies to infanticide in mammals. Biol. Rev. Cambridge Philosophical Soc., 73:321-346.

Ellison, L. E. and C. Van Riper, III. 1998. A comparison of small-mammal communities in a desert riparian floodplain. J. Mammal., 79:972-985.

Engelthaler, D. M., C. E. Levy, T. M. Fink, D. Tanda, and T. Davis. 1998. Short report: Decrease in seroprevalence of antibodies to hantavirus in rodents from 1993-1994 hantavirus pulmonary syndrome case sites. Am. J. Trop. Med. Hyg., 58:737-738.

Falkenberg, J. C. and J. A. Clarke. 1998. Microhabitat use of deer mice: Effects of interspecific interaction risks. J. Mammal., 79:558-565.

Feldhamer, G. A., J. C. Whittaker, and E. M. Charles. 1998. Recent records of the cotton mouse (*Peromyscus gossypinus*) in Illinois. Am. Midl. Nat., 139:178-180.

Frank, D. H., D. Fish, and F. H. Moy. 1998. Landscape features associated with Lyme disease risk in a suburban residential environment. Landscape Ecol., 13:27-36.

Frankham, R. 1998. Inbreeding and extinction: Island populations. Conserv. Biol., 12:665-675.

Galindo-Leal, C. and C. J. Krebs. 1998. Effects of food abundance on individuals and populations of the rock mouse (*Peromyscus difficilis*). J. Mammal., 79:1131-1142.

Gavrilovskaya, I., R. LaMonica, M. E. Fay, B. Hjelle, C. Schmaljohn, R. Shaw, and E. R. Mackow. 1999. New York 1 and Sin Nombre viruses are serotypically distinct viruses associated with hantavirus pulmonary syndrome. J. Clin. Microbiol., 37:122-126.

Green, W., R. Feddersen, O. Yousef, M. Behr, K. Smith, J. Nestler, S. Jenison, T. Yamada, and B. Hjelle. 1998. Tissue distribution of hantavirus antigen in naturally infected humans and deer mice. J. Infect. Dis., 177:1696-1700.

Hall, L. S. and M. L. Morrison. 1998. Responses of mice to fluctuating habitat quality II. A supplementation experiment. Southwest. Nat., 43:137-146.

Hanchey, M. F. and K. T. Wilkins. 1998. Habitat associations in the grand prairie of north-central Texas. Texas J. Sci., 50:107-122.

Hayssen, V. 1998. Effect of transatlantic transport on reproduction of agouti and nonagouti deer mice, *Peromyscus maniculatus*. Lab. Anim., 32:55-64.

Henein, K., J. Wegner, and G. Merriam. 1998. Population effects of landscape model manipulation on two behaviourally different woodland small mammals. Oikos, 81:168-186.

Hicks, N. G., M. A. Menzel, and J. Laerm. 1998. Bias in the determination of temporal activity patterns of syntopic *Peromyscus* in the southern Appalachians. J. Mammal., 79:1016-1020.

Hnida, J. A., W. D. Wilson, and D. W. Duszynski. 1998. A new *Eimeria* species (Apicomplexa: Eimeriidae) infecting *Onychomys* species (Rodentia: Muridae) in New Mexico and Arizona. J. Parasitol., 84:1207-1209.

Hofmeister, E. K., C. P. Kolbert, A. S. Abdulkarim, J. M. H. Magera, M. K. Hopkins, J. R. Uhl, A. Ambyaye, S. R. Telford, F. R. Cockerill, and D. H. Persing. 1998. Cosegregation of a novel Bartonella species with *Borrelia burgdorferi* and *Babesia microti* in *Peromyscus leucopus*. J. Infect. Dis., 177:409-416.

Hurst, L. D. 1998. Peromysci, promiscuity and imprinting. Nature Genetics, 20:315-316.

Jacquot, J. J. and S. H. Vessey. 1998. Recruitment in white-footed mice (*Peromyscus leucopus*) as a function of litter size, rarity, and season. J. Mammal., 79:312-319.

Jameson, E. W., Jr. 1998. Prepartum mammogenesis, milk production, and optimal litter size. Oecologia, 114:288-291.

Jones, C. G., R. S. Ostfeld, M. P. Richard, E. M. Schauber, and J. O. Wolff. 1998. Chain reactions linking acorns to gypsy moth outbreaks and Lyme disease risk. Science, 279:1023-1026.

Kass, D. H., J. A. Peppers, M. Maltbie, and R. J. Baker. 1998. Enrichment of a LINE subfamily in a single chromosomal region in *Peromyscus*. Mammal. Genome, 9:488-490.

Kavaliers, M., D. D. Colwell, and E. Choleris. 1998. Sex differences in opioid and N-methyl-D-aspartate mediated non-opioid biting fly exposure induced analgesia in deer mice. Pain, 77:163-171.

Kirkland, G. L., Jr., P. K. Sheppard, M. J. Shaughnessy, Jr., and B. A. Woleslagle. 1998. Factors influencing perceived community structure in nearctic forest small mammals. Acta Theriol., 43:121-135.

Koysoy, M. Y., R. L. Regnery, O. L. Kosaya, D. C. Jones, E. L. Marston, and J. E. Childs. 1998. Isolation of *Bartonella* spp. from embryos and neonates of naturally infected rodents. J. Wildlife Dis., 34:305-309.

Kriegsfeld, L. J. and R. J. Nelson. 1998. Short photoperiod affects reproductive function but not dehydroepiandrosterone concentrations in male deer mice (*Peromyscus maniculatus*). J. Pineal Res., 25:101-105.

Lacy, R. C. and J. D. Ballou. 1998. Effectiveness of selection in reducing the genetic load in populations of *Peromyscus polionotus* during generations of inbreeding. Evolution, 52:900-909.

Ladine, T. A. and A. Ladine. 1998. A multiscale approach to capture patterns and habitat correlations of *Peromyscus leucopus* (Rodentia, Muridae). Brimleyana, 25:99-109.

Levin, M. L. and D. Fish. 1998. Density-dependent factors regulating feeding success of *Ixodes scapularis* larvae (Acari: Ixodidae). J. Parasitol., 84:36-43.

Lewellen, R. H. and S. H. Vessey. 1998. Modeling biotic and abiotic influences on population size in small mammals. Oecologia, 113:210-218.

Lewellen, R. H. and S. H. Vessey. 1998. The effect of density dependence and weather on population size of a polyvoltine species. Ecol. Monographs, 68:571-594.

Lockhart, J. M., W. R. Davidson, D. E. Stallknecht, and J. E. Dawson. 1998. Lack of seroreactivity to *Ehrlichia chaffeensis* among rodent populations. J. Wildlife Dis., 34:392-396.

Lopez-Wilchis, R., J. L. Jardines, M. G. S. Hernandez. 1998. Specimens of mammals from Mexico in collections in the United States and Canada. J. Mammal., 79:1029-1037.

Loxterman, J. L., N. D. Moncrief, R. D. Dueser, C. R. Carlson, and J. F. Pagels. 1998. Dispersal abilities and genetic population structure of insular and mainland *Oryzomys palustris* and *Peromyscus leucopus*. J. Mammal., 79:66-77.

Manson, R. H., R. S. Ostfeld, and C. D. Canham. 1998. The effects of tree seed and seedling density on predation rates by rodents in old fields. Ecoscience, 5:183-190.

Manson, R. H. and E. W. Stiles. 1998. Links between microhabitat preferences and seed predation by small mammals in old fields. Oikos, 82:37-50.

Margulis, S. W. 1998. Differential effects of inbreeding at juvenile and adult life-history stages in *Peromyscus polionotus*. J. Mammal., 79:326-336.

Margulis, S. W. 1998. Relationships among parental inbreeding, parental behaviour and offspring viability in oldfield mice. Anim. Behav., 55:427-438.

Markowski, D., H. S. Ginsberg, K. E. Hyland, and R. J. Hu. 1998. Reservoir competence of the meadow vole (Rodentia: Cricetidae) for the Lyme disease spirochete *Borrelia burgdorferi*. J. Med. Entomol., 35:804-808.

Masino, A. M., S. R. Denison, and I. F. Greenbaum. 1998. Populational variation of chromosomal fragility in the deer mouse (*Peromyscus maniculatus*). Cytogenet. Cell Genet., 82:136.

Masters, R. E., R. L. Lochmiller, S. T. McMurry, and G. A. Bukenhofer. 1998. Small mammal response to pine-grassland restoration for red-cockaded woodpeckers. Wildlife Soc. Bull., 26:148-158.

Meagher, S. 1998. Physiological responses of deer mice (*Peromyscus maniculatus*) to infection with *Capillaria hepatica* (nematoda). J. Parasitol., 84:1112-1118.

Mills, J. N., J. M. Johnson, T. G. Ksiazek, B. A. Ellis, P. E. Rollin, T. L. Yates, M. O. Mann, M. R. Johnson, M. L. Campbell, J. Miyashiro, M. Patrick, M. Zyzak, D. Lavender, M. G. Novak, K. Schmidt, C. J. Peters, and J. E. Childs. 1998. A survey of hantavirus antibody in small-mammal populations in selected United States national parks. Am. J. Trop. Med. Hyg., 58:525-532.

Morrison, M. L. and L. S. Hall. 1998. Responses of mice to fluctuating habitat quality I. Patterns from a long-term observational study. Southwest. Nat., 43:123-136.

Morzunov, S. P., J. E. Rowe, T. G. Ksiazek, C. J. Peters, S. C. St Jeor, and S. T. Nichol. 1998. Genetic analysis of the diversity and origin of hantaviruses in *Peromyscus leucopus* mice in North America. J. Virol., 72:57-64.

Nelson, R. J., G. E. Demas, and S. L. Klein. 1998. Photoperiodic mediation of seasonal breeding and immune function in rodents: A multi-factorial approach. Amer. Zool., 38:226-237.

Netski, D., B. H. Thran, and S. C. St. Jeor. 1999. Sin Nombre virus pathogenesis in *Peromyscus maniculatus*. J. Virol., 73:585-591.

Nicholson, W. L., S. Muir, J. W. Sumner, and J. E. Childs. 1998. Serologic evidence of infection with *Ehrlichia* spp. in wild rodents (Muridae: Sigmodontinae) in the United States. J. Clin. Microbiol., 36:695-700.

Nupp, T. E. and R. K. Swihart. 1998. Effects of forest fragmentation on population attributes of white-footed mice and eastern chipmunks. J. Mammal., 79:1234-1343.

Ogden, N. H., K. Bown, B. K. Horrocks, Z. Woldehiwet, and M. Bennett. 1998. Granulocytic Ehrlichia infection in *Ixodid* ticks and mammals in woodlands and uplands of the UK. Med. Vet. Entomol., 12:423-429.

Oswald, C. 1998. Geographic variation and plasticity in renal function in the white-footed mouse, *Peromyscus leucopus*. J. Mammal., 79:1103-1110.

Parmenter, C. A., T. L. Yates, R. R. Parmenter, J. N. Mills, J. E. Childs, M. L. Campbell, J. L. Dunnum, and J. Milner. 1998. Small mammal survival and trapability in mark-recapture monitoring programs for hantavirus. J. Wildlife Dis., 34:1-12.

Perrot-Sinal, T. S., M. Kavaliers, and K.-P. Ossenkopp. 1998. Spatial learning and hippocampal volume in male deer mice: Relations to age. Testosterone and adrenal gland weight. Neuroscience, 56:1089-1099.

Phelix, C. F., D. M. Adai, C. Cantu, H. Chen, and M. J. Wayner. 1998. Immunohistochemical demonstration of serotonin-containing axons in the hypothalamus of the white-footed mouse, *Peromyscus leucopus*. Brain Res., 808:197-219.

Qualls, C. W., R. A. Lubet, R. L. Lochmiller, C. S. Elangban, J. W. Lish, and R. W. Nims. 1998. Cytochrome P450 induction in feral Cricetid rodents: A review of field and laboratory investigations. Comp. Biochem. Physiol. C-Pharmacol. Toxicol. Endocrinol., 121:55-63.

Ribble, D. O. and S. Stanley. 1998. Home ranges and social organization of syntopic *Peromyscus boylii* and *P. truei*. J. Mammal., 79:932-941.

Richter, D., A. Spielman, and F. R. Matuschka. 1998. Effect of prior exposure to noninfected ticks on susceptibility of mice to Lyme disease spirochetes. Appl. Environ. Microbiol., 64:4596-4599.

Rodriguez, L. L., J. H. Owens, C. J. Peters, and S. T. Nichol. 1998. Genetic reassortment among viruses causing hantavirus pulmonary syndrome. Virology, 242:99-106.

Schnepf, K. A., J. A. Heselmeyer, and D. O. Ribble. 1998. Effects of cutting Ashe juniper woodlands on small mammal populations in the Texas hill country (USA). Nat. Areas J., 18:333-337.

Sikes, R. S. 1998. Tradeoffs between quality of offspring and litter size: Differences do not persist into adulthood. J. Mammal., 79:1143-1151.

Sinclair, J. A., R. L. Lochmiller, C. W. Qualls, and C. C. Cummings. 1998. Alopecia associated with post-juvenile molt in a wild population of *Peromyscus maniculatus*. Southwest. Nat., 43:405-407.

Sorensen, T. C. and R. A. Moses. 1998. Host preferences and temporal trends of the tick *Ixodes angustus* in north-central Alberta. J. Parasitol., 84:902-906.

Staubs, P. A. and E. L. Bradley. 1998. Oxygen consumption and carbon dioxide production in male prairie deermice (*Peromyscus maniculatus bairdii*) in different reproductive conditions and group densities. Comp. Biochem. Physiol., 119A:287-294.

Stoyanovsky, D. A. and A. I. Cederbaum. 1998. ESR and HPLE-EC analysis of ethanol oxidation to 1-hydroxyethyl radical: Rapid reduction and quantification of POBN and PBN nitroxides. Free Rad. Biol. Med., 25:536-545.

Sullivan T. P., C. Nowotny, R. A. Lautenschlager, and R. G. Wagner. 1998. Silvicultural use of herbicide in sub-boreal spruce forest: Implications for small mammal population dynamics. J. Wildlife Manage., 62:1196-1206.

Sullivan, T. P., D. S. Sullivan, E. J. Hogue, R. A. Lautenschlager, and R. G. Wagner. 1998. Population dynamics of small mammals in relation to vegetation management in orchard agroecosystems: Compensatory responses in abundance and biomass. Crop Prot., 17:1-11.

Swilling, W. R., M. C. Wooten, N. R. Holler, and W. J. Lynn. 1998. Population dynamics of Alabama beach mice (*Peromyscus polionotus ammobates*) following Hurricane Opal. Am. Midl. Nat., 140:287-298.

Tannenbaum, M. G., S. L. Seematter, and D. M. Zimmerman. 1998. Endophyte-infected and uninfected fescue seeds suppress white-footed mouse (*Peromyscus leucopus*) reproduction. Am. Midl. Nat., 139:114-124.

Telford, S. R. 1998. Focal epidemic of sarcoptid (Acarina: *Sarcoptidae*) mite infestation in an insular population of white-footed mice. J. Med. Entomol., 35:538-542.

Terman, C. R. 1998. Early-summer reproductive curtailment in wild white-footed mice and reproductive recovery in the laboratory. J. Mammal., 79:320-325.

Unice, S. M. M., D. W. Hale, and I. F. Greenbaum. 1998. Karyotypic variation in populations of deer mice (*Peromyscus maniculatus*) from eastern Canada and the northeastern United States. Can. J. Zool., 76:584-588.

Van Buskirk, J. and R. S. Ostfeld. 1998. Habitat heterogeneity, dispersal, and local risk of exposure to Lyme disease. Ecol. Appl., 8:365-378.

Vander Wall, S. B. 1998. Foraging success of granivorous rodents: Effects of variation in seed and soil water on olfaction. Ecology, 79:233-241.

Von Trebra, C., D. P. Lavender, and T. P. Sullivan. 1998. Relations of small mammal populations to even-aged shelterwood systems in sub-boreal spruce forest. J. Wildlife Manage., 62:630-642.

Vrana, P. B., X-J. Guan, R. S. Ingram, and S. M. Tilghman. 1998. Genomic imprinting is disrupted in interspecific *Peromyscus* hybrids. Nature Genetics, 20:362-365.

Vrana, P. B. and S. M. Tilghman. 1998. Altered genomic imprinting in the rodent genus *Peromyscus*. Develop. Biol., 198:246.

Waters, J. R. and C. J. Zabel. 1998. Abundances of small mammals in fir forests in northeastern California. J. Mammal., 79:1244-1253.

Whittaker, J. C., G. A. Feldhamer, and E. M. Charles. 1998. Captures of mice, *Peromyscus*, in two sizes of Sherman live traps. Can. Field-Nat., 112:527-529.

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