# PEROMYSCUS NEWSLETTER

NUMBER TWO

SEPTEMBER 1986

Cover: *Peromyscus maniculatus*.

Sketched by Victoria C. Hollowell

from a "platinum" mutant animal.

## OFF TO A GOOD START.....

We are immensely pleased by the response to our first PEROMYSCUS NEWSLETTER. We received many favorable comments and much encouragement. The suggestions and ideas for future issues are appreciated, and we hope that you will continue to provide them. We also are most gratified by your willingness to share reports of Peromyscus research in progress. We believe the individual contributed reports greatly enhance the scope and value of our effort. As we undertake this second issue, we hope you will continue to lend us your support and advice.

We mailed approximately 170 copies of the first newsletter. Since then we have added another 50 or more names to our mailing list including 35 individuals who signed up at the Amer. Soc. Mammalogists meeting in Madison. There may still be others involved with Peromyscus who would benefit from the newsletter. We hope that they can be located and get on the mailing list. Spread the word.

In this second issue we are concentrating on the genetics of species other than P. maniculatus. A listing of genetic loci of P. maniculatus and its sibling species was given in the first issue and will be updated in the third (March 1987) issue. In the current issue are lists of loci identified in P. leucopus, P. truei and P. boylii and other members of their respective species groups. Most of loci in these species are known from biochemical polymorphisms in natural populations. In future issues we will update all of the gene lists and add those for still other species.

We also have in this issue the first resume on Peromyscus molecular genetics, a feature we expect to include in alternate issues. In this section we will list DNA libraries, available probes, genes (or proteins) which have been sequenced, mitochondrial DNA variants and other information.

We are attempting to develop a system for standardizing cytogenetic nomenclature, so that variation between and within species can be given with reference to the standard karyotype. Oscar Ward is working with Ira Greenbaum, Lynn Robbins, Robert Baker and others on this. In an issue next year we hope to present the known cytogenetic variation in Peromyscus in tabular form. If you have thoughts concerning this, you should contact Dr. Ward, Dept. Zoology, University of Arizona, Tuscon.

We want to stress again that **PEROMYSCUS NEWSLETTER** is not a formal journal and information from it should not be cited without permission of the contrbutor. Also, in generating tables of known loci, chromosome variations, etc. we are using only previously published information, excluding abstracts. Reports in **PEROMYSCUS NEWSLETTER** do not constitute "publication" in the usual academic or scientific sense. For this reason we encourage informal entries reporting work-in-progress, tentative results, Peromyscus stocks on hand and other information which may not be appropriate in a formal journal. Entries in the newsletter are given verbatim and edited only for consistent format.

Our historical sketch for this issue features **Francis B. Sumner**, a true pioneer "peromyscologist". Betty Horner was very kind to give us a copy of Sumner's "**Autobiography of an American Naturalist**" from which much of the information was obtained. We also want to thank Debra Day, Archivist at Scripps Institute, and William Provine, Professor of History at Cornell, for providing additional information.

Our first **PEROMYSCUS NEWSLETTER** also led to our receiving a copy of the first issue of **MOUSE NEWS LETTER** (originally called "**Mouse Genetic News**") from Sue VanOoteghem. It is dated November, 1941. It is noteworthy that L. R. Dice (U. Michigan) and R. R. Huestis (U. Oregon) reported the Peromyscus genetic variants in their stocks. Reports of Peromyscus genetics appeared periodically in **MOUSE NEWS LETTER** for many years.

We hope you enjoy and benefit from this second **PEROMYSCUS NEWSLETTER**, and once again solicit your entries, suggestions and comments.

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C O N T E N T S



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NEWS AND COMMENT...

P. LEUCOPUS COLOR MUTATIONS. Coat color mutations in P. leucopus have appeared recently at three locations. A pronounced diluted mutant white-footed mouse appeared and was bred by King, Haigh, Robbins and Cushing at Michigan State. This mutant is now being maintained at the Peromyscus Stock Center at the University of South Carolina. Betty Horner, at Smith College, has a couple of P. leucopus which appear to be equivalent to brown in the deer mouse. Jack Cranford at Virginia Tech has some P. leucopus that are nearly albino, possibly homologous with ivory in P. maniculatus. Preliminary data suggest that each of the mutants is recessive. The only published reports of coat color variants in P. leucoupus were by Castle (1912) who recorded and bred albinos, and Morgan (1911) who investigated inheritance of the "ammodytes" pattern in Massachusetts populations.

Ron Barry (Frostburg State) has sent us photographs of what appears to be a brown P. maniculatus nubiterrae he caught on his study site in June. The brown mutation has been reported several times previously in P. maniculatus, and a stock is maintained at the Peromyscus Stock Center at South Carolina.

* * * *

BRUCE BUTTLER has completed his first Bibliography of Peromyscus (Rodentia) Genetics. It lists citations of more than 400 papers on Peromyscus genetics. It also contains a historical analysis of the numbers of papers published by decade as well as by three year blocks for those published since 1968. Anyone involved with Peromyscus genetics, reproduction and evolution will benefit from this handy reference. It is available from Bruce Buttler, Department of Biology, Canadian Union College, College Heights, Alberta, Canada (TOC OZO).

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Twenty four papers featuring Peromyscus were presented at the 66th Annual Meeting of the American Society of Mammalogists held at Madison WI 15-19 June 1986.

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LYME DISEASE.... The importance of P. leucopus and P. maniculatus as a reservoir host for the spirochete agent responsible for Lyme disease is receiving much attention in medical circles and in the popular press. The pathogen Borrelia burgdorferi is transmitted by ticks of the genus Ixodes. The disease produces sometimes severe symptoms in humans, but there are no noticible pathological effects in white-footed mice. Lyme disease is a "new disease", only recognized in the last few years.

**Ira Greenbaum** and **Joseph Nadeau** have been added to the Advisory Committee of the Peromyscus Stock Center. John ("Jack") King has retired.....

.....and speaking of Ira Greenbaum, he and his active group at Texas A&M have been publishing like gangbusters lately. He has at least eight papers in the past couple of years dealing with **Peromyscus**. The Greenbaum group has greatly clarified the long-standing riddle of relationships among populations of **P. maniculatus, P. oreas**, etc. in the Pacific Northwest. One of Ira's students, Marc Allard, has joined Rodney Honeycutt at Harvard Museum to undertake Ph.D. studies. Kim Nelson, formerly a student of Robert Baker at Texas Tech, is also currently with Honeycutt.

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**Lee R. G. Snyder Memorial Fund**

A memorial fund to support graduate student research in evolutionary biology has been established in recognition of Lee Snyder, who passed away last year. Contributions may be directed to Mary Price or N. Waser, Dept. Biology, Univ. of California-Riverside, Riverside CA 92521. Lee had been very active in **Peromyscus** ecological genetics.

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**ANN BAKER** is soliciting data from individuals who trap **Mus** and **Peromyscus** in their houses. We are enclosing a form with this issue which can be used to enter information to be sent to her. She will appreciate any data which can be provided for her study.

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**CONGRATULATIONS** to **ELIZABETH ("BETTY") HORNER** who was recognized with a special award from the American Society of Mammalogists at the 1986 meeting for her many contributions to mammalogy. In addition to a certificate, she received a **Peromyscus** exquisitely sculpted in wood.

We have received cards and letters which include comments and suggestions that may be of interest. We want to share portions of these with our readers:

W. A. Fuller....."My first project in retirement is to build a house, which we are now doing. After that I hope to get back to my Peromyscus data and get some of it published.".

Alden Lackey (SUNY-Oswego) makes this suggestion: "In view of the demise of Recent Literature in the Journal of Mammalogy -- a source of literature citations I found very useful over the years -- I suggest that a note be included in the PEROMYSCUS NEWSLETTER (PN) asking for suggestions on how subscribers to the PN might compensate for that loss of information. The use of computer searches is only part of a possible answer because it is likely some institutions charge for the searches, and I have found the searches to miss important citations. It seems to me that the general availability of personal and other computers should make it possible for interested subscribers to prepare something similar to Recent Literature, without a great deal of effort by any one person. Perhaps those who wish to contribute to such a cooperative effort could enter the citations they have located onto a floppy disk (with appropriate key word(s) for each citation) and send the disk to the editor, who could then transfer them to a single disk for sorting according to keywords and printing for the PN; at some future date, a single printing of several years' worth of these citations could then be printed and sold at cost. It would be necessary, of course, that all who contributed to the process use the same kind (or compatible) computer; if such is not possible, perhaps arrangements could be made to transfer the information to the appropriate computer."

Paul A. Moody....."Thank you for remembering me. It has been many years since I have been concerned in any way with Peromyscus. I wish you every success with your publication..... My, how I do date back! I was one of the two first graduate students Lee R. Dice had. He was just getting started on his Peromyscus research. Must be that has something to do with my now being 83 1/2 years old!"

We have also heard from Pat Daugherty (East Carolina), Ron Barry (Frostburg State), Don Dewsbury (Florida), Betty Horner (Smith College), Ramone Baccus (Mountain Lake Laboratory) and others with words of encouragement for the NEWSLETTER.

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DEADLINE FOR ENTRIES IN PEROMYSCUS NEWSLETTER # 3 is 31 Jan 87.

## Francis B. Sumner

1874 - 1945

The classic investigations of Francis B. Sumner, summarized in his monographic "Genetic, Distributional and Evolutionary Studies of the Subspecies of Deer Mice (Peromyscus)" (1932), were among the first comprehensive studies of mammalian population genetics. His work provided major impetus to the neo-Darwinian synthesis during the following decades and established Peromyscus as an ideal group for evolutionary and speciation studies. It was upon this foundation that subsequent research by L. R. Dice, W. F. Blair and many others was based. The Peromyscus studies also led to Sumner's notable conversion from Lamarkianism to neo-Darwinism. Largely because of his Peromyscus work between 1913 and 1930, Sumner was elected to the National Academy of Science and received other honors and distinctions.

Francis Sumner was born at Pomfret, Connecticut, August 1, 1874, the second of three children. His youth was marked by an unorthodox upbringing and family discord. His father was an eccentric itinerant who moved the family successively to California, Colorado, Minnesota and Maryland. Sumner obtained his undergraduate degree from the University of Minnesota in 1894. It was here under professor Henry Nachtrieb that Sumner embarked on a serious interest in zoology, and was employed during two summers collecting freshwater fish. Following a period of uncertainty after completion of his undergraduate studies and a summer junket to Rio de Janeiro, he enrolled, with the financial support of an aunt, in graduate school at Columbia University and soon was engaged in research on fish embryology. At Columbia he was influenced by E. B. Wilson, the pioneer experimental embryologist, Henry Fairfield Osborn, the paleontologist, and Bashford Dean, who was his principal adviser. While in graduate school he travelled to the famous biological research station at Naples and to Egypt to collect the lungfish Polypterus. He completed his Ph.D. in 1901. From 1899 until 1905 he was on the faculty of City College of New York in a teaching position he largely detested. During this period Sumner married Margaret E. Clark, a minister's daughter. While at CCNY he began spending his summers at Woods Hole research station, and was eventually was appointed director of the U. S. Bureau of Fisheries laboratory there, a position he retained until 1911. He continued to conduct fisheries research including studies of color changes in flatfish and temperature tolerances in Fundulus, work which impinged on his interest in the inheritance of acquired characteristics. He also conducted a Lamarkian experiment on temperture effects upon physical features of white mice. Two years of mouse studies yielded ambiguous results, but represented a shift from fish to rodents.

In 1911 his laboratory director position was reduced to part time and Sumner accepted a position on the research vessel "Albatross" surveying the California coast, a situation which brought him into association with the zoology faculty at the University of California, including the mammalogist Joseph Grinnell. Through the U.C. associations he acquired an appointment at the Scripps Institution at La Jolla in 1913. It was at Scripps that Sumner's **Peromyscus** studies were conducted.

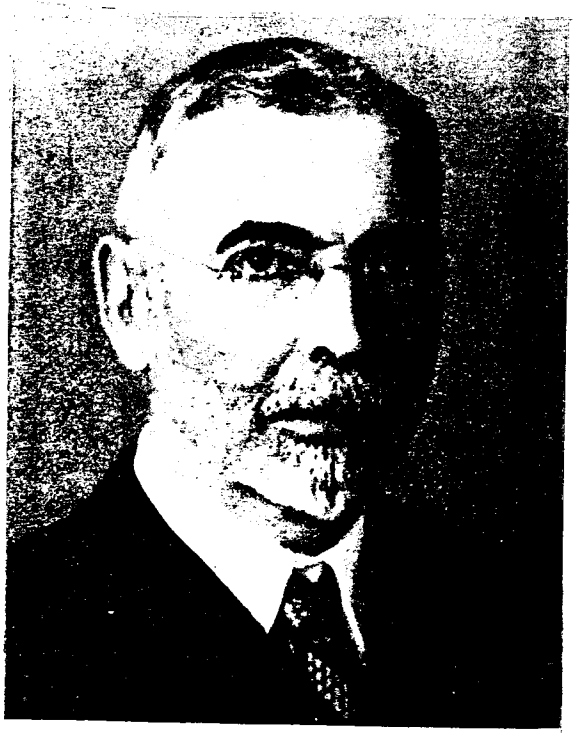
At the outset of his **Peromyscus** work Sumner was primarily interested in the effect of the environment, particularly temperature and humidity, on coat color differences observed between the subspecies **P. maniculatus gambeli**, **P. m. rubidus** and **P. m. sonoriensis**. He collected and made colorometric measurements on large series of animals, and raised and hybridized races of **Peromyscus** in captivity. In 1917 (**Genetics** 2:291-300) he reported the first two deermouse mutants, yellow and "albinic" (pink-eyed dilution). At this point Sumner was convinced that natural continuous variation, as observed between subspecies, had an environmentally acquired basis, and differed fundamentally from Mendelian inheritance which he thought applied only to discrete mutants or "sports" that arose accidentally or under domestication, and which had no relevance to evolution in nature. His analysis of the **P. maniculatus** races did not furnish a firm conclusion.

In 1920 Ralph Huestis, who had been working with the geneticists E. B. Babcock and Roy Clausen at Berkeley, joined Sumner to undertake Ph.D. studies. Huestis initiated a parallel study with two subspecies of **P. eremicus**. Huestis' results (1925. J. Exp. Zool. 41:429-470) were consistent with a Mendelian multiple factor hypothesis, although they still did not provide conclusive evidence against a Lamarkian interpretation.

About 1923 Sumner learned of the extremely pale and distinct races of beach mice (**P. polionotus**) which occur in the Florida panhandle. Collection trips in 1924 and 1927 together with analysis of laboratory-produced hybrids convinced him that racial variation in **P. polionotus** could be interpreted only in terms of the multiple factor extension of mendelism. Near Chipley, Florida, he found a narrow zone of intergradation between the darker inland race and the paler beach form. He concluded that the pale races residing on light sand soils were produced by natural selection favoring "small hereditary differences" which accumulated to produce coloration typical of the subspecies. It is noteworthy that Sumner utilized the formula of Sewall Wright in estimating the number of genetic loci involved in coat color differences. These landmark studies were published in a series of papers in the **Journal of Mammalogy** and **Proceedings of the National Academy of Sciences** between 1926 and 1929. A summary paper on the **P. polionotus** work appeared in **Journal of Genetics** (23:275-376) in 1930, and then in 1932 Sumner published his **Bibliographia Genetica** (9:1-104) monograph cited above covering his seventeen years of study of **Peromyscus** evolution.

During the period of his **Peromyscus** work Sumner enjoyed the active interest and support of William Ritter, then director of the Scripps Institution, and of E. W. Scripps, the founder. However, by the late 1920's the mission of the Institution had become directed more specifically to oceanography, and the **Peromyscus** work was not appropriate. In spite of plans to continue mouse work Sumner was coerced into returning to fish research beginning in 1930, His stocks of **Peromyscus** passed to Dice at Michigan and to Huestis who was now at the University of Oregon. Sumner continued to work with fish until the 1940's.

Sumner died September 6, 1945 at LaJolla. He was survived by his wife, two daughters and a son. The same year as his death his autobiography **"The Life History of an American Naturalist"** was published. A biographical assessment **"Francis B. Sumner and the Evolutionary Synthesis"** by William Provine in **Studies in the History of Biology** (1979, 3:211-240) and an extensive obituary by Charles Manning Child in **Biographical Memoirs of the National Academy of Sciences** (1948, 25:147-173) provide a wealth of information concerning this Peromyscus Pioneer. These works describe a facinating, introverted, self-analytical individual whose philosophy was frequently out of the mainstream, but who yet accepted many of the predjudices and stereotypes of his times. Photographs, letters and other materials are retained in the archives of Scripps Institute. Sumner will long be remembered as the "Father of Peromyscus genetics", and as an example of a scientist who had the integrity and courage to repudiate a strongly held and publicly proclaimed viewpoint because of the force of his own data.



Francis B. Sumner

## PEROMYSCUS STOCK CENTER

The deer mouse colony at the University of South Carolina has been designated a genetic stock center under a grant from the Biological Resources 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. 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.

Peromyscus types currently available in the 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. maniculatus** (SM Stock) | Closed colony since 1978. Derived from ancestors wild-caught in southern California Combined *sonoriensis* and *gambelii* ancestry. |
| **P. maniculatus rufinus** (CO Stock) | New stock under development. In captivity since 1983. Origin central Colorado. |
| **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. leucopus** (LL Stock) | Derived from 38 wild ancestors captured between 1982 and 85 near Linville NC. Early generations. |
| **P. maniculatus X P. polionotus** $F_1$ Hybrids | Sometimes available. |

MUTATIONS IN THE SOUTH CAROLINA STOCK CENTER:

| COAT COLOR MUTANTS | ORIGINAL SOURCE |
|---|---|
| Albino c/c | Sumner,s albino deer mice (Sumner, 1922) |
| 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. |
| 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 $A^{WB}/-$ | Natural polymorphism. Univ. Michigan stock (McIntosh, 1954) |
| Yellow y/y | Sumner's original mutant. (Sumner, 1917) |

| OTHER MUTANTS 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) |
| Flexed-tail **f/f** | Probably derived from Huestis flexed-tail (Huestis and Barto, 1936) |
| Hairless-1 **hrl/hrl** | Sumner's hairless (Sumner, 1924) |
| Hairless-2 **hre/hre** | Egoscue's hairless (Egoscue, 1962) |

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

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Small numbers of other stocks, mutants and variants are on hand, or under development, but are not currently available for distribution. For additional information of details about any of these mutants or stocks contact:

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The Advisory Committee for the Peromyscus Stock Center:

John C. Avise (University of Georgia)
Ira F. Greenbaum (Texas A and M University)
Clement L. Markert (North Carolina State University)
Joseph H.Nadeau (Jackson Memorial Laboratory)
Suellen Van Ooteghem (Wright State University)
Wallace D. Dawson (University of South Carolina)

GENETIC LOCI IN THE

PEROMYSCUS LEUCOPUS, P. TRUEI AND P. BOYLII

SPECIES GROUPS

Table I lists the genetic loci which have been described in P. leucopus and P. gossypinus based on formal genetic analysis of laboratory matings. The albino mutant in P. leucopus, reported by W. E. Castle in 1912 was the first mutation recorded in any species of Peromyscus. Since that time most laboratory genetic studies have centered on P. maniculatus, thus the formally recognized loci in P. leucopus and other species are few compared with those in the deer mouse. In P. truei only a single locus, Es-1 with two alleles ($Es\text{-}1^{100}$ = fast electromorph and $Es\text{-}1^{85}$ = slow electromorph, co-dominantly inherited) described by Zimmerman and Kilpatrick (1975), has been reported. No other loci analyzed by formal genetics in the P. truei or P. boylii species groups have been published.

Tables II, III and IV list genetically variant loci known from biochemical polymorphisms in natural populations of members of the P. leucopus, P. truei and P. boylii species groups respectively. Reports of monomorphic loci are not reported. Since different investigators may not have employed the same methods or criteria in defining genetic loci, identity or homology of loci reported by different workers may not necessarily be inferred from the locus or allele designation either within or between species. Where different alleles at a locus are recorded in a given investigation in different members of the same species group, but each species is monomorphic for one allele, the locus is recorded as "polymorphic" since the sister species may be able to hybridize in captivity, and formal analysis and/or linkage studies potentially could be conducted.

For both formally described loci and genetic variants recorded in natural populations, only those are listed which have been reported in publication form, abstracts not included. Full citation for references in the tables are given in Bibliography of Peromyscus (Rodentia) Genetics which may be obtained from Bruce Buttler, Biology Department, Canadian Union College, College Heights, Alberta, Canada, TOC OZO. Full citation to most recent papers (1984 - 1986) are given in the "Recent Peromyscus Literature" section of this newsletter.

TABLE I

GENETIC LOCI IN THE PEROMYSCUS LEUCOPUS SPECIES GROUP

DEFINED BY FORMAL GENETIC ANALYSIS

| Name of locus | Symbol and alleles | Mode of inheritance | Reference |
|---|---|---|---|
| ALBINO | c = albino<br>(C = pigmented) | recessive | Castle (1912) |
| CARBONIC ANHYDRASE | $Ca^f$ = fast electromorph<br>$Ca^s$ = slow electromorph | co-dominance | Wilmot and Underhill (1972) |
| CATALASE | $Cs^a$ = fast electromorph<br>$Cs^b$ = slow electromorph | co-dominance | Jensen (1969) |
| ESTERASE-1 | $Es\text{-}1^a$ = null<br>$Es\text{-}1^b$ = erythrocytic band | semi-dominant | Wilmot and Underhill (1973) |
| ESTERASE-2 | $Es\text{-}2^a$ = null<br>$Es\text{-}2^b$ = fast serum electromorph | semi-dominant | Wilmot and Underhill (1973) |
| HEMOGLOBIN | $Hb^A$ = type A in P. gossypinus<br>$Hb^B$ = type B in P. gossypinus<br>$Hb^O$ = type C in P. gossypinus<br>$Hb^D$ = P. leucopus type | co-dominance | Foreman (1966) |

TABLE II

BIOCHEMICAL GENETICALLY VARIANT LOCI REPORTED IN NATURAL POPULATIONS OF PEROMYSCUS OF THE P. LEUCOPUS SPECIES GROUP.

| Protein | Locus Symbol | Species | References |
|---|---|---|---|
| ALBUMIN | Alb | P. leucopus<br>P. gossypinus | Brown and Welser (1968)<br>*Jensen and Rasmussen (1971)<br>Browne (1977)<br>Price and Kennedy (1984)<br>Robbins et al. (1985) |
| ALCOHOL DEHYDROGENASE | Adh-1 | P. leucopus | Robbins et al. (1985) |
| AMYLASE | Amy-1 | P. leucopus | Aquadro and Patton (1980) |
| CARBONIC ANHYDRASE | Ca-1 | P. leucopus | Wilmot and Underhill (1972) |
| ESTERASE | Es-1<br>Es-2<br>Es-3<br>Es-4<br>Es-5<br>Es-9 | P. leucopus<br>P. gossypinus | Price and Kennedy (1980)<br>Wilmot and Underhill (1973)<br>Browne (1977)<br>Smith et al. (1984)<br>Robbins et al. (1985) |
| GLUTAMATE OXALOACETATE TRANSAMINASE | Got-1 | P. leucopus | Price and Kennedy (1980) |
| alpha-GLYCEROPHOSPHATE DEHYDROGENASE | Gpd-1<br>Gpd-2 | P. leucopus<br>P. gossypinus | Mascarello and Shaw (1973)<br>Browne (1977)<br>Robbins et al. (1985) |
| GLUCOSE PHOSPHATE ISOMERASE | Gpi-1 (Pgi-1) | P. leucopus<br>P. gossypinus | Price and Kennedy (1980)<br>Robbins et al. (1985) |
| HEMOGLOBIN | Hb | P. leucopus<br>P. gossypinus | Foreman (1966)<br>Price and Kennedy (1980) |
| ISOCITRATE DEHYDROGENASE | Icd-1 (Idh-1) | P. gossypinus | Robbins et al. (1985) |
| LACTATE DEHYDROGENASE | Ldh-1 | P. leucopus | Robbins et al. (1980) |
| NUCLEOSIDE PHOSPHORYLASE | Np-1 | P. gossypinus | Smith et al. (1984) |
| PHOSPHOGLUCONATE DEHYDROGENASE | Pgd-1 | P. leucopus | Robbins et al. (1985) |
| PHOSPHOGLUCOSE MUTASE | Pgm-1 | P. leucopus<br>P. gossypinus | Mascarello and Shaw (1973)<br>Browne (1977)<br>Price and Kennedy (1980)<br>Robbins et al. (1985) |
| SUPEROXIDE DISMUTASE | Sod-1 (Ipo-1, Tetra-1) | P. leucopus<br>P. gossypinus | Mascarello and Shaw (1973)<br>Browne (1977)<br>Price and Kennedy (1980)<br>Robbins et al. (1985) |
| TRANSFERRIN | Trf | P. leucopus<br>P. gossypinus | Price and Kennedy (1980)<br>Davin et al. (1984)<br>Robbins et al. (1985) |

TABLE III

BIOCHEMICAL GENETICALLY VARIANT LOCI REPORTED IN NATURAL POPULATIONS OF MEMBERS OF THE PEROMYSCUS TRUEI SPECIES GROUP.

| Protein | Locus Symbol | Species | References |
|---|---|---|---|
| ALBUMIN | Alb | P. truei<br>P. difficilis | Brown and Welser (1968)<br>Jensen and Rasmussen (1971)<br>Johnson and Packard (1974)<br>Zimmerman et al. (1975)<br>Avise et al. (1979) |
| ESTERASE | Es-1<br>Es-2<br>Es-3<br>Es-4<br>Es-5<br>Es-6 | P. truei<br>P. difficilis | Rasmussen and Jensen (1971)<br>Johnson and Packard (1974)<br>Zimmerman et al. (1975) |
| GLUTAMATE OXALOACETATE TRANSAMINASE | Got-1 | P. truei<br>P. difficilis | Zimmerman et al. (1975)<br>Avise et al. (1979) |
| alpha-GLYCEROPHOSPHATE DEHYDROGENASE | Gpd-1<br>Gpd-2 | P. truei<br>P. difficilis | Mascarello and Shaw (1973)<br>Johnson and Packard (1974)<br>Avise et al. (1979) |
| ISOCITRATE DEHYDROGENASE | Idh-1 | P. truei | Mascarello and Shaw (1973)<br>Johnson and Packard (1974)<br>Avise et al. (1979) |
| LACTATE DEHYDROGENASE | Ldh-1 | P. truei | Mascarello and Shaw (1973) |
| 6-PHOSPHOGLUCONATE DEHYDROGENASE | Pgd-1 | P. truei<br>P. difficilis | Mascarello and Shaw (1973)<br>Johnson and Packard (1974)<br>Zimmerman et al. (1975)<br>Avise et al. (1979) |
| PHOSPHOGLUCOSE ISOMERASE | Gpi-1<br>Pgi-1 | P. truei<br>P. difficilis | Avise et al. (1979) |
| PHOSPHOGLUCOMUTASE | Pgm-1<br>Pgm-2<br>Pgm-3 | P. truei<br>P. difficilis | Mascarello and Shaw (1973)<br>Johnson and Packard (1974) |
| TRANSFERRIN | Trf | P. truei<br>P. difficilis | Avise et al. (1979)<br>Johnson and Packard (1974) |

TABLE 1.
BIOCHEMICAL GENETIC POLYMORPHIC LOCI REPORTED IN NATURAL POPULATIONS OF SPECIES OF THE PEROMYSCUS BOYLII GROUP.

| Protein | Locus Symbol | Species | References |
|---|---|---|---|
| ALBUMIN | Alb | P. boylii<br>P. pectoralis | Jensen and Rasmussen (1971)<br>Avise et al. (1974)<br>Kilpatrick and Zimmerman (1975)<br>Zimmerman et al. (1975)<br>Kilpatrick and Zimmerman (1976a)<br>Kilpatrick (1984)<br>Rennert and Kilpatrick (1986) |
| AMYLASE | Amy-1 | P. boylii | Rennert and Kilpatrick (1986) |
| CARBONIC ANHYDRASE | Car-1 | P. boylii | Rennert and Kilpatrick (1986) |
| ESTERASE | Es-1<br>Es-5<br>Es-6<br>Es-7 | P. boylii<br>P. attwateri<br>P. pectoralis<br>P. polius | Rasmussen and Jensen (1971)<br>Avise et al. (1974)<br>Kilpatrick and Zimmerman (1975)<br>Zimmerman et al. (1975)<br>Kilpatrick and Zimmerman (1976a)<br>Kilpatrick (1984)<br>Rennert and Kilpatrick (1986) |
| GLUTAMATE OXALOACETATE TRANSAMINASE | Got-1 | P. boylii<br>P. pectoralis | Avise et al. (1974)<br>Kilpatrick and Zimmerman (1975)<br>Zimmerman et al. (1975)<br>Kilpatrick and Zimmerman (1976a)<br>Kilpatrick (1984)<br>Rennert and Kilpatrick (1986) |
| alpha-GLYCEROPHOSPHATE DEHYDROGENASE | Gpd-1<br>Gpd-2 | P. boylii<br>P. pectoralis | Mascarello and Shaw (1973)<br>Avise et al. (1974) |
| GLUCOSE 6-PHOSPHATE DEHYDROGENASE | ~~G6pd-1~~ H6pd-1 | P. pectoralis | Avise et al. (1974)<br>Kilpatrick (1984)<br>Rennert and Kilpatrick (1986) |
| HEMOGLOBIN | Hb-1<br>Hb-2 | P. boylii<br>P. pectoralis<br>P. attwateri | Rasmussen et al. (1968)<br>Avise et al. (1974)<br>Kilpatrick and Zimmerman (1975)<br>Zimmerman et al. (1975)<br>Kilpatrick and Zimmerman (1976a)<br>Kilpatrick and Zimmerman (1976b)<br>Kilpatrick (1984) |
| HEXOSE 6-PHOSPHATE DEHYDROGENASE | H6pd-1 | P. boylii | Rennert and Kilpatrick (1986) |
| ISOCITRATE DEHYDROGENASE | Idh-1 | P. boylii<br>P. pectoralis<br>P. attwateri | Mascarello and Shaw (1973)<br>Avise et al. (1974)<br>Kilpatrick and Zimmerman (1976a)<br>Kilpatrick (1984)<br>Rennert and Kilpatrick (1986) |
| LACTATE DEHYDROGENASE | Ldh-1<br>Ldh-2<br>Ldh-3 | P. boylii<br>P. pectoralis<br>P. polius | Mascarello and Shaw (1973)<br>Avise et al. (1974)<br>Kilpatrick and Zimmerman (1975)<br>Kilpatrick and Zimmerman (1976)<br>Kilpatrick (1984) |
| LEUCINE AMINOPEPTIDASE | Lap-1 | P. boylii<br>P. attwateri | Kilpatrick (1984) |
| MALATE DEHYDROGENASE | Mdh-1 | P. boylii<br>P. pectoralis | Avise et al. (1974)<br>Kilpatrick and Zimmerman (1976) |
| PHOSPHOGLUCONATE DEHYDROGENASE | Pgd-1 | P. boylii<br>P. pectoralis | Avise et al. (1974)<br>Kilpatrick and Zimmerman (1975)<br>Zimmerman et al. (1975)<br>Kilpatrick and Zimmerman (1976) |
| PHOSPHOGLUCOSE ISOMERASE | Pgi-1 | P. boylii<br>P. pectoralis<br>P. attwateri | Avise et al. (1974)<br>Kilpatrick (1984)<br>Rennert and Kilpatrick (1986) |
| PHOSPHOGLUCOMUTASE | Pgm-1<br>Pgm-2<br>Pgm-3 | P. boylii<br>P. pectoralis | Mascarello and Shaw (1973)<br>Avise et al. (1974)<br>Kilpatrick and Zimmerman (1976)<br>Rennert and Kilpatrick (1986) |
| TRANSFERRIN | Trf | P. boylii<br>P. pectoralis<br>P. attwateri<br>P. polius | Rasmussen and Koehn (1966)<br>Avise et al. (1974)<br>Kilpatrick and Zimmerman (1975)<br>Zimmerman et al. (1975)<br>Kilpatrick and Zimmerman (1976)<br>Kilpatrick (1984)<br>Rennert and Kilpatrick (1986) |
| XANTHINE DEHYDROGENASE | Xdh-1 | P. boylii<br>P. attwateri | Kilpatrick (1984) |

## Sequences reported:

I. INDIVIDUAL COPY STRUCTURAL GENES.

None yet reported. Adult globin sequences soon to be reported by Padgett et al.

II. REPEAT ELEMENTS.

**Mys-1 element in P. leucopus (Wichman et al. 1985)**

Features: 2843 bp. 343 bp terminal repeats (1-343) and (2501-2843). Open reading frame [1] 489 bp (595-1083) and ORF [2] 642 bp (1552-2193) with a single interrupt codon at 1795. ORF [1] translated reveals homologies with other known reverse transcriptase proteins. 20 bp pyrimidine tract (344-364); internal direct repeats 1243-1280, 1281-1318; T A sequences beginning at 1516 and at 2240. Lys tRNA binding site at 2487-2498. Mys elements 2 - 8 share common restriction sites. Mys probe hybridizes with P. gossypinus and other cricetid, but not murid, genomic digests. Mys elements probably occur in 500 to 1000 copies per haploid genome in both P. leucopus and P. gossypinus.

.....

**L1 long interspersed repeat family in P. maniculatus.**

Features: Sequence not accomplished in Peromyscus, but partial sequence in progress by Honeycutt. Homology with Mus and other mammalian L1 sequences shown by Burton et al. (1986).

## DNA Libraries:

P. leucopus. Constructed from P. l. leucopus from Georgia. Dr. H. A. Wichman, School of Basic Life Sciences, Univ. Missouri-Kansas City, Kansas City MO 64110. (Wichman et al. 1985).

P. maniculatus. Constructed from P. m. sonoriensis from California, using lambda phage Charon 4A vector. (Dr. M. Edgell and associates, Dept. of Bacteriology and Immunology, Univ. North Carolina, Chapel Hill NC 27514). Several separate libraries from individual animals.

Mitochondrial DNA:

RESTRICTION ENZYME ANALYSIS.

P. polionotus, P. maniculatus and P. leucopus. Digest with EcoRI, HindIII, BstEI, BstEII, HaeIII and PstI. 25 combinational types from 23 populations indicated. (Avise et al., 1979)

P. maniculatus, P. polionotus, and P. leucopus. Digest with HincII, BglII, HindIII, BstEII, EcoRI, BamHI, Xba and HpaII. 61 combinational types in P. maniculatus, 22 combinational types in P.polionotus, and 12 combinational types in P. leucopus. (Lansman et al., 1983; Avise et al. 1983)

Other mitochondrial DNA analyses (P. leucopus and P. maniculatus) are in progress.

# C O N T R I B U T I O N S

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Co-worker:
Jerry O. Wolff

**Population genetics of Peromyscus leucopus and Peromyscus maniculatus**

A study is underway to measure the genetic variability of these two sympatric species. Currently, populations have been analyzed for three years (1981, 1984, and 1985). The 1986 populations have also been sampled but have not been analyzed at this date. Thirty-three presumptive loci common to both species have been analyzed using standard electrophoretic techniques. Mean heterozygosity (H) levels are comparable to those found in other studies on these two species (H = 15.9 and H = 13.1, for P. leucopus and P. maniculatus, respectively). Two allozymes, 6-PGD and P-Alb showed species specific differences in electrophoretic mobility. No hybrids were detected between species using these loci. Genetic identity (Nei, 1972) measures between species were I = 0.89, within the range of values expected for congeneric species. However, using a G-test of independence on each electrophoretic locus, two systems (IDH-1 and CAT) show a greater similarity between species across years than within species between years. In other words, frequencies of the various alleles across years within one species appears to track the frequencies across years of the same alleles within the other species. A number of systems exhibited significant deviations from Hardy-Weinberg proportions and in every case resulted from a deficiency of heterozygotes. Using selection component analysis (Christiansen and Frydenberg, 1973), on mother-offspring combinations sampled during the 1984 season, non-random mating was implicated in four systems for P. leucopus and one system for P. maniculatus, and female gametic selection was implicated in one system for P. leucopus and three systems for P. maniculatus. Mother-offspring combinations have also been collected for 1985 and 1986 but have not been analyzed at this date.

* * *

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Co-workers/Associates:
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Edward H. Stephenson

Prevalence of Q fever Anitbodies Among Wild Mice in Frederick County, Maryland

Wild mice from rural areas of Frederick County, Maryland were surveyed by an enzyme-linked immunosorbent assay (ELISA) for antibodies to **Coxiella burnetii**, the causative agent of Q fever. Three distinct ecological habitats (barns, wooded fencelines, and open fields) were sampled, and proximity of the mice to the presence of large domestic animals, traditionally a major source of human infection, was ascertained. Three genera of mice were found within the habitats: **Mus**, **Peromyscus**, and **Microtus**. **Mus** predominated in the barns, while **Peromyscus** predominated in both wooded fencelines and open fields. Initial testing by ELISA revealed the inability of conjugated **Mus** antisera to recognize immunoglobulins (IG) of **Peromyscus** or **Microtus**. To circumvent this problem, pooled sera were obtained from **Peromyscus** (W. Dawson, University of South Carolina) and **Microtus** (W. Burgdorfer, Hamilton, Montana). The IG portion was extracted from each pool, by using ammonium sulfate precipitation followed by elution from a protein-A sepharose column. Each individual extract was used to immunize rabbits against either **Peromyscus** or **Microtus** IG. The genus-specific antisera were then used in the ELISA to detect **Peromyscus** and **Microtus** IG which had bound to **C. burnetii** antigens.

Survey results show a high proportion (65-84%, inclusive) of seropositives to Q fever among all three genera, regardless of habitat. These observations are analogous to those of other studies which showed a comparatively high incidence of Q fever antibodies in both domestic ungulates and humans in central Maryland. However, in this study, there appears to be no relationship between proximity of mice to large domestic animals and prevalence of Q fever antibodies. Results of this study strongly suggest the possibility of endemic foci of the disease being maintained within wild animal communities in central Maryland.

* * *

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I am maintaining a small breeding stock of P. eremicus and P californicus captured in Riverside county, California, taken from allopatric populations. I am also developing small breeding colonies of P. maniculatus from selected islands in the San Juans of the Puget Sound, Washington. My primary interests are in kin recognition specifically and in behaviour genetics in general.

* * *

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We are currently maintaining breeding populations of Peromyscus leucopus noveboracensis and Peromyscus maniculatus nubiterrae. The former stock was derived from 45 animals initially captured in 1978 on Brush Mt. and the adjacent Craigs Creek drainage 5 miles NW from Blacksburg, Montogmery Co., Va. Peromyscus maniculatus stock was 51 animals from Potts Mt., Giles Co., Va. 5 miles W of New Castle Va. Stocks have been outbred annually to wild stock and hence have very low inbreeding coefficients. Two years ago J. Wolff caught a pair of albino P. leucopus at the Mt. Lake research station in early spring. The female died and I think is now at the Smithsonian, while the remaining male was brought to me for breeding purposes. We have now determined by all appropriate breeding crosses that albinism is a totally recessive trait, as would be expected. We have enough data from at least 20 different female sources (homozygous and heterozygous) to examine litter size, growth, survivorship, and behavioral parameters associated with albinism. The analysis completed to date shows no differences in litter size, but slower postweaning growth and poorer survivorship in albinos as compared to normal P. leucopus. Some of these differences appear to be related to poor maternal behavior (away from nest longer and general inattention to out of nest young) which is evident when observations are done. My primary interest in the albino offspring centers on their energetics, particularly growth and pelage characteristics and how they relate to winter energetics. Sufficient stock is now at hand to initiate these projects. We have recently submitted manuscripts

describing reproductive parameters of P. leucopus and P. maniculatus from three complete years of colony records. When putting the data together I was surprised to find that a large number of the females were at parity 19 or higher. In addition, we have compared these laboratory data to similar data from the source field populations. In a field study we examined 6-MBOA's effect on reproduction in the field during the summer breeding hiatus. We are currently finishing up several papers on cross fostering, infostering and normal fostering effects in both species over long (2 years) and short term (3 months) periods. One additional project completed in 1985 investigated differences in social group size and their effect on winter energetics. The results demonstrate clearly that no torpor occured in either species regardless of group size, and that maximum energy conservation occurs for groups of 5 individuals. Individuals in groups larger than 5 experience no significant reduction in energy expenditure beyond that achieved by the group of 5 itself. These results were verified by both BMR data and total energy budget data. Our work with other species continues particularly with pine voles, meadow voles, golden mice and the punare from South America.

* * *

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Co-workers and Associates:
David Covington
David Kass
Fred Marsteller

Formal genetics of the platinum locus in Peromyscus maniculatus has been completed. This coat color mutation was originally diagnosed by Elizabeth Barto in the 1940's and has been perpetuated during the interval. However, a formal analysis of the trait and detailed comparisons with other color dilution traits had not been done. Bruce Cushing and Gale Haigh found and studied a smilar mutation, "pewter", from a natural population near Lansing MI. Subsequent study indicated that the pewter and platinum mutants were indistinguishable phenotypically and genetically, indicating a recurrence of the platinum mutation. In collaboration with Cushing, Haigh and Sue Van Ooteghem, we found that the platinum locus is non-allelic with the silver, blonde, dilute and brown mutations in Peromyscus. The locus is independent of the agouti locus, as well. (Dawson and Dodson-Hughes)

The inheritance of burrow building in P. polionotus is under investigation. P. polionotus builds an extensive burrow with entrance and exit tunnels and other distinctive

features. P. maniculatus bairdii constructs a much simpler nest site. Laboratory reared animals of these species, together with their $F_1$ and backcross hybrids were tested in a large earth-filled chamber. P. polionotus retain the ability to construct a burrow essentially like that of their wild ancestors after many generations in captivity. $F_1$ hybrids build burrows virtually identical to those of P. polionotus. At least two gene pairs seem to be involved in this behavioral difference. (Dawson, Lake and Schumpert)

The genetic architecture of traits associated with somatic and sexual maturation in P. maniculatus bairdii is being analyzed. Analyses of growth will be based upon body masses recorded twice weekly through 6-weeks of age and weekly through 10 weeks, plus an adult mass recorded at roughly 12 weeks. Measures of growth and mass relative to adult mass will be computed. In addition, age and mass at the opening of the ear canals and at eye opening are being recorded. Sexual maturation in females is being recorded as the age and mass at 1) vaginal opening, 2) first estrus, 3) first mating and 4) birth of the first litter. For males, sexual maturation is being recorded as the age and mass at the descent of the testes and the age at the birth of the first litter. All mice are weaned at 24 days and paired with adults at 28 days.

Genetic analyses will be based upon regression of offspring on parents and upon the intraclass correlations among full-sib families. The difference between these two will indicate the magnitude of genetic dominance and maternal effects. Results of these analyses will be used to make inferrences regarding the evolution of the diverse patterns of development found in Peromyscus. (Marsteller)

* * *

Donald A. DEWSBURY
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Co-workers:
Judith Bryan
Bruce Ferguson
John Pierce
Kim Sawrey
Lawrence Shapiro
Stephen Taylor

The focus in our laboratory is on the evolution and adaptive significance of reproductive and social behavior in rodents. We are conducting a variety of studies on the role of behavior in affecting reproductive success. A major emphasis in our current work is on contrasting patterns in different species of Microtus. However, our Peromyscus work also remains active.

We are maintaining wild-type and blonde (Pratt & Robbins, 1982) deer mice, P. maniculatus bairdi. These are in a closed colony to which we add wild stock when available.

Our current and recent studies of P. maniculatus can be conceptualized as dealing with the roles of effectiveness, access, capacity, and choice in affecting differential reproduction. With respect to effectiveness, we have been interested in the role of copulatory behavior in pregnancy initiation, the dynamics of sperm competition, the disruption of recently-delivered ejaculates, and the pregnancy blockage that can result when females mate with more than one male. Our studies of access are in semi-natural enclosures and concern the relationships among dominance, copulation, and differential reproduction, with a current emphasis on the effects of kinship on agonistic interactions and on the possible inheritance of dominance relationships. Studies of male capacity concern males' ability to deliver repeated ejaculates and changes in the content and function of ejaculates both within and across days. In studies of choice, we are interested in the factors that affect the location and selection of mating partners by both females and males.

Whereas in our earlier work we emphasized descriptive studies of many species of muroid rodents, we now emphasize more intensive studies of the dynamics of differential reproduction in fewer species. However, we retain our interest in working with new species, where some special characteristic renders them especially interesting. For many years we have been seeking a source of three species with relatively thick glans penes--P. flavidus, P. pirrensis, and P. thomasi. All have small ranges. We would welcome any leads toward obtaining animals of these species.

* * *

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Currently my work with Peromyscus is limited to the natural populations and their distribution in Alabama. I am especially concerned with the beachmice and their ecological dilemma as human populations increase. I have no graduate students in Peromyscus studies at present.

* * *

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Co-workers:
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Mary Ann Hardwicke
Debbie Sauer

We are working toward understanding the molecular basis of the defect in ADH-negative deermice using cloned cDNA probes for the mouse **Adh-1** gene. Thus far, we have shown that the ADH-negative mice in contrast to ADH-positive mice are deficient in a 1.5 Kb mRNA. We are also using the deermouse as a model system for studying ethanol metabolism. An ethanol-inducible cytochrome P-450 has been purified from ethanol-fed ADH-negative mice and used to generate specific antibodies. These have been used in Western analysis of the induction process and in cloning the ethanol-inducible P-450 from a mouse lambda gt 11 expression library. We plan to confirm the nature of the clones and to use them as specific probes to study the induction process.

* * *

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Studies of the endangered subspecies of beach mice (**Peromyscus polionotus allophrys, P. p. ammobates** and **P. p. trissyllepsis**) are being initiated:

Status of **P. p. trissylepsis**

A population survey was conducted during April 1986 to determine the current status of the Perdido Key beach mouse (**P. p. trissyllepsis**) population on Florida Point, Perdido Key, Alabama. This is the only known remaining population of this subspecies. Livetrapping was conducted for 5 nights using Sherman traps placed at 10 m intervals, 2 traps per station, in a line along the primary dunes for the full length of the habitat. There were 146 trapping stations (292 traps) in use. Captured mice were toe-clipped and released at the capture site. Nineteen beach mice were captured a total of 37 times at 21 stations. Program CAPTURE (Otis et al. 1978. Wildl. Monogr. 62. 135 pp) provided a population estimate of 20 with an approximate 95% confidence interval of 18-22. This estimate was derived using Model $M_t$ which allows for the time specific changes in capture probabilities which were evident in our data and was probably conservative. The geometric estimator (Burnham and Overton. 1969. Oregon State Univ. Tech. Rep. 14) provided

an estimate of 32. This estimate should be viewed with caution as tests of equal catchability of marked and unmarked individuals were not conducted. It seems likely that the actual population is somewhere between 20 and 30 a figure close to the estimate of 26 provided by Humphrey and Barbour (1981. J. Mamm. 62: 840-844) for 1979. The population remains in an extremely precarious condition. This survey was supported by the U. S. Fish and Wildlife Service. Reestablishment of beach mice in unoccupied critical habitat.

The Choctawhatchee beach mouse (P. p. allophrys) and Perdido Key beach mouse are presently absent from major areas of critical habitat in public ownership and management. Recovery of these subspecies would be greatly enhanced if their respective ranges could be significantly expanded into these protected lands. Over the next 2 years P. p. allophrys will be translocated from the Topsail Hill Area (east of Destin, FL) to the Grayton Beach State Recreation Area and P. p. trissyllepsis from Florida Point to the Gulf Islands National Seashore, Perdido Key, FL. All translocated mice will be placed in large enclosures in the dune habitat to permit adjustment prior to full release. Additionally a captive colony of P. p. trissyllepsis is being established to guard against sudden loss of the entire population as a result of storms or disease. This recovery effort was proposed by the Florida Game and Fresh Water Fish Commission and major support is being provided by that agency. Additional support is being provided by the National Park Service.

Population ecology of the Alabama beach mouse P. p. ammobates and determination of the importance of foxes as beach mouse predators on Bon Secour National Wildlife Refuge.

Little is known concerning the biology of beach mice. Most studies conducted to date have dealt with systematics or have been short trapping surveys to document presence and to provide some information on habitat requirements. Blair (1951. Contr. Lab. Vert. Biol., Univ. Mich. 48:1-47) conducted an important study of P. p. leucocephalis which provided information on population structure, home range, activity and some aspects of social behavior; however, data were only obtained for 1 fall-winter and 1 spring period. Likewise, little information exists on the biology of fox in the beach habitat and no definitive information is available on the extent of fox predation on beach mice or the interaction between the two species. We are initiating a two-year capture-recapture study of P. p. ammobates on Bon Secour National Wildlife Refuge to obtain data on population structure, mortality, survival, population turnover, seasonal habitat use and home ranges. Simultaneously, through trapping, radio telemetry, tracking and scat

analysis we will investigate use of the dune habitat by fox, interactions between fox and beach mice and occurrence of beach mice remains in fox scats. This study is being supported by the U. S. Fish and Wildlife Service.

* * *

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We maintain the following stocks of **Peromyscus** and are willing to provide animals when possible. Those wishing mice must provide shipping containers and pay for shipping.

| Species | strain | # in colony |
|---|---|---|
| **Peromyscus leucopus** | Wisconsin | 200 |
| **P. maniculatus bairdii** | Wisconsin | 400 |
| **P. maniculatus bairdii** | Ontario | 100 |
| **P. maniculatus bairdii** | Colorado | 50 |
| **P. maniculatus bairdii** | Connecticut | 40 |

Our Connecticut strain has the recessive gene for black fur.

* * *

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Co-workers:
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Elmer Finck
Sharon Gurtz
Glennis Kaufman
Laura McLellan

Our research efforts are directed toward ecological studies of free-living populations of (1) **Peromyscus maniculatus** in native and disturbed habitats in the tall-grass and mixed-grass prairie regions of eastern and central Kansas and (2) **P. leucopus** in natural and planted woodland habitats in the same regions. Work in eastern Kansas is focused on Kansas State University's Konza Prairie Research Natural Area; a research site managed for the experimental study of the role of fire (ongoing) and grazing by large unglates (to be initiated) in the tall-grass prairie.

Some of the specific projects presently in progress by our group are described by title below.

1) Temporal variation in demography of P. maniculatus, P. leucopus, and other small mammals in tall-grass prairie (Finck, Kaufman, and Kaufman).
2) Effects of fire on density, reproduction, and dispersal of P. maniculatus in tall-grass (Clark, Finck, Gurtz, Kaufman, and Kaufman).
3) Experimental study of the effects of predator risk on foraging behavior of P. maniculatus (Kaufman and Kaufman).
4) Habitat-specific patterns of reproduction for P. maniculatus: a field experiment using mixed-grass and cropfield habitats (Kaufman and Kaufman).
5) Habitat selection by P. maniculatus and P. leucopus: effect of management for game species (Clark, Kaufman, and Kaufman).
6) Morphological variation in P. maniculatus associated with prairie and cropfield habitats (McLellan).
7) Experimental analysis of effect of prairie litter on habitat selection by P. maniculatus, P. leucopus, and other small mammals (Clark).

* * *

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Student:
David Ribble

David Ribble, a new student, is just beginning a research project on Peromyscus to be done at our Hastings Natural History Reservation. At this point the project is: Social and micro-habitat structuring in populations of Peromyscus californicus. A more informative statement of his work will follow his pilot studies this summer.

Ribble's project is the only current one on Peromyscus in this department. Maybe we are entering a new phase.

* * *

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Co-worker:
Janice Schnake

Electrophoretic and chromosomal variability within and among populations of Peromyscus attwateri and P. leucopus is being examined in southwest Missouri. Populations of P. attwateri are found only in isolated rocky glades, whereas,

P. leucopus has continuous distribution among these areas. Preliminary analysis indicate no chromosomal variability within or among populations of the same species. However, we examined 33 gene loci and have found six polymorphic enzyme systems for P. attwateri and eight systems for P. leucopus. These data will be used to compare genetic differentiation among populations that have potential gene flow and populations that are completely isolated.

* * *

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My primary interest is in allometry -- body size (especially insular giganitism) and morphometrics -- and I have been maintaining colonies of **Peromyscus maniculatus gambelii** (from near Santa Barbara, CA) for comparisons of ontogenetic trends in body size and shape. I am currently analyzing morphometric data on growth series of these two subspecies. In the meantime, Mary Klein and I have published the results of some experimental work (at Yale University) on the determinants of body size in these animals (Roth & Klein 1986). Using techniques of embryo transfer, we found evidence that prenatal nongentic maternal effects (1) contribute to the large body size of neonates of **P. m. santacuzae**, but (2) do not influence the size eventually attained by adults. The size difference between adults of the two subspecies appears to have a genetic basis.

A new color mutant, provisionally referred to as "California blond", arose in my colony of P. m. santacruzae (then at Yale) four years ago. It is an autosomal recessive, and is phenotypically similar to -but complements- blonde (Pratt & Robbins 1982). It is not allelic with any other mutants tested to date by W. Dawson at the University of South Carolina. A description of the mutation is currently in preparation.

Pratt, B. P. & R. J. Robbins. 1982. Blonde, a new mutation in Peromyscus maniculatus affecting fur, skin, and eye pigmentation. J. Hered. 73: 69-70.

Roth, V. L. & M. S. Klein. 1986. Maternal effects on body size of large insular Peromyscus maniculatus: evidence from embryo transfer experiments. J. Mamm. 67: 37-45.

* * *

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We are curently working with **Peromyscus mexicanus** occuring in a tropical rainforest at Los Tuxtlas Biological Station, and with **Neotomodon (Peromyscus) alstoni** and **Peromyscus melanotis** in a pine forest located in Parres, near Mexico City.

**Los Tuxtlas** research. I have been studying for two years the ecology of **P. mexicanus** under field and laboratory conditions. Information regarding demographic and reproductive patterns, home range and ontogeny has been obtained (Reproductive Trends of the Mexican Deermouse **Peromyscus mexicanus** in a Seasonal Rainforest (MS); Laboratory Reproduction of Tropical: Effect of Female Weight and Litter Size on Young (MS) and Reproductive Tactics of Tropical **Peromyscus** (MS).
Current reasearch includes: 1. Long-term study on population dynamics. 2. Examine the effect of natural perturbation -e.g., gap opening, plant succession and mature forest-on the spatial distribution between species and between age-classes within species of rodents. 3. Investigate copulatory behavior and parental care.

**Parres** research: We are currently studying the population ecology of **N. alstoni** and **P. melanotis**. Information includes population dynamics, reproduction, home range, food habits and habitat selection (Canela-Rojo, M., y V. Sanchez-Cordero. 1984. Patron del Area de Actividad de **Neotomodon alstoni** (Rodentia: Cricetinae). Anales Inst. Biol. Univ. Nal. Auton. Mexico 55 (2):285-306, and V. Sanchez-Cordero and M. Canela-Rojo. The population ecology of the Volcano mouse **Neotomodon alstoni** in Central Mexico, (in prep.).

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BEHAVIORAL ECOLOGY OF PEROMYSCUS LEUCOPUS AND P. MANICULATUS AT THE MOUNTAIN LAKE BIOLOGICAL STATION, VIRGINIA.

We have continued to monitor the intrafamilial dispersion patterns of P. leucopus and P. maniculatus in the mixed deciduous forests of south-western Virginia. Among P. leucopus, juvenile males tend to disperse from their natal site whereas about 25% of juvenile females remain and breed within their natal home range. The greatest possibility of inbreeding occurs between fathers and daughters, but the relatively high turnover rate of animals in any one year has kept inbreeding below 2%. No obvious differential dispersal occurs among juvenile P. maniculatus, but we have recorded no cases of inbreeding between parents and offspring or between siblings.

Both P. leucopus and P. maniculatus bred throughout the 1985-86 winter. This is the first time in six years that we have recorded winter breeding in our area. Winter reproduction could be attributed to a large acorn crop last fall and to a relatively mild winter. As a consequence of winter recruitment, the spring population density was higher than it was last fall and reached a peak of 50-60 animals/ha in June. This high density followed a two year incline from a low of 6 animals/ha in 1983 and was comparable to the 58 animals/ha in 1981. An obvious difference, however, is that in 1981 the P. leucopus/P. maniculatus ratio was 3:2 and in 1986 it was 5:1. We do not have an explanation for the relative decline in P. maniculatus over the last few years.

Current publications:

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