Jennrich, R.I. and F.B. Turner. 1969. Measurement of non-circular home range. J. Theoret. Biol. 22:227-237.
Karasov, W.H. and R.A. Anderson. 1984. Interhabitat differences in energy acquisition and expenditure in a lizard. Ecology 65:235-247.
Knowlton, G.F. 1949. Food of the island night lizard. Herpetologica 5:45-46.
Lee, J.C. 1974. The diel activity cycle of the lizard, *Xantusia henshawi*. Copeia 1974:934-940.
______. 1975. The autecology of *Xantusia henshawi henshawi* (Sauria: Xantusiidae). Trans. San Diego Soc. Nat. Hist. 17:259-277.
Mautz, W.J. 1979. The metabolism of reclusive lizards, the Xantusiidae. Copeia 1979:577-584.
______. and T.J. Case. 1974. A diurnal activity cycle in the granite night lizard, *Xantusia henshawi*. Copeia 1974:243-251.
Miller, M.R. 1951. Some aspects of the life history of the yucca night lizard, *Xantusia vigilis*. Copeia 1951:114-120.
______. 1954. Further observations on reproduction in the lizard, *Xantusia vigilis*. Copeia 1954:38-40.
Nagy, K. A. 1982. Energy requirements of free-living iguanid lizards. Pp. 49-59. *In:* G. M. Burghardt and S. S. Rand (eds.), Iguanas of the world: their behavior, ecology and conservation. Noyes Publications: Park Ridge, NJ. 472 pp.
______. 1983. Ecological energetics. Pp. 24-54. *In:* R.B. Huey, E.R. Pianka and T.W. Schoener (eds.), Lizard ecology: studies of a model organism. Harvard University Press: Cambridge, MA. 501 pp.
______ and V.H. Shoemaker. 1975. Energy and nitrogen budgets of the free-living desert lizard *Sauromalus obesus*. Physiol. Zool. 48:252-262.
Pough, F.H. 1973. Lizard energetics and diet. Ecology, 54:837-844.
______. 1983. Amphibians and reptiles as low-energy systems. Pp. 141-188. *In:* W.P. Aspey and S.I. Lustick (eds.), Behavioral energetics: the cost of survival in vertebrates. Ohio State University Press: Columbus, OH. 300 pp.
Raven, P.H. 1963. A flora of San Clemente Island, California. Aliso 5:289-347.
Regal, P.J. 1967. Voluntary hypothermia in reptiles. Science 155:1551-1553.
______. 1968. An analysis of heat-seeking in a lizard. Ph.D. dissertation, University of California, Los Angeles, CA. 139 pp.
Savage, J.M. 1957. Studies on the lizard family Xantusiidae. III. A new genus for *Xantusia riversiana* Cope, 1883. Zoologica 42:83-86.
______. 1963. Studies of the lizard family Xantusiidae. IV. The genera. Los Angeles Co. Mus. Contrib. Sci. 71:1-38.
______. 1967. Evolution of the insular herpetofaunas. Pp. 219-227. *In:* R. N. Philbrick (ed.), Proceedings of the symposium on the biology of the California Islands. Santa Barbara Botanic Garden: Santa Barbara, CA. 363 pp.
Schoener, T.W. and A. Schoener. 1980. Densities, sex ratios, and population structure in four species of Bahamian *Anolis* lizards. J. Anim. Ecol. 49:19-53.
Schumacher, F.X. and R.W. Eschmeyer. 1943. The estimation of fish populations in lakes and ponds. J. Tenn. Acad. Sci. 18:228-249.
Schwenkmeyer, R.C. 1949. Food habits of the island night lizard, *Xantusia riversiana reticulata*, from San Clemente Island. Nat. Hist. Miscel. 38:1-3.
Snell, H.L. and K.A. Christian. 1985. Energetics of Galapagos land iguanas: a comparison of two island populations. Herpetologica, 41:437-442.
Turner, F.B. 1977. The dynamics of populations of squamates, crocodilians and rhynchocephalians. Pp. 157-264. *In:* C. Gans and D. W. Tinkle (eds.), Biology of the Reptilia. Vol. 7. Ecology and behavior A. Academic Press: New York, NY. 720 pp.
______, P.A. Medica and B.W. Kowalewsky. 1976. Energy utilization by a desert lizard (*Uta stansburiana*). US/IBP Desert Biome Monog. (1):1-57.
von Bloeker, J.C. 1967. The land mammals of the Southern California Islands. Pp. 245-264. *In:* R. N. Philbrick (ed.), Proceedings of the symposium on the biology of the California Islands. Santa Barbara Botanic Garden: Santa Barbara, CA. 363 pp.
Zweifel, R.G. and C.H. Lowe. 1966. The ecology of a population of *Xantusia vigilis*, the desert night lizard. Amer. Mus. Novit. (2247):1-57.

Preliminary Studies on the Distribution of Native Mice on Santa Catalina Island, California

Gary B. Perlmutter[1]
Department of Biological Sciences
Humboldt State University
Arcata, CA 95521

Abstract — Small mammal populations were sampled in six plant communities on Santa Catalina Island during the summer of 1986. Two of three native species were captured, namely: *Peromyscus maniculatus catalinae* and *Reithrodontomys megalotis catalinae*. Both species were found to be widely distributed on the island and apparently abundant in maritime desert scrub.

Introduction

Santa Catalina Island is one of the least studied, yet one of the most biologically diverse of all the California Islands (Minnich 1980). Because geologic evidence does not support the hypothesis that a land bridge once connected Santa Catalina to the mainland or other Channel Islands (Rowland 1984), it is reasonable to presume that the flora (and by implication, the fauna) arrived over water by waif dispersal from the mainland (Thorne 1967; Wenner & Johnson 1980; Gill 1980). As a result, Santa Catalina has a depauperate biota, and plant and animal associations differ in composition from those found on the Southern California mainland and other Channel Islands. The island's native mice are endemic at the subspecies level: deer mice *(Peromyscus maniculatus catalinae)* and western harvest mice *(Reithrodontomys megalotis catalinae)*. Yet aside from scattered details from studies of other species (Collins & Martin 1985; Williams 1983), practically nothing is known about these mice ecologically. This study is the first contribution to an understanding of the ecology of small mammals on Santa Catalina Island. The project was conducted during an internship with the Santa Catalina Island Conservancy.

[1]**Current Address:** Bioassay Department, BTC Environmental, Inc. Ventura, CA 93003

Santa Catalina Island is a rugged, 194 km² island located 31.7 km southwest of Pt. Vincente, Palos Verdes peninsula in Los Angeles County, California. The sample sites were selected in representative examples of six plant communities, as described by Thorne (1967): maritime desert scrub, coastal sage scrub, coastal grassland, chaparral, oak and riparian woodlands. Sites were chosen because they exhibited minimum disturbance by introduced species.

The maritime desert scrub sample site is located on Indian Head Point at 60.9 m (200 ft) elevation. There was no evidence of feral animals. The coastal sage scrub site is located in Middle Canyon on a south-facing slope at 224 m (600 ft) elevation. Pig rooting was evident in approximately 50% of the study area and 20% of the vegetation exhibited damage from grazing and browsing. Feral cats have been observed in the area (Martin pers. comm.). The site sampled in coastal grassland lies on an exposed Pacific coastal ridge between Mills Landing and Ben Weston Point, on a gentle southwest slope at 305 m (1,000 ft) elevation. This site is protected from grazing by a fence laid parallel to the shoreline. Located on the northeast (channel) side of the island, the chaparral site lies 0.32 km southeast of Wrigley Reservoir at 306 m (1,300 ft) elevation. Pig rootings occurr in approximately 30% of the area and all trees and shrubs exhibit a browse line. The oak woodland site is located on the channel side of the island, 0.59 km west of Echo Lake at 478 m (1,570 ft) elevation. An estimated 20% of the area has been rooted and all trees exhibit a browse line. The riparian woodland sample site is in Sweetwater Canyon at 152 m (500 ft) elevation, which is about 2.4 km inland from the Pacific coast. The canyon holds a permanent southwest draining stream. An estimated 20% of the area has been rooted and all trees and shrubs exhibit a browse line.

A modified Sullivan (1982) capture-recapture method was used to sample mouse populations. Twelve Sherman live traps (2 x 2-1/2 x 6-1/2 in) were placed in each habitat. Sample sites generally covered an area of 0.4 ha, with traps spaced 40 ft (12.2 m) apart. At each site, two traplines were laid at right angles, bisecting each other over an imaginary midpoint, thus laying three traps in each of the four directions, outward from the center. Six sites, one per habitat, were sampled. Martitime desert scrub was too dense to lay traps in this manner without altering the habitat. The placement of traps in this habitat was therefore restricted to its permeability, covering an area of 0.04 ha. Trapping continued at each site for five nights. Since they were left open both day and night, traps were checked morning and evening.

Traps were baited with a peanut butter-oatmeal mixture. Each animal captured was identified to species and sex. The time, date, trap station, habitat and previously marked animals also were recorded. Animals caught for the first time were marked by toe clipping and released at the point of capture. The number of disturbed traps also was noted during each visit.

The data were analyzed to determine species composition within each habitat and species distribution according to habitat. Trap success (captures/100 trapnights) and trap disturbance (disturbed traps/100 trapnights) were calculated for each habitat. Trapping methods also were designed to calculate density estimates and determine sex ratios in each habitat. However, capture sizes were too small to produce meaningful results.

Table 1. Trap results for mice in six habitats on Santa Catalina Island.

	No. of mice captured[1]		% trap	% trap
Habitat[2]	P. m.	R. m.	success	disturbance
MDS	13 (27)	9 (11)	63	0
CSS	0	5 (5)	8	13
CG	1 (1)	0	2	57
Ch	8 (14)	4 (4)	30	28
OW	8 (20)	0	32	17
RW	3 (7)	4 (6)	22	52
Total	33 (69)	22 (26)	27.5	27.8

[1]Number in ( ) equals total captures, including recaptures.
[2]For habitat designation see Fig. 1
P.m. = *Peromyscus maniculatus*
R.m. = *Reithrodontomys megalotis*

Results and Discussions

In 360 trapnights during the summer of 1986, 33 deer mice and 22 western harvest mice were caught. Overall trap success was 27.5%. Trap success was highest in the maritime desert scrub site (63%) and lowest in the coastal grassland site (2%) (Table 1). Deer mice were captured in every site except the coastal sage scrub while western harvest mice were caught in all sites except the grassland and oak woodland sites. In habitat sites where both species occurred, deer mice were captured more frequently than harvest mice except in riparian woodland (Fig. 1). Trap disturbance was highest in grassland (57%) and lowest in desert scrub (O%) with a percentage of 27.8 for the study as a whole (Table 1).

The data provide insights into the distribution of mice on Santa Catalina Island. From the data, both species appear to be widespread on Santa Catalina. Deer mice were found in all habitats sampled except coastal sage scrub. However, they have been recorded in this habitat by Collins & Martin (1985). This seems to agree with the limited knowledge of mouse distribution on other Channel Islands: the same species are found on more of these islands than any other species of rodent and deer mice are the more widespread of the two (von Bloeker 1967). My findings also agree with the distribution of these mouse species on the

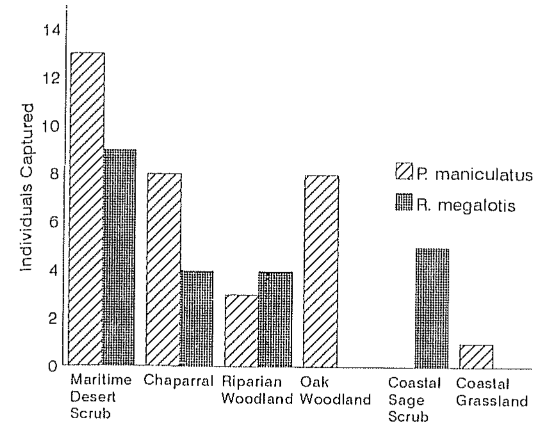

Figure 1. Total numbers of mice captured in each habitat site. Sites are ordered by increasing penetrability.

California mainland: both species occur in many habitats, with deer mice found in more plant communities (Baker 1968; Ingles 1965).

Factors that may have influenced the data include the traps themselves, possibly being too small for rats, and their triggers not properly set for small animals such as shrews. The trap disturbance which occured in most sites also may have influenced the data by reducing the chances for capture of small mammals, thus possibly omitting a rare species in a given habitat.

The results of this study suggest a pattern of habitat association for the native mice on Santa Catalina Island. However, a more intensive study involving a more extensive trapping program would shed more light on the ecology of these species.

Acknowledgments

I am greatly indebted to Terrence D. Martin, Naturalist for the Santa Catalina Island Conservancy, whose permission to do research on the island, and whose help and support both in the field and in manuscript preparation, made this study possible. Staff at Humboldt State University I am grateful to are: Timothy E. Lawlor, William A. Brueske, and especially Steven A. Smith and Tom Rooth for their advice in analysis and manuscript proofing. I also would like to thank Kathy Taylor, biologist at the U. S. Forest Service Redwood Science Laboratory and Paul W. Collins of the Santa Barbara Museum of Natural History for their help in preparing the manuscript. Ellen Kelley, Richard Herrmann and Grant Francis assisted in the field. Mice were captured under a collecting permit from the California Department of Fish and Game.

Literature Cited

Baker, R. H. 1968. Habitats and distribution. Pp. 98-126. *In:* A.J. King (ed.), Biology of *Peromyscus* (Rodentia). American Society of Mammalogists, Special Publication No. 2. 593 pp.

Collins, P. W. and T. D. Martin. 1985. A review of the population status of the Santa Catalina Island shrew *Sorex ornatus willetti* Final Report, Order No. 10181-5693 (BW)'85 SE-0018-85. Endangered Species Office: Sacramento, CA. 93 pp.

Gill, A. E. 1980. Evolutionary genetics of the California Islands *Peromyscus*. Pp. 719-743. *In:* D. M. Power (ed.), The California Islands: proceedings of a multidisciplinary symposium Santa Barbara Museum of Natural History: Santa Barbara, CA. 787 pp.

Ingles, L.G. 1965. Mammals of the Pacific states. Stanford University Press: Stanford, CA. 506 pp.

Minnich, R. A. 1980. Vegetation of Santa Cruz and Santa Catalina Islands. Pp. 123-137. *In:* D.M. Power (ed.), The California Islands: proceedings of a multi-disciplinary symposium. Santa Barbara Museum of Natural History: Santa Barbara, CA. 787 pp.

Rowland, S. M. 1984. Geology of Santa Catalina Island. Calif. Geol. 37 (11): 239-251.

Sullivan, T. P. 1982. *Peromyscus* and *Microtus*. Pp. 320-321. *In:* D.E. Davis (ed.), CRC handbook of census methods for terrestrial vertebrates. CRC Press: Boca Raton, FL. 397 pp.

Thorne, R. F. 1983. A flora of Santa Catalina Island, California. Aliso 6 (3): 1-77.

von Bloeker, J. C., Jr. 1967. Land mammals of the southern California Islands. Pp. 245-263. *In:* R. N. Philbrick (ed.), Proceedings of the symposium of the biology of the California Islands. Santa Barbara Botanic Gardens: Santa Barbara, CA. 363 pp.

Wenner, A. M. and D. L. Johnson. 1980. Land vertebrates on the California Channel Islands: sweepstakes or bridges? Pp. 497-530. *In:* D.M. Power (ed.), The California Islands: proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History: Santa Barbara, CA.

Willimas, D. F. 1983. Population surveys of the Santa Catalina, San Bernadino, and Suisun shrews. Contract No. 11310-1242-2. U. S. Dept. of Interior, Fish and Wildlife Service, Endangered Species Office: Sacramento, CA. 69 pp.

Dwarfism and Variability in the Santa Rosa Island Mammoth (*Mammuthus exilis*): An Interspecific Comparison of Limb-bone Sizes and Shapes in Elephants.

V. Louise Roth
Zoology Department, Duke University, Durham, NC 27708

Abstract – Mammoths (*Mammuthus exilis*) from the Pleistocene of Santa Rosa Island were small and highly variable in size. Linear measurements and principal components analysis scores from humeri and tibiae provide quantitative indices of size and shape for comparisons with the ancestral mainland mammoth,the two Recent species of elephants and another Pleistocene insular dwarf elephant (from Sicily). Adult elephantids appear to follow a single allometric pattern: a large proportion of the total variation is size-related and the remaining variability in shape is not species-specific. Although dwarf mammoths are significantly smaller than their mainland relatives and significantly more variable in size than other elephant species, they do not differ significantly in any index of shape or shape variability; nor do they appear to be achondroplastic. A combination of biological and geographic factors contributed to size reduction and size variability in the island mammoths.

Introduction

Dwarf mammoths (*Mammuthus exilis*), known from Pleistocene fossil deposits on Santa Rosa Island, are among the most intriguing endemics of the California Islands. Unique among mammoths for their small size — the smallest adults attained approximately one-third the shoulder height of their closest relatives on the mainland (Orr 1968) — they exemplify in their dwarfism a trend common among extinct island-dwelling members of the Elephantidae (Hooijer 1967; Sondaar 1977)

The Northern Channel Islands were united for a portion of the time mammoths inhabited them (Vedder & Howell 1980; Madden 1981b; Fergusson & Libby 1962). Fossil mammoth specimens have been found on San Miguel, Santa Cruz and San Nicolas Islands, but by far the most abundant and complete material, and that representing the smallest individuals, is known from Santa Rosa Island. From the perspective of preservational bias, it is perhaps not surprising that the more restricted Quaternary sediments of Santa Cruz Island have yielded mainly large dental specimens. The small number of mammoth specimens known from Santa Cruz and San Nicolas Islands have been described elsewhere (Cushing *et al.* 1984). The limited material available from San Miguel Island is retained in miscellaneous collections and has not yet been assembled or studied in a concerted fashion. For these reasons, I restrict my attention in this paper to material from Santa Rosa Island.

From the available fossils, it is evident that the mammoths, in addition to being small, were highly variable. Although I will here refer to all material from Santa Rosa Island as *M. exilis*, Orr (1968) and Madden (1981a) have suggested that the Santa Rosa Island material represents two or more distinct forms, and possibly two or more species of mammoth. The evidence currently is inconclusive. There is no discontinuity or clustering amongst the material now available (Fig. 1); if more than one mammoth species was endemic to the islands, a larger sample and better stratigraphic control will be needed before a pattern becomes apparent.

It is nevertheless clear that the adults span a remarkable range of sizes. Among mature specimens, for example, the largest individuals are estimated to be twice the shoulder height of the smallest (Orr 1968; Roth 1982).