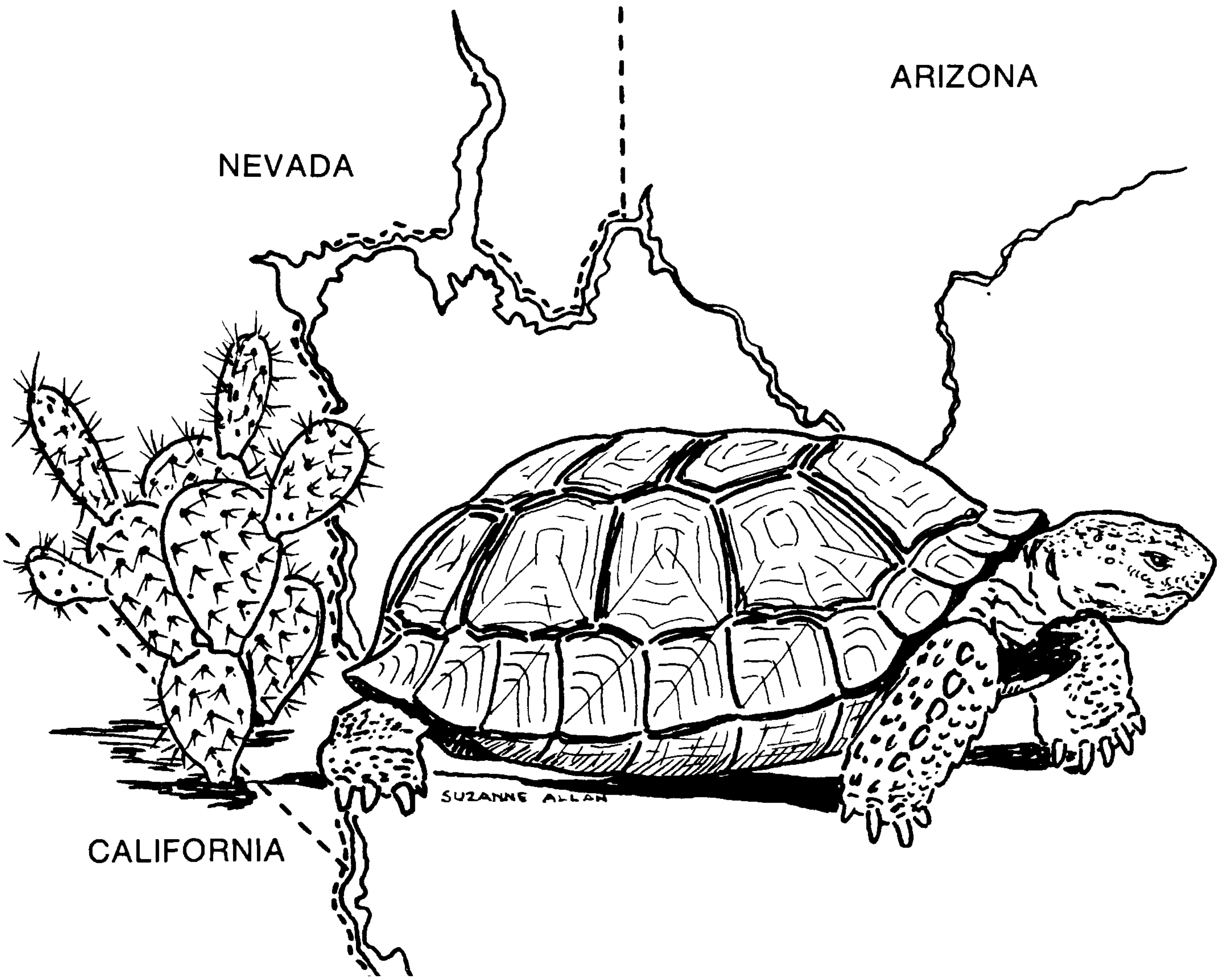
THE

DESERT TORTOISE COUNCIL



PROCEEDINGS OF 1978 SYMPOSIUM

DESERT TORTOISE COUNCIL

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A compilation of reports and papers presented at the third annual symposium of the Desert Tortoise Council, 1-3 April 1978, in Las Vegas, Nevada

Copies of the 1976, 1977, or these 1978 proceedings may be obtained from the Desert Tortoise Council, 1835 Klauber Avenue, San Diego, California 92114. Make checks payable to Desert Tortoise Council, in the amount of $5.00 per copy for U.S. orders.
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DESERT TORTOISE COUNCIL

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Acknowledgment

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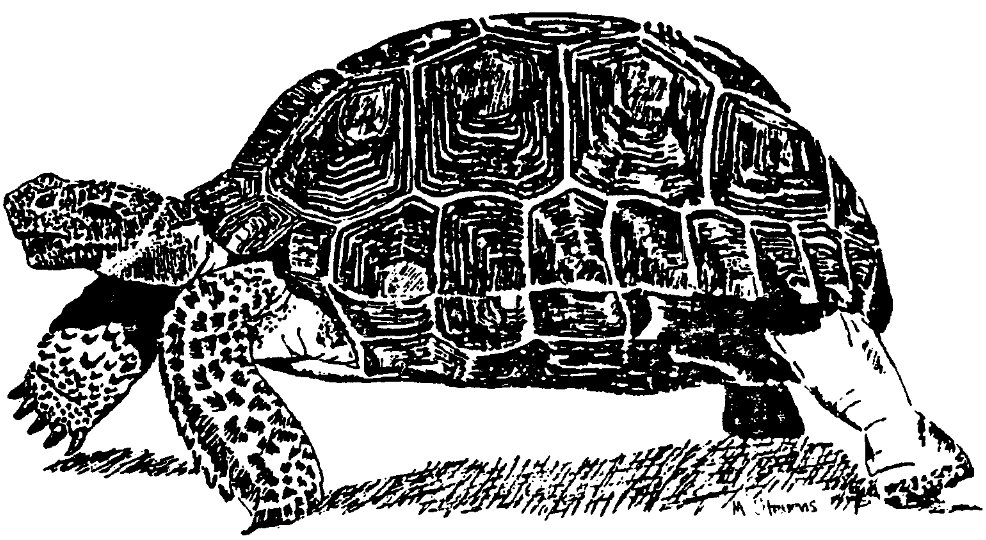
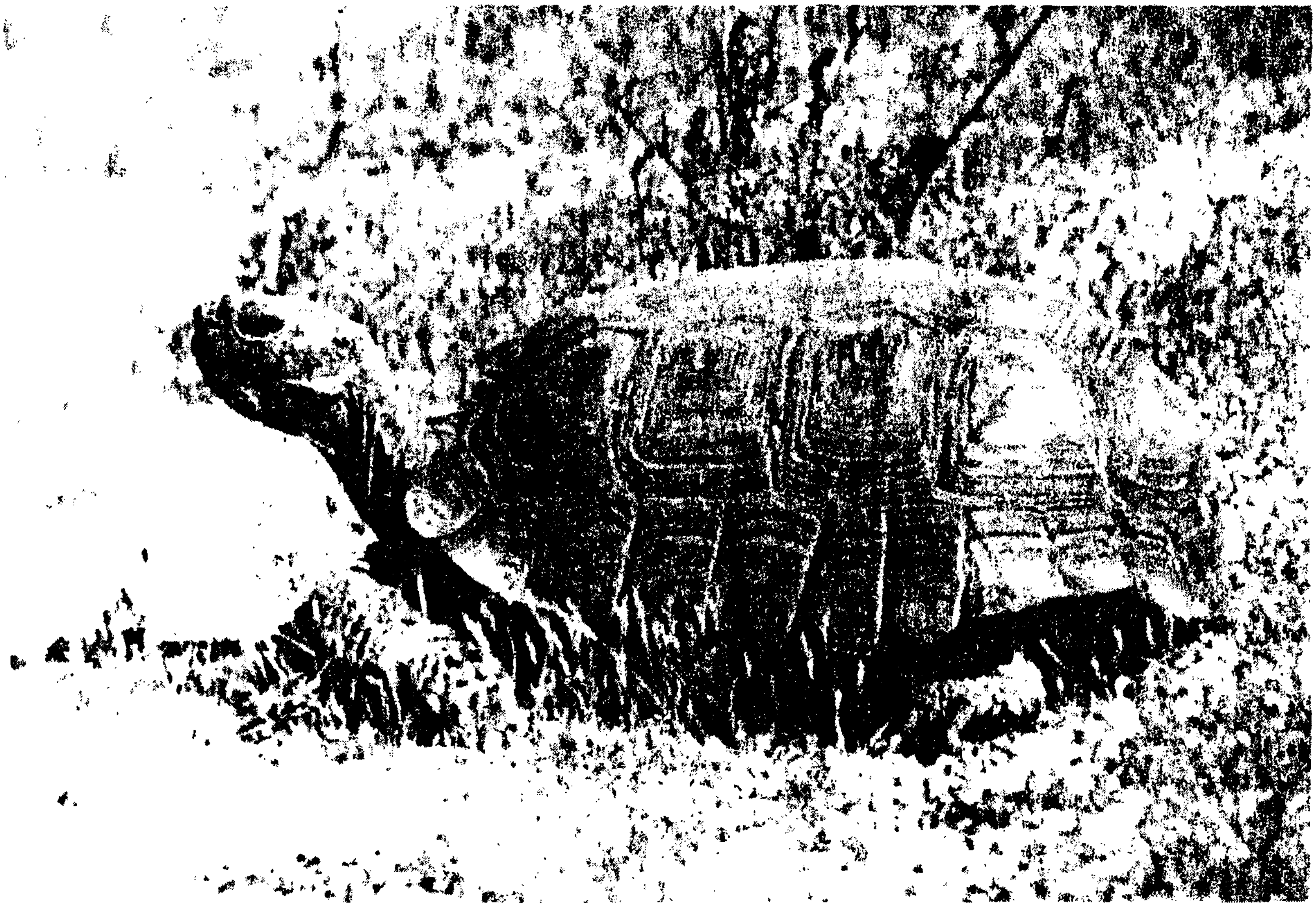




In the Mojave Desert, California, a male desert tortoise basks in the sun.

Photo by Beverly F. Steveson

The Desert Tortoise Council

Glenn R. Stewart

In its 3rd year, the Desert Tortoise Council has continued to advance toward the goal of assuring the maintenance of viable populations of the desert tortoise throughout the tortoise's existing range. To this end, the Council has effectively combined the efforts of state and federal agencies, academic institutions, museums, zoos, turtle and tortoise clubs, and concerned citizens.

The principal functions of the Council are:

1) To serve in a professional advisory manner, where appropriate, on matters involving management, conservation and protection of desert tortoises
2) To support such measures as shall work to insure the continued survival of desert tortoises and the maintenance of their habitat in a natural state
3) To stimulate and encourage studies on the status and on all phases of life history, biology, physiology, management and protection of desert tortoises, including studies of native and exotic species that may affect desert tortoise populations
4) To provide a clearinghouse of information among all agencies, organizations and individuals engaged in work on desert tortoises
5) To disseminate current information by publishing proceedings and transactions of meetings and other papers as deemed useful
6) To maintain an active public information and conservation education program
7) To commend outstanding action and dedication by individuals and organizations fostering the objectives of the Council.

The reports and scientific papers contained in this Proceedings volume are a testimonial to the Council's success in carrying out these functions. They also are a reminder that much remains to be done. However, I am confident that the Council will continue to grow and to achieve its objectives. Your help during the past year has been very much appreciated, and I look forward to seeing you next spring at the Fourth Annual Symposium in Tucson, Arizona.

Biological Sciences Department
California State Polytechnic University
Pomona, California 91768

The Third Annual Meeting and Symposium

Our deepest appreciation to Dr. Robert C. Stebbins, Museum of Vertebrate Zoology, University of California at Berkeley, for his inspiring and thought-provoking keynote address, "Controversy in the California desert."

Our sincere thanks also to Dr. James C. Bacon, Curator of Reptiles and Amphibians, Zoological Society of San Diego, who entertained and enlightened us with his after-dinner talk on the captive management of giant tortoises.

Excerpts from the Minutes of the Third Annual Business Meeting

Research Advisory Committee. During 1977 three proposals for research within the Desert Tortoise Preserve were submitted to the Council for review. Ron Marlow and Kristine Tollestrup (students of Dr. Robert Stebbins) requested to continue their studies of tortoises and leopard lizards, respectively. One study was a request by the Bureau of Land Management to study the kit fox on the Preserve. Dr. Glenn Stewart mentioned that it took longer than desirable for the Committee to approve the studies, but the delays by the BLM Area Manager were unreasonable. It was suggested that in the future the Committee send a letter of approval of proposed studies to the BLM State Director with a copy to the District Manager to help avoid these delays.

Tortoise Shells Report. Dr. Kristin Berry stated that during the 1977 BLM studies at 5 sites in the desert, several hundred tortoise shell skeletal remains were collected. These were catalogued and permanent file cards completed. When the data are analyzed, the shells will be transferred to interested museums. Several hundred additional shells will be collected and catalogued during 1978. There should be enough shells to supply several museums. Dr. Berry recommended that prior to any relocation, we discuss the matter with Robert Patterson since it was his 1977 paper that prompted collection of these shells.

New Resolutions and Proposals. The following new resolutions and proposals were made:

1) Ivanpah Valley

   A letter will be drafted for the Council to be sent to California State BLM Director regarding concern for the protection of the Ivanpah tortoise population.

2) Desert Tortoise Natural Area

   A letter to the California State BLM Director with a copy to Senator Alan Cranston will be drafted. The letter will address the following concerns:

a) Delay in forwarding Petition for Withdrawal of lands in the Preserve from mining and mineral leasing. Delay in designating the area formally as a Natural Area.

b) Recognition of the existing Habitat Management Plan and that funding for acquiring private lands should not be sought from recreation sources as it would require recreational measures not compatible with the designated use of the Preserve.

c) Concern for delay in building the long-promised interpretive center, nature trails, etc.

d) Need to complete fencing, particularly in new lands acquired by The Nature Conservancy.

e) Need for signs indicating that tortoises are fully protected by law and that captives should not be released.

3) Arizona Game and Fish

a) Letter to Director Robert Jantzen recommending inclusion of a tortoise program in their Information and Education Program will be drafted.

b) Also, a letter to Mr. Jantzen will be drafted recommending that Arizona's list of threatened and endangered wildlife use language similar to that used under Fish and Wildlife Service's Endangered Species Act.

c) When preliminary results from the BLM's Arizona statewide tortoise surveys are in, they will be presented to the Game and Fish Commissioners, and at that time the Council will recommend a program for protection of the tortoise in Arizona.

4) California Fish and Game Captive Tortoise Registration

The proposed abandonment of the registration and tagging of captive tortoises was discussed. All members agreed that abolition of this practice would decrease knowledge of and control over the captive population. James St. Amant will report this back to Fish and Game, and a letter stating the Council's position will be written.

5) Off-Road Vehicles

The Executive Committee will draft a resolution for the next meeting regarding the Council's concern for ORV effects on tortoises and tortoise habitat and the need for monitoring such activity. The letter will be addressed to the Department of Interior, Secretary Cecil Andrus, Director of BLM, CEQ, Fish and Wildlife Service, and Fish and Game.

6) Position on *Gopherus flavomarginatus*

A letter will be written to Dr. C. Kenneth Dodd, Endangered Species Office, recommending that the bolson tortoise be included on Appendix I and that this species be listed as threatened.

7) Proposed Nevada Tortoise Program

The Council will write a letter to Nevada BLM Director John Boyles thanking him for his welcome of the Symposium attendees and offering the assistance of the Executive Committee in drafting a tortoise program for Nevada.

Field Trip - Ivanpah Valley, 3 April 1978. As part of the Third Annual Meeting and Symposium of the Desert Tortoise Council, there was a field trip to a Bureau of Land Management Study Site in Ivanpah Valley, San Bernardino County, California. The Ivanpah Valley site was selected by Dr. Kristin Berry of the California Desert Program, Bureau of Land Management, for a special 30-day survey in spring 1977. Ms. Betty Burge, contractor for the study, found and marked about 150 tortoises on a 2.59 square kilometre plot, establishing densities of 88 to 102 tortoises/km^2.

At 09:45, 21 persons arrived in caravan and were met at the site by Jim Bicket of the Cima Area Office, Bureau of Land Management. Almost immediately, members of the group began to call out their discoveries of tortoises. By noon at least 10 tortoises, including 2 juveniles that had probably hatched during the previous fall, had been found. Three of the tortoises were recaptures of those marked during spring 1977 by Betty Burge. Lori Nicholson marked and measured unmarked tortoises and remeasured recaptures as part of a continuation of the study on the 2.59 km^2 study plot.

One of the more important observations made during the field trip was the extreme sensitivity of tortoises, especially small tortoises, to livestock grazing. The potential threat to juvenile tortoises was particularly obvious. At their deepest, the burrows of juveniles were covered by only a few centimetres of soil, easily collapsed by the brush of a human foot. The burrows of the 2 juveniles discovered on this trip were not under the taller denser shrubs that might protect them from trampling by cattle, but were covered only in part by low and sparse vegetation, such as dead bushes. Although cattle were not on the study plot during the field trip, relatively recent sign was obiquitous. The area has a long history of grazing.

Those attending were Walter Allen, Ariel Appleton, Thomas Belzer, Dr. Kristin Berry, Betty Burge, Dr. Mark Dimmitt, Dr. Kenneth Dodd, Lynn Dolan, Dr. John Hendrickson, Barbara Horton, John and Eleanor Janulaw, Shelly Johnson, Thomas Lackey, Paul Lucas, Mark Maley, George and Shirley Moncsko, Lori Nicholson, William Radtkey, and Winton West. Some members of the group were still in the area after 15:30.

Attendees - Third Annual Meeting and Symposium

Dr. Gary Adest	California State University, Los Angeles
Walter Allen	California Turtle and Tortoise Club, Fountain Valley, CA
Arden Anderson	Bureau of Land Management, Cedar City District Office, Cedar City, Utah
Dr. Fred P. Andoli	California Polytechnic University, San Luis Obispo
Ariel Appleton	The Research Ranch, Elgin, Arizona
Dr. James P. Bacon, Jr.	Zoological Society of San Diego, San Diego, CA
John Barrow	Pomona, CA
Thomas J. Belzer	Pasadena City College, Pasadena, CA
Dr. Kristin H. Berry	Bureau of Land Management, California Desert Plan Staff, Riverside
James L. Bousquet	Animal Control, Las Vegas, Nevada
Dr. Dennis M. Bramble	University of Utah, Salt Lake City
Betty L. Burge	Las Vegas, Nevada
Dr. R. Bruce Bury	National Fish and Wildlife Laboratory, Fort Collins, Colorado
Patricia Busbee	Pierce College, Woodland Hills, CA
Bill Butler, Jr.	Bureau of Reclamation, Boulder City, Nevada
Dee Butler	Boulder City, Nevada
James C. Cook	Student-California State Polytechnic University, Pomona
Ted Cordery	Bureau of Land Management, Phoenix District Office, Phoenix, Arizona
Kenneth Detweiler	Bureau of Land Management, Las Vegas District Office, Las Vegas, Nevada
Dr. Mark A. Dimmitt	Bureau of Land Management, Riverside District Office, Riverside, CA
Dr. C. Kenneth Dodd, Jr.	Office of Endangered Species, Fish and Wildlife Service, Washington, D.C.
Frederick H. Emmerson	Las Vegas Valley Zoo, Las Vegas, Nevada
Elizabeth W. Forgey	Desert Tortoise Preserve Committee, Boron, CA
Warren W. Forgey	Desert Tortoise Preserve Committee, Boron, CA
Rochelle Freid	California Turtle and Tortoise Club, Fullerton, CA
Dr. Richard M. Hansen	Colorado State University, Fort Collins
Dr. J.R. Hendrickson	University of Arizona, Tucson
Judy P. Hohman	Student-Arizona State University, Tempe
Erik Holmback	Las Vegas Valley Zoo, Las Vegas, Nevada
Frank Hoover	California Department of Fish and Game, Chino
Barbara Horton	The Nature Conservancy, Pasadena, CA
Dr. Crawford G. Jackson, Jr.	San Diego Natural History Museum, San Diego, CA
Eleanor Janulaw	Los Angeles, CA

John Janulaw	Los Angeles, CA
Shelly R. Johnson	Pasadena City College, Pasadena, CA
Thomas Lackey	California Turtle and Tortoise Club, Canoga Park, CA
Thomas A. Liles	Arizona Game and Fish Department, Kingman
Paul Lucas	Nevada Department of Fish and Game, East Ely, Nevada
Mark R. Maley	Bureau of Land Management, Las Vegas District Office, Las Vegas, Nevada
Bernardo Maza	UCLA-Laboratory of Nuclear Medicine, Mercury, Nevada
Philip A. Medica	UCLA-Laboratory of Nuclear Medicine, Mercury, Nevada
George E. Moncsko	Desert Tortoise Preserve Committee, Ridgecrest, CA
Shirley F. Moncsko	Desert Tortoise Preserve Committee, Ridgecrest, CA
Dr. David J. Morafka	California State College, Dominguez Hills
Lori Nicholson	Bureau of Land Management, Riverside, CA
Dr. Robert D. Ohmart	Arizona State University, Tempe
Robert G. Patterson	Independent Researcher, Orange, CA
Evelyn Perrine	California Department of Fish and Game, Long Beach
Lauren Porzer	Student-Arizona State University, Tempe
Roscoe Poland	Conservation Call, San Diego, CA
Wilma Poland	Conservation Call, San Diego, CA
William Radtkey	Bureau of Land Management, California State Office, Sacramento, CA
Wilma S. Rogers	Las Vegas, Nevada
James A. St. Amant	California Department of Fish and Game, Long Beach
James L. Schwartzmann	Student-Arizona State University, Tempe
Mary L. Scully	Las Vegas, Nevada
Rick Seegmiller	Bureau of Land Management, California Desert Plan Staff, Riverside
Donald J. Seibert	Bureau of Land Management, Arizona State Office, Phoenix
Dr. Robert C. Stebbins	University of California, Berkeley
David W. Stevens	Southern California Edison Company, Environmental Affairs, Rosemead, CA
Dr. Glenn R. Stewart	California State Polytechnic University, Pomona
Caroline Stiles	Las Vegas, Nevada
Mary Trotter	Desert Tortoise Preserve Committee, San Diego, CA
Ann E. Weber	Student-California State Polytechnic University, Pomona
Winton K. West, Jr.	Loma Linda University, Loma Linda, CA
Darrell M. Wong	California Department of Fish and Game, Blythe
Martha Young	California Turtle and Tortoise Club, Garden Grove, CA

1978 Annual Award: Profile of Recipient, Dr. Robert C. Stebbins

Dr. Stebbins completed both his undergraduate and graduate work at the University of California, Los Angeles. He initially selected the Roadrunner as the subject of his dissertation--even devising capture techniques and learning to imitate the Roadrunner's call--but then became intrigued with lizards while on a field trip to the desert with the late Dr. Raymond Cowles. After Dr. Cowles pointed out the third eye in a partially buried fringe-toed sand lizard, Dr. Stebbins made the decision to study the ecology of fringe-toed sand lizards, primarily of the Coachella Valley, instead of continuing work on the Roadrunner. He eventually expanded the study to include locomotion, respiration, and adaptations for sand living.

Dr. Stebbins accepts Annual Award from Dr. Kristin Berry.

After completing his dissertation, Dr. Stebbins worked for two summers as a ranger-naturalist at Lassen Volcanic National Park. In 1945 he became the first herpetologist and Curator in the official sense at the Museum of Vertebrate Zoology, University of California, Berkeley, a position which provided many opportunities for field research, travel, and lecturing.

His years at Berkeley have been tremendously productive. Stimulated by the publication of the Peterson Field Guide series to prepare a similar work covering western amphibians and reptiles, Dr. Stebbins was already preparing the paintings for such a book when he arrived at Berkeley. This effort culminated in the 1954 publication of "Amphibians and Reptiles of Western North America." A major revision of this work, which he is now preparing and hopes will be available in 1979, may expand the book to two volumes. His other books include: "Birds of Lassen Volcanic National Park and Vicinity," "Amphibians of Western North America," "A Field Guide to Western Reptiles and Amphibians," "Birds of Yosemite" (with his father), "Lives of Desert Animals in Joshua Tree National Monument" (with Alden Miller), field guides to reptiles and amphibians of California and the San Francisco Bay Area, and a textbook, "General Zoology" with Storer, Usinger, and Nybakken.

His career has numerous highlights, the first of which was the publication of the rassenkreis study on *Ensatina* in two papers, "Speciation in salamanders of the plethodontid genus *Ensatina*" (University of California Publications in Zoology, 1949) and "Natural history of the salamanders of the genus *Ensatina*" (University of California Publications in Zoology, 1954). A second important area is his work with the pineal eye. His paper entitled, "Role of the 'third' eye in reptilian behavior" (American Museum Novitates, 1958) with Richard Eakin, initiated a lot of research in this field The two investigators studied the effects on free-living lizards of loss of the pineal eye. Their publication represented a breakthrough and demonstrated the importance of studying lizards in the field as well as the laboratory. Another area of importance was the preparation of "Animal Colouration, an Introduction to Natural Selection and the Principles of Concealing Colouration" for elementary schools. This unit was published in Australia and the United States in the 1960s with Ipsen and Gillfillan as co-authors.

Dr. Stebbins has made a number of important contributions to the desert tortoise and its habitat in the Southwest. Some of the contributions are direct, others indirect. First, he has brought the study of amphibians and reptiles to the attention of the public through his books. Without these exceptionally fine guides and the accompanying drawings and paintings, many people would not have had the opportunity to become acquainted and interested in the herpetofaunas of the Southwest. Some members of the Desert Tortoise Council developed an interest in desert reptiles and amphibians primarily through his books.

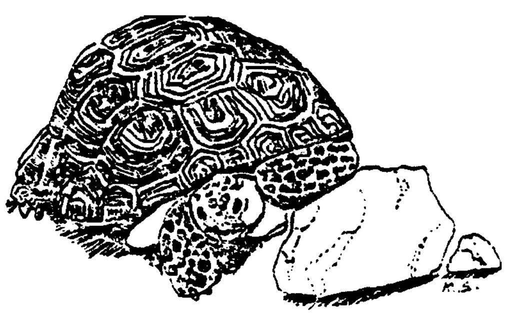
He has worked with the California Department of Fish and Game and federal agencies on problems of potentially rare, endangered, and threatened species of reptiles and amphibians and their habitats. He has been involved with such species as the Santa Cruz long-toed salamander, the limestone salamanders, the Coachella fringe-toed lizard, and the flat-tailed horned lizard. His concern extends from the species to the preservation of the habitats.

His courses on conservation education for elementary school teachers and other levels have provided materials for teachers on the importance of acquainting young people in a land ethic and land conservation, in animals themselves, and in their educational and scientific values. He is one of the few professors who is interested in and who emphasizes the importance of conservation of natural resources.

In the last few years, his interests have turned to the problems of land use management, particularly in the California deserts. There has been serious deterioration in desert habitats during the last 20 years from off-road vehicle use, mining, grazing, vandalism, and other sources. Dr. Stebbins has succeeded in bringing the problems of off-road vehicle use to the attention of educators, conservationists, students, and government officials through a two-part paper entitled, "Off-road Vehicles and the Fragile Desert" published first in the "American Biology Teacher" and later distributed by the San Diego Natural History Museum through its publication, "Environment Southwest." There is a third article on the subject in the "Sierra Club Bulletin." He has lectured widely and corresponded extensively with government officials concerning deterioration in public lands from recreational vehicle users.

Most recently Dr. Stebbins undertook a study on the educational and research uses of the desert, an area largely ignored by the land-managing agencies. His survey included public and private schools, colleges and universities, and organized groups (National Audubon Society) in southern California. There were 548 respondents who reported approximately a quarter million person-use-days per year in the California deserts. Dr. Stebbins found through his survey that research and educational uses in the desert are significant, valuable, and important uses of public lands and a multimillion dollar business.

In summary, Robert C. Stebbins has made major contributions toward providing information and promoting interest and conservation of desert reptiles and amphibians and their habitats during the last 30 years. His books and other publications, his teaching efforts, and his unflagging but gentle pressure on land-managing agencies have influenced immeasurably many sectors of society to protect and preserve reptilian species in the deserts and throughout the world. Most of his contributions to the tortoise have been indirect but are nevertheless of great significance. He has been and continues to be a source of inspiration to us all.



State Report - Arizona

Donald J. Seibert
Bureau of Land Management

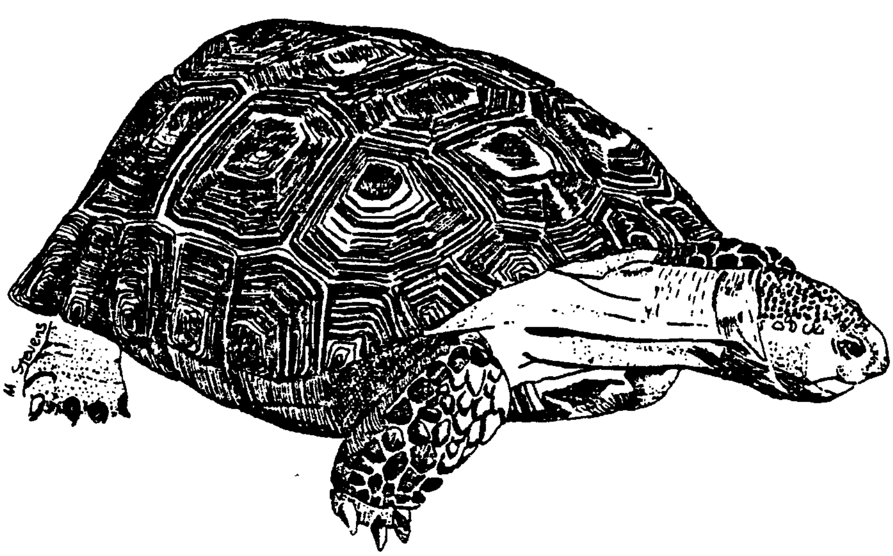
At present the following investigations of the desert tortoise are being conducted in Arizona:

1) James Schwartzmann is studying the tortoise population of the eastern end of the Picacho Mountains. His study is funded by Arizona State University.

2) Judy Hohman is investigating the Beaver Dam Slope tortoise population in Arizona. Her study, funded by the Bureau of Land Management, is in its 2nd year, and the Bureau hopes to fund the study for 5 years.

Within the next month the Bureau of Land Management and the Bureau of Reclamation anticipate issuing a joint contract to inventory the desert tortoise throughout its range in western Arizona. The purpose of this study will be to survey the areas of importance to the tortoise in Arizona. Eight hundred 1.6 km [= 1 mile] transects will be run this spring and summer. The results of this project will be reported at the next annual meeting of the Council.

Bureau of Land Management
Arizona State Office
2400 Valley Bank Center
Phoenix, Arizona 85073



State Report - Arizona

Thomas A. Liles
Game and Fish Department

Arizona's regulations governing the desert tortoise *(Gopherus agassizii)* have not changed. Possession of 1 tortoise per family member is still allowed and none may be killed or exported.

The revision of the Department's "Threatened Wildlife" list has yet to be completed. Suggested changes were received from many sources, but none reference the desert tortoise. It will most likely remain listed in Group III (i.e., "Species or subspecies whose status in Arizona may be in jeopardy in the foreseeable future").

The initial portion of the inventory phase of the Department's "Statewide Fish and Wildlife Plan" is complete. Data input has been received on species distribution throughout the state. Maps are being prepared delineating known ranges, with big game species receiving first priority. It is unknown at this time when maps may be prepared for nongame species such as the desert tortoise.

Arizona Game and Fish Department
1420 West Beale Street
Kingman, Arizona 86401

Special Report - Arizona

The Research Ranch

Ariel Appleton

The Research Ranch was established in 1969 as a private nonprofit operating foundation to conserve a sizeable area of grassland which is returning to a natural condition. Its 3238 hectare [= 8,000 acres] constitute the only large land holding in the United States from which domestic grazing animals have been removed, and continuously updated baseline data have been compiled, computerized and stored at the University of Arizona, and are internationally available as a base for scientific studies. Many masters theses and several doctoral dissertations have resulted from research conducted at TRR, in participation with University of Arizona, Arizona State University, University of Colorado, Harvard University and the University of California.

The recent history of southwestern grasslands is predominantly that of usage for domestic livestock grazing or for farming.

The Research Ranch is 65 miles southeast of Tucson via 1-10 and Route 83.

On the 2-km-high Sonoita plains in southeastern Arizona, the short to mid-grass prairies have been grazed almost continuously for over a hundred years. In all of the grazed and overgrazed southwest, grassland ecosystems have been fundamentally altered and attempts to maintain or improve their productivity to benefit both man and wildlife, have been essentially blind endeavors, matters of trial and error, because there has been no ungrazed or original situation to which one could refer, to understand what the potential productivity and the processes that contribute to it are.

The Research Ranch provides a unique "natural laboratory," an undisturbed control area, to serve as an ecological benchmark against which man introduced changes to Western land such as contour plowing, seeding of non-native grasses, and the effects of range fires can be evaluated with regard to their long-term impact on the health and stability of plant and animal life.

It also constitutes a "conservation island," a plant and animal gene bank in beautiful and highly desirable terrain. Open prairie to the north supports the mule deer herds, oak savannah and oak woodland are the preferred sites of white-tail deer populations and of the Montezuma Quail. Six healthy groupings of collared peccary, the only native member of the pig family in the United States, utilize the grassy hillsides and broad Sacaton grass flats along O'Donnell Canyon stream and the seasonally flowing dry river washes, as do the largest number of species of grassland finches to be seen in the United States, some 23 in all.

Young ash, walnut and willow trees are springing up in the washes, and the 2 great cottonwoods, who were the sole representatives of their species on the entire ranch in 1969, have found their perpetuity in the hundreds of young cottonwoods which have established themselves since grazing ceased. There are 5 species of trees at TRR that have been recognized as "monarchs" by the American Forest Registry, each the largest of their kind to be recorded in the United States--velvet ash, black walnut, Arizona oak, Emery oak, and yew leaf willow.

Research, conservation and education are TRR's 3 functions and, in 1971, a landmark agreement was reached with the U.S. Forest Service, dedicating their 921 hectares [= 2,275 acres] of land formerly leased by TRR, to its programs and objectives.

In 1977, TRR was selected by the National Science Foundation, with high priority, as one of an initial national metwork of 67 Experimental Ecological Reserves, chosen from among 171 candidate areas in the United States and Carribean and 1 of only 5 private organizations so designated.

Environmental tours are conducted for groups such as the International Union for the Conservation of Nature's Survival Service Commission, the Board of the National Audubon Society, the U.S. Forest Service, the Society for Range Management, the

Cleveland Museum of Natural History, the Southwest Research Station, Arizona Game and Fish, Arizona Governor's Advisory Committee on the Environment, the Barnes Arboretum, and annual groups of college and university students from across the country.

In March of this year, the U.S. Department of the Interior arranged a trip for an initial group of Egyptian bioscientists to 4 pertinent U.S. areas, including TRR as the only private site selected.

A wide diversity of research studies, self funded and ranging from effects of naturally occurring fire, air quality sampling, aquatic analyses, range grasses, wildlife, photographic documentation of vegetation changes, etc. are carried out with the objective of broadening understanding of the functions of natural systems, but with the least possible disturbance to these systems.

The foundation is also concerned with expediting the reintroduction of indigenous animal species that have been regionally eliminated, such as the Mexican pronghorn antelope, once plentiful in southeastern Arizona, and, when appropriate, in providing restricted areas for certain select endangered species, whose native habitats are similar as to climate and plant growth. Currently, in cooperation with the Institute of Ecology in Mexico City, 2 separate projects involving the bolson tortoise are ongoing, one an endangered species breeding program, the other a behavorial study conducted by Dr. John Hendrickson of the University of Arizona.

A spring fed pond will soon receive a population of Arizona desert pup fish, now only located at Organ Pipe National Monument, where there has been recent concern about airborne pollutants resulting from agricultural practices in nearby Mexico.

Throughout history, man's inability to manage grasslands, especially in the semiarid areas which are slow to regenerate, has led to their degradation or disappearance. They are the first exploited, the most abused, the least understood. Their preservation is critical--both for conservation of the beauty and variety of native plant and animal life and as a primary source of human food. If man must alter to exist, surely it is wise to examine the potential long range costs to man himself, when natural balances are changed. There is a critical need to understand how healthy grassland is sustained--what role each component plays in the overall picture of strength and diversity.

The Research Ranch is dedicated to furthering scientific and philosophical inquiries that place a prime value on the natural environment, not to exclude the needs of man but to contribute to a better understanding of wise usage.

P.O. Box 44
Elgin, Arizona 86511

State Report - California

Kristin H. Berry
California Desert Program, Bureau of Land Management

The Bureau of Land Management report for the California deserts is subdivided into 6 parts: continuation of the previous studies of desert tortoise distribution and relative densities by using the transect technique, a summary of the 1977 studies on 5 permanent study plots in the Mojave and Colorado deserts, a review of the study on the effects of highways on desert tortoise populations, projects planned for 1978, and a status report on the Desert Tortoise Natural Area. Miss Lori Nicholson will give the paper on the effects of highways on desert tortoise populations, and Mr. William Radtkey will present the report on the Desert Tortoise Natural Area.

Studies on Distribution and Relative Density. At the 1976 Annual Meeting, I reported that over 40 transects had been made in the eastern Mojave Desert of San Bernardino County and another 80 transects were made in the Colorado Desert region in summer 1976. Between July 1977 and March 1978, an additional 300 transects were completed in both the Mojave and Colorado deserts by Lori Nicholson, who was employed by the California Desert Program. Miss Nicholson is now under contract to the California Desert Program to undertake further transects to cover all public lands in the California Desert Study Area. Each transect is 2.4 kilometres [= 1.5 miles] long; transect density averages .01287/km^2 [= 1.2 per township or 1.2 per 36 square miles]. The transect project should be completed by October 1978.

Permanent Study Plots. Permanent study plots 2.59 square kilometres [= 1 square mile] in area or larger were established in 5 areas in San Bernardino and Riverside counties in 1977. An attempt was made to mark every tortoise occurring on each plot over a 30-day period in spring. Data were obtained on size class structure, sex ratios, movements, burrows, feeding habits, and other population and behavioral parameters. All shell-skeletal remains were collected for estimates of mortality rates. The studies were accomplished through contracts to Betty L. Burge, Lori Nicholson, and James Cook, and the results are summarized below.

Ivanpah Valley, San Bernardino County (Betty L. Burge). For 30 days between 30 March and 6 June, 151 tortoises were captured, marked and released on a 2.59 km^2 [= 1 square mile] plot in a creosote bush scrub habitat. The population consisted of 43% adults, 18% subadults, 34% juveniles, 3% very young tortoises, and 2% hatchlings.* The density is estimated at 87-106/km^2 [= 225

* The carapace lengths for all size/age classes shown here are: <60 mm, hatchlings; 61 to 100 mm, very young tortoises; 101 to 180 mm, immatures; 181 to 214 mm, subadults; and >214 mm, adults.

to 275 tortoises per square mile]. The sex ratio of individuals > 180 mm was 0.7 ♂♂:1.0 ♀♀. Shell-skeletal remains totalled 129.

The predominant shrubs on the plot are burrobush *(Ambrosia dumosa)* and creosote *(Larrea tridentata)*. Two major washes cross the study area and contain woolly-fruited burbush *(Ambrosia eriocentra)*, California joint fir *(Ephedra californica)*, paper-bag bush *(Salazaria mexicana)*, and cheesebush *(Hymenoclea salsola)*. Smaller wash channels have such species as galleta grass *(Hilaria rigida)* and Anderson thornbush *(Lycium andersonii)*.

Goffs, San Bernardino County (Betty L. Burge). The Goffs plot is in creosote bush scrub habitat with creosote bush, burrobush, galleta grass, darning needle cactus *(Opuntia ramosissima)*, and silver cholla *(Opuntia echinocarpa)*. There are washes with smoke tree *(Dalea spinosa)* and catclaw *(Acacia greggii)*. During 30 days between 1 April and 11 June, 148 tortoises were captured, marked and released on one square mile. Of 152 different individuals observed, adults composed 47% of the population, subadults 29%, juveniles 20% and very young tortoises and hatchlings, < 5%. Density was estimated at 77-94/km^2 [= 200 to 244 tortoises per square mile]. The sex ratio for individuals > 180 mm is 1.2 ♂♂:1.0 ♀♀. The collected shell-skeletal remains represented about 94 individuals.

Chemehuevi Valley, San Bernardino County (James Cook). This study plot is 5.18 km^2 [= 2 square miles] and lies in a creosote bush scrub habitat dissected by washes. The dominant shrubs in the flats are little-leaved ratany *(Krameria parvifolia)*, burrobush and creosote, whereas smoke tree is common in washes. Thirty-one days were spent on the plot between 15 April and 21 May. Thirty-three tortoises were marked, of which 33.3% were adult, 36.4% subadult, 24.2% immatures, and 6.2% hatchlings. There were no "very young" tortoises. The sex ratio of tortoises > 180 mm is 0.77 ♂♂:1.0 ♀♀. Shell-skeletal remains of 20 tortoises were found. Density is estimated at 12-23 tortoises/km^2 [= 30 to 60 per square mile].

Fremont Peak, San Bernardino County (Lori Nicholson). Two study plots 2.59 km^2 [= 1 square mile] each in size were selected in a saltbush community west of Fremont Peak. Common shrubs include: shadscale *(Atriplex confertifolia)*, Mojave saltbush *(Atriplex spinifera)*, spiny hopsage *(Grayia spinosa)*, burrobush, cheesebush, and goldenhead *(Acamptopappus sphaerocephalus)*. Thirty days were spent on the 2 plots between 31 March and 12 June. Fifty tortoises were marked, of which 34% were adult, 16% subadult, 48% immature and 2% very young tortoises. There were no hatchlings. Remains of 99 tortoises were found. The sex ratio of tortoises > 180 mm is 1.75 ♂♂:1.0 ♀♀. Densities are estimated at 12-15 tortoises/km^2 [= 30 to 40 per square mile].

Chuckwalla Bench, Riverside County (Lori Nicholson). The study plot here is in a diverse vegetative community on desert pavements intersected by large rocky or sandy washes. Vegetation on pavements consists of creosote, burrobush, white ratany *(Krameria grayi)*, California joint fir, cheesebush, jojoba *(Simmondsia chinensis)*, ocotillo *(Fouquieria splendens)*, teddy bear cholla *(Opuntia bigelovii)*, and Mojave yucca *(Yucca schidigera)*. Washes have trees of palo verde *(Cercidium floridum)*, smoke tree and desert willow *(Chilopsis linearis)*. Thirty days were spent in collecting data from 25 April to 31 May. One hundred twenty tortoises were marked, of which 49.2% were adults, 22.5% subadults, 25.8% immatures, and 2.5% very young tortoises. There were no hatchlings. Sex ratios of tortoises >180 mm were 1.0 ♂♂:1.0 ♀♀. Remains of 75 tortoises were collected. Densities are estimated to be about 77 tortoises/km^2 [= 200 tortoises per square mile].

Study Projects for 1978. The California Desert Program has awarded several contracts for study of 10 additional 2.59 km^2 [= 1 square mile] or larger study plots during spring 1978. The 10 plots represent several different habitat types; some are relatively undisturbed, whereas others have off-road vehicle use, sheep grazing, or former use by military tanks in the 1940s. Data will be collected (over a 30-day period between March and June) on size, sex, behavior and location of every live tortoise, and on size, sex and condition of every shell. These data will be used to estimate densities, age structure, sex ratios and mortality rates in the 10 areas.

By late 1978 we anticipate having adequate information from transects and the study plots to prepare a map of desert tortoise distribution and density for the California deserts and to comment on status of selected populations.

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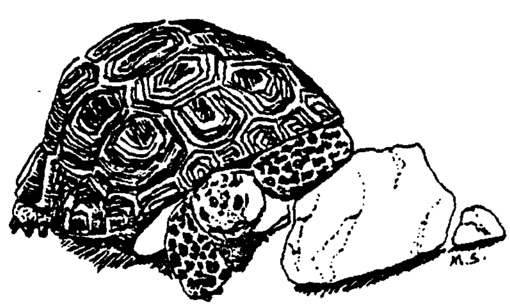

State Report - California

William Radtkey
Bureau of Land Management

I have been asked to report on two subjects: progress on managing the Desert Tortoise Natural Area, and the status of proposed oil and gas leases in the Ivanpah Valley.

DESERT TORTOISE NATURAL AREA

Implementation of management for this area has been underway for several years. In 1973 the area was closed to recreational vehicle traffic. In 1975 a request was submitted to withdraw the area from the general mining laws. The area has been closed to grazing on the public lands. Additionally there are several continuing projects identified in the habitat management plan.

Request for Withdrawal from the General Mining Laws. The withdrawal request is still pending in Sacramento. Apparently there is some concern about the adequacy of the minerals report. When the report is completed, the withdrawal request will be submitted to the Washington Office, and then to the Secretary of Interior. Finally, because an area of more than 20.23 km^2 [= 5,000 acres] is involved, the request will be submitted to Congress.

Interpretive Structure. Construction of these facilities was planned for last year. Several things happened, causing the construction contract not to be let. There were delays in getting the design approved and delays in submitting the contract proposal to our contracting office.

In spite of all this, the contract could have been awarded except that the only bid received exceeded our available funds by ≈ $15,000. This bid was rejected, and there was insufficient time to negotiate or readvertise. The funds could not be carried over to a new fiscal year and were lost.

During the current fiscal year, which began 1 October, there are no funds planned for these facilities. However, at the midpoint of our fiscal year, 1 April, we do a complete fiscal analysis to determine the status of funds and projects. Many times during this analysis we encounter funds that are excess to planned work. In the event that there is funding available, a proposal has been developed to fund the interpretive facilities construction contract. This proposal is as follows:

Interpretive Center	$30,000
Interpretive Panels	35,000
Sanitation Facilities	10,000
Access Road and Parking	45,000

The proposed road crosses private land. The district has completed the survey and appraisal for the access easement necessary to go along with the center. They have the funds available and an apparently willing land owner, so this should be completed soon.

As part of the interpretive program, nature trails are proposed near the interpretive center. The actual construction of the trails will be done by Comprehensive Employee Training Act (CETA) crews. The CETA provides federal funds to counties for hiring and training the generally unskilled worker. These crews are provided to BLM, usually without cost except for supervision and transportation. The trail work will probably start after fencing is completed.

Fencing. The district is planning to move 2.4 km [= 1.5 miles] of fencing across the northeast corner of the Natural Area. This fencing material, plus an additional approximate 8 km [= 5 miles] of material, will be used to enclose the area known as the northern extension. The location for the fence is being surveyed and flagged now. CETA crews will also be used for this work. The fence will cross ≈ 1.6 km [= 1 mile] of land owned by Southern Pacific Railroad. An easement for this is being negotiated.

Research Proposals. There are currently 2 research projects authorized on the area: Ron Marlow -- desert tortoise research and Kristine Tollustrup -- leopard lizard research. I overlooked getting a report on these projects, so I have no report on progress.

Land Acquisition Plans. This is a difficult program to tie down to specifics. Currently there are 2 types of actions proposed:

1) Exchanges--trading federal land somewhere else for private land within the area. This will probably be used on fairly large areas owned by a single owner. To complete an exchange requires about 18 months if no difficulties are encountered, and we work hard at ensuring no one gets sidetracked. If funds become available in our next fiscal year, we hope to start on the first exchange this December or January.

2) Land Purchase. This program is even more unreliable than the exchange program. To accomplish this will require congressional appropriations, through direct appropriations or the land and water conservation fund. In January 1978 a budget proposal was submitted to Washington requesting funds for fiscal year 1980 from the land and water conservation fund. To qualify for use of this fund source, it has to be demonstrated that there are important recreation values on the lands being purchased.

Patrols and Supervision. A California Department of Fish and Game warden has been assigned to the Ridgecrest area. One of his responsibilities is to patrol the Desert Tortoise Natural Area. Bureau of Land Management rangers make occasional trips to the area on weekends. These are generally just spot checks to known trouble areas and may be only every other week.

OIL AND GAS LEASING - IVANPAH VALLEY

The BLM has received several applications to lease parts of Ivanpah Valley for oil and gas development. A large part of the area applied for is within habitat occupied by the desert tortoise. Especially significant is the area in the south of Ivanpah Valley which has the second highest known density of desert tortoises. There are currently several hundred existing leases in the areas being considered. Some of these leases have expired and are up for renewal; additional areas are under application for new leases. Of all of these leases, none is producing oil or gas. Only 4 exploratory wells have been drilled in the past several years.

An analysis of the impacts of oil and gas leasing and especially impacts on potential wilderness areas is required. The environmental analysis was prepared and the impacts were based on several assumptions:

1) The area has low potential for discovering commercial quantities of oil and gas.

2) There is little industry interest in exploring the area; it is mostly speculators.

3) Less than 15 test wells will be drilled within the next 10 years.

4) Any reservoirs discovered are apt to be small and widely scattered.

The lease, however, does convey to the lessee the right to use as much of the area as is necessary to explore and develop the oil and gas resource. Mitigation has been proposed, based on the 4 previous assumptions, with some seasonal restrictions and avoidance of some areas of high tortoise density.

Where are we now? The Riverside district has recommended a decision. However, before a decision is finally made, the district is asking the advice of most of the state and federal agencies on advisability of leasing considering the low mineral potention and high wildlife value.

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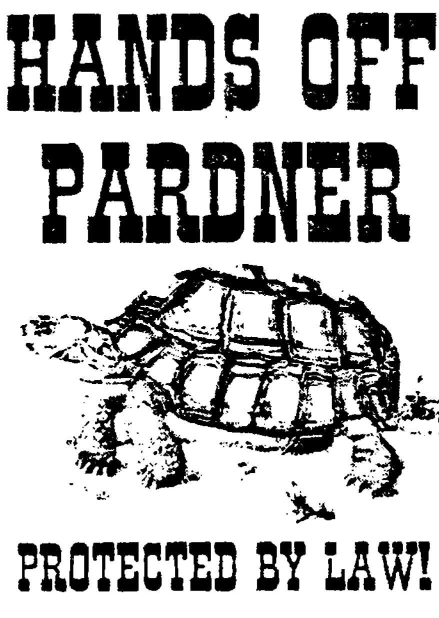
State Report - California

Department of Fish and Game
Part I
James A. St. Amant

The California Department of Fish and Game projects with the state reptile include:

1) Public information and education
2) Inventory of wild populations
3) Permit and tagging program of captive tortoises
4) Experimental tortoise rehabilitation program

Public Information and Education. Public information includes slide presentations by area biologists, news releases, and recently, a revision of our desert tortoise informational leaflet. The Desert Tortoise Council Executive Committee provided the expertise in the new leaflet, and the Council also assisted the Department in the development of the tortoise poster. These posters are being placed in desert areas to inform the general public that tortoises are protected by law.



Inventory of Wild Populations. The Region 5 Inland Fisheries section of the Department has begun a systematic inventory of the deserts to determine the status of tortoise populations. The data collected assist in designating important tortoise and other desert wildlife areas for possible land acquisition and protection and also for potential future reintroduction sites for tortoises. This information is also essential to evaluate properly environmental impact reports.

At this time the inventory work is a small program, limited to the efforts of 2 area biologists who integrate this with an already heavy work schedule.

Frank Hoover, area fishery biologist for San Bernardino and Orange counties, reports:

Seventeen tortoise transects were made in San Bernardino County since the last Council Symposium. The transects were made in the general area between Lucerne Valley and Barstow. Some tortoise evidence was found on all but 1 transect. On 1 transect near Daggett, 16 burrows were found. Many were old, but a number were active, and a live tortoise was found in 1. The location apparently has a high density of tortoises, but it is probably quite localized because nearly all transects were found to have significantly less tortoise evidence than this area. Tortoise transects will continue this year with emphasis on inventorying the populations on military installations.

Darrell Wong, area fishery biologist for the Colorado River area, reports:

Tortoise and lizard transects are being conducted in desert areas near the Colorado River. Results to date indicate that tortoises are generally widespread but densities are low. In addition, faunal inventories of desert water sources are being conducted. It is important that such inventories be completed before any alterations are conducted as "spring improvement work" or before the water source is used as a refugium for an "exotic" threatened or endangered species. All desert aquatic habitats surveyed are closely scrutinized for the presence of undescribed or unique fauna.

Additional funding has been provided for native species projects, so part-time employees will be assisting in this program starting this year.

Desert Tortoise Permit and Tagging Program.

5000. It is unlawful to sell, purchase, harm, take, possess, transport, or shoot any projectile at a tortoise *(Gopherus)*. This section does not apply to the taking of any tortoise when authorized by the department.

5001. The provisions of Section 5000 do not prohibit the possession of any tortoise *(Gopherus)* when the owner can demonstrate that such tortoise was legally acquired and possessed before the effective date of this section. The owner of a tortoise which may be possessed under this section shall mark or otherwise identify such tortoise to the satisfaction of the department, and shall not transfer such tortoise to any other person without prior approval of the department.

The Department's Sacramento office, in charge of permits, at the time of this meeting is considering dropping the tortoise permit and tagging program. This is being proposed due to the large number of tags having been issued--over 9,000 to date. (Subsequently, as a result of the Council's recommendation, the majority of the Turtle and Tortoise Societies and the Department's Region 5 recommendations, it was decided to continue the permit and tagging program.) The program is an important factor in minimizing the removal of tortoises from the wild.

Part II

James A. St. Amant and Frank Hoover

Progress Report on the Experimental Rehabilitation of Captive Desert Tortoises. Although it has been illegal to remove desert tortoises, *Gopherus agassizi*, from the wild since 1961 in California (Fish and Game Code section 5001), it is possible that there are more tortoises in captivity than in the wild. In effect, these captive tortoises are "biologically dead" in relation to wild populations. Presently there are known to exist in captivity 9,000-10,000 legally possessed tortoises.[1/] It is estimated that there are at least this many more in captivity being held without permits. The investigation and inventory of the official state reptile has only been in progress several years. The Department (responsible for the state's wildlife resources) and the Bureau of Land Management (responsible for wildlife habitat on Bureau of Land Management lands) are cooperating in determining the status of tortoise populations in the state. Initial results have shown that desert tortoise populations have been severely depleted in vast areas and have disappeared in some areas. Habitat loss due to livestock grazing and increased off-road vehicle use is the main cause, but also contributing is the collecting and killing of tortoises.

A need for a desert tortoise management program became obvious. The Prohibited and Protected Fishes, Amphibians and Reptiles Committee of the 7 western states' Colorado River Wildlife Council found that the desert tortoise, native to Utah, Nevada, Arizona and California, was in serious trouble in all 4 states. (The Utah tortoise population is presently being proposed for federal Endangered status.) Subsequently, the Desert Tortoise Council was formed to develop and coordinate programs to save and maintain the desert tortoise throughout its native range.

Part of the tortoise management program is the potential

[1/] In 1973 regulations were passed requiring legally acquired tortoises to have a permit and tag. No permit can be issued for desert tortoises removed from the wild since 1961, or sold or purchased since 1939.

reestablishment of tortoises in depleted areas. Captive tortoises could fulfill this need.

Pet owners who no longer want their tortoises usually turn them in to zoos, humane societies or the Department. In addition, many captive tortoises escape from backyards and are turned in. Most of these unwanted captive tortoises eventually are given to the Department, which has the legal responsibility for all native apecies.

Prior to 1969, disposing of these animals consisted of transporting truckloads (when sufficient numbers were accumulated) out to various desert locations for release. None of the released tortoises were marked, and it is not known how many survived. Dr. Glenn Stewart and his students released tagged captive tortoises during 1969, 1970 and 1971 and found survival rates to be low.

In 1969, the Inland Fisheries Branch of the Department was given responsibility for managing reptiles, including the desert tortoise. Because most of the tortoise range occurs in the Department's Region 5 (which manages the wildlife in the Mojave and Colorado deserts) and most of the captive tortoises turned in are in Region 5, the majority of the program's responsibility falls on Region 5's Inland Fisheries personnel.

After it became apparent that releasing tortoises directly to the desert was unsatisfactory for various reasons, including low survival, it was suggested that captive tortoises might be rehabilitated prior to release so they would be better adapted for survival in the wild. If techniques could be developed that would rehabilitate captive tortoises for survival in the wild, we would have the capability to reestablish tortoises where necessary to maintain viable populations throughout their natural range.

An alternative to rehabilitation would be to destroy all tortoises that are received from the public. The Department of Fish and Game considers this alternative totally unacceptable even though it might prove to be the simplest method of dealing with the problem. Another alternative would be to distribute all tortoises to local turtle and tortoise clubs for adoption. This has the advantage of disposing of the tortoises with a minimum of handling and might serve to keep some people from illegally removing tortoises from the desert. It does, however, have the disadvantage of permanently removing these animals from the wild breeding populations.

An experimental program was initiated to determine if screening (selecting suitable individuals) and rehabilitation could increase survival rates of captives released to the wild. Because this was the first attempt at rehabilitating a reptilian species, suggestions and criticisms were requested and welcomed.

The Desert Tortoise Council provided useful suggestions and numerous individuals provided suggestions for methodology. Dr. Kristin Berry of the Bureau of Land Management and Dr. Glenn Stewart of California State Polytechnic University, Pomona, in particular, contributed valuable recommendations.

The first step in the experimental rehabilitation plan was to construct a pen which came to be known as the "Halfway House" on Bureau of Land Management property at Fort Soda near Baker, California. Its purpose was to provide an area where desert tortoises could be held while being acclimated to the desert environment. The facility consisted of .4 hectare (≈ 1 acre), enclosed by a 1.2 metre pig-wire fence (5 X 10 cm mesh) having its lower 0.3 metre portion buried to prevent tortoises from burrowing out. Inside the pen various shelters were installed to provide protection from the heat. In addition, a fiberglass tank was placed as a source of water for the tortoises.

In 1975, 40 tortoises were introduced to the Halfway House. These animals had been turned in by the public and been held at the Chino Fish and Wildlife Base. As more was learned about captive tortoises, their behavior in a desert environment, and their diseases, it became apparent that another facility would be desirable where they could be observed for a period of time prior to their placement in a more natural setting. This would give time for any hidden diseases to become apparent and provide an apportunity to recognize any tortoises that appeared to have lost basic survival instincts, such as burrowing.

It came to the Department's attention that the Living Desert Reserve in Palm Desert receives desert tortoises from the public and that the Reserve had facilities for holding large numbers of these animals. The person working with tortoises was agreeable to incorporating the facilities into the rehabilitation program. A plan was worked out whereby tortoises would be collected at Chino and transported to Palm Desert. They would stay there for a period of time sufficient to allow for the detection and treatment of diseases as well as sorting out the obviously unfit animals. The tortoises passing this screening process would be taken to Fort Soda and kept there for at least 1 year in a near-natural environment. The next step in this experimental program would be to release a small number of tortoises at selected sites in the desert and monitor their survival.

As expected in developing a new program, a number of problems were encountered. Shortly after the initial introduction of 16 tortoises into the Halfway House on 13 June 1975, a heat wave resulted in temperatures of approximately 46°C. Apparently some tortoises could not cope with this and 3 were found dead on 22 June.

When the Fort Soda pen was installed, 2 aboveground shelters were constructed of various materials. A third was provided shortly after tortoises were introduced. It was hoped that these would provide adequate shelter from the heat, but it was found that summer temperatures in these shelters exceeded 38°C. Consequently, 3 underground dens were constructed. These were made of plywood and sloped downward so that the bottoms of the approximately 3-metre-long structures were covered with about 1.2 metres of sand. They were "L"-shaped to simulate a natural tortoise den. Temperatures in these structures remained suitable for tortoises and they were heavily utilized. In addition to these artificial shelters, many of the tortoises dug their own burrows.

The fiberglass water tank had one sloping side allowing access to the water and was buried to its upper edge. There is evidence that tortoises utilized it, but, unfortunately, 3 drowned in it. Attempts to alleviate this hazard did not prove entirely successful. Although this method of watering tortoises appeared suitable, the results show that in future situations, a different, less hazardous method should be developed.

Between June 1975 and May 1977, 60 tortoises were introduced into the Halfway House. Due to losses, however, there was a maximum of only 53 tortoises in the pen at one time. It was believed that the natural vegetative growth plus supplemental feeding could maintain that number of tortoises. When the animals were removed, it was apparent that the pen had been overstocked. Consequently, when a new group of tortoises was placed at the Halfway House, the number was reduced to 25.

Of the 60 tortoises in the first group, 20 died. These losses are high; however, an analysis of the mortality is revealing. Twenty percent of the deaths occurred within the 1st month and are probably related to the aforementioned heat wave and disorientation following placement. Drownings accounted for 10% of the mortality and 40% of the dead tortoises expired after emerging from their second hibernation at Fort Soda. Between their introduction and the spring of 1976, only 6 non-drowning deaths occurred. These 6 deaths amount to 30% of the mortality or $<$ 12% of the total number of tortoises released in the pen. Recognizing that some mortality may occur in any experimental program, 12% is not considered high.

In May 1977, the 1st group of tortoises was released into the wild. The following June a 2nd group was introduced in the Fort Soda pen. Twenty-five tortoises were in this group. Of these, 5 died, 2 by drowning. This mortality is unexplainable, particularly because all of these tortoises were examined by a veterinarian and x-rayed prior to their introduction. All of them appeared in good health at that time.

James Cook, an employee of the Los Angeles City Zoo and a graduate student at California State Polytechnic University, Pomona, and Ann Weber, an undergraduate at California State Polytechnic University, Pomona, are studying the survival and behavior of the released tortoises. This study began in May 1977 when 33 tortoises were released. Twenty-one of these animals were from the 1st group placed at Fort Soda and (because not enough were available from there) 7 were included from those being held at the Living Desert Reserve and 5 young ($\approx$ 5 years old) captive tortoises just turned in to the Department.

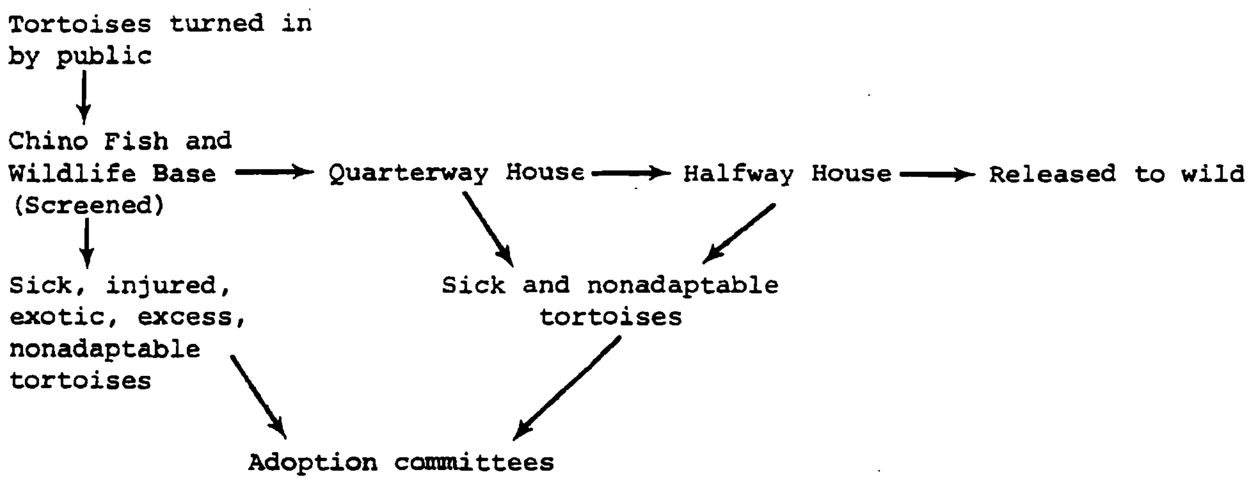
In May 1978, Cook and Weber released 18 tortoises from the 2nd group at Fort Soda. The study of these 2 groups of tortoises will continue until spring 1979, and will provide data for a Master's thesis for Cook. Preliminary results indicate that, to date, the 1st group of tortoises had a survival rate of 82%, which, it is felt, is acceptable providing the mortality rates at the Quarterway (Living Desert Reserve) and Halfway Houses are also acceptable.

The majority of the tortoises at this time appear to have adjusted to living in the wild.

Shortly after the facility at the Living Desert Reserve was incorporated into the rehabilitation program as a "Quarterway House," problems developed. Unusually heavy rains produced flooding in Deep Canyon which flowed through the Reserve and washed out their tortoise pen. The fence was totally destroyed. Most of the vegetation was scoured out and many tortoises were lost. The fence was replaced, largely through the efforts of tortoise club members who raised funds for purchasing the fence material and helped install it.

High temperatures were very likely a contributing factor in the poor health of the tortoise population. It was evident that there was not enough shelter in the pens, so 1.2-metre lengths of concrete pipe were split and placed partially underground to simulate burrow openings in hopes of providing an opportunity for the tortoises to dig deeper burrows. This was only partially successful. If this portion of the rehabilitation program continues, deep plywood dens similar to those constructed at Fort Soda will be installed to provide more shelter.

Based on our experience with the rehabilitation program thus far, we have developed a procedure to rehabilitate captive tortoises for eventual release into the wild. Its success is presently being evaluated in Cook and Weber's study. Basically, the procedure can be summarized as follows:



Tortoises will be either directly or indirectly turned in by the public to the Chino Fish and Wildlife Base. Here they will be examined and any sick, injured or exotic animals will be separated and given to adoption committees. Tortoises passing inspection will then be taken to the Quarterway House where they will be observed for 1 year in a controlled situation. Any tortoises which develop diseases here, or which appear not to be able to readapt to the desert environment, can be removed for adoption. When it has been determined that the facilities at the Quarterway House have reached their capacity, further tortoises received at Chino also will be placed for adoption.

From the Quarterway House, tortoises will be given to the Halfway House. Here they will be maintained for 1 year in a seminatural situation and allowed to revert to wild behavior. Human contact will be kept to a minimum. Each spring, tortoises will be brought in from the Halfway House, examined for condition and diseases, and suitable individuals will be released at selected locations in the desert. Tortoises which do not pass this inspection will be placed for adoption.

Reintroduction of depleted species is an accepted, recognized technique in recovery programs. Areas selected for tortoise release sites must have the potential for maintaining populations of tortoises but, for one reason or another, have populations that are reduced in numbers. Generally this would be the result of human activity. An area of good tortoise habitat that had considerable human activity which caused extirpation of the tortoise population, but which was subsequently closed to the public and has recovered sufficiently, would be a choice location.

As with any reintroduction, a number of precautions are necessary to avoid detrimental effects to the species we are attempting to recover and to the rest of the ecosystem. Possible detrimental effects include:

1) Introduction of diseases, particularly those foreign to wild populations.
2) Interference with social structure if reintroduction is in vicinity of existing populations.
3) Disruption of species integrity (gene pool mixing).

Therefore, we recommend that tortoises NOT be reintroduced into areas where existing populations, although reduced in number, still have the capability of recovery. Tortoises should be released ONLY in areas where wild populations no longer exist or where numbers are so low that the population is no longer viable and cannot recover on its own.

To perfect the procedures for successfully rehabilitating captive tortoises, a second phase of the experimental program is needed. It should be a study directed toward answering the following questions:

1) What age group or groups are best suited for release and eventual reestablishment? Should we attempt to release a number of age classes similar to those in existing healthy tortoise populations?
2) What sex ratio is best suited?
3) How many should be released in a given area; i.e., what is the minimum or the maximum carrying capacity?

In conjunction with the rehabilitation program, the desert tortoise survey program presently being conducted by the Department and the Bureau of Land Management should be accelerated to determine the status of the wild population. These surveys will aid in determining needs for reintroduction.

With the completion of the first phase of the experimental program, tortoises have been removed from the Quarterway and Halfway Houses and all of the tortoises presently turned in to the Department are being given to the adoption committee.

The second phase of the experimental rehabilitation program will be incorporated into the Desert Tortoise Management Plan. A location on Southern California Edison Company land has been selected. Now we must develop a study plan and obtain funding.

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Special Report - California

The Nature Conservancy and Desert Tortoise Protection

Barbara Curtis Horton

The Nature Conservancy, acting also in behalf of the affiliated Desert Tortoise Preserve Committee (to date the principal fund raiser) has purchased 64.75 hectares [= 160 acres] of land in Section 36 of the proposed natural area. Conservancy has also under negotiation several possible gifts or purchases in more critical tortoise population areas in the southwestern part of the preserve. It is in final stages of negotiation for Sections 25 and 35 in the north triangle.

Much needs to be done; much will be done. Even if public and private agencies join in a truly cooperative effort, this must be a project to involve years of work. That is to be expected and accepted.

What seems unacceptable is the cleavage within the Bureau of Land Management between the intent of its stated Habitat Management Plan (January 1977) and its performance in office and field.

The plan uses the term "Desert Tortoise Natural Area" not only in the title, but 18 times in the first 4 pages of its introduction, claiming "additional protection" was obtained in 1975 with submission of withdrawal application to the Department of the Interior. In 3 succeeding years, nothing seems to have been done to complete what had been begun.

In September 1977 Jim Ruch (Associate State Director, BLM) stated to 2 representatives of The Nature Conservancy that necessary papers to finalize withdrawal were complete; by 1 November, public posting of the withdrawal notice had elicited no significant objection, i.e., no public hearing was required. The last step toward withdrawal at the state level was thus supposedly taken. Senator Alan Cranston wrote on 22 December that Mr. Hastey had assured him that withdrawal papers would reach Washington about 15 December.

Yet, in January, I received a letter from Mr. Hastey, announcing itself as follow-up to a meeting with concerned persons in Pasadena on 5 October (3 months before). This letter mentions nothing of progress toward Natural Area classification; in fact it states that in exploring land acquisition funding possibilities with the Bureau of Outdoor Recreation, Natural Area classification appeared a hampering term.

Exactly. And that is exactly what it should be and why the designation is essential. Natural Area classification will remind all concerned that we are acquiring an area not for motorcycles but for tortoises. The whole point of our effort, to quote from lines 5 and 6 of the Habitat Management Plan, is "...an area managed primarily for the protection of the desert tortoise and its habitat." Funding is currently a BLM problem, granted. But surely that cannot affect the mailing of these completed papers to Washington.

I would respectfully urge this body to ask the Bureau to proceed at once with achieving formal and official Natural Area status for the entire tortoise preserve area, including the northern triangle presently excluded from the Bureau's fencing effort. Further, it would seem appropriate for the Council to express its opinion in other areas where management plan and action are far apart.

Fencing is one of these areas, as yet far from complete. Easements to close several mile-long gaps are needed. The north fence (placed to exclude 64.75 hectares [= 160 acres] of land already acquired by Conservancy by the time the fence was laid, and Sections 25 and 35 now in final stages of negotiation) should be moved as promised. Despite a federal appropriation of $135,000 to fence the area, a sum so generous that at least $20,000 was diverted to other projects, the Bureau recently demanded the Desert Tortoise Preserve Committee put up $3,000 to do this work.

We believe the Bureau should, if need be, redirect the necessary funds to complete this fence. If these funds could properly be diverted in the first place, then surely they can as well be returned to the purpose for which Congress designated them.

Signing. The introduction alone to the Desert Tortoise Natural Area Special Wildlife Habitat Management Plan Bakersfield District is 14 pages. This considerable document outlines, graphically and well, the needs of the tortoise and its habitat; herein a matter of considerable public concern is proposed and developed in detail. Yet, strangely, to this day, no sign or text posted by the Bureau reveals to the public the purpose of closing the area or the most positive objectives to be carried on within the area boundaries. Few visits to the preserve fail to turn up trespassers who claim they do not know that they should not be there. Thus, for example, one wonders how, without explicit signs, this paragraph on page 10 of the Management Plan is to be effected:

> "Hunting will be on a walk-in basis. No vehicles will be used in the natural area. Only shotguns will be used for hunting and only the game species identified in the previous paragraph may be taken. No litter, shells or remains of the bagged game will be left in the natural area. Etc."

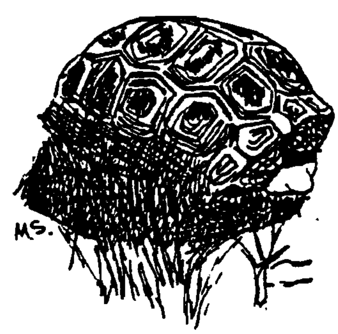
As the cause of public information and education would be served by good signs, so it would be served by an interpretive center. Again, funds had been appropriated for this project. Plans drawn up by the Preserve Committee had been complete for several months when they were put out for bid. At the last minute, there was not time to obtain a reasonable bid for the construction. The appropriation date expired. As with funding, it might be pointed out that the project is now entitled to special consideration in the Bureau's funding plans, for again the project has been sadly mistreated.

The Desert Tortoise Natural Area, if it is important, is as much the proper concern of the private sector as of public agencies. It is most certainly the proper concern of Conservancy, whose primary work is the habitat of threatened species. We expect to be so concerned for a long time. It is not unusual for us. After all, additions are still being made to our first project, the Mianus Gorge in Connecticut. That project was begun some 25 years and 1800 projects ago.

We have as allies one of the finest and most vital committees imaginable, the Desert Tortoise Preserve Committee. They are not quitting either. We have also an avowed management plan put forth by the BLM itself. If its stated intentions and most of its content are carried out, it will certainly be a work of which the Bureau and public could be proud. Let's get on with it.

Let the Bureau provide as basic framework the formal Natural Area classification as well as such supportive tools as fencing, signs, interpretive center. Then the acquisition of lands for tortoise habitat may proceed through public and private agencies alike in an atmosphere of trust and confidence towards our objective -- "...an area managed primarily for the protection of the desert tortoise and its habitat."

1869 Pasadena Glen Road
Pasadena, California 91107



Special Report - California

The Desert Tortoise Preserve Committee Report

Laura A. Stockton

The Desert Tortoise Preserve Committee appreciates this opportunity to report on the progress and concerns of the Committee at this Third Annual Meeting of the Desert Tortoise Council. Progress this past year can be likened to how the tortoise travels--slowly, but steadily. The Committee formed 4 years ago with several goals. The primary goal is to establish a preserve or natural area for the protection of desert tortoise habitat. A second goal is to inform the public about the tortoise and about compatable recreational uses of the natural area. A third goal is necessarily to fund raise for fencing the perimeter and for purchasing the private land within. The 15 members of the Committee, with the continuing active support of many individuals and organizations, have addressed these goals.

Toward a Desert Tortoise Natural Area. The proposed natural area includes 98 square kilometres [= 38 square miles] of prime tortoise habitat of the Mojave Desert north of California City. The Bureau of Land Management, using funds appropriated by Congress, succeeded in fencing most of the perimeter during the spring of 1977. The fence allows wildlife to pass under, but eliminated access to sheep and vehicles. The fence is a major accomplishment toward the integrity of the area. However, the natural area has yet to be designated officially. To this end politics and bureaucracy are obstacles which, with a loud concerned public voice being heard, can be overcome.

Toward Public Information and Education. The Committee Program Chairman reported that during 1977 over 2000 people attended 58 slide programs on the tortoise and the preserve. Several talented individuals presented these programs to schools, and to conservation, service and other special interest groups. The programs were complimented by group tours of the preserve during the spring months.

The preserve concept is discussed in the Committee brochure of which 30,000 have been printed to date. Newspaper articles, special publications like the BLM Newsbeat, and conservation organization newsletters have publicized the tortoise situation, preserve and fence, not to mention the articles by a Committee member that have appeared in several 1977 issues of Desert Magazine.

As previously reported to the Desert Tortoise Council, the Committee received a contract from the Bureau of Land Management for interpretive materials for the natural area. This is a significant contribution to public education and recreation on the part of the Committee and the many others who have contributed their slides, artistic talents, and scientific expertise. As an outgrowth of the contract the Committee has three different slide programs available for purchase by educational institutions or organizations.

Toward Fund Raising. Through products sales and donations made by over 10,000 individuals and groups the Committee has raised nearly $60,000 during its 4 years of existence. Because the Bureau of Land Management was able to fund the fencing, the Committee can channel funds toward acquiring the majority of the 16 sections of private land within the proposed preserve that cannot presently be acquired by the Bureau. The Nature Conservancy, with which the Committee is proudly affiliated, has done an outstanding job of land purchase negotiations. In addition to acquiring 64.75 hectares [= 160 acres], as reported to the Council previously, dealings are being finalized on 2 sections in the northeastern triangle. This deal will serve as an important stride in terms of price and amount of land acquired, but will deplete the financial resources of the Committee. One-eighth of the private land will be in hand, but the $60,000 and additional funds raised by the Southern California Chapter of The Nature Conservancy is a small amount compared to what is needed for the remaining land.

In continuing to address our goals focus must necessarily remain on people and money. Concerned and informed individuals are needed to express this concern to the Department of Interior and Congress to achieve the official designation of the natural area. Fund raising will be facilitated by a firm official status. The Committee has also made provisions for a contributing membership status for individuals who wish to support the Committee goals without being actively involved. Associate memberships for organizations wishing to support the Committee are also still available.

The tortoise T-shirt sold by the Committee has a saying "I may be slow...But I get there." This sometimes appears to characterize Committee progress. But with the continuing collective support of people like Desert Tortoise Council members, "WE WILL GET THERE."

President
Desert Tortoise Preserve Committee, Inc.
P.O. Box 453
Ridgecrest, California 93555

Special Report - California

Conservation Call

Roscoe A. Poland

When I was asked to speak at this meeting, I assumed, and hoped, that although you would be interested in hearing about our little organization and what it has done and is doing, you would also expect something more than that. Presumably, you have all worked for conservation goals, just such as the preservation of the desert tortoise, and should then respond to a conservation call.

What I will lay upon you will seem at first just another exhortation to the born-again conservationist, but bear with me a little, while I go into the conclusions arrived at after 26 years of almost incessant conservation activity, by my wife and myself. I am sure you all know by now, that not behind, but alongside almost every stick-to-it male conservationist is a shoulder-to-shoulder wife.

During that time I worked as Conservation Chairman for the San Diego Chapter of the Sierra Club, and for the San Diego Audubon Society, and Wilderness Review spokesman for the Wilderness Society. We fought to preserve mountains, forests, rivers and deserts, including the Desert Wildlife Range near this city. We have worked with City Councils, Boards of Supervisors, state and federal agencies, commissions and committees of every degree. These efforts have nearly always been concerned with the saving of habitats and their inhabitants such as the desert tortoise.

I felt I had arrived when offered a $10,000 bribe to drop our efforts to save a nesting grounds of an endangered species of bird. In that instance, we won the battle, and won an enormous reward of satisfaction.

Through these years we won some other battles, lost some, and managed to bring about holding actions on others. Sometimes we had to settle for half the loaf, or even a couple of slices. We finally found it necessary to start a newsletter with which to rally and inform our growing number of conservation-minded people, the name Conservation Call coming very naturally. We have tried to make it a service as well as a publication.

We are celebrating our 9th year this month. It would be too tedious to even name all the issues we have taken up, but let me mention, that in all those years we have <u>always</u> been working to preserve arid lands--and the desert tortoise. We even rescued one sturdy fellow who wandered into our yard, after obviously having escaped a captor--the hole in his shell testified to that. So far as we know, he is still in the San Diego Zoo.

I mentioned my conclusions, and should say that I have long had the benefit of a summing up statement that aided me in arriving at them. The statement is by Henry Beston and is found in his enduring classic, "The Outermost House." He said, "Whatever attitude to human existence you fashion for yourself, know that it is valid only if it be the shadow of an attitude to nature." His book, written during the year he spent in the little 20 x 16 shingled cabin on what he called The Great Beach, at Cape Cod, contains many memorable lines, but early in it, he offers the pure gold:

> The animal shall not be measured by man. In a world older and more complete than ours, they move finished and complete, gifted with extensions of the senses we have lost or never attained, living by voices we shall never hear. They are not brethren, they are not underlings; they are other nations, caught with ourselves in the net of life and time, fellow prisoners of the splendor and travail of the earth.

Those words, "other nations," have formed the foundation of my attitude to nature. For that is what the furry creatures, the feathered ones, and the desert tortoises are: other nations.

We should not consider them as "game," or crops," or convenience foods, or sources of body-coverings, or materials or items of vanity. We must save these other nations, and educate other people to realize their value and their needs for living space in which to live undisturbed and unexploited, as we hope to do for the desert tortoises. These nations include the whales, the dolphins, the deer, the coyote, the big horn sheep, the mountain goats, the grizzly, and the bobcat, to mention some of the most endangered.

We do, of course, have to make adjustments. Our alterations of the earth make compromise a necessity. I cast a glum eye at zoos, considering the caged members of those other nations as quite unnatural representatives of their groups. Yet, in the San Diego Zoological Society's Wild Animal Park, and at, I believe a park in Arizona, the Arabian oryx is being saved from extinction. Very likely, some of the African rhinos will be preserved after that "nation" is wiped out in Africa.

Yes, we do have to make compromises, but there are positive actions we can take, some of which I know our friends in the agencies will disagree with, I am sure. But, for the record, the Montana grizzly should not only not be hunted, he should have the proposed Great Bear Wilderness to live in, undisturbed by our nation, just such a situation as we desire for the tortoises.

If it proves impossible to take tuna without killing dolphins, the fishermen should be diverted to other fish, and tided over in the interim. This idea has already been accepted in the case of the redwood loggers of California, to save what we can well call the "redwood nation." The idea that these nations are property was given a blow by the men who released 2 dolphins.

There should be population control for the dog and cat nations--they deserve to live, fewer in numbers, and as cherished companions, rather than show-pieces and toys, too often mistreated, lost, and cast-off.

There should be no importation of any animal species exotic to our nation--tropic birds, felines, snakes, whatever.

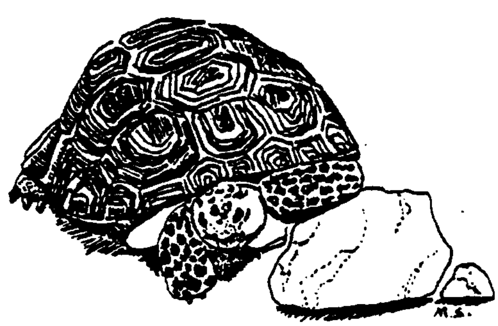
We can take some actions ourselves, now:

Buy no furs of any kind.

Boycott Japanese products until they stop whaling and put a stop to the recent killing of dolphins by their fishermen. There, we see, unfortunately, the recognition of animals as "other peoples," but in this case, as "gangsters," we are told.

There are other actions I am sure that this group can think of to do. Let us again remember conserving nature is the way to save life for all of us. Saving those other nations will create a better life for <u>our</u> nation.

Director
Conservation Call
3942 Hughes Court
San Diego, California 92115



Special Report - California

California Turtle and Tortoise Club

Walter Allen

Those of us here today to represent the California Turtle and Tortoise Club are members of the founding chapter, the Westchester Chapter. We also, however, represent the spirit and enthusiasm of the widely scattered membership of the four chapters now in existence.

The purpose of my presentation will be to acquaint you further with the scope and depth of the activities of the California Turtle and Tortoise Club, and to emphasize the value of our (and other similar organizations) as an interface between state and federal agencies and the general public. The California Turtle and Tortoise Club will always be found leading the drives for animal and habitat conservation, protection of the species, public information, education, and tortoise adoption.

The latter function, tortoise adoption, has been the major objective since the club's beginning in 1964.

In October of the year of its beginning, 1964, the Club received its state charter as a nonprofit organization, and has grown since that time from less than a dozen to its present membership of over 800 active and subscribing members. During my 10 years as an active member, I have been impressed by the constant dedication of the growing membership, and by their willingness to support conservation legislation as well as state and local activities, not necessarily directly related to just their particular fields of interest.

The present membership draws from 23 states as far away as Massachusetts, the District of Columbia, Hawaii, and even Holland. The Westchester Chapter membership alone represents more than 100 cities and communities extending the width of the state from La Jolla to the south, and Berkeley to the north. Although the California Turtle and Tortoise Club is the oldest and largest chelonian club of its kind in the United States, it still maintains a new, fresh and serious approach to the goals and responsibilities encumbent upon such an organization. It endeavors to reach out to coordinate with community, city, and state functions and agencies with similar or parallel goals, and its members are active in exploring new directions in wildlife conservation, education, and research.

Prior to the tortoise registration program initiated by the California Department of Fish and Game in March 1973, the club informally, but on a large-scale continuing basis, "adopted out" to qualified foster homes hundreds of strayed, unwanted, or displaced tortoises throughout the southland. An example is the placement of those animals removed by the military from the Edwards Air Force Base sector of the desert to the already stabilized population area of the California City sector, which in turn was concurrently being encroached by development, construction, and intensified annual sheep grazing.

Club members repeatedly assisted in relocating tortoises from this man-made high-density, seriously encroached area to such new locations as Death Valley, the Anza-Borrego area, and to private foster homes, generally within the Los Angeles and adjacent inland areas. The club's informal adoption program, with the blessing of the Department of Fish and Game, was intensified and refined up through May of 1976 at which time the California Turtle and Tortoise Club was informed in writing that the club was now the legally approved desert tortoise adoption arm of the California Department of Fish and Game.

Since those early days of the club, some 14 years ago, the California Turtle and Tortoise Club and its members have adopted out, relocated, or otherwise rehabilitated about 3000 desert tortoises, both formally and informally. This is necessarily a conservative number as it does not reflect, for example, the large numbers of animals casually relocated by members from highways, encroached area, etc., back into adjacent desert areas.

The club membership was also effective in assisting in the statewide drives to place the tortoise on the protected list as well as in the selection of the desert tortoise as the official State Reptile. The club was also active in the defeat of Senate Bill No. 49 which, if passed, would have left the green sea turtle open to needless exploitation.

These items are mentioned only to underline the value of cooperative group efforts in increasing the public awareness when support for state agency fostered projects is needed.

In addition to relocating hundreds of chelonians to qualified foster homes each year, the club, through membership dues, shows and private donations, currently raises in excess of $7000 annually. This money is used exclusively for club activities directed toward adoptions, education, conservation, and study projects. Further, private expenditures are expected to bring the 1977-1978 year total to a conservative figure in excess of $10,000. In addition to the cost of compiling, printing, and distributing the Tortuga Gazette, the club newspaper, the club donated $475.00 to cover the cost of building a live animal display in the Reptile Building at the Los Angeles Zoo. Five hundred dollars was expended in relocating the printing of the Tortuga Gazette and in upgrading its format; hundreds, if not thousands of dollars in private funds are expended annually in serious habitat, life-cycle, animal care, and related studies. The club has provided funding for medical equipment and supplies, as well as funding for professional services for the treatment and care of distressed animals. Each chapter also maintains, through purchase, growing libraries of publications on chelonians for interested members.

On an ever-increasing basis, tortoise-owning club members are developing skills in the diagnosis and treatment of the more common chelonian ailments such as fungus, eye problems, soft shell, intestinal worms, maggots and respiratory problems. Further, many members are becoming more familiar with dietary requirements, and are becoming proficient in injury treatment. Through the use of club-purchased microscopes and other laboratory equipment, serious members are learning to diagnose certain of those ailments formerly unsuspected, or treatable only at the office of a reptile-oriented veterinarian.

In this vein, we are pleased to note that tortoise medicine has progressed immeasurably in the past decade, due in some respect at least to the increasing concern of tortoise owners for their charges, and to the continued efforts of the club to bring more veterinarians into the reptile field.

To no small extent, this increased awareness in the field of medicine has been the result of the transfer of information between club members, qualified veterinarians, college and university biology students, recognized authorities in their respective fields, and researchers. Much of the information derived is disseminated across the country by way of articles printed in Tortuga Gazette and through care sheets made available to all interested persons. Much new and additional information is made available to the membership by guest speakers at the various monthly club meetings. As a direct result of medical care data being made available to the membership, increased numbers are becoming familiar with the techniques of slide studies, antibiotic injections, oral medicine, and treatment for dietary deficiencies.

To acquaint the general public further with knowledge gained, and to generate public awareness and concern, the California Turtle and Tortoise Club employs several programs in the area of public education. Club members provide live animal displays and information booths available to thousands at the annual Los Angeles County Fair, soliciting registration, answering questions on care and feeding, as well as distributing printed material commonly referred to as our "care sheets." Club members also make themselves available as guest speakers to other clubs, schools, and other interested groups. Annual turtle and tortoise shows, open to the general public, are held by the Westchester, the Orange County, and the Foothill-Pasadena chapters, each in its own respective area, making live animal displays and information available to additional thousands of interested persons. An indication of increased public awareness and concern was made in 1977 when the Culver City Citizens and Loan Bank called upon the California Turtle and Tortoise Club to man an information and display booth in their main lobby during a bank-sponsored turtle awareness week.

Another such example was the Westchester City Recreation Center's "Octoberfest" of 1977 when approximately 2000 visitors were exposed to the California Turtle and Tortoise Club display and information booth, hundreds of whom showed interest in the displays, asked questions relative to tortoises, or picked up care sheets provided by the club. A live animal display at the 1977 Annual Claremont Reptile Show drew an additional 1000 or so visitors to the club-sponsored booth.

In addition, and on a continuing basis, the club furthers public awareness through stories in the Los Angeles Times, as well as in numerous smaller community newspapers, by announcements on local radio stations, and by way of television spots.

Realizing that there are other items yet to be covered on this afternoon's agenda, I will take only a few more minutes of your time to conclude my presentation. Besides, in a program such as this, a long-winded speaker is as popular as a clawed frog in James St. Amant's bathtub.

The growth and impact of the California Turtle and Tortoise Club has, since the club's beginning, been centered around and directed toward the conservation and care of the desert tortoise. The major concern has been the rehabilitation of displaced animals through the unprecedented and highly successful adoption program. The additional beneficial fallout from this Department of Fish and Game—California Turtle and Tortoise Club cooperative project has taken many forms.

In the club's formative stages only some few years ago, the club's chief concern was just to find someone, virtually anyone, who would take in a strayed or wandering tortoise. The present impressive program of ongoing projects of the Westchester Chapter alone, plus individual member projects, goes something like this:

1) An active program is underway to establish active chapters and/or associate clubs in some 20-plus target communities throughout Central and Southern California.

2) A massive registration program designed to bring additional animals under the umbrella care afforded by the club.

3) A statewide project aimed at gaining a more accurate census of those animals in captivity, regardless of whether they are registered or not.

4) A vast increase in the flow of care and treatment data to assure that an ever increasing number of those tortoise holders have access to pertinent information.

5) Continued progress in bringing more veterinarians into the field of reptile medicine.

6) Continued programs of coordination with education and research centers.

7) A program to integrate an ever larger number of community animal shelters into our pick-up and rehabilitation program.

8) A program designed to coordinate with other wildlife and conservation groups with interests varying from whales to wildflowers. This is to develop a rapport and an interchange of information relative to mutual interests.

9) We are working to establish scheduled seminars for chapters, associated clubs, and interested nonafiliated individuals.

10) Increasing numbers of individual members in widely scattered localities are being designated as contact points for tortoise adoption, pick-up and rehabilitation, and general information.

11) Additional action teams are now available to lend assistance in cases of emergency, such as the Palm Desert Wildlife Museum flood disaster, to assist the Department of Fish and Game in relocating animals threatened by encroachment or habitat destruction or to build fences for compound areas, or whatever.

12) A program is well underway to coordinate with major corporation executives and biologists directly associated with environmental impact concerns.

13) A club breeding-stock rotation program has been instituted.

14) A Speakers' Bureau has been established to provide qualified speakers to schools, clubs, or other groups desiring information.

Clubs and/or individual member projects now beyond the embryo stage and into the action stages include, but are not limited to:

1) Remote-area-population census and study field trips in both California and Arizona.

2) Further investigation of an as yet unidentified population reliably reported to be normal to a relatively remote area north of Mexico City.

3) Field trip investigations of reported populations in remote areas of Baja California.

4) Establishment of a greater Los Angeles area tortoise holding/treating/and rehabilitation center. This top priority project we consider to be essential to the projected growth of the Department of Fish and Game—California Turtle and Tortoise Club registration and adoption program.

Individual member study and research projects, some totaling thousands of animal-hours of observation, are now shedding considerable light on the heretofore little known or understood desert tortoise. Several individual life-cycle studies are now into the third generation and have produced considerable data in such areas as: medicine, longevity, genetics, mating habits individual characteristics, intelligence, development of the senses, communication, physical capabilities, social structures within the communities, environmental effects upon egg viability and incubation periods, infant and pre-adult mortality rates, the hatchling/juvenile/adult growth stages, growth rates versus variation in diet and environment, age determination and physical anomolies.

Also of interest are those studies of variations within the species *Gopherus agassizii*, including the distinct possibility of subspecies or as yet unrecognized species.

In closing, I would like to stress the importance of the registration and adoption program, and emphasize the fact that we of the California Turtle and Tortoise Club expect to see a continued vigorous growth in all areas pertinent to the protection and care of the desert tortoise.

President, Westchester Chapter
California Turtle and Tortoise Club
10456 Calle Madero
Fountain Valley, California 92708

State Report - Nevada

Mark Maley
Bureau of Land Management

The Las Vegas District, Bureau of Land Management, encompasses $\approx$ 38,450 km^2 [= 14,800 square miles or 9.5 million acres] of public land. According to the 1974 Phase One Watershed Survey, we estimate there are 14,243 km^2 [= 5,500 square miles] of desert tortoise habitat. All vegetation types (creosote bush, burrobush, cheatgrass, etc.) from this survey that were believed to be indicative of tortoise habitat were delineated from inventory data sheets and compiled to arrive at this area figure.

Our major workload commitment in the District is the completion of 3 Grazing Environmental Statements (ES) before October 1983. This schedule is the result of a court decision filed against the Bureau of Land Management by the National Resource Defense Council. The following table shows this schedule in respect to the number of square kilometres of desert tortoise habitat in each ES area.

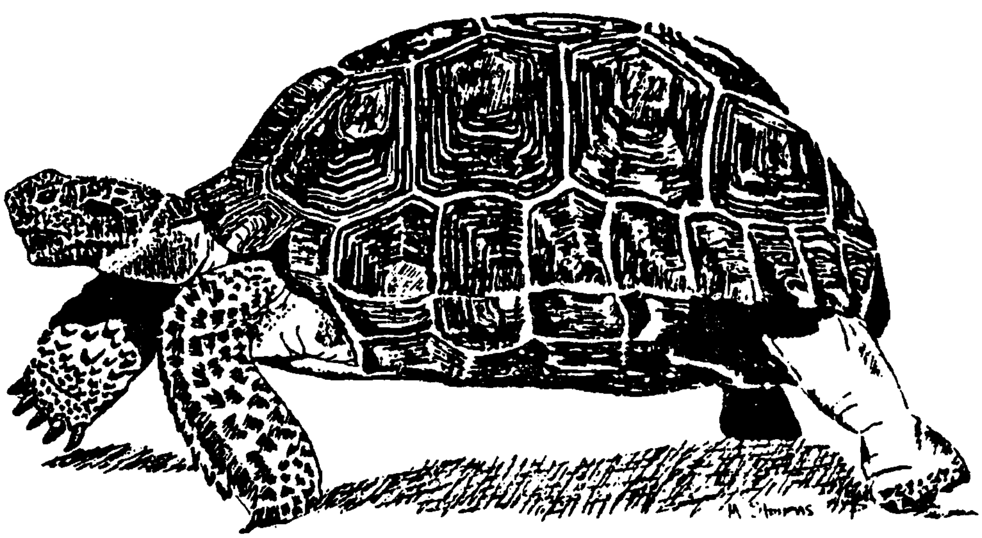
District
Grazing ES Schedule

Estimate of square kilometres of desert tortoise habitat	Grazing ES area	Proposed completion date of ES
2,330 [= 900 square miles]	Caliente	September 1979
9,583 [= 3,700 square miles]	Clark	September 1981
2,330 [= 900 square miles]	Esmeralda	September 1983
14,243 [= 5,500 square miles]	total Desert Tortoise Habitat in District	

Manpower and fund shortages prevented us from initiating any studies for the desert tortoise in the Caliente ES area. However, we are planning to inventory the Clark ES area in fiscal year 1979, and Esmeralda ES area in fiscal year 1980, for tortoises. The purpose of the inventory will be to determine distribution, density and population condition. Also, we will encourage all district personnel and members of the Young Adult Conservation Corps to report tortoise observations.

We plan to work closely with the Desert Tortoise Council, State Departments of Fish and Game and BLM districts in Arizona, California, Nevada, Utah, other federal agencies, and other interested individual groups in the protection and enhancement of desert tortoise habitat.

Bureau of Land Management
P.O. Box 5400
Las Vegas, Neveda 89102



State Report - Nevada

Paul Lucas
Department of Fish and Game

Nevada law and regulation remained the same but was considered to provide sufficient legal protection. Additional funding for Information and Enforcement Programs would insure higher public compliance.

A ground survey during May documented the northeastern distribution of the desert tortoise in southeastern Nevada. Lack of population data prevented an accurate determination of status and trend. Additional funding is necessary before intensive inventories can be initiated.

Nevada Law and Regulation. Nevada law and regulation remained the same as reported in detail in the 1976 Desert Tortoise Council Symposium Proceedings. Current Nevada law gives the desert tortoise sufficient legal protection from capture and harassment. Additional funding for Information and Enforcement Programs would insure higher public compliance.

The captive tortoise question remains unanswered. A permit system to allow for possession of tortoises presently in captivity but discourage future capture is currently unfeasible due to lack of funding.

Biological Surveys. A ground survey during May was conducted in the Beaver Dam Slope, Tule Desert and Upper Toquop Wash drainages of southeastern Nevada to determine distribution and use areas in coördination with similar surveys in Utah and Arizona. Caliche formations in washes were searched for sign to locate active dens. A helicopter was not tested due to scheduling problems.

The northeastern distribution of desert tortoise in Nevada was documented from scat and bone collections at dens in Cherokee Mine Wash, Garden Wash and Snow Wash. All areas were in the creosote—caliche wash habitat type. Much of western and southwestern Tule Desert appeared lacking in wash—caliche denning sites. Some tortoise wash—caliche formations were found along the road from North Toquop Gap to the Mormon Mountains. The bajada from Halfway Wash north to the junction of North and South Toquop washes had the most abundant active denning sites and probably the highest tortoise densities.

Lack of data on desert tortoise populations prevents an accurate determination of status and trend. Additional funding is necessary before intensive inventories can be initiated.

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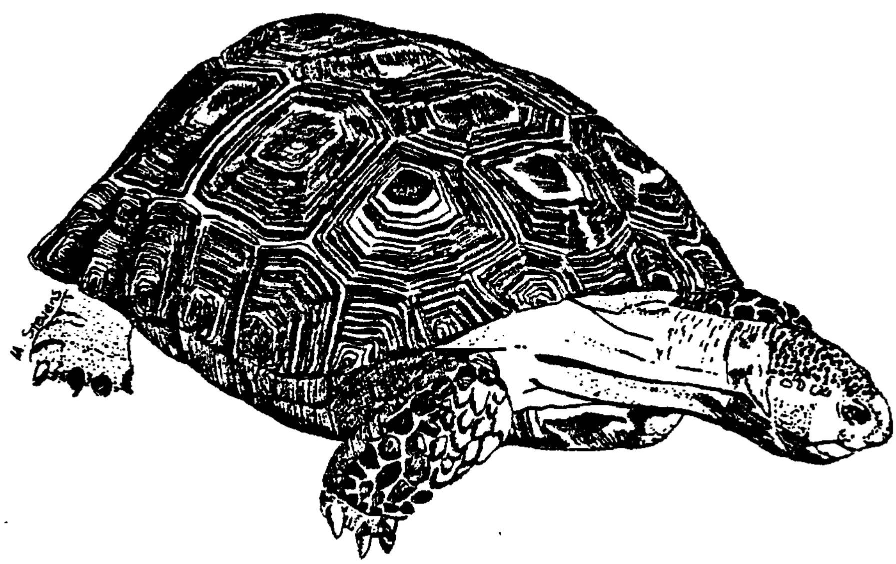
East Ely, Nevada 89315



State Report - Utah

Donald A. Smith
Division of Wildlife Resources

Be advised that we will not have a representative present at the Desert Tortoise Council meeting in Las Vegas this year.

I am enclosing copies of materials you may wish to use. The recommendations portion of our 1976 report to the Bureau of Land Management summarizes research activities of prior years.

Daily Activity

The daily ranges of tortoises vary with the size of the tortoise and the area and time of the year. Tortoises move most in late April, May, early June, late August, September and early October. The peak times are May and September.

A medium size tortoise may move 150-365 metres in an active day. On cooler days a tortoise may stay out longer, but still not move as far as on a warm day. Tortoises are only out for a short time on hot days. A young tortoise about hatchling size was observed to move about 15-45 metres on a warm day. The larger tortoises, especially PCT-2, was observed to move >548 m on a single day. They may be from 150-457 m per day, given that it is a warm day for tortoise activity. The establishment of territory, social interaction, breeding, feeding and comfort seeking are the main factors that govern daily tortoise movements.

Management

The management of desert tortoises and their habitat may be a difficult task, both physically and economically. Several ideas and recommendations are presented as different methods of management. Certainly no one or all of these methods may guarantee the survival of the desert tortoise on the Beaver Dam Slope in Utah.

Recommendations

1. Grazing changes: The most important factor in tortoise survival is that of being sustained by its habitat. The grazing record of the Beaver Dam Slope is one of long abuse.

a) Grazing Entirely Omitted. Omitting livestock grazing entirely will completely reduce direct competition, trampling of food, shelter and young, give area a long needed rest, lessen traffic, and create fewer disturbances in the area. A total rest from grazing may be considered until perennial grasses can build up to withstand grazing in the future should it be again permitted. Perhaps the livestock in the lower areas of tortoise habitat can be moved to higher ground or to a chained area, thus leaving a more natural and less disturbed habitat for this tortoise population.

b) Rest Rotation Grazing. Rest rotation may be implemented, to give each tortoise area in separate allotments a complete year of rest from any grazing, and 2 spring rest periods. Pastures may be set up using existing allotments. The emphasis should be on managing for perennial grasses and forbs that have the higher importance values in tortoise diet.

c) Reduction in Numbers. If there were less numbers of livestock, the pressure in each area would be less on the environment, thus increasing important food and cover.

d) Duration of Grazing. The time of year that grazing occurs may also be managed. It is strongly recommended that there be no grazing below the 900-metre elevation level any later than 1 April of any year. This would enable tortoises to receive full benefit of the annual production, and allow livestock to utilize a winter pasture. Grazing should only be allowed from 1 November to 1 April, thus increasing production and reducing competition.

e) Development of Watering Sites. Not all of the Beaver Dam Slope is good tortoise habitat. The placement of watering holes for livestock concentrates heavy use in higher tortoise density areas. The development of pipelines to distribute livestock into other areas not used by tortoises would increase tortoise food production in once overgrazed areas, and spread livestock into more areas. Watering holes should be placed at least 0.8 kilometres from high tortoise use areas, and utilize the forage production of areas that have no tortoises.

f) Salt Stations. All salt lick stations should be strategically placed away from water holes, so as to insure more dispersed grazing, instead of concentration at water holes. The placement of salt blocks at least 0.8-1.6 kilometres from each water hole would result in more widespread and effective use of forage for livestock and less of the direct heavy concentrated use of forage where water holes are located in high tortoise density areas.

2. <u>Transplants</u>: If transplanting wild tortoises from other areas could be implemented, then the desired sex ratio, density and age class distribution of each area could be achieved. The Paradise Canyon and St. George populations could easily provide a number of young tortoises for strategic placement on the Beaver Dam Slope. Also, wild adult female tortoises might be obtained from another state that may not have the critical situation, in order to redistribute population sex ratio and increase the reproductive potential.

3. <u>Fencing Special Areas</u>: Certain areas around the tortoise habitat could be fenced off from livestock grazing, especially around certain winter denning and summer range areas. Areas like Woodbury's major denning washes, part of Welcome Wash and the Upper Beaver Dam Well road colonies could at least be partially protected from livestock and traffic, and yet it would only take a small portion of land from the livestock. Thus tortoises would have less competition and disturbances from livestock related activities.

4. <u>Predator Control</u>: The predation rate on nests and young tortoises is high. If there were methods of capturing or removal of kit foxes from winter dens that would prove effective, it would benefit the natality and survival rate of desert tortoises. Coyotes would not be considered, as they tend to stay in the higher reaches of tortoise habitat, whereas foxes utilize tortoise dens and holes with a high preference throughout the area.

5. <u>Captives</u>: The introduction of captive tortoises in areas no longer inhabited may continue to aid this program as far as it has already been carried out. One major problem is that tortoises are protected in all states and there are fewer and fewer captives being turned in.

6. Seeding: The dispersal of perennial grass seeds in high tortoise use areas may help reestablish food items in the abundances that may take decades to do naturally, even if grazing were stopped. This in combination with selective fencing or rest rotation grazing may help reestablish food and water supplies that were once abundant and essential for tortoise survival and reproduction.

7. Sprinkling: The use of sprinkling systems in certain selected enclosed areas near winter dens may give an advantage to tortoises in overgrazed areas or in event of poor production years. The water could be utilized from existing pipelines in the area, and from any that might be developed.

8. Artificial Nesting: Gravid female tortoises can be collected during certain times of the year and be induced to lay eggs under controlled conditions in a laboratory. Female tortoises are palpated in the field, and the eggs are felt and their development estimated. If the eggs are near completion and ready to be laid, the female is then taken to the lab or other facility. It is given an injection of oxypitocin, a drug which makes the uterus contract and the eggs are laid from 30 seconds to 30 minutes later. The eggs are put in a special container and placed in an incubator until they hatch. This method has proved effective with other species of turtles. If this procedure were utilized, the success rate could be many times that of the wild. The young can be raised or transplanted to the desired area. This method has been proven biologically and economically and its ramifications deem it very worthy of consideration.

9. Winter Den Improvements: If manpower were no obstacle, certain areas could be improved by constructing winter dens. The dens can be made in areas where there are no tortoises if this is determined to be a limiting factor. Existing dens can be repaired where they have collapsed or where woodrats have obstructed entrances so that tortoises are unable to utilize the dens. Burning, raking, digging and sifting dirt at den mouths would all help certain dens become more attractive for tortoises. The placement of more sandy soil at den entrances may improve nesting activity by providing a more suitable nesting medium.

10. Tortoise Watering Stations: It was suggested that tortoise watering devices be placed near winter

dens, so tortoises may have access to extra water for reproduction and survival. This may work, except that a water source would be used by many other animals. Such concentration of wildlife would no doubt increase predation of tortoises at a water station by a thirsty and hungry predator.

11. Protection of Winter Denning Areas: Because the winter dens are the most important and limiting factor for desert tortoises in Utah, all measures should be made for their protection. Any digging in winter dens should be discouraged, as it changes the environment of the den and may alter the temperature equilibrium to the disadvantage of the tortoise. Any new roads should be kept a minimum of 75 metres away from any existing winter dens. The vibrations and usage of roads close to winter dens may cause them to cave in, which may have been the cause of the caving in of Dix and Rex dens in the Woodbury study area. The construction of power lines and pipelines should not be allowed within 150 m of any existing dens. The effects of the heavy machinery will doubtless cause damage, not only to winter dens, but also to the valuable summer range, and the tortoise themselves. The summer territory extends to a 0.8 kilometre-radius of any winter den, thus any development should be discouraged or not allowed. A safety margin of 1.5 km should be observed from any major tortoise habitat.

12. Land Exchange for Paradise Canyon: It is recommended that some other land be exchanged in order to acquire the Paradise Canyon area as a desert wildlife refuge. Both the desert tortoise and Gila monster are found together in the Canyon, both of which are thriving. These populations may serve as a natural transplanting stock in the future. The area is slightly more than 2.59 km^2 [= a square mile].

Division of Wildlife Resources
1596 West North Temple
Salt Lake City, Utah 84116

State Report - Utah

Frank Rowley
Bureau of Land Management

Since our report last year, many changes have occurred which we believe are a benefit to the management and survival of the desert tortoise *(Gopherus agassizii)*. Probably the most important is the break in drought conditions. Last year our total precipitation for the Beaver Dam Slope was 170 millimetres. From December to the present time we have received 251.5 mm of rain. This abundant moisture has turned the area into a carpet of filaree *(Erodium circutarium)*, cheatgrass *(Bromus tectorum)*, and red brome *(Bromus rubens)*.

Eric Coombs' study shows that these 3 species are very important for forage to the desert tortoise during the spring season. Our management objective is to insure that sufficient forage is present to meet the needs of the desert tortoise. We are using Coombs' report as a guideline to assist us in the management of the area.

Last year we proposed some interim management goals. I would like to report on those management objectives. Last year we removed livestock grazing by 15 March. Because of the drought, no annual production occurred; however, noticeable growth on the perennial grasses and shrubs did occur. This year cattle will graze longer in the area to take advantage of the abundant crop of annuals. Weekly monitoring is being done to insure that cattle grazing is controlled and minimal competition occurs. Weekend supervision is also being done to control off-road vehicle use and the possible removal of tortoises from the area. No oil and gas leases have been issued in the area. Protection of the winter dens is being provided by prohibiting any surface-disturbing activities within 500 feet [= 152.4 m] of these areas. All new construction work for livestock management projects is prohibited until the Hot Desert Environmental Statement is completed.

We requested the U.S. Fish and Wildlife Service to control the kit fox in the desert tortoise winter denning areas. The Utah Division of Wildlife Resources (DWR) did not approve this request because the kit fox is a sensitive species in Utah, so no progress has been accomplished on controlling predation.

We plan to continue with our interim management goals until we can intensify our management efforts by implementing an allotment management plan for livestock grazing and establish "The Woodbury Desert Study Area," which will provide protection for the desert tortoise.

Presently, the Hot Desert Environmental Grazing Statement is being reviewed by the Interior Department's Office of Environmental Protection and Review. As of this date we have not received permission to print the statement nor have we received any comments from the Department. Once permission to print is received, it will take approximately 2 months before the Draft Environmental Statement will be available for public review and comment. Any requested changes prior to printing will result in further delays beyond the projected 2-month period.

We are not involved in any desert tortoise studies at present. However, a wildlife habitat management plan for the Beaver Dam Slope is scheduled for development in fiscal year 1979. If all goes well, implementation of the plan should commence in fiscal year 1980. One of the early projects will be fencing of The Woodbury Desert Study Area to exclude livestock grazing and serve as a study area for monitoring changes in the desert ecosystem. We propose to continue cooperative studies with the Utah DWR on monitoring of the desert tortoise populations to determine trends in age class, sex ratios, and hatching success. These studies will also monitor changes in plant densities, composition, and the effect of vegetative change on the diet of the tortoise. Similar studies would be conducted on an area adjacent to the study area that is grazed by livestock for comparative purposes. We think that our management goals are responsive to problems which we feel are occurring to the desert tortoise population in Utah.

Our feelings on identifying the desert tortoise as an Endangered Species are similar to those expressed by the Director of the Utah DWR in his letter of 23 September 1977, to Gynn Greenwalt, Director of the U.S. Fish and Wildlife Service. We also agree, in general, with the views expressed by Eric Coombs in his letter of 26 October 1977 to Dr. Glenn R. Stewart, Department of Biology, California State Polytechnic University, Pomona.

We appreciate the opportunity of presenting our management goals to you and are willing to consider any recommendations you may have.

Bureau of Land Management
Dixie Resource Area Office
P.O. Box 726
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Special Report - Utah

Status of the Petition to List the Beaver Dam Slope Population of *Gopherus agassizi* as Endangered

C. Kenneth Dodd, Jr.
Office of Endangered Species
U.S. Fish and Wildlife Service

On 8 August 1977 the U.S. Fish and Wildlife Service was petitioned by the Desert Tortoise Council to list the Utah desert tortoise population as "Endangered" under provisions of the Endangered Species Act of 1973. Included in the petition was a recomendation for Critical Habitat to include roughly a 50-square-mile section [= 130 square kilometres] of southwestern Utah bordered by the state boundaries of Arizona to the south and Nevada to the west; various land sections form the boundaries to the north and east. The main threats to this unique population include competition from grazing animals, overgrazed habitat, and problems with collection of individuals.

After careful review of the petition by the Office of Endangered Species, the Director of the Service notified the Desert Tortoise Council on 30 August 1977 that the petition did indeed qualify as a formal petition. As a courtesy, Regions 2 (Albuquerque) and 6 (Denver) of the Fish and Wildlife Service as well as the State of Utah received a copy of the petition. Although neither Region made any comments, Donald A. Smith, Director of the Division of Wildlife Resources, responded for the State.

Mr. Smith acknowledged that the tortoise population is declining and took no exception to the data presented in the petition. However, he did indicate that the State would object to listing the population at this time. Mr. Smith's main concern was that a Federal listing would prompt attempts to use the Act to eliminate or drastically reduce grazing and provide legal arguments against grazing adjustments. As such, the State would prefer to adopt a scientifically documented case for reduction of grazing which (although still allowing some grazing activity) would include an amount of forage sufficient to provide the year-round needs of the tortoise population. If these measures failed, then other measures (unspecified in his letter) would have to be taken, although it might take several years to document the effects.

Mr. Smith also objected to Dr. Glenn Stewart's comments on the reintroduction of individuals from Paradise Canyon and the St. George area to Beaver Dam Slope. The State would favor such reintroduction. Mr. Smith doubts that collecting would be much affected by listing the population under the Act as Utah already protects the tortoise. Also, the recovery of the population hinges on the recovery of the habitat, and Mr. Smith doubts that Federal listing will hasten that recovery. Finally, Mr. Smith stated that the State will continue to work closely with BLM to ensure a viable population of the desert tortoise within this portion of its range.

Aside from the State's objections, there are a number of questions which have to be raised. These are summarized below:

1) If federally listed, what would be the status of the Beaver Dam Slope population in relation to populations from St. George and Paradise Canyon?

2) Why use political state boundaries to determine "Critical Habitat"? Are there populations across the border in Arizona and Nevada and what is their status?

3) How would the Act be enforced with respect to the Beaver Dam Slope population? After all, there are no distinguishing characteristics of the population other than geographic origin.

4) What is the status of other populations of *Gopherus agassizi*? A piecemeal approach to protection is neither desirable nor very effective.

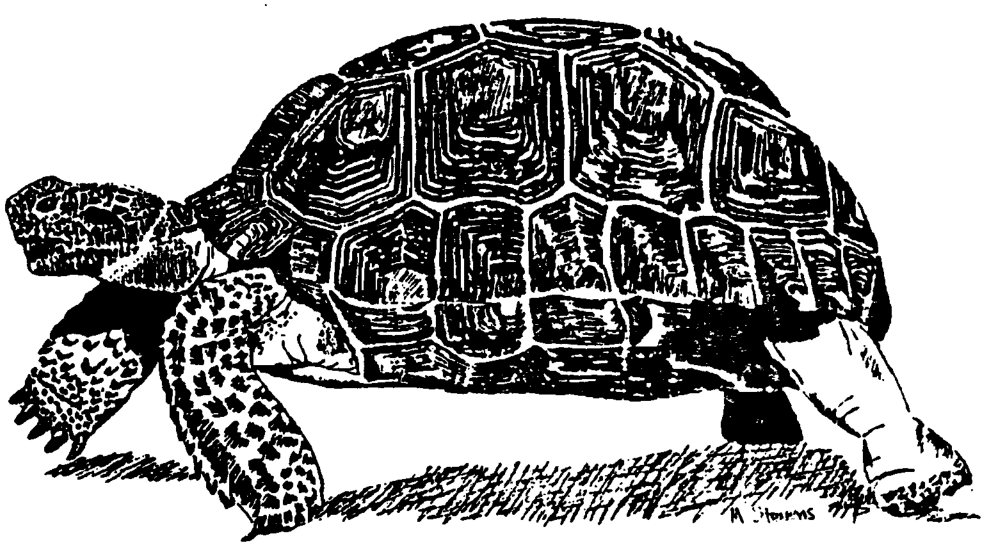
5) What are the alternatives to Federal listing? Is BLM management coupled with state "taking" laws effective to insure survival?

6) Utah is presently negotiating with the U.S. Fish and Wildlife Service for a cooperative agreement for state and federally listed endangered species. What impact could this have on the Beaver Dam Slope population of the desert tortoise?

7) What is the mood of the local people with respect to the desert tortoise in light of other endangered species' activity in the St. George area? Could Federal listing actually prove detrimental?

In the end, the important thing is to do what is best to insure the survival of the unique Beaver Dam Slope population of *Gopherus agassizi*. If, after careful consideration of the questions raised above, Federal protection still seems to be warranted, then the Office of Endangered Species will prepare a proposal for the Director's approval. However, all available approaches should be carefully considered and weighed before any action is taken.

Office of Endangered Species
U.S. Fish and Wildlife Service
Washington, D.C. 20240



Some Functional and Evolutionary Correlates of Burrowing Behavior in Gopher Tortoises

Dennis M. Bramble

Abstract

Prior investigations have demonstrated that 2 distinct species groups are represented among Holocene tortoises of the genus *Gopherus*. These may be recognized as the Agassizi (*G. agassizi, G. berlandieri*) and Polyphemus (*G. polyphemus, G. flavomarginatus*) complexes. Available fossil materials document the phyletic independence of these 2 species groups since at least the middle Miocene. Recent studies have attempted to establish the functional and evolutionary significance of a suite of cranial and cervical characters that strongly differentiate the Agassizi and Polyphemus complexes.

Current evidence suggests that most or all of the differences in head and neck morphology that separate the 2 lineages of *Gopherus* may be attributed to distinctly different modes of burrowing behavior. Members of the Polyphemus complex tend to be highly fossorial; they use the head and neck to brace the body while digging just as do many burrowing mammals. Mechanical stresses arising within the neck as a result of body bracing are complex and achieve maximum intensities in the posterior third of the neck and at its union with the shell. Structural accomodation within the cervical column of these tortoises includes the development of relatively short, massive vertebrae and a unique mechanism for passively locking the posterior cervical and cervico-dorsal articulations to resist mechanical loading.

Members of the Agassizi complex do not employ the head and neck while digging. Unlike representatives of the Polyphemus complex which tend to dig while prone on the plastron, Agassizi complex tortoises dig while standing and appear to brace the body with the contralateral fore and hind feet. The cervical morphology of these tortoises is not appreciably different from that of typical testudinids.

Species of the Polyphemus complex also possess skulls which are relatively wider than those of the Agassizi complex. The difference in cranial proportions stems chiefly from the uniquely modified inner ear of the Polyphemus complex. In these turtles the membranous labyrinth is grossly hypertrophied and contains a saccular otolith of exceptional size. Otolithic structures of comparable size are unknown in other tetrapods, but do occur in some fishes. Expansion of the inner ear complex in *G. flavomarginatus* and *G. polyphemus* is coupled with a marked reduction in the surface area of the

tympanic membrane and an increase in the area of the stapedial footplate. Similar modification of the external and middle ear structures has been recorded in fossorial squamate reptiles. Tortoises of the Agassizi complex exhibit no obvious specialization of the auditory apparatus.

The functional meaning of the unusual inner ear of Polyphemus complex gopher tortoises is presently unknown. However, mechanical and physiologic considerations suggest that the otolithic mass is most probably concerned with the reception of weak, low-frequency substrate vibrations or "sounds" and not with spatial orientation or aerial sound reception. Such a substrate hearing mechanism may be used to gain information about important surface factors (e.g., presence of potential predators) prior to emergence from the burrow. Alternatively (or additionally) it may indicate the position of commensals within the tortoise's tunnel system or perhaps aid in some as yet unrecognized mode of underground intraspecific communication.

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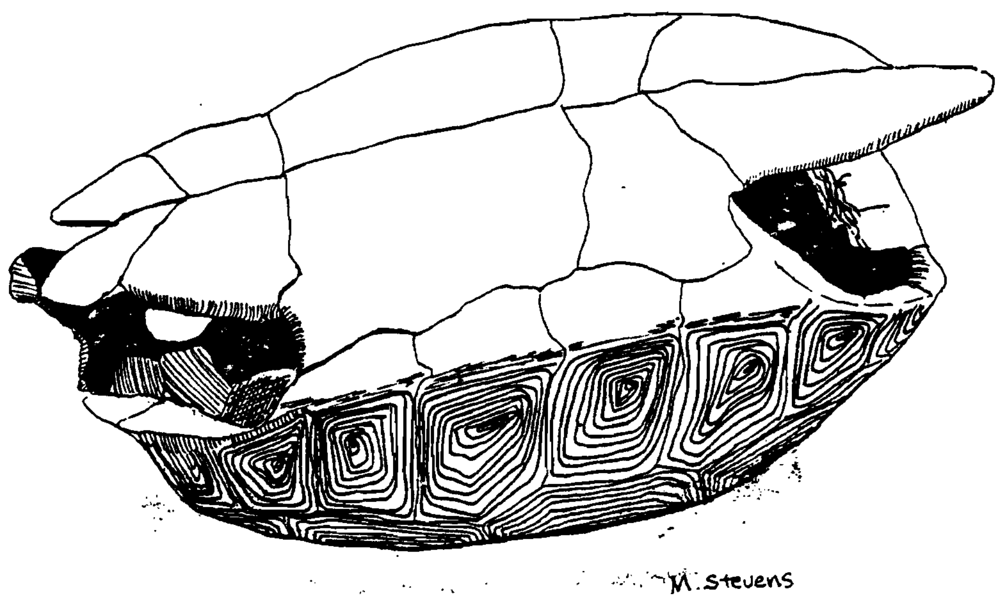

Shell Growth in the Desert Tortoise and in Box Turtles

Robert Patterson

When a comparison is made between the desert tortoise, *Gopherus agassizi*, and box turtles, *Terrapene* sp., it appears that box turtles increase the density of their shell, close the shell fontanelles and complete shell growth at a much faster rate and at a shorter plastron length (i.e., an earlier age). Shell closure proceeds somewhat differently in the 2 groups in part because the desert tortoise shell has a fontanelle, the periphero-plastral, not found in box turtles.

The present study attempted to examine several questions about turtle and tortoise shell growth. The first question was to determine if the shell density of box turtles increased with age as it does in tortoises. The second question concerned how the completion of shell growth was accomplished in the fontanelle regions of the shell.

METHODS

Seventeen *Gopherus agassisi* and 4 *Terrapene carolina* were weighed and measured prior to or just after natural death. They were opened, cleaned and the shell volume and mass was determined. Three dead *T. carolina* with mild organ decay were opened, cleaned and the shell mass and volume was determined. Shell mass (grams) divided by shell volume (millilitres) provides a measure of shell density (grams/millilitre).

Ten *G. agassizi* shells were examined for closure of the shell fontanelles. The degree of closure of the plastral fontanelle was estimated by making rubbings of the shell onto graph paper and then determining the percentage of closure of that region. The degree of closure of the costoperipheral fontanelle was accomplished by photographing the shell, preparing several prints and then directly measuring the areas.

RESULTS

A strong positive correlation ($r = .836$) was found between the density of the shell (Y) and the carapace length (X) for *G. agassizi*. As shown in Fig. 1, the associated equation is:

$$\text{Shell density } (\bar{Y}) = 0.23X^{0.57}$$

A strong positive correlation ($r = .991$) was found between the density of the shell (Y) and the carapace length (X) for *T. carolina*. As shown in Fig. 2, the associated equation is:

$$\text{Shell density } (\bar{Y}) = 0.21X^{0.76}$$

Regression equations for both equations were determined using the method of least squares. A null hypothesis of no difference between the obtained regression coefficients and a value of zero was tested using Student's distribution. Because of the small sample size and the tentative nature of the work a P value of .1 was selected as being significant. As shown in Table 1, the null hypothesis was rejected for both regression equations. As the graphs show, density of the shell increases at a much faster rate in the box turtle than in the desert tortoise.

At hatching, areas of the skeletal structure of the shell remain incomplete where the bones of the shell have not yet articulated with adjacent bones. These areas or fontanelles appear to close by the time that sexual maturity is reached. According to Legler (1960) in *Terrapene ornata* there are two medial plastral fontanelles and the carapace has two fontanelle regions on each side of the shell. The plastral fontanelles include the anteromedian and the posteromedian fontanelles. The anteromedian is limited anteriorly by the hyoplastral bone and posteriorly by the hypoplastral bones. The posteromedial fontanelle is limited anteriorly by the hypoplastral bones and posteriorly by the xiplastral bones. The fontanelles of the carapace include the costoperipheral and costoneural fontanelles. The costoperipherals are found between the ribs and are limited laterally by the peripheral bones. The costoneurals are triangular fontanelles on either side of the middorsal line between the proximal ends of the costal plates and the developing neural plates.

Table 1. Results of regression coefficient tests

Species	t-value	P
Gopherus agassizi	3.86	.01
Terrapene carolina	12.8	.01

It appears that in the desert tortoise, at hatching, there is a single large median plastral fontanelle that closes at the entoplastral area followed by rapid closure at the hypoplastral area. This is followed by the gradual growth, towards the midplastral line of the hyoplastron and the hypoplastron. In the desert tortoise there is a second plastral fontanelle, the peripheroplastral fontanelle, on each side of the shell. The fontanelle is quite variable but appears between the 4th and 6th peripheral bones and the lateral edges of the hyoplastron and hypoplastron.

At hatching, the area between the neurals, adjacent free ribs and the peripherals includes a large single fontanelle for each rib pair. This soon closes off due to the growth of the costal plates on the rib forming the costoneural and costoperipheral fontanelles. The rate of closure and the area involved appears quite variable; however, the more posterior costoperipheral fontanelles appear to close at a slower rate.

As shown in Fig. 3, *G. agassizi* appears to have accomplished plastral fontanelle closure by the time that the plastron has reached a length of 21 cm with the bulk of the closure growth being accomplished by a carapace length of 10 cm.

Legler (1960) determined the degree of closure of the costoperipheral fontanelle in 7 *T. ornata* and was able to show that closure is usually complete by the time that sexual maturity is attained. As shown in Fig. 4, closure appears to be complete by the time that a plastron length of 10 cm has been reached.

In *G. agassizi* closure of the costoperipheral fontanelles appears complete by the time that the plastron has reached a length of 20 cm as shown in Fig. 5.

Woodbury and Hardy (1948) estimated that in *G. agassizi* maturity was reached somewhere between 15 and 20 years of age. This age of tortoise would correspond to a carapace length of 12 to 25 cm according to Patterson (1972) which also agrees with the findings of Patterson and Brattstrom (1972) that the period of rapid shell growth slows when a carapace length of 15 cm is reached.

ACKNOWLEDGMENTS

I am greatly indebted to Dr. B.H. Brattstrom and Mr. Nick Gaspar for their many helpful suggestions, original ideas and assistance with the interpretations.

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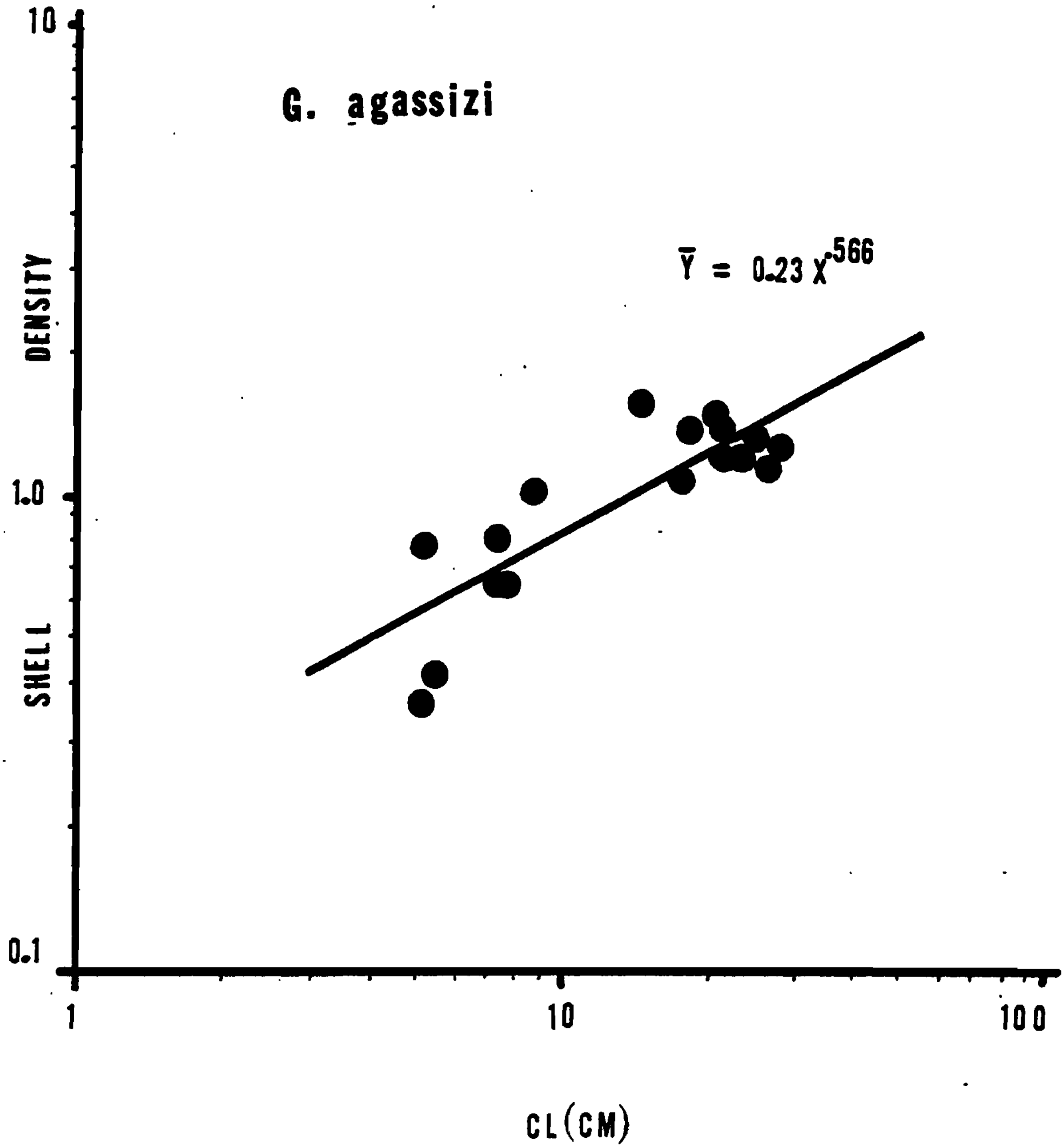

Fig. 1. Relationship between shell density and carapace length (CL) in *Gopherus agassizi*.

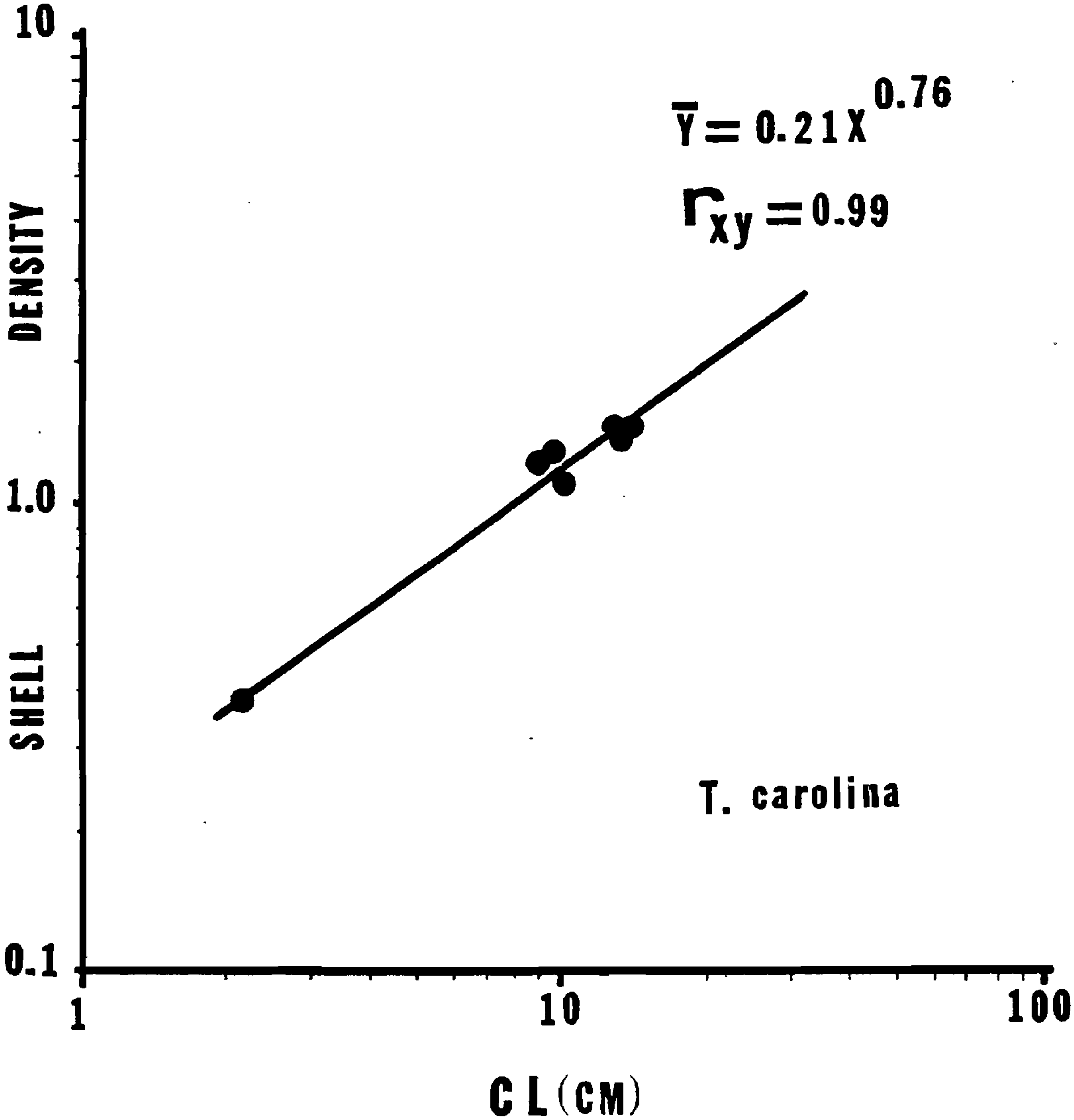

Fig. 2. Relationship between shell density and carapace length (CL) in *Terrapene carolina*.

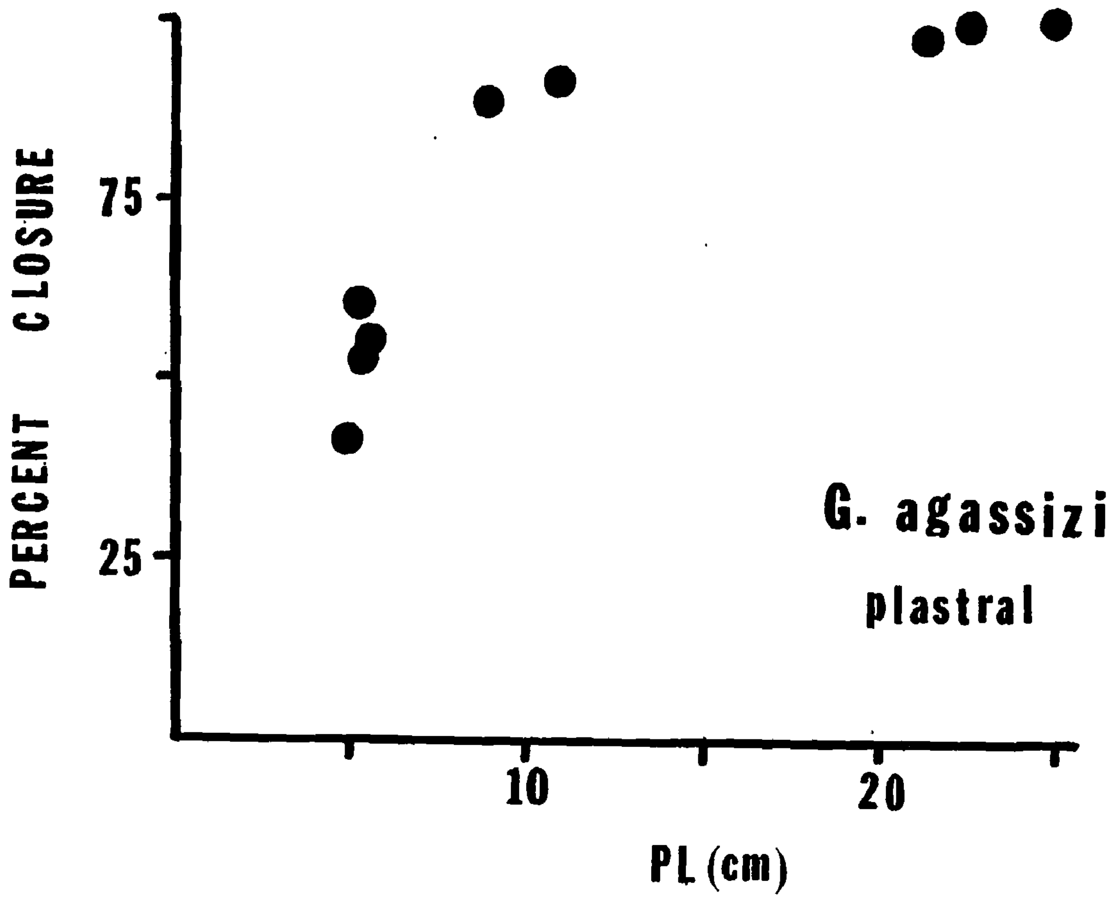

Fig. 3. Relationship between present closure of the plastral fontanelle and plastron length (PL) in *Gopherus agassizi*.

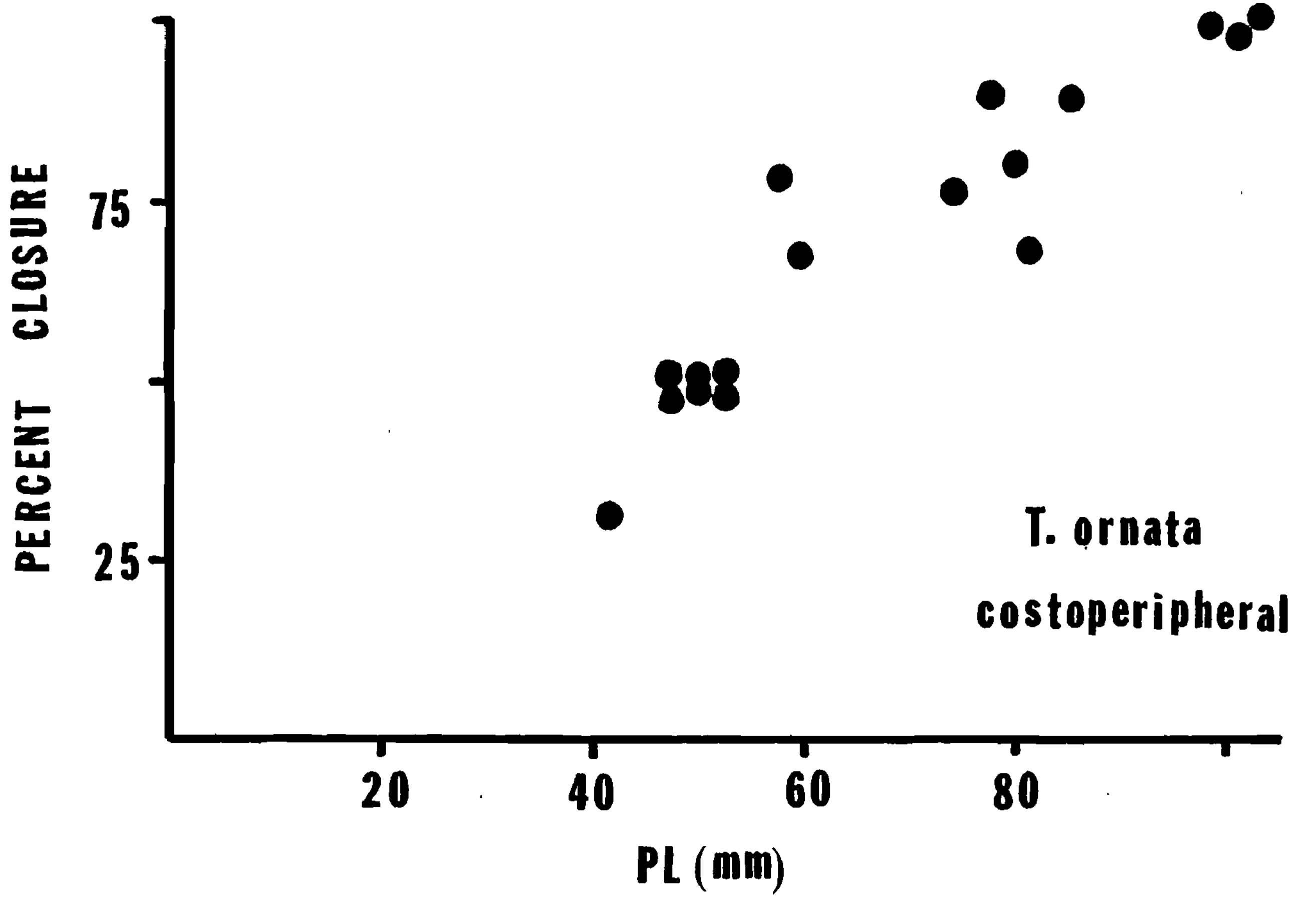

Fig. 4. Relationship between percent closure of the costoperipheral fontanelle and plastron length (PL) in *Terrapene ornata ornata*.

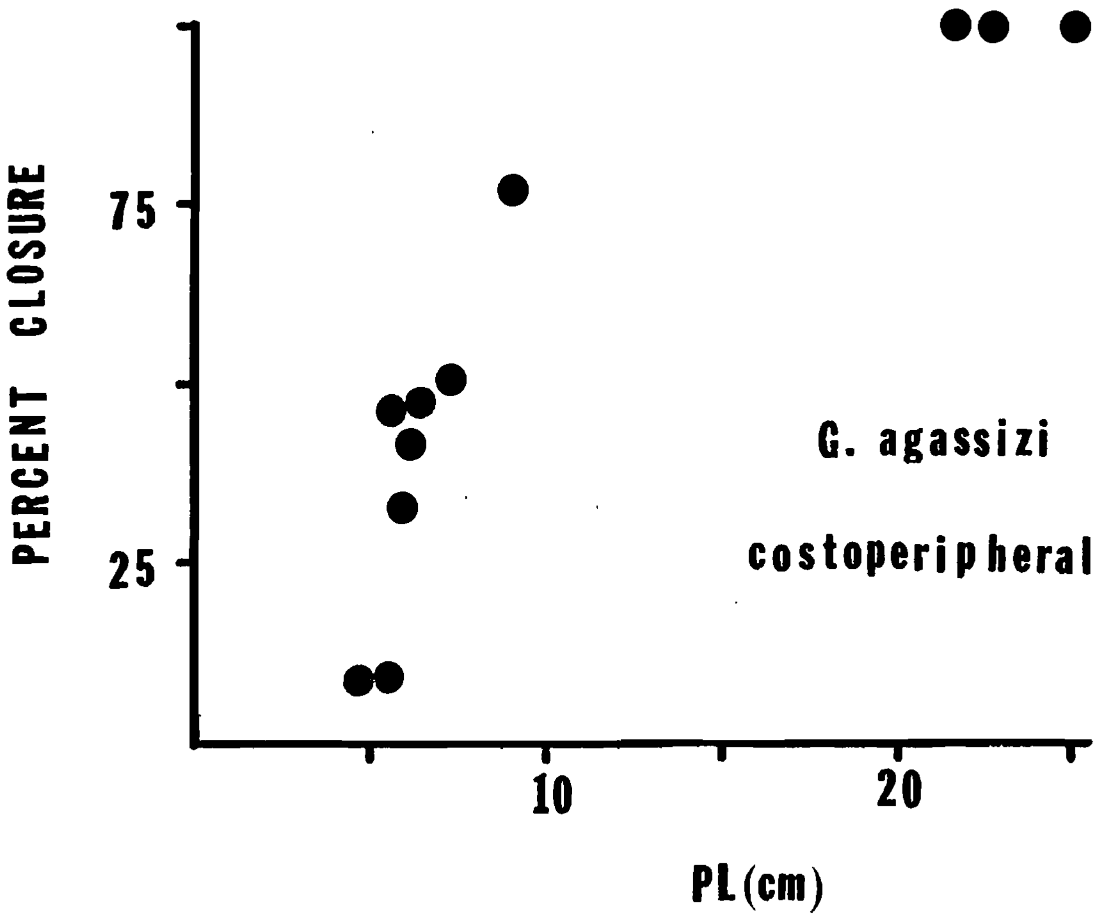

Fig. 5. Relationship between percent closure of the costo-peripheral fontanelle and plastron length (PL) in *Gopherus agassizi*.

Observations on *Gopherus agassizii* from Isla Tiburón, Sonora, Mexico

R. Bruce Bury, Roger A. Luckenbach, and
Luis Roberto Muñoz

More than a third of the geographical range of the desert tortoise *(Gopherus agassizii)* is in Mexico (Stebbins, 1966). Our understanding of the ecology of these populations is meager (Smith and Smith, 1975; Soulé and Sloan, 1966) and the few reports available make little or no mention of the habitat conditions or use of burrows by desert tortoises in Mexico. There is no information available on the tortoises of Isla Tiburón.

As part of a cooperative research program between the Direccíon General de la Fauna Silvestre of Mexico and the U.S. Fish and Wildlife Service, we visited Isla Tiburón in early December 1977. Our purpose was to survey resident tortoise populations and to initiate a study of their ecology.

DESCRIPTION OF THE ISLAND

Isla Tiburón, the largest island of the Pacific Coast of North America south of Canada (Fig. 1), is 1210 km^2 in area, and has elevations up to 875 m. Two mountain ranges are present, oriented along the north-south axis of the island and parallel to each other. The westernmost range is named the Sierra Menor; the eastern and higher range is Sierra Kunkaak. Between the ranges is a large alluvial plain, the Agua Dulce Valley (Gentry, 1949).

Historically, the island has been occupied by the hunting—gathering and seafaring Seri Indians (Moser, 1963). Felger and Moser (1970) wrote that the impact of the Seris on vegetation and fauna was probably minimal. However, desert tortoises constituted a regular food for the Seri Indians that occupied Isla Tiburón (Felger and Moser, 1976). The effects of this predation are unknown.

The island has been largely unoccupied since 1955. In 1967, the Dirrecíon General de Fauna Silvestre initiated a wildlife management program, including research on the distribution, abundance, and status of the island fauna.

Felger and Lowe (1976) recently reviewed the vegetation and floristic associations of Isla Tiburón; there are no endemic plants presently known, but further work at higher elevations along the Sierra Kunkaak may reveal new montane forms. Brown and Lowe (1977) characterized 2 biotic communities on

Isla Tiburón: Sonoran Desertscrub (Central Gulf Coast Subdivision) over most of the island, and Sinaloan Thornscrub at higher elevations on the Sierra Kunkaak.

MATERIAL AND METHODS

We established study plots (4 ha each) at Caracol (9 km west of Punta Tormenta) and 2 km west of Punta Tormenta (Fig. 1). Our survey procedures are outlined elsewhere (Bury and Luckenbach, 1977). The Punta Tormenta site is in Creosote—Mixed Desert Scrub; Caracol is in Subtropical Thornscrub (Table 1). We established boundaries and surveyed the Punta Tormenta site from 0800 to 1230 h on 9 December 1977. At Caracol, we laid out the plot and surveyed half of the area from 1530 to 1715 h on 9 December and finished the other half from 0930 to 1130 h on 11 December.

Also, we walked transects 1-4 km long at 6 different sites (Table 2) and searched for tortoise sign and evaluated habitat. Two to 4 persons walked each transect, and visually scanned areas 10-30 m across.

RESULTS

Study Plots. Most of our data were obtained at the Punta Tormenta site. We located 7 tortoise scats and 4 burrows. An inactive burrow was at the base of a woodrat *(Neotoma albigula)* midden under a palo verde *(Cercidium microphyllum)*. The burrow measured 45 cm long, 30 cm across (width), and 15 cm high at the mouth (abbreviated 45 x 30 x 15 hereinafter). The slope of this burrow was shallow (maximum depth was < 10 cm below the surface). One actively used burrow (70 x 40 x 23) was at the base of another woodrat midden. The bottom of this burrow was ≈ 20 cm below the surface. We found a collapsed burrow (35 x 30 x 11) under a small tree.

We found 2 tortoises. One was active at 0800 h on 9 December (air temp = 18°C). Fog was condensing on all vegetation, and perhaps the tortoise was seeking water. This animal (No. 1) was about 20 m from a burrow (outside our plot). We located the burrow by tracing the tortoise's tracks. This burrow (56 x 29 x 17) was at the base of a woodrat midden; the bottom was ≈ 10 cm below the level of the surface. We found another tortoise (No. 2) at 1140 h (air temp 26°C) in a burrow (33 x 25 x 15) under a large bush (*Krameria* sp.). The burrow sloped down gently to a maximum depth of ≈ 15 cm. The tortoise was fully alert when taken from the burrow.

We found part of 1 tortoise shell (No. 3) under a palo verde tree. Some fragments, apparently from this shell, were found nearby in a woodrat midden.

Field measurements of these tortoises and shell are shown in Table 3. Adult No. 1 had protuberant and unworn spurs on the front legs and hind feet (Fig. 2). Adult No. 2 possessed normal leg scales, which also showed little abrasion.

We found only 3 tortoise scats and no tortoises or burrows on the Caracol plot. Norman J. Scott *(personal communication)* had seen 8 tortoises in this general area during early October 1977. A caretaker on the island reported that tortoises are generally inactive from October to spring.

Transects. Little data were collected on the transects (Table 2). Most sign was seen on the 2 transects 2 km west of Pt. Tormenta. The burrows north of the road (Site B) were all active. One (30 x 38 x 14) was dug into the side of a wash. A second was under a woodrat midden but was inaccessible to us due to scrub growth. Another burrow ≈ 1 m deep and in a woodrat midden was under an elephant tree (*Bursera* sp.). In the shade of another elephant tree, we located a burrow (50 x 30 x 15) that was ≈ 25 cm at its deepest point. Fresh scats were present and sign indicated that a tortoise had recently left the burrow.

DISCUSSION

Habitat requirements of Mexican *Gopherus agassizii* are unknown. Bogert and Oliver (1945) collected 4 specimens from near Alamos, Sonora, but they did not mention habitat conditions. Loomis and Geest (1964) reported that a single female collected in Sinaloa was found in xeric vegetation which included senna *(Cassia)*, palo verde *(Cercidium)*, screw-bean mesquite *(Prosopis)* and randia *(Randia)*. Although they examined no specimens, Hardy and McDiarmid (1969) claimed that the desert tortoise in Sinaloa is restricted to low elevations (0-300 m) in Tropical Thorn Woodland. Auffenberg (1969) did not give the habitat associations of Mexican tortoise populations on which he reported.

Tortoises on Isla Tiburón occurred in Creosote—Mixed Desert Scrub and Subtropical Thornscrub. Both associations on the island contain relatively dense scrub that offers hiding and resting areas for tortoises. The lower branches of these shrubs and lush grasses, and the ephemeral blooms of flowers during and after the rainy season, provide ample forage. The well-developed desert vegetation is striking and is a result of the absence of livestock.

Habits of *G. agassizii* in the southern half of its range are also little known. Bogert and Oliver (1945) did not find any burrows in Sonora. They also commented that burrows were not detected in the Tucson Basin in Arizona, and speculated that the desert tortoise retreats to crevices rather than to burrows in the southern portion of its range. Auffenberg (1969) claimed that the desert tortoise in Sonora was completely nomadic throughout most of the year with "a very large activity range," and that the animals commonly dig shallow hollows into the bases of arroyo walls.

Our observations indicate that adult *G. agassizii* on Isla Tiburón construct shallow burrows (30-100 cm long) that are used as winter retreats. We do not know if tortoises use these retreats during other seasons or if they regularly return to 1 or more burrows. They apparently construct fewer burrows of shallower depth than do tortoises in California (Bury and Luckenbach, 1977) and Nevada (Burge, 1978). Tortoises on Isla Tiburón frequently seemed to dig into the base of woodrat middens rather than burrow into the gravelly soil. The protuberant spurs on one tortoise and unworn scalation of both tortoises that we found indicate that burrowing habits are little developed. Deep burrows may not be needed in the relatively mild winters on Tiburón. We did not find any burrows in areas of sandy soil. Future work should determine whether these tortoises burrow in the sandy substrates of lower wash areas and the interior of the island (Agua Dulce Valley).

We locatea only 1 active tortoise. Residents report that tortoises are at their peak of activity during warm weather, especially following rainstorms in late summer.

Our limited observations suggest a low tortoise population level on the eastern half of Isla Tiburón. Isla Tiburón is an excellent area for studying tortoises because the entire island is protected from man's activities. The vegetation is not affected by domestic livestock, a situation uncommon anywhere else within the range of *Gopherus agassizii*. Isla Tiburón is now one of the largest reserves for desert tortoises in western North America.

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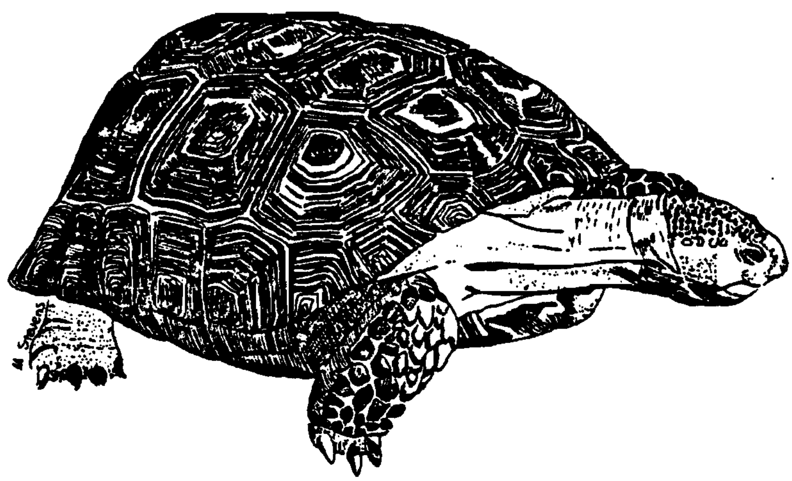

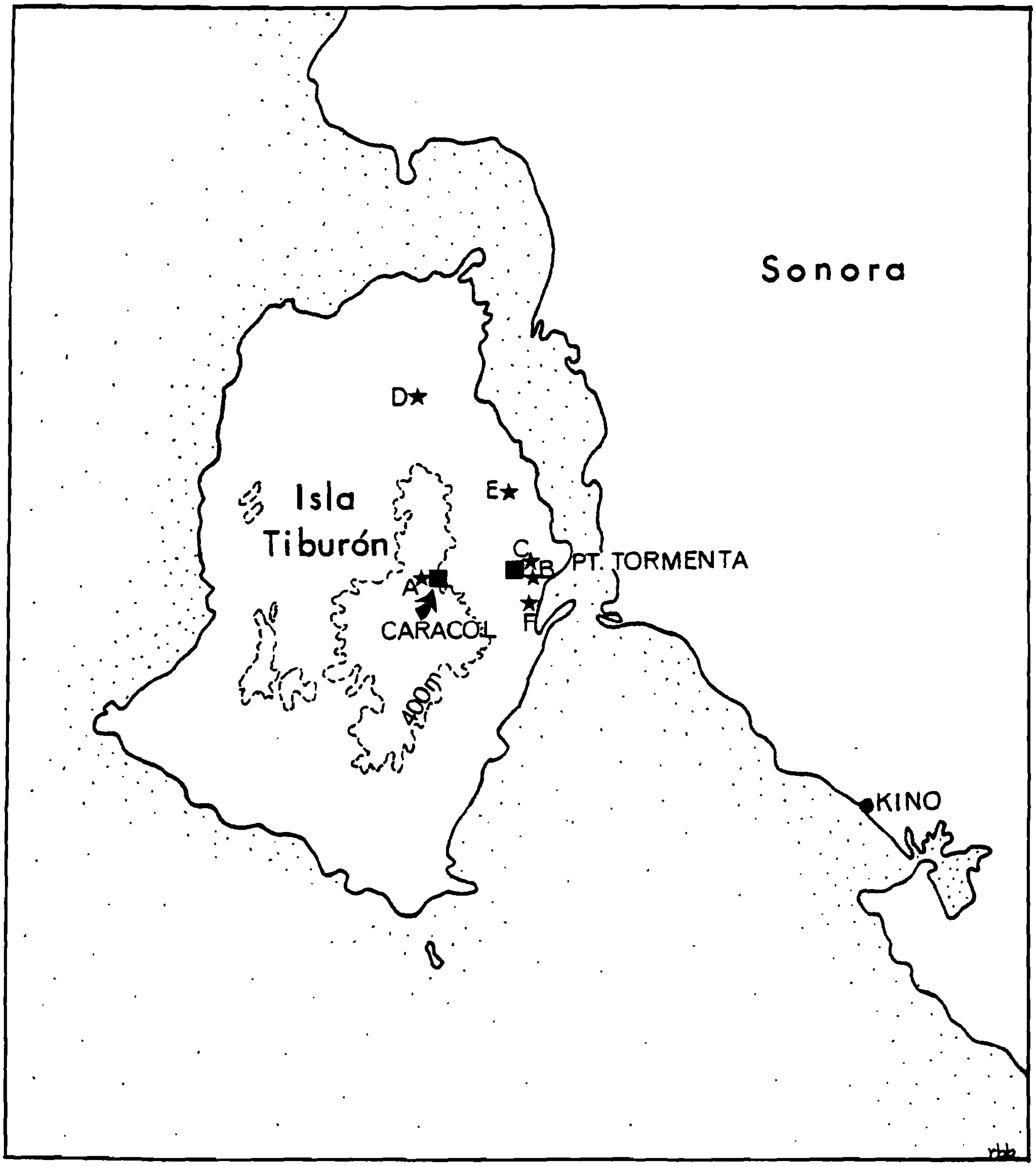

Fig. 1. Isla Tiburón, Sonora, Mexico. Squares are study plots and stars are sites of walking transects.

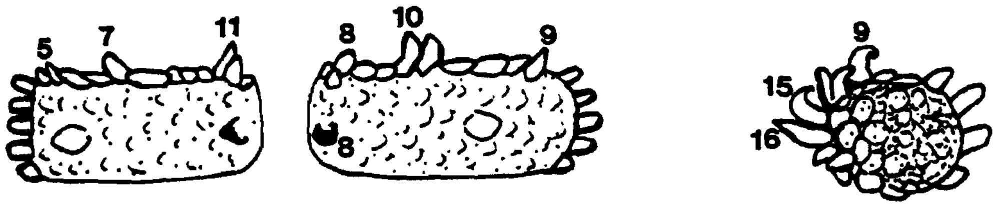

Fig. 2 Scalation of front legs and left rear foot of an adult *G. agassizi* ♀. Numbers are the lengths of scales in millimetres.

Table 1. Vegetational components of tortoise plots, Isla Tiburón, Sonora, Mexico. Dominant shrubs are listed in order of decreasing frequency by scientific name: Family (Spanish common name).

2 km W of PUNTA TORMENTA:	CARACOL
Larrea divaricata: Zygophyllaceae (gobernadora)	*Ruella californica*: Acanthaceae (rama parda)
Ambrosia dumosa: Asteraceae	*Bursera microphylla*: Burseraceae (torote)
Encelia farinoso: Asteraceae (incienso)	*Bursera hindsiana*: Burseraceae (copal)
Bursera microphylla: Burseraceae (torote)	*Olneya tesota*: Fabaceae (palo fierro)
Cordia parvifolia: Boraginaceae	*Lysiloma divaricata*: Fabaceae (palo blanco)
	Fouquieria splendens: Fouquieriaceae (ocotillo)
	Cercidium microphyllum: Fabaceae (palo verde)

Table 2. Tortoise sign and habitat at 6 sites surveyed by transects.

Site	Date and time	No. of observers	Approximate distance (Total)[a]	Vegetation	Tortoise sign				
					Shells	Burrows	Pallets	Scats	Tracks
A. Caracol	9 Dec 1730-1815	2	1(2)	Subtropical Thornscrub	1 shell	...	...	...	...
B. 2 km W Pt. Tormenta, S of road	9 Dec 1300-1430	3	3(9)	Creosote—Mixed Desert Shrub	1 bone	1 collapsed	...	...	1
C. 2 km W Pt. Tormenta, N of road	10 Dec 0800-0900	2	3(6)	Creosote—Mixed Desert Shrub	...	4 active	...	in one burrow	2
D. 18 km NW Pt. Tormenta	10 Dec 1115-1300	4	4(16)	Mixed Desert & Cactus Scrub	...	...	...	1	...
E. ca. 7 km NNW Pt. Tormenta	10 Dec 1500-1530	4	1(4)	Desert and Littoral Desert Scrub with Saguaro Cactus	...	...	...	...	...
F. 2 km SW Pt. Tormenta	10 Dec 1605-1635	3	2(6)	Creosote and Littoral Scrub	...	...	...	...	...

[a] Total distance (in kilometres) covered by all of the observers.

Table 3. Some measurements (following Bury and Luckenbach [1977]) of 3 adult desert tortoises found 2 km S of Pt. Tormenta. All lengths are in millimetres.

Measurement	No. 1	No. 2	No. 3 (shell)
Sex	♀	♀	♂
Weight (g)	3700	1900	...
Carapace length	268	210	...
Carapace width	197	156	...
Shell depth	112	96	...
Plastron length (max)	264	213	216
Plastron length (notch to notch)	240	193	198

Physical Characteristics and Patterns of Utilization of Cover Sites Used by *Gopherus agassizi* in Southern Nevada

Betty L. Burge

Physical characteristics and patterns of use of cover cover sites were determined during a 1½-year study of various aspects of the ecology of *Gopherus agassizi* on 305 ha in southern Nevada. A total of 921 cover sites was examined. Mean density of repeatedly used cover sites (pallets and burrows) was 3.5/ha; 85% were dug in soil typical of the area; 4% were in consolidated gravels of wash banks; and 11% were in predominantly loose gravel. Most openings faced east, northeast, or north; 72% were located under shrubs; 26% were located in the banks or beds of washes. Mean floor inclination below the horizontal was 15°. The longest burrows were located in consolidated banks but because of turns (which made excavation impractical) ultimate lengths >300 cm were not determined. Burrow lengths of tortoises >180 mm carapace length ranged from 30 to >300 cm; 62% were 30-70 cm and, excluding hibernation, comprised 38% of the use; 2% were >190 cm and comprised 30% of the use. Data from 6 adults (fitted with radio transmitters) whose movements were monitored for at least a full active season indicated that individuals used 12-25 cover sites per year, with most used repeatedly. During the active season $\approx 75\%$ of the individual's burrows were used by 1-5 other tortoises. Most burrows were single-occupant burrows; dens with capacities for several tortoises comprised 0-2 of each individual's group of burrows. Monthly frequency of use of cover sites of various lengths was determined from 10 adults carrying radio transmitters and 70 tortoises not carrying radio transmitters >180 cm; also determined were lengths used by tortoises 45-175 mm and by 30 tortoises of 90-286 mm during hibernation.

Aspects of cover-site characteristics and burrowing behavior of *Gopherus agassizi* have been described by Auffenberg and Weaver (1969), Berry (1972, 1974*a*, 1974*b*), Camp (1916), Grant (1936), Johnson, et al. (1948), McGinnis and Voigt (1971), and Woodbury and Hardy (1948).

A 10-year study of numerous ecological aspects of *G. agassizi* in southwest Utah (Woodbury and Hardy, 1948) included physical characteristics and use of dens located in the more or less consolidated banks of washes in contrast to use of burrows in soil located on the flats between the washes. Berry's data from northern Mojave Desert in California pertain to populations whose burrows did not include dens. McGinnis and Voigt (1971) compared daily and seasonal changes in temperatures of free-living desert tortoises and their microenvironments above and belowground.

The present paper is primarily descriptive of a number of basic physical characteristics of cover sites and the daily and seasonal utilization of various types of cover by free-living tortoises in southern Nevada. The detailed analysis of a small area (305 ha) and the frequent location checks of individuals in cover provide a considerable amount of new data. These data were collected during a 1½-year study of individual and population characteristics (Burge, 1977*a*; Burge, 1977*b*; Burge and Bradley, 1976). The Arden Study Area near Las Vegas was described in the abovementioned works.

The utilization of cover sites, particularly of the subsurface structures, is an integral part of the daily life of *G. agassizi*. The tortoise's choice to dig and/or use subsurface cover of certain lengths, depths and substrate types on a daily and seasonal basis are measurable indicators and possibly water regulatory needs.

COVER SITE TERMINOLOGY

The terms "burrow," "pallet," "form," "winter den," "summer hole" have been used by other investigators to indicate cover types of both general and specific nature used by terrestrial turtles (Auffenberg and Weaver, 1969; Berry, 1972, 1974*b*; Coombs, 1974; Stickel, 1950; Woodbury and Hardy, 1948). Cover-type names used in this paper are defined to clarify references to them in this work only, and no revisions of terminology are implied or suggested. The terms used are: DEN, BURROW, PALLET, and NONBURROW COVER. The difference between burrow cover and nonburrow cover is essentially a matter of degree. A BURROW is a subsurface cavity formed by erosion, excavated by a tortoise or other animal, or any combination of these. The minimum length of a burrow (as defined here) is slightly greater than the length of the individual; therefore, the minimum burrow length would be relative to the size of the tortoise. A hatchling's burrows would be a minimum of about 5 cm long and an adult's about 30 cm. Identifying the burrow as (1) belonging to a tortoise and (2) being a "burrow" was not difficult in most instances. The opening of a burrow that has been dug in the soil by a tortoise is characteristic in shape being a relatively well-defined half circle with a flat bottom. The size and shape of the opening and most of the interior conform to that of the tortoise, being only slightly greater in height and width than the individual (Camp, 1916). Although more than 1 individual may use a burrow, it was unusual to find a small juvenile using a burrow that was dug by an adult. Because of these characteristics the size of the tortoise using the burrow could be estimated and the designation "burrow" made if appropriate.

The term DEN refers to a type of burrow, possibly originally a karstic cavity or one excavated in part by tortoises by removal of weaker cementing layers of the consolidated gravels that form portions of the banks of stream channels. The interior or these burrows usually widens to greater than the width of 1 tortoise. Turns are evident and there is sometimes more than 1 chamber. Dens of this type have been described in detail by Woodbury and Hardy (1948). On the Arden site the actual shape and ultimate length of most dens were not investigated but measurable portions of some were slightly greater than 300 cm long.

NONBURROW COVER includes exposed shaded ground, low overhanging branches of shrubs, and below surface cavities which cover the tortoise but are just short of extending beyond the length of the shell. A tortoise may alter the most superficial nonburrow cover until it becomes a burrow.

Typically the tortoise orients itself in nonburrow cover with head and limbs withdrawn and with the anterior edge of the shell pressed against the base of the boulder or shrub. Use of this site may leave no disturbance of the soil surface; however, a slight depression may be created by the plastron as the tortoise presses forward and downward under the overhang. The depression may be enlarged by shimmying movements which eventually undermine the soil surface creating a lip of soil that extends over the anterior of the shell. Excavation may stop at any point and a site may show no sign of change despite repeated use. Up to the point that the overhanging soil was short of covering the shell or if the only "roof" was shrub canopy or a boulder the cover site was referred to as a PALLET.

The "apron" of a burrow was the term adopted for the pile of excavated soil that is formed in front of the opening. In some situations the apron persists long after the burrow is leveled. Characteristics of the apron may indicate the age of the burrow and changes in the orientation of the opening.

METHODS

A map was made as the study area was methodically searched and the locations of cover sites and stream channels were plotted. The technique employed included (1) pacing from plotted points and (2) unaided triangulation using salient topographical features. Comparison with aerial photographs and ongoing use of the map to relocate cover sites showed the pacing distances to be accurate to within 5%. The map was of use in determining cover-site density. An additional density comparison was made between the rates per hour at which cover sites were encountered on the initial traverse in the major stream channels and over the flat areas between.

Most field visits were made at 1- to 3-day intervals. The pattern of coverage was dictated in part by the relative locations of 10 tortoises fitted with radio transmitters--adults 220-286 mm carapace length, equal number of each sex. On most days during the active season, priority was given to observing these tortoises 1 to 3 times; however, as I moved from one tortoise to another, there was opportunity to seek new cover sites and to check known cover sites for occupants.

As each cover site was found, its location relative to topographic features was noted, e.g., whether in a stream channel or on the flat areas between. When found in a stream channel, its position in the bed or bank was noted. Substrate type was described as typical soil, consolidated, or unconsolidated gravel. If located under a shrub, the species was noted. The direction which the opening faced was expressed as 1 of the 8 cardinal points of the compass. If a cover site was occupied by a tortoise, routine procedures included measurement of the tortoise's shell and the location of the tortoise relative to the opening. If occupied by another kind of animal this was noted.

Burrow length was measured to the nearest 5 cm by inserting a 180 cm fishing pole marked in 10-cm divisions. Any deviations to the right or left were noted. Approximate dimensions of the opening were measured as width across the base and greatest height. Subsequent increases in length or the size of the opening were noted.

For a selected number of burrows the degree of inclination of the floor was measured from the entrance to distances up to 70 cm into the burrow. If a change of slope occurred within that distance, both inclinations were measured. Changes beyond 70 cm were estimated. Burrows in which the floor was disturbed by other animals and/or was insufficiently compacted to prevent uneven settling of the inclinometer were not measured.

The inclinometer (Fig. 1) was constructed from two 6 x 18 mm strips of wood 35 and 45 cm in length bolted together at one end to form a movable joint which could be adjusted to conform to the floor of the burrow. A 30-cm ruler was glued along its midline at right angle to the lower, narrower edge of each strip. A bubble level tube was affixed to a half-circle protractor which, in turn, was bolted to the side of the free end of the longer strip of wood. With the protractor base aligned with the long axis of the wood strip and leveled, 0^{o} and 180^{o} points were etched in the wood adjacent to the protractor which was permitted to rotate only when turned by hand.

The presence of tortoise egg shell fragments on the apron was considered an indication of a nest site. Soil near the opening was probed with the fingers for a nest cavity that might still be discernible and measurable. The use of burrows as nesting sites was described previously (Burge, 1977*a*).

The interior temperatures of a den were monitored for a year using a thermal recorder. The sensor was set on the floor of den 2.3 m from the opening. A sharp turn in the channel prevented placing the sensor beyond the turn. Tortoises rested at the 2.3 m distance as well as beyond. The depth below the surface at 2.3 m was estimated at $\approx$ 1 m.

Comparisons of ambient temperatures (T_a) as departures from the normal were based upon averages since 1937 (United States Weather Bureau) recorded at Las Vegas.

The frequency of use of the den with the thermograph was determined by direct observation, and (because a tortoise without a transmitter could remain unseen) lengths of small sticks (7.5 cm) were inserted along a ridge of loose soil raised across the floor of the opening. Sticks were easily pushed flat when a tortoise passed through the opening and the direction was thus indicated. The tracks and plastral impressions in the loose soil identified the agent as a tortoise.

A cover site "use" was tallied for those sites found occupied with a tortoise and a "use" was counted for each tortoise occupying a site simultaneously.

With increasing T_a in the spring, daily activity becomes bimodal with a period during late morning through early afternoon during which tortoises retreat to cover. The effect of seasonal T_a change in creating 1 or 2 daily periods that are conducive to activity has been described for this population (Burge, 1977*b*) and observed in other populations by Berry (1972), Brattstrom (1961), McGinnis and Voigt (1971), and Woodbury and Hardy (1948).

In 1975, the change from 1 to 2 activity periods per day occurred during the 1st week in May, and from 2 to 1 at the end of September.

Because of the frequent daily checks of tortoises carrying transmitters, repeated or continuous use of the same cover site during days with 2 activity periods were counted at 2 "uses" as were any 2 different cover sites which preceded and followed activity.

Data from tortoises carrying radio transmitters were considered separately from data from tortoises not carrying transmitters.

RESULTS AND DISCUSSION

Physical Characteristics. Most of the study area substrates--soils with depths of 0.76-1.5 m (USDA, 1967)--appeared to be suitable for digging burrows. Although calcic horizons were commonly exposed in wash beds the relationship of burrow depths to impeding calcic layers was not investigated and no apparent limitations were observed in burrows dug in the typical soil of the flats.

Karstic cavities used as burrows occurred in the interrupted exposures of consolidated gravel of wash banks. Four of these major washes (3-25 m wide) transected the study area. Bank heights varied from <1 to 4 m; some were gently sloping, soil covered and vegetated. Wash beds were irregularly covered with gravels, accumulations of silty soil, and perennial vegetation. Except for a flood on 3 July 1975 no recent sign of flowing water was observed in these washes.

Well-developed desert pavement was common but apparently was not mechanically restrictive to burrowing for most tortoises. Beneath the 1 to 3 cm layer of pavement pebbles, soil was characteristic of the area--fine sand with various amounts of gravel.

Four burrows were located in the ridges of soil raised along the shoulder of unpaved roads and the few bulldozed swaths. Small tortoises did utilize narrow cavities in the consolidated substrates; however, very few small burrows were located in areas covered by desert pavement.

Of 783 burrows and pallets the percent located in each of the 3 general substrate types was as follows: 4% in consolidated gravels; 11% in predominantly unconsolidated gravels; and 85% in soil with varying amounts of gravel. In the large washes 151 burrows were located in the banks and 56 in the soil and vegetation in the beds of those washes.

An average density of pallets and burrows in good condition was determined for a sample area of 101 contiguous hectares that had been mapped and monitored well throughout the study. The total was 345 ($\bar{x} \pm 1$ SE = 3.5 ± 0.2, range 0-8 pallets and/or burrows per ha).

Of the 921 discrete cover sites located on and contiguous to the study area, 661 (72%) were under shrubs (Table 1).

Large and small burrows were found with equal frequency under most species with the exception of *Yucca* where small burrows were less frequently found. The utilization of various shrub species as sites for burrows and pallets showed no correlation to availability (density) of shrub species. Overall availability of sites in terms of shrub density relative to burrow and pallet density was apparently not a significant factor in determining use; i.e., maximum cover site density was 8/ha. Those species with the lowest densities that were used by tortoises were estimated to be of densities > 8/ha.

The more obvious correlation was to that of the shade-giving properties of the species. *Acacia*, in particular, despite its low density (0.9) showed the greatest relative use (37.7%). Those pallets and burrows under *Yucca*, the other low density/high use species, may have provided an added advantage because the *Yucca* bases formed most of the roof structure of burrows and pallets under them, possibly increasing the insulative properties. Despite the 3-fold greater density of *Ambrosia* (56.7) over the species with the next highest density, *Larrea* (16.0), *Ambrosia* showed the lowest relative use of any species used 4 or more times. This was most probably because of the small plant size.

The degree of preference for *Ephedra* was probably not related to shade and possibly not to availability, although the density value was close to that of *Larrea*. The habitus of *Ephedra* was typically open, low, and sprawling. Its density (14.0) was only slightly greater than that of *Krameria* (12.5); however, *Ephedra* was used more than 7 X more often than *Krameria* and with greater frequency of use relative to availability despite its relatively poor shade-giving properties. *Ephedra* was very commonly found growing in relatively wide (> 2 m) and deep accumulations of gravel-free soil, particularly at the base of wash embankments. These soil accumulations were more often associated with *Ephedra* than most other shrub species. The tortoises' preference for the soil conditions was probably the reason for the heavy use of sites associated with *Ephedra*. *Lycium*, another low density/high relative use species, was also localized in these deep silty deposits.

It was assumed that facing direction of cover-site openings would be equally represented unless factors such as sun and shade or possibly substrate characteristics were involved;

therefore, those cover sites located on embankments which were sufficiently steep to restrict the facing direction of cover sites were not included. Of the 151 cover sites in wash banks, 143 (95%) were in washes with east-west channels; of these, 57% were located on the south bank and faced north, 43% were in the north bank and faced south.

By including only recently-used nonburrow cover sites over the active season, the effects of any differences in the tortoises' orientation under cover during any one season or at different times during a 24-h period would tend to cancel out. Each of 689 cover sites (not in wash banks) was placed in a group according to presence or absence of shrub cover (Table 2). Depressions and pallets in exposed situations were uncommon and were possibly only abandoned attempts to burrow.

The significant number of depressions and pallets facing north and of burrows under shrubs facing north and northeast suggested utilization of a thermal advantage in that the sun's rays would be directed into the opening only during the early morning in summer. The shrub would shade part of the opening and roof for most of each day year round. As for the significantly fewer burrows in exposed situations that faced westerly and southerly directions, tortoises may have been compensating for the lack of shade.

Lengths of 747 burrows ranged from 6 to >300 cm. To compare the length distributions, burrows made by small, medium, and large-sized tortoises were considered separately.

Tortoise size was indicated by the height and width of the opening; however, with use and weathering the margins of the opening erode and each dimension may increase 5 cm or more. The inner dimensions were difficult to measure accurately; therefore, the approximate opening dimensions were used and with experience the size of the tortoise using the burrow could be estimated with sufficient accuracy to place the tortoises in 1 of 3 size groups which overlapped somewhat.

Of the 35 burrows used by tortoises 45-110 mm in carapace length, 63% were 30-40 cm long (Table 3). Burrow lengths ranged from 1.3 to 5.4 X the shell length of the 12 tortoises found in these burrows. Of 134 burrows estimated to have been used by tortoises 95-179 mm, 61% were 30-60 cm long. Of 13 tortoises 125-175 mm carapace length found in burrows, 12 were in burrows 1.9-4.5 X the shell length. One exceptionally long burrow relative to the tortoise length was 112 cm long--9 X the body length (125 mm).

Texas tortoises *(G. berlandieri)* of <100 mm carapace length tended to dig longer pallets relative to carapace length than did tortoises >100 mm long (Auffenberg and Weaver, 1969). During the present study the burrows that were defiitely those of tortoises < 100 mm in length were too few to warrant analyzing, particularly if seasonal variation was a factor.

Of 659 cover sites used by 89 tortoises ≥ 180 mm, $\approx$ 12% were pallets; 54% were burrows 30-70 cm long or 1-3 X mean shell length. Only 12% were 90-120 cm, the common length of "summer holes" used by tortoises on the Utah study area (Woodbury and Hardy, 1948). On the Arden site, burrows ≥ 190 cm comprised only 2% of the cover sites located. Only 1 of the 12 burrows (190 cm) had been dug in soil; the remaining 11 were dens in consolidated gravels. The 11 comprised $\approx$ one-third of the burrows and pallets located in consolidated gravels.

The 35 smallest burrows were considered low as a representative number. Smaller burrows are more difficult to see and more difficult to identify as tortoise burrows because rodents and lizards use them and tend to alter the characteristic shape of the opening as well as obscuring tortoise tracks. For this reason each of the 35 smallest burrows measured was either occupied by a tortoise or else recent tortoise sign was present.

Single turns of the burrow tunnel were observed in 58 burrows (7%). Not included were turns in burrows in the consolidated banks which may have been the result of weathering or factors other than those which typified digging behavior. Most turns were estimated to be of $< 30^{\circ}$ deviation; 29 were to the right and 29 to the left. Most occurred well within the burrow and in only 2 cases was a possible cause discerned. In one, a root protruded into the interior and in the other, a large cobble. The remaining deviations may have been the result of unobserved obstructions. There was no apparent correlation of the location or direction or deviation with the facing direction of the burrow.

Inclination of burrow floors below the horizontal were measured for 75 burrows: 61 (30-$>$300 cm long) used by tortoises 180-286 mm in carapace length and 13 (35-90 cm long) used by tortoises 86-179 mm long.

The slope of the burrow floor was typically without major undulations, either continuing at the same degree of inclination or changing at a definite point, becoming less steep. Inclination of the floor changed in 46% of the measured burrows used by tortoises 180-286 mm in length. Only 2 of the 14 burrows (14%) used by smaller tortoises showed a change of slope.

The location of the initial slope change for the majority of burrows was within the first 30 to 40 cm regardless of the total length of the burrow or the height of the channel.

With the exception of dens, the ends of most burrows were visible. Beyond 75 cm there was no obvious change in inclination except a slight rise within the last 10-30 cm.

Burrows (used by tortoises 180-286 mm in carapace length) which changed slope showed a mean inclination ($\pm$1 SD) of $14.3^\circ \pm 3.0^\circ$ (9-21); for the initial slope $\bar{x} = 20^\circ \pm 3.7^\circ$ (13°-28°) and for the portion after the change, $\bar{x} = 8.3^\circ \pm 4.7^\circ$ (0°-18°). Burrow floors with no apparent change in inclination averaged $15.7^\circ \pm 4.7^\circ$ (4°-22°). The average for the 61 burrows used by tortoises ≥ 180 mm was $15.0^\circ \pm 4.0^\circ$ (4°-22°). The mean inclination of 14 burrows used by tortoises 86-179 mm long was $16.5^\circ \pm 4.4^\circ$ (5°-22°); and the mean for the 75 burrows, $15.3^\circ \pm 4.1^\circ$ (4°-22°).

Burrows in consolidated material showed the full range of inclinations, but 50% of them showed the lowest inclinations measured--4° and 5°. The integrity of the cementing layers and the tilt of the strata were considered to be the major factor determining floor inclinations.

Most burrows dug in soil of embankments were more horizontal than those dug into flat surfaces. This would seem to indicate that thermal cues and possibly associated visual cues influence the angle of excavation.

Burrows used over 2 seasons were included as well as new and improved burrows. There was no observable tendency for inclinations to vary consistently with the age of the burrows.

The depth of the soil above the end of the burrow tunnel was observed directly for the few burrows which had been found destroyed but with dimensions remaining evident. Burrows 45-60 cm in length had roof thicknesses of 15-20 cm above the end. Additional estimates of roof depths above the end of burrows were based upon floor inclinations, length of the burrow, and the depth of soil above the opening. Burrows 100-190 cm in length dug in soil on more or less level ground were estimated to have a range of roof depths above the far end of 40-70 cm (190 cm was the longest found in soil). The effect of the slightly rolling topography on the actual depths of burrows below the surface remained an undetermined variable. Burrows in the steep banks of washes were usually 1-2 m below the rim; however, several were only 20-30 cm below the rim.

Underground shelters of 2 types used by tortoises at the

Utah study site were described by Woodbury and Hardy (1948). There were dens in the consolidated banks of washes and "summer holes" dug by tortoises in the soil of the flat areas between and above the washes. There were 95 dens, with most ranging in length from 2.4-4.6 m; some were 6.1-9.2 m; summer holes were 0.9-1.2 m. These were estimated to be 4 X as numerous as the dens. The inclinations of summer holes ranged from horizontal to 20^{o}-40^{o} below the horizontal. Of the 95 dens, 50 were more or less level, 4 sloped down at the end and the remaining sloped up to various degrees at the end. The internal arrangement included forks, turns, anastomosing passages and chambers. Although the dens in washes on the Arden Study Area were far less common and of unknown internal form, they were essentially in the same type of geologic formation as those that I have observed on the Utah study site.

Three cover site types used by tortoises in the Mojave Desert, California, were described by Berry (1972, 1974*a*, 1974*b*). These were (1) pallets which included shorter burrows and (2) burrows similar to the "summer holes" described above--.9-1.2 m in length and usually dug at the base of shrubs or under rocks. Soil depth of the roof at the opening 2.5 cm to 25 cm at the end. Considered "temporary," some lasted a few seasons, some, less; (3) more "permanent" burrows or "winter" burrows 2.4-3 m with roof depths over the opening 25-30 cm and over the end, 60-120 cm. In that particular area, dens in consolidated gravels were not available; however, none of the winter burrows had chambers.

Additional examples of burrow characteristics of *G. agassizi* in other areas and of other *Gopherus* species suggest the tortoises' adaptability in relation to climate and substrate (Auffenberg and Weaver, 1969; Hallinan, 1923).

Patterns of Utilization. Excluding repeated location checks during hibernation use was determined from 1593 sightings in cover of 10 adults with transmitters and 70 tortoises 180-286 mm without transmitters. The frequency of use of cover sites of various lengths was determined only for those individuals $\geq$ 180 mm because the number of captures in cover of tortoises < 180 mm (25) was insufficient for reliable analysis.

About 11% of the sightings in cover involved exposed shade or pallet-type sites where no discernible sign was evident on the soil surface after the tortoise departed.

During the active season 1975 and with the exception of burrows $\geq$190 cm, use reflected availability (Fig. 2). This is not surprising in an area where substrates apparently allowing tortoises to dig to the desired length and depths were widely available. The disproportionately greater use of burrows $\geq$ 190 cm in length was partly the result of the number of tortoises that simultaneously occupied these burrows, and their year-round use (70-100% of the days each month).

Observed increases in length were considered neither frequent or extensive enough to negate the reliability of the comparisons made between availability and utilization of various lengths.

The lengths of cover sites used were compared on a monthly basis for the active season 1975 and during hibernation (Fig. 3). Data from males and females were combined after analysis of data from 70 tortoises without transmitters showed no significant difference between the sexes within any month ($p > .05$). With few exceptions, tortoises fitted with transmitters and those without showed similar trends.

Burrow lengths used during hibernation are known for 30 tortoises, 3 of which were juveniles of 90, 140, and 150 mm carapace length. Each hibernated respectively in soil burrows 40, 55, and 40 cm long.

Fifteen of the larger tortoises shared 5 dens with at least 2-5 other tortoises (Table 4). These individuals represented an unknown percentage of the occupants. Ten of the remaining 12 were known to have hibernated singly. In 2 of the soil burrows (180 and 190 cm) there may have been more than 1 tortoise.

The pallet used by Female No. 90 was under the low overhanging branches of an acacia $\approx$ 2 m tall and was shaded for most of each day. Late fall and winter T_a minima were at or near $0^{\circ} \pm 5^{\circ}C$.

The channels of occupied burrows remained open throughout hibernation. In soil burrows, neither tortoises nor those rodents active intermittently throughout winter created any barrier to air (temperature) circulation. All soil-filled burrows found were probed; none contained tortoises.

The sample size was too small to make statistically significant comparisons between the facing directions of burrows. The orientation of the dens was imposed by their location in vertical banks. The lengths (depths) and possibly substrate type of dens or the opportunity to aggregate that they afforded were probably more responsible for their use than was their orientation. There was no observable correlation between observed physical characteristics of burrows and the dates of tortoises' emergence in the spring. Individuals emerged at different times from a given den over the period of initial emergence.

Woodbury and Hardy (1948) noted that the use of the longer dens was uncommon between mid-April and the end of September, whereas almost all use of the summer holes occurred during those months. Dens on the Arden Study Area were neither used exclusively for hibernation nor were they the only burrows used for hibernation. Despite the limited number of caliche dens and their heavy use, no dens were dug in soil by tortoises.

As reported by Berry (1972, 1974*a*, 1974*b*) the longer, more permanent "winter" burrows were used more often during summer and winter; the shorter burrows and pallets were used more during spring and fall when day and nighttime ambient temperatures were moderate.

Most of the soil burrows used by the tortoises at the Arden Study Area at all times of the year were more like the "temporary" "summer holes" described above. Climatic conditions are similar for the Utah, California and Nevada areas; however, closer comparisons between seasonal use and cover type were not possible from the data available.

The period of initial emergence from hibernation extended from 1 March through 20 April. Following a tortoise's first emergence the tendancy was to move to superficial cover (pallets and short burrows). Some tortoises continued to use superficial cover, others returned to long burrows and dens. At both types of cover sites some tortoises emerged only to bask, others apparently resumed hibernation, few were active.

Ambient temperatures during most of March and April were below average, remaining below 21°C. The mean low was 5°C with occasional extremes to 0°C. Floor temperatures at 2.3 m inside a den where tortoises were hibernating remained between 12° and 14°C during most of the emergence period. Initial emergence was observed when floor temperatures reached 15°C and above.

Nonburrow cover was used during each month (Fig. 3). The absence of nonburrow captures in March of tortoises not carrying transmitters was the result of the low level of activity. During March and April, individuals carrying transmitters emerged on 80 occasions. After egress, nonburrow cover or burrows 30-45 cm in length were chosen 43 times (54%). With higher nighttime temperatures available in dens and the option to emerge and bask during each day it was surprising that any tortoises remained in superficial cover. Possibly one post-emergence stratagem is to choose the situation in which the highest T_a might be available for the greatest duration, i.e., in very exposed sites. A possible parallel may exist in the behavior of *G. berlandieri* living in areas where the predominant type of cover used was the pallet. Auffenberg and Weaver (1969) observed that in the summer proportionately more tortoises were found in pallets located in thick brush than in open areas. Conversely, in winter a greater proportion were found in pallets in open brush and grass.

The use and implied function of nonburrow cover from May through September can be shown more clearly by separating nighttime use from daytime use, a natural result of the seasonal occurrence of 2 activity periods per day.

Although midday use of nonburrow cover, i.e., day cover out of burrows (DCO) included shaded ground with no additional protection from closely overhanging branches or rocks; night cover out of burrows (NCO) was almost always in a more protected situation. On only 1 occasion was a tortoise observed sleeping at night outside of cover of any kind.

The use of DCO was greatest in May (Fig. 5) comprising 60% of the nonburrow use. May was colder than usual by as much as 6^{o}-9^{o}. McGinnis and Voigt (1971) demonstrated that (during the active season) shade temperatures were consistently higher than burrow temperatures ($\approx$ 1 m inside) except for a short period following sunrise. On the Arden site shade temperatures apparently were still within tolerable limits during the colder than usual period in May.

During May, $\approx$ two-thirds of the nighttime T_a were $< 18^{o}C$; however, tortoises continued to sleep out. Voigt (1972) observed no use of NCO during March and May when nighttime T_a were $< 20^{o}C$.

In June, use was greater during the first half of the month. From 19 through 26 June T_a were below normal (but moderate); lows ranged between 14^{o} and $17^{o}C$ and no tortoises were observed sleeping out at night. Despite the seasonal T_a highs occurring in July, tortoises used nonburrow cover during the day; however, DCO comprised only 8% of recaptures in cover. The use of nonburrow cover reached its peak during July with the greater percentage occurring at night. Greater night use continued through September.

The thermal advantage that resulted from sleeping outside a burrow at night during summer was demonstrated by McGinnis and Voigt (1971). Because ambient temperatures at night are typically lower than burrow temperatures, a tortoise sleeping out could begin morning activity at the lower part of its body temperature (T_b) activity range and remain active longer than the tortoise emerging from a burrow at a temperature much closer to that at which the tortoise must again return to cover, $T_b = 37.6^{o}C$ (McGinnis and Voigt, 1971).

The relatively greater nighttime use of nonburrow cover July through September suggested that tortoises on the Arden site were utilizing this potential advantage. In July, forage was available through most of the month and activity levels were high (Burge, 1977*b*) and maximum T_a were reached; however, nighttime use of nonburrow cover comprised only one-third of the nighttime cover-use observed during that month.

Tortoises continued to sleep out at night through 5 October after which T_a was below normal and few tortoises were seen. Nighttime lows from the last week of September through 8 October were between 15° and 17°C.

Use of burrows 30-149 cm in length comprised from 40-65% of the use each month. The increase in use of burrows in this group during June was due to the continued use of burrows 30-69 cm in length with the additional use of burrows 70-149 cm in length. Presumably the greater lengths and therefore greater depths were sought for their cooler daytime temperatures.

The gradual decrease in use of burrows >150 cm in length was not significantly less than the mean use of that length group for the season except in July by tortoises bearing transmitters ($p < .05$). Burrows of these greater lengths were fewer in number and the increased use of burrows dug in soil that were shorter than dens was coincident with increases in the use of larger areas with stops for cover farther from the few and widespread dens (Burge, 1977*b*). Also as the season progresses, temperatures within the longer dens would tend to remain at increasingly higher levels. The longest period of no use of the den with the thermograph was between 24 and 27 July. Floor temperatures at 2.3 m inside the den during the last week in July and first half of August were at or near maximum for the season, 30.0°-32.8°C and the range of daily fluctuation in the den, 0.5°-2.2° was not conducive to loss of body heat.

Preferred body temperature as reported by Brattstrom (1965) is 30.6°C. McGinnis and Voigt (1971) included body temperatures of sequestered tortoises which resulted in a mean of 33.3°C. Naegle (1976) reports 32.9°C for tortoises < 125 mm carapace length and ≤ 500 g and 29.2°C for tortoises ≧ 125 mm and > 500 g.

The increase in use of the longest burrows during October was the result of movement to hibernation burrows during the weeks prior to the beginning of hibernation.

During the period May through September 1975, data for cover site changes that occurred in consecutive activity periods over a day or a day and a half were examined for indications that choice of burrow length, other than choice between burrow and nonburrow cover, correlated with period of the day (implied temperatures). There was no apparent correlation between the length chosen and the time of day; however, during the day, tortoises were often found resting at intermediate distances from the opening, possibly indicating use of a temperature gradient that existed.

None of the openings of burrows occupied by tortoises were plugged with soil with the exception of 1 instance as a result of rodents (to be described). Auffenberg and Weaver (1969) reported that adult *G. agassizi* were observed to plug their burrows in exceedingly hot and dry summer months, a behavior which they observed among smaller *G. berlandieri* (60-100 mm carapace length) in particular; suggesting that the plug was probably important in both conserving water and providing concealment from predators.

<u>Use Patterns of Individuals</u>. An average of 91% of the relocations of transmitter-bearing tortoises in cover were in sites that the individual used repeatedly or its "primary cover site group." The individual's group included (1) burrows observed being used 1 or more times and (2) nonburrow cover sites observed being used 2 or more times. The potential number of nonburrow cover sites is limited only by the number of shrubs and rocks of appropriate size--not considered a limiting factor on the study area. Use of such a site was typically transitory and therefore the return of the individual to a specific site distinguished that site as discrete and preferred. Only 44% of discrete nonburrow cover sites showed sign of subsequent use in contrast to 95% of the burrows. Burrows observed being used only once were probably used (unobserved) at least once by that individual. This assumption was based upon the tortoises' fidelity to specific cover sites (to be described). Actually, single observed uses of burrows amounted to only 1 or 2 per tortoise. During the year, individual tortoises carrying a transmitter used 12 to 25 primary cover sites, and nonburrow sites were among those used most frequently.

The number of primary cover sites used by an individual each month varied from 3 to 7 and the sequence of use also varied. Some were used for a few days during almost every month; others were used exclusively for a week or more during only 1 month. The mean frequency of total number of days or parts of days in which each individual used each of its primary cover sites was as follows: 8% were used for all or part of 1 day; 73%, 2-15 days; and 19%, 16-46 days.

Another pattern of cover-site utilization was that of shared use, either simultaneously or separately by other tortoises. This was exemplified by the 6 transmitter bearing tortoises whose activities were monitored for at least 1 full active season (Table 5). The length distributions of their 92 primary cover sites were representative of the lengths of all the cover sites used by tortoises of comparable sizes.

None of the nonburrow cover sites were known to have been shared, whereas an average of 75% of an individual's cover site group was used by 1-5 other tortoises. Most burrows were used by 1 tortoise at a time (0-2 of an individual's primary cover site group were dens). Other than in dens simultaneous use was infrequent, seasonal, and associated with periods of increased sexual interaction (Burge, 1977*b*).

Cover Site Turnover. Individuals showed a considerable degree of fidelity to specific cover sites from season to season despite loss of burrow integrity between use. For example, of 30 burrows used by transmitter carrying tortoises in 1974 between July and the beginning of hibernation, 83% of those burrows were used by the same individuals during the active season 1975 and some of the burrows did not remain intact between uses.

Over a period of a year loss of burrow integrity for the study area as a whole was as follows: collapse of moisture-laden roof soil due to winter rain, 3%; filling of burrows with soil as a result of tunnelling rodents, 3%; man, his horse, dog, and off-road vehicle, 2%; and predator excavation, 1%. Due to an exceptional flood during July, up to 48% of the burrows in some areas collapsed. Tortoises themselves were responsible for the collapse of some burrows. During lengthening of a burrow, pressure of the top of the carapace against slightly resilient *Larrea* roots penetrating the roof caused the roof soil to fragment and collapse.

As an example of cover site turnover, the 92 cover sites used by 6 transmitter bearing tortoises were examined. Seventy-two of the 92 cover sites were dug in soil and were of sufficient length as to be vulnerable to collapse or excavation. Over the year ≈ one-third were damaged or destroyed due to various causes and of these, 71% were either reopened, or the pallet lengths remaining were used as they were as pallets, or a new burrow was dug within a few centimetres of the damaged one. Burrows changed or destroyed by various causes apparently were opened with equal frequency.

Habitually used sites were common with several old damaged burrows adjacent to one showing recent use. In time the repeated improvement following collapse or predator excavation was responsible for aprons that extended 3 to 4 m from the present opening.

Beginning on the day following heavy rain and flooding (3 July 1975) the extent of burrow damage was assessed. Collapsed roof soil filled the openings to different degrees. It was not possible to see into many of them and these were probed to measure the remaining portion and to check for occupants. More than 50 burrows were obstructed completely and yet no tortoises were found behind or beneath the heavy, thick piles of collapsed soil. Neither were there any indications that a tortoise had emerged over or through the collapses. Possibly the tortoises' tendency to emerge from cover in response to rain had secondarily resulted in their avoidance of collapsing roofs (Burge, 1977*a*). Burrowing activity was evident within 2 days after the flood; within 10 days, the number of flooded burrows that were reopened and previously collapsed burrows that were improved was sufficient to prevent further accurate assessment of the flood damage.

Woodbury and Hardy (1948) reported that "summer holes" occasionally lasted from year to year, but the majority tended to become filled partly or completely between the seasons, weathering and use by other animals, particularly burrowing rodents contributing to the process.

At the Arden site, the use of collapsed burrow sites as starting locations for new burrows was a common tendency in spite of the apparent widespread suitability of the substrate for digging new burrows. It is possible that this behavior may be independent to some extent of an individual's fidelity to a specific site. Although not based upon controlled experimental findings, I have repeatedly observed that tortoises placed in more or less unnatural surroundings are attracted to dark and shaded areas at the base of vertical surfaces as well as low overhanging ledges.

Johnson et al. (1948) recount the following behavior of an individual [presumably free-living] that was released at midday in June: The tortoise started a burrow at an old badger hole. When moved again, the tortoise started another burrow by enlarging the 8 cm diameter opening of a rodent burrow. These instances and those that I observed were not examples of opportunistic use of ready-made, suitable cover and were therefore considered to be comparable in that respect to the use of collapsed tortoise burrows. I hypothesize that each of the previous examples were similar in that a visually perceived releaser or sign stimulus(i), i.e., some element or elements of "cover site opening appearance" elicited a locomotor response toward the stimulus. This phase of search and response may be referred to as appetitive behavior (Craig, 1918; Tinbergen, 1951). The tendency for tortoises to move toward and initiate digging at sites such as those which indicate previous burrowing activity may be of adaptive advantage by reducing the time that the tortoise remains exposed above ground.

The time required to dig a burrow of minimal adequate length and depth varies with the substrate among other factors. I observed the excavation time in only 1 instance: a burrow 45 cm long, dug in soil typical of the area, was completed in an hour. Berry (1972) observed that a burrow that covered the end of a tortoise could be completed in 45-90 min; however, construction usually required 120 min. McGinnis and Voigt (1971) demonstrated experimentally that a tortoise exposed to midday desert sun may reach critical thermal maximum within 15 min.

Monitoring the behavior of transplanted free-living and captive tortoises, Berry (1974*b*) observed the following: "Problems arose on 2 occasions for a transplant (T-006) and for captives when newly excavated burrows collapsed. Air and ground temperatures in late spring and summer usually exceed the maximum thermal tolerances of tortoises every day. There was not time for some of the introduced tortoises to construct other burrows to evade the heat before thermal stress ensued. Transplant T-006 was removed from the field twice under such situations, as were captives C-001 and C-009." Repeated collapses were a common result of burrowing attempts by the introduced captives (Berry, 1974*b*).

One may appreciate the margins within which the tortoise functions to support epigean activities, which must include cover-seeking behavior. The reuse of collapsed cover sites by tortoises on the Arden site may be an expression of a characteristic behavior having species survival value.

Use by Other Animal Species. A number of animal species were found using unoccupied tortoise burrows or sharing use with tortoises. One of the more common burrow associates was the wood rat, *Neotoma lepida*, a common rodent of the southern Nevada Creosote Bush Community. Distribution appears to be determined by suitable nesting sites, particularly those at the base of *Yucca* clumps, in rock crevices, and bank ledges (Bradley and Mauer, 1973).

On the Arden Study Area it was in the karstic cavities and at the base of *Yucca schidigera* that tortoises and *Neotoma* were associated. Middens at the bases of *Yucca* were only a few centimetres tall, usually lacking the quantities of twigs so common to middens in the dens. In using a *Yucca* site, a tortoise would wedge itself between the "apron" of the middens and the slight excavation under the *Yucca* made by the *Neotoma*. Shared use of this superficial cover was common; however, *Neotoma* was never found using or usurping a tortoise's burrow that was located under a *Yucca*.

The use of tortoises' soil burrows by *Dipodomys merriami* was apparently transient for most of the year. Rodent entry holes (1-3) might be located at various distances inside the burrow. Piles of excavated soil extended toward the burrow opening partially to completely filling the interior.

In 1 instance from 20-27 September female No. 94 had remained inside a burrow without egress. The burrow extended only 10 cm beyond the end of her carapace. As a result of rodent activity, over a period of 2 days, excavated soil was piled against the sides, the posterior of her shell nearly filling the opening. Following female No. 94's egress and return on the 29th, rodent tracks and soil piled during the night almost concealed her tracks and the toppled sticks. Female No. 94 continued to use the burrow until 1 October. Apparently neither rodents nor tortoise were much disturbed by the activity of the other.

Use of the inner walls of tortoises' burrows as a starting location for the rodents may have been advantageous to the rodent by increasing concealment or shading the opening; however, the proportion of rodent burrows located in tortoises' burrows was low. For both species the occurrence of burrows in mounded soil at the base of shrubs was common and the use of tortoise burrows by rodents may have been coincidental.

The Burrowing Owl, *Speotyto cunicularia* was observed directly or by sign on 18 occasions between October 1974 and August 1975. The burrows used ranged in length from 30-190 cm; some were in soil, and some in consolidated stream banks. From the amounts of owl feces and numbers of regurgitated pellets at each burrow, the duration of burrow use was estimated to have ranged from < 1 to 2 days. During December and January, there were several days of use of female No. 96's hibernation burrow. This was the only instance in which simultaneous use was observed.

On 26 February 1975, a sidewinder, *Crotalus cerastes*, was observed basking in the entrance of a den in which tortoises were hibernating. Impressions of the snake's ventral scutes were present inside the opening. Transient use of unoccupied tortoise burrows was made by *C. cerastes*; coachwhip, *Masticophis flagellum*; white-footed mouse, *Peromyscus* sp.; antelope ground squirrel, *Ammospermophilus leucurus*; jackrabbit, *Lepus californicus*; and a feral house cat, *Felix domesticus*. At the opening of smaller burrows, tracks of lizards were common and their use of burrows for escape cover was observed on numerous occasions.

Invertebrates commonly found in burrows occupied by tortoises included the black widow spider, *Latrodectus mactans*, other spider species, and the silverfish (Lepismatidae sp.).

An unidentified species of small moth in groups of 20-30 emerged from inside 2 of the dens when these were probed for tortoises. The flocks of moths were observed on several occasions from mid-July through the 1st week of August. The roach, *Arenivega erratica*, was occasionally observed just below the surface of the loose soil of the floor of the burrow opening. The soft tick, *Ornithodorus* sp., was twice collected from the superficial layer of burrow soil; however, these ticks were more commonly found on the tortoises (Burge, 1977*a*).

Invertebrates found inside unoccupied burrows included the darkling beetles *Eleodes* sp., and *Cryptoglossa*, a tarantula, *Aphonopelma* sp., and a wasp, the tarantula hawk, *Pepsis* sp., apparently hunting.

Most of the more commonly found species above were among those reported by Woodbury and Hardy (1948) to be associated to various degrees with tortoise burrows at the Utah site.

Berry (1974*b*) reported an instance in which the burrows of kangaroo rat, kit fox and tortoise intersected. The kit fox and the tortoise were in their respective burrows when observed. On the Arden Study Area, there were 6 burrow complexes similar in construction with 6-10 interconnecting channels. One complex was occupied by a family of kit foxes (*Vulpes macrotis*) and another by at least one tortoise.

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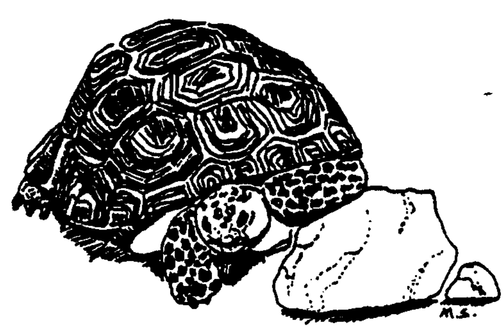

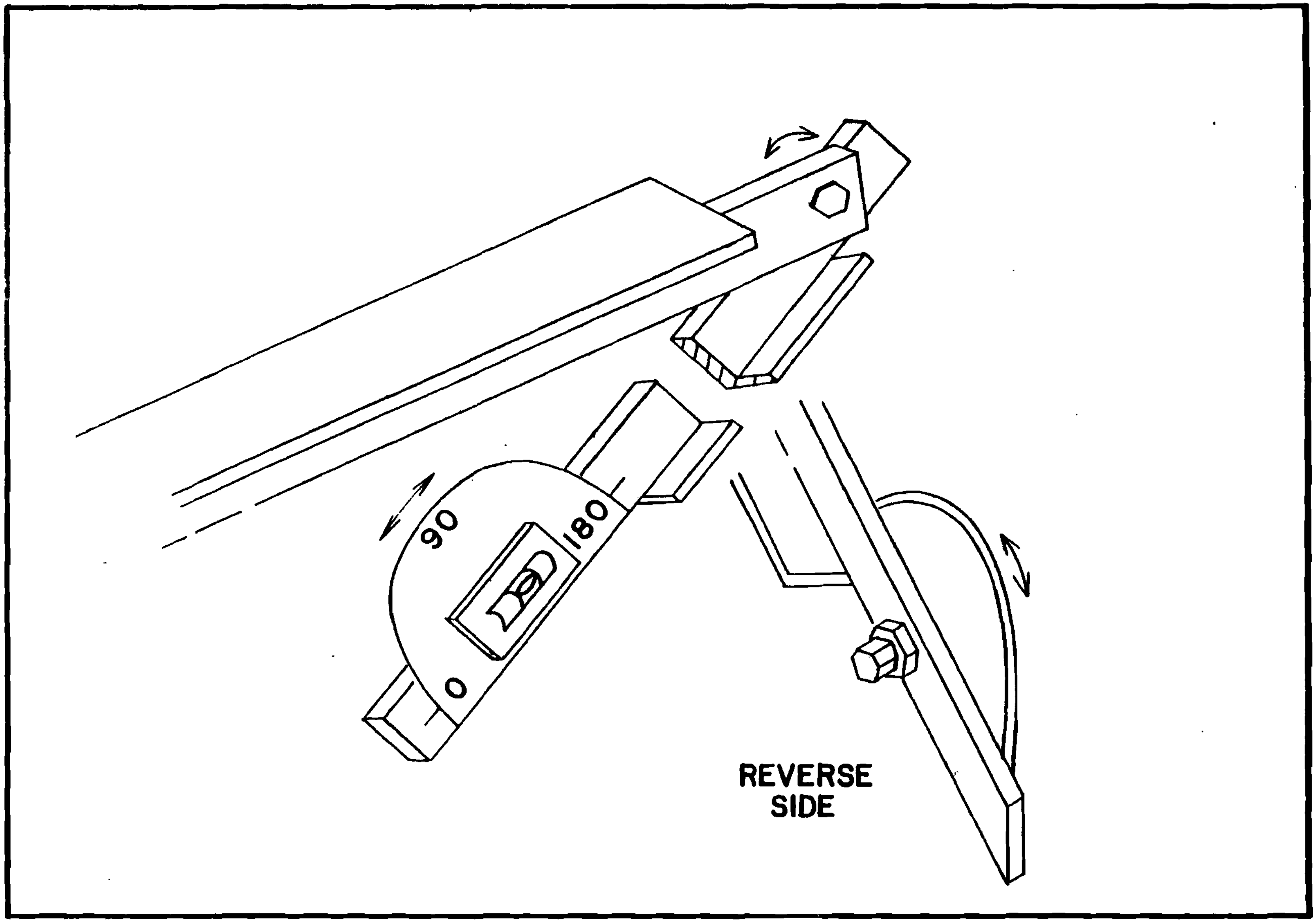

Fig. 1. Schematic diagram of inclinometer constructed for measuring slopes of burrow floors.

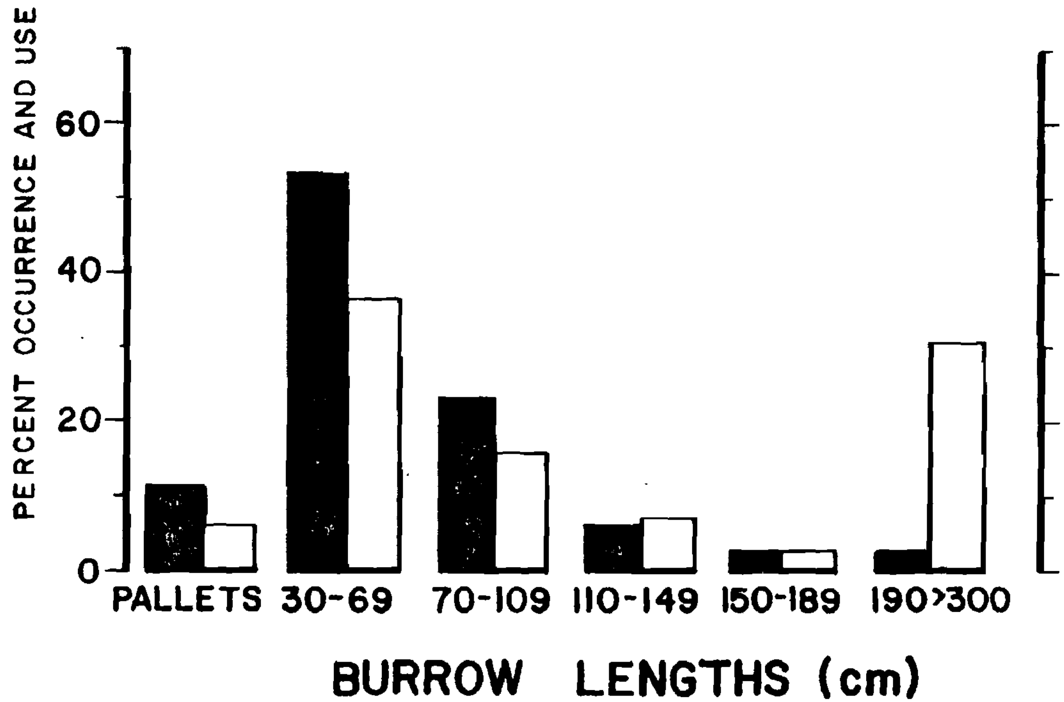

Fig. 2. Percent occurrence of pallets and burrows of different lengths, $N = 659$ (solid bars) and percent use - lengths occupied, $N = 1077$ (open bars) of captures in cover, March-October 1975; hibernating tortoises not included. Date from 6 tortoises bearing transmitters and 70 tortoises not bearing transmitters (carapace length = 180-296 m).

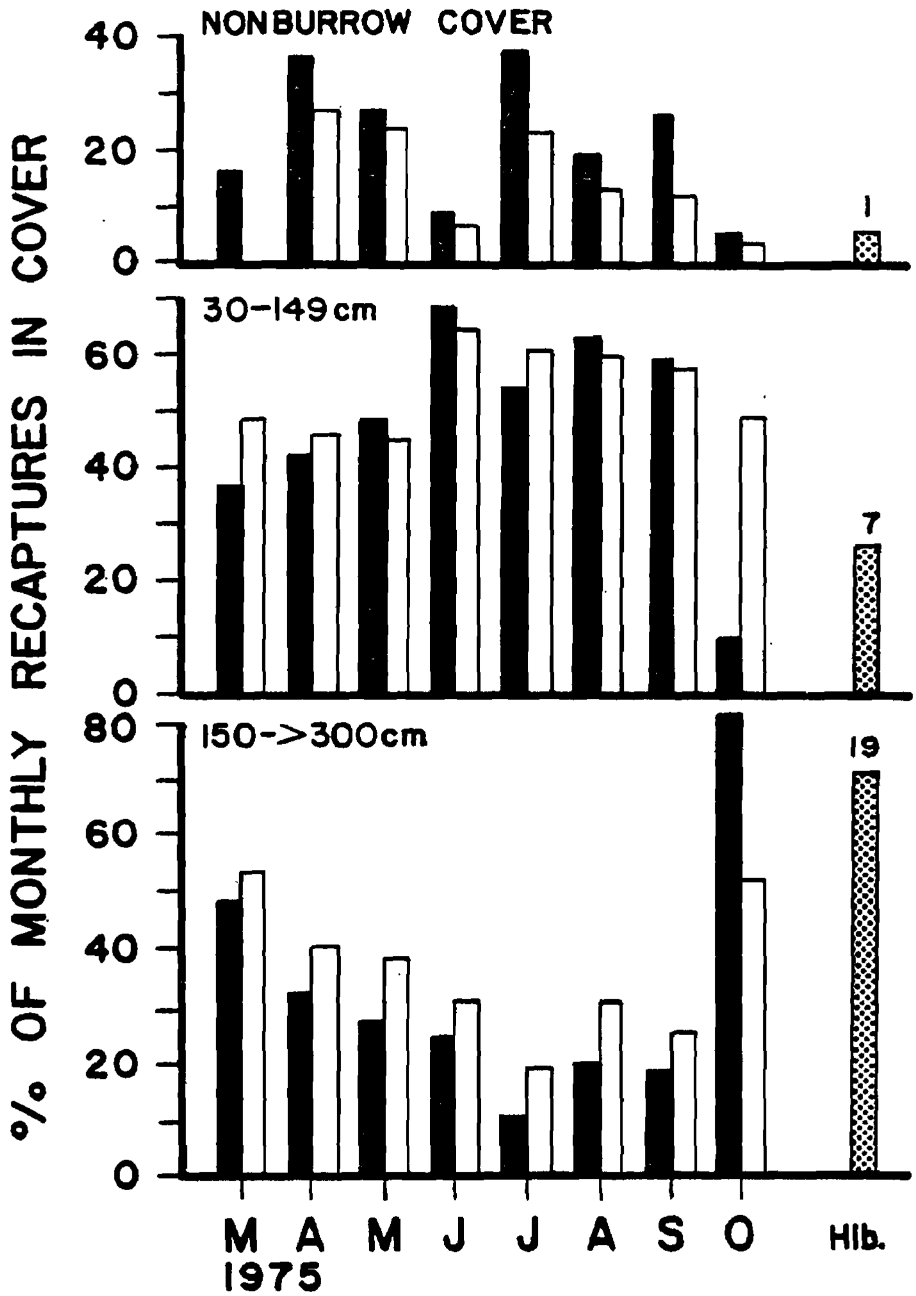

Fig. 3. Frequency distribution of monthly use of cover sites of different lengths following initial emergence from hibernation by 10 tortoises carrying transmitters (solid bars) and 70 not carrying transmitters (open bars) 180-286 mm ($N = 1593$). Use by hibernating tortoises from October 1974 through 20 April 1975 (stippled bars) with the number of individuals written above each bar.

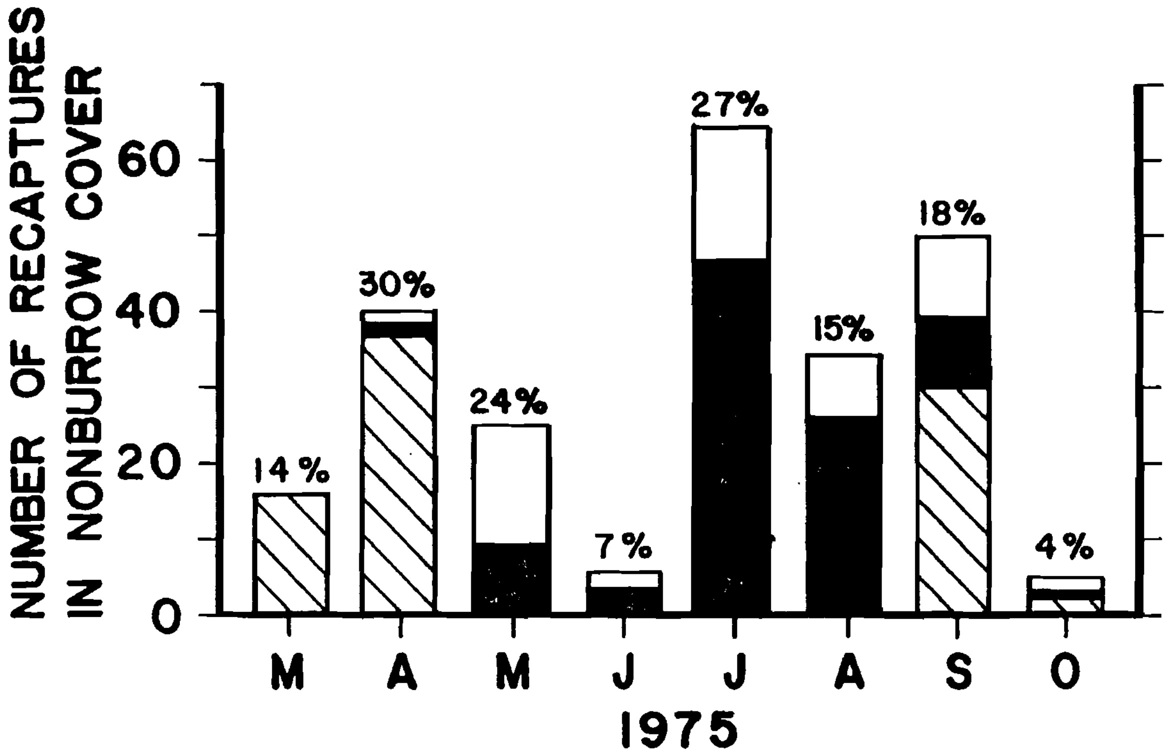

Fig. 4. Number of captures in nonburrow cover of tortoises 180-286 mm after initial emergence from hibernation. Data from 70 tortoises not bearing transmitters and 6 bearing transmitters monitored for a full active season. ▧ = use when 1 potential activity period (PAP) was operating; □ = use during midday retreat when 2 PAP/day were operating; and ■ = use at might when 2 PAP/day were operating. The percent of the captures in cover that each month's use represents appears above each bar ($N = 242$).

Table 1. Frequency of occurrence of cover sites under various plant species and occurrence relative to species density.

Species	Average[a] density per 6x30 m^2	Cover sites (*N*)	Percent species use	Plant height modal range (dm)	% use relative to density (8 spp)
Ambrosia dumosa	56.7	24	4	2-4	0.3
Larrea divaricata	16.0	390	59	5-10	16.6
Ephedra nevadensis	14.0	100	15	3-5	4.8
Krameria parvifolia	12.5	12	2	2-3	0.6
Dalea fremontii	2.2	4	1	5-10	1.2
Yucca schidigera	1.3	58	9	15-25	30.3
Acacia greggii	0.9	50	8	15-20	37.7
Lycium andersonii	0.8	10	2	2-3	8.5
Other species[b]	<1.0	13	2		

[a] Glen Bradley, unpublished data.

[b] 8 species, used < 4 times.

Table 2. Frequency distribution of facing directions of cover site openings at sites with 360° option. (*) significant at 5% (chi-square).

		Facing direction of opening								
		E	NE	N	NW	W	SW	S	SE	Total
Nonburrow cover	Under shrubs or cobbles	11	8	17*	7	7	7	9	4	70
Burrows	Under shrubs	61	83*	76*	48	50	46	59	45	468
	Exposed	27	28	24	15*	15*	14*	10*	18*	151

Table 3. Number and length distribution of burrows used by juveniles (45-179 mm carapace length) from May 1974 through October 1975. Burrows are shown in 2 groups divided according to observed or estimated tortoise lengths.

	Burrow length groups (cm)																
	6	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	
No. of burrows		12	17	26	18	16	22	8	4	4	2	2			2	1	
Range of opening size 9.5-15 x 6-10 cm (width x height)																	Total = 134
Tortoise lengths (95-179 mm)																	
No. of burrows	1*		4	10	12	5	3										
Range of opening size 5-9 x 4-5 cm (width x height)																	Total = 35
Tortoise lengths (45-110 mm)																	

* Hatchling

Table 4. Length, substrate type, and orientation of burrows used for hibernation by tortoises 180-286 mm carapace length. Tortoises using the same den are grouped.

Consolidated gravel

Tortoise No.	Sex	Minimum den length (cm)	Facing direction
94	♀		
161	♂	300	S
104	♂		
160	♂		
182	♀	300	S
183	♂		
190	♂	300	W
191	♂		
48	♂		
47	♀		
108	♂	300	S
211	♂		
202	♂		
214	♂	300	E
103	♂		

Soil

Tortoise No.	Sex	Burrow length (cm)	Facing direction
96	♀	190	E
209	♂	180	NE
46	♀	160	N
193	♂	150	NE
200	♂	90	SW
Unidentified		90	N
Unidentified		90	S
95	♀	90	N
199	♀	60	SW
194	♂	60	E
90	♀	25	S
(predominantly gravel)			
192	♂	90	SW

Table 5. Number of primary cover sites used by each of 6 tortoises bearing transmitters and the number and percent of cover sites used simultaneously or separately by other tortoises from September 1974 through October 1975. B = burrow, NB = nonburrow.

	B	NB	B	NB	B	NB	ΣB	ΣNB	Total
♂♂	No. 160		No. 108		No. 161				
No. in individual's group	14		18	1	17	3	49	4	53
No. used by others	12		13		13		38		38
Percent used by others	86		72		76		78		72
♀♀	No. 96		No. 94		No. 203				
No. in individual's group	11	1	16	4	20	5	47	10	57
No. used by others	8		12		14		34		34
Percent used by others	73		75		70		72		60

Quantitative Vegetational Data
of Desert Tortoise *(Gopherus agassizii)* Habitat
in the Lower Sonoran Desert

James L. Schwartzmann and Robert D. Ohmart

Fifty-two desert tortoises were marked in an approximately 2.6 square kilometre area over a 3-year period in the Picacho Mountains, Pinal County, Arizona. Eleven of them were radio instrumented to determine movements, burrow locations, and habitat preferences.

Six habitat types were delineated in the study area based on a preliminary analysis of perennial vegetation. The preliminary analysis was undertaken to evaluate what importance perennial vegetation may have as an indicator of suitable tortoise habitat in the Sonoran Desert. Stratified random sampling (18 transects 15 m long) using point-quarter and line intercept techniques were used to sample perennial vegetation (Cox, 1976).

Perennial vegetation was used to indicate potentially good tortoise habitat because its dominance, density, and species composition remain temporally more stable that annual vegetation (Lowe, 1964). This stability allows one to obtain reproducible results irrespective of the variable rainfall experienced in this area. The yearly biseasonal variability in rainfall does, however, affect annual growth dramatically (Sellers and Hill, 1975). In years of heavy winter rainfall, the annuals proliferate and become the temporary dominant vegetation with respect to species composition, cover, and density (Whittaker and Niering, 1965).

Table 1 lists the 6 areas sampled, including tortoise use, number of plants sampled, density, and percent cover of the types. Tortoise use in the 6 habitat types was based on both transients and permanent residents. Animals classified as transients either briefly entered or passed through the sampling areas, normally remaining less than 3 weeks. Many of the transients remained only 1 or 2 days in the habit types sampled. The resident animals remained in or immediately adjacent to the sampling areas for at least 3 months--often longer.

No permanent residents were found in habitat types 1, 4, and 5. Habitat types 2 and 3 had 1 permanent resident each. Habitat Type 6 had 8 permanent residents.

Habitat Type 1 had the lowest plant densities of all types sampled (Table 1). Creosote *(Larrea divaricata)* comprised 97% of all plants sampled. One tortoise was observed and it

Table 1. Some vegetation parameters of desert tortoise habitat in south-central Arizona.

Factor	Habitat type 1	2	3	4	5	6
Tortoise use	1	2	4	15	15	20
Number of plant species on sampling lines	2	5	6	6	10	6
Plant density per 10 m^2	1.09	2.70	6.78	6.17	14.80	16.10
Percent cover	12.44	14.07	17.09	23.23	33.90	17.77

remained only 1 day. What appeared to be several tortoise burrows were found but all were collapsed or partially filled with soil and showed no signs of recent activity. The percent cover value of 12% was also the lowest in Type 1.

Type 2 had a low plant density with only 2.7 plants per 10 m^2. Triangle bur-sage *(Ambrosia deltoidea)* comprised 55% of the relative density. There was 1 permanent resident and 1 transient in the area.

One resident and 3 transients were observed in Type 3. Plant density was moderate with 6.8 plants per 10 m^2. Triangle bur-sage had a relative density of 68%.

Over a 2-year period, habitat Type 4 had the highest fall (September-October) tortoise densities of any area. There were no permanent residents or burrows located. Radio-marked animals have migrated to the area from up to a kilometre away. They remained for only 2 weeks or less during the fall season only.

Type 5 had transient tortoises in the spring and fall. Sampling showed 10 plant species which was the nighest number of all the areas. The area also had the highest cover value of 34%. Triangle bur-sage comprised 80% of the total plant density of 14.8 plants per 10 m^2.

Habitat Type 6 had the highest number of permanent resident tortoises with 8. It also had the highest density value of all the areas sampled with 16.1 plants per 10 m^2. Two plants comprised 87% of this value: California buckwheat *(Eriogonum fasciculatum)* with 64%, and brittle-bush *(Encelia farinosa)* with 23%.

This preliminary analysis of vegetation in the Picacho area seems to indicate tortoise densities may be related to perennial plant density and species composition. Yearly production of annual grasses and forbs, soil friability, livestock grazing, and other factors provide unknown compensatory effects in determining potentially suitable tortoise habitat.

Type 5, for example, had high seasonal tortoise use, high plant density and high percent cover but lacked permanent residents, possibly due to lack of friable soil. Soil could be a compensatory factor because this area had a granite substrate with a thin layer of friable soil on the surface. This layer was far too shallow for a burrow. At thermally optimum times of the year the high plant cover (providing shelter and concealment) may compensate for the lack of burrow sites.

Type 1 was used very little by tortoises although it had deep sandy-loam soil in which tortoises could easily dig permanent burrows. Cattle graze this flat accessible area more heavily than the other 5 areas. Cattle are known to crush tortoise burrows and could potentially shift the plant species composition to a point that it was unfavorable to the desert tortoise (Berry, 1978).

Quantitative plant sampling techniques can be used at any time of the year in evaluating desert tortoise habitat when sampling perennial plants. The perennial plants are more indicative of the ecological parameters of an area than the annuals from year to year (Duke, 1976).

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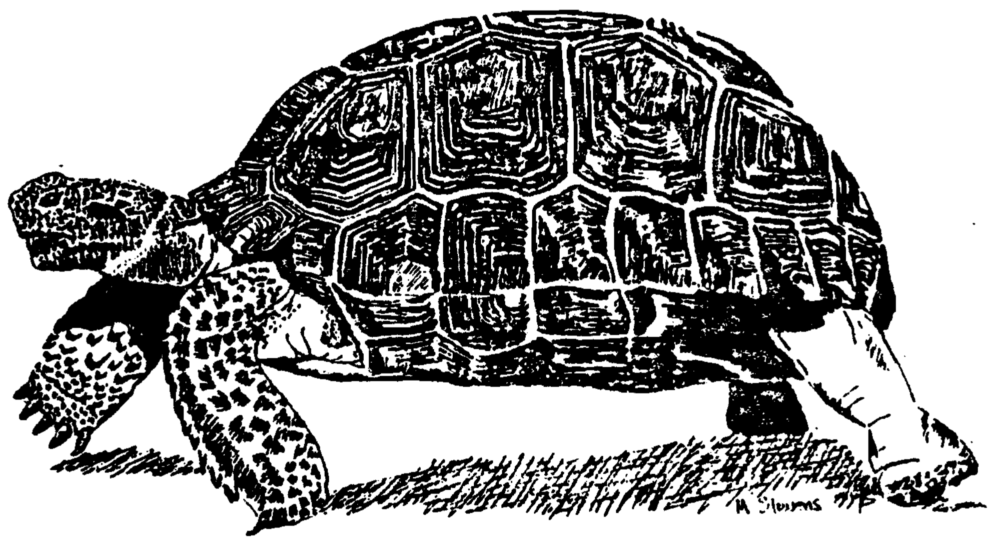

Historical Range Use of the Beaver Dam Slope, Arizona, and Its Possible Effects on a Desert Tortoise Population

Judy P. Hohman and Robert D. Ohmart

A 2-year study of desert tortoises *(Gopherus agassizii)*, on the Beaver Dam Slope, Mohave County, Arizona, was initiated in 1977 with financial support from the Bureau of Land Management. The purpose of the study was twofold: (1) to obtain biological data on the tortoise including information on population dynamics, movements, food habits, and reproduction, and (2) to research historical human activities on the Slope which may have been deleterious to the desert tortoise.

Historical activity concerning past livestock grazing practices on the Arizona Slope, and information regarding plant species composition and density from early and present surveys will be examined along with tortoise shell remains data from the study area. Biological data on the Arizona Slope population of the desert tortoise will be published after completion of the study in 1978-1979.

Historical Land Use Practices. Livestock were first grazed on the Slope in Arizona in 1849. The California (or Old Spanish) Trail, which was the main route between Santa Fe, New Mexico, and California, crossed the Slope approximately at the present site of U.S. Highway 91. Wagon trains using the California Trail herded a remuda of horses as replacement mounts and to pull wagons, and hundreds of cattle to be used as a fresh meat source (Corbett, 1952). Each time a wagon crossed the Arizona Slope the area adjacent to the Trail was grazed and trampled by livestock.

Livestock ranching was introduced to the Arizona Slope in the late 1850s when the Beaver Dam—Littlefield area was settled (Cross, 1975). Agriculture was generally confined to the alluvial flood plain along the Virgin River and Beaver Dam Wash. By 1870 private cattle herds as well as wild herds were well established on the Slope (Brooks, 1973). Conflicting reports concerning the status of cattle on the Slope during the 1870s are in the literature; Crampton (1972) claimed that cattle herds along the Virgin River had increased, but Wright (1968) reported that only a paucity of livestock were grazed on the Slope during the 19th century. Both public domain and community allotments were grazed by cattle.

The first decade of the 20th century was a period of tremendous growth for the cattle industry. There were estimates of more than 100,000 cattle in Mohave County, more cattle than the range could support (Mohave County Miner, 1941). Also during this period the sheep grazing industry was established on the Slope. The Arizona portion of the Slope was used as sheep winter range and the Utah portion was used as a summer range (Wright, 1968).

With the passage of the Taylor Grazing Act in 1934 the General Land Office (now called the Bureau of Land Management) was established to conserve and improve rangelands, stabilize the livestock industry and halt the destructive use of public lands. In 1935 the livestock owners of northwest Arizona organized Arizona Grazing District I under the Taylor Grazing Act. This district included the Arizona Slope. For the first time livestock operators were required to submit grazing applications for specific numbers of livestock to the General Land Office. The number of livestock requested for the first year was in excess of the carrying capacity of the land (Wright, 1968).

The first livestock grazing limits for the Slope were established in 1936 by the General Land Office. The Arizona Slope was granted a 400 cattle year load or 4800 animal unit months (AUM). Grazing capacities for the Slope were re-evaluated in the early 1940s. Livestock were now grazed on a seasonal basis from October through May. Prior to that, cattle could be grazed year around. Sheep grazing predominated in late winter and early spring and cattle grazed the range fall through spring. In 1941, 2730 AUM for sheep were recorded for the Beaver Dam Slope allotment in Arizona or 4550 sheep per month for the 3-month grazing season. Fencing of the Slope was begun at this time to separate sheep and cattle.

The cattle grazing season was shortened by 1 month and the sheep grazing season was reduced to 45 days in 1952. In 1969 sheep grazing was terminated on the Arizona Slope.

During drought years the number of livestock on the Slope was often reduced or eliminated. This was reported for 1942, 1950, 1957, and 1965. For the 1950 drought the literature reports that all livestock were removed from the Arizona Strip, which includes the Arizona Slope (Wright, 1968), yet grazing records indicate that 716 AUM for cattle were allowed for the Slope.

The current grazing plan for the Arizona Slope allotment was initiated in 1970 by the now Bureau of Land Management. The allotment currently has 3 pastures. Pasture 1 is grazed December through February. Pastures 2 and 3 are grazed 1 March to 15 May on a rotational basis. For 1977 the AUM recorded for cattle were 864 or 157 cattle present for the 5½-month grazing season. This was a substantial reduction when compared to 1942 when 838 AUM for cattle and 2730 AUM for sheep were recorded. The 1942 data are equivalent to 129 cattle present for the 6½-month grazing period.

Vegetation Changes. One possible result of intensive livestock grazing on the Beaver Dam Slope would be a change in the flora of the area. Evidence of vegetational change was recorded as early as 1864. The Paiute Indians of the area were angered because the seeds which they used as a major food source were no longer available because livestock had depleted the plant supply (Corbett, 1952).

Information gathered during U.S. Geological Surveys of the Arizona—Nevada and Arizona—Utah borders in 1870 and 1901 indicated that perennial bunch grasses were relatively abundant at that time; however, species compositions were not given. The 1912 and 1921 Arizona Slope surveys frequently mentioned various forms of cactus, suggesting that these plants may have been more numerous in the past. All 4 surveys confirmed that creosote bush *(Larrea divaricata)*, burro weed *(Ambrosia dumosa)* and Joshua tree *(Yucca brevifolia)* were the major perennial shrubs on the Arizona Slope. Also the current range of the Joshua tree, found at elevations above 646 m differs slightly from survey reports which recorded it as below 615 m in some areas.

In 1945, Hardy listed the dominant perennial shrubs, grasses and forbs of the Slope. Common perennial shrubs included: burro weed, Joshua tree, winter fat *(Ceratoides lanata)*, and little-leaved ratany *(Krameria parvifolia)*. Perennial grasses that were usually found "growing in the shelter of a shrub" were "clumps of" big galleta *(Hilaria rigida)*, Indian rice grass *(Oryzopsis hymenoides)*, and bush muhly *(Muhlenbergia porteri)* (Hardy, 1945:87). These were "common grasses of the area" (Hardy, 1945:87). Abundant spring annuals were milk vetch *(Astragalus nuttalianus* var. *trichocarpus)*, foxtail brome *(Bromus rubens)*, plantain *(Plantago insularis)*, and filaree *(Erodium cicutarium)*. Filaree was probably introduced to Mohave County, Arizona, from California by a herd of sheep in the late 1870s (Arizona Republic, 1952). It eventually became established on the Slope in Arizona and Utah.

A recent study of the flora of Beaver Dam Mountains and vicinity still listed the dominant plant community of the Beaver Dam Slope as a creosote—burro weed community (Higgins, no date). Twenty-one annual and perennial grasses have been found on the Arizona Slope of which 8 are exotic (Table 1). These 8 introduced grasses plus the introduction of filaree by livestock indicate that changes in plant species composition have occurred on the Slope since the area was first settled in the late 1850s.

Additional evidence supporting the concept of changes in plant species densities can be found by comparing vegetational observations made by Hardy (1945) and Coombs (1974) for the same location on the Beaver Dam Slope. As previously stated Hardy (1945) reported that bush muhly and Indian rice grass were common perennial grasses of the area with winter fat listed as a common shrub. Coombs (1974) found that bush muhly and Indian rice grass were present in lower densities than described by Hardy 30 years earlier and that density of winter fat was sparse.

Records from the 1870 and 1901 U.S. Geological Surveys, which indicated past abundance of perennial grasses on the Slope, combined with Hardy's (1945) and Coombs' (1974) observations strongly support the thesis that perennial grass densities were higher in the past on the Beaver Dam Slope than at present. Coombs (1974) also noted that the density of winter fat had decreased over the last 3 decades. This information plus the spread of many introduced species to the Slope strongly indicates that both plant species composition and density on the Beaver Dam Slope have changed since the area was first grazed in the mid-nineteenth century.

After over 100 years of livestock grazing on the Arizona Slope, density estimates for the desert tortoise show a downward trend. Woodbury and Hardy (1948) calculated a density of 58 tortoises/km^2 for the Utah Slope study site, whereas recently, Coombs (1977) estimated only 10 tortoises/km^2. Our data are preliminary and 1977 was a dry year which probably curtailed above ground activity, but present density estimates are near those reported by Coombs.

The Utah population of tortoises which is only a few kilometres north of our study area revealed a very high adult to nonadult ratio--9.05:1.0 (Woodbury and Hardy, 1948) and 2.25:1.0 (Coombs, 1974). This large ratio disparity is believed characteristic of disturbed populations.

<u>Desert Tortoise Shell Remains</u>. As of 30 September 1977 a total of 87 tortoise shell remains has been found within the 5.18 km^2 which serves as our study area. All shells were classified as to estimated time since death using criteria presented by Berry (1976). Approximately 20 of the 87 shells were from tortoises dead $<$1 year, 37 were from animals dead 1 to 2 years, 23 were from animals dead $>$2 years (Table 2). Estimated mortality for the Arizona Slope population may be as high as 20%.

Examination of age classes of tortoise shell remains showed that 49 were from adults, 34 were from nonadults, and 4 were too far decomposed to determine (Table 3). Male and female adult shells were similar in number. Coombs (1977) has suggested that predation may be high for all age classes of tortoises in Utah. For the Arizona Slope 43 of the 87 shells showed some evidence of predation (Table 4). Whether predation was the primary cause of death for these animals cannot be determined from shell examinations. Other possible mortality factors include aging, starvation, disease, malnutrition, and hyperthermia. Examination of historical livestock use of the Slope as rangeland plus changes in plant densities and species composition indicate that adequate nutritional forage for tortoises may be lacking because of past overgrazing practices. Ross Hardy *(personal communication)* firmly believes that the decline of tortoise numbers on the Slope in Utah was directly related to overgrazing. If true, once a tortoise is in a weakened condition from lack of adequate food resources it may succumb from a proximate mortality factor such as predation or disease. Whatever the cause or causes of high mortality were, if this trend continues, coupled with much lower natality, the populations in the area may be headed toward extinction.

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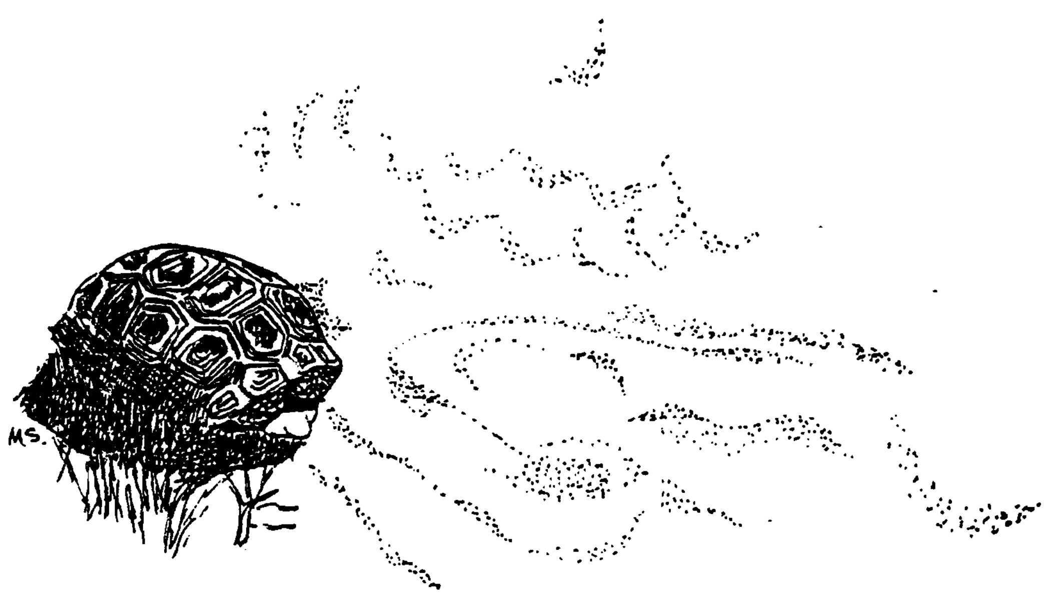

Table 1. Grasses on the Beaver Dam Slope, Arizona[1].

Fluff grass	*Erioneuron pulchellus*
Orchard grass	**Dactylis glonerata*
Foxtail brome	*Bromus rubens*
Cheatgrass	*Bromus tectorum*
Brome	**Bromus catharticus*
Brome	**Bromus trinii*
Fescue	*Festuca octoflora*
Wheatgrass	**Agropyron elongatum*
Barley grass	**Hordeum stebbinsii*
Schismus	**Schismus barbatus*
Schismus	**Schismus arabicus*
Oat	*Avena fatua*
Beardgrass	**Polypogon monspeliensis*
Threeawn	*Aristida glauca*
Indian rice grass	*Oryzopsis hymenoides*
Dropseed	*Sporobolus contractus*
Bush muhly	*Muhlenbergia porteri*
Big galleta	*Hilaria rigida*
Galleta	*Hilaria jamesii*
Sixweeks grama	*Bouteloua barbata*
Johnson grass	*Sorghum halepense*

*Introduced

[1]Higgins, no date.

Table 2. Estimated time since death of desert tortoises remains, Beaver Dam Slope, Arizona.

Stage	<1 year	1-2 years	2-5 years	>5 years
Adult	6	23	19	1
Subadult	11	6	2	2
Immature	2	2	2	...
Young	1	1	...	...
Hatchling	...	1	...	3
TOTAL	20	37	23	7

Table 3. Age classes of tortoise shell remains within 2 study sites on Beaver Dam Slope, Arizona.

	Sex			
Stage	♂♂	♀♀	Unknown	Total
Adult	22	25	2	49
Subadult	3	9	9	21
Immature	...	...	7	7
Young	...	...	4	4
Hatchling	...	...	2	2
Unknown	...	...	4	4
				87

Table 4. Tortoise shell remains with evidence of predation, Beaver Dam Slope, Arizona

Stage	Sex			Total
	♂♂	♀♀	Unknown	
Adult	15	9	1	25
Subadult	1	4	6	11
Immature	...	...	3	3
Young	...	...	2	2
Hatchling	...	...	2	2
				43

Desert Tortoises and Off-Road Vehicles: Do They Mix?

R. Bruce Bury

Abstract

High intensity usage of off-road vehicles (ORV) in the western Mojave Desert occurs in many areas occupied by the desert tortoise. In 1974-1975, I found 18 tortoises on 8 unused areas (2 ha each) but only 5 individuals on 8 ORV-used sites. In 1976-1977, I censused two 25-ha sites near Barstow: 34 tortoises were in the control area but only 15 occurred in the ORV-used area. The estimated tortoise biomass was 3.4 kg/ha in the unused area and 0.5 kg/ha in the ORV-used area.

There were 171 burrows (51% actively used) in the control; only 35% of the 62 burrows in the ORV area were active. Adult tortoises apparently are removed or killed in the ORV area. ORVs also collapse burrows, destroy vegetation, and cause indirect mortality of tortoises. Operation of off-road vehicles in the western Mojave Desert may be a major factor in the decline of these tortoise populations.

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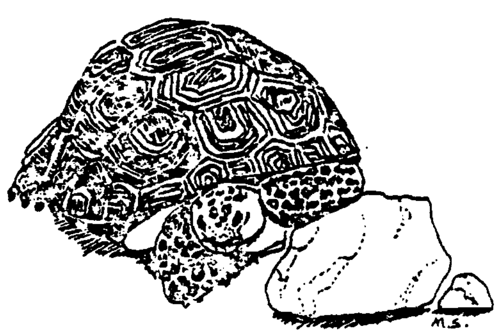

The Effects of Roads on Desert Tortoise Populations

Lori Nicholson

The effect of vehicular travel upon paved roads on the desert tortoise *(Gopherus agassizi)* in the Mojave Desert, California, was investigated from September through November 1977. Ten study sites were selected adjacent to paved roads. The location of each road, year paved, number of lanes, and traffic volume (Average Daily Traffic-vehicles/day) are as follows:

1) Highway 58, west of California City Boulevard; 1946; 2 lanes; ADT 4950 (1976).

2) Neuralia Road, north of Phillips Road; 1955; 2 lanes; ADT 150 (1977).

3) Redrock—Randsburg Road, 6 kilometres west of Randsburg; 1935; 2 lanes; ADT 140 (1977).

4) Highway 395, north of Twenty-Mule Team Road; 1933; 2 lanes; ADT 2250 (1976).

5) Highway 95, north of Turtle Mountain Road; 1933; 2 lanes; ADT 1100 (1976).

6) Interstate 15, 10 km south of Barstow; 1961; 4 lanes; ADT 17700 (1976).

7) Interstate 40, Ward Valley; 1931; 4 lanes; ADT 6000 (1976).

8) Interstate 40, east of Daggett Interchange; 1965; 4 lanes; ADT 7000 (1976).

9) Barstow Road, 19 km south of Barstow; 1953; 2 lanes; ADT 340 (1976).

10) Shadow Mountain Road, 2 km east of Highway 395; 1974; 2 lanes; ADT 285 (1977).

Vegetation and topography throughout each site were nearly homogeneous. All sites were dominated by creosote bush *(Larrea tridentata)* and burrobush *(Ambrosia dumosa)*, however other perennial species, percent vegetative cover, soils, and human impacts varied between sites. Four transects, 4.83 km long by 9.14 metres wide, were walked parallel to each road at distances of 91.4, 365.6, 804.3, and 1608.6 metres, respectively, from the road. All observed tortoise sign (burrows, shells, live individuals, scats, etc.) within each transect area were recorded on a Bureau of Land Management standard tortoise survey form. The total number of sign per transect provides a relative measure of tortoise density.

Generally, the data indicated an increase in tortoise sign with increasing distance from the road. The increase in sign averaged approximately 8X from the 91.4 to 1608.6 metre transects. At 9 of the 10 sites there was an increase in sign up to the 804.3-m transect. At 6 of the 9 sites there was an increase from the 804.3- to the 1608.6-m transects, at 2 a slight decrease in sign, and at the other site, Barstow Road, sign number decreased sharply at the 1608.6-metre transect. The sharp decline was attributed to sampling error, which was probably caused by very low tortoise densities adjacent to Barstow Road. An increased sampling area may be required to adequately measure very low number of sign. Tortoise sign at the remaining site, Shadow Mountain Road, increased with increasing distance from the road except at the 804.3-m transect, which intersected an area receiving excessive off-road-vehicle use. This may have caused a reduction in tortoise sign in the area. Excluding Barstow and Shadow Mountain roads because of the aforementioned biases in the data, the correlation coefficient for data from 8 sites was .87. At these 8 sites, the average difference in number of sign between the 2 transects farthest from the road was less than the average differences between other transects, indicating that tortoise densities beyond the 804.3-metre transect may become relatively constant. The decrease in tortoise densities adjacent to roads presumably is a result of mortality via vehicular collision or from removal by passing motorists.

Of all road parameters examined (age, width, and traffic volume) the most distinctive trends in sign increase were among sites adjacent to roads paved either relatively recently or long ago. Sign increase of 4 roads paved between 1931 and 1935 was gradual and nearly linear. The correlation coefficient for these roads was .95. In comparison, 3 roads paved in 1961, 1965, and 1974 exhibited a sharp increase in sign from the 91.4- to 365.6-metre transects, and beyond the 365.6-metre transect there was a significantly lesser increase. These 3 new roads had a correlation coefficient of .73, probably lower because the relationship was more curvilinear. Apparently the newer roads have not existed long enough to affect tortoises more than 0.4 km away, whereas the older roads may have reduced tortoise numbers up to 2 about 2 km away.

These data indicated that paved roads and vehicular traffic have a detrimental effect upon tortoise populations within about a kilometre of a road. Considering the many kilometres of paved roads and additional kilometres of unpaved roads throughout desert habitats occupied by tortoises, roads may be a major factor contributing to the reduction of tortoise populations.

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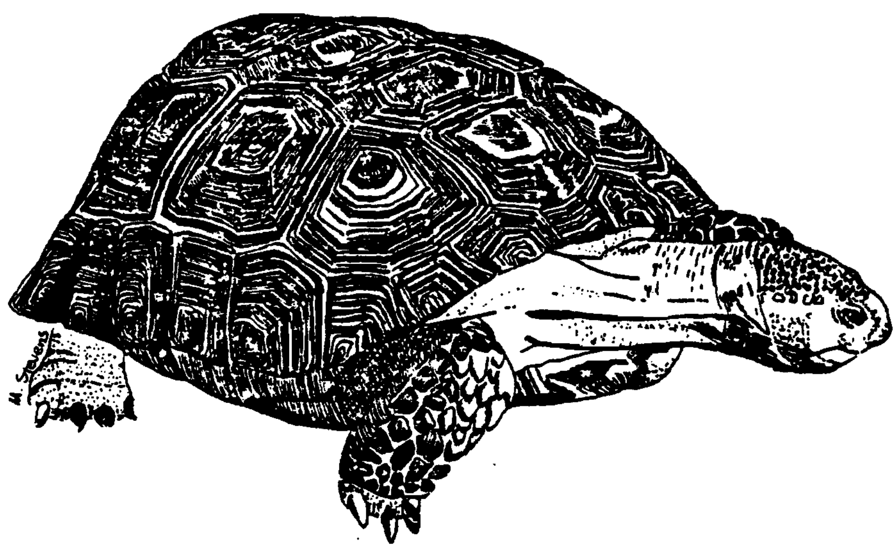

Survival of Captive Tortoises Released in California

James C. Cook, Ann E. Weber, and
Glenn R. Stewart

During June of 1977, 33 desert tortoises, *Gopherus agassizii*, were released into the Mojave Desert after completing the California Department of Fish and Game's Rehabilitation Program. As of May 1978, 72% have survived. Weight changes in 11 of the tortoises after 1 year show an average gain of 13 g. During May of 1978, 18 additional tortoises were released. After 2 weeks at liberty, all have survived.

The removal of desert tortoises from their natural habitat is a continual drain on the populations located in accessible areas. Miller (1939) noted that "there are many specimens picked up by the curious motorist, thrown into the back of the car, and carried home." In addition, the pet trade has removed large numbers from the native populations. Since 1939, it has been illegal to sell a desert tortoise in the state of California. In 1961, regulations made it unlawful to remove tortoises from their native environment. Possession of a tortoise was prohibited in 1972, unless the tortoise was legally acquired before the effective date of the law; a permit must be obtained for such tortoises. As a result of this ruling, many people chose to release their tortoises rather than obtain permits. Desert tortoises have been released in large numbers by zoos, museums, and the California Department of Fish and Game, as well as private individuals (C. V. Maris and R. McAdams, *personal communication*).

Studies done by Crooker (1971), McCawley and Sheridan (1972), and Bryan and West (1972) on the survival of released pet tortoises in California proved to be inconclusive. However, studies done by Dr. K. H. Berry on captive releases showed 100% mortality (Kristin Berry, *personal communication*). Based on these and additional observations, the California Department of Fish and Game developed a "rehabilitation" program for captive tortoises (St. Amant, 1977) to increase their ability to cope with desert conditions. The rehabilitation program begins with the inspection of all tortoises turned in to the Department at the Fish and Game field station at Chino. The desert tortoises are either adopted out or transported to the Palm Desert Living Reserve (Quarterway House), where diseased tortoises are treated and healthy tortoises released in an enclosure for additional observation. Human contact is reduced to a minimum, and water and succulent foods are limited. After a suitable period, the tortoises are moved to Fort Soda

(Halfway House) where desert conditions prevail and human contact is further reduced. After a full year at this site, the tortoises are considered "rehabilitated".

The first "graduates" of the rehabilitation program were released in June 1977 and a second group in May 1978. The survival of the released tortoises is being monitored as part of an evaluation of the rehabilitation program.

METHODS

A release site was chosen 40 kilometres east of Lancaster, California, adjacent to Saddleback Buttes State Park. The area is a Joshua tree *(Yucca brevifolia)* woodland with an understory of creosote bush *(Larrea tridentata)*, burrobush *(Ambrosia dumosa)*, and various grasses. It had been used previously as a release site for unwanted tortoises (C. V. Maris and R. McAdams, *personal communication*), so it was felt that additional releases would not impact a "natural" population.

Prior to release, all tortoises were X-rayed and checked for disease. Those suffering mild respiratory infections were treated for 1 week with antibiotic injections (Combiotic®, Squibb, Inc.). Weights, measurements, and identifying marks were recorded for each tortoise, and each had an individual number painted on the rear of the carapace. Age classes were based on Berry (1976).

Twenty-six tortoises were released on 13 June 1977 and 7 more on 2 July 1977. The tortoises were released at 12 evenly spaced points in a 2.59-square-kilometre area. Of the 33 tortoises released in 1977, 21 had completed the rehabilitation program, 7 were from the Quarterway House at Palm Desert, and 5 were from a holding facility in Bakersfield (Table 1). Radio transmitters were affixed to 14 (6 males, 8 females) of the released tortoises as described by Schwartzmann and Ohmart (1977).

Two groups of 9 tortoises were released in 1978 in an adjacent 1.29-square-kilometre area, one on 13 May and another on 20 May. All 18 of the tortoises released in 1978 had completed the rehabilitation program (Table 2). Of these, 5 carried transmitters (3 adult males, 2 adult females).

RESULTS AND DISCUSSION

During the past year, each transmitter-bearing tortoise was located and observed 45 times, and attempts were made repeatedly to locate the tortoises not bearing transmitters.

As of 27 May 1978, 7 of the 33 tortoises released in 1977 are known to have died (Table 3). Four of the dead tortoises carried transmitters. Thus the survival rate may be calculated at between 72% and 79%. No tortoises from the 1978 group are known to have died.

Six of the 7 deaths during 1977 were due to lethal body temperatures. Three tortoises died the 1st day, being unable to find suitable protection from the sun. Three more perished within 2 weeks of release. These deaths may have been prevented by release earlier in the year. There was some evidence (tracks, feces, sightings) of displacement by native tortoises (Patterson, 1971). For example, a released female moved into an existing burrow. Ten days later, a wild female tortoise was observed using the burrow and the released captive had moved to another unoccupied den to the southeast. The 7th death was 10 months after release, in the spring following emergence from hibernation.

Eleven of the tortoises released in 1977 were weighed after nearly 1 year in the desert. Seven of the 11 showed a gain in weight and only 2 had lost weight (Table 4).

While we are hesitant to draw conclusions at this time, we do feel that release as soon as possible after emergence from hibernation (when temperatures are mild in the desert and foliage is still green) and release in the early afternoon, rather than the morning hours (all 1st day deaths were morning releases), afford tortoises the best survival chances. Also, we are encouraged by the survival of at least 72% of the released tortoises. If weight gain is an indicator of health, and other more subjective observations, such as an increase in "normal" behavior, can indicate adaptation to environmental conditions, then the desert tortoise rehabilitation program may be achieving its goal of readapting "pet" tortoises for life in the desert.

ACKNOWLEDGMENTS

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Table 1. Tortoises released in 1977.

Tortoises completing rehabilitation program	
10	adult ♂♂
9	adult ♀♀
1	subadult
1	juvenile
Tortoises from Quarterway House	
3	adult ♂♂
2	adult ♀♀
2	subadults
Tortoises from Bakersfield holding facility	
5	juveniles

Table 2. Tortoises released in 1978.

Tortoises completing rehabilitation program	
13	adult ♂♂
4	adult ♀♀
1	juvenile

Table 3. Known tortoise deaths.

Tortoises completing rehabilitation program	
1 adult ♂	first day
1 adult ♀	first day
1 adult ♀	2 weeks
2 adult ♂	2 weeks
Tortoises from Quarterway House	
1 adult ♀	first day
1 adult ♀	10 months

Table 4. Weight changes in 11 tortoises after 1 year.

Carapace length (cm)	Weight change (g)
24.13	+ 39
25.65	+ 36
21.08	+ 36
25.40	+ 24
24.64	+ 13
28.19	+ 5
26.42	+ 3
27.43	0
24.38	0
22.10	- 5
27.94	- 9

Livestock Grazing and the Desert Tortoise

Kristin H. Berry

The desert tortoise *(Gopherus agassizi)* is the largest reptilian herbivore in the Southwest. Certain of its life history characteristics and behaviors render it suspectible to environmental changes caused by sheep and cattle grazing. These include its low reproductive potential, long period between hatching and age at first reproduction, low survival of young, low population turnover, reliance on annual and perennial grasses and annual wildflowers for food, limited periods for feeding, small home range size in females and young individuals, and burrowing habits. Sheep and cattle have the potential for removing forage, damaging or destroying perennial shrubs used for shelter, and crushing burrows and small tortoises, especially where grazing is intensive. Grazing induced declines in tortoise populations may be difficult to detect in initial stages and once recognized, slow to reverse. However, potential problems are detectable with examination of natality and mortality rates, sex ratios, and size-class structures of populations. Problems with some grazing systems are outlined, and recommendations for future research are made.

The desert tortoise occurs throughout the deserts of southern California, southern Nevada, extreme southwestern Utah, western and southern Arizona, and south into Mexico. During the last 50 years biologists, reptile collectors, and desert residents have reported declines in populations throughout the geographic range in the United States. Declines have been attributed to collecting, vandalism, and habitat destruction through agricultural and urban developments, livestock grazing, mining, and off-road vehicle use. Unfortunately there is little documentation of the effects of these human-related activities on specific tortoise populations.

Livestock grazing occurs throughout much of the geographic range of the desert tortoise in the United States. Although controlled studies on the effects of grazing on the tortoise are lacking, domestic sheep and cattle can have a deleterious effect by causing changes in tortoise habitat through reducing forage, trampling shelter and cover sites, and, in some instances, trampling tortoises.

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This paper addresses a number of the problems related to managing livestock grazing in desert tortoise habitat: how the life history characteristics and behaviors of the desert tortoise contribute to making the species sensitive to livestock grazing, the extent of livestock grazing within the geographic range of tortoises, the effects of livestock grazing on tortoises, problems with livestock grazing systems in tortoise habitats, and future research needs.

THE SENSITIVITY OF DESERT TORTOISES TO LIVESTOCK GRAZING

Knowledge of the life history patterns and behaviors of desert tortoises is a prerequisite to understanding the potential effects of livestock grazing on their populations and habitats. Important life history characteristics are: tortoise growth rates, age and size at first reproduction, life span, mortality rate, and recruitment rate. Pertinent behavior patterns include daily and seasonal activities, feeding habits, home range size, extent of movements, and burrowing habits.

Growth Rates, Life Span, and Age at First Reproduction. Because tortoises are long-lived and few scientists undertake research projects that span decades, there are few data available on growth rates, age at first reproduction, and life span in wild populations. Estimates reported here are based on personal observations and the combined data from several studies.

Tortoises are long-lived and may live 50 to 100 years in the wild under natural conditions (Woodbury and Hardy, 1948; Hardy, 1972). Even these estimates may be conservative because close relatives, such as the common European tortoise *(Testudo graeca)* and Aldabra giant tortoise *(Testudo gigantea)*, are known to live over 100 years in captivity (Schmidt and Inger, 1957).

Wild tortoises probably require 15 to 20 years to reach sexual maturity or age at first reproduction. These estimates are derived from size at first reproduction and average time to reach that size. I estimate the size at first reproduction to be 215 to 220 mm in carapace length.

Four wild tortoises have been observed during egg laying. They ranged in size from 220 to 235 mm in carapace length (Berry, 1974*b*; Burge and Bradley, 1976; Burge, 1977*b*). Additional data are available from Woodbury and Hardy (1948). In the 1940s they marked a female 217 mm in length. When recaptured 25 years later, she had increased in length by only 1 millimetre (Hardy, 1972). She was probably adult at the

217 mm size. Burge (1977*a*) has suggested that females 206 mm and larger in southern Nevada may be reproductively active because they show shell wear typical of older females. Camp (1917) reported egg laying by an individual 208 mm long. However, for this review females $\geq$ 215 mm will be considered reproductively mature. In a 10-year study of tortoises in southern Nevada, Medica et al. (1975) found that tortoises 100 mm in length were $\approx$ 6 years old and those 200 mm were $\approx$ 16 years old. Using the same growth rates, tortoises 215 mm long would be approximately 20 years old.

Captive tortoises are known to reach sexual maturity at 12 to 13 years of age (Glenn Stewart, *personal communication*) and even earlier. Recent research by Jackson et al. (1976, 1978) indicates that captives can reach sexual maturity after 4 years when kept on a special diet.

The lengthy period of growth prior to sexual maturity for wild tortoises can be attributed to limited food availability. Growth rates in wild tortoises vary from year to year and appear to be related to winter rainfall and production of annuals (Medica et al., 1975). Production of annual wildflowers and grasses is unpredictable in desert environments and depends upon winter and/or summer rains. In some years food is abundant and in others scarce. Forage plants may be available for only 6 weeks to 3 months each spring. Thus, tortoises have a short period for feeding in the wild and will grow more slowly than in captivity where they may be fed from 7 to 9 months or more a year.

Clutch size. There are few data relating clutch size to age and size of the female. Most information on clutch size and frequency comes from owners of captives. Reports indicate that tortoises will lay from 4 to 13 eggs per clutch in spring and often lay more than one clutch per season (Stuart, 1954, and others). The 4 observations of egg laying in the wild (see above) included clutches of 4 to 6 or more eggs (Berry, 1974*b*; Burge and Bradley, 1976; Burge, 1977*b*). In the absence of data on clutch size for females of many different sizes, one might postulate that tortoises are like other reptiles: young, small females lay smaller clutches than the older, larger females (Fitch, 1970). There may be a gradual decrease in clutch size as females approach senility.

It is also possible that females do not lay eggs in years when forage production is low. This appears to be true for another long-lived and herbivorous desert reptile, the chuckwalla *(Sauromalus obesus)* and for the insectivorous Colorado Desert and Mojave fringe-toed lizards *(Uma scoparia, Uma notata)* (Berry, 1974*a*; Mayhew, 1966*a*, 1966*b*). Mayhew (1968) stated that breeding success in lizards is "...intimately associated with quality and quantity of food available..." and is probably "...controlled in large measure by the amount of rainfall that occurs during the preceding breeding season." This may also apply to the desert tortoise.

Population Age Structure and Sex Ratios. The age structure of a population (percentages of hatchlings, juveniles, subadults, and adults) and sex ratios can reveal information on reproductive potential, survivorship, population turnover, and population condition.

Desert tortoise populations can be divided into 5 age or size classes based on carapace length: hatchlings and very young tortoises ($<$100 mm), juveniles (101-179 mm), subadults (180-214 mm), and adults ($\geq$215 mm). Data on age structures and sex ratios have been collected for 12 populations: 1 in Utah (Woodbury and Hardy, 1948; Hardy, 1972; Coombs, 1977); 2 in Arizona (Judy Hohman, *personal communication*; James Schwartzmann, *personal communication*), 1 in southern Nevada (Burge and Bradley, 1976; Burge, 1977); and 8 in California (Berry, 1974*b*, 1975*a*, 1975*b*; Burge, 1977*b*, 1977*c*; Nicholson, 1977*a*, 1977*b*; Cook, 1977). Nine study areas have similar values for size classes: they are composed of 33-58% adults, 14-36% subadults, 20-36% juveniles, and 5-12% very young tortoises.

The exceptions are the Utah and Arizona populations. The Utah population was estimated to be composed of 90% adults between 1935 and 1945 (Woodbury and Hardy, 1948). A recent study by Coombs (1977) indicates that this population contains $\approx$ 70% adults but it has diminished considerably in density to the point where it qualifies for listing under the Endangered Species Act of 1973. Adjacent populations on the Beaver Dam slopes in Arizona also appear to be in trouble. Judy Hohman and Robert Ohmart *(personal communication)* report similar low densities, recent high mortality, and a population with 19% adults. In a second Arizona study area at Picacho Peak, the population is composed of 69% adults, 27% subadults, and 4% juveniles. There are no tortoises in the hatchling and very young size classes (James Schwartzmann and Robert Ohmart, *(personal communication)*.

Sex ratios varied considerably in the 12 populations noted above. In some, males predominated, whereas in others females outnumbered males. Male to female sex ratios of adults and subadults varied from 0.39:1.0 to 3:1. Eight of the 12 populations had ratios in the range of 0.39-1.15 ♂♂: 1.0 ♀♀. The population near Fremont Peak in California had ratios of 1.88:1.00 (Nicholson, 1977*a*), the Nevada population 1.34:1.00 (Burge and Bradley, 1976), the northern Arizona population 3:1 (Judy Hohman, *personal communication*), and the Utah population 2.36:1.00 (Coombs, 1977). There is some variation in sex ratios in healthy tortoise populations. However, the Fremont Peak, northern Arizona and Utah populations have sex ratios heavily biased in favor of males and all are known to be in poor condition.

Natality, Mortality, Recruitment, and Population Turnover. In natural, undisturbed situations tortoise populations are probably stable. They exhibit the characteristics of K-selected species with a low birth rate, low recruitment, low mortality (at least of individuals in the older age categories), and low population turnover (Pianka, 1970, 1972; Hairston et al., 1970).

There are limited data on natality for the 12 intensively studied wild tortoise populations. Natality will be expressed here as the percent of hatchlings produced per year compared to the total population. (Actually, the number of hatchlings found would be more accurate; small tortoises are more difficult to find than the larger individuals and may be underestimated in any population sample.) Hatchlings (<60 mm carapace length) composed from 0 to 6% of the 10 populations. The Utah population probably averaged <1% small tortoises annually between 1935 and 1945 (Woodbury and Hardy, 1948). Coombs (1977) reported finding 1.4% hatchlings in the same area over 30 years later. Burge and Bradley (1976) found 1.5% or more hatchlings (they defined hatchlings at 45 mm carapace length) during a 1-year study in Nevada. The 8 California populations had values ranging from 0 to 6% ($\bar{x} = 1.4$). Because hatchlings probably are not produced every year, the estimate of annual production should be averaged over a several year period. Unfortunately, only the Utah population has yielded sufficient data to do this.

The hatchling and very young size classes can be pooled to include tortoises up to ≈ 6 years old (animals <100 mm long). Together these 2 age classes composed 5 to 12% of the 8 populations in California, 12% in Nevada, 0% in Picacho Peak, Arizona, and <8% in Utah (my estimate from Coombs [1977] data.) Ignoring differential mortality for the 1-, 2- and 3-year-old tortoises, etc., the average natality for all areas except Arizona and Utah was 1% per year. Thus, recruitment of young individuals into the larger size classes appears to be low.

Mortality has been calculated for 5 populations and is generally quite low, but it appears to exceed natality. In Utah, Woodbury and Hardy (1948) estimated mortality at 1% per year over a 10-year period in a population of 281 individuals. Their estimate was based on a collection of shell-skeletal remains. For 1974-1976 Coombs (1977) estimated natural sources of mortality of 6.86% per year in the same area, but this figure would be closer to 3.4% if he had used the same techniques as Woodbury and Hardy (1948). Betty Burge *(personal communication)* reported collecting 16 shells in a population of 127 live tortoises at the Arden study site in southern Nevada. The shell-skeletal remains showed little weathering, thus deaths were estimated to have occurred during the preceding 3 years. Mortality probably averaged 4.2% annually. The population at Picacho Peak, Arizona, has a mortality of <2% annually. (James Schwartzmann and Robert Ohmart, *personal communication*). However, the northern Arizona population exhibited high mortality. Ninety shell-skeletal remains 5 years or less in age were found in a 5.2 km^2 area, where population densities are estimated at 7.7/km^2. Mortality appears to have averaged in excess of 20% per year during the last 5 years (Judy Hohman and Robert Ohmart, *personal communication*). Berry (1974*b*) estimated natural loss at < 5% annually in a low density population in Salt Wells Valley in San Bernardino County, California. There are data for several other populations in California, but they are not yet analyzed (Burge, 1977*b*, 1977*c*; Cook, 1977; Nicholson, 1977*a*, 1977*b*).

Feeding Habits. In spite of the variety of habitats in which tortoises occur, some feeding habits are common to many populations. Tortoises emerge from hibernation in late winter or early spring (February to April) and feed on annual wildflowers, annual and perennial grasses and some perennial shrubs. Genera of annuals utilized include: *Astragalus, Camissonia, Coreopsis, Cryptantha, Erodium, Euphorbia, Gilia, Lupinus, Malacothrix, Mentzelia, Phacelia*, and *Plantago*. Annual grasses include such species as *Bouteloua barbata, Bromus rubens, Festuca octaflora*, and *Schismus barbatus*; some perennial grasses utilized are *Hilaria rigida, Muhlenbergia porteri*, and *Oryzopsis hymenoides*. Shrubs are used relatively little overall, except for herbaceous types like *Sphaeralcea ambigua*. Tortoises also have been observed eating flowers, fruits, and new stem tips of *Stephanomeria pauciflora, Krameria parvifolia, Echinocactus polycephalus, Opuntia basilaris*, and *Opuntia ramosissima*. In late winter and spring, annual wildflowers and grasses compose most of the diet, if they are available. If these foods are limited, tortoises will eat perennial grasses and dried annuals. (Woodbury and Hardy, 1948; Berry, 1974*b*, 1975*a*, 1975*b*; Burge and Bradley, 1976; Burge, 1977*b*, 1977*c*; Cook, 1977; Coombs, 1977; Nicholson, 1977*a*, 1977*b*).

Desert tortoise activity patterns are closely associated with forage availability. For example, in the western Mojave Desert, tortoises are active primarily when there is succulent green forage between March and May. During the dry season in late spring, summer, and fall few tortoises are active (Berry, 1974*b*, 1975*a*, 1975*b*).

Tortoises feed on wildflowers and grasses in a variety of ways. They may take 1 to several bites out of a single plant and then move on to another, or they may eat most of the plant. In general, foraging is in the open. I have not observed tortoises crawling into shrubs to feed.

Home Range and Movements of Tortoises. The home range of a tortoise is the area in which it forages, burrows, travels, and interacts with other animals. Hence, it is an activity area. Home range size may vary according to geographic locality, population density, and food supply and may depend upon sex and size of the tortoise. In Salt Wells Valley, California, large tortoises had large home ranges, and small tortoises had small home ranges, with females generally possessing smaller areas than males (Berry, 1974*b*). Burge (1977*a*) reported similar findings in her southern Nevada study area.

There are a variety of reports on home range sizes for populations in Utah, Nevada, and California. In Utah Woodbury and Hardy (1948) and Coombs (1977) estimated sizes of 4 to 40 ha and 0.2 to 7.3 ha, respectively. In Salt Wells Valley, California, adult male tortoises had home ranges between 39 and 77 ha; females ranged over 8 to 45 ha (Berry, 1974*b*). Some males studied here may have home ranges of 129 to 259 ha. Burge (1977*a*) reported home ranges for the Nevada population of 20 to 38 ha for males and 11.3 to 27 ha for females.

In a recent study at Picacho Peak, Arizona, James Schwartzmann *(personal communication)* found that tortoises travel extensively. One female followed using radio transmitters moved up to 1.6 km. Coombs (1977) reported that a medium-sized tortoise may move 182 to 437 m in a day; his largest tortoise moved 656 m. At the Salt Wells site in California adult males travelled up to 1443 m in a day during spring (Berry, 1974*b*).

The movements of small tortoises appear to be much more restricted. Hatchling and juvenile tortoises had very small activity areas and were associated with 1 or 2 burrows. Their activity areas had radii of <50 m (Berry, 1974*a*; Coombs, 1977; Ron Marlow, *personal communication*).

Burrowing Habits, Pallets, and Dens. Tortoises use different kinds of burrows for different purposes in different geographic locations. The type and depth of burrows may be related to soil type and to winter and summer temperature extremes.

In southwestern Utah, the extreme northeastern corner of the geographic range, there are 2 types of burrows: dens and summer holes. Dens are used for hibernation in winter, and summer holes for protection during spring and summer. Dens are horizontal tunnels constructed in the banks of gullies and washes. They are usually 2.4 to 4.5 m long and occasionally reach 6.0 to 9.4 m. Summer holes are shallower and are constructed on flats and mesas. The tunnels have slopes of 20° to 40° and are 1.8 to 2.4 m long. Summer holes are more fragile and temporary than deep dens. The burrow types described by Woodbury and Hardy (1948) for Utah are also found in southern Nevada, eastern California, and northern Arizona.

Burrows are much shallower in the western, northern, and central Mojave Desert of California. The deep burrows or dens are 2.4 m or more long and are excavated from a flat surface downward at angles of 20° to 40°. There may be a 0.61 m to 0.91 m layer of soil covering the deepest portion. The shallow burrows or pallets are 25 cm to 1.2 to 1.5 m long. These burrows are fragile and have a shallow soil covering over the roof; they often last only one season. Sometimes only a few centimetres of soil cover the deepest portion. These shallow burrows are used during spring, summer, and fall, whereas the deep, permanent burrows are primarily in summer and for winter hibernation. Tortoises excavate burrows in the open, under shrubs, and under rocks.

Dens and burrows are important to tortoises because they spend most of their lives under cover. For example, in the northwestern Mojave Desert during a year with abundant food supply, adults and juveniles are aboveground and active for 3 months between late February or early March and late May to mid-June. Adults also may be active for 3 to 6 weeks in September and October. At most, adults are out of burrows on a regular basis for 4 to 5 months per year. Juveniles may be active from March to mid-April and then again in fall for a total of 3 months aboveground and 9 months belowground. (Berry, 1974*b*, 1975*a*, 1975*b*).

LIVESTOCK GRAZING AND THE DESERT TORTOISE

There are few historical records of livestock grazing throughout much of the geographic range of the desert tortoise. However, available information indicates that domestic livestock have grazed in tortoise habitat in the United States from the 1850s to the present.

In Utah cattle and sheep have grazed the limited tortoise habitat since about 1862 when the town of St. George was established. The intensity of grazing increased in the 1940s over what it had been during the previous 80 to 100 years (Ross Hardy, *personal communication*). In the early 1960s sheep grazing was discontinued in Utah's desert tortoise habitat, but cattle still use the area.

Paul Ernst (California Desert Program, Bureau of Land Management, Riverside) is compiling historical data on grazing in the California deserts. He has interviewed ranchers, and has prepared maps showing livestock use since 1885. Historically, much of the California desert has been grazed by sheep and cattle. There has been a slight reduction in the area used since the early 1900s, but at present there are 2 principal grazing areas: the western and eastern Mojave Desert.

Much of the geographic range of the desert tortoise in Arizona and Nevada is currently being grazed. Exceptions are the Nevada Test Site and Desert National Wildlife Range in Nevada.

Although no field studies have been undertaken to determine the effects of livestock grazing on the desert tortoise, casual observations indicate that livestock can have deleterious effects on tortoise populations and their habitats through trampling of young soft-shelled tortoises, damage to burrows and shrubs used for shelter, and removal of critically needed forage. Inferences about the potential and actual impacts of grazing can be drawn by examining evidence from several sources: (1) casual observations of the effects of sheep and cattle grazing on desert tortoise habitat, (2) a review of the status of the tortoise population in southwestern Utah (Woodbury and Hardy, 1948; Coombs, 1977), (3) an examination of the population status at 2 heavily grazed study sites in Arizona, (4) indirect evidence from studies of grazing impacts on other species of desert reptiles, (5) impacts of livestock on vegetation in habitats throughout the Southwest, and (6) general knowledge of the life history and behaviors of desert tortoises and the behaviors of livestock.

Casual Observations. Observations have been made on the effects of sheep grazing in the Desert Tortoise Natural Area and surrounding lands in the western Mojave Desert since 1971. This area has been grazed by sheep since the turn of the century. During the spring of 1973 sheep grazed on the Natural Area and throughout the western Mojave Desert during the lushest display of annual wildflowers in recorded history. Although the legal date for initiation of the grazing season in that area is 16 March, sheep were in the area in trespass earlier--by mid-February. They continued to graze until late May when most annuals had cured or been eaten. In many areas sheep removed almost all traces of annual forbs and grasses; the desert floor appeared more devoid of herbaceous growth than in drought years. Where sheep grazed intensively near water tanks, at bedding sites, and at loading and unloading areas, the annual flora was denuded or essentially so. One bedding site was directly within one tortoise study site. Sheep tracked through the area and bedded within the plot in mid-April. When they departed a few days later, the area looked more barren than in a drought or during summer and fall months. Sheep also trampled and uprooted perennial shrubs, such as burrobush *(Ambrosia dumosa)*, goldenhead *(Acamptopappus sphaerocephalus)*, and Anderson thornbush *(Lycium andersonii)*. Even large creosote bushes *(Larrea tridentata)* were uprooted. Some bushes were "hedged", whereas others, especially in trailing, bedding, and concentrating areas, were obliterated. Numerous bedding and concentrating areas, old and recent, can be found throughout this grazing area. All show signs of this heavy use.

Sheep trampled most shallow tortoise burrows and pallets that were in the open, and they also crushed and caved in those near the edges of or within shrubs. Ron Marlow *(personal communication)* described the loss of a juvenile tortoise and its small burrow, presumably because of trampling by sheep during the same spring. The marked juvenile tortoise had a single burrow at the base of a perennial shrub. Sheep passed through the area soon after, trampled the shrub, and destroyed the burrow. The marked tortoise was never observed again. Also during the same spring and in the same study area, a small 2- to 3-year-old tortoise with a hole through its shell was found near a temporary watering trough. It appeared to have been killed by sheep within the last few days; the hole in the shell was about the size and shape of a sheep's hoof.

During 1977 Burge made observations on cattle use at 2 tortoise study sites in the vicinity of Goffs and Ivanpah Valley in eastern San Bernardino County, California (Burge, 1977*b*, 1977*c*). She reported that cattle grazed at both study sites in spring. Cattle concentrated in washes under the shade of large shrubs, collapsed adjacent banks by trailing and seeking forage, and broke apart large portions of shrubs by trampling and foraging. At bedding sites they uprooted or trampled essentially all vegetation, including shrubs, thereby denuding the area. At the Ivanpah site they cropped annuals and galleta grass *(Hilaria rigida)* heavily. At both sites cattle walked over and broke in numerous tortoise burrows and in one case caused collapse of a shallow burrow in a bank 1.2 m high.

A final example can be taken from comments of Mr. Eldridge of the OX Cattle Company in Lanfair Valley, California. In 1976 Mr. Eldridge stated to Bureau of Land Management personnel that he could hardly take a ride without seeing a tortoise in Lanfair Valley 20 years ago. He noted that tortoises have become less common over the years until now he hardly ever sees one. Several transects taken to determine the relative abundance of desert tortoises and their sign in Lanfair Valley revealed little evidence of their presence.

Lanfair Valley has had intensive and sometimes abusive cattle use since the late 1800s and early 1900s. There were agricultural developments in some areas in the 1920s. The Joshua tree—grassland community has been altered considerably and now contains a high percentage of weedy, invader, perennial species typical of overgrazed desert lands, i.e., *Gutierrezia microcephala*, *Hymenoclea salsola*, etc. In many areas near stock tanks the ground is devoid of vegetation for hundreds of metres. Trailing is heavy, and damage is extensive within 4.6 to 6.4 km of the tanks. There are few recent human activities that could account for decline in tortoise number in this area except for the overgrazing.

<u>The Woodbury and Hardy Study Site in Southwestern Utah.</u> Woodbury and Hardy (1948) studied a semi-isolated group of about 300 tortoises in a 485 ha area on the Beaver Dam slopes of southwestern Utah between 1935 and 1945. They marked 281 tortoises and estimated a density of 58/km^2 within their study site. The population was composed of about 90% adults, 9% subadults and 1% juveniles (based on 129 marked individuals). The sex ratio was estimated at 0.66 ♂♂:1.0 ♀♀.

Since that time, Hardy (1972, 1976) has returned several times to the area, and Coombs (1977) has undertaken studies for the Bureau of Land Management and the Utah Wildlife Resources Division. Coombs (1977) estimated a total of 335 tortoises in the entire 33.7 km^2 of "good tortoise habitat" on the Beaver Dam slopes and has reported that the density has declined to about 10 tortoises per square kilometre. The age class structure is still weighted heavily in favor of adults (71%) and the sex ratio is 2.36 ♂♂:1.0 ♀♀.

Both Hardy (1976) and Coombs (1977) suggested that the precipitous decline in the once dense population was the result of collecting and overgrazing. The Beaver Dam slopes have been grazed by both sheep and cattle since about 1862. In 1948 Woodbury and Hardy noted possible competition between sheep grazing and spring forage for tortoises as follows:

> Sheep "frequently denude the annual plant cover by grazing and trampling. Often the only annuals and grasses remaining are those which grow about the base of and up through the perennial shrubs and cactuses. The degree of denudation varies somewhat from year to year...The lush carpet of annuals that usually fills up the spaces between the bushes in early spring and sometimes in fall...is normally limited to a 30 to 40 day period in spring and in fall but when the sheep herds sweep the carpet clean the tortoise access to the fresh green vegetation is limited to a few days."

In 1976 Hardy reiterated the problems of livestock grazing (including cattle) and suggested that the tortoises must be protected from so much competition for food.

Coombs (1977) discussed the possible competition for forage between livestock and tortoises. A comparison of food habits between tortoises and livestock revealed a food overlap of 37% based on the volume and number of plant species in the diets. Coombs (1977) also reported changes in perennial vegetation in the area between the 1940s and the present based on plant studies undertaken by Hardy in 1945 and more recently by the Bureau of Land Management. Increases in the number of creosote, burrobush, and winterfat *(Eurotia lanata)* shrubs and decreases in Anderson thornbush and other species were noted. Overall, cover of perennials decreased 33.8% (from 22.32 to 14.78%), and the height and width of shrubs also decreased. There was less bush muhly *(Muhlenbergia porteri)*, one of the tortoise's forage plants, in 1977 than during the 1940s. Unfortunately there are no comparative data on the composition, diversity and biomass of the annual vegetation.

Coombs (1977) recommends altering livestock grazing practices to ensure production of increasing percentages of forbs and annual and perennial grasses.

Beaver Dam Slopes Study Site, Arizona. In late 1976 the Bureau of Land Management initiated a research project on the effects of livestock grazing on the desert tortoise and on the status of the population on the Beaver Dam slopes in northern Arizona. The study site lies immediately south of the Woodbury—Hardy study area and also has a long history of livestock grazing. However, sheep grazing was eliminated in 1969 and cattle grazing was placed on a rotational system in the early 1970s. Thirty-four live tortoises have been marked in a 5.2 km^2 area to date. Most are juveniles. The mortality rate appears to be very high. Ninety recent shell-skeletal remains, which probably represent tortoises that have died in the last 5 years, have been found. Fifty percent of the remains were of adults. (Judy Hohman and Robert Ohmart, *personal communication*).

Picacho Mountain Study Site, Pinal County, Arizona. This study site, which has a density of about 53 tortoises in a 3.9 km^2 area, has a long history of livestock grazing. With the exception of 2 individuals, the tortoises are all adults or subadults. Few shell-skeletal remains have been found and mortality may be low. (James Schwartzmann and Robert Ohmart, *personal communication*).

The Effects of Livestock Grazing on Other Reptiles. Busack and Bury (1974) reported on the effects of sheep grazing on 5 species of lizards in two 1-hectare study plots, one grazed and one ungrazed. The ungrazed plot had 2 X the number of lizards with 3.7 X the biomass as the grazed plot. All lizards sampled were insectivores. The authors suggested that grazing has a negative effect on some lizards due to loss of cover, reduction in invertebrate food sources, disturbance of social structure, and direct casualties.

The Effects of Livestock Grazing on Vegetation. There are numerous studies of the effects of sheep and cattle grazing on different habitat types. Studies of grazing in arid scrub and desert grasslands indicate that heavy livestock use or overgrazing reduces biomass and diversity of grasses and annual forbs, and changes the composition of shrubs (Ellison, 1960; Laycock, 1967; Potter and Krenetsky, 1967; Brown and Schuster, 1969; Turner, 1971). Where livestock are excluded or grazing is light after years of overgrazing, vegetation recovers very slowly. Decades may be required before grasses and forbs return to some semblance of normality, particularly in areas of low rainfall. Although much of the research has been undertaken outside of desert tortoise habitats, the results are applicable here.

Cattle and sheep can have particularly deleterious effects on tortoise foods and shrubs used for cover. In late winter and spring, livestock eat many of the same winter annuals and grasses that form the principal diet of tortoises. Shrubs are browsed, hedged, or trampled in the process. The same pattern can be observed in summer, fall and winter depending on the season of grazing and the degree of livestock concentration in specific areas near water sources, salt licks, tall shrubs that provide shade, and bedding sites.

Tortoises whose home ranges include severely impacted areas can be deprived of forage essential for growth, maintenance, and reproduction. Females and the smaller tortoises with small home ranges are particularly vulnerable. For example, each bedding site for a flock of sheep can deprive hatchlings or young tortoises of forage and burrows, because the tortoises may be incapable of significantly expanding their home ranges.

Trampling of Tortoise Burrows. Cattle and sheep frequently trample shallow tortoise burrows, such as the summer holes described by Woodbury and Hardy (1948) and the permanent winter dens and pallets used in other parts of the geographic range. Livestock are unlikely to affect deep dens that occur in the banks of washes. Although damage to burrows may seem trivial, there is ample evidence that individual tortoises know the locations of their burrows and rely on them for protection from the extremes of heat and cold. If, for example, a tortoise returned to a damaged burrow on a hot spring morning, it might be unable to reach or excavate another before dying from overheating.

Trampling of Tortoises. Smaller tortoises can be crushed easily by cattle or sheep. Until they are ≈ 100 mm in carapace length, their shells remain flexible, and the bony skeleton is poorly developed. Tortoises can be crushed when herds of sheep just move through an area, as well as when they concentrate.

ANALYZING THE EFFECTS OF LIVESTOCK GRAZING

Damage to tortoise populations and habitats can be subtle and difficult to detect in the initial stages, primarily because the tortoises are long-lived, have a low reproductive potential and low mortality rate. Changes in population dynamics probably would not be noticeable for several years. Detection even then would require intensive research. Potential impacts of grazing on growth rates, age at first reproduction, natality, size class structure, sex ratios and mortality are outlined below.

Growth Rates and Age at First Reproduction. Reduction of food supply potentially can slow growth rates in young tortoises and increase the time to reach age at first reproduction. Medica et al. (1975) reported that tortoises appear to have lower growth rates when winter annuals are scarce. Livestock grazing during late winter and spring often reduces the abundance of tortoise food to a point where drought conditions are simulated. Continuous livestock use in late winter and spring could be particularly deleterious.

Natality. Livestock grazing potentially can reduce the number of clutches produced by adult females. If tortoise reproduction is dependent on an adequate diet, as is the case with some other desert reptiles (Mayhew, 1968; Berry, 1974a), then females may lay smaller clutches or be unable to lay eggs when forage is limited, whether due to drought or grazing. If livestock grazing continues in a given area for many years and depletes the forage, the effect on females may be similar to a long-term drought. Females may not reproduce for years, and there may be a low percentage of young in the population. This may have been the situation in Utah between 1935 and 1945 when the population was composed primarily of adults (Woodbury and Hardy, 1948). The population in Pinal County, Arizona, may be in a similar condition.

Size or Age Class Structure of Population. From studies undertaken in 12 populations throughout the geographic range it is apparent that there is some variation in the size class structure of different populations. However, most have a ratio of adults to nonadults that is close to 1:1 (range 0.5-1.4:1.0) (Berry, 1974*b*, 1975*a*, 1975*b*; Burge and Bradley, 1976; Burge, 1977*a*, 1977*b*, 1977*c*; Cook, 1977; Nicholson, 1977*a*, 1977*b*). There are 3 exceptions: the Utah population, which had a ratio of 9.05:1.0 between 1935 and 1945 (Woodbury and Hardy, 1948) and 2.33:1.0 in the 1970s (Coombs, 1977); the Pinal County, Arizona, population which has a ratio of about 2.18:1.0 (James Schwartzmann and Robert Ohmart, *personal communication*); and the Beaver Dam slopes, Arizona, population, which has a ratio of 0.19:1.0 (Judy Hohman, *personal communication*). If livestock grazing suppresses reproduction over a long period of time, recruitment of young individuals into the adult population will be reduced. It appears that recruitment nearly ceased in the Utah population in the 1940s and is very low at present in Pinal County, Arizona.

The 0.19:1.0 ratio in the tortoise population on the Beaver Dam slopes, Arizona, is more difficult to explain. Perhaps reductions in grazing since the mid-1960s have allowed some reproduction. However, the recent high mortality, the low percentage of adults, and the low density indicate the population is still in serious condition. Hopefully future research will shed more light on the sources of the problems here.

<u>Sex Ratios</u>. Heavy livestock grazing may contribute to an imbalanced sex ratio. Grazing can have a greater impact on adult female tortoises than on males because of the heavy metabolic demands of egg laying. Eggs are laid in late spring and early summer, usually after winter annuals have dried and succulent green forage is no longer available. The spent female may have to wait until the following spring to replenish fat reserves and perhaps a 2nd or 3rd year if there is a drought or continuous impact from livestock grazing. Thus a female recently depositing eggs might be more likely to suffer stress and greater mortality than males of a similar size. The imbalanced sex ratios in favor of males in the Fremont Peak (California) and Utah populations may be a result of this process.

<u>Mortality</u>. The groups of tortoises most likely to be affected by forage loss and trampling are those with small home ranges, fragile shells, and high energy commitments, i.e., hatchlings, very young tortoises, and/or females. Because mortality in undisturbed tortoise populations is probably quite low, averaging $< 5\%$ per year, even slight increases in the rate are likely to raise average annual mortality above average annual natality. Over a long period, increased mor-

tality would result in a decline in population density and a decline in the nonadult size classes.

GRAZING SYSTEMS AND THEIR POSSIBLE EFFECTS ON THE DESERT TORTOISE

Several types of grazing systems are commonly employed in the West. These include but are not limited to ephemeral, deferred, year-round or continuous grazing, as well as other systems that involve seasonal use. Obviously, the systems were not developed with the goal of protecting tortoise habitat, which essentially requires maintenance and enhancement of the production of native annuals and grasses, preservation of a shrub composition close to the original density and diversity, and maintenance of a relatively undisturbed substrate.

There are few areas in the deserts of the Southwest that have actual grazing systems. Where systems are in use they are usually designed to provide maximum forage for sheep and/or cattle. Production of forage on a sustained-yield basis may be the goal, but it is not the practice in many desert areas.

Each type of grazing system offers disadvantages to the tortoises, some more so than others. Disadvantages of ephemeral use are most obvious. Ephemeral use is a common practice in the desert, especially when there is a "good" annual wildflower year. Livestock operators usually request supplemental permits and turn out additional sheep and cattle for a few weeks or months to take advantage of the annuals. This type of use can be particularly damaging to tortoise habitats and populations, especially if livestock use is heavy. Reproduction and growth in tortoises is largely dependent on these years when forage levels are above average thereby allowing tortoises to store fat for use during dry years.

Rest-rotation grazing with a 2 or more pasture system is in use in a few areas, particularly for cattle. Sometimes pastures are used sequentially throughout the 4 seasons; other times there is only 1 or 2 seasons of use, with pastures being rested for 1 or more years. Most rest-rotation systems are not designed to cope with the fluctuating environment of the desert. For example, a 3-pasture system in which each pasture receives heavy to moderate livestock use every 3rd year does not take into account annual variation in rainfall. Pastures will receive the same intensity of use each year, but forage availability will not be the same. In some years there will be a lush ground cover of winter annual wildflowers and annual grasses, and in other years there will be almost nothing for livestock to eat but the perennial grasses and shrubs. When annual forbs and grasses are available, they will receive heavy use. During those years there probably will not be much forage for tortoises.

A system that has continuous use, especially continuous to heavy use, is likely to be devastating to tortoise habitat and populations. There will be no respite from trampling, and forage availability will be limited much of the time.

It is readily apparent that new types of grazing systems should be developed in areas where tortoises occur and where one of the management objectives is to maintain tortoise populations. Range scientists and tortoise biologists must address many problems including the following: the diet of the tortoise at a particular site, the status of tortoise populations, the density of tortoises to be maintained, the amount of forage to be allotted to the tortoises by season, the amount of forage needed for adult female tortoises to reproduce, mortality of tortoises caused by livestock grazing (above the "natural" level), tortoise natality, the effects of livestock "presence" on tortoise behavior (tortoises frequently cease all activity and withdraw into the shell when a human is nearby and may do so in the presence of cattle or sheep), and the level of livestock use by season and its effects on vegetation.

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Status Report and Observations on a Captive Gene Pool of Bolson Tortoises

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Abstract

The 20,000-hectare Mapimí Reserve in the Mexican State of Durango is now fully functional under Mexico's Man and the Biosphere Program, with construction of a field station completed and a visiting investigator program underway. A husband and wife team from the Institute of Ecology, Mexico, has been appointed to manage the preserve, with particular responsibilities for the resident population of bolson tortoises. Inquiries are welcomed and postal information is available.

Fifteen adult tortoises (purchased or donated local captives, not wild-caught) were brought to The Research Ranch in southeastern Arizona in July 1976. Two selected pairs were placed in special breeding enclosures and the remaining 11 animals were established in a 2-hectare enclosure intended for observation with minimal disturbance under conditions as close to "wild" as possible. This large, circular enclosure of heavy wire with hardware cloth to prevent escape of hatchlings is located in alluvial bottom land with a good growth of tobosa grass *(Hilaria mutica)* sloping to better-drained soil. Each animal is permanently marked by small holes drilled through marginal plates and bears a conspicuous identification number painted on front and rear aspects of its carapace. Courtship behavior and one apparently successful mating have been observed, but no nests or young have so far been detected. Burrow construction has not progressed as far as expected, presumably due to the soil characteristics of the area. One death has occurred, with postmortem examination indicating intestinal torsion assumed to have preceded acquisition; histological examination of this animal showed it to be a sexually active male.

Observations on diet and behavior will be summarized, and suggestions for future management action will be solicited.

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Captive Maintenance and Breeding of the Bolson Tortoise

John Janulaw

Some degree of success in hatching *Gopherus agassizii* and *Gopherus berlandieri* in the early 1960s spurred me on to obtain another species of *Gopherus*, the bolson tortoise, *Gopherus flavomarginatus*. Newly discovered in 1959 in northern Mexico, *G. flavomarginatus* tortoises were offered for sale in the May-June 1967 issue of the now defunct "International Turtle and Tortoise Society Journal." A private zoo in El Paso, Texas, advertised the tortoises as "surplus specimens ranging from 8 inches to 17 inches in length."

Within a week after I ordered a pair for $55.00, they arrived by air freight. They were so vigorous that they had nearly kicked out the sides of their shipping crate. I found them to be in excellent health, their droppings composed of desert plant material, not the "lifeless" droppings of tortoises being fed lettuce and other civilized fare.

Aggressive Behavior. Both the male and the female bolson tortoise immediately demonstrated antisocial activity toward the other 15 or so *Gopherus* in my yard, resulting in *G. agassizii* males and females being overturned. I removed the *G. agassizii* and the *G. berlandieri* from the area at once and to date have not reintroduced them. The bolsons tolerate my exotic species (i.e., redfoot and leopard tortoises), however, and over the years have shared their enclosure with approximately 6 at a time.

Environment. Several years before I acquired the bolsons, I had constructed artificial burrows (Fig. 1) for the other tortoises. I enlarged the burrows for the bolsons, and hoped that the security of a suitable retreat would quiet them. However, they remained so extremely nervous and hyperactive that subsequent observations over the next year had to be made with binoculars. When the tortoises did spot me, they retreated into their burrows, and, of course, would not graze. I learned to advance toward them very slowly and quietly, making no quick movements with my hands. Gradually they learned to accept me, and later Eleanor. I believe that they survived their first year in my yard not because of attention but because of the lack of attention. My not being home for 5 days a week provided them with freedom from human interference.

Food and Growth. Evidently the 2,000 square feet of coastal bermuda, clover, and bluegrass in the tortoise enclosure provides satisfactory grazing, as the female bolson's weight has increased from 5103 grams ($\approx$ 11 lbs. 4oz.) to 11,340 grams

(≈ 25 lbs.), and her carapace length has increased from 292 mm (≈ 11½ inches) to 381 mm (≈ 15 inches). (After the first year, cabbage sprinkled with bone meal and sandwiched between leaves of romaine lettuce has been offered regularly as a food supplement.) The female's weight gain has tapered off since she achieved sexual maturity. The male bolson, no doubt older than the female, has not increased measurably in length (292 mm) or weight (4678 grams or ≈ 10 lbs., 5 oz.).

Hibernation. The adult bolson tortoises hibernate in their burrows starting in early November. At that time we cover the burrows with the regular tarpaulin we use at night, plus an extra tarpaulin to block out the daylight. (They come out into sunlight, if they can see it, even in the cold weather.) In checking the animals during heavy rainstorms, we usually discover condensation running off of their backs. At that time we remove them to cardboard boxes (heavily lined, top and bottom, with newspaper) in the garage where they remain for the rest of their hibernation. When the weather reaches 27+°C for a couple of days, usually in late February, the bolsons come out of hibernation, always before the other *Gopherus* awaken.

Mating Activity. A few weeks out of hibernation, the bolson starts to graze. In about two-and-a-half more weeks, the first mating activity of the season usually occurs, depending on the weather, of course. Most mating occurs in the spring and fall (although not as often in the spring, possibly because the weather is more changeable), during which activities are feverish and may be observed every day or so. As long as the days reach 27°C, courtship continues, even into November.

The bolson tortoise also differs from *G. agassizii* and *G. berlandieri* in mating activities (Fig. 2). Instead of mating occurring at any random, convenient location that consenting male and female happen to meet, the bolson female only allows the male to mate with her at the burrow "entrance." The female is usually within the burrow, or has just been chased there. While she faces the male, he goes through perfunctory circular head nodding and shaking which seems to be a vigorous slapping of the head within the confines of the gular horn and prefrontal carapace. The female then rotates, exposing her carapace to the male, and backs out of the burrow. The male bolson will then mount the female for a mating that generally lasts a minute or two.

Egg laying. When the female is even more active than usual or climbs up on the porch, she will usually lay eggs within a week. She may start egg laying for the season as early as April 3rd or, if there is a late spring, early May. The location she seems to prefer for her nest is the apron of her burrow, although her early clutches were laid in nests hurriedly dug in just 45 minutes in any dry, sunny site. She usually lays 3 clutches per season, with 4-7 eggs in each nest. The bolson's nest is left completely dry; she does not urinate on her eggs as the other species of *Gopherus* do.

Incubation of Eggs. Incubation of her eggs has always been accomplished by artificial means. To a regular Sears-Roebuck® egg incubator, I added a 6.3 cm x 6.3 cm square, 5 cm deep container which holds 30-45 ml of distilled water. (I must add a little water about once a month to maintain the proper level.) Except during daily morning and evening inspections, the inside of the incubator is dark. With the temperature set at 29.5°C, the bolson tortoise eggs hatch in an average of 83 days.

Hatchlings. From 1971-1977, our bolson tortoise female laid 15 clutches of eggs from which we have obtained 52 hatchlings (Fig. 3). Only 5 are still living; the average survival time for those who died was 4 months.

All of the hatchlings have had a trait that the parents display, an unequal number of shields. Cleft palate--another inheritance or perhaps the result of inbreeding--effects some, making it almost impossible for the hatchlings to eat.

Food for the hatchlings consists of a mixture of a mixture of endive, escarole, and cabbage which has been cut up with a scissors, plus finely grated zucchini squash, lightly salted with bone meal and Squibb's Vionite®, a powdered multivitamin. They also graze, weather permitting.

The two oldest survivors, hatched 2 years ago, weigh 350 grams and have attained a length of 125 mm. At the present time these tortoises reside in our home in West Los Angeles, having been given complete freedom of our tortoise yard. There they share burrows with their parents occasionally, but are always taken indoors when temperatures drop below 21°C. The other 3 survivors have been raised by Mr. and Mrs. Max Greene of Ojai, California, where they are thriving. *(Author's note: Six months after this report was written, one of the 3--the only survivor with cleft palate--died.)*

Comparison with Captive Breeding of Other Tortoises: However, captive breeding programs can be applied more successfully to at least some other species of tortoise. For example, our work with *Geochelone pardalis babcocki*, which started in 1970 with 2 breeding pairs, has resulted in several hundred hatchlings. The older ones are now sexually mature, and we have obtained second generation hatchlings. Our *G. p. babcocki* hatchings are rarely deformed, and, as our specimens were obtained from widely separated localities, probably do not suffer from inbreeding. I estimate 30% to 40% survive to adulthood. A more accurate report is difficult because many hatchlings were put out for adoption.

<u>Prospects</u>. Future plans for our bolson tortoises call for our eventually moving to a larger piece of property where we hope to recreate some of the terrain native to them. Just allowing them more land than their present 2,500 square feet should help the bolson breeding program, as well as our 4 other tortoise breeding programs. It is fortunate that our tortoises seem to thrive within the artificial semi-urban life zone we provide.

ACKNOWLEDGMENT

I would like to thank my wife Eleanor whose full coopera- and infinite patience in feeding and caring for our many animals has been essential in all of our long-range tortoise breeding projects.

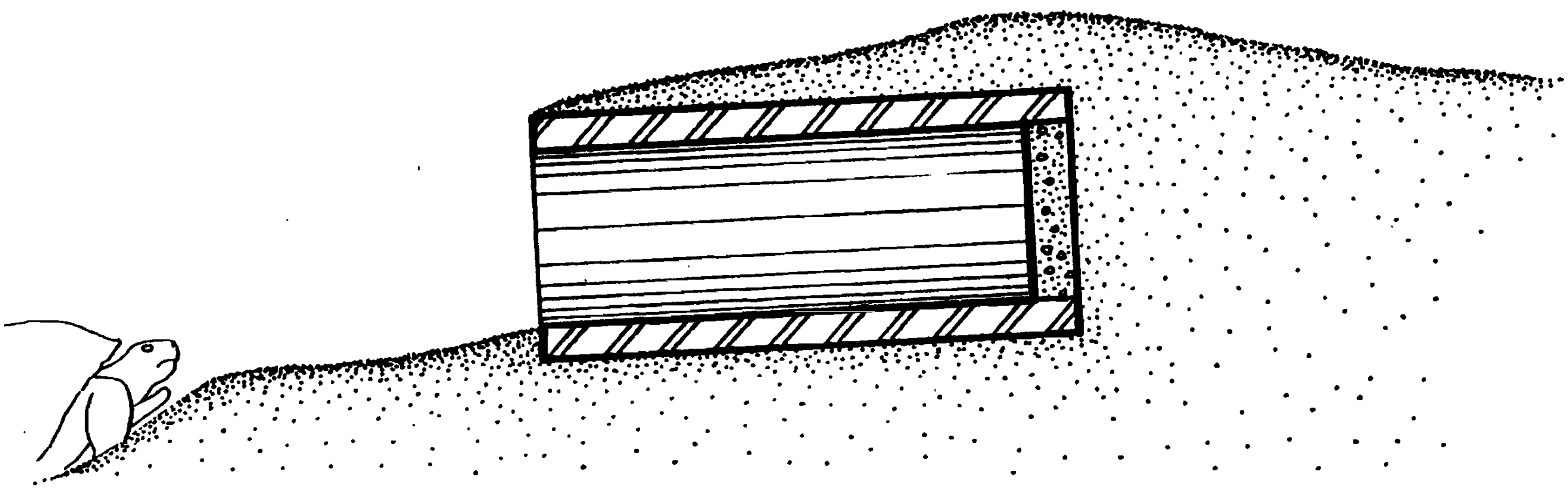

Fig. 1. Longitudinal section through artificial burrow embedded in mound of builder's sand and desert soil. Note, burrow is a 0.6-metre concrete flue pipe plugged with concrete, painted with a clear water sealer (six coats). Burrow is sloped 2.5 centimetres to drain urine and rain water. In winter a waterproof tarpaulin placed over the burrow provides the tortoise a dry, dark place for hibernation.

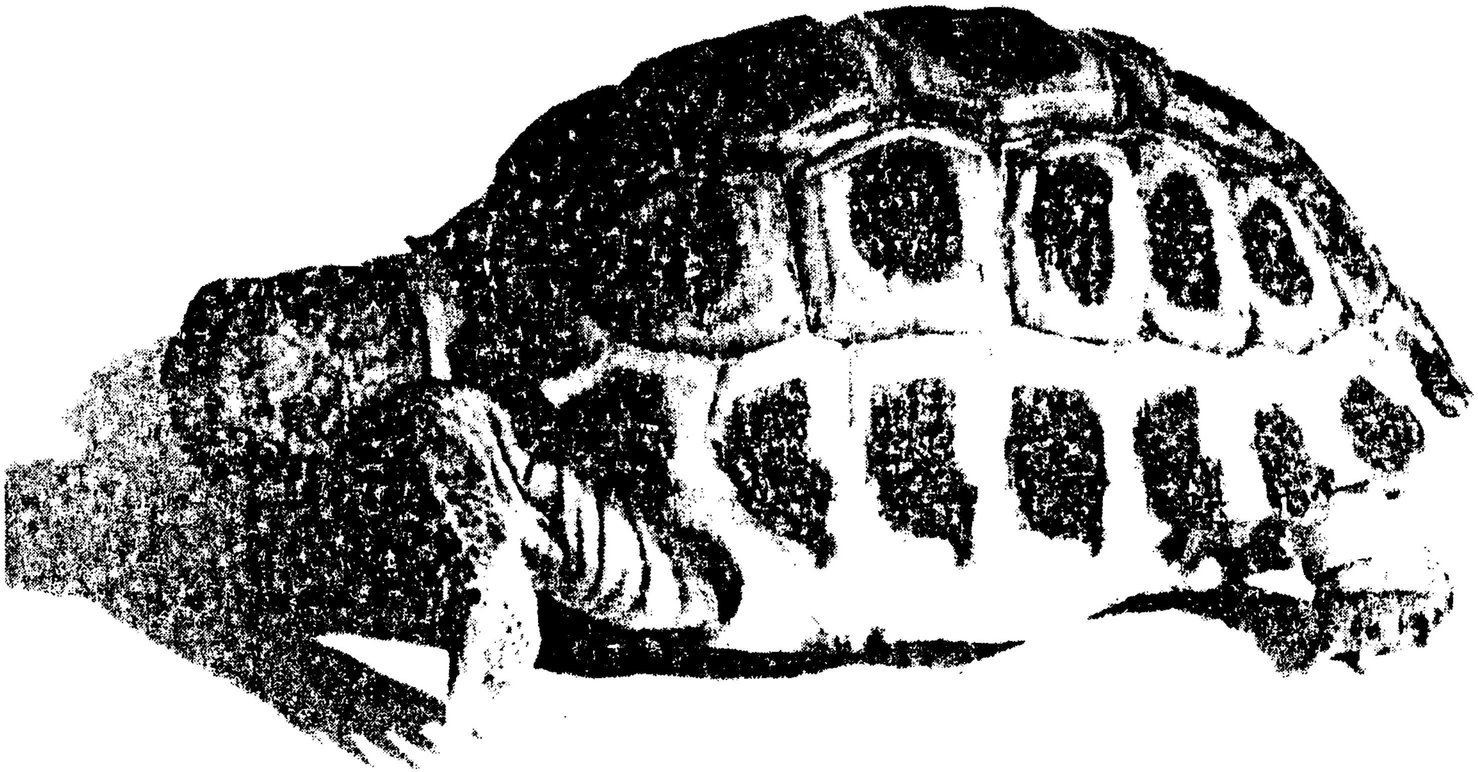

Fig. 2. A 6-month-old bolson tortoise hatchling from our first clutch emerges from hibernation in February 1972. Note supernumerary left lateral scute.

Fig. 3. Typical mating activity of our adult bolson tortoises is shown as (A) the male approaches the female as she comes out of her burrow and (B) bobs his head. In (C) she has turned around and allows him to mount her. She then (D) backs out of her burrow toward him.

Bolson Tortoises (*Gopherus flavomarginatus* Legler)
at The Research Ranch

Ariel Appleton

It all began with one female--given to resident Director of The Research Ranch, Dr. Jack Meyer, by Dr. David Morafka in the fall of 1971. Dr. Meyer started a burrow, covered with a wood frame, in the yard of the headquarters house. The tortoise commenced to lengthen and deepen it, hibernating successfully during the colder months of the first winter. Up to November, she was staked out on the lawn daily, on a chain attached to a hole in her shell, against which she would strain while feeding. Dr. Meyer reported that she fed solely on bermuda grass, accepting no supplement. On 25 May 1972, before leaving the ranch, he took the following measurements along the curve of the carapace: length, 38.1 cm; width, 38.1 cm.

In 1972 Dr. Meyer left her at The Research Ranch, hoping that a mate could be obtained and breeding would result, judging that the climate and summer rainfall patterns were approximate to the native north central Mexican plateau habitat, where bolsons were identified as a distinct species in 1959. Since their identification, the zoos and the scientists who have brought them into the United States have had poor success in keeping them alive and, to my knowledge, no record of breeding captive offspring.

When the bolson came under my care, I named her Gertie, brought her cherry tomatoes, melons, dandelions and cabbage and began to plan for a location and a life that would give her an opportunity for choices and for as much reversion as possible to independence.

By spring of 1973, a 4/5 acre [= 0.3 hectare] enclosure in bottomland below my house was completed, an easily viewed flat grass meadow with an oak dotted hillside to the east, occasional oaks to the western border. When danger of frost was past, I moved her to the new site, weighing her in at 7.257 kilograms. Having provided a large, gently sloping concrete basin set at ground level for water, I set her down near it and watched her wade in, submerge her head and drink deeply for over a minute. This was my first observation of drinking. Probably the steep-sided porcelain sink that had been sunk in the ground at headquarters presented a threat.

During the next 3 weeks she cruised the fence line repeatedly, spending the nights burrowed under fallen oak leaves. I felt it important for her to choose her burrow site, that instinct would guide her to an appropriate grade level and exposure. When there were no indications of settling down, I put a sprinkler on the north area to see if moisture would encourage digging activity. That same evening, a 24-hour rain started, penetrating the soil deeply, and she commenced a burrow at the edge of a clump of tall grass at the rise of the hillside slope to the southeast end of the enclosure. A large harvester ant nest was located about 2½ metres to the northwest of the burrow. The burrow angle was steep; she encountered an oak root about 2/3 metre down, then curved her tunnel to the right and continued excavation for about 2/3 metre more. She made repeated scrapes with one front leg--up to 13 times--then would alternate legs and repeat. Excess soil began building up at the lip of the burrow. I never saw this done systematically. It seemed to result from her movements along the tunnel, both backing up or coming up head first. Eventually a broad, tidy apron, gently sloping outward, resulted. The tunnel had a steep grade and, when alarmed, she rapidly plunged downward. Although she cruised the entire acre initially, when burrowing began she confined her forage trips to an area near her home.

Summer rains were sparse this year, drying up in August. I was afraid the burrow was not long enough to protect her during hibernation at this lower, colder location. Sprinkling the area for 24 hours engendered a period of active digging and by October the tunnel measured over 2½ metres. She foraged actively during the wet summer months, with a weight gain of 1361 grams from May to October, mostly on plains love grass *(Erigrostis intermedia)* and sideoats, hairy and spruce top grama *(Bouteloua)*. I gave only enough supplement to maintain a familiar contact with her, not offering watery foods in the fall as I felt the natural drying of the grasses after the rainy season might indicate that these tortoises go into hibernation without much late moisture intake. She did not go directly into hibernation in November, as at headquarters, but, up to the start of steady mighttime frosts in mid-December, she basked at the burrow mouth during warm hours. In February, she was basking again. A March weigh-in indicated a loss of only 227 grams during the cold period. This has been consistent through subsequent winters.

Spring and summer of 1974 passed with minimum digging activity, seemingly just a little scratching out of manure; I'm not sure if she was satisfied with the burrow depth or if it was due to lack of deep rain penetration. Foraging took place along paths she had made near the burrow, where some clumps of grass are kept cropped by her grazing but produce new green growth steadily during the climax season. These are interspersed among tall grass clumps which remain untouched. Feeding is a move, stop, munch and move process which perhaps serves to protect the grazed clumps from overuse.

Summer gain for 1974 was 1134 grams, bringing her weight from 7.257 kg to 10.206 kg in 17 months.

Gertie was shy and wary but had confidence in my presence. Early in the summer of 1973, both before and during the onset of digging activity, she would go out of her way to come to my feet or close to my side while I was seated watching her. She did not approach if I was standing.

A herpetologist visited during that time, grabbed her as she was diving down the burrow and showed her to a companion. After that experience, she reverted to extreme wariness and has never regained the initial familiarity but she does respond to my knock on the plastic hood that is placed above the burrow opening. Even during a winter drop to a record -20°C I heard her move in answer to my knock and knew she'd weathered the extreme cold, also that hibernation is not a precise word for her winter condition.

I have always been careful to keep her in a horizontal position on the necessary occasions for handling, during weighing and measuring. Even when I transported her carefully by car to the pasture site, there was no apparent trauma. Tortoises have reason to be fearful of being overturned; exposing their vulnerable areas and intestinal torque is a factor in tortoise mortality. Beyond that, with such a wary and reclusive species, I believe it is important to maintain a nonthreatening atmosphere both for their own well-being and for purposes of observation.

With a healthy Gertie, established, gaining weight and living on the native grasses, with a threatened population of bolsons in Mexico, it certainly seemed logical to try for reproduction, but ideas are one thing, their realization another. The Office of Endangered Species, in Washington, D.C., would not sanction importation until all possible sources in the U.S. had been examined. I called zoos, stalked scientists with a background interest in bolsons, received varied and conflicting opinions as to the merits of a breeding program. The sad fact was that many bolsons had died after importation to the U.S. Getting to know a number of private tortoise collectors was the one bright side of months of frustration. They cared deeply for their charges, lived closely with them, developed much needed medical skills to treat them, and shared their experiences with patience and generosity.

Eleanor and John Janulaw, in Los Angeles, had a breeding pair of bolson tortoises and were incubating young successfully. They introduced me to Max Greene and his wife, in the Ojai valley, who were raising some of the Janulaws' hatchlings. The Van Swinderins, in Phoenix, came to visit TRR and kindly arranged the donation of a hatchling bolson. To my sorrow, I was not able to keep him alive.

In 1976, Dr. John Hendrickson of the University of Arizona, in cooperation with The Institute of Ecology in Mexico City, put together a program whereby 15 tortoises would be imported to TRR from Durango, Mexico--captive stock, not taken from the wild. Dr. Hendrickson transported the tortoises from Mexico by jeep, so it was Christmas in July as we unloaded crates, unwrapped burlap bags and installed 15 healthy bolsons in a pen at headquarters for a period of quarantine and observation. Eleven tortoises, under Dr. Hendrickson's direction, were to be placed in a 2.8-hectare enclosure of tobosa grassland (*Hilaria mutica*--said to be a major food source of bolsons in Mexico) for ecological fieldwork, experimentation and observation on reproductive and general social behavior. Four tortoises would join Gertie in her enclosure, now divided by a center fence, as a breeding herd under my care. Funds for Dr. Hendrickson's pen and for the crossfencing of Gertie's area were donated by SAFE, through the assistance of Dr. Thomas Lovejoy.

Dr. Hendrickson had been informed that there were 2 males in the group. Examining the plastrons did not yield much information about sex; there was little concavity, all the tails were fat and stubby, the gular shields were similar in length. We made a guess at 2 possible males and I took them to the north section of my enclosure. They immediately began eating and cruising, sheltering at night in a dog crate I had placed in one corner.

The next day I selected a large, light colored tortoise from the headquarters group to join the 2 males. She immediately began foraging down a center path, demolished a vine of the pea family before I had a chance to identify it, was bobbed at by the males when she encountered them but I observed no further interaction. They all sheltered in the crate at night.

Meanwhile, I was waiting to place one male in the southeast enclosure with Gertie but first wanted to make sure the new arrivals remained healthy. I had put a temporary fence around her burrow so there would be no chance that the newcomer would preempt her homesite.

The afternoon of July 11th, I noticed Gertie in a new activity, digging a hole with her back legs on the rise of her burrow apron, then bracing herself with back legs in the hole and pulling forward on the front legs with her rear straining down. It looked like egg-laying behavior to me but there were no results. She then came off the apron, cruised around the small enclosure scratching dirt here and there, then back to the burrow to dig again halfway down the ramp, again straining and subsequently scratching dirt with her front legs. Did she scent the newcomers after her long solitude?

The next day one male attacked the other, ramming him and looking as if he was trying to overturn him. No such action was taking place with the group at headquarters; they were relatively passive, resigned to human interference. The group in my area seemed well oriented, alert and reverting to a wilder state. Gertie was going through the back leg digging routine again.

On the 13th, I moved the more aggressive male to Gertie's temporary pen; they advanced towards each other, the male, half her size, bobbing actively, Gertie looking purposeful. They met and clashed; he scuttled away, she in hot pursuit, moving faster than I'd ever seen her. I removed him from her temporary enclosure but left him in the south 0.2-hectare pen, hoping he would start to burrow and I could then remove the fencing around Gertie's home without fearing she would be ousted, although now I'd watched her in action it hardly seemed likely.

In the north pen, the remaining two were still cruising the fence lines, getting the lay of the land. Bolsons don't seem to like exposure to rain, always take shelter if possible. The first week of introduction to the new site, the weather was unusually cool, overcast and drizzly. I hoped for sun and the beginning of burrowing. On the 20th, the male in Gertie's area began a burrow at the south fence line, continuing to deepen it on subsequent days. Because he outran Gertie and was the first to start digging, I named him Spry.

Dr. Hendrickson gave me permission to select a second female tortoise from headquarters (presumably they were all females) and I brought over a medium-sized yellow one, who virtually fell upon the grama grasses like manna from tortoise heaven. I placed her near the crate. The male emerged and bobbed rapidly. She walked away; he didn't follow.

The big female is named Jane, the smaller one is Laura, after Dr. Jane Bock, TRR's current President, and her daughter. Seems only fair since they give such tender care to Mrs. Appleton, a South American red-footed cousin, who travels with them between Boulder and TRR.

In August, Jane started a burrow at the roots of a bush in the north pen. Soon Laura selected her site, about 15 metres removed, under a clump of Sacaton grass. The male still uses the crate as shelter. There doesn't seem to be interference or interaction between the three and they've established roughly separate areas for foraging. Spry's burrow is down about 1¼ metres, not as steep as Gertie, Jane and Laura's and curving left rather than right as theirs do. The rains continue, the ground is damp and I'm sure this contributes to digging activity. Gertie's temporary fencing has been removed and she spends a lot of time visiting Spry's burrow--sitting on the apron, sometimes trying to force her way in, but the tunnel is too small to accommodate her.

In late September, the small male in the north enclosure started digging on the west side of the north pen. The rains have stopped and as the ground dried, he lost interest, so I saturated the hole while he was out foraging and this speeded activity to up to a foot a day of digging. All the new tortoises now had burrows about 1¼ metres long and should be safe for the winter. Gertie's burrow, spiraling to the right, was about 3.7 metres in length from the burrow lip. Three out of four of the new burrows faced southwest as did Gertie's; the fourth, last to be dug, faced southeast. The angle of slope at the mouth is between 26° and 28° on all burrows.

By the end of October '76 Spry had gone from a weight of 6.237 kg to 6.634 kg, Potent (so named when he was observed twice during the fall in mating action with Jane) from 6.577 to 6.690 kg and Jane from 8.505 to 8.647 kg--not as rapid a weight gain as Gertie but they were placed in the enclosure and began a diet of wild grasses and plants later in the summer--July vs May. My weighing records are insufficient but Potent, for example, weighed 7.325 kg in May '77, and 8.278 kg in March '78, a weight gain of 1531 grams in 21 months. Gertie gained 5216 grams from May '72 to August '77, and her carapace length increased from 38.1 cm to 47.62 cm.

Dr. George Milliken assisted with observations from March to August '77. His charts on average daily foraging, social behavior and basking are available on request and his notes have been invaluable to me in reviewing my own obsersations of behavior. I am not a scientist; the notebook is never at hand when things start popping but the visual impressions are indelible.

On the average, February is the month when basking begins, mostly head up at the burrow mouth, sometimes rear end up, sometimes sideways. Depending on temperature, there is some movement beyond the burrows in March and April, for water and frequent foraging. Food doesn't seem a requirement at that season. The first scats are cast about that time. Laura did not appear, or disturb the cobwebs at the mouth of her burrow till 13 April--why? The others have been seen since mid-February. On 3 April, Potent made a trip to the water trough, even though there was snow on the ground at dawn and the afternoon temperature was 11.7°C. Mostly, action takes place at temperatures around 21°C or over. At the end of April, we noticed head bobbing when a tortoise would return to its burrow, 2 or 3 bobs.

May 1st, Gertie visited Spry's burrow; ate a mixture of dry and green grass on her route home, and actively foraged that day over a wide area; drank, submerging her head 2-3 times for 15 seconds at the depressed concrete water basin, waded through it and on home, bobbing her head up and down once as she climbed the apron. All the tortoises were doing some moving and foraging by mid-May--the rains are still 6 weeks off. Temperatures at the time of activity are in the 20°s. Gertie has been more active than the rest; perhaps it is just that she's been established here longer.

June 7th, Jane brought up some moist earth with decayed fecal matter to her tunnel entrance. The group is grazing actively. At 12:45 Gertie was visiting Spry again--scratching with her front feet, bobbing her head at him, trying to enter his burrow where he remained protected, head facing out; she wiggled from side to side, moved her hind legs, gave up and went off to forage. There was distant thunder and the sky was overcast, a few raindrops fell and Gertie returned to Spry's burrow, bobbing at least 60 times, scratching, going up to the tunnel entrance and touching Spry, who was facing sideways, halfway out of the tunnel overhang. She put a left front foot on top of him and chewed at the soil above the burrow mouth. Gertie then walked over his exposed half, out of the burrow, foraging on her way home.

I'm sure the relative humidity is an important factor in tortoise action; it reached 45% this afternoon.

On 12 June, a scat found in the north pen contained 13 small stones weighing a total of 24.1 grams (the largest weighed 9.2 grams and was 3.1 centimetres long). It also contained a woody stem 5.5 centimetres long and several undigested, dried oak leaves. Dr. Milliken's summary: not very selective as to what they eat; my guess: that it may be a purging process.

Rain on 22 June and the next morning Potent was at Jane's burrow, bobbing his head and mounting her when she turned to face down towards the tunnel. Plastic hoods had been placed over all the burrows for winter protection and were low enough to dislodge Potent as Jane slipped down towards the burrow mouth. I removed the hoods. Early afternoon, Gertie visited Spry's burrow--he must have been out and when he returned and found her on his burrow apron he ran in frantic circles, then took off and hid under a small oak, motionless for ½ hour. Then Jane visited Potent's burrow and head bobbed, but he remained in the tunnel entrance.

June 24th, Potent was at Jane's burrow at 0830, but left and ran rapidly back to his home, reminiscent of Spry's fast movement. Laura keeps to herself.

The tortoises have good eyesight--notice observers at least 60 metres away. They are also aware of footsteps--ground vibrations, I believe--but I notice no response to human voices, even when loud.

They have begun to kick back soil with swipes of the front feet when they reenter their burrows, sometimes just a motion or two, sometimes up to 30 times.

Jane will accept supplement of melon, or cabbage as does Gertie, who comes out to get it when I rap on her plastic roof. She will move out from deep down in her tunnel at the familiar "3 knock—2 tap" signal.

On 1 July, Laura was head bobbing at Jane's burrow, up to 100 bobs in 3 minutes; Jane came out, hissed, turned to the left and faced towards her tunnel; Laura mounted her but was pushed off by the borrow top as Jane slid into her tunnel. Laura ???? went home.

On 3 July, Laura (rechristened Larry) visited Jane again, bobbed her up from the burrow twice, mounted and slid off the first time; then, with Jane sideways to the tunnel, rather than facing towards it, mounted her for several minutes, grunting with each thrust, then left. There was moisture on the earth and also around Jane's tail.

Potent was keeping to himself--intimidated by Larry? Gertie was still visiting unresponsive Spry. Larry revisited Jane often. One afternoon he made the same kind of running dash along the north fence that had been observed with Potent and with Spry. I haven't seen this behavior with Jane and Gertie.

On 18 July, I decided that Spry was too intimidated by Gertie to woo her. When he was out foraging I carried him to the center dividing fence and placed him on the north side, about 2½ metres from Larry who was feeding in the area. Spry moved forward, then Larry approached, both bobbed heads, rammed and Larry quickly upended Spry, rolling him backwards over his tail end. I righted Spry and carried him to Larry's burrow lip, then placed Larry in the south pen in front of Gertie's burrow. Spry left Larry's burrow, headed down the center path and turned left to Potent's; he head bobbed and appeared to enter the burrow mouth, backed up, bobbed, then returned to Larry's burrow (his new home), then back to Potent's burrow for behavior similar to Larry's courting of Jane. Later in the year Potent was seen responding to Spry's bobbing; he came up to the crest of the apron, turned to face down towards the burrow mouth and allowed Spry to mount him briefly. Subservience to dominant male? Potent is larger and heavier than Spry. He certainly acted a male role when observed courting Jane.

Meanwhile Gertie did not appear so I carried Larry to Spry's old site; he circled 0.6 metres from the "porch," then returned--kicked soil with his front legs and descended. The next morning, he and Gertie met about 15 metres from her burrow--she was headed towards his. He advanced rapidly, biting at her head and front end; she turned back to her burrow, proceeding rapidly, while Larry, half her size, tried to run in circles around her, snapping and running till she reached the top of the apron, headed down the beginning of the funnel slope, where he mounted her an extended time, thrusting and grunting for over 15 minutes. I tried to approach cautiously but could not see if there was successful copulation.

She braced herself well and didn't slide downward so that he would be dislodged by the tunnel lip, as Jane so often does. At the end, he came up to the crest of the apron, bobbed and returned to his new home. Spry, still bobbing at Potent, hasn't visited Jane's burrow.

July 21st, I decided to replace some of the earth of Gertie's apron with a sandy soil. She was lying in her tunnel when I started digging on the right side at the crest and, to my horror, the first shovelful brought up a broken egg shell and exposed, from as much as I could see, 2 more broken eggs and 4 intact. They were about 13 cm below the surface, carefully deposited very close together, end up, in a circle. The broken eggs seemed very fresh--could they have been fertile, from the mating only 2 days before? As I removed the broken pieces and one whole egg that had been knocked sideways, Gertie was moving closer and, as I tried to replace the soil carefully around the eggs, I was lying on my side sheltering them with my arm to hide the crime. She came to my arm, turned sideways against it and pushed at me, an unprecedented action. I hastily patted down the soil and moved back. She then placed herself over the disturbed area, motionless. I noticed her there frequently during the summer. On advice from the Desert Museum as to incubation of *Gopherus agassizi* eggs, I placed the removed, whole egg in a bucket of dry sand and kept it at a temperature between 27°C and 29°C until the following spring. It had spoiled. At that time I dug carefully at Gertie's burrow lip but found no trace of eggs or shells.

In the future, I plan to try for natural hatching with half of a laid clutch and remove half for artificial incubation, following the Janulaw's procedure. I also believe it would be wise to improve the soil condition at the burrow aprons, again following John Janulaw's advice. Eleanor Janulaw's observations of her bolson also indicate that the female is conscious of the location of her clutch and resentful of interference.

Spry is now bobbing at Jane's burrow, without response.

July 24th, Larry visits Gertie, head bobs for 40 minutes, no mating behavior. Apparent copulation the next day, also on 27 July. Larry seems settled in his new surroundings but Spry was seen trying to climb the dividing fence on 29 July, and he and Larry met and clashed, through the fence mesh, with their bodies at a 45° angle. Gertie dug extensively with her front feet at Larry's apron that afternoon; then mating activity was observed, but not for long; then he followed her to her burrow, biting and running in circles and mounted her as she faced downwards, their bodies at about a 75° angle. Does this make copulation easier? The action took place for at least 12 minutes. There was a circle of moisture on her rear. Additional mating action at Gertie's burrow 30 July and 4 August.

Manure is being brought up from the tunnels, and scattered on the aprons. It must be dropped at the back end of the burrows as it is seldom seen in the visible portion of the tunnel mouth.

Dr. Milliken took measurements with two carpenter's levels and noted that Larry tried to defend his burrow, coming up, turning sideways and hissing when the level was placed on the burrow crest. Jane, Spry and Larry all actively tried to push the level away from the burrow.

Spry has been observed in mating action with Jane several times, always near the mouth of her burrow. Potent keeps to himself. As the rains cease, there is foraging and mating behavior through the fall, till the onset of cold weather.

Until severe cold sets in, the tortoises bask at the mouth of their burrows and, this mild winter, they were all visible well into December.

Gertie will respond to the knock signal to come up for an occasional cabbage leaf and I am continually mesmerized by her deliberate ascent from that steep nest, carried back in time to where man, my tribe, was just a gleam in the eye of cosmic design, then forward to the hope that this small group will thrive and reproduce--contribute to the endurance of their kind--and the sentence of captivity that lies upon them will be justified.

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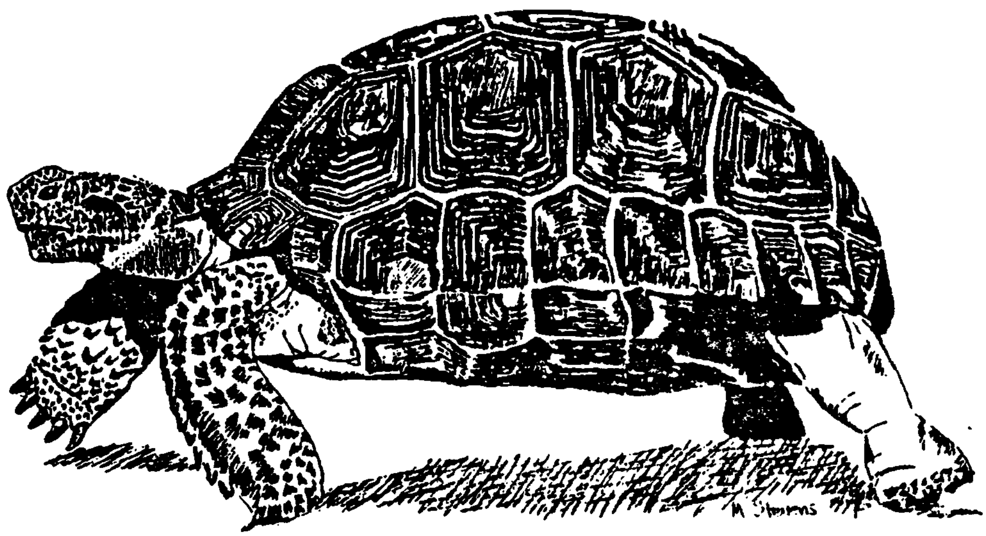

The Bolson Tortoise

A Panel Discussion

David J. Morafka, *Moderator*
Department of Biological Sciences
California State College, Dominguez Hills

J. R. Hendrickson
Department of Ecology and Evolutionary Biology
University of Arizona, Tucson

John Janulaw
California Turtle and Tortoise Club
Los Angeles, California

Ariel Appleton
The Research Ranch
Elgin, Arizona

Morafka: From the comments that have been made, I think there are several areas to focus on. One is where to continue baseline studies in the field. Another is where, how, and what should be done to bring young tortoises through their ontology to reproductive size. Obviously this is a very serious issue. The third is what constitutes an appropriate place to reproduce and maintain bolson tortoises.

Walter Allen (California Turtle and Tortoise Club): You mentioned a place to put the tortoises. Where in the United States is there a place similar to their native habitat in altitude, temperature, etc.?

Morafka: From my own information, there are two areas that are most similar. One is the area around the Hevo Basin in TransPecos, Texas, which was recommended to me by David Riskind of the Texas Park and Recreation Department, and he's pointed out several alternative areas that might be suitable. They do have this tobosa grassland. Pleistocene tortoises of similar physique inhabited those areas. Climates and elevations are quite similar. That's one area that comes close to their current habitat, in some ways virtually continuously. Another is certain areas in southeastern Arizona, particularly in the Patagonia area. Tom Van Devender, whom I've mentioned before as being particularly active in the study of the fossil tortoise, has made up a "flavo chart" for me based on climatic considerations from a number of long-term stations in southeastern Arizona. Some of the grassland in southeastern Arizona is a little bit lower than The Research

Ranch in the areas of 3 to 4,000' towards Nogales. We may be close to finding an optimum as far as climate goes, but there are still issues there looking at specific sites and looking at substrates, dangers of predation, and the legally protected nature of the site. In those aspects The Research Ranch is nearly ideal because of its protected nature. Too, to defend myself against John Hendrickson's accusation that I overplayed tobosa as a factor, if you treat me as a rare and endangered species and observe my habitat, I tend to eat a lot of bagels and lox and cream cheese, but I don't recommend your using that as a substrate to keep me in, or as an all-inclusive bottom line for my reproductive and social needs. After about two or three hours at the Sahara buffet, I'd really feel pretty bored with the whole thing. That's why climate and substrate have to be considered. Quite frankly, the areas that are optimal for tobosa as far as density are not optimal for tortoises themselves. They're on the edges of the tobosa grassland, not in the heart of it. So all that glitters isn't gold, and all that's covered by tobosa is not prime tortoise habitat. It's just one key to start looking for. But those are the areas--southeastern Arizona, the very lowest parts of southern New Mexico, and TransPecos, Texas.

Hendrickson: I have a feeling that if a captive gene pool rather than a truly natural population is what's desired, and frankly it's the first that I'm interested in at this moment, then you have a wide leeway. I'd be perfectly ready to push my colony--by the way, I don't want to move my colony that Ariel has given me space for--but were I to move it, I would be perfectly ready to move to some of these Mohave Desert areas if I would be allowed to manipulate a little bit and produce a little more green forage. The soil, the slope, and things like that suit me just fine. There're all sorts of places. I'm becoming less and less convinced that each animal has its own magic formula which must be conformed to to have any success with it. I think that all these things--the skeletal adaptations which are so distinctive about *flavomarginatus* and a whole lot of other things like this--are the fine-tuning of evolution that results in success eventually, but are almost inconsequential as far as immediate survival and reproduction goes. My animals act like *berlandieri* in many ways when they have such trouble burrowing in that soil, and then you give *berlandieri* a more friable soil and I'll bet a buck it'll burrow more.

Appleton: I hope that Dr. Hendrickson will talk to the Scientific Committee at The Research Ranch--of which I am not a member and I do not make these decisions--if he feels there would be a more appropriate site. I think that we have a dichotomy on The Research Ranch because this is a manipulative situation in that we have put in a 7-acre pen. The installation of a 7-acre pen has taken place though we are basically an organization that wants to let nature do its thing. So disruption of the land in this way is something that we only do for very exceptional reasons. But I think that it's certainly worth considering. It's been heartbreaking to me to think of a colony there not settled down to the extent that scientific observations can be made.

Hendrickson: If I may immediately respond, David, to get this past. There is no point to any misunderstanding here. The place at The Research Ranch, because of what I've just said, ought to suit me just about as well as any other if I just leave the artificial burrows going for the ultimate bit of protection. They're already dug, and as long as I keep that lower one from flooding, which isn't too hard to do--just rearranging the soil that's already been disturbed to provide little dikes so the runoff doesn't go into it or really nothing that I see amounts to further manipulation--I think maybe all they needed was the time. It just took longer than I wanted. They went through a bad time. But, getting right back to what I'm saying, I don't think that we have to fine-tune all of these little details too much. Give them a chance. Put them in good health. They're going to make do in a whole lot of different environments.

J. Janulaw: If they can reproduce in Los Angeles, anything is possible.

Kristin H. Berry (California Desert Program, BLM, Riverside): Will the females be able to dig nests at The Research Ranch?

Hendrickson: That's what's worrying me, Kris.

Berry: I've walked around your pen and the big question in my mind is if the soils are suitable for nesting, especially after hearing about the problems with the giant tortoises.

J. Janulaw: Just importing a slight amount of builder's sand and some other softer, more powdery desert soil, about six inches to a foot deep on the mounds I mentioned, seemed to create an environment more conducive to the females in laying eggs. Just this slight change in the yard really helped.

Appleton: Can you tell us just what these soil conditions are in which egg laying takes place?

J. Janulaw: The burrows are a moderately hard mixture of soil including sand and clay. The first 3 feet are fairly easy to dig, but deeper into the burrow, the soil is harder. The egg laying, as far as I've been able to tell, is close to the surface in the mounds. That soil contains about 70% sand--

much more sand than I anticipated--according to a soil analysis.

Hendrickson: David, to illustrate this, I would say that in the places I've seen at Rancho Benthon and Chihuahua and in Mapimi, a person my weight could take an ordinary garden spade and go--wham!--and get that spade halfway down with the first bang.

Morafka: Oh, yes.

Hendrickson: Now Ariel knows that you'd break your foot if you tried that out there at The Research Ranch. I mean, it's like trying to do that on this floor because that tobosa sod is the most resistant stuff I've met in my rather extensive experience with soil. I have never met sod like that.

Berry: What is the soil composition in the mounds at The Research Ranch?

Appleton: It's pretty tough. It's occurred to me that it might be hard for hatchlings to break out of it. Of course, I discovered the eggs when I was going to replace half of one mound with some sandier soil. And I still think maybe John Janulaw's suggestion is good--that I ought to do that perhaps with half of each of the female's mounds to give them a choice of a slightly more friable, porous soil.

Eleanor (Mrs. John) Janulaw: Our female bolson usually digs her nest close to the burrow-pipes, either to the back, front, or sides. Also, she sometimes digs in the sandy loam behind our garage. For our other tortoises, we break up the compacted soil with a steel bar.

Hendrickson: That sounds perfectly logical. Policies at The Research Ranch are very finely drawn. They're reasonable policies, but very finely drawn, so every little manipulation like that is the kind of thing that should be discussed with the Committee. But I agree it's a ready-made thing. I have a needle-ended bar and know exactly what you're talking about and that certainly would be the kind of thing that should be discussed.

Appleton: I guess the thing that worries me, John, is in the three-fourths to four-fifths of an acre here--granted only three tortoises in one end and two in the other--nevertheless, they do seem to have established individual burrows. And is there a reason for this? Does the female prefer to be in a solitary site where she lays her eggs on the apron? Will that work with your communal burrow? I just don't know.

Hendrickson: I don't know what to expect out of the communal burrow. That's an insurance policy. That's all it is. I hope they stop using the burrow until winter comes. That would suit me just fine, and maybe it would even be good to block it off.

Appleton: I think it was most interesting that in the cold weather your tortoises that wouldn't accept the burrow sustained themselves in very shallow depressions the first year.

Hendrickson: That's another thing--cold tolerances in these tortoises. They come from rather far south, and at first I was pretty touchy about the whole business because The Research Ranch gets quite cold--and often. I was really worried about it. I was frantic, as a matter of fact. That's why I built all those vinyl tents and everything, but I had to live with animals that would be put at the entrance to the artificial burrow, go down it, and next time we'd come out--which might be the next day--they'd be gone. If you'd wait 2 hours, they would sneak out. And they'd insist on going off to their own place. And tortoises were not even so far underground that the last part of their carapace was not visible from directly above. In other words, they had no complete shelter at all in 20^{o} below freezing--12^{o}F--temperatures, which were sometimes, on a cloudy day, maintained for 36 to 48 hours. As it can do there, let the sun break through and the temperature goes up to 70^{o}F and these animals come out and bask. And then they go back down. They super-cool. They've got to super-cool. And they're able to stand it apparently. They can take a lot more low temperature than I at first thought.

Morafka: The area from which they come is south in latitude but it's quite high in altitude--4,000' or more--and it's quite arid. There's often not a lot of cloud protection. There's tremendous exposure by winds, and local weather stations do report temperatures of 16^{o}F in their native habitat. So they are exposed to a brutal range of temperatures.

Appleton: And they're in a basin, too.

Hendrickson: Well, on the periphery of it. Probably not directly exposed because of the extent of the burrows, but still those are pretty brutal ranges of surface temperatures.

Berry: I'd like to ask John Janulaw why he thinks he has such a high mortality rate in the hatchlings--from 72 down to 5.

J. Janulaw: It would be interesting to make a comparison with, say, the *agassizii* of how many hatchlings really make it to adulthood. There is a tremendous attrition rate, at least in the wild, both from predators and from natural causes such as the harshness of the environment. I have no figures on survival of those born in captivity. Regarding the mortality rate in our hatchlings, there's the possibility that the adult pair of bolson tortoises we have may be closely related because we've had hatchlings with cleft palates. These tortoises were not able to manipulate their jaws to eat, although they were sturdy, healthy-looking animals. The only problem was the cleft palate.

E. Janulaw: Sometimes they had double cleft palate, one on each side. They were all healthy and active with harelip. Of course, with no palate it's hard for them to bite and swallow.

J. Janulaw: There is a high percentage with that problem. It's possible that the male we have is the uncle of the female or other very close relative because they were collected from the same area. Through hundreds of thousands of years and not travelling a great distance, they are localized in large burrow concentrations. There was no new blood brought in. This might be the reason for our problem, but I think that more experimentation in warm enclosures for these tortoises, and experimentation with foods is indicated. Just this last weekend we took the tortoises up to Max and Lillian Greene in Ojai--they're taking care of them now--and put them in a pen where they saw sawbugs. They charged after those sowbugs with their mouths open. We don't have that many sowbugs in West Los Angeles--we could find them, I'm sure--but the tortoises are starved for bugs. I believe Dr. Morafka mentioned in one of his talks the fact that they possibly live to a certain extent as hatchlings eating insects because their jaws are not able to crop off the grass at this tender age. They have to eat other items of food. I think more observations of hatchlings and their behavior will have to be made in the field.

Morafka: Natives in Durango have observed hatchlings eating the new green shoots of tobosa.

E. Janulaw: John, you also might bring out that we feed droppings from the female to put friendly bacteria into the hatchlings' food to help their digestion.

Hendrickson: Well, let's face a couple of facts here. Second time around is not a completely unusual policy in the animal kingdom. Rabbits depend upon it all the time. Cows, if you don't give the calf a chance--maybe this is not true, but that's what the cowmen tell me--if you don't give the calf a chance to get dirty with its mother's feces, you'll likely have a sickly calf. You've got to have these bacteria. Any of these animals eating a lot of coarse vegetable material need it, and a lot of them get just as much out of it the second time around. Most of you've seen tortoise feces and it looks like there ought to be a lot of good there they didn't make use of. I'm perfectly ready to accept in my ignorance the idea that the Mexicans have which is that the baby tortoises in the Bolson run down the burrow--get their first shelter down the parental burrow as much as anything else--and that they graze on the triturated feces down there, as well as the crickets and sowbugs that are in it. This is all anecdotal. I don't have any basis for it whatsoever, but we're not getting totally satisfactory results the way we are so we've got to keep an open mind to anything else. I wouldn't hesitate a minute, even on the parasite load. I'm less impressed with parasite problems than most zoo people are because I don't suffer so much grief from it, you see. But even with a parasite load, I'd still think it might be so important in survival that I'd take a chance on it. I'd make adult feces--and MOIST adult feces--available to those babies practically all the time, if I were running some experiments on it.

E. Janulaw: We have been feeding female feces to our hatchlings for years.

Hendrickson: Now one thing, I know David has been down in the burrows, and I have, maybe most of the rest of you haven't, so it's worth trying to share some experience that way. I had a picture there with that kid way down in the burrow. The one burrow that I saw--well, I saw that one and I've seen two burrows excavated--and the arthropod life down in there is considerable. We didn't happen to hit any snakes or anything else, but we did hit plenty of crickets--cave cricket type things, and so on. There's a fair number of arthropods down in there, at least I found them. Did you, David?

Morafka: A few. Actually, I saw the burrows at a very dry point in the year, but there were some arthropods and I would have expected a good deal more if things had been a little moister.

Hendrickson: Most of you are familiar with this little soft-bodied succulent cave cricket with the long legs and the very long antennae, and we found numbers of those down in both the two that I saw.

Morafka: And a number of tenebrionid beetles. If anyone's planning to pursue this, I should advise you that the common rattlesnake in the area is the Mojave green, and it tends to make its presence rather cryptic until it's too late. I have found those more when pursuing *Uma* sand lizards than tortoises, but I've found them within a few feet of the burrows.

Appleton: Can I ask, also, if you have noticed in the wild the relative lack of feeding in the spring--basking activity, but no feeding? And have you noticed this even in Los Angeles, John?

J. Janulaw: Yes.

Hendrickson: This kind of observation in the wild is most difficult to make.

Morafka: I've been told that by the natives, but I haven't been there at critical times.

Hendrickson: That's it. Neither have I.

Appleton: This is the second year around now.

E. Janulaw: Our adult bolsons had only been out of hibernation 3 weeks when they took their first mouthful of coastal bermuda grass last year.

Appleton: Los Angeles is a lot warmer than The Research Ranch.

Morafka: Gary, do you have a question?

Gary Adest (California State University, Los Angeles): Just a couple of interrelated observations and related questions. It seems apparent to me at this point from what James Bacon told us and what Dr. Hendrickson told us and what the captive breeders have pointed out that both soil composition and temperature are very broad profiles about these tortoises and probably the only specifics about this species that we do know. Along that line I was wondering exactly what the Mexican Government had planned now that they have the specifics for a desert laboratory, particularly related to things like temperature, egg sites, home burrows, densities, and home ranges of individuals--base-line data that nobody has collected in the field.

Hendrickson: I have a proposal, David. It's probably a wild one--I've never made one like it before--but I'm going to answer your question and then move straight into the proposal.

Adest: May I please say one more thing--that the idea of inbreeding genetics' effect is probably not really a farfetched one considering that the Chihuahua Desert was a good candidate for an isolated, low-lying desert refuge in the past, much like an island. Western and eastern sand lizards have very low levels of genetic variability when examined electrophoretically.

Hendrickson: The question was about what plans does the Mexican Government have? The best answer I can give, and you must understand I could be wrong--I'm not inside Dr. Halffter's skin and don't necessarily know anything he didn't tell me in advance, but I'm interpreting with fair confidence--the Mexican Government has in mind a general productive, scientific program to elucidate the environmental requirements and the *status quo* of the bolson tortoise and nothing on specifics--nothing on specifics. Now the proposal that I would like to put forward is that this society, or a group of people from this society, really give fairly serious consideration to pooling two or three cars and making a trip down there. Give them the satisfaction of seeing these dormitories fully used by a group of Americans who are passionately interested, answer the questions that you'll be asked by the people on the spot, ask your own questions, and with the kind of people that are sitting here in this room today, a result would be a program which the Americans didn't lay out on paper and send down. It'd be a Mexican-devised program. And then look for bits and pieces of it that attract various people here and my guess is that even the first time down would have enormous side benefits for the *ejidos*, the cooperative peasant farmers who are looking for a chance to rent horses and to serve as guides, and so on. In addition to that, I think there'll be pieces of action which will include volunteering by the Mexican Government of no charge for the dormitory as long as you want to stay there. They may promise you a dual-wheeled dump truck that can safely get you in and out at any season once every week--or some facilities like that at no charge. They're ready to put up some money on it, but get some activity started--and I think they're primed for it right now--they're absolutely primed for it. It goes beyond that. I think that if it goes more than a year more and goes stale, then the usual may happen.

Adest: It seems to me that the scientists and captive breeders are going to have to work cooperatively; a number of suggestions that came up today would be things to directly look for in the field, e.g., soil characteristics and juvenile foraging. The captive breeders have indicated where we want to look in the field based on their data.

Hendrickson: I'll give you one other thing, but it's all tentative. I don't have anything definite at all. One of my tentative plans--and I've got to make it clear that I'm not making promises because I have four other major projects and this is the real sideline on the other things that take most of my time--but I've been collecting information from some of the people around here that have been very good about giving it. I intend to produce a fairly short and sweet package proposal for radiotelemetry to instrument a small select number of animals. I intend to put in for enough of a grant to cover about two years of visits down there, plus a certain minimum off-the-shelf radio package, plus some air-charter funds because the man who owns the 20,000 hectares that are reserved for this use now, and donated the 20 hectares, is a pilot who has his own little airstrip right there. Get him to fly a whole bunch of transects while I'm leaning out the window of that light plane photographing, and try by means of this photographic beginning to make plots of the soil heaps of the active burrows, plus the very conspicuous excavated burrows which will be ten to every one of the functioning burrows and begin to get some idea. Give this to the Mexicans, they'll begin to get an area distribution plan, then make the land surveys according to where the air photos show it. I think this can be done rather rapidly, straight forward--no big deal--find the concentrations, put the radios on them. At least, it's a start. To this you can add any number of other things. All sorts of people have different ideas, but I'd like to get something started.

R. Bruce Bury (National Fish and Wildlife Laboratory, Ft. Collins, Colorado): The Director of my lab, Dr. Clyde Jones, is supportive of research in Mexico. He has talked directly to the USA-Mexico Joint Committee on Wildlife Conservation about the plight of the bolson tortoise. We must make sure of protocol and cooperation with Fauna Silvestre. They now have identified the bolson tortoise as a species needing study on a cooperative basis. I think the idea is terrific. People could go down there and visit, get involved, but Fauna Silvestre should always be actively included. I think it's critical that the Mexicans initiate the basic work.

Hendrickson: You're absolutely right.

Bury: Tortoise researchers here may try to write or talk to several individuals in Mexico, which could cloud our interests. Somebody has to make contact in a unified manner.

Hendrickson: I will be very happy to help in any way I can, but any Spanish speaker can have a direct telephone conversation with Dr. Halffter with no trouble at all; I've got his telephone number. You can write to him in English, of course; I've got the addresses. I'll lay it out for anybody. That's what he wants me to do. I am speaking for him.

Berry: I think you're at a great advantage because you can speak Spanish. I did get a letter from Dr. Halffter in English, but I regret that I can't speak or write in Spanish. What I wanted to ask you is when you'll have time to go. I personally would love to go, and I'd like to stop by The Research Ranch in Elgin on the way down.

Appleton: Take me with you.

Hendrickson: I really would like to get something going. The best time to go... I'll say this about it. Plan on the monsoon rain system the same as southern Arizona has and so tell yourself: if it's the first of July--let's just say roughly speaking--to the end of July, then we're going to hit the rainy season. Now there may be reasons for hitting the rainy season. That's when all the tortoises in the Bolson get drowned out of their burrows--the tracks are going this way and that all over the country--and are all out in the open for you, roasting under the nearest creosote bush till the burrows dry out and they can go back underground again.

Several persons: Maybe that's the best thing.

Hendrickson: If you like that, do it, but I would suggest that you'll be ever so much more comfortable going down just before the rainy season. In other words, from mid-May to mid-June would be a perfect time, right after classes let out of school for those that are involved. That would be a beautiful time to go down. What do you think, Dave?

Morafka: I think early June or late August.

Hendrickson: Late August, okay, but if you've got the rains running late, you still get the mud.

Morafka: I've found summer rains in July to be extremely unreliable. There have been Julys in Chihuahua when there's been no rain at all, and that's about the same as going down in January. There's nothing at all going on. It's just a month long siesta for everyone so that's capricious. With rains you know you'll have discomfort, you know you'll have misery and suffering, you know the roads'll be washed out occasionally, but you know there's a reason for going. July may be very convenient as the roads will be in good shape, but maybe so convenient that there's nothing to see. So I would say, from what I've heard from you and from people down there, too, there is a spring flurry of activity with those first spring rains.

Hendrickson: It's going to be too late for that.

Morafka: You think it would be too late in late May?

Hencrickson: I think so.

Morafka: Given school schedules and that kind of thing, I'd say that in late August would be the safest time to go to see the animals active. And by the end of August or the first week of September you begin to have the opportunity to see hatchlings also. That's the time you can get the most consistent observations.

Hendrickaon: Now we went through in March one year and there were animals up basking that would zip on down the burrow as we approached, and so on. This in the Bolson, near Mapimi. I didn't have David's pickup in Rancho Benthon. I don't want to recommend that everybody try to find their way into the Rancho Benthon anyway. The reserve where the dormitories are is a safer place to get introduced to the country.

E. Janulaw: Have you ever seen a female lay?

Morafka: No.

Hendrickson: I certainly haven't.

E. Janulaw: The bolson tortoise has shorter back legs than any of the other *Gopherus* species. The female reaches as deep as she can, but the nest is still comparatively shallow considering the size of the eggs [an average of 60 grams or 2 ounces each] and the number of eggs in each clutch. For that reason and because the female has such long nails and is rather careless, egg breakage is likely. Therefore, we remove the eggs from the nest as she lays them.

Morafka: An old Indian trick.

E. Janulaw: After removing the eggs from the nest, cover any cracks in the eggs with Scotch transparent tape.

Appleton: Gertie's eggs were about five inches down and very tidy. They were just beautifully laid, all pointing up and in a very tight cluster.

E. Janulaw: Last year it was imperative that we remove the last 2 eggs from the 3rd clutch as she laid them; the nest was just too small for the 7 large eggs. She lays 3 clutches a year now, usually the 1st in April, the 2nd in May, and the 3rd in June or July.

Morafka: Tremendous. It really is. I do think a tortoise is such a slow creature, but if you can get proven breeders laying 3 clutches a year, you can do a lot to build up a population quickly. Unfortunately, I think we'd better cut off formal discussion in fairness to the group and the lateness of the hour.

Hendrickson: David, here's one thing so important I'd like to ask if you would agree. Dr. Dodd said when he was giving his presentation here that there were attitudes on the bolson that he would like to get advice on, and it would be far better if we got it from a group, I think, Dr. Dodd, rather than from individuals. Do you agree?

C. Kenneth Dodd (Office of Endangered Species, Fish and Wildlife Service, Washington, D.C.): Yes, I would think that would carry more weight in D.C.

Hendrickson: Well, I can make it short and sweet. I favor classifying the bolson as an endangered species, if it can be done, for the very purpose which Dr. Dodd suggested as an aside, not because I think it will do a lot of good in saving the tortoises on the spot, and possibly not even because--literally speaking, we could prove with facts and figures that it has to be done, in other words, is so rare--but because by so classifying it, we can open another new and necessary channel for the binational cooperation between the two countries. This could be the answer to getting things done that we might not get any other way. It's a whole new channel. It does not exist now in quite the same way as it would if our country called it that. And so I personally, speaking for myself, recommend it to Dr. Dodd, and I invite any other comment.

Morafka: I would strongly agree, and I think while the evidence is circumstantial and in some cases rather crude, I've surveyed the Bolson area reasonably thoroughly over a 2½-year period through summers and winters, and there are literally maybe three to five ridges where there are dense colonies and only scattered pockets elsewhere. You're dealing with tiny surface areas and highly fragmented distribution of a large vertebrate. So, if we have to guess, it's an endangered species, I think by any reasonable criteria.

Dodd: It doesn't take nearly as much data to back up listing a foreign species as it does to get a domestic species on the list. There's no problem I see at all in getting the bolson tortoise listed as Endangered.

Morafka: Yes. Through Dr. Bury or myself.

Dodd: I understand that you [Dr. Morafka] have a report summarizing all data available on the bolson tortoise.

Morafka: I can show a copy today and then get an address from you and I'll mail that right out to you, or Bruce can. He's got it.

Dodd: I'll be waiting for it. I understand also that there have been Americans in Mexico recently seeking to buy tortoises. I believe Tom Van Devender may have more information.

Morafka: This was in a letter to me from Chihuahua sent in February of this year. He said that he was looking at fossil woodrat middens at the time. He's associated with the University of Arizona at Tucson with the laboratory of Paul S. Martin. He said that the natives said that American dealers were through there offering $5.00 apiece recently. [Morafka's note: Illegal bolson tortoises go for $50 to $250 in the U.S. pet trade.]

Dodd: I'm very interested in it because all members of the genus *Gopherus* are listed on Appendix II of the International Convention on Trade in Endangered Species of Wild Fauna and Flora. As such, importation into the United States would require a certificate from Mexico that the animal has been taken in accordance with the laws of that country. I would also recommend that the Council notify U.S. Customs that the tortoise does require a valid exportation permit from Mexico. This kind of action certainly would serve notice to those enforcing the law of the actions needed to prevent trade in this endangered species which would then effectively be shut down. I would also like to point out that any individual can report a violation of the Endangered Species Act. In fact, you can receive half the assessed penalties, to a maximum of $2,500 upon conviction.

Morafka: That would buy probably half of Rancho Benthon.

Dodd: And it would be money well spent.

Morafka: That makes a very worthwhile afternoon, I think, for all of us in a number of different ways. I thank you all for your endurance and your enthusiasm, particularly the panel for all they've had to share with us.

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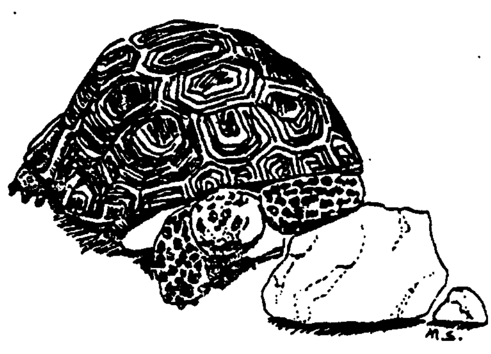

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