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THIRTY-THIRD ANNUAL MEETING

April 15, 1989

UNIVERSITY OF NEVADA, LAS VEGAS

LAS VEGAS, NEVADA



1988-89 Annual Reports



Participating Societies

Arizona Junior Academy of Science  
American Water Resources Association  
Arizona Hydrological Society

APRIL 1989

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**PROCEEDINGS**  
OF THE  
**33RD ANNUAL MEETING**  
OF THE  
**ARIZONA-NEVADA ACADEMY OF SCIENCE**

APRIL 15, 1989  
UNIVERSITY OF NEVADA, LAS VEGAS  
LAS VEGAS, NEVADA

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## **ABBREVIATED SCHEDULE AND ACTIVITY LOCATIONS**

### **Friday April 14**

All activities on Friday evening will take place at the **Continental Hotel**, 4100 Paradise Road, Las Vegas, Nevada.

**6:30 P. M.** Executive Board Meeting. The room number will be posted.

**7:00 - 8:00** Preregistration and Social Hour. The room will be posted.

### **Saturday April 15**

All activities (except the luncheon) will take place in White Hall.

**7:00 A. M.** Registration will be held on the Patio Deck, 2nd Floor.

**8:00 - 10:00** Paper Sessions (See section Schedules)

**10:00 - 10:30** Coffee Break (Patio Deck, 2nd Floor).

**10:30 - 11:30** Paper Sessions (See Section Schedules)

**12:00 - 1:40** Annual Academy Awards Luncheon and Business Meeting, **Student Union**.

**1:45 - 3:00** Paper Sessions (See Section Schedules)

**3:00 - 3:30** Coffee Break (Patio Deck, 2nd Floor)

**3:30 - 4:30** Paper Sessions (See Section Schedules)

**4:30** Governing Board Meeting, **Room 207**

**Note:** A map of the campus is located at the end of the Proceedings.

## SUMMARY OF SECTION MEETINGS

<b>Section</b>	<b>Session</b>	<b>Time</b>	<b>Room</b>
Anthropology	I	8:00	114
Biology	I	8:00	201
	II	1:45	201
Conservation	I	8:00	207
	II	1:50	207
Genetics and Developmental Biology	I	8:00	312
Geography	I	8:00	304
	II	1:45	304
Geology	I	8:00	115
	II	1:30	115
Hydrology	I	8:00	105
	II	2:00	105
Science Education	I	8:00	202

\* Indicates Paper to be considered for the Best Student Paper Award

## **ANTHROPOLOGY**

**SESSION I: 8:00 A.M.**

Room: 114

Chairperson: Margaret M. Lyneis

**8:00-8:15 COGNITIVE GRAMMAR AND FOLK BIOLOGICAL  
NOMENCLATURE**

Gary B. Palmer (University of Nevada, Las Vegas, Las Vegas, Nevada)

The study of how life-forms are classified in languages has revolved around two approaches: (1) the approach of taxonomy in which categories of plants or animals are arranged into sets of more comprehensive categories (ex. cats and lions belong to the cat family), and (2) the approach of prototype-clustering, in which categories are grouped according to their resemblance to exemplars (ex. 'true huckleberry', 'related to huckleberry'). Many studies have demonstrated that folk systems of classification and naming generally do not fit either approach very precisely. Previous studies have left a residue of unexplained phenomena and unorganized data. Some of the unexplained phenomena include the occurrence of taxa which are recognized but unnamed, the functioning of terms at multiple taxonomic levels, and the apparent mix of taxonomic and protytype-satellite relations within nomenclatural domains. The new linguistic subfield of cognitive grammar provides the concepts and notational conventions necessary to resolve these and other problems, thereby enabling more coherent descriptions of folk biological nomenclatures and more exhaustive accounts of their underlying semantic domains.

**8:15-8:30 SOCIETY, SELF CONTROL, AND SOCIAL CONFLICT IN  
THE FICTION OF WILLIAM DEAN HOWELLS -- AN  
ANTHROPOLOGICAL APPROACH TO NEW HISTORICIST  
LITERARY CRITICISM**

John J. Swetnam (University of Nevada, Las Vegas, Las Vegas, Nevada)

This paper presents an anlysis of A Hazard of New Fortunes and The Rise of Silas Latham to illustrate the contribution which anthropological theory can make to a historically oriented approach in literary criticism. The analysis of the structure of discourse between characters in the text is used to generate a set of underlying cultural assumptions embodied in the actions of major characters. Using Radcliffe-Brown's interpretation of joking behavior, the paper argues that concepts of self-denial and abstemiousness are central to Howell's concept of the social order. This sub-text of cultural assumptions can then be related to the social and economic context of the

production of the novel. The result is a form of literary criticism which places the work of art in historical context by treating it as the product of a distinct cultural milieu.

**8:30-8:50                    UTAH INDIANS AND THE HOMESTEAD LAWS**

Martha Knack (University of Nevada, Las Vegas, Las Vegas, Nevada)

For the first two decades of the 20th century, the Bureau of Indian Affairs actively encouraged non-reservation Indians in Nevada and Utah to file for land under provisions of the Homestead Acts. The nature of the resulting title and legal protections to such land will be explored. The subsequent history of one such homesteaded area in northern Utah will be compared with another held under Indian allotment title to determine the advantages and disadvantages to Indians of the differing land policies.

**8:50-9:05                    ANALYSIS OF FAUNA FROM SCOUTS SHELTER, CLARK COUNTY, NEVADA**

Charles L. Douglas (University of Nevada, Las Vegas, Las Vegas, Nevada)

Scouts Shelter is a small, late prehistoric rock shelter situated near the eastern base of the McCullough Mountains SE of Las Vegas, NV. Late prehistoric Yuman pottery and Cottonwood series projectile points (post A.D. 1300) and a Gatecliff series projectile point (3000 B.C. - 1300 B.C.) were found on the surface. Because all excavated fill was fine-screened and washed, the recovery of faunal remains was disproportionately large for the size of the site. Of 8500 bones and fragments recovered, 2007 were identified to element at the generic or specific level. Twenty-two taxa were represented. Heavily fragmented artiodactyl and tortoise bones could not be identified to element, but comprised substantial percentages of the assemblage. Several methods were used to evaluate these fragments. Relationships of numbers of bones to weights and to MNI were evaluated by regression analysis. Seasonality of site occupation is reflected by age structure of desert woodrats and by the seasonal availability of species that aestivate during part of the year. Types of hunting and procurement needed for various taxa are considered.

**9:05-9:20                    PREHISTORIC SITE DISTRIBUTION IN THE EASTERN GREAT BASIN: A TEST OF "IMACS"**

Heidi Roberts (University of Nevada, Las Vegas, Las Vegas, Nevada)

This paper analyzes over 1700 eastern Great Basin archaeological sites to illustrate the research potential of computerized site data bases. Sample data were obtained from the Intermountain Archaeological Computer Systems (IMACS) and

represent all of those sites recorded since 1981 in the Basin portion of Utah. Analysis of all sites provides a test of current settlement/subsistence models during the Paleo-Indian, early Archaic, middle Archaic, and Fremont/Anasazi periods. By extending these hypotheses to include surface sites, the analysis both confirms selected aspects of existing hypotheses and identifies areas for further study.

**9:20-9:40 VIRGIN ANASAZI TRADE PATTERNS AS SEEN FROM CLARK MOUNTAIN**

Kevin Rafferty (Div. of Anthropological Studies, University of Nevada, Las Vegas, Las Vegas, Nevada)

Recent archaeological research at sites in the Clark Mountains, San Bernardino County, California, have revealed evidence of Virgin Anasazi use of the uplands areas of southern California mountain ranges for resource exploitation and habitation. It is suggested that the use of such areas by the Virgin Anasazi were part of a larger support system for the long-distance trade system conducted by the Virgin Anasazi during the Lost City (A.D. 700-1100) and Mesa House (A.D. 1100-1150/1200) phases that was based on the exploitation of the Halloran Springs turquoise mines, 30 miles to the southwest of the Clark Mountains. The Clark Mountains may also have been the area where trade was carried on between the Virgin Anasazi and local Patayan groups, and groups to the north who traded obsidian long-distance. The archaeological data from the Clark Mountains will be examined and discussed as evidence that these activities were undertaken by the Virgin Anasazi during the periods under discussion.

**9:40-9:55 THE PRESENCE OF SHIWITS BROWN AND OTHER VIRGIN ANASAZI CERAMICS IN THE CLARK MOUNTAINS OF CALIFORNIA**

Lynda M. Blair (Environmental Research Center, University of Nevada, Las Vegas, Las Vegas, Nevada)

Lyneis reports the co-occurrence of Moapa Gray Ware and Shiwits Brown Ware from archaeological sites within the Moapa Valley of southern Nevada and the Uinkaret/Shiwits Plateau of Utah and Arizona. These ceramic types found together with San Juan Redwares are indicators of economic exchange between the lower Moapa and upland Virgin Anasazi peoples.

Information gathered during excavations at Clark Mountain in San Bernardino, California, show a similar association. The co-occurrence of these Virgin Anasazi Wares with Colorado River buff and brown wares is indicative of trade relations along the southern Colorado River drainage as well as the northern Plateaus.

**10:00 - 10:30 COFFEE BREAK - Patio Deck, 2nd Floor**

**10:30-10:45 RECAPTURING FUGITIVE RED IN LOST CITY CERAMICS**

Keith Myhrer (Bureau of Land Management, Las Vegas District, Nevada)

Binocular analysis of 27,000 sherds from a Virgin Anasazi site in the Lost City area of southern Nevada's Moapa Valley has yielded interesting associations concerning the presence of Fugitive Red staining. The Steve Perkins site was occupied by both late Basketmaker and Pueblo II period peoples. In this collection, red oxide staining is limited to the exterior surfaces of Pueblo II sand-tempered North Creek and olivine-tempered Moapa Gray Ware. Moapa Gray is considered to have been manufactured by the upland Virgin Anasazi and transported to the Moapa Valley. Although Moapa Gray Ware represents only 20% of the total amount of ceramics at the site, more than 50% of the number of Fugitive Red sherds are plain olivine-tempered. The disproportionate number of red-stained Moapa Gray sherds in the collection indicates these transported, olivine-tempered vessels might have had special functions, such as storage of particular items or use as burial goods.

**10:45-11:05 VIRGIN ANASAZI SUBSISTENCE AND SETTLEMENT IN SOUTHWEST UTAH**

James R. Allison (Brigham Young University, Provo, Utah)

Recent archaeological research in southwestern Utah has focused on issues related to subsistence and settlement. The importance of wild foods relative to domestic crops, and the role of seasonal mobility in the economy of the Virgin Anasazi, have been the subject of some debate. The issues involved in this debate are examined, and evaluated in light of data from excavations at Anasazi Valley, near Santa Clara, Utah, and other Virgin Anasazi sites.

**11:05-11:25 VIRGIN ANASAZI CERAMIC PRODUCTION AND EXCHANGE: A VIEW FROM THE KANAB PLATEAU**

Helen C. Fairley (Northern Arizona University, Flagstaff, Arizona)

An archaeological survey conducted by Northern Arizona University on the Kanab Plateau in Grand Canyon National Park during 1988 documented 75 Virgin Anasazi sites dating between ca. A.D. 400 and 1200. Preliminary analyses of ceramic data from the survey collections indicate the existence of at least three temporally distinct ceramic assemblages. The three major assemblages correspond to the BMIII (A.D. 400-800), late PI-early PII (A.D. 900-1050), and late PII periods (A.D. 1100-1150). Differences in the predominance and diversity of temper and paste



constituents within each assemblage suggest that distinct shifts in the complexity and geographical orientation of Virgin Anasazi ceramic exchange systems characterized these three temporal intervals. The diachronic variations in Kanab Plateau ceramic assemblages appear to correlate with shifts in regional cultural boundaries and are interpreted as local reflections of region-wide changes in Virgin Anasazi interaction spheres.

**12:00 - 1:30      ANNUAL ACADEMY AWARDS LUNCHEON AND  
BUSINESS MEETING, STUDENT UNION, ROOM 201**

**4:00                GOVERNING BOARD MEETING, ROOM 207**

## BIOLOGY

**SESSION I: 8:00 A.M.**

**ROOM : 201**

Chairperson: Robert Bowker

**8:00-8:15 MICROBIAL TESTING IN ASH SPRINGS AND CONDOR CANYON**

Deborah Hall and Penny S. Amy (University of Nevada, Las Vegas, Las Vegas, Nevada)

Water samples were evaluated monthly beginning August 1988 from two sites at Ash Springs and four sites in Condor Canyon to determine the impact of water quality on two endangered fish species: White River Spring fish (*Crenithyes baileyi baileyi*) and Big Springs Spindace (*Lepidomedia mollispinis pratensis*). Using membrane filtration techniques and selective media, the samples were quantitatively tested for *Pseudomonas aeruginosa* and *Aeromonas hydrophila*, two microbial fish pathogens, along with fecal coliforms and total coliforms because of nearby ranching. Water chemistry has been monitored with declining organic and total phosphorus content over time. The air temperature became cooler but the water temperature in Ash Springs remained stable at 34<sup>0</sup>C. Total microbial counts in colony forming units (CFU) have decreased. *Pseudomonas aeruginosa* was found only at Ash Springs with no clear trend indicated. Coliform CFU have dropped substantially with cooler weather. In Condor Canyon water temperature has decreased over all with a declining gradient observed moving downstream. *Aeromonas hydrophila* was noted at both locations, but no clear trend was observed at either place. Coliform CFU decreased over time, and numbers decreased moving downstream away from the most heavily grazed area of Condor Canyon.

**8:15-8:30 FREEZE-SURVIVAL OF ICE NUCLEATION ACTIVE AND INACTIVE STRAINS OF PSEUDOMONAS SYRINGAE**

Mark P. Buttner and Penny S. Amy (University of Nevada, Las Vegas, Las Vegas, Nevada)

The survival after freezing of ice nucleation active (INA) and genetically engineered non-ice nucleation active (non-INA) strains of *Pseudomonas syringae* was compared. Each strain was applied to oat seedlings, allowed to colonize for three days, and the plants subjected to various freezing temperatures. Plant leaves were harvested before and after freezing on two consecutive days and bacterial populations determined. Populations of the INA wild-type strain increased 15-fold in 18 hours after

incurring frost damage to oat plants at  $-5^{\circ}\text{C}$  and  $-12^{\circ}\text{C}$ . Plants colonized by the non-INA strain were undamaged at  $-5^{\circ}\text{C}$  and exhibited no changes in population size after two freeze trials. As freezing temperatures were lowered ( $-7^{\circ}\text{C}$ ,  $-9^{\circ}\text{C}$ ,  $-12^{\circ}\text{C}$ ), oat plants colonized by the non-INA strain suffered increased frost damage, concomitant with bacterial population increases following 18 hours. At  $-12^{\circ}\text{C}$ , both strains behaved identically. The data show a relationship between frost damage to plants and increased bacterial population size during the following 18 hours, indicating a potential competitive advantage of INA strains of *P. syringae* over non-INA strains in mild freezing environments.

**8:30-8:45            DETERMINATION OF BACTERIAL DEGRADATION OF  
BENZENE AND CHLOROBENZENE FROM A SERIES OF  
CONTAMINATED WELL SITES**

Michael V. Staudaher and Penny S. Amy (University of Nevada Las Vegas, Las Vegas, Nevada)

Water samples from a series of wells known as the Pittman Lateral were tested for the presence of bacteria which could degrade Benzene and/or Chlorobenzene. These two organic compounds were present normally as contaminants in the tested water samples, and results indicated that bacteria present in them were indeed able to breakdown the Benzene and Chlorobenzene naturally present, as well as in samples which contained artificially elevated levels of these two compounds. Degradation was determined by the use of a scanning spectrophotometer (Beckman DU-65).

**8:45-9:00            BACTERIAL SURVIVAL AND DETECTION IN AN AQUATIC  
ENVIRONMENT**

Hermi D. Hiatt and Penny S. Amy (University of Nevada, Las Vegas, Las Vegas, Nevada)

A genetically engineered plasmid, pPSA131, was used as a DNA probe to detect homologous DNA in *Escherichia coli* HB101/pPSA131 after mixing with aquatic microorganisms from Lake Mead; survival of *E. coli*/pPSA131 was tested in various treatments of lake water or buffer. Full-strength Luria-Bertani (LB) agar proved better than 0.1x LB at recovering *E. coli*/pPSA131 after survival in low nutrient environments. Survival of *E. coli*/pPSA131 remained high in filtered (0.22  $\mu\text{m}$ ) lake water and salts buffer on both selective (LB+) and non-selective (LB) agars, but was lower in untreated lake water or lake water treated by filtration (0.8  $\mu\text{m}$ ). Total colonies recovered on LB agar were higher when lake water was filter treated (0.8  $\mu\text{m}$ ) than in untreated lake water. Microorganisms recovered from lake water alone increased rapidly on non-selective media probably due to the "bottle effect". *E. coli*/pPSA131

were detected in various treatments and from a mixture with Lake Mead water organisms at three times over 48 h by colony blotting using a non-radioactively labeled DNA probe. Target cells were best detected when a combination of selection and DNA probing was used and when there was no competition with native lake microorganisms.

**9:00-9:15      COMPARISON OF PLASMID DNA IN *HALOBACTERIUM*  
SP. ISOLATES AS IT RELATES TO PHENOTYPIC  
CHARACTERISTICS**

Brian D. Green and Penny S. Amy (University of Nevada, Las Vegas, Las Vegas, Nevada)

*Halobacterium* sp. were isolated from three geographically separate high saline environments covering a three state area. Plasmid DNA was extracted from each of the isolates. There were six plasmid patterns observed within the isolates, with two of the patterns present in all three geographic locations. The plasmid DNA was analyzed for conserved nucleotide sequences by restriction enzyme digest (EcoRI) and a non-radioactive DNA probe kit (ChemiProbe FMC). The pigmentation of each isolate and colony morphology was described with some isolates showing the same colony morphology while having different plasmid patterns. A variety of biochemical tests were performed on the isolates and correlations with a particular plasmid or plasmids were noted. Amylase, nitrate reductase, and resistance to triple sulfa correlated well with specific plasmids.

**9:15-9:30      EVALUATING MICROALGAE FOR GROWTH POTENTIAL  
AND LIPID PRODUCTION**

Milton R. Sommerfeld, Stephen B. Ellingson and Patti L. Tyler (Arizona State University, Tempe, Arizona)

Approximately 700 unialgal cultures of microalgae have been isolated from aquatic sites in the Southwest. Growth rate determinations were made using SERI Type I and II Media and a variety of culture conditions. Approximately 50 strains of primarily diatoms and chlorophytes demonstrated growth rates exceeding one doubling per day. Five strains exceeded two doublings per day, and one strain exceeded three doublings per day. Growth optimization efforts indicated that the most rapid growth occurs when urea is provided as the nitrogen source with moderate temperature (25<sup>0</sup>C) and moderate illumination (500 uE/m<sup>2</sup>/sec). The fluorescent dye, Nile Red, was used to microscopically screen for intracellular neutral lipid storage and to fluorometrically quantify culture lipid concentration. Seven microalgal cultures yielded more than 200 mg/l and three yielded greater than 900 mg/l of neutral lipid. These microalgae may represent the necessary biological materials for future efforts to develop a renewable liquid fuel source.

9:30-9:45

**IMMUNOCYTOCHEMICAL EVIDENCE FOR INTRALUMINAL  
PROLACTIN SECRETION IN THE CHICKEN PITUITARY**

Kevin A. Krown (University of Arizona, Tucson, Arizona)

The cellular arrangement of the chicken pituitary includes colloid-filled follicles that resemble a hypertrophic thyroid gland. Scanning electron microscopy of freeze-cracked pituitaries revealed cytoplasmic granules (200 - 600 nm diameter) and exocytotic pores on the apical surface of cells surrounding a central lumen. Granule concentration was also evident on the basal surface bordering perivascular spaces. Further elucidation of granule content was accomplished by light microscopic observation of the avidin-biotin peroxidase (ABC) immunocytochemical stain. There was a dense concentration of PRL-containing granules in the center of some follicles. In addition, PRL immunoreactivity was evident on the apical and basal boundaries of some cells. These results suggest that PRL and possibly other hormones are released from pituitary cells by a dual secretory mechanism. One mechanism releases the granules into the follicular lumen (intraluminal) and the other mechanism discharges the granules through the basal lamina to the perivascular space. The fate of the intraluminal PRL may be storage and eventual transport to a capillary.

9:45-10:00

**A REVISION OF THE GENUS *CRINODENDRON*  
(ELAEOCARPACEAE)**

Jerald S. Bricker and L. R. Landrum (Department of Botany, Arizona State University, Tempe, Arizona)

A taxonomic revision of the genus *Crinodendron* Molina (Elaeocarpaceae) is provided. The goals of this study were to consider all previously described species of *Crinodendron* and to study as many of these in their native habitat as was possible. The revision utilizes several lines of evidence including herbarium and field studies, cytotaxonomy, wood anatomy, cladistic analysis, and pollination biology. The results of the systematic portion of the study indicate the correct name for the genus is *Crinodendron* Molina with *Tricuspidaria* Ruiz Lopez and Pavon as a synonym. *Crinodendron* comprises four species: *C. pataqua* Molina, *C. tucumanum* Lillo (including *C. boliviensis* Carenzo), *C. brasiliense* Reitz and Smith and *C. hookerianum* C. Gay. *Crinodendron hookerianum* and its close relationship to *Dubouzetia* of the South Pacific is discussed. *Dubouzetia* is retained as an independent genus although there is some evidence that *Dubouzetia* and *Crinodendron* should be combined. A study of the pollination biology of *Crinodendron* was conducted to understand the floral structure and pollination syndromes of *Crinodendron* native to South America. The results of the pollination study indicate *C. pataqua* and *C. tucumanum* are insect-pollinated while *C. hookerianum* is hummingbird-pollinated.

**10:00 - 10:30 COFFEE BREAK - Patio Deck, 2nd Floor**

**10:30-10:45 THE *OPUNTIA STANLYI* COMPLEX (CACTACEAE)**

Donald J. Pinkava, Bruce D. Parfitt and Marc A. Baker (Arizona State University, Tempe, Arizona)

In 1848 George Engelmann provisionally described *Opuntia stanlyi* based on a drawing made by artist J. M. Stanly during Col. W. H. Emory's Expedition from Fort Leavenworth to San Diego. We consider the name invalid, however, because Engelmann never accepted it. Before the name was validated by B. D. Jackson (1895) in *Index Kewensis*, Engelmann (1856) validly renamed the taxon, *O. emoryi*, including a spiny-fruited form of southwestern Arizona. This spiny-fruited form was named *O. kunzei* by Rose in 1908.

Benson (1969, 1982), considering *O. stanlyi* as the correct name for the species, made the following new combinations, *O. stanlyi* vars. *kunzei* and *parishii* plus new var. *peeblesiana* from south-central Arizona.

Our morphological and chromosome studies lead us to treat the complex as three species - tetraploid *O. emoryi* Engelm. and *O. kunzei* Rose and diploid *O. parishii* Orcutt. The last consists of major disjunct populations, the southernmost basically representing Benson's concept of var. *peeblesiana*. Typification details are currently being reviewed for *O. emoryi* and *O. parishii*.

**10:45-11:00 HYBRIDIZATION BETWEEN *PSIDIUM GUAJAVA* AND *PSIDIUM GUINEENSE* (MYRTACEAE)**

Leslie R. Landrum and William P. Sharp (Arizona State University, Tempe, Arizona)

*Psidium guajava*, the guava, is one of the most common cultivated tropical and subtropical fruits and is also a widespread weed. One of its close relatives, *P. guineense*, is similar in being widespread and weedy, but is not normally cultivated. These species have long been suspected to hybridize. We here offer clear evidence that hybridization is taking place in a small population in Argentina using the characters: lateral vein distribution, anther length, peduncle length, hair covering and stomata frequency on the lower leaf surface, stamen number, ovule number, and calyx structure. Hybridization between these two species, which seems to be frequent and broadly distributed, may have played a role in the evolution of the cultivated guava and provides for a future source of genetic variability.

**11:00-11:15 EVIDENCE FOR THE POSSIBLE HYBRID ORIGIN OF QUERCUS DUNNII (FAGACEAE)**

Leslie R. Landrum, Greg Owens, William R. Sharp (Arizona State University, Tempe, Arizona)

The taxon that has most recently been treated as *Quercus dunnii* in Arizona is similar to *Q. chrysolepis* and has long been associated with it in the subgenus *Protobalanus*. *Q. dunnii* is also similar to *Q. turbinella* of the subgenus *Leucobalanus*. Field studies, and morphological and chemical analysis indicate that *Q. dunnii* combines characteristics of *Q. chrysolepis* and *Q. turbinella* but also shows characteristics found in neither species. Thus, two opposing hypotheses are indicated: 1) *Q. dunnii* is a hybrid between two very dissimilar parents; or 2) *Q. dunnii* is closely related to *Q. chrysolepis* but has independently evolved some characters found in *Q. turbinella*. Characters used in the evaluation of these hypotheses are: habit, habitat, leaf venation pattern, number and prominence of lateral veins, leaf margins, petiole length, acorn cup form, indumentum of inner cup and nut surfaces, leaf waxes, and leaf flavonoids.

**11:15-11:30 \*HABITAT CHARACTERISTICS OF HOME RANGES AND CORE AREAS USED BY REINTRODUCED MASKED BOBWHITE**

Karen M. Simms and Norm S. Smith (Arizona Cooperative Fish and Wildlife Research Unit, U.S. Fish and Wildlife Service, University of Arizona, Tucson, Arizona)

We examined habitat characteristics of home ranges and core areas used by reintroduced masked bobwhite (*Colinus virginianus ridgewayi*) during 1986-88 on the Buenos Aires National Wildlife Refuge in southern Pima County, Arizona. We calculated home range boundaries from relocations of radio-tagged bobwhite. We sampled percent ground cover and percent vertical cover of vegetation and heights and densities of woody species. We compared vegetation characteristics between core and non-core areas of home ranges. Home ranges for 5 coveys and 3 pairs of masked bobwhite averaged 10.9 ha (5.2-14.6 ha). Core areas enclosing 50% of locations within the home ranges averaged 1.1 ha (0.2-2.7 ha). Core areas had significantly higher ( $P < 0.05$ ) vertical cover from 0-1 dm, and aerial and basal grass cover. Non-core areas had significantly higher ( $P < 0.05$ ) vertical cover from 5-20 dm, bare ground, litter, half-shrub cover, and half-shrub density. Our analysis indicates that habitat needs of masked bobwhite include approximately 11 hectares for home ranges including a core area or areas with a high percent cover of grasses, an interspersed cover of grass and shrub cover and absence of half-shrubs.

**12:00 - 1:30 ANNUAL ACADEMY AWARDS LUNCHEON AND BUSINESS MEETING, STUDENT UNION, ROOM 201**

**SESSION II: 1:45 P.M.**

**ROOM : 201**

Chairperson: Robert Bowker

**1:45-2:00 THE SIGNIFICANCE OF PROGENESIS AND LARVAL BEHAVIOR IN THE EVOLUTION OF DIGENETIC TREMATODES.**

John V. Aliff (Glendale Community College, Glendale, Arizona)

It is generally thought that digenetic trematode parasitism originated in molluscan or premolluscan hosts and additional invertebrate and vertebrate hosts were subsequently added; but the first intermediate host remained a mollusk. Progenesis, the occurrence of gravid adult trematodes or larvae (cercariae or metacercariae) in snails, would therefore represent a relict stage of development. Reports (36) of progenesis occurring in second intermediate hosts are more common than those (6) from first intermediate host mollusks. Progenesis was observed in two genera of Digenea occurring in *Goniobasis semicarinata* Say snails collected from the North Elkhorn Creek, Kentucky River Drainage. *Plagioporus* sp. (Opecoelidae) gravid adults were discovered in egg filled sporocysts (new record). *Proterometra macrostoma* Faust, Horsfall (Azygiidae) and *Proterometra edneyi* Aliff were observed in all stages of development including gravid cystocercous cercariae. *Proterometra dickermani* Anderson has only one snail host; other *Proterometra* spp. have fishes as definitive hosts. Cercarial swimming behavior and size determines which host fish, darter (Percidae) or sunfish (Centrarchidea), will acquire the sexually reproducing adult parasite.

**2:00-2:15 FORAGING BEHAVIOR OF MOUNTAIN SHEEP (*OVIS CANADENSIS NELSONI*) IN THE MOJAVE DESERT**

Kathleen Longshore (University of Nevada, Las Vegas, Las Vegas, Nevada)

The foraging ecology of mountain sheep (*Ovis canadensis nelsoni*) in the River Mountains, Nevada was studied to determine how sheep in a desert ecosystem respond to seasonal changes in the food resource. The population inhabiting the River Mountains is one of the most successful in the Mojave Desert and is used as stock for transplant purposes. As a result, the population has been studied intensively to determine why these sheep are so successful. The data presented, representing a portion of the foraging study, were obtained in 1987 and 1988 and deal with aspects of foraging which are under behavioral control and thus subject to change as foraging conditions change. These aspects include; activity budgets (the proportion of time allotted to foraging activities), selection of food items, search rates, and bite rates.



2:15-2:30

**THE RELATIONSHIP BETWEEN SOIL TYPES AND  
POPULATION DENSITIES OF THE DESERT TORTOISE  
(*Gopherus agassizii* )**

Randal W. Wilson (USDA, Soil Conservation Service, Las Vegas, Las Vegas, Nevada)

Detailed soil survey data was collected in the Piute Valley, Clark County, Nevada. A total of 58 soil sites were sampled and analyzed in the study area and seven soil map units were derived from the data. The purpose of this inventory was to categorize the soil types that occur within known population densities of the desert tortoise (*Gopherus agassizii*). An index rating for desert tortoise habitat was developed using four soil properties, available water capacity, soil consistence, depth to limiting layer, and rock fragment content. By comparing soil map unit deliniations, index rating, and landscape position to population estimate data of the desert tortoise (*Gopherus agassizii*), a direct correlation was observed. The data indicates that there is a relationship between soil types and population densities of the desert tortoise (*Gopherus agassizii*).

2:30-2:45

**SECONDARY PRODUCTION OF *RANATRA MONTEZUMA*  
(HETEROPTERA:NEPIDAE) IN A NEAR THERMALLY  
CONSTANT LIMNOCRENE**

Clay Runck and Dean W. Blinn (Northern Arizona University, Flagstaff, Arizona)

Secondary production of *Ranatra montezuma* was estimated by four methods: 1) annual size-frequency, 2) cohort size-frequency, 3) instantaneous growth, and 4) growth increment summation. Montezuma Well is near thermally constant (21° + 4°C annually) limnocrène located in north-central Arizona. There are no fish in Montezuma Well, apparently due to high CO<sub>2</sub> concentrations (>550 mg l<sup>-1</sup>). *Ranatra montezuma* is endemic to Montezuma Well and is the major insect predator in the littoral region. Monthly quadrat samples were taken from January 1987 to December 1988 to census *R. montezuma* instar, adult, and egg densities. *Ranatra montezuma* is multivoltine, producing 3 generations during March through October; *R. montezuma* overwinters as adults from November through February. Mean (± S.E.) annual egg density for March through October is 63.6 ± 13.0 eggs m<sup>-2</sup>, with highest egg densities of 124.0 ± 31.8 and 156.3 ± 48.2 eggs m<sup>-2</sup> occurring in March and September respectively. Mean egg incubation time was 21 days at 21°C and mean duration times (at 21°C) of first, second, third, fourth, and fifth instars were 10.0, 10.2, 9.6, 11.7, and 18.7 days respectively. Estimated annual secondary production of *Ranatra montezuma* averaged over a two year period was: 1) annual size-frequency = 1260.0 mg m<sup>-2</sup> yr<sup>-1</sup>, 2) cohort size-frequency = 1226.1 mg m<sup>-2</sup> yr<sup>-1</sup>, 3) instantaneous growth = 1610.2 mg m<sup>-2</sup> yr<sup>-1</sup>, and 4) growth increment summation = 1102.9 mg m<sup>-2</sup> yr<sup>-1</sup>.

**2:45-3:00**

**BLOOD GAS TRANSPORT AS A FUNCTION OF BODY SIZE  
IN THE NORTHERN LEOPARD FROG *RANA PIPIENS***

Mary B. Saethre and R. Keith Dupre (University of Nevada, Las Vegas, Las Vegas, Nevada)

The mass-dependency of metabolic rate of animals is well established. Not surprisingly, significant allometric relationships have also been described for several blood gas transport indices of mammals, birds, and reptiles. Despite phylogenetically representing an evolutionary transition from aquatic to terrestrial life, amphibians have been largely ignored with respect to blood gas transport as related to body mass. To assess the existence of such a mass-specific relationship, blood gas transport indices (including hemoglobin oxygen affinity, hemoglobin concentration, hematocrit, red blood cell count, and intraerythrocytic organic phosphate concentration) were measured for the northern leopard frog, *Rana pipiens*. Contrary to inverse relationships between hemoglobin oxygen affinity and body mass reported for all vertebrates (except snakes) studied to date, least squares regression analysis revealed a significant positive correlation of hemoglobin oxygen affinity with body mass. Regression analysis also revealed significant positive mass-dependent relationships for hemoglobin concentration, hematocrit, red blood cell count, and intraerythrocytic 2,3-diphosphoglycerate concentration. The fixed acid Bohr shift was inversely related to body mass. These relationships suggest that blood gas transport characteristics of larger frogs improve unloading of oxygen to the tissues, thus supporting the higher absolute metabolic rates of larger animals.

**3:00 - 3:30**

**COFFEE BREAK - Patio Deck, 2nd Floor**

**4:00**

**GOVERNING BOARD MEETING, ROOM 207**

## CONSERVATION

**SESSION I: 8:00 A.M.**

**ROOM: 207**

Chairperson: Dennis Kubly

**8:00-8:20 EVALUATION OF MANAGEMENT OPPORTUNITIES ALONG  
BILL WILLIAMS RIVER, ARIZONA**

Steve Ferrell, Dave Conrad, Brad Jacobson and Richard Glinski (Arizona Game and Fish Department, Phoenix, Arizona)

Prior to this decade, the Bill Williams River, in west-central Arizona, received relatively little attention from resource management agencies. However, four unrelated events during the mid-1980's caused several agencies to intensify their interest in this region: the 1984 purchase of 13,000 acre-feet of Bill Williams River water rights by the City of Scottsdale; the 1984 discovery of breeding bald eagles in the Alamo Lake Region; the 1986 discovery of significant trespass livestock within the riparian corridor of the river; the 1987 proposal by the Corps of Engineers to drawdown Alamo Lake, in order to repair Alamo Dam.

In recognition of the significant existing and potential resource values within the region, the Arizona Game & Fish Department established a scoping committee whose objective was to identify and evaluate management opportunities along the Bill Williams River. This evaluation focused primarily on prescribing guidelines for the operation of Alamo Dam to maximize resource potentials. Resources targeted by this evaluation included: riparian and wetland habitats; warm-water and cold-water fisheries; recreation; and habitats for bald eagles, waterfowl, shorebirds, furbearers, and native fish species.

**8:20-8:40 POSSIBLE INFLUENCES OF WATER DIVERSION ON  
RIPARIAN TREES**

Alvin L. Medina (Rocky Mountain Forest and Range Experiment Station, Tempe, Arizona)

Densities and diameter-breast-height (dbh) measurements of Arizona alder (*Alnus oblongifolia*) and boxelder (*Acer negundo*) were made on perennial and ephemeral stream reaches of Pine Creek. The objective was to determine differences in stand characteristics above and below a water diversion dam. Results of t-tests revealed perennial stream reaches had greater tree densities in all diameter size classes compared with ephemeral stream reaches where small diameter trees were poorly represented. No differences in density occurred in reproduction or older trees,

but only between saplings (dbh > 0.25 dm) and young trees (dbh < 3.0 dm). This size range (0.25 to 3.0 dm) would generally coincide with about 27 years of expected normal tree growth. Hence, differences in size and density of riparian trees in the man-induced ephemeral reach may be a result from the construction of the water diversion dam in 1965.

#### **8:40-9:00      IMPACT ANALYSIS OF SPRING CANYON PUMPED STORAGE PROJECT**

Dave Walker (Arizona Game and Fish Department, Mesa, Arizona), Judy Hohman (Fish and Wildlife Service, Phoenix, Arizona)

The Bureau of Reclamation (BR), Fish and Wildlife Service (FWS), National Park Service (NPS), and Arizona Game and Fish Department (AGFD) cooperatively conducted an impacts and tradeoff analysis for a proposed pumped storage project on the south side of Lake Mead's Virgin Canyon, Lake Mead National Recreation Area, Mohave County, Arizona. Techniques used included the FWS Habitat Evaluation Procedures (HEP) and the BR's Multi-Attribute Tradeoff System (MATS). Concurrent evaluation of impacts to the desert bighorn sheep and Lake Mead were conducted separately from the HEP procedure due to their biological, social and economic habitat importance. The agencies considered the quality and quantity of habitat that would be lost or gained and evaluated the impacts of key species associated with these habitats. Tradeoff analysis indicated that a small amount of wetland or riparian habitat would offset the inundation of 1,821 acres of terrestrial habitat consisting primarily of Mohave desert scrub. The study results on the desert bighorn sheep and the aquatic resources in Lake Mead indicated the need for additional mitigation.

#### **9:00-9:20      LAKE PLEASANT FISH POPULATION SURVEY RESULTS**

Sue Morgensen, Teresa Tharalson, Bill Silvey, and Steve Ferrell (Arizona Game and Fish Department, Phoenix, Arizona)

During the week of September 26, 1988, 3 Lake Pleasant coves (2.3 ha total) were treated with rotenone to determine fish species composition and standing crop. Species composition results from the rotenone project were compared with results obtained from gill netting and electrofishing surveys conducted between September 1987, and February 1989.

Prior to treatment, plastic barriers were placed across the cove entrances to confine fish and chemicals to the area being treated. All coves were then electrofished, and fish were fin-clipped to evaluate recovery rate after treatment with rotenone. Coves were treated with rotenone and neutralized with potassium permanganate 6 hours after rotenone application. Fish were collected, weighed, and measured for 3 consecutive days. Lake-wide estimates for the littoral fish populations were calculated.

A total of 146,987 fish was collected. Threadfin shad was the most abundant species (85.0%), followed by sunfish (11.4%), carp (1.3%) and largemouth bass (1.1%). Carp accounted for the greatest biomass (averaging 315 kg/ha), followed by sunfish (194 kg/ha), threadfin shad (157 kg/ha) and largemouth bass (109 kg/ha).

**9:20-9:40 THE STATUS OF STRIPED BASS IN LAKE MOHAVE**

Thomas A. Liles (Arizona Game and Fish Department, Kingman, Arizona)

Despite a management goal to exclude striped bass from Lake Mohave, a reproducing population may exist. The occurrence of striped bass was first documented in Lake Mohave in June, 1981 with the capture of a 220 mm fish. The number of striped bass taken during fishery surveys and by anglers increased through 1984, but no sexually mature females were collected until April, 1985. Tow netting below Hoover Dam in 1986 (13,010 m<sup>3</sup> effort) yielded four striped bass eggs, but no larvae. Sampling with the same gear in 1988 (38,560 m<sup>3</sup> effort) produced 429 striped bass eggs and 857 larval fish, none of which were striped bass.

Future surveys will be designed to confirm the presence of larval striped bass in Lake Mohave and describe their habitat.

**9:40-10:00 CONSERVING GENETICALLY DISTINCTIVE POPULATIONS: THE CASE OF THE HUACHUCA TIGER SALAMANDER (*Ambystoma tigrinum stebbinsi* Lowe)**

James P. Collins and Howard J. Berna (Arizona State University, Tempe, Arizona)

Huachuca tiger salamanders are a genetically distinctive race of *Ambystoma tigrinum* found only in 17 localities in the San Rafael Valley (SRV) in southeastern AZ. Most adults are aquatic, branchiate morphs with mature, metamorphosed morphs, which can be terrestrial, comprising a small fraction of SRV populations. No populations had cannibalistic morphs. Mean time to first reproduction in SRV salamanders is one year. Populations of SRV salamanders are threatened by introduction of exotic fishes and disease. Salamanders were largely eliminated from four habitats after introduction of sunfish and/or catfish. An unknown fatal disease killed all aquatic morphs in two other habitats. An additional threat includes possible hybridization and introgression of SRV populations resulting from introduction of exotic salamanders. Introduced bullfrogs may also prey on salamanders, or act as vectors for disease. *A. tigrinum* is broadly distributed throughout North America, but protection is still needed for some locally adapted populations, such as those in SRV, to conserve their special traits within the total range of variation characteristic of this polytypic species.

**10:00 - 10:30 COFFEE BREAK - Patio Deck, 2nd Floor**

**10:30-10:50 ASU CAMPUS: AN ECOLOGICAL PERTURBANCE**

R.J. Becker (Arizona State University, Tempe, Arizona)

The half square mile of ASU campus has 43,500 students, 6,500 staff and faculty, and many sales and service people.

Tempe has a population of about 150,000 and covers 35.5 square miles.

The campus concentration of people and activities is intense, and will increase. The campus is gaining a dozen new multi-million dollar structures and an expanded football stadium with parking to accommodate NFL football. Spaces in the student union buildings and along malls are used increasingly for commercial sales of foods, gifts, etc.

Traffic converges around the campus: 1) all cross-town traffic must go around the campus; 2) arrivals and departures focus at 8 a.m. and 5 p.m.; 3) accidents and pollution rates increase at those times, on adjacent streets.

Campus consumption of utilities and other supplies results in concentrations of effluents and other wastes. The increased density of people in the campus area brings an increase of aggression and crime.

**10:50-11:10 THE USE OF HALOPHYTES AS IRRIGATED CROPS IN THE SAN JOAQUIN VALLEY OF CALIFORNIA**

Carolyn Watson (University of Arizona, Tucson, Arizona)

The reuse of saline drainage water to grow halophytes as a forage component could provide an alternative method of reducing on-farm drainage water disposal in farmlands affected by salinity and drainage problems. Since 1986, field trial studies have been conducted in Mendota, California to evaluate halophytes as crops under irrigated conditions. Both annual and perennial plants represented by native and exotic species were tested. Dry matter yields, chemical composition and nutritional value of selected plants were determined. The most promising candidate forage plants for drainage water irrigation belong to the genus Atriplex. These plants were not only productive but also provided a good source of nutritive components for use in an animal feed. Many of the species tested were amenable to mechanical harvest using standard farm equipment. Cultural practices of the perennial plants to insure long-term multiple cuttings and provision of quality feed components would be species dependent.

**11:10-11:30 ARIZONA'S FIRST DESERT BIGHORN SHEEP TRANS-  
PLANT INTO A NATURAL POPULATION**

James C. DeVos, Jr. (Arizona Game and Fish Department, Phoenix, Arizona)

Several mountain ranges in southwestern Arizona maintain sheep populations well below historic levels and the current carrying capacity. The Eagletail Mountains once had a viable bighorn population which declined to 20-25 in 1980. Unlike populations in surrounding areas, this herd failed to take advantage of good climatic conditions and showed continual declines. It was hypothesized that the population had declined below what was necessary to maintain a viable population and would soon become extinct. In 1984, 2 releases of 8 sheep were made in the Eagletails in an attempt to test this hypothesis. To date, the herd continues to expand and has the ability to react to environmental conditions. We also tested the hypothesis that fidelity to lambing areas by ewes could be manipulated as a function of the time of year when the capture was made. We found a relationship did exist between season of capture and movements from the release site.

**12:00 - 1:30 ANNUAL ACADEMY AWARDS LUNCHEON AND BUSINESS  
MEETING, STUDENT UNION, ROOM 201**

**SESSION II 1:50 P.M.**

**ROOM : 207**

Chairperson: Dennis Kubly

**1:50-2:10 HABITAT REQUIREMENTS OF WHITE-TAILED DEER**

Gerald I. Day, Dennis D. Haywood, Charles H. Lewis, and Timothy Rogers (Arizona Game and Fish Department, Phoenix, Arizona)

White-tailed deer (*Odocoileus virginianus couesi*) in Arizona inhabit the southeast quarter of the state. Over 88% of this habitat is owned and managed by public agencies. Land management practices, arising from the multiple use concept, are believed to impact white-tailed deer habitat, and consequently, deer productivity. This study was designed to evaluate what vegetation southern Arizona white-tailed deer use, their water requirements, the effects of grazing, and the impacts of human interactions resulting from hunting and high road density.

Preliminary results of this study indicate that southern Arizona white-tailed deer primarily consume shrubs or herbaceous browse. Major diet components include

primarily consume shrubs or herbaceous browse. Major diet components include range ratany, mesquite, oak, mimosa, and false-mesquite. Deer were not found to directly compete with cattle for forage. Most deer observations occurred within 800 meters of a water source, and thus the requirement of free standing water may be indicated. Lastly, more deer were harvested by hunters within 100 meters of a road than expected, assuming harvest to be proportional to distance from a road.

**2:10-2:30            GIS: AN IMPORTANT TOOL FOR NATURAL RESOURCE  
MANAGEMENT**

Dennis D. Haywood (Arizona Game and Fish Department, Phoenix, Arizona)

Geographical Information Systems (GIS) is a software package that was developed in the late 1970's, but is only now reaching the point of widespread acceptance by natural resource agencies. During 1988, the U.S. Forest Service completed a national GIS plan that calls for purchase of hardware and software by 1991 at a national price tag of \$100,000,000. The U.S. Bureau of Land Management is likewise following a parallel path. They anticipate an expenditure of \$150,000,000 and expect a completion date of 1993. Still, many wildlife professionals are not fully aware of the software's uses, and how to plan for the advent of GIS in Federal and State Agencies.

GIS provides the capabilities to store and manipulate mapped data. Natural resource agencies map timber, minerals, soil conditions, public facilities, etc., for the purposes of maintaining records, inventory, and evaluating alternative management strategies. These natural resource maps can be computerized with GIS for rapid access and evaluation. GIS is described, and a discussion of potential application is provided. Lastly, future planning for GIS is discussed.

**2:30-2:50            FACTORS AFFECTING MOUNTAIN LION DENSITIES AND  
CATTLE DEPREDATION IN ARIZONA**

Harley G. Shaw, Norman G. Woolsey, James R. Wegge, and Ronald L. Day, Jr.  
(Arizona Game and Fish Department, Phoenix, Arizona)

A total of 144 mountain lion track count routes was run in 22 Game Management Units representing 11 habitat complexes. Representatives were interviewed from 29 ranches encompassing the survey routes. Lion track densities were found to be related to habitat type and to vary significantly among Game Management Units. Lion track densities were related to densities of mule deer and unrelated to other prey or to additive densities of prey. Tracking conditions and method of travel of observers affected track count results. Track condition was not significantly related to habitat type.

Rancher impressions of losses were directly related to lion density. Highest



claims of losses occurred on ranches with cow-calf operations in interior chaparral habitats. Calving out of lion country and allowing calves to gain initial growth away from lion habitat reduced losses for those few ranches with ranges suitable to this management strategy. Other options (use of horned cows, steer-only operations) were difficult to evaluate. In general, ranchers using such options were also exerting lion control efforts. They were also the ranchers that claimed the highest rates of cattle losses.

**2:50-3:10 PEREGRINE FALCON SURVEY OF THE ARIZONA STRIP DISTRICT, BUREAU OF LAND MANAGEMENT**

Curtis W. Warrick (Bureau of Land Management, St. George, Utah)

A five-year survey of peregrine falcon populations on public lands management by the Bureau of Land Management (BLM) on the Arizona Strip District was initiated in 1988 by the BLM and the Arizona Game & Fish Department (AGFD).

The survey will increase information on the status of the endangered falcon and its use of the Arizona Strip. Managers will obtain information to insure that land use authorizations do not adversely affect the species continued existence on the public lands. Information will also be generated to assess the rate of recovery of the falcon on the Arizona Strip and how that recovery relates to the state and habitat-wide recovery.

The survey is unique in that it also involves cooperative efforts of the private sector and a simple repeatable survey methodology. In 1988, Energy Fuels Nuclear, Inc., a Denver-based firm with uranium mining interests on the Strip, contributed \$10,000 to the survey effort, while the BLM and AGFD invested approximately \$24,000.

A survey report for 1988 was completed, summarizing the findings of four months of field work. An Annual Operating Plan was developed to direct survey efforts, identify contributors, and define the specifics of the 1989 effort.

**3:10-3:30 WILDLIFE ATTITUDES AND PARTNERSHIPS: CONFLICT OR COOPERATION**

Thomas K. Ohmart and Kerry Baldwin (Arizona Game and Fish Department, Phoenix, Arizona)

The attitudes and values we possess towards wildlife strongly influence the various types of activities and groups we interact with. It is clear that the wildlife interests of Arizona and Nevada need to enhance relationships and establish new partnerships on critical wildlife issues. However, our philosophical differences towards wildlife sometimes get in the way of creating or maintaining these necessary partnerships. This presentation will explore basic attitudes towards wildlife, as

identified by Dr. Steve Kellert, Yale University, and show comparisons of Arizona Game and Fish employees' attitudes versus those attitudes of other selected wildlife constituents.

**3:30-3:50            VEGETATION OF THE PANAMINT MOUNTAINS, DEATH VALLEY NATIONAL MONUMENT, CALIFORNIA**

David J. M. Bradney (University of Nevada, Las Vegas, Las Vegas, Nevada)

The Panamint Mountains form the western boundary of Death Valley National Monument. Physiographically they are part of the Basin and Range Province with elevation ranging from below sea level to above 3500 m (11,000'). Results of a two year study of the flora and vegetation of the area are presented. An inventory of the plant species present has been prepared with attention paid to the abundance and distribution of rare, threatened and endangered species. The vegetational matrix has been analysed, described and mapped. Phytogeographic relations of the study area have been analysed using the floristic composition of each vegetational unit. Results of each aspect will be presented emphasising the value of such information to conservation efforts.

**4:00                    GOVERNING BOARD MEETING, ROOM 207**

## GENETICS AND DEVELOPMENTAL BIOLOGY

**SESSION I 8:00 A.M.**

**ROOM:312**

Chairperson: Fredric Lehle

**8:00-8:15 INHERITANCE OF CHILLING REQUIREMENT FOR GERMINATION IN 'KENDALVILLE' *ARABIDOPSIS THALIANA***

Karin Glinsky and Fredric R. Lehle (University of Arizona, Tucson, Arizona)

The life cycle of many plants of temperate climates is regulated by low temperatures. An example of such regulation is that some seeds must be exposed to near freezing temperature before they will germinate. Our objective was to study the inheritance of this trait in three wild strains of *Arabidopsis thaliana* originally isolated in Montcalm County, Michigan in 1984. Seed samples from field harvests of the three *Arabidopsis* strains 'Kendalville', 'Turk Lake', and 'Greenville' were selected on the basis of requiring chilling at 4°C for 2 weeks before germination would occur. One seed from each of 10 randomly selected, self-pollinated parents exhibiting this trait was grown to maturity. Single seed descent with reselection was continued for a total of four generations to increase homozygosity. After 2 cycles of self-pollination, most lines originating from Turk Lake and Greenville exhibited severe infertility and excessive times to flowering (>6 months) and for this reason were dropped from the study. Reciprocal crosses were made between the 'Columbia' strain without the chilling trait and the remaining Kendalville lines with the chilling trait. The F<sub>1</sub> progeny exhibited a strong maternal influence both for chilling requirement for germination and for time to flowering.

**8:15-8:30 METHODOLOGIES FOR DEVELOPING SALT-TOLERANT ALFALFA**

A. K. Dobrenz, D. L. Robinson, T. McKimmie, D. Poteet, D. W. Johnson and S. E. Smith (University of Arizona, Tucson, Arizona)

High saline soils are a constant threat to successful alfalfa production in many areas of Arizona and Nevada. New salt-tolerant germplasm must be developed for this important forage crop to remain a profitable enterprise. We have developed a successful screening technique for germination salt-tolerance which has been used to produce nine cycles in a recurrent mass selection breeding program. Germination percentages of these cycles starting with the original population "Mesa-Sirsa" and

continuing through Cycle 9 at -1.7 MPa NaCl were 3,9,14,33,60,65,69,87,89, and 90% respectively. Techniques for improvement of salt tolerance during the emergence and establishment stages of alfalfa growth have also been developed. Yield of the Cycle 3 establishment tolerant germplasm yielded 20% better than the original population when grown at 0.5 MPa NaCl.

**8:30-8:45            BIOLOGICAL DYNAMICS OF SEED HYDRATION AND  
PROTEIN CONTENT IN ALFALFA (*MEDICAGO SATIVA L.*)**

David C. Poteet, D. L. Robinson, K. Matsuda and A. K. Dobrenz (University of Arizona, Tucson, Arizona)

Enzymatic activity is responsible for the release of stored sugars and may be partly responsible for vigor of salt tolerant alfalfa seed under stress. Our research evaluated changes in seed protein content as a consequence of selection for germination salt tolerance. Cycle 9 of a selected population and its non-tolerant parent, Mesa-Sirsa, were initially evaluated for germination and imbibition in 0 and -1.1 MPa NaCl solutions. Cycle 9 and Mesa-Sirsa germinated similarly in the control solution at 7.5 hours after planting (HAP) but exhibited 100% and 40% germination, respectively, at 13 HAP. In the saline solution, Cycle 9 and Mesa-Sirsa displayed 58% and 0% germination, respectively, at 18.75 HAP. Cycle 9 germinated more vigorously compared to Mesa-Sirsa in both stressed and non-stressed environments. Cycle 9 consistently imbibed more water in the control solution but less water in the saline solution compared to Mesa-Sirsa. There were significant differences between Cycle 9 and Mesa-Sirsa for milligrams nitrogen/100 seed due to differences in seed size. However, seed protein content was similar for both populations. Differences in hydration and germination salt tolerance were not related to percent seed protein. Further research will examine the role of amino acids in seed salt tolerance.

**8:45-9:00            BI-DIRECTIONAL SELECTION FOR ALFALFA SEEDLING  
VIGOR UNDER SODIUM-CHLORIDE STRESS**

D.L. Robinson, A.K. Dobrenz and T.J. Ellsworth (University of Arizona, Tucson, Arizona)

A hydroponic technique has been established that allows for the uniform evaluation of seedling response to salinity stress. Six thousand seed of a popular alfalfa cultivar (*Medicago sativa* L. cv. "Lew") were sown and sub-irrigated daily with a hydroponic solution containing NaCl (-0.45 MPa). Three weeks after planting 20 of the tallest and 20 of the shortest plants were identified and transplanted. Bi-directional selections were similarly made from the same cultivar grown without NaCl. The large growth differences seen between these four populations at the seedling stage was not consistent with their vigor at maturity. The populations produced similar biomass

within three months after selection. Each of the populations were individually polycrossed so their progeny could be evaluated for their ability to germinate, emerge and grow under salt stress. This study allows for the comparison of selection criteria most appropriate for improving alfalfa seedling salt adaptability.

9:00-9:15

### PHYSIOLOGICAL RESPONSES OF GUAR TO SALINITY

D. T. Ray, M. I. Andrade and A. K. Dobrenz (University of Arizona, Tucson, Arizona)

Guar (*Cyamopsis tetragonoloba* (L.) Taub) is a drought tolerant annual legume that has potential as an annual seed crop in Arizona. This species produces galactomannan gum in the endosperm of the seed which has been useful for many food and non-food products. Photosynthesis, respiration, transpiration, water potential and stomate density were measured on "Kinman" and "Santa Cruz" cultivars grown at 0 and -1.5 MPa NaCl, KCl, NaCl & KCl and PEG. The type of salt did not influence apparent photosynthesis. Drought stress did not reduce CO<sub>2</sub> uptake in young and older plants, however, salt stress significantly reduced carbon dioxide uptake. Respiration rates were not influenced by drought but were significantly reduced at the highest level of NaCl. Transpiration decreased as soil water potential increased. Significant variation among genotypes of guar verified the validity of selection for salt-tolerant genotypes based on physiological performance.

9:15-9:30

### CHARACTERIZATION OF ASPARAGINE STIMULATION OF SALT TOLERANCE IN *ARABIDOPSIS THALIANA*

Fredrick R. Lehle, Futai Chen and Karen R. Wendt (University of Arizona, Tucson, Arizona)

Many plants accumulate specific amino acids during salinity stress, but it is not known if this response is adaptive. One approach to this problem is to assess if exogenously supplied amino acids alter salinity tolerance. We have shown that exogenous asparagine stimulates salt tolerance in *Arabidopsis thaliana* and our objective was to characterize this response further. All experiments were conducted aseptically on agar media supplemented with inorganic nutrients. Maximal reversal of NaCl (120 mM) inhibition during germination occurred at D- and L-asparagine concentrations from 2 to 4 mM. Higher concentrations of L-asparagine were severely inhibitory to *Arabidopsis* germination but innocuous to established seedlings. D-Asparagine was less inhibitory to germination than L-asparagine. Reversal of NaCl inhibition was similar both when asparagine and NaCl were presented simultaneously and when asparagine was presented for up to 24 h prior to the addition of NaCl. Exogenous asparagine did not extend the upper limit of NaCl tolerance during germination above about 225 mM NaCl. The positive effects of L-asparagine in mitigating the inhibitory effects of NaCl on seedling fresh and dry weights were not reflected in seedling Na<sup>+</sup> and K<sup>+</sup> ion contents.

9:30-9:45

**THE INDUCTION OF ALCOHOL DEHYDROGENASE (ADH)  
IN GUAYULE (*PARTHENIUM ARGENTATUM*)**

F. Chen, D. T. Ray and K. K. Oishi (University of Arizona, Tucson, Arizona)

Other studies have indicated that guayule has problems when seeds and cuttings are rooted in soil with a high water content. This symptom is similar to plants which have a low tolerance to anaerobic stress. The major enzyme required by cells in order to survive anaerobic stress is alcohol dehydrogenase (ADH)-I. The ADH-I enzyme activities in 3 polyploid lines (N565, N576, 11605) and one diploid line (Cal-3) have been characterized by native polyacrylamide gel electrophoresis and by a spectrophotometric assay. The results showed that diploid seed contains the same alleles for ADH-I, but has a much lower activity than polyploid seed. In contrast, there is no detectable ADH-I activity in guayule leaf, stems, and 1 to 2 week-old seedlings under normal growth conditions. When guayule seedlings were anaerobically stressed, the temporal expression and activity of ADH-I varied from cultivar to cultivar. The activity of ADH-I in N565 is induced around 2 hr stress, but has the least overall activity (units/min/mg total protein). In 11605 activity is induced around 20 hr and has a moderate overall activity. The activity of ADH-I in N576 is induced very late, around 36 hr, but has the highest overall activity.

9:45-10:00

**ELEVATED CO<sub>2</sub> EFFECTS ON GAS EXCHANGE OF  
SORGHUM IN A SEMI-NATURAL SETTING**

S. G. Allen, S. B. Idso, and B. A. Kimball (USDA-ARS, U.S. Water Conservation Laboratory, Phoenix, AZ)

An experiment was conducted to examine the interactive effects of atmospheric CO<sub>2</sub> concentration and other environmental factors on gas exchange processes of sorghum plants (*Sorghum bicolor*, L. Moench) growing in a semi-natural setting. Sorghum plants were grown in 11-L pots, 3 plants per pot, in outdoor, open-top, clear-plastic-wall CO<sub>2</sub> enrichment chambers maintained at either ambient CO<sub>2</sub> (about 340 μmol CO<sub>2</sub> mol<sup>-1</sup> air) or 640 μmol CO<sub>2</sub> mol<sup>-1</sup> air. Net photosynthesis (P<sub>n</sub>), stomatal conductance of water vapor (G<sub>s</sub>) and leaf minus air temperature differential (T<sub>d</sub>) were measured hourly between 0700 and 1700 hr on 26 April 1988 and 3 and 4 May 1988. P<sub>n</sub> in the high CO<sub>2</sub> treatment, averaged over all times and days, was 10% higher than the ambient CO<sub>2</sub> treatment. There was no apparent interactive effect between CO<sub>2</sub> and other environmental variables on P<sub>n</sub>. Average G<sub>s</sub> in the high CO<sub>2</sub> treatment, was 27% lower than in the ambient CO<sub>2</sub> treatment. A significant CO<sub>2</sub> by environment interaction did affect G<sub>s</sub>, such that under high light and temperature conditions the relative difference between treatments was greater than under low light and temperature conditions. T<sub>d</sub> in the high CO<sub>2</sub> treatment was significantly higher than in the ambient CO<sub>2</sub> treatment. These results suggest that increased productivity and water use efficiency of C<sub>4</sub> plants can be expected if the atmospheric CO<sub>2</sub> concentration continues to increase as predicted.

**10:00-10:30      COFFEE BREAK - Patio Deck, 2nd Floor**

**12:00 - 1:30      ANNUAL ACADEMY AWARDS LUNCHEON AND BUSINESS  
MEETING, STUDENT UNION, ROOM 201**

**4:00                GOVERNING BOARD MEETING, ROOM 207**

## GEOGRAPHY

**SESSION I: 8:00 A.M.**

**ROOM: 304**

**Chairperson: Christopher Exline**

### **8:00-8:15 MICROCLIMATES OF SUN CITY**

Anthony J. Brazel and Herbert J. Verville (Arizona State University, Tempe, Arizona)

Sun City, Arizona serves as an excellent laboratory to test effects of land surface change on microclimatic conditions in a desert urban environment. The Sun City locale is symmetrically planned with well identified landscaped features such as housing tracts, lakes, turf and desert landscapes. For the period September 1987 through August 1988, weather stations were established over desert, turf, and lake landscapes. Pronounced diurnal and seasonal air temperature contrasts are evident among these three landscape components. All year round the desert landscape air temperature is warmer than turf and lake areas. Air temperatures over the turf landscape are indicative of an irrigation and evapotranspiration cooling effect. As expected, lake temperatures show a pronounced temperature lag through the year, cooler than turf from February through June and warmer than turf in August through October. These results are considered important in terms of energy consumption differences that may arise within these microclimates. The degree of relative cooling experienced in the irrigated and lake environments represents a possible microclimate-induced effect on neighborhood summer cooling requirements.

### **8:15-8:30 TEMPE, ARIZONA CLIMATE CHANGE: SEARCHING FOR A CLEAN URBAN CLIMATE SIGNAL**

Sandra W. Brazel and Robert C. Balling, Jr. (Arizona State University, Tempe, Arizona)

Climate change detected in temperature data from the official weather station at the Phoenix Sky Harbor Airport has been attributed to the rapid rate of urbanization in the Phoenix metropolitan area. Separate studies using summertime temperature data from long-term weather stations in the region and AVHRR surface temperatures from selected summer days and nights have revealed the existence of a complex spatial heat island pattern and a strong link between land use and surface temperatures. Two weather station sites in Tempe, Arizona, within the metropolitan Phoenix area, have recorded temperatures in unchanged surroundings for almost 40 years. These sites can be used to identify the magnitude of the change at the Airport due to local land use changes. Regional climate effects can be subtracted by comparing the Tempe sites to Wickenburg, a nearby rural site free of urban effects. The resulting temperature trend reflects the impact of urbanization on a regional scale.



**8:30-8:45**

**PALM SPRINGS: THE COOL ISLAND OF THE DESERT**

Robert C. Balling, Jr. and Nina K. Lolk (Arizona State University, Tempe, Arizona)

Summertime maximum temperature records for Palm Springs and Redlands, California are analyzed for a 48-year period, 1940 to 1987. The results reveal differential cooling in Palm Springs beginning in the early 1970s. This relative cooling period coincides with the construction of dozens of large golf courses in the Palm Springs area. This study indicates that the growing cities in the desert southwestern United States may reduce their developing heat islands by maintaining substantial green space within the metropolitan area.

**8:45-9:00**

**SURFACE EMITTANCE AND TEMPERATURE CHARACTERISTICS  
IN MOUNTAINOUS KASHMIR AND LADAKH**

Anthony J. Brazel and Melvin G. Marcus (Arizona State University, Tempe, Arizona)

Observations of air, slope, flat surface, and apparent sky temperatures were recorded during 16 July to 9 August, 1988 in Kashmir and Ladakh, northwestern India. These measurements represent a spatio-temporal transect through a rugged, moist mountain region (3230-4090 m in Kashmir) to a higher, arid environment (3280-5080 m in Ladakh).

Results suggest that surface temperatures of valley slopes of the Kashmir data array were consistently 3°C cooler at noon than similarly facing surfaces in Ladakh. In Kashmir, horizontal surfaces experienced high surface temperatures (3°C) than valley slopes. This is, in part, because horizontal surfaces at these latitudes face the sun more directly in July and August than the high angle valley slopes. The differential was higher in drier Ladakh (8°C). On average, Kashmir air temperatures were 3-5°C cooler than in Ladakh during the noon to sundown period.

The above spatial and temporal variations of long-wave emittance and temperature result not only from changes in elevation, latitude, slope, and aspect, but also reveal the strong influence of differing surface cover.

**9:00-9:15            OBSERVATIONS OF WINTER DIURNAL TEMPERATURE IN A  
MOUNTAIN TOWN, SILVERTON, COLORADO**

Michael George and Melvin G. Marcus (Arizona State University, Tempe, Arizona)

The temperature field of Silverton, Colorado, was observed over two diurnal periods during November 22-24, 1988. Cold, clear weather prevailed through the evening of the 23rd followed by low clouds and persistent snowfall on the 24th. Temperatures were taken at 50 of 53 possible street intersections using an automobile-mounted, shaded thermister. Additionally, these data were tied to five topographic temperature transects onto surrounding slopes. In-city elevations ranged over 45 m with most occurring within a 20 m range. Cold air ponding shows a good correlation with elevation and topography only along the town boundaries, while within the city temperature variations seem to be driven by urban factors rather than relief. On the other hand, the cold basin-wide inversion tends to override development of a proper heat island.

**9:15-9:30            WINTER INVERSION EFFECTS, SILVERTON, SAN JUAN  
MOUNTAINS, COLORADO**

Michael George (Arizona State University, Tempe, Arizona)

The diurnal, vertical thermal regime for Silverton, Colorado was observed over three cold, clear days in November, 1988. Micro-level and macro-level measurements indicate the occurrence of a strong and persistent inversion over this steeply-walled alpine basin. There was a snowcover throughout the period. Temperatures at Silverton ranged from a low of  $-22^{\circ}\text{C}$  to a high of  $14^{\circ}\text{C}$ . Temperatures were measured by portable thermister along four transects radiating from the city center and climbing several hundred meters. The inversion developed as deep as  $5^{\circ}\text{C}$  and sustained itself for at least 150 meters, never breaking up during clear conditions but lifting 50-70 m during late afternoon.

**9:30-9:45            A COMPARISON OF RADIATION BALANCES BETWEEN  
SILVERTON AND A RURAL LOCALE, SAN JUAN MOUNTAINS,  
COLORADO**

Matthew J. Stoll (Arizona State University, Tempe, Arizona)

Radiation balance observations have been performed periodically from 1977 to 1988 along a transect in the San Juan Mountains, Colorado from Molas Pass (3325 m) through Silverton (2840 m) to Red Mountain Pass (3355 m). This paper reviews these measurements in terms of variations of short- and longwave radiation; these are shown as functions of elevation, aspect, surface condition, seasonal sky horizon, pollution, and weather conditions. While shortwave energy attenuates at predictable levels, longwave radiation is affected by local haze and inversions.

**9:45-10:00      EXPERIMENTS ON SNOW ALBEDO CHARACTERISTICS, RED MOUNTAIN PASS, COLORADO**

Bruce L. Gwilliam (Arizona State University, Tempe, Arizona) and Paul J. Weser (Scottsdale Community College, Scottsdale, Arizona)

A series of incoming and outgoing shortwave radiation measurements were taken in March, 1984 and November, 1988 with the purpose of determining variations of albedo under varying natural and simulated snow surface conditions. Surface additives included dust, rainwater, sand, pumice, and ash. Major changes in surface configuration occurred within hours after treatment. Albedo changed immediately and progressively altered over time. The combination of effects often formed a dense, micro-penitente landscape. Classical increases in albedo occurred in low sun angle periods, enhanced by the reflective characteristics of local relief.

**10:00 - 10:30 COFFEE BREAK**

**10:30-10:45      DAILY CHANGES IN SURFACE ALBEDO OVER A MELTING GLACIER**

Tomas A. Miller (Arizona State University, Tempe, Arizona)

As part of a microclimatic research program, surface albedo was measured over the West Gulkana Glacier, Alaska during the summer of 1986. Unlike most past research, radiation instruments remained in place throughout the summer season, recording changes in glacier albedo as the surface changed from snow to slush to bare glacier ice. During the early season snow-melt, albedo continually dropped from a high of 0.74 to a low of 0.29. Once the glacier surface conditions changed to a deep slush layer, albedo rapidly increased to 0.51 as a result of periodic freeze-thaw episodes. After the slush layer melted and bare glacier ice was exposed, surface albedo dropped to 0.28 and then gradually decreased throughout the remainder of the season. These results agree well with previous albedo studies and indicate that efforts to model microclimatic changes over glacier surfaces must account for wide seasonal variability in albedo.

**10:45-11:00      DOES THE SEASONAL SNOWCOVER LOSE MASS FROM WITHIN?**

Leland Dexter (California State University, San Bernardino, California)

While much attention has been directed to factors affecting snowmelt and subsequent runoff into the stream channel, relatively little attention has been given to the amount of snow water which may be lost before reaching the stream channel. Accordantly, little is known about the magnitude of such losses and estimates vary widely from "negligible" to as much as 60% of the total snowfall. When such "shrinkage" is documented it is usually attributed to surface sublimation and evaporation. This paper addresses an issue pivotal to such losses; can we consider the snow surface to be the only zone active in vapor transport or do we need to consider additional processes active within the body of snowpack. The conclusion reached from this field study is that internal vapor diffusion or convection may serve to enhance total snowpack vapor ablation in some cases.

**11:00-11:15      THE 1986-89 DROUGHT IN WESTERN NEVADA - HOW BAD IS IT?**

John W. James (University of Nevada-Reno, Reno, Nevada)

Except for extremely heavy record-setting precipitation in Western Nevada associated with the Storm of Record in mid-February 1986, climatic conditions in that region of the State have been one of well below normal precipitation for the past three years. Carryover water from the 1986 wet episode was used to ease water shortages during the dry 1986-87 Water Year. However, most of this was exhausted as yet another very dry winter plagued the area in 1987-88, causing the worst drought conditions in at least 11 years and, considering today's population demands, the worst since the early 1930's. Record warm temperatures and high evaporation have exacerbated the drought. The 1988-89 Water Year began with a very dry October, a wet November and a wet December, as drought conditions continued in the Tahoe-Truckee, Carson and Walker River watersheds.

**11:15-11:30      CORRELATIONS BETWEEN AGRICULTURAL CROPS AND ACID SULFATE SOIL SERIES ON THE BANGKOK PLAIN OF THAILAND**

S. Harry Tsutsui (Northern Arizona University, Flagstaff, Arizona) and Prasert Witayarut (Srinakharinwirot University, Bangkok, Thailand)

Agricultural crops surveyed at 50 meter intervals along five transects totalling 80.55 km were compared to soil series designated in the 1972 Detailed Reconnaissance Soil Map of Southern Central Plain Area, and the 1985 End of Assignment Report on Technical Assistance to the Acid Sulfate Soils Improvement Project, Volume 1. Spearman's rank correlation coefficients showed that rank order of idle land and thirteen crops grown in the study area could be used to distinguish

Thanyaburi from Rangsit soil series, as mapped in the first report. The second report redesignated as much as 40% of the soils within the study area, yet, rank order of crops could be used to differentiate Rangsit (all phases from the first report) from the new Rangsit yellow mottle phase in the second report, and the Rangsit yellow mottle phase from the Chachoengsao series, both as mapped in the second report.

**12:00 - 1:30      ANNUAL ACADEMY AWARDS LUCHEON AND BUSINESS MEETING, STUDENT UNION, ROOM 201**

**SESSION II:      1:45**

**ROOM:            304**

Chairperson:    Christopher Exline

**1:45-2:00            RISK, GENETIC ENGINEERING, AND AGRICULTURE**

Melinda Laituri and Altha Cravey (University of Arizona, Tucson, Arizona)

Genetic engineering will have far-reaching effects on agriculture in the form of enhanced crop yields, accelerated growth rates, and increased crop resistance to biological and environmental stress. Genetic engineering will not only change traditional agricultural practices, but will affect the relationship between government, industry, science, and universities.

This paper focuses on genetic engineering in agriculture and its implications for risk assessment analysis. Increased genetic uniformity, complications of the Green Revolution, increased dependence on pesticides and insecticides, and starving masses are all indications of agricultural problems. But risks will be realized if genetic engineering continues to be developed under the existing infrastructure.

The risks associated with genetic engineering and agriculture can be divided into three groups: genetic risks -those associated with the genetic make-up of plants; status-quo risks- those which occur due to the new technology being developed within a framework of traditional goals; insidious risks- those resulting from changes the new technology has on the existing infrastructure. These risks will have long-term effects in shaping the political and institutional framework.

**2:00-2:15**

**THE USE OF MULTISPECTRAL VIDEO REMOTE SENSING TO MONITOR SUSPENDED SEDIMENT CONCENTRATIONS**

Christopher T. Lee (University of Arizona, Tucson, Arizona)

Reliable, continuous data on the suspended sediment load of streams are virtually nonexistent. Standard stream gauges permit continuous, reliable estimates of stream discharge, but independent data on sediment load are equally essential for understanding stream channel stability and predicting downstream rates of reservoir sedimentation and channel degradation. Suspended sediment concentration is highly varied with time, and is largely independent of stream discharge. Estimates of suspended sediment loads at critical times are usually derived indirectly by means of crude empirical curves relating a limited number of sediment samples to a restricted range of contemporaneous estimates of stream discharge.

The relatively new technology of video remote sensing has the potential to provide a monitoring system with temporal sensitivity and spatial accuracy far superior to traditional ground based methods. This study is designed to develop data acquisition, image processing, and modeling techniques to further the basic understanding of video remote sensing and sediment transport and serve as the foundation for the future implementation of a full scale monitoring system which can be adapted to a wide variety of river networks.

**2:15-2:45**

**GRAFFITI IN MEXICAN-AMERICAN NEIGHBORHOODS**

Malcolm L. Comeaux (Arizona State University, Tempe, Arizona)

Mexican-American neighborhoods are distinguished by the amount and visibility of graffiti. The writing of graffiti is done by gang members, usually on the walls of public and semi-public buildings, and it has purpose and meaning to the locals. It is usually seen near the core of a gang's territory, asserting the gang's control over that turf, and is also commonly found along the edges of the gang's territory, serving as a warning to other gangs.

Two types of lettering are found in this graffiti. One is large block lettering identifying the gang. This lettering is intended to be easily read. The other type is a highly stylized form of writing that gang members do not really care whether others can read or not. It is usually used to list the names or nicknames of gang members. There are also a few symbols that have special meaning to all gang members. Each writer of graffiti attempts to develop a unique style, and a person skilled at this receives considerable recognition for his talent. The defacing of graffiti is considered an insult and is an indication of tension between gangs.

**2:30-2:45      PLANS AND PLANNING WITHOUT POWER: LAND USE  
UNCONTROLLED**

Christopher H. Exline (University of Nevada-Reno, Reno, Nevada)

A planning process and resulting plan lacking in adequate strength of regulation often will be ineffective in controlling and directing the use of land. In such situations the "plan" rather than bring order upon the land may, in fact, invite chaos. The study will investigate the planning process and resulting plan developed for Reno, Nevada, a rapidly growing city with a myriad of environmental and land use problems. The investigation will conclude with an assessment of the effectiveness of Reno's land use plan.

**3:00-3:30      COFFEE BREAK - Patio Deck, 2nd Floor**

**4:00            GOVERNING BOARD MEETING, ROOM 207**

## GEOLOGY

**SESSION I      8:00 A.M.**

**ROOM:            115**

**Chairperson:    Fredrick W. Bachhuber**

**8:00-8:15        PROTEROZOIC GRANULITES FROM NORTHWEST  
ARIZONA: HIGH TEMPERATURE/LOW PRESSURE  
CONSTRAINTS ON THE CRUSTAL EVOLUTION OF THE  
SOUTHWESTERN UNITED STATES**

David Palais (Arizona State University, Tempe, Arizona)

Low-pressure granulite facies metamorphism is characteristic of Proterozoic gneiss complexes in northwest Arizona and represents the southern extension of the granulite terrane reported in southeastern Nevada (Thomas et al., 1988). Preliminary mineral thermobarometry on pelitic assemblages containing garnet + biotite + plagioclase + K-feldspar  $\pm$  sillimanite  $\pm$  cordierite  $\pm$  hercynite suggests peak metamorphic temperatures of 630-770°C and pressures of 2-5 kbar. Major and trace element geochemical analysis of 21 prograde and retrograde granulites indicates that U and Th have been variably depleted from the high grade rocks whereas Rb shows little or no depletion with respect to K (K/Rb~250). Reconnaissance field studies have revealed a possible eastward increase in the degree of retrogression from the Black Mountains along the Colorado River to Grapevine Mesa. The proximity of structural and published geochronologic boundaries to the amphibolite/granulite facies transition (constrained by amphibolite facies gneisses in the Hualapai Mountains) suggests a connection between the granulite facies event and a major crustal amalgamation event. Continuing field studies will delineate the extent of the granulite facies metamorphism and whether it is constrained to one geochronologic (and/or structural) province or whether the granulite facies metamorphism overprints these boundaries.

**8:15-8:35        DETAILED MAPPING AND STRUCTURAL ANALYSIS OF  
THE HANGING WALL BLOCK OF THE VERDE FAULT,  
CENTRAL ARIZONA**

David Brumbaugh (Northern Arizona University, Flagstaff, Arizona)

The Verde fault is a large normal fault which bounds the western margin of the Verde Valley of Arizona. The displacement, measured by stratigraphic offset, is uncertain but at a minimum exceeds 3000 ft. The major movements were part of a



tectonic event known as the Basin and Range orogeny, characterized by regional crustal extension, localized along high-angle normal faults.

Detailed mapping of part of the Blowout Creek area of the Verde fault gives insight into the mechanics of deformation of the hanging wall block of high-angle normal faults. A variety of perviously unknown or largely unremarked structures has been identified as a result of the mapping. These include convex up normal faults, high-angle reverse faults, thrust faults, and folds.

Clearly planar normal faults of the hanging wall block as well as the convex up normal faults form as a result of movements on the master normal fault in a extensional environment. The presence of chevron folds and thrust faults requires the presence of a near horizontal  $\sigma_1$  and a resulting shortening of section. Such structures exist on the hanging wall block of the Verde fault and lend support to a complex stress configuration during fault movement, as well as a complex sequence of events.

**8:35-8:50            THE TECTONIC IMPLICATIONS OF UNIQUE TERTIARY  
SEDIMENTS IN THE UPPER PLATE OF THE ARCH  
MOUNTAIN DETACHMENT FAULT, MOHAVE COUNTY,  
ARIZONA**

Eschner, Edward, and Sewall, Angela, J. (University of Nevada, Las Vegas, Las Vegas, Nevada)

A sedimentary section containing breccia with limestone clasts, subarkosic sandstone, bedded limestone and large blocks of Precambrian(?) granite crop out in the upper plate of the Arch Mountain detachment fault, northwestern Mohave County, Arizona. This section is about 40 m thick and may be correlative with the lithologically similar Horse Spring Formation. Outcrops of the Horse and Saddle Island detachment fault also contain large blocks of distinctive Precambrian granite. Although exposures of Precambrian rocks in the Black Mountains have been suggested as a possible source for the blocks of granite, the only documented potential source area is in the South Virgin Mountains, near Gold Butte. We suggest that the occurrence of Horse Spring Formation in the upper plate of the Arch Mountain and Saddle Island detachment faults and at Frenchman Mountain may indicate that the outcrops were transported westward from the South Virgin Mountains area in the upper plate of a west-dipping regional detachment system.

**8:50-9:05 REGIONAL METAMORPHISM, DUCTILE DEFORMATION,  
AND PLUTONISM IN THE CENTRAL OLD WOMAN  
MOUNTAINS, SE CALIFORNIA**

David Rothstein, Thomas D. Hoisch, and Karl E. Karlstrom (Northern Arizona University, Flagstaff, AZ)

In the central Old Woman Mountains in southeastern California high-temperature regional metamorphism, ductile deformation, and granitoid plutonism occurred contemporaneously during orogeny in the Late Cretaceous. A thin, gently north-dipping sheet of isoclinally folded, transposed, and thrust-faulted Paleozoic strata and Precambrian basement rocks forms a partition that serves as both the roof and the floor of two petrologically distinct, gently north-dipping, sheet-like granitoid plutons, both of Late Cretaceous age (74m.y.). The resultant "sandwiching" of the Paleozoic section between the simultaneously cooling plutons has important thermal implications, the generation of an extremely high grade of metamorphism that reaches the sillimanite-K feldspar facies, and the production of significant fluid flux, as evidenced by the occurrence of massive wollastonite throughout the Pennsylvanian Supai Formation. Severe isoclinal folding and attenuation of stratigraphic units indicates that the rocks were extremely hot and ductile during their deformation. The occurrence of folded dikes, granitoid-filled saddle reefs, and pegmatites perpendicularly cross-cutting foliation indicates the granites intruded and "sandwiched" the Paleozoic section during deformation.

**9:05-9:25 PROVENANCE OF LOWER PALEOZOIC SANDSTONES IN  
THE ROBERTS MOUNTAINS ALLOCHTHON, NEVADA:  
IMPLICATIONS FOR REGIONAL TECTONICS**

Wallin, E. T., (University of Nevada, Las Vegas, Las Vegas, Nevada)

Poorly-understood terrigenous deposits within the Roberts Mountains allochthon (RMA) constitute much of the fragmentary record of lower Paleozoic tectonics in Nevada. The provenance of these deposits is the subject of speculation as well as a principal uncertainty in reconstructions of tectonic history. Geochronometry of detrital zircon from four sandstones within the RMA provides new constraints on the provenance of these units.

The Upper Cambrian(?) Harmony Formation consists primarily of first-cycle detritus derived from an uplifted cratonic block. Pb-207/Pb-206 ages for detrital zircon from the Harmony suggest a crystallization age between 1.75 and 1.85 Ga for this block. These ages are compatible with derivation of the Harmony from a widespread Pb-207/Pb-206 ages for zircon from a lower Ordovician sandstone of the Vinini Formation are similar to those of the Harmony. This similarity is consistent with the idea that some Vinini sandstones were derived either directly from the source of the Harmony or by recycling of the Harmony itself. Polycyclic zircons from the Middle

Ordovician Palmetto Formation and the Middle Devonian Slaven Chert also yield Precambrian ages. These data underscore uncertainty regarding interpretation of the RMA as a closed back-arc basin.

**9:25-9:40 SEISMICITY AND STRESS PATTERN AT THE WESTERN GREAT BASIN BOUNDARY**

Ute R. Vetter (University of Nevada, Reno, Reno, Nevada)

The number of seismic stations recorded by the Seismological Laboratory of the University of Nevada increased in the last two decades from 11 stations in 1970 to 78 stations in 1988. With the improvement of the network also the quality of location of earthquakes and determination of their focal mechanisms increased. We are now able to locate earthquakes smaller than magnitude 1 and our catalog is complete to magnitude about 2 1/4.

The tectonics of the whole area is characterized by regional extension. Focal mechanisms of the earthquakes show that faulting is governed by strike-slip at the western Great Basin-Sierra Nevada boundary in the west of our network, but in central Nevada normal faulting is more common; about half of the earthquakes show a strong component of normal slip. Most of the mapped Holocene faults in the whole area document normal slip, while modern seismicity shows larger strike-slip components. The reason may be that most earthquakes occur on preexisting zones of weakness of any direction. The tectonic stress pattern, derived from this moderate seismicity, changes near the eastern boundary of the Sierra Nevada from an east-westerly extension direction in eastern California to a northwest-southeasterly direction in Nevada.

**9:40-9:55 RECONSTRUCTION OF CINDER CONE BREACHING EVENTS: AN EXAMPLE AT STRAWBERRY CRATER AND O'NEILL CRATER, ARIZONA**

Richard Harwood (Northern Arizona University, Flagstaff, Arizona)

Examination and mapping of rafted agglutinate mounds can be used to reconstruct breaching events of cinder cones. Position of rafted mounds is used to determine; 1) the relative timing of the breach in relation to the lava flow event, and 2) the number of flow units. Textural examination is used to place the rafted mounds stratigraphically in the cone, thus allowing the stratigraphic position of the initial breach to be determined.

Studies at Strawberry and O'Neill Crater, Pleistocene cinder cones in the San Francisco volcanic field, north-central Arizona, have revealed unique breaching histories. At Strawberry Crater, over-steepening of agglutinate beds and radially oriented extension cracks in the rim suggest occupation of the crater by a lava lake prior to breaching. Breaching of the cone by over-topping of the rim is indicated by

distally located rafted mounds whose original stratigraphic position was the rim.

Rafted mounds at O'Neill Crater show two periods of lava extrusion. The first flow was a non-breaching event, supported by the absence of rafted material on the flow. The second flow breached the cone near the base, rafting the eastern portion of the cone a short distance, thus opening a gap through which the lava flowed.

**10:00-10:30      COFFEE BREAK - Patio Deck, 2nd Floor**

**10:30-10:45      \*ANALYSIS OF BREACH AZIMUTHS FOR CINDER CONES  
IN THE SAN FRANCISCO VOLCANIC FIELD, ARIZONA**

Richard Harwood (Northern Arizona University, Flagstaff, Arizona)

Statistical analysis of breach azimuths for 36 cinder cones in the San Francisco volcanic field, north-central Arizona, results in a bimodal distribution with mean vectors of the azimuths at S57.7E (122.3°) and N67.9W (292.1°). These directions are roughly perpendicular to the least principal horizontal stress direction of N50E (50°) determined for the volcanic field. Four local controls on breaching mechanisms appear to operate in determining the direction of breach in cinder cones: 1) local topographic stress regimes, 2) local fault/joint system control, 3) wind direction/cone strength, and 4) vent location of the breaching lava. The connection between the identified local controls and the influence by the regional stress regime is not fully understood and is the subject of continuing investigation.

**10:45-11:05      MAPPING ASH-FLOW ZONES OF THE BISHOP TUFF WITH  
LANDSAT SATELLITE IMAGES**

Alan H. Levine (Arizona State University, Tempe, AZ)

Landsat Thematic Mapper (TM) data is used to produce a detailed map of the various zones of welding and crystallization within the Bishop Tuff of eastern California. This large volume ash-flow tuff erupted 0.71 Ma leading to the collapse of Long Valley caldera. In exposures of the Bishop Tuff east and southeast of Long Valley, an area known as the Volcanic Tableland, the TM imagery distinguishes: (1) non-welded tuff; (2) partly-welded tuff; (3) vapor-phase altered tuff; and (4) fumarolic mounds. The distribution of these units agrees excellently with the USGS geological map (White Mountain Peak Quadrangle, Map GQ-1012) that includes the northern part of the Volcanic Tableland. Based on the TM data, the partly welded tuffs are divided into vitric matrix and crystalline matrix units. Three varieties of vapor-phase altered tuffs are recognized which differ in degree of crystallinity. Alluvial units deposited after and on top of the Bishop Tuff can be differentiated in terms of their proportion of

granitic to rhyolitic clasts, which indicate the highland sources to the west. Field investigations have verified these unit assignments. Laboratory reflectance spectra for collected samples explain the variations recorded in the satellite data.

**12:00-1:30 ANNUAL ACADEMY AWARDS LUNCHEON AND  
BUSINESS MEETING, STUDENT UNION, ROOM 201**

**SESSION II 1:30 P.M.**

**ROOM: 115**

**Chairperson: Fredrick W. Bachhuber**

**1:30-1:45 ANISOTROPY OF MAGNETIC SUSCEPTIBILITY AS A  
PRELIMINARY INDICATOR OF FLOW DIRECTION OF THE  
APACHE LEAP TUFF, CENTRAL ARIZONA**

Catherine A. Nist (U.S. Geological Survey, Flagstaff, AZ, and Northern Arizona University, Flagstaff, AZ) and Gary J. Calderone (U.S. Geological Survey, Flagstaff, Arizona)

Anisotropy of magnetic susceptibility (AMS) measurements for each of 117 samples collected from eight sites in the middle Miocene Apache Leap Tuff near Superior, Arizona, define magnetic lineation and foliation in the tuff. Mean maximum susceptibilities of the five stratigraphically lowest sites are directed north-south. In contrast, mean maximum susceptibilities from the uppermost three sites are directed northwest-southeast. If we assume that the maximum susceptibility direction indicates the flow direction, several interpretations are possible: (a) the lower north-south direction reflects the influence of basement topography on the flow direction, (b) the lower north-south direction reflects the true source direction, (c) the upper northwest-southeast direction reflects the true source direction, (d) the upper northwest-southeast direction reflects a second source direction, and (e) some combination of the above. AMS data from more widespread localities may help determine which of these hypotheses are valid and help locate the source or sources of the Apache Leap Tuff.

**1:45-2:00**

**ARTIFICIAL RECHARGE, EAST MESA, IMPERIAL CO., CA**

K. Doebbler, E. Burnett, F. Croxen, P. Matuska (USBR, Yuma, Arizona)

The Colorado River Board of California and the agencies it represents, in conjunction with Coachella Valley Water District, and the U. S. Bureau of Reclamation, are testing use of the old, unlined Coachella Canal for artificial recharge of the East Mesa, Imperial County, CA. The East Mesa is a triangular desert area of over 200 square miles, located east of the Imperial Valley in southeastern CA. Formed largely by fluvial processes, the geology consists of fine to medium sand overlying a thick sequence of lakebed clays and sands.

The East Mesa site was chosen due to the ease of transferring excess Colorado River flows from the new, lined Coachella Canal to the old, unlined canal. In addition, an existing finite difference ground-water model, calibrated to the geologic and hydrologic features of the area, was applied to predict long-term recharge and pumping effects.

A study was designed to respond to the following recharge-related questions: effects on (1) confined water and drainage into the Salton Sea and East Highline Canal, (2) area water table elevations, (3) water quality and recoverability, and (4) ground-water flow to Mexico. To answer these questions, existing observation wells, in addition to wells drilled specifically for the study, were used to provide data.

**2:00-2:15**

**ARTIFICIAL RECHARGE THROUGH AN UNLINED CANAL,  
EAST MESA, IMPERIAL COUNTY, CALIFORNIA**

P. Matuska, E. Burnett, F. Croxen, K. Doebbler (USBR, Yuma, Arizona)

The East Mesa recharge site has unique conditions which would contribute to long-term recharge feasibility. Geologic investigations reveal a two-layer aquifer below the test site; a shallow water table aquifer and a deep, thick confined aquifer separated by a low permeability clay. Recharged water readily flows to the water table aquifer where it flows laterally and forms a mound which eventually makes saturated connection with the canal. Some vertical flow through the confining clay into the deep aquifer is indicated. Recent test drilling has shown good quality water in the shallow aquifer while the deep aquifer yields water of poor quality; therefore recovery wells must be screened within the shallow aquifer. This brought up the following questions: (1) can good quality recharged water be recovered in the future at quality equal to that recharged?, (2) how fast can water be recharged?, and (3) how will hydraulic connection between the canal and water table affect the recharge rate?

A cluster of observation, pumping, and neutron-probe access wells were drilled to help answer these questions. After overcoming the problems of remoteness, flow measurement, and the shear volume of data collected, infiltration rates in excess of 40 inches per day were noted during the first month of operation.

2:15-2:35

## CIRCULAR ORIENTATION OF INVERTEBRATE FOSSIL SHELLS IN PERMIAN KAIBAB FORMATION, NORTH-WESTERN ARIZONA

Stanley S. Beus, Heidi Johnson, H. Tim Nicholson, Brian Withrow, and Elizabeth Dyer (Northern Arizona University, Flagstaff, Arizona)

Rayleigh and chi-square tests of orientation data from three different macroinvertebrate shell forms exposed on bedding planes show the following:

1) Elongate, tapering tubular shells of the scaphopod Plagioglypta, near the top of the Harrisburg Member of the Kaibab Formation, are aligned at or near the horizontal and exhibit a completely random circular orientation of their long axes (369 specimens from two localities).

2) Plano-convex shells from more than 600 specimens of the productid brachiopod Peniculauris bassi, at one locality in the lower Fossil Mountain Member, are nearly all articulated; 76% are in presumed life position, convex down, and exhibit a random circular orientation of the posterior-anterior axis.

3) At the above locality about 25% of the biconvex, ribbed shells of the strophomenid brachiopod Meekella occur in presumed life position with the commissure up. Bidirectional measurements of the circular orientation of the commissure indicate a uniform or random distribution.

The lack of preferred orientation in the scaphopod shells suggests that they were in a low energy environment with little or no post-mortem orientation by currents. The orientation and occurrence of the two large brachiopod forms in the Fossil Mountain Member likewise suggest little or no post-mortem current transport.

2:35-2:50

## DEVONIAN PLACODERMS FROM FLAGSTAFF ARIZONA

D. K. Elliott, M.W. Ruddell, and H. G. Johnson (Northern Arizona University, Flagstaff, Arizona)

Placoderms were an early group of jawed fishes in which the head and trunk were covered by an armor of bony plates. They flourished in marine and freshwater environments during the Devonian and became extinct at the start of the Mississippian. Very few have been described from Arizona though large collections have been made from Devonian rocks in the state. The earliest collections were made by L. F. Hussakof in 1942. He identified a small coccosteid arthrodire, *Eldenosteus arizonensis*, of which only parts of the body armor were found, and a ptyctodont, *Ptyctodus bradyi*, of which only tooth plates were present. Recent collecting at the original site has provided additional information on the skull and body armor of *Eldenosteus* and the ptyctodont that allows a more comprehensive description to be made of both genera. The new material substantiates the view that *Eldenosteus* is a coccosteid, but the presence of body armor for the ptyctodont means that a new genus will have to be created for it as *Ptyctodus* is now considered to be a form genus restricted to teeth.

**2:50-3:10      A DISCRIMINANT FUNCTION ANALYSIS OF THE  
SWASTIKA SANDSTONE**

Donald Harris (Northern Arizona University, Flagstaff, Arizona)

The Swastika Formation is produced along the Eastern Shelf of the Permian Basin. The formation has two production zones, one a prolific quartzarenite, the other a marginal subarenite. Efforts to distinguish between the two zones using electric log analysis and cuttings have not been successful. This has caused many problems because the two zones do not have a stratigraphic relation to help the well-site geologist pick the payzone. This problem can be eliminated with the use of gravity and gas-to-oil ratio data in an discriminant function analysis to differentiate between the two zones. Such analysis will allow a quick field check of the oil properties from Drill Stem Tests, and the perforation of the producing zone.

**3:10-3:30      CALCRETE MORPHOLOGY AND DEVELOPMENT OF THE  
RED ROCK CANYON ALLUVIAL FAN, CLARK COUNTY,  
NEVADA**

Cheryl McDonnell-Canan (University of Nevada, Las Vegas, Las Vegas, Nevada)

Morphology and amount of secondary  $\text{CaCO}_3$  may date calcic soils and pedogenic calcretes on the Red Rock alluvial fan leading to a chronostratigraphy in southern Nevada. Soils on the fan form a chronosequence where all factors are held constant except time. All surfaces contain limestone alluvium, occur at elevations of 853 m, and share similar climate and vegetation. Four main surfaces were delimited by color, texture, degree and nature of dissection, relative vertical position, and soil development. The surfaces are ranked in age by elevation and topographic position; highest equals oldest, lowest equals youngest. Younger surfaces support braided channels, less than 1 m in depth, that distribute down the fan surface. Depth of channel incision increases with age and is marked by dendritic channels with parallel first order rilles. Because it is hard to measure secondary  $\text{CaCO}_3$  in soils derived from calcareous parent materials, a new technique employing macroscopic and microscopic determinations, combined with the wet chemical Chittick method, was used to estimate secondary  $\text{CaCO}_3$ . Rates of secondary  $\text{CaCO}_3$  of Surface 2 and 3 range from 0.21 to 0.45 g/cm<sup>2</sup>/ky and correlate with  $^{234}\text{U}/^{230}\text{Th}$  age-dated calcic soils and pedogenic calcretes developed on the Kyle Canyon fan. These rates compare favorably with those obtained on similar fans in Kyle Canyon, Nevada, and southern New Mexico.

**4:00            GOVERNING BOARD MEETING, ROOM 207**



## HYDROLOGY

**SESSION I: 8:00 A.M.**

**ROOM:105**

Chairperson: Martin Karpiscak

**8:00-8:15 WATER QUALITY OF STREAMFLOW FROM FORESTED WATERSHEDS IN ARIZONA**

Peter F. Ffolliott (University of Arizona, Tucson, Arizona)

Limited quantitative information on water quality of streamflow from forested watersheds in Arizona has restricted, to some extent, the development of appropriate water resource policies and management strategies. Fortunately, baseline information regarding the physical, chemical, and bacteriological water quality parameters has been collected on "experimental watersheds" representing a wide range of vegetative and physiographic conditions. In this paper, a "status of knowledge" analysis of water quality is presented to characterize, in particular, the chemical properties of streamflow from forested watersheds. Specifically, appropriate baseline information required to evaluate, in part, the hydrological conditions of forested watersheds in Arizona is reported upon, along with the empirical associations of water quality parameters and land use patterns. Source data for this work currently is being utilized in the development of computerized simulation techniques to estimate the effects of land use patterns on the chemical properties of streamflow.

**8:15-8:30 GROUND WATER/SURFACE WATER INTERACTIONS AND INSTREAM FLOW PROTECTION AT THE HASSAYAMPA RIVER PRESERVE, WICKENBURG, ARIZONA**

Michael E. Jenkins (University of Arizona, Tucson, Arizona)

The Arizona Nature Conservancy's Hassayampa River Preserve is located 50 miles northwest of Phoenix near the town of Wickenburg. Four miles of the largely ephemeral Hassayampa River are perennial within the preserve, supporting one of the state's finest remaining cottonwood-willow forests. Stream flows are affected by wells pumping ground water directly from the alluvial aquifer and may be influenced by wells which intercept lateral inflow from the regional basin-fill aquifer. Developing effective management strategies to protect base flow conditions (~4 cfs) depends on a clear understanding of the preserve's surface and ground-water systems. Piezometers installed in conjunction with a continuously recording stream gage monitor riparian water-table elevations. Geologic cross-sections defining aquifer geometry have been developed from seismic refraction data, providing accurate

estimates of sub-flow through the study area. Structural controls and changing evapotranspiration rates produce downstream variations and diminish base flow within the preserve. Ground-water hydrographs for wells within and near the alluvial aquifer have not exhibited significant declines in the last ten years, however, wells in the regional aquifer near Wickenburg have. Provided that ground water developers near Wickenburg recognize and incorporate the interconnected nature of each hydrologic system, perennial flow within the preserve is not believed to be immediately threatened.

**8:30-8:45 PERILS OF PROGRESS - HYDROGEOLOGIC HAZARDS IN LAS VEGAS VALLEY, CLARK COUNTY, NEVADA**

Terry Katzer and Kay Brothers (Las Vegas Valley Water District, Las Vegas, Nevada)

The prehistoric Indian population in Las Vegas Valley found abundant water for their needs from springs flowing from the base of numerous fault scarps throughout the Valley. The faults are considered to be compaction faults caused by subsidence resulting from dewatering aquifers as the climate became dry and warm during the interglacial periods of the Pleistocene.

The valley's aquifers, for historical purposes, eventually reached steady state conditions which lasted until the first half of this century, when urban growth created a demand for water that was satisfied by overdrafting the groundwater system, reactivating subsidence. Today, subsidence effects cover about 1,000-1,300 km<sup>2</sup> of the valley and the maximum vertical displacement is about 1.5 m.

As the demand for water continued to increase with population, large imports from the Colorado River via Lake Mead provided "excess" water, which helped create additional hazards: a rising shallow water table, resulting from over irrigating landscapes (secondary recharge), intersects land surface in places in the central and eastern part of the valley creating a hazard to structures and facilities, and also increases the liquefaction potential; and, the potential for degradation of the deep aquifers from downward percolation of the poorer quality water from the shallow system.

**8:45-9:00 ESTIMATION OF ORGANIC CONTAMINANT RELEASE FROM URBAN LAKE SEDIMENTS**

Frederick A. Amalfi and Milton R. Sommerfeld (Arizona State University, Tempe, Arizona)

Volatile and purgeable organics and acid and base/neutral extractable organic priority pollutants were measured in composite sediment samples collected from five urban lakes in Central Arizona. Identification and quantification of compounds were made by purge and trap gas chromatography and gas chromatography/mass spectroscopy. Compounds detected included dichlorobromomethane, tetrachloroethylene, chloroform, 1,1,2-trichloroethane, toluene, trichloroflouromethane,

and diethyl, dioctyl, and dibutyl phthalates. Concentrations ranged from 10 to 330 ug/kg (wet weight). An empirical mathematical model based on octanol-water partition coefficients was used to predict the extent of pollutant release from the sediments to the water column or to possible groundwater resources below the lakes. Estimated compound concentrations for the aqueous phase were below proposed drinking water standard maximum contaminant levels. Based on the model, only phthalate esters would reach concentrations in the water column that would be potentially toxic to aquatic organisms.

**9:00-9:15            OCCURRENCE OF ENTEROVIRUSES AND *GIARDIA*  
CYSTS IN LAND DISPOSED SEWAGE SLUDGE IN PIMA  
COUNTY**

Kristina Sores, Karen L. Josephson, Ian L. Pepper and Charles P. Gerba (University of Arizona, Tucson, Arizona)

Disposal of domestic sewage sludges is a major problem faced by most communities in the United States. This material produced during the "activated sludge" treatment of sewage can contain high concentrations of pathogenic microorganisms. This study is designed to determine the concentration of enteroviruses and *Giardia* cysts before and after anaerobic sludge digestion before disposal on farm land in Pima County. The concentration of enteroviruses in raw sludge ranged from 174 to 12,220 per liter before anaerobic digestion and 3 to 85 per liter after treatment. *Giardia* cyst concentrations were largely unchanged after treatment and ranged from 5,000 to 28,000 per liter. These results suggest that significant concentrations of enteroviruses and *Giardia* are present in anaerobically digested sludges being applied to farm land in Pima County.

**9:15-9:30            MONITORING FOR VIRUSES IN RECLAIMED WASTE-  
WATER**

Jaime E. Naranjo, Andy Rice and Charles P. Gerba (University of Arizona, Tucson, Arizona)

The wastewater reuse permit system in the State of Arizona requires that reclaimed domestic sewage to be used for irrigation and recreational purposes meet certain enteric virus standards. Such reclaimed wastewater must now be monitored on a routine basis to ensure compliance with these standards. For the unrestricted use of effluents for park land and golf courses, virus levels must not exceed 1/40 liters. Our laboratory is currently monitoring 24 wastewater reclamation plants in Arizona and have tested 124 samples for enteric viruses. To date, enteric viruses have been isolated in 18.5% of the samples. Of these, 8.5% have exceeded the standard for unrestricted irrigation. Disinfection of the effluents and filtration appear necessary for the wastewater to meet the standard.

**9:30-9:45      HYDROGEOLOGIC CONSIDERATIONS IN SITING A SOLID WASTE LANDFILL**

Edward D. Ricci (Water Resources Associates, Inc., Phoenix, Arizona)

Criteria for the siting of a solid waste landfill are selected based on hydrogeologic, demographic, and political considerations. The hydrogeologic considerations include the study of surface and subsurface geology, vadose zone properties, water table conditions, watershed characteristics, and surface water influences. Basic data may be collected from public agencies; detailed data is usually collected from soil boring programs.

Alternative candidate sites are selected based on a ranking system using criteria items and associated weighting factors. The highest weighting factors are applied to the most important hydrogeologic considerations. These include ground-water depth, bedrock/confining unit depth, and floodplain relationship. Secondary consideration is given to a multitude of other factors. These include the following items: available water supply, vadose zone characteristics, location and number of downgradient wells, continuous area available to be landfilled, continuous area available for the entire planned site, adjacent land uses, occurrence of recharge areas, ground-water declines, ground-water velocity, areas of possible subsidence, land slope, and site location regarding proximity to residences.

**10:00-10:30      COFFEE BREAK - Patio Deck, 2nd Floor**

Chairperson:    Kenneth E. Foster

**10:30-10:45      MAPPING THE MARICOPA AGRICULTURAL CENTER USING GIS**

John J. Regan, Donald F. Post, and Roy S. Rauschkolb (University of Arizona, Tucson, Arizona)

The University of Arizona's 2100 acre research and demonstration farm - the Maricopa Agricultural Center (MAC) has been mapped and data entered into a Geographical Information System (pc ARC/INFO). Project objectives were to map the farm in an absolute X-Y coordinate system using the Universal Transverse Mercator grid. Selected section corners with permanent markings noting the property boundaries (surveyed by the rectangular township-range system) were used as reference points. The mapping procedure used coordinate geometry and a Topcon GTS-3C electronic distance measurement instrument to precisely locate various points on the farm. This system provides us with a permanent spatial record to locate fields or research plot boundaries; monitor cropping histories and crop yields; keep records of soil test data; keep water-related information; etc. Map products will be displayed

and discussed that show applications related to monitoring soil-water-plant conditions on the farm. Remotely sensed data can be referenced to this system and will also be discussed. We see this as an important tool to help in making management decisions related to the operation of the Maricopa Agricultural Center.

**10:45-11:00 USE OF MULTI-SPECTRAL DATA TO MONITOR THE WATER AND PLANT NUTRIENT STATUS OF SWEET CORN**

D. E. Post, T. A. Doerge, A. R. Huete, J. L. Stroehlein, J. Qi, T. C. Tucker, D. D. Fangmeier, and T. W. McCreary (University of Arizona, Tucson, Arizona)

Multi-spectral remotely sensed data in the visible and NIR parts of the spectrum were used to evaluate the growth of drip-irrigated sweet corn. The experiment was conducted on the Maricopa Agricultural Center in 1987 and 1988 using a randomized complete block experimental design. We had 72 and 36 plots in 1987 and 1988 respectively, and each plot was 6.1 x 15.2 meters in size. Three irrigation levels were used both years (60%, 100% and 130% of the evapotranspiration for the area). Three levels of nitrogen and two levels of phosphorus were used in 1987 and three levels of nitrogen only in 1988 with four replications per treatment. Multispectral data were collected only on May 20, 1987, however in 1988 we collected data on five dates between May 6 and June 1. Relationships between the spectral data and biomass production will be presented. The potential of remotely sensed data to assist in irrigation scheduling and to monitor plant health will be discussed.

**11:00-11:15 DESERT RIPARIAN HABITATS OF THE SOUTHEAST SIERRITA MOUNTAINS, ARIZONA: GEOLOGY, SOILS, VEGETATION AND CHANGE**

Jeffrey Zauderer (University of Arizona, Tucson, Arizona)

The perennial riparian vegetation of the Sierrita Mountains, about twenty miles south of Tucson, is densest in the southeastern quadrant of the area. Riparian habitat location is controlled by the juxtaposition of silty fluvial terraces and interfluvial clay covered soils. Channel slope, rainfall, and underlying geology are also determining factors. Landsat images, soil mapping and field studies illustrate the controls of habitat that make the location unique in the Sierritas. Changes in stream morphology, and the location of abandoned streams cut by younger channels indicate processes of change becoming significant probably in the 1880s to recent times. These changes are the probable result of drought, the introduction of cattle, and regional dewatering of the Santa Cruz basin. The riparian habitats are in a degrading system that buffers against erosion and severe peak flooding. The loss of these habitats could have cascading impacts through the riparian system.

**12:00- 1:30 ANNUAL ACADEMY AWARDS LUNCHEON AND BUSINESS MEETING, STUDENT UNION, ROOM 201**

**SESSION II 2:00 P.M.**

**ROOM: 105**

Chairperson: Martin Karpiscak

**2:00-2:15 POTENTIAL CONTRIBUTION OF WATER RESEARCH TO PUBLIC POLICYMAKING**

Joe Gelt (University of Arizona, Tucson, Arizona)

Studies have indicated that water-related university research has not significantly affected the public policymaking process in Arizona. This paper will discuss what conditions, process or strategies best enable lawmakers to utilize research as a valuable resource when developing water policy in Arizona. In other words, what is the best way to communicate relevant research results to policymakers? What channels presently exist, and do they work? What more needs to be done? Also reviewed will be various recent university research projects with public policy implications.

**2:15-2:30 A PLANNING PROCESS FOR WATER SUPPLY DEVELOPMENT**

Steven L. Olson (Arizona Department of Water Resources, Tucson, Arizona)

Arizona's Groundwater Management Act has changed the perspective that water providers must use when planning to meet growing water demands. The goal of safe-yield in the Active Management Areas and the requirements of the Second Management Plan and Assured Water Supply provisions will require all water providers to expand their water supply plans beyond identifying additional groundwater development. A simplified framework will be presented that addresses the need for planned, cost-effective water resource planning to meet management requirements for both public and private water providers. The framework relies on an initial projection of water demand, an analysis of demand reduction potential, an analysis of supply alternatives, and a discussion of the characteristics that must be considered when weighing the demand reduction and supply alternatives for implementation. Development of water supply plans that meet existing and future needs for growing service areas will be increasingly important to water providers in Arizona and throughout the arid West.

**2:30-2:45      WATER CONSERVATION POTENTIAL RESEARCHED AT  
CASA DEL AGUA**

Kennith E. Foster and Martin M. Karpiscak (University of Arizona, Tucson, Arizona)

Casa del Agua is a research and demonstration project to test the efficiency and liveability of a house that has been relandscaped and redesigned with water saving and recycling devices. Ongoing research focuses on six interrelated tasks: 1) water quality sampling to characterize graywater and rainwater and to determine their potential to impact the environment; 2) water balance analysis that quantifies fresh water use, graywater production and use, and rooftop runoff and use; 3) evaluation of system components that could enhance graywater reuse; 4) determination of impacts of water reuse and conservation on quantity and quality of sewer flows; 5) refinement of "W-Index," a residential water efficiency rating system, for retrofit and new home construction that provides a measure of their water conservation potential; and 6) maintenance and modification of existing systems. An interpretation of recent data and information derived from the performance of the above tasks indicates the effectiveness of the project's water-saving strategies, as well as other significant findings relevant to water conservation in an urban, residential setting.

**2:45-3:00      EVALUATING THE EFFECTIVENESS OF THE CASA DEL  
AGUA WATER CONSERVATION DEMONSTRATION TOUR**

Glenn France (University of Arizona, Tucson, Arizona)

A typical family residence in Tucson, Arizona (Casa del Agua) was retrofitted with water conserving devices, graywater and rainwater recycling systems, and a low water use landscape. An educational tour designed to promote the incorporation of these water saving technologies has been ongoing since the home opened in December, 1985. During the period of April through June 1988 a series of questionnaires relating to current levels of water conservation awareness, water conservation practice adoption, increased water conservation awareness and increased water conservation practice adoption were administered to visitors of the project. A random survey of Tucson area residents dealing with water conservation awareness and current water conservation practices was also completed. Preliminary results indicate that the educational tour increases awareness of water conservation practices. The ability of the tour to promote increased water conservation implementation was less clear. Final results of the effectiveness of the tour will be presented at the Academy Meeting in April.

**3:00-3:30      COFFEE BREAK - Patio Deck, 2nd Floor**

**4:00            GOVERNING BOARD MEETING, ROOM 207**

## SCIENCE EDUCATION

**SESSION I      8:00 A.M.**

**ROOM: 202**

Chairperson:    Roy Doyle

**8:00-8:20      OPENING ADDRESS**

Dr. Lawson is a professor of zoology at Arizona State University. He was named Outstanding Science Educator of the Year in 1981 by the Association for the Education of Teachers in Science. The National Association of Research in Science Teaching has given him the JRST award three times for the most significant research article in their journal in 1976, 1985, and in 1987. Dr. Lawson has also received their highest honor, the NARST award in 1986 for distinguished contribution to science education research over a career.

**8:20-9:20      THE LEARNING CYCLE: A BETTER WAY TO TEACH  
SCIENCE**

Meg Burton and Bart James (Trevor Browne High School, Phoenix, Arizona)

In order to adequately prepare our students for success in the rapidly changing world beyond high school, we must develop their creative and critical thinking abilities. Since these skills improve with experience, the science curriculum should provide opportunities for students to practice them whenever possible. The learning cycle approach to instruction is designed to teach critical thinking skills by emphasizing the process of science as well as the fundamental concepts of biology. It provides students with the opportunity to inquire into biological phenomena first hand, stimulating their interest and curiosity. Laboratory activities allow the teacher to introduce concepts and terms, while emphasis is placed on active participation by students in generating hypotheses as well as designing and carrying out experiments. Cooperative learning is encouraged as each lab team develops and tests its ideas. Each learning cycle consists of three phases called Exploration, Term Introduction and Concept Application. During Exploration the students learn through their own actions and reactions in a new situation. Term Introduction assigns terms to patterns discovered during the Exploration activity. In Concept Application students apply the new term or reasoning pattern to additional examples.



**9:20-9:50           TEACHER SCIENCE UPDATES**

Charles Y. Hoyt (Arizona Alliance for Math, Science & Technology Education, Phoenix, Arizona)

Through a series of Science Update Workshops conveniently arranged for teachers to attend, Engineers, Scientists, & Researchers present the most recent information on a given topic. Teachers will not only be informed but receive hands-on experience and material aids to assist them with their educating of students. Participating teachers usually receive academic and/or salary credits. Discussion will cover the complete design for an Update Series to include:

Kinds of topics to be presented; criteria for each participant to receive the desired credit; objectives for each presentation; activities in which each will be involved; various kinds of teacher evaluation; and the costs of science update series. Those who do participate at the local school or district level will provide the leadership and science specialization experiences to all their teachers thereby enhancing mathematics, science and technology education.

**10:00-10:30       COFFEE BREAK - Patio Deck, 2nd Floor**

**10:30-11:00       MENTAL MODELING AS AN ALTERNATIVE TO THE  
DIDACTIC METHOD OF INSTRUCTION IN HIGH SCHOOL  
PHYSICS**

Malcolm Wells (Marcos de Niza High School, Tempe, Arizona)

There has been a considerable amount of research directed toward identifying numerous scientifically naive misconceptions that are common among introductory university physics students. There have, however, been very few studies that have examined the misconceptions common to high school students.

I will discuss a study that compared the patterns of naive misconceptions common among high school physics students with the patterns common to university students, as well as techniques that utilized these misconceptions in the construction of mental models utilized by the cognitive processes to consistently interpret observations of physical phenomenon so that they were consistent with the scientifically accepted models in mechanics.

**12:00-1:30       ANNUAL ACADEMY AWARDS LUNCHEON AND  
BUSINESS MEETING, STUDENT UNION, ROOM 201**

**4:00               GOVERNING BOARD MEETING, ROOM 207**

**ACADEMY BUSINESS  
AND  
ANNUAL REPORTS**

**OFFICERS 1988-1989**

**Elected**

Sandra Brazel .....	President
Dale Nations .....	Past-President
Neil Berman .....	President-Elect
Dennis T. Ray .....	Corresponding Secretary
Bud Ellis .....	Membership Secretary
Ray Henkel .....	Treasurer
Robert Altschul .....	Director, Southern Arizona
Lynn Smith .....	Director, Southern Arizona
Jud May .....	Director, Central Arizona
Malcolm Wells .....	Director, Central Arizona
Gordon Johnson .....	Director, Northern Arizona
Norman Thomas .....	Director, Northern Arizona
Leonard Storm .....	Director, Nevada
Charles Douglas .....	Director, Nevada

**Appointed**

Bud Ellis .....	Permanent Secretary
Stephen Williams .....	Editor, Newsletter
Elizabeth Cooper .....	Editor, Proceedings
David K. Elliott .....	Coeditor, Journal
W. Linn Montgomery .....	Coeditor, Journal
Donald Galen .....	Director of the Junior Academy

**Section Chairs**

Anthropology .....	Margaret M. Lyneis
Biology .....	Robert W. Bowker
Conservation .....	Dennis Kubly
General and Physical Sciences .....	Ron So
Genetics and Developmental Biology .....	Fredric Lehle
Geography .....	Christopher Exline
Geography .....	John James
Geology .....	Fredrick Bachhuber
Hydrology .....	Martin Karpiscak
Science Education .....	Roy Doyle

**Committee Roster  
1988-1989**

**Membership**

Bud Ellis

**Necrology**

Bud Ellis

**Nominating**

Bud Ellis

Kennith Foster

Dale Nations

**State Science Talent Search**

Leonard Storm

Donald Galen

**Outstanding Student Paper Award**

Robert Bowker

Fredrick Bachhuber

**Outstanding Science Teacher Award**

JoAnne Dombrowski

**Resolutions**

Neil Berman

**R. M. Harris Award**

David Elliott

W. Linn Montgomery

**Scholarship**

Eleanor Davy

## REPORT OF THE PRESIDENT

The 1988-1989 year began with a successful Annual Meeting in April. Ninety-eight papers were presented in 11 sessions. 146 people registered for the meeting.

Board of Governors meetings were held in September, November, and January. The new by-laws have expanded Board membership to include scientists in non-University positions. Along with several new members in the roles of officers, the Board has provided solid leadership and new ideas to strengthen the Academy. Areas of attention included participation at the Annual meeting, submission of papers to the Journal, the Junior Academy program, and publicizing the Academy as more than a "once-a-year" organization.

I wish to thank all of the Board of Governors members and the many appointed officers for their willingness to participate in this organization. Bud Ellis, permanent secretary, and Ray Henkel, treasurer, attended to the many housekeeping duties of the Academy. Neil Berman, the long-time corresponding secretary, now serves as President-Elect and helped Dennis Ray take on his old duties. The eight regional directors have provided input and support and represent a mix of long-term active members and new members interested in getting involved.

Special thanks are due to Steve Williams for the excellent newsletters he produces. The publication of an up-to-date membership list in the September issue will be an annual occurrence and should promote a better awareness of who we are. Betsy Cooper continues to do an excellent job as Proceedings Editor. David Elliott and Linn Montgomery, with the help of Paul Holmgren, have been extremely conscientious and successful in upgrading the quality of the Journal. Special thanks are also due to Don Galen as Junior Academy Director. I would hope that more members of the Academy would be interested in assisting Don in maintaining the interest he has generated in this activity.

Many members have assisted in the various appointed committee positions. Eleanor Davey (Scholarship), Jo Ann Dombrowski (Outstanding Teachers), and Tony Brazel (Grant-In-Aid) have provided excellent leadership in these Academy programs. Also providing leadership and contributing to successful meetings in 1988 and 1989 are the section chairs. All have worked hard to solicit paper presentations and provide stimulating formats for the Annual Meetings. Some have suggested specific topics for discussion, organized activities in conjunction with the meeting such as social gatherings and field trips, and sent out hundreds of letters to colleagues in the region. Many thanks to these people.

It has been a real pleasure to be involved with the Academy. I hope we will continue to attract new members from all scientific disciplines and function as a viable organization providing a common ground for the discussion of research as well as supporting and encouraging students to pursue scientific careers.

Sandra Brazel

## **ARIZONA - NEVADA ACADEMY OF SCIENCE MINUTES OF THE ANNUAL MEETING**

Minutes of the Annual Meeting of the Arizona - Nevada Academy of Science held at The University of Arizona, Tucson, Arizona, April 16, 1988.

1. Chair Nations called the meeting to order at 12:40 P.M. and then turned the meeting over to the President Elect Sandra Brazel. The business meeting and the awards presentations were held at the banquet.
2. The minutes of the previous meeting were approved as printed in the 1988 Proceedings Supplement. Reports of the Treasurer, Membership Secretary and other committees were also approved as printed.
3. The necrology committee reported on the death of Carl Marvel.
4. The report of the fellows committee was approved. New Fellows are Vorsila L. Bohrer, Richard H. Hevly, Donald F. Hoffmeister, and Herbert M. Hull.
5. The Scholarship Committee reported the following awards to outstanding high school students who will be attending Arizona or Nevada Colleges as science majors:

\$100 Awards -

Four Year Alan T. Wager Award

-Heather S. Hastings, Canyon del Oro, Tucson, AZ

One Year - Lisa Kwok-Yin Yao, Clark High School, Las Vegas, NV

Gerald D. Kvaall, Jr., Sahaurita, AZ

Brian James Bourgon, Chaparral High School, Las Vegas, NV

John E. Hayes, Buena High School, Sierra Vista, AZ

Honorable Mention - David E. Lucas, Tucson, AZ; Alana Kroll, Fallon, NV; Georgia L. Poe, Tucson, AZ; Deepinder K. Brar, Tucson, AZ; Patrick H. Wirtz, Boulder City, NV; David A. Shafer, Phoenix, AZ; Thuy Duong, Tucson, AZ; James Alexander, Las Vegas, NV; Richard J. Dressman II, Phoenix, AZ; Nancy Ann Osness, Las Vegas, NV; Craig Moiola, Elko, NV; Eva Tsang, Phoenix, AZ.

6. The Grants in Aid committee reports the following Awards:

Christopher T. Lee - University of Arizona

Brian L. Cluer -Northern Arizona University

Tad C. Theimer -Northern Arizona University

Stephen E. Travis -Northern Arizona University

7. The best student paper award was shared by Wayne Ranney and Marco Coccia.

8. The Outstanding Science Teacher Awards were received by

Junior High School - Charles E. McKenzie  
Eagle Valley Junior High  
Carson City, NV

High School - Larry Van Pelt  
Virginia City High School  
Virginia City, NV

Elementary School - Mary Brace  
Park Elementary School  
Holbrook, AZ

9. The cover art awardee was Katie Reffruschinni.

10. The slate of officers submitted by the Nominating Committee was accepted by unanimous vote.

11. The meeting was adjourned at 1:15 P.M.

Neil S. Berman  
Corresponding Secretary

### **REPORT OF THE MEMBERSHIP SECRETARY**

As of January 23, 1989, there were 340 active members in the Arizona-Nevada Academy of Science in the following membership categories: 222 Regular, 8 Family, 1 Sustaining, 1 Patron, 13 Emeritus, 44 Student, 33 Life, 16 Fellows, 1 Honorary and 1 Exchange. The membership has decreased by 29 in the past year.

Increasing effort is being put into recruiting new members for the Academy. New membership applications are now included in every newsletter and we urge you to give this application form to a colleague and urge he or she to support the Academy. Brochures detailing the activities of the Academy and benefits of joining have been developed and are available from the membership secretary.

Bud Ellis  
Membership Secretary

## **Report of the Nominating Committee**

Members of the Academy who have been nominated for elective office for 1988-1989 are:

President-elect	Milton Summerfeld, Arizona State University
Corresponding Secretary	Dennis Ray, University of Arizona
Treasurer	Sandra Brazel, Arizona State University
Membership Secretary	Bud Ellis, Glendale Community College
Directors:	
Southern Arizona	Roy Johnson, National Park Service Research Unit
Central Arizona	Malcolm Wells, Marcos de Niza High School
Northern Arizona	Norman Thomas, Lowell Observatory
Nevada	Len Storm, University of Nevada, Las Vegas
Dale Nations, Chairperson	
Bud Ellis	
Ken Foster	

## **REPORT OF THE NECROLOGY COMMITTEE**

It is with deep sorrow that the Academy announces the death of one of its long time members.

Dr. Paul T. Miller, a charter member of the Academy and founder of the Department of Geology at Arizona State University, died April 16, 1988, in Mesa, Arizona.

Bud Ellis, Chairperson

## **REPORT OF THE JUNIOR ACADEMY**

During the 1988 Annual Meeting of the Arizona-Nevada Academy of Science at the University of Arizona in Tucson, Arizona, the Junior Academy held its annual meeting. More than 40 high school students, teachers, and parents attended, representing six high schools: Phoenix Camelback, Phoenix Central, Scottsdale Chaparral, Tempe Corona del Sol, Tucson Canyon del Oro, and Tucson Emily Gray.

Thirty students presented papers on their research work. A booklet of abstracts was prepared by the Director, student officers, and Ann Justus and was distributed. The presentations were judged by Abdulaziz Al-Bahrany, Anna Hocker, Christine Chaulk, Davis Chen, Lucinda Salo, and Abdouahamane Alou. They all attended the University of Arizona. Trophies were given to the best presentors.

Winners in the Life Science Division were, starting with first place on down: Dan Brncic, Douglas Smith, Sheri Miller, Zina Gregos, and Joshua Rusev. Winners in the Physical Sciences were, starting with first place on down: Chris Lux, Darin Lease, Jason Kim, Steven Williams, Steven Graham, and Jared McLain. Winners in the Ecological Sciences were, starting with first place on down: Jeffrey Jennings, Jeffrey Maxson, Ty Peskind, Justin Lofquist, and Steve Stoltenberg.

Officers for 1988-89 were elected. Steven Graham of Tempe Corona del Sol was elected President. The remaining officers will all be board members. They are Steven Williams of Tucson Canyon del Oro, Ty Peskind and Sheri Miller of Phoenix Camelback, Jesse Graybill and Zina Gregos of Phoenix Central, Justin Lofquist and Jason Kim of Scottsdale Chaparral, and Steve Stoltenberg and Jeff Jennings of Tempe Corona del Sol.

The members of the Junior Academy extend special thanks to Sandra Brazel for her efforts in our behalf.

Donald Galen  
Phoenix Central High School  
Director



## **SOUTHERN ARIZONA DIRECTOR'S ANNUAL REPORT FOR 1988**

My activities in 1988 included the following:

1. Attended all board meetings held in 1988.
2. At the Annual Meeting in Tucson, April 16, 1988:
  - a. was Geography Section Chair;
  - b. assisted with local arrangements.
3. Judged the Earth Science Projects (High School Level) at the Southern Arizona Regional Science & Engineering Fair, March 15, 1988.

I have agreed to do so again on March 14, 1989.

4. Distributed information about membership and participation at the annual meeting to departments and colleagues at the University of Arizona.

D. Robert Altschul  
Director, Southern Arizona

## TREASURER'S REPORT

### INCOME

<b>Memberships</b>	
Regular	\$6145.00
Family	\$275.00
Student	\$490.00
Life	\$600.00
Sustaining	\$60.00
<b>Journal</b>	
Subscriptions	\$1700.00
Reprints & Page Charges	\$3550.00
Registration & Annual Meeting Fees	\$2705.81
Interest Endowment	\$1069.20
Scholarship Contributions	\$285.00
<b>TOTAL INCOME</b>	<u>\$15810.81</u>

### EXPENDITURES

Printing Journal	\$4710.70
ASU Expense Account	\$3000.00
Annual Meeting	\$1534.24
Research Grant	\$1000.00
Scholarships	\$500.00
Science Teacher Search	\$150.00
Junior Academy	\$300.00
Outstanding Teacher	\$100.00
Science Fairs Support	\$650.00
Printing Newsletter, etc.	\$337.95
Supplies	\$216.52
AAAS & Other Dues	\$88.00
<b>TOTAL EXPENDITURES</b>	<u>\$12587.41</u>

### FINANCIAL ACCOUNTS

<b>First Interstate Bank</b>	
Balance 1 January 1988	\$1712.55
Add: Income	\$15810.81
Less: Expenses	<u>\$12587.41</u>
Balance 31 December 1988	\$4935.95
<b>Endowment Fund -</b>	
Western Savings	
Balance 1 January 1988	\$12509.93
Add: Interest	<u>\$1069.20</u>
Balance 31 December 1988	\$13579.13
<b>Arizona State University Fund</b>	
Balance 1 January 1988	\$1669.00
Add: Deposits	\$3000.00
Less: Withdrawals	<u>\$3104.00</u>
Balance 31 December 1988	\$1565.00

### ASSETS

First Interstate Bank	\$4935.95
Western Savings	\$13579.13
ASU Account	<u>\$1565.00</u>
<b>TOTAL ASSETS</b>	<b>\$20080.08</b>

Ray Henkel  
Treasurer



