1975

Rock Valley Validation Site Report

F. B. Turner

1974 PROGRESS REPORT

ROCK VALLEY VALIDATION SITE REPORT

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University of California, Los Angeles

US/IBP DESERT BIOME
RESEARCH MEMORANDUM 75-2

in

REPORTS OF 1974 PROGRESS
Volume 2: Validation Studies
Rock Valley, 53 pp.

1974 Proposal Nos. 2.2.2.2.1 and 2.2.2.2.2

Printed 1975

Citation format: Author(s). 1975. Title
US/IBP Desert Biome Res. Memo. 75-2.
Utah State Univ., Logan. 53 pp.

Ecology Center, Utah State University, Logan, Utah 84322

ABSTRACT

Various abiotic and biological measurements were made on a 46.1-ha site in Rock Valley, Nye County, Nevada, during 1974. Abiotic measurements included wind speed and direction, air temperatures, insolation, rainfall, soil temperatures and soil moisture contents. Biological measurements included estimates of standing crops of annual and perennial plants together with state changes associated with production of new tissue during the spring of 1974, periodic estimates of the relative abundances of various ground- and shrub-dwelling arthropods and estimates of densities and biomasses of selected species of vertebrates.

Mean monthly air temperatures at 244 cm rose from about 3 C in January to 30 C in July. Between midsummer and the end of the year, mean monthly air temperatures fell to about 4 C in December. Incoming longwave radiation ranged from about 900 to 1000 ly/day during the spring. Outgoing longwave radiation was generally somewhat less than incoming and showed no pronounced seasonal trend between early April and mid-October (daily values of around 800 to 900 ly). Incoming shortwave radiation was 300 to 400 ly/day during the spring and rose to around 800 ly/day in midsummer. By late August, incoming shortwave radiation was around 700 to 800 ly/day. Almost all of the rainfall recorded during 1974 (ca. 130 mm) fell during early January (34 mm), late July (26 mm), October (26 mm) and December (33 mm). Rainfall between January 8 and July 21 was negligible. The July rainfall was without precedent during the three previous years of observation. Total rainfall for the year was similar to that recorded in 1971 (104 mm) and 1972 (114 mm). The most intense rains ($>$ 2 mm/hr) occurred in late January, early July, early October and early December. Mean monthly relative humidity fell from 56% in January to 13-17% in May, June and July. The July rains did not elevate mean humidities during that month. Winds in Rock Valley were predominantly from the east to south quadrant, and azimuths of monthly resultant winds ranged from 82° (December) to 186° (June). Overall annual mean wind velocity was around 12 km/hr. Mean monthly soil temperatures (at 3-cm depth) rose from about 6 C in January to around 37 C in July, and then fell gradually to 8 C in December. Measurements at 3 and 15 cm were lower than those at 30 and 45 cm during January, October, November and December, but higher (from 1 to 3 degrees C) during the rest of the year. Soils were near saturation (ca. 12% moisture by weight) from January 1974 until early March 1974. By mid-May, soil moisture tensions at 3 cm were $\leqslant$ 80 bars and drying continued until the rains of July. In general, moisture contents of soil beneath shrubs were lower than those of soils in the open. The July rains wet soils only to a depth of around 30 cm. Rains during October and December raised the moisture contents of soil again -- at least at 3 and 15 cm.

The Rock Valley site has been divided into six homogeneous zones of vegetation, ranging in extent from 1.41 to 21.21 ha. The vegetation of these zones differs in species composition and relative abundance of major perennials. In all zones, eight shrubs compose from 94-97% of the perennial populations: *Ambrosia dumosa*, *Ephedra nevadensis*, *Ceratoides lanata*, *Grayia spinosa*, *Krameria parvifolia*, *Larrea tridentata*, *Lycium andersonii* and *L. pallidum*. *Ambrosia dumosa* is the most common species in all zones. During the spring of 1974 the site was estimated to sustain about 40 million annuals (ca. 88/m^2). Over 57% of these plants were two grasses (*Festuca octoflora* and *Bromus rubens*), and these two species, together with *Chaenactis carphoclinia*, *Chaenactis fremontii*, *Cryptantha circumscissa* and *Cryptantha recurvata* made up about 80% of all the annuals on the site. The 1974 density was much higher than densities in 1971 and 1972 (8 and 11/m^2), and not greatly less than that observed in 1973 (ca. 100/m^2). However, the 1974 annuals were extremely small (similar to those of 1972). Production was estimated to range from about 9 to 23 kg/ha, depending upon the zone of reference. The overall site mean was about 17.4 kg/ha (cf. 3-5 kg/ha in 1971 and 1972; 674 kg/ha in 1973). Fruits made up around 19% of the 1974 production (cf. 30% in 1973 and 12.5% in 1972). Survival of annuals in 1974 was poor, ranging from around 20% in Zone 24 to 55% in Zone 20 (cf. $>$90% in 1973).

Total coverage by 21 perennial species is about 22% on a site-wide basis. Over 400,000 perennials occur on the site (ca. 8900/ha) and around 10% of these are dead. Overall, the ratio of above-ground standing dead to living plant material has been estimated at 5:4. Plants increased in size (and weight) during 1973 and remeasurements of shrubs in 1974 showed conspicuous volume increases of up to 100% in *Ceratoides lanata* and *Grayia spinosa*. The 1974 estimate of total live above-ground standing crop on the site is around 1200 kg/ha (cf. previous estimate of 926 kg/ha). Root biomass has been estimated to be in the range of 5500 to 6000 kg/ha. The largest contributors to live standing crop are *Lycium andersonii* (344 kg/ha) and *Larrea tridentata* (154 kg/ha). On a site-wide basis, production of new above-ground tissue (shoots, leaves, flowers and fruits) by perennials in 1974 was estimated to be 181 kg/ha (cf. 157 to 183 kg/ha in 1971 and 1972; 573

kg/ha in 1973). New leaves made up the greatest part of production in 1974 (85%), conspicuously more than in 1973 (45%) and somewhat more than in 1971 (76%) and 1972 (63%). Production of flowers and fruits (ca. 4%) was the lowest observed in four years. The greatest decrease in productivity (relative to 1973) was exhibited by *Lycium andersonii* (—91%), but declines of 35-70% were typical. Only *Grayia spinosa* sustained apparent productivity near 1973 levels.

Sampling of invertebrates included ground-dwelling and shrub-dwelling species, soil microarthropods and nematodes. Work on ground- and shrub-dwelling forms was restricted to Plots 11 and 12 on the site proper. Three species became active earlier in 1974, and one of these (a predator) was active for six weeks longer than previously observed. However, the general tendency in 1974 was later appearance, and 13 species appeared from 3 to 11 weeks later than usual, with only two exhibiting activity periods comparable to previous years. Thus, many species were active for relatively shorter periods of time. Numbers of ground-dwelling arthropods trapped were generally less than those taken in previous years, and conspicuously less than captures during 1973. Absolute densities of tenebrionid beetles were not estimated in 1974 because only one marked individual (of five species) was recaptured. However, trapping indexes for 9 of 11 tenebrionids decreased relative to 1973, and 1974 indexes were often the lowest recorded for the years 1971-74. Two 100-m^2 exclusion plots were established in March 1974 and trapped continuously until the end of the year. In the course of 8+ months of trapping, larger tenebrionid beetles (e.g., *Asidina semilaevis*, *Centrioptera muricata*, *Cryptoglossa verrucosa* and *Eleodes armata*) were each represented by three individuals from the two plots (200 m^2). Extrapolated minimum densities of these species (150/ha) are lower than indirect estimates made between 1971-73, but these differences must be viewed in the light of general declines in trapping indexes during 1974. Minimum densities of smaller tenebrionid beetles (e.g., *Araeoschizus sulcicollis*, *Conibiosoma elongatum*, *Metoponium* sp., *Eusattus dubius*) ranged from 2650 to 6550/ha and the collective density of eremobatid solpugids was over 11,000/ha. Can traps spaced at 15 m may be insufficient for estimating true numbers of smaller arthropods. Shrub-dwelling arthropods were sampled by D-Vac and consisted mainly of phytophagous insects and their associated predators and parasites. Fewer kinds of arthropods (180) were collected than in previous years. Total numbers taken (2878) were far fewer than in 1973 (12,618). Relatively more larvae of gelechiid and coleophorid moths were taken in 1974, but larger larvae (e.g., cutworms and measuring worms) were less abundant. Defoliators on *Larrea* made up only about 7% of all phytophages on this shrub. Apparent densities of the grasshopper *Booettix punctata* declined in 1974 to around 20% of estimated numbers in 1973. Mealybugs (pseudococcids) were the most numerous of sap-feeders in 1974. Evidence is adduced to indicate that densities of mealybugs are inversely related to soil moisture. Parasitic species declined in 1974, apparently because of the paucity of hosts. Average live and dry weights of 41 species of arthropods were summarized, and year-to-year variations in body weights and water contents of certain species were brought out. Combining mean dry weights with estimated densities of tenebrionid beetles yielded estimated standing stocks of several hundreds of grams per hectare between 1971 and 1974. The distribution of soil-dwelling arthropods is strongly influenced by vegetation, with the largest numbers of animals found in the upper 10 cm of soil near the bases of shrubs. Estimated numbers of microarthropods ranged from around 2000/m^2 in February to roughly 4000/m^2 in March and April 1974. Localized densities were estimated to range from 7000 to 18,000/m^2 in March.

The most abundant mammal on the site is *Perognathus longimembris*. The spring density of this species was around 20/ha (59 g/ha dry weight). This was much higher than spring densities observed between 1971 and 1973 (5-10/ha), and clearly derived from the large numbers of animals recruited during the summer of 1973. The estimated spring standing stock (10 species) on the site was around 221 g/ha dry weight, again more than that reported at any time between 1971 and 1973. Reproduction by kangaroo rats, ground squirrels and grasshopper mice was limited in 1974, and apparently nil by pocket mice. Trapping in the summer of 1974 indicated a slight decline in total numbers of rodents, but a somewhat higher aggregate biomass (273 g/ha). The 1974 reproductive failure may be a density-dependent response associated with the large numbers of rodents present on the site at the beginning of the 1974 breeding season.

The most abundant reptile is the lizard, *Uta stansburiana*. The observed density of this species in 1974 was about 79/ha (57 g/ha dry weight). The combined density of four other species of lizards was about 43/ha (115 g/ha). The total biomass of five principal lizard species increased about 16% in 1974 (relative to 1973), mainly due to increases in numbers of *Uta stansburiana* and *Cnemidophorus tigris*.

ACKNOWLEDGMENTS

Category	Assistance in field and laboratory	Authorship
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INTRODUCTION

In seeking to understand the functioning of arid land ecosystems, it is important that predictive models of ecological processes be as general as possible. To this end, research areas have been established in each of four major arid land types in western North America -- the Great Basin, the Mohave, the Sonoran and the Chihuahuan Deserts. The Desert Biome research design embraces two types of endeavors. One involves the investigation of specific abiotic and population processes and the development of models of these processes and of the function of larger systems. The other involves the testing of these models by comparing their predictions with actual measurements of changes in the states of desert ecosystems. The validation of a systems model requires, then, an exhaustive initial inventory of the system, followed by periodic evaluations of extensive arrays of state variables and of the external influences impinging upon the system (meteorological variables). Such measurements are being conducted at four validation sites located within the desert types designated above. One of these sites in in Rock Valley, Nye County, Nevada, in the northern Mohave Desert. The initial inventory in Rock Valley was begun in March of 1971. The measurements to be subsequently reported are generally applicable to the state of the system in the early spring of 1974. Because of the distinct changes in the state of the arthropod fauna, sampling was continued regularly from April until early fall. Measurements of changes in other system attributes were made at varying intervals depending upon expected rates of change.

OBJECTIVES

The objectives of the validation measurements are four-fold:

1. To conduct an initial inventory (standing crop measurements) of energy, nitrogen, phosphorus, carbon and water in as many as possible of the biotic (species) and abiotic components of the site.
2. To make periodic assessments of the state of the major biotic and abiotic components of the system.
3. To make periodic measurements of the physical factors and inputs of the site.
4. To develop equipment and facilities to accomplish the above.

SITE DEVELOPMENT

Research facilities have existed in Rock Valley since about 1961. Because of the remoteness of Rock Valley and its location on the U.S. Atomic Energy Commission's Nevada Test Site, little in the way of formal site development and fencing was required. The validation site itself was established to the north of three fenced 9-ha areas which were used until 1973 in a long-term irradiation experiment. Two air-conditioned laboratory trailers are located near the validation area. Electricity is available from gasoline-powered generators. Accomodations, services and laboratory facilities are available at Mercury, about 24 km to the east.

During the spring of 1971, the validation site was delimited and mapped and a 100-m NS, EW rectilinear grid system established and marked with numbered stakes (Fig. 1). The site is about 0.46 km² in extent.

The vegetation of the Rock Valley Validation Site is heterogeneous, with a gradient of change downslope along a NNW-SSE line. Six areas of relatively homogeneous vegetation could be recognized, however, on the basis of aerial photography and counts made along belt transects. The Rock Valley Validation Site has been photographed on two occasions. Small-scale aerial photographs were taken in July 1970, and assisted in the recognition of homogeneous zones of vegetation on the area. In July 1971, the site was photographed at two scales: 1:2400 and 1:600. These photographs are being kept as a permanent record of the validation site, and may also be used to evaluate changes brought about by continued use of the area. The areas of the six vegetational zones ranged from 14,080 m² to 212,080 m² (Fig. 2). Sampling of perennial vegetation was carried out in 190 quadrats of 2 x 25 m. The coordinates of these quadrats were generated by a computer program designed to ensure a random dispersion.

Three mammal trapping grids (12 x 12, 15-m interval) were established in different zones of the validation site. Smaller areas for sampling reptiles were set up within these grids. A 6-ha area for counting birds was delimited within the site. Pitfall traps for the collection of terrestrial arthropods were set out in the same areas used for mammal trapping.

Meteorological measurements were made at two stations (I and V) on or near the validation site at various times during 1974. Station V (near the southeastern corner of the site) is a permanent station operated by the Air Resources Laboratory, NOAA.

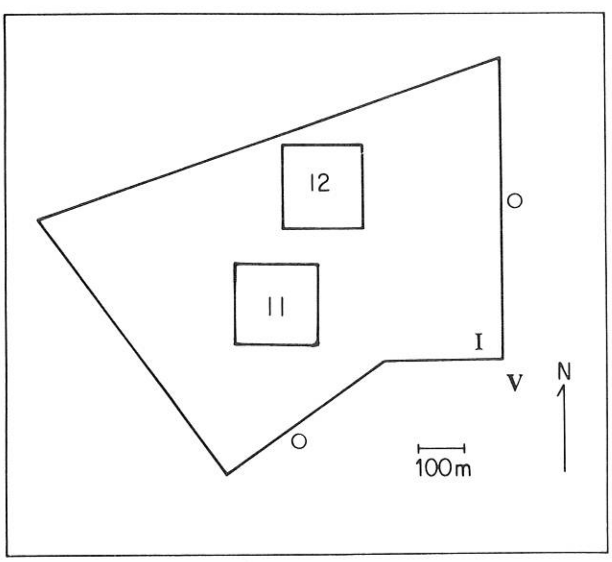

Figure 1. Study areas in Rock Valley, Nye County, Nevada. The five-sided polygon is the validation site (0.46 km²). Plots 11 and 12 were used for pitfall trapping of arthropods. Mammals were trapped in Plot 12. The two small circular enclosures south (Plot 70) and east (Plot 71) of the validation site were used for continuous pitfall trapping and removal of arthropods. The numbers "I" and "V" at the southeast corner of the site refer to abiotic measurement stations.

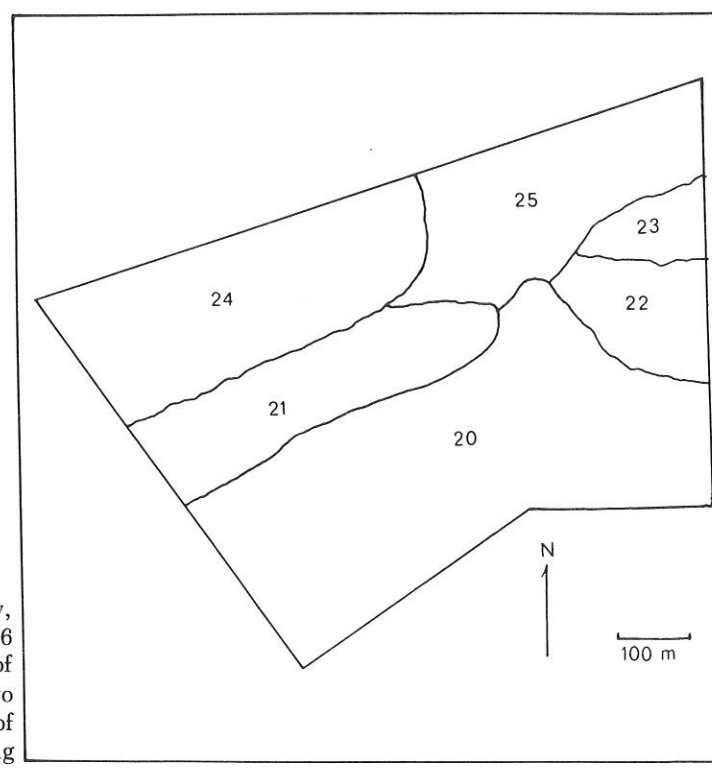

Figure 2. The Rock Valley site indicating six zones of generally homogeneous vegetation.

DATA COLLECTION DESIGN

Parameters measured and investigators	DSCODE	Years of measure-ment	Page
ABOVE-GROUND VEGETATION			
Dynamics of perennial populations			
(Bamberg, Ackerman, Vollmer)	A3UTJ25	1971-	24
Species		1971-	
Density		1971-	26
Biomass and new growth		1971-	26
Zone summaries (Bamberg, Kaaz)	A3UTJ26	1971	
Live and dead biomass		1971	
Area covered		1971	
Plant volumes		1971, 1974	26
Quadrat sampling data (Bamberg,			
Ackerman, Kaaz)	A3UTJ27	1971	
Species		1971	
Density		1971	
Foliage density		1971	
Plant dimensions		1971, 1974	24
Number of dead plants		1971	
Coverage		1971	24
Diversity		1971	
Annuals (Bamberg, Ackerman)	A3UTJ20	1971-	22
Species		1971-	
Density		1971-	
Biomass		1971-	
Phenology		1971-	
Phenology of perennials (Ackerman, Bamberg)	A3UTJ22	1971-	
Untreated data		1971-	
Phenology of perennials (Ackerman, Bamberg)	A3UTJ23	1973-	28
Species totals and averages		1973-	
LITTER			
Biomass (Bamberg)	A3UTJ70	1972-73	
Plant type		1972-73	
MICROBES			
Rhizosphere microorganisms (Au)	A3UTJ15	1971	
Numbers/g of soil		1971	
Relative abundance of six general types		1971	
Nonrhizosphere microoganisms (Au)	A3UTJ16	1971	
Numbers/g of soil		1971	
Relative abundance of six general types		1971	
Dehydrogenase activity (Skujins)		1972-	
Cellulose decomposition rates (Skujins)		1972-	

Data Collection Design, continued

Parameters measured and investigators	DSCODE	Years of measure-ment	Page
MINERAL CONTENT			
Mineral element composition (Romney, Alexander)	A3UTJ21	1971-73	52
Species		1971-73	
Plant parts		1971-73	
Twenty-eight different minerals		1973-73	
INVERTEBRATES			
Captures in pitfall traps (Sleeper, Thomas)	A3UTJ30	1971-	31
Species		1971-	
Relative numbers		1971-	
Seasonal distributions		1971-	
Phenology		1971-	
Soil type preferences		1971-	
Dry weights		1972-	
Stages		1971-	
Captures by D-Vac (Sleeper, Thomas)	A3UTJ34	1971-	35
Species		1971-	
Densities		1971	
Biomass		1972-	
Stages		1971-	
Host specificity		1971-	
Phenology		1971-	
Seasonal distributions		1971-	
Shrub dimensions		1971	
VERTEBRATES			
Reptiles			
Uta stansburiana (Medica)	A3UTJ40	1971-	46
Density			
Biomass			
Age distribution			
Sex ratio			
Whiptail and leopard lizards (Medica)	A3UTJ42	1971-	46
Density			
Biomass			
Age distribution			
Sex ratios			
Other reptiles (Medica)	A3UTJ44	1971-	46
Species			
Relative numbers			
Body weights			
Birds			
Breeding birds (Hill)	A3UTJ60	1971-73	
Species		1971-73	
Densities and pairs		1971-73	
Biomass		1971-73	

Data Collection Design, continued

Parameters measured and investigators	DSCODE	Years of measurement	Page
Breeding birds, continued			
Clutch size		1972-73	
Nesting sites		1971-73	
Nesting materials		1971-73	
Nesting success		1971-73	
Phenology		1971-73	
Nonbreeding birds (Hill)	A3UTJ61	1971-73	
Species		1971-73	
Counts and relative abundance		1971-73	
Utilization schedules		1971-73	
Rodents			
Heteromyids (Maza)	A3UTJ50	1971-	48
Species			
Densities			
Biomass			
Reproductive condition			
Sex ratios			
Cricetids and sciurids (Maza)	A3UTJ52	1971-	48
Species			
Densities			
Biomass			
Reproductive condition			
Sex ratios			
Lagomorphs -- jackrabbits (Maza)	A3UTJ54	1971-73	
Densities			
Biomass			
METEOROLOGICAL			
Wind speed and direction, hourly 3 m (Air Resources Lab.)	A3UTJ01	1971-	11
Air temperatures, hourly, one station, 2.4 m (Air Resources Lab.)	A3UTJ02	1971-	11
Air temperatures, every 6 hr, 30 cm (Balding)	A3UTJ03	1972-	11
Air temperatures, every 6 hr, two stations, 15 cm (Bamberg)	A3UTJ04	1972-73	
Insolation, weekly totals, one station (Bamberg)	A3UTJ05	1973-73	
Precipitation intensity (Balding)	A3UTJ06	1974	11
Precipitation, daily, one station (Air Resources Lab.)	A3UTJ07	1971-	11
Relative humidity, every 6 hr, 15 cm (Bamberg, Balding)	A3UTJ10	1972-	11
Incoming longwave radiation (Balding)	A3UTJ91	1974	11
Outgoing longwave radiation (Balding)	A3UTJ92	1974	11
Shortwave radiation (Balding)	A3UTJ93	1974	11
SOILS			
Soil survey (Romney, Hale)	A3UTJ11	1971	53
Color, consistency, texture, conductivity, organic matter, cation exchange capacity, cations, available elements, etc.			

Data Collection Design, continued

Parameters measured and investigators	DSCODE	Years of measurement	Page
SOILS, continued			
Soil temperatures, every 6 hr, four depths (Bamberg, Balding)	A3UTJ08	1971-	17
Soil moisture by weight, weekly, four stations, two cover types, two depths (Romney, Childress)	A3UTJ09	1971-73	
Soil moisture potential (bars), same as above (Romney, Balding)	A3UTJ12	1971-	19
REMOTE SENSING			
Aerial photography (Tueller)	A3UTJ99	1971	

FINDINGS

ABIOTIC

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Air Temperature

Air temperatures were measured at two heights in Rock Valley during 1974. At one station (V), temperatures were recorded hourly at 244 cm by the Air Resources Laboratory in Las Vegas, Nevada (DSCODE A3UTJ02). Temperatures were recorded continuously at 25 cm in the open at Station I with a Wescor hygrothermograph. When these data were reduced, temperatures were recorded at 6-hr intervals (A3UTJ03).

Table 1 gives means and extreme temperatures recorded at Station I on a monthly basis. Table 2 gives comparable figures recorded at 244 cm at Station V. Figure 3 illustrates monthly mean, maximum and minimum air temperatures recorded at Stations I and V.

Radiation

Incoming and outgoing longwave radiation (A3UTJ91, 92) was measured in Rock Valley with two Eppley pyranometers. These sensors were mounted at a height of 2 m, one facing upwards and one facing the ground. Amounts of radiation were recorded continuously with a Thornthwaite Chart Recorder. These charts were read at 3-hr intervals. To obtain total radiation (langleys) for a 24-hr period, the eight readings were summed and multiplied by 180 (1440 min/8 min).

Shortwave radiation was measured with a Kahl Scientific Instrument Corporation star pyranometer (A3UTJ93). Radiation measurements were recorded with a KahlSciCo 2-channel recorder (No. 28AM150). Readings were recorded at 2-hr intervals and converted to daily totals (langleys) as above.

Data are available for only a portion of the year. The recorder for incoming longwave radiation ceased to operate in early June. The recorder was removed from the field and not replaced. Recordings from the other two instruments were often unusable between the fall of 1974 and the end of the year, and no usable data were acquired after October 21.

Table 3 gives weekly totals of radiation and Table 4 gives daily means derived from the summations in Table 3.

Precipitation

Rainfall was recorded on a daily basis at Station V by the Air Resources Laboratory in Las Vegas, Nevada (A3UTJ07). Rainfall at the validation site was also recorded with a tipping gauge (Station I) so that the duration of individual rainfall events as well as the amount of precipitation could be recorded. From these data, rainfall intensities could be computed (A3UTJ06).

Monthly totals recorded at Station V are given in Table 5. The annual total (ca. 130 mm) is less than that recorded in 1973 (213 mm), but more than that registered in 1971 and 1972 (104 and 114 mm).

The distribution of rainfall events during the year and the corresponding intensities are set forth in Table 6. Some of the monthly totals and the overall total given in Table 5 do not correspond exactly with measurements given in Table 6, because different instruments and slightly differing locations were involved. The most intense rains (> 2 mm/hr) occurred in January, July, October and December. Rainfall between October and December (62 mm) was about 48% of the annual total. This amount of rainfall would normally be expected to promote favorable growth of annuals during 1975. In general, 1974 was unusual in the large amounts of rainfall during both January and December, and for the remarkable rainfalls in July. Figure 4 illustrates climographs based on monthly mean air temperatures (Table 2) and monthly rainfall totals during 1971, 1972, 1973 and 1974.

Relative Humidity

Relative humidity was measured at Station I on the validation site with a Wescor hygrothermograph about 25 cm above ground level. Values were generally accurate to within ± 5%. Chart readings of less than 5% were arbitrarily set at 5%. Readings were taken from a continuous chart recording at 6-hr intervals (A3UTJ10).

Table 7 gives means and extremes based on monthly intervals. For a given month, with *n* days, the hourly mean is the mean of 4*n* measurements. Mean hourly humidities during the first five months of 1974 were well below those measured in 1973 because of the heavy rains during early 1973 (see Bamberg et al. 1974:Table 10). Monthly means in 1974 were also generally lower than those recorded in 1972 (see Turner et al. 1973:Table 15). Figure 5 illustrates monthly means, maxima and minima during 1974.

Wind

Wind speeds and directions were automatically recorded at Station V (244 cm) in Rock Valley during 1974 (A3UTJ01). The equipment was provided by the Air Resources Laboratory (ARL) of the National Oceanic and Atmospheric Administration (NOAA) in Las Vegas, Nevada. ARL personnel transcribed wind data from strip charts to IBM cards. Data on these cards were analyzed with a computer program written by Bernardo Maza.

Table 8 summarizes general attributes of monthly winds in Rock Valley during 1974. Mean wind velocities and predominant directions (i.e., from the east to south quadrant) were quite similar to those reported for 1973. As in 1973, April had the lowest resultant run of the wind, reflecting winds of variable direction (low steadiness). Between October and January the winds blow fairly steadily from the east, leading to high resultant runs of the wind.

Table 1. Air temperature data (°C) at Rock Valley Station I during 1974

MONTH	MINIMUM	MAXIMUM	HOURLY MEAN	RANGE OF DAILY MINIMA	RANGE OF DAILY MAXIMA	RANGE OF DAILY MEANS
JANUARY	-10	13	3	-10 - 8	0 - 13	-8 - 9
FEBRUARY	-1	17	7	-1 - 6	2 - 17	1 - 12
APRIL	0	24	12	0 - 14	6 - 24	5 - 17
APRIL	4	29	17	4 - 16	15 - 29	12 - 22
MAY	3	34	19	3 - 21	14 - 34	10 - 26
JUNE	12	40	27	12 - 23	29 - 40	22 - 32
JULY	15	40	29	15 - 26	30 - 40	24 - 33
AUGUST	13	39	28	13 - 27	32 - 39	26 - 33
SEPTEMBER	15	37	27	15 - 25	32 - 37	26 - 31
OCTOBER	11	33	21	11 - 21	22 - 33	17 - 27
NOVEMBER	1	22	11	1 - 13	5 - 22	5 - 15
DECEMBER	0	17	7	0 - 10	7 - 17	3 - 12

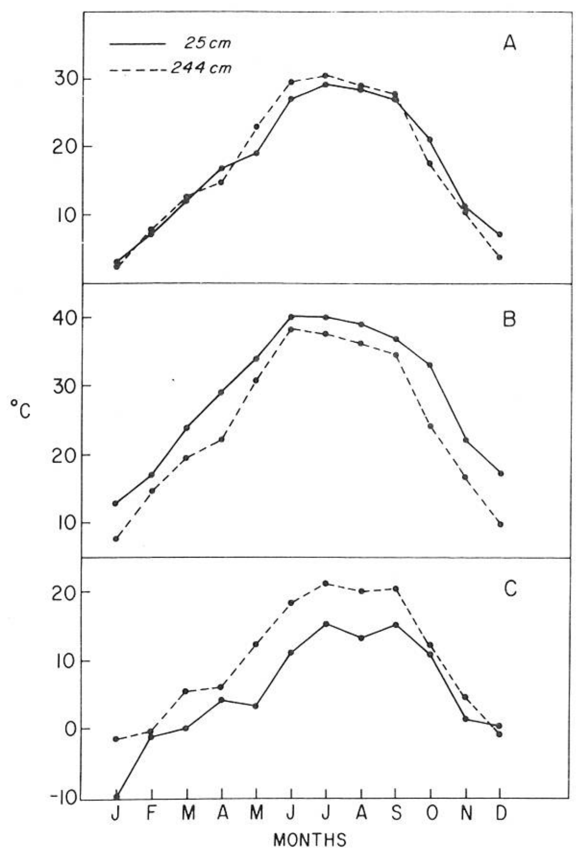

Figure 3. Monthly mean (A), maximum (B) and minimum (C) air temperatures at Station I (25 cm) and Station V (244 cm) during 1974).

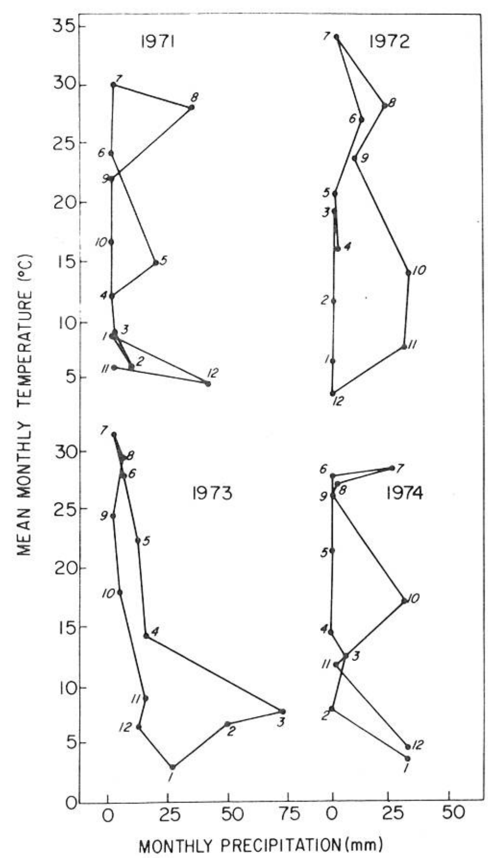

Figure 4. Climographs contrasting temperature-rainfall regimens during 1971, 1972, 1973 and 1974. Figures are based on measurements at Station V.

Table 2. Air temperature data (°C) recorded at Rock Valley Station V during 1974 (244 cm)

Month	Minimum	Maximum	Hourly mean	Range of daily minima	Range of daily maxima	Range of daily means
January	-1.5	7.7	2.7	-10.0 - 4.5	2.2 - 15.6	-7.3 - 7.7
February	0.5	14.7	7.4	- 5.0 - 8.9	8.3 - 20.0	3.4 - 13.4
March	5.1	19.4	12.3	- 3.9 - 12.2	6.1 - 28.3	2.0 - 18.6
April	5.8	22.1	14.4	0.0 - 10.0	15.6 - 30.0	9.4 - 19.8
May	12.2	30.8	22.6	2.2 - 20.0	15.0 - 41.1	9.1 - 31.1
June	18.1	38.4	29.5	12.2 - 23.3	30.0 - 45.0	21.1 - 33.5
July*	21.0	37.7	30.1	10.0 - 26.7	29.4 - 43.3	24.2 - 33.3
August*	19.8	36.1	28.7	15.6 - 23.9	32.8 - 37.8	26.1 - 31.0
September	20.2	34.6	27.5	15.6 - 26.1	30.0 - 37.8	22.5 - 32.5
October	11.8	24.0	17.5	0.6 - 18.9	5.6 - 33.3	4.5 - 24.9
November	4.4	16.7	10.2	0.0 - 10.0	10.0 - 23.3	5.4 - 14.4
December	-1.0	9.7	3.8	- 8.9 - 5.6	0.0 - 16.1	-3.6 - 9.7

* Missing data

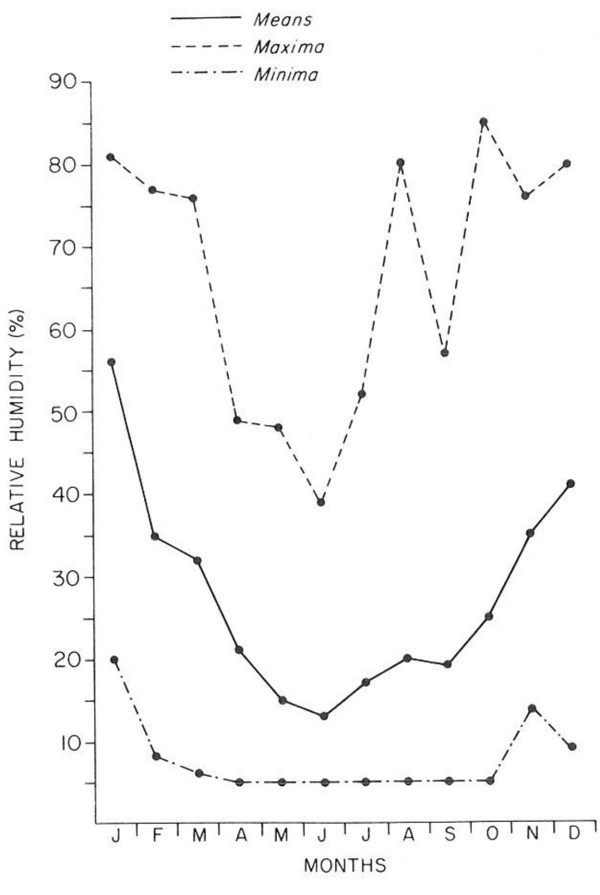

Figure 5. Monthly mean, maximum and minimum relative humidities in Rock Valley during 1974.

Table 3. Total weekly radiation (cal/cm^2) measured in Rock Valley during 1974

Time period	Incoming long-wave radiation	Incoming short-wave radiation	Outgoing long-wave radiation
March 26 - April 1	6196	2045	
April 2 - 8	6531	2647	6267
April 9 - 15	5868	2846	6053
April 16 - 22	6133	3252	6354
April 23 - 29	6109	3770	5840
April 30 - May 6	6570		
May 7 - 13	7076	3848	6503
May 14 - 20	6392	3747	5013
May 21 - 27	6930	4315	6411
May 28 - June 3	7041		6481
June 4 - 10			
June 11 - 17		5459	
June 18 - 24		5402	6461
June 25 - July 1		5632	6705
July 2 - 8			6549
July 9 - 15		4661	6934
July 16 - 22			7395
July 23 - 29			6470
July 30 - August 5			6652
August 6 - 12		5634	6353
August 13 - 19		4700	
August 20 - 26		4716	6179
August 27 - September 2		4934	6101
September 3 - 9			6026
September 10 - 16			5938
September 17 - 23			6076
September 24 - 30			6030
October 1 - 7			
October 8 - 14			6055
October 15 - 21			6186

Table 4. Mean daily radiation (cal/cm^2) in Rock Valley during 1974. Means were based on weekly totals given in Table 3

Time period	Incoming long-wave radiation	Incoming short-wave radiation	Outgoing long-wave radiation
March 26 - April 1	885.1	292.1	
April 2 - 8	933.1	378.1	895.3
April 9 - 15	838.4	406.6	864.6
April 16 - 22	876.2	464.6	907.7
April 23 - 29	872.8	538.6	834.3
April 30 - May 6	938.6		
May 7 - 13	1010.9	549.8	928.9
May 14 - 20	913.1	535.4	716.1
May 21 - 27	989.9	616.4	915.9
May 28 - June 3	1005.9		925.8
June 4 - 10			
June 11 - 17		779.8	
June 18 - 24		771.8	922.9
June 25 - July 1		804.5	957.9
July 2 - 8			935.6
July 9 - 15		665.8	990.5
July 16 - 22			1056.4
July 23 - 29			924.3
July 30 - August 5			950.3
August 6 - 12		804.9	907.6
August 13 - 19		671.5	
August 20 - 26		673.7	882.7
August 27 - September 2		704.9	871.6
September 3 - 9			860.9
September 10 - 16			848.2
September 17 - 23			868.1
September 24 - 30			861.4
October 1 - 7			
October 8 - 14			865.0
October 15 - 21			883.8

Table 5. Rainfall in Rock Valley during 1974

Month	Rainfall (mm)
January	34.0
February	1.0
March	6.4
April	0.0
May	0.3
June	0.0
July	25.6
August	1.6
September	0.0
October	25.9
November	2.5
December	32.8
Total	130.1

Table 6. Individual rainfall events and rainfall intensity in Rock Valley during 1974

Date of rainfall event		Hours duration	Rainfall during event (mm)	Rainfall intensity (mm/hr)
January	1	2	0.76	0.38
	6	10	10.92	1.09
	7	22	14.99	0.69
	8	1	0.25	0.25
	16	1	1.02	1.02
	17	1	0.25	0.25
	20	2	0.51	0.25
	21	1	3.05	3.05
		1	2.29	2.29
February	19	1	0.66	0.66
	28	1	0.41	0.41
March	3	5	3.30	0.66
	8	3	0.76	0.25
		2	2.90	1.45
		1	0.25	0.25
May	19	1	0.25	0.25
July	22	2	3.05	1.52
	23	7	17.78	2.54
	30	3	4.06	1.35
August	3	1	1.27	1.27
October	2	1	2.54	2.54
		2	0.51	0.25
	3	2	7.35	3.67
	7	2	0.51	0.25
	8	1	0.25	0.25
	26	3	3.56	1.19
	27	1	0.25	0.25
		1	0.25	0.25
	28	1	0.76	0.76
		9	9.13	1.01
	31	2	1.02	0.51
November	2	1	0.27	0.27
		2	2.32	1.16
December	4	6	17.78	2.96
		2	3.30	1.65
	28	4	5.84	1.47
	29	4	5.59	1.40

Table 7. Relative humidity data (%) at Rock Valley Station I during 1974

MONTH	MINIMUM	MAXIMUM	HOURLY MEAN	RANGE OF DAILY MINIMA	RANGE OF DAILY MAXIMA	RANGE OF DAILY MEANS
JANUARY	20	81	56	20 - 62	46 - 81	32 - 68
FEBRUARY	8	77	35	8 - 36	23 - 77	16 - 52
APRIL	6	76	32	6 - 58	18 - 76	15 - 67
APRIL	5	49	21	5 - 31	8 - 49	8 - 35
MAY	5	48	15	5 - 27	10 - 48	7 - 33
JUNE	5	39	13	5 - 20	10 - 39	7 - 28
JULY	5	52	17	5 - 31	5 - 52	5 - 44
AUGUST	5	80	20	5 - 31	12 - 80	9 - 51
SEPTEMBER	5	57	19	5 - 18	11 - 57	7 - 34
OCTOBER	5	85	25	5 - 31	9 - 85	6 - 59
NOVEMBER	14	76	35	14 - 36	31 - 76	29 - 57
DECEMBER	9	80	41	9 - 52	31 - 80	29 - 68

Table 8. General attributes of monthly winds in Rock Valley during 1974

Month	Hourly mean velocity (km/hr)	Predominant direction of measurable wind (and hours)	Total run of the wind (km)	Azimuth of resultant wind	Resultant run of the wind (km)	Percent wind steadiness
January	11.6	E (526)	8338	87° 40'	6708	80
February	12.7	E (291)	8507	87° 14'	4746	56
March	11.7	S (236)	8718	172° 02'	4508	52
April	13.5	E (219)	9722	126° 14'	1856	19
May	12.0	S (276)	8914	178° 58'	5352	60
June	11.5	SW (203)	8250	185° 55'	3735	45
July	11.9	S (244)	8013	168° 35'	4834	60
August	10.6	E (258)	7860	181° 12'	3344	43
September	10.8	E (338)	7781	120° 53'	3427	44
October	11.1	E (449)	8269	104° 45'	5042	61
November	11.4	E (494)	8198	97° 20'	5911	72
December	10.8	E (449)	7778	82° 10'	5886	76

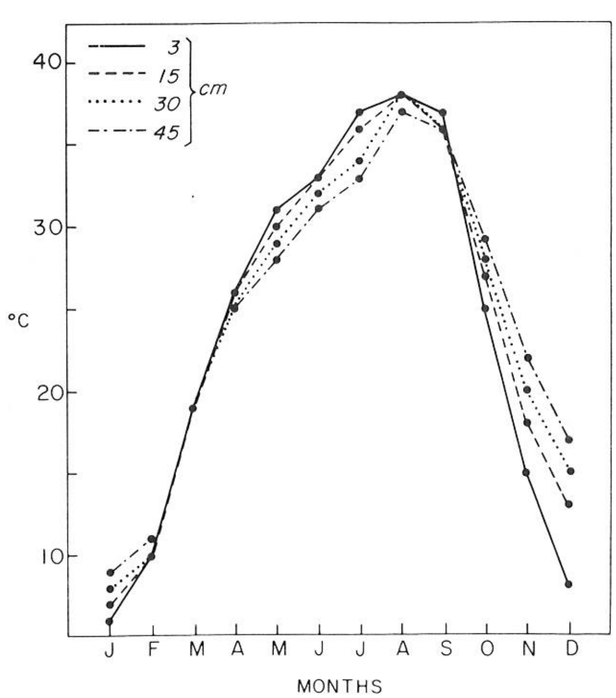

Figure 6. Monthly mean soil temperatures at four depths in the open at Station I during 1974.

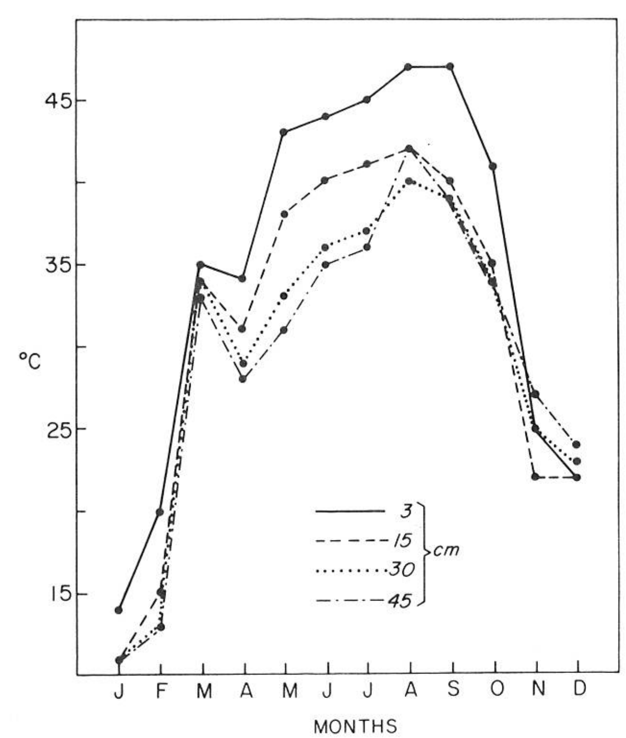

Figure 7. Monthly maximal soil temperatures at four depths in the open at Station I during 1974.

Soil Temperature

Between January and March 15, 1974, soil temperatures were measured every 6 hr with Fenwal KA31L4 thermistors buried at 3, 15, 30 and 45 cm. These measurements were made at Station I in the open (A3UTJ08). Chart readings (A) were in milliamperes and were converted to degrees Celsius as follows:

$$C = -11.42 + 87.77A - 33.12A^2$$

For the remainder of 1974 soil temperatures were measured with Thornthwaite Model 301 copper-constantan thermocouples buried in the same situations as described above. Readings were recorded in degrees Celsius with a Rustrak chart recorder. Readings were transcribed at 6-hr intervals.

Table 9 gives monthly means and extremes measured at the four depths at Station I. For a given month of n days the hourly mean was computed from $4n$ measurements. Figure 6 illustrates seasonal trends in mean soil temperatures at Station I based on the monthly means in Table 9. Figures 7 and 8 illustrate seasonal trends in maximum and minimum soil temperatures recorded each month at Station I.

Soil temperatures recorded during 1974 were often remarkably higher than those recorded in 1972 and 1973, and monthly means (at —3 cm) between May and September (inclusive) ranged from 31 to 38 C. In the two previous years, monthly means during this period ranged from 25 to 33 (1972) and 26 to 32 (1973). Whereas differences between monthly mean soil temperatures (—3 cm) and air temperatures (30 cm) were never more than 3-4 C (during the warmest periods of 1972 and 1973), differences of up to 10 and 12 C were recorded in 1974. Yet air temperatures recorded during 1974 were not notably warmer than those registered in 1972 and 1973. The problem may be perceived more clearly by examining regressions of monthly mean soil temperatures (—3 cm) on corresponding monthly mean air temperatures (at 25-30 cm) for the years 1972, 1973 and 1974 (Table 10). We are particularly concerned with the larger intercept (2.00) for 1974, relative to the essentially zero intercepts for the two previous years. We suggest that the soil temperatures recorded between April and October of 1974 be regarded with some caution. It is possible that the instrument was not calibrated properly and/or that a significant over-response occurred during the warmer months.

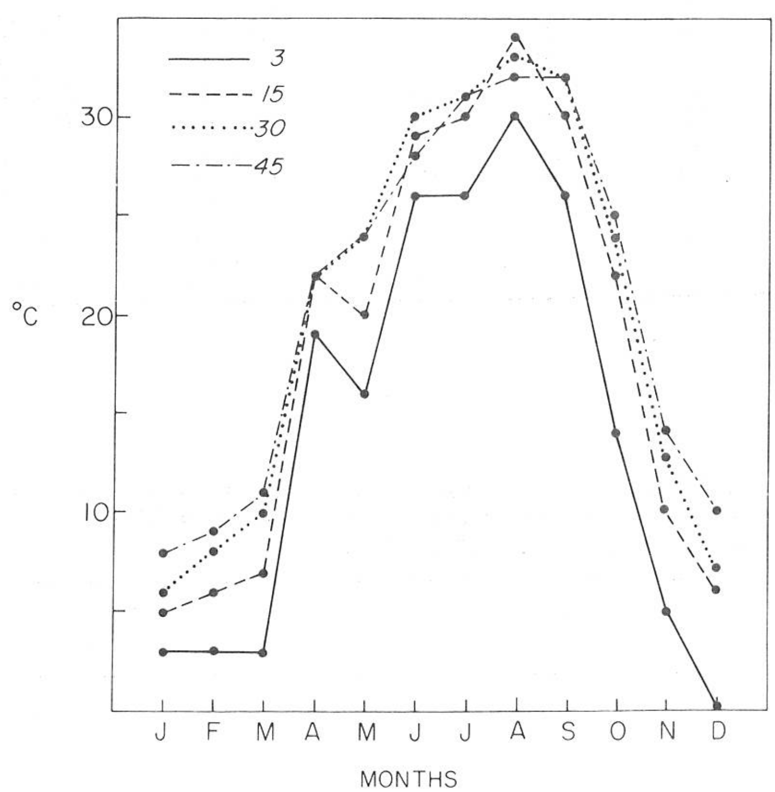

Figure 8. Monthly minimal soil temperatures at four depths in the open at Station I during 1974.

Table 9. Soil temperature data (°C) at Rock Valley Station I in the open, 1974

MONTH	CM. DEPTH	MINIMUM	MAXIMUM	HOURLY MEAN	RANGE OF DAILY MINIMA	RANGE OF DAILY MAXIMA	RANGE OF DAILY MEANS
JANUARY	-03	3	14	6	3 - 8	4 - 14	3 - 10
	-15	5	11	7	5 - 8	6 - 11	5 - 10
	-30	6	11	8	6 - 10	6 - 11	6 - 10
	-45	8	11	9	8 - 11	8 - 11	8 - 11
FEBRUARY	-03	3	20	10	3 - 10	11 - 20	7 - 13
	-15	6	15	10	6 - 12	10 - 15	8 - 12
	-30	8	13	10	8 - 12	9 - 13	9 - 12
	-45	9	13	11	9 - 13	10 - 13	10 - 13
MARCH	-03	3	35	19	3 - 31	10 - 35	8 - 33
	-15	7	34	19	7 - 31	11 - 34	9 - 33
	-30	10	34	19	10 - 32	11 - 34	10 - 33
	-45	11	33	19	11 - 32	12 - 33	11 - 32
APRIL	-03	19	34	26	19 - 25	26 - 34	23 - 29
	-15	22	31	26	22 - 26	25 - 31	24 - 28
	-30	22	29	25	22 - 26	25 - 29	24 - 27
	-45	22	28	25	22 - 26	25 - 28	24 - 27
MAY	-03	16	43	31	16 - 31	30 - 43	25 - 36
	-15	20	38	30	20 - 32	29 - 38	26 - 35
	-30	24	33	29	24 - 30	27 - 33	26 - 31
	-45	24	31	28	24 - 29	27 - 31	26 - 30
JUNE	-03	26	44	33	26 - 31	38 - 44	32 - 37
	-15	29	40	33	29 - 34	35 - 40	32 - 37
	-30	30	36	32	30 - 33	32 - 36	31 - 35
	-45	28	35	31	28 - 31	31 - 35	30 - 33
JULY	-03	26	45	37	26 - 34	40 - 45	34 - 38
	-15	30	41	36	30 - 35	37 - 41	34 - 37
	-30	31	37	34	31 - 34	35 - 37	34 - 35
	-45	31	36	33	31 - 33	33 - 36	32 - 34
AUGUST	-03	30	47	38	30 - 35	40 - 47	34 - 40
	-15	34	42	38	34 - 38	37 - 42	36 - 40
	-30	33	40	38	33 - 38	35 - 40	34 - 39
	-45	32	42	37	32 - 37	34 - 42	33 - 39
SEPTEMBER	-03	26	47	37	26 - 36	39 - 47	32 - 40
	-15	30	40	36	30 - 37	34 - 40	33 - 39
	-30	32	39	36	32 - 36	34 - 39	33 - 38
	-45	32	39	36	32 - 36	34 - 39	33 - 38
OCTOBER	-03	14	41	25	14 - 28	23 - 41	20 - 35
	-15	22	35	27	22 - 31	26 - 35	24 - 33
	-30	24	34	28	24 - 32	27 - 34	26 - 33
	-45	25	34	29	25 - 32	27 - 34	27 - 33
NOVEMBER	-03	5	25	15	5 - 15	8 - 25	6 - 19
	-15	10	22	18	10 - 20	13 - 22	12 - 21
	-30	13	25	20	13 - 22	16 - 25	14 - 24
	-45	14	27	22	14 - 25	18 - 27	16 - 25
DECEMBER	-03	0	22	8	0 - 11	0 - 22	0 - 17
	-15	6	22	13	6 - 16	8 - 22	7 - 19
	-30	7	23	15	7 - 19	10 - 23	9 - 21
	-45	10	24	17	10 - 21	13 - 24	12 - 23

Table 10. Regression equations relating monthly mean soil temperatures (—3 cm) to monthly mean air temperatures (25-30 cm) for the years 1972, 1973 and 1974 in Rock Valley

Year	Mean soil temperature (Y) in terms of mean air temperature (X)	Standard error of regression coefficient	r
1972	Y = 0.04 + 1.20X	0.044	0.994
1973	Y = 0.23 + 1.08X	0.027	0.997
1974	Y = 2.00 + 1.25X	0.086	0.977

Table 11. Soil moisture tensions (—bars) at Station I in Rock Valley during 1974

Date	Depth (cm), in open 3	15	30	45	Depth (cm), beneath shrub 3	15	30	45
January 17		1.0	1.0			1.0	1.0	
January 23		1.0	1.0			1.0	1.0	
January 30		1.0	1.0			1.0	1.0	
February 10		1.0	1.0			1.0	1.0	
February 15		1.0	1.0			4.0	1.0	
February 22		3.0	1.0			2.9	3.3	
March 1		1.0	1.0			3.3	2.8	
March 11		1.0	1.0			3.7	1.7	
March 15		3.6	3.0			5.2	11.3	
March 27	3.6	1.0	1.0	1.0	7.5	1.0	4.0	3.1
April 3	6.0	4.5	1.0	1.0	10.1	1.0	4.0	1.1
April 10	7.9	1.6	1.3	1.0	4.0	2.0	6.3	4.5
April 17	13.2	6.0	2.4	1.6	3.5	4.3	9.1	6.0
April 24	21.5	9.2	5.9	3.6	5.2	8.7	11.5	6.6
May 1	20.2	14.0	11.0	9.3	12.3	15.5	19.0	8.3
May 8	14.0	13.0	10.0	12.5	15.0	19.0	12.0	10.6
May 15	<80	22.6	16.0	14.6	<80	22.6	21.3	12.0
May 22	<80	32.8	16.7	20.3	<80	44.9	26.8	16.4
May 29	<80	49.3	21.9	26.7	<80	<80	29.3	26.7
June 6	<80	<80	26.0	31.0	<80	<80	36.0	44.0
June 12	<80	<80	26.0	32.0	<80	<80	40.0	52.0
June 19	<80	<80	33.0	35.0	<80	<80	44.0	49.0
June 26	<80	<80	41.0	40.0	<80	<80	<60	<50
July 3	<80	<80	47.0	37.0	<80	<80	<60	<50
July 10	<80	<80	71.0	39.0	<80	<80	<60	<50
July 17	<80	<80	<70	41.0	<80	<80	<60	<50
July 23	1.0	<80	<70	43.0	7.0	<80	<60	<50
July 24	1.0	<80	<70	52.0	0.7	<80	<60	<50
July 25	1.0	--	<70	49.0	0.5	<80	<60	<50
July 26	1.7	2.4	<70	49.0	2.3	<80	<60	<50
July 29	3.4	2.9	--	48.0	3.1	--	<60	<50
July 31	0.7	2.7	--	48.0	5.3	--	<60	<50
August 7	7.9	6.4	37.0	45.0	<80	45.0	<60	<50
August 14	15.0	7.0	25.0	41.0	<80	41.0	<60	<50
August 21		11.1	19.2	38.4	<80	<80	<60	<50
September 3	<80	30.6	21.1	33.5	<80	<80	<60	<50
September 17	<80	<80	27.8	40.1	<80	<80	<60	<50
October 1	<80	<80	39.5	47.3	<80	<80	<60	<50
October 8	10.5	<80	<70	48.3	12.5	<80	<60	<50
October 31	1.0	1.0	--	--	1.0	1.0	--	--
November 13	6.1	7.1	6.9	10.0	10.5	6.7	1.9	2.5
December 3	11.2	15.4	1.8	5.3	1.5	2.2	1.8	2.2

Soil Moisture

Soil moisture data (A3UTJ12) were acquired at Station I at approximately weekly intervals, or more often, until early September 1974. Readings thereafter were irregular. From January to mid-March 1974, measurements were made at two depths (15 and 30 cm), in the open and beneath a shrub, using the same system as described in earlier reports (see Bamberg et al. 1974:22). From March 27 until the end of the year moisture tensions were calculated from measurements made with a Wescor HR33T Dewpoint Microvoltmeter. Wescor soil moisture psychrometers (PT51-05) were buried at 3, 15, 30 and 45 cm in the open and beneath a shrub. The psychrometers in the open had cooling coefficients (π_V's) ranging from 65 to 72, those beneath shrubs from 39 to 68.

Cooling coefficients (at 25 C) were adjusted according to soil temperature (T), and the instrument set accordingly:

$$\text{Adjusted } \pi_V = \pi_V(25\text{ C}) - 0.7\,(25 - T)$$

The instrument reading related to soil moisture (M, microvolts) was adjusted for soil temperature at the time of reading:

$$M_{adj} = M/(0.325 + 0.027T)$$

Soil moisture tensions (—bars) were then computed as $1.333 M_{adj}$. When soils were saturated the reading of M was zero and under these conditions soil moisture tensions were arbitrarily taken as —1 bar. Saturation of the soils in the vicinity of Station I amounts to a water content of about 11.5% by weight (Bamberg et al. 1974:22).

Table 11 summarizes soil moisture data available for 1974. At the beginning of the year soils were wet, following rains of about 12 mm on December 27, 1974, and from a series of rains totaling about 26 mm during the first eight days of January. Soils remained generally wet through mid-February and showed (in the open at least) some response to rains in late February and early March. No significant rains fell after March 8 until late July. Soils began to dry out by mid-April and by mid-May the uppermost soil layer was completely dry. Some moisture persisted at 30 and 45 cm, but by late June even these lower strata were dry. The rainfall on July 22-23 (ca. 21 mm) wet only the soil surface, although some of this moisture ultimately penetrated to 15 cm in open areas. Light rains in late July and early August wet the upper soil layers but this moisture disappeared rapidly and another extremely dry period persisted throughout the rest of August and September. Between mid-May and October, soils were often so dry that no readings could be obtained with the microvoltmeter. These circumstances indicated moisture tensions lower than the measurement limits of the various psychrometers in use. Moisture tensions recorded as <-50, <-60, <-70 and <-80 bars in Table 11 reflect the extremely dry situations described above. The rains of October and November (ca. 30 mm) certainly restored

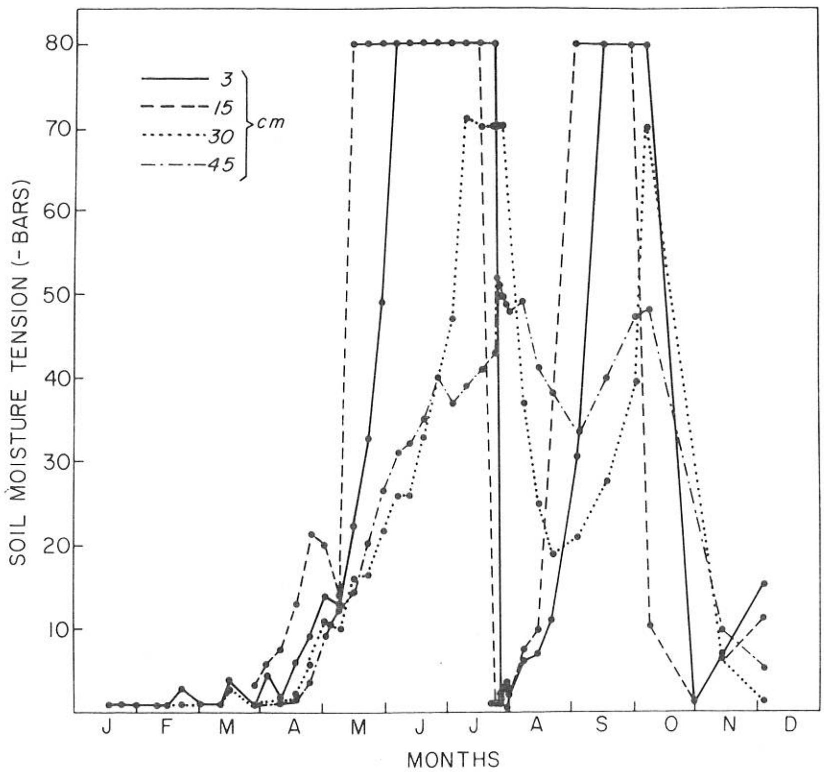

Figure 9. Weekly soil moisture tensions at four depths in the open at Station I during 1974.

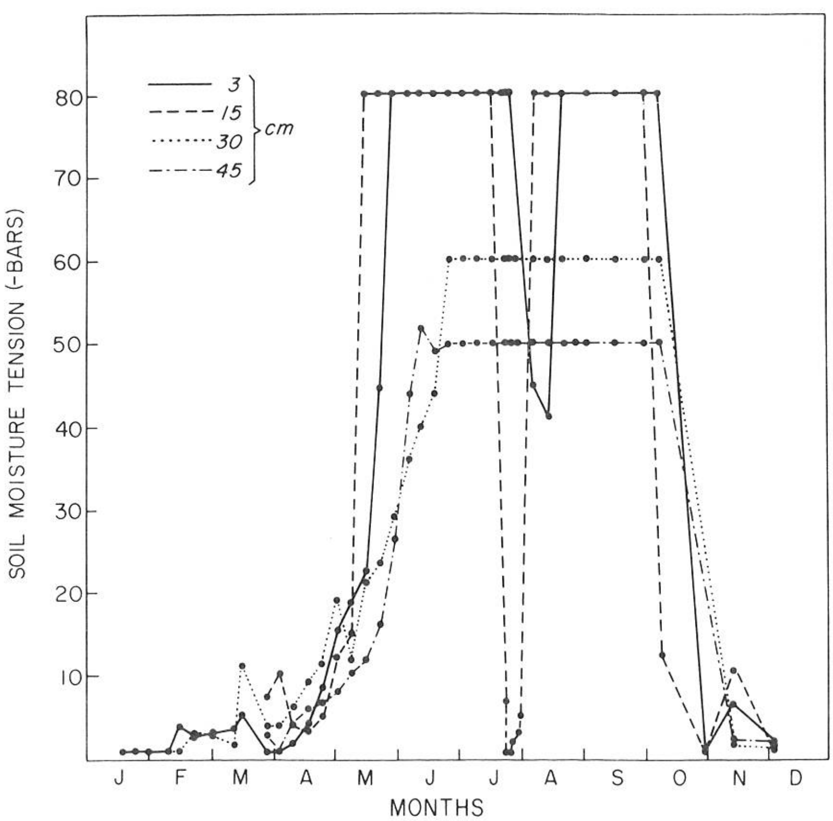

Figure 10. Weekly soil moisture tensions at four depths beneath a shrub at Station I during 1974.

moisture to the upper soil levels (3 and 15 cm). There is some question as to whether the reported moisture tensions for November 13 and December 3 (at 30 and 45 cm) are reliable. On the basis of measurements near the CETO Laboratory, Hunter (pers. comm.) determined that 5 mm of rainfall wet the soil to a depth of 2.5 cm. It is doubtful that 30 mm of rainfall could wet soils to depths of 30 and 45 cm. Another 33 mm of rain fell during December so that soils may have been wet down to 30 cm by the end of the year. No measurements were made after December 3, although soils were recorded as "wet" on December 12. Figure 9 illustrates moisture tensions (at four depths) in the open during 1974. Figure 10 illustrates comparable measurements made beneath shrubs. In these figures, values of <—50, <—60, <—70 and <—80 bars have been set at —50, —60, —70 and —80 bars.

Literature Cited

Bamberg, S. A., H. Kaaz, B. Maza, and F. B. Turner. 1974. Abiotic measurements. Pages 11-24 *in* F. B. Turner and J. F. McBrayer, eds. Rock Valley Validation Site report. US/IBP Desert Biome Res. Memo. 74-2. Utah State Univ., Logan. 64 pp.

Turner, F. B. (Coordinator) et al. 1973. Rock Valley Validation Site report. US/IBP Desert Biome Res. Memo. 73-2. Utah State Univ., Logan. 211 pp.

Table 12. Estimated densities (n/ha) of winter annuals in six zones composing the Rock Valley Validation Site during the spring of 1974

SPECIES	VEGETATIONAL ZONE/HECTARES					
	20 (21.21)	21 (5.66)	22 (3.01)	23 (1.41)	24 (7.83)	25 (6.99)
AMSINCKIA TESSELLATA	1506	1042	0	2778	0	735
ANDROSTEPHIUM BREVIFLORUM	0	0	0	0	0	735
ASTRAGALUS ACUTIROSTRIS	0	0	1786	0	840	735
ASTRAGALUS LENTIGINOSUS	301	1042	1786	0	3361	1471
ASTRAGALUS DIDYMOCARPUS	301	6250	0	8333	840	735
BROMUS RUBENS	187952	39583	112500	27778	5882	9559
CAULANTHUS COOPERI	301	0	0	0	0	735
CAULANTHUS LASIOPHYLLUS	3012	1042	5357	5556	3361	735
CHAENACTIS CARPHOCLINIA	32831	57292	5357	50000	66387	36029
CHAENACTIS FREMONTII	61446	92708	96429	66667	50420	166176
CHAENACTIS MACRANTHA	301	0	0	0	0	0
CHAENACTIS STEVIOIDES	2108	38542	0	0	24370	2206
CHORIZANTHE BREVICORNU	3916	12500	12500	8333	5882	8088
CHORIZANTHE RIGIDA	6627	5208	16071	0	4202	5882
CRYPTANTHA CIRCUMSCISSA	25904	54167	7143	50000	23529	19118
CRYPTANTHA MICRANTHA	0	7292	0	0	840	22059
CRYPTANTHA NEVADENSIS	37349	22917	12500	27778	18487	15441
CRYPTANTHA PTEROCARYA	1205	4167	0	8333	10924	1471
CRYPTANTHA RECURVATA	61145	47917	57143	108333	14286	26471
CRYPTANTHA SPP.	7831	25000	3571	47222	12605	7353
CUSCUTA NEVADENSIS	0	1042	0	0	0	0
DESCURAINIA PINNATA	25000	18750	7143	0	3361	2941
ERIOGONUM MACULATUM	3313	3125	0	5556	3361	8088
ERIOGONUM NIDULARIUM	0	0	1786	0	1681	2206
ERIOGONUM TRICHOPES	3012	0	0	0	0	0
ERIOPHYLLUM PRINGLEI	29518	39583	5357	19444	8403	19853
FESTUCA OCTOFLORA	658735	222917	660714	308333	54622	53676
GILIA CANA SUBSP. TRICEPS	301	0	0	0	0	0
GILIA TRANSMONTANA	301	1042	0	0	0	0
IPOMOPSIS POLYCLADON	301	0	0	0	0	0
LANGLOISIA SETOSISSIMA	3313	0	5357	2778	0	0
LUPINUS FLAVOCULATUS	602	1042	0	0	840	0
LYGODESMIA EXIGUA	2108	4167	3571	5556	3361	2206
MALACOTHRIX GLABRATA	904	2083	1786	2778	3361	6618
MENTZELIA OBSCURA	6024	12500	0	2778	14286	12500
MONOPTILON BELLIDIFORME	0	0	0	0	0	735
OENOTHERA BOOTHII	1506	1042	0	8333	2521	3676
OENOTHERA MUNZII	9940	0	7143	0	0	0
OXYTHECA PERFOLIATA	301	0	1786	13889	5042	1471
PHACELIA FREMONTII	1205	9375	3571	0	1681	0
PHACELIA VALLIS-MORTAE	9036	0	1786	8333	3361	7353
PLAGIOBOTHRYS JONESII	0	3125	0	0	0	0
PECTOCARYA SPP.	32229	8333	5357	5556	840	2941
RAFINESQUIA NEOMEXICANA	602	0	0	0	0	0
STREPTANTHELLA LONGIROSTRIS	301	0	3571	5556	0	0
TRICARDIA WATSONII	0	0	1786	0	0	0
ALL SPECIES (N/HA) $(X10^3)$	1223	745	1120	800	354	460
ALL SPECIES (N/ZONE) $(X10^3)$	25931	4216	3371	1128	2770	3217

PLANTS

Annual Plant Populations

T. L. Ackerman, F. B. Turner, H. W. Kaaz

The 1974 growing season was notable for the relatively high density of annuals measured on the site, coupled with the extremely small sizes of most of the species. Dry weights of annuals were on the order of those measured in 1972, or even less. Data on annuals are stored under A3UTJ20.

Densities of annuals were estimated from counts made in 776 quadrats located in sets of four around 194 randomly dispersed points. The quadrats used were 0.1 m^2 (20 x 50 cm), as in 1973. Plants of most annual species were collected at times of peak flowering and fruiting, separated into constituent parts, dried and weighed.

Ackerman et al. (1974:25) list annual species known to occur on the Rock Valley site; 55 species of annuals from the site in 1973 (cf. 41 spp. in 1971 and 1972). In 1974 data were acquired for 46 species.

Estimated 1974 densities of winter annuals are given in Table 12. The overall site density (87.6/m^2) was far greater than densities reported for 1971 and 1972 (7.8 and 11.0/m^2, respectively), and only a little less than the density recorded in 1973 (101.5/m^2). However, of the estimated 40 million annuals on the site in 1974, over 23 million (57%) were two grasses (*Festuca octoflora* and *Bromus rubens*). Other common species were *Chaenactis fremontii, Chaenactis carphoclinia, Cryptantha circumscissa* and *Cryptantha recurvata*, with an aggregate site-wide density of a little over nine million.

Mean dry weights of individual species by constituent parts are given in Table 13. In general, annuals were small in 1974. This may follow from the fact that, although winter rains germinated many plants, rainfall in February and March was inadequate to sustain much growth (see Turner et al. 1973:81).

Estimated total winter annual production is given in Table 14. These estimates are derived from density values (Table 12) and mean dry weights (Table 13). Production by annuals in 1974 was about 17.4 kg/ha on a site-wide basis. This figure emphasizes how small the 1974 plants were, for although the density of annuals was about 86% of that observed in 1973, the 1974 production was only about 2.6% of that of the preceding year. Table 15 gives net production by winter annuals for each zone in terms of various plant parts.

Table 13. Mean dry weights (mg) of parts of the species of winter annuals during spring 1974, and total dry weights of entire plants during spring 1974

SPECIES	LEAVES	STEMS	FLOWERS	FRUITS	ROOTS	TOTALS
AMSINCKIA TESSELLATA	33.0	14.0	15.0	0.0	6.0	68.0
ASTRAGALUS LENTIGINOSUS	16.0	3.5	0.0	0.0	3.0	22.5
ASTRAGALUS DIDYMOCARPUS	11.0	2.7	3.2	0.0	2.8	19.7
BROMUS RUBENS	13.2	6.1	15.4	7.9	1.5	44.0
CAULANTHUS LASIOPHYLLUS	2.7	4.3	0.0	5.0	2.7	14.7
CHAENACTIS CARPHOCLINIA	11.6	8.3	10.2	4.1	2.3	36.5
CHAENACTIS FREMONTII	6.4	7.9	11.9	4.0	1.8	32.0
CHAENACTIS MACRANTHA	10.9	8.2	19.0	6.2	2.4	46.6
CHAENACTIS STEVIOIDES	5.3	5.3	11.0	2.8	2.7	27.1
CHORIZANTHE BREVICORNU	3.9	14.5	2.0	21.5	2.2	44.1
CHORIZANTHE RIGIDA	11.3	15.9	6.2	24.7	6.1	64.2
CRYPTANTHA CIRCUMSCISSA	4.7	1.7	3.3	3.4	0.9	14.0
CRYPTANTHA MICRANTHA	0.9	0.4	1.1	0.0	0.2	2.7
CRYPTANTHA NEVADENSIS	4.3	6.0	4.4	6.8	1.3	22.8
CRYPTANTHA PTEROCARYA	10.9	10.5	7.7	4.1	2.9	36.1
CRYPTANTHA RECURVATA	6.4	6.8	5.4	7.1	1.6	27.4
DESCURAINIA PINNATA	1.7	1.9	0.3	2.3	0.7	6.9
ERIOGONUM MACULATUM	9.0	6.0	8.5	0.0	2.1	25.7
ERIOGONUM TRICHOPES	30.3	81.0	9.8	8.7	14.9	144.6
ERIOPHYLLUM PRINGLEI	2.9	0.9	5.8	0.9	0.6	11.1
FESTUCA OCTOFLORA	1.8	0.8	1.8	2.1	0.3	6.9
GILIA CANA SUBSP. TRICEPS	6.7	2.3	4.0	0.0	2.0	15.0
LANGLOISIA SETOSISSIMA	5.5	0.9	5.3	8.2	0.7	20.6
LUPINUS FLAVOCULATUS	33.0	15.6	9.8	0.0	6.2	64.6
LYGODESMIA EXIGUA	1.7	3.0	2.0	0.0	1.0	7.7
MALACOTHRIX GLABRATA	13.0	6.0	13.0	0.0	5.0	37.0
MENTZELIA OBSCURA	8.3	6.7	3.2	3.0	2.5	23.6
OENOTHERA BOOTHII	12.3	6.7	17.4	1.0	3.4	40.8
OENOTHERA MUNZII	14.0	17.9	12.4	1.3	4.3	49.9
PHACELIA FREMONTII	2.4	2.2	4.0	0.5	1.5	10.7
PHACELIA VALLIS-MORTAE	41.0	48.2	37.0	2.0	3.5	131.7
PECTOCARYA SPP.	2.9	2.5	0.4	6.1	0.9	12.8
RAFINESQUIA NEOMEXICANA	17.3	24.0	18.7	0.0	5.0	65.0

Table 14. Estimated total annual production (kg/ha) by winter annuals on the Rock Valley Validation Site during spring of 1974

SPECIES	ZONES 20	21	22	23	24	25
AMSINCKIA TESSELLATA	0.1	0.1	0.0	0.2	0.0	0.0
ASTRAGALUS LENTIGINOSUS	0.0	0.0	0.0	0.0	0.1	0.0
ASTRAGALUS DIDYMOCARPUS	0.0	0.1	0.0	0.2	0.0	0.0
BROMUS RUBENS	8.3	1.7	5.0	1.2	0.3	0.4
CAULANTHUS LASIOPHYLLUS	0.0	0.0	0.1	0.1	0.0	0.0
CHAENACTIS CARPHOCLINIA	1.2	2.1	0.2	1.8	2.4	1.3
CHAENACTIS FREMONTII	2.0	3.0	3.1	2.1	1.6	5.3
CHAENACTIS MACRANTHA	0.0	0.0	0.0	0.0	0.0	0.0
CHAENACTIS STEVIOIDES	0.1	1.0	0.0	0.0	0.7	0.1
CHORIZANTHE BREVICORNU	0.2	0.6	0.6	0.4	0.3	0.4
CHORIZANTHE RIGIDA	0.4	0.3	1.0	0.0	0.3	0.4
CRYPTANTHA CIRCUMSCISSA	0.4	0.8	0.1	0.7	0.3	0.3
CRYPTANTHA MICRANTHA	0.0	0.0	0.0	0.0	0.0	0.1
CRYPTANTHA NEVADENSIS	0.9	0.5	0.3	0.6	0.4	0.4
CRYPTANTHA PTEROCARYA	0.0	0.2	0.0	0.3	0.4	0.1
CRYPTANTHA RECURVATA	1.7	1.3	1.6	3.0	0.4	0.7
DESCURAINIA PINNATA	0.2	0.1	0.0	0.0	0.0	0.0
ERIOGONUM MACULATUM	0.1	0.1	0.0	0.1	0.1	0.2
ERIOGONUM TRICHOPES	0.4	0.0	0.0	0.0	0.0	0.0
ERIOPHYLLUM PRINGLEI	0.3	0.4	0.1	0.2	0.1	0.2
FESTUCA OCTOFLORA	4.5	1.5	4.5	2.1	0.4	0.4
GILIA CANA SUBSP. TRICEPS	0.0	0.0	0.0	0.0	0.0	0.0
LANGLOISIA SETOSISSIMA	0.1	0.0	0.1	0.1	0.0	0.0
LUPINUS FLAVOCULATUS	0.0	0.1	0.0	0.0	0.1	0.0
LYGODESMIA EXIGUA	0.0	0.0	0.0	0.0	0.0	0.0
MALACOTHRIX GLABRATA	0.0	0.1	0.1	0.1	0.1	0.2
MENTZELIA OBSCURA	0.1	0.3	0.0	0.1	0.3	0.3
OENOTHERA BOOTHII	0.1	0.0	0.0	0.3	0.1	0.1
OENOTHERA MUNZII	0.5	0.0	0.4	0.0	0.0	0.0
PHACELIA FREMONTII	0.0	0.1	0.0	0.0	0.0	0.0
PHACELIA VALLIS-MORTAE	1.2	0.0	0.2	1.1	0.4	1.0
PECTOCARYA SPP.	0.4	0.1	0.1	0.1	0.0	0.0
RAFINESQUIA NEOMEXICANA	0.0	0.0	0.0	0.0	0.0	0.0
All species (kg/ha)	23.3	14.6	17.4	14.8	8.9	11.9
All species (kg/zone)	493.5	82.8	52.5	20.9	69.4	83.5

Table 15. Estimated total annual production of plant parts (kg/ha) by winter annuals on the Rock Valley Validation Site during spring of 1973

ZONE	LEAVES	STEMS	FLOWERS	FRUITS	ROOTS	TOTALS
20	6.3	4.5	6.7	4.7	1.2	23.3
21	3.7	3.0	4.2	2.8	0.9	14.6
22	4.4	3.2	4.9	4.0	0.9	17.4
23	4.0	3.2	4.0	2.8	0.8	14.8
24	2.4	2.1	2.5	1.4	0.6	8.9
25	2.9	2.9	3.6	1.8	0.7	11.9
SITE TOTALS	4.6	3.5	5.0	3.3	0.9	17.4

Table 16 illustrates the relative importance of only six annual species with respect to the state of the Rock Valley site during the spring of 1974. These species accounted for about 80% of total numbers and about 75% of the 1974 biomass.

The distributions of annuals in relation to shrubs and soil type are given in Table 17. Most of the annuals grew in open areas of desert pavement, but the highest densities were (as in the past) observed beneath shrubs.

No annuals were produced during the last months of 1973, and germination did not begin until January 18, 1974. As indicated above, rains after January 6-7 were apparently not sufficient to promote good growth and survival. Estimated survival of annuals in Zone 24 was about 21%, and in Zone 25 around 35%. Survival in Zone 20 was 55% over the first part of the growing season, but further mortality occurring later in the season was not evaluated.

Table 16. Estimated densities and biomass values for six annuals on the Rock Valley site in the spring of 1974

Species	Approximate number on site (millions)	Approximate biomass (kg/ha)
Bromus rubens	4.7	4.5
Festuca octoflora	18.5	2.8
Chaenactis carphoclinia	1.9	1.5
C. fremontii	3.8	2.6
Cryptantha circumscissa	1.3	0.4
C. recurvata	2.3	1.4
Totals for six species	32.5	13.2
Totals for all annuals	40.4	17.4

Table 17. Approximate distribution (%) of annual plants in terms of shrub cover and soil type

ZONE NUMBER	TOTAL QUADRATS (0.1M)	UNDER SHRUB (%)	LOOSE SOIL (%)	DESERT PAVEMENT (%)
20	332	16	3	71
21	96	10	9	58
22	56	26	7	34
23	36	21	9	64
24	119	16	8	42
25	136	18	8	42

Perennial Plant Populations

T. L. Ackerman, A. T. Vollmer, F. B. Turner, B. G. Maza

During 1973, perennials experienced growth and production far in excess of that observed in 1971 and 1972 (Bamberg et al. 1974:30). Between 1971 and 1973 we assumed that total stem weights (live and dead) remained constant, or at least not detectably changed. Estimates of standing crops and productivity for 1971, 1972 and 1973 were based on dimension analyses carried out in 1971. However, it seemed likely that 1974 shrubs would be demonstrably larger than in previous years and that coverage would be increased. Also, because net production of shrubs is estimated in terms of live stem biomass (Turner et al. 1973:96-97), it was important to assess increases, if any, in live stem components of total standing crop (A3UTJ25).

Hence, one aspect of the 1974 program involved remeasurements of shrubs on the site. The remainder of the 1974 effort was devoted to estimating net production by seven species of shrubs and recording the phenology of important perennials. New 1974 measurements were made of shrubs occupying selected quadrats in each of the six vegetation zones of the site (see Fig. 2 in Site Development section). From measurements of shrub diameters (d_1 and d_2), new estimates of shrub areas (A) were derived:

$$A = \pi\ [(d_1 + d_2)/4]^2$$

Mean areas of eight species of shrubs measured in 1974 were compared with mean areas of shrubs measured in the same quadrats in 1971 (Table 18). Areas of all but two species (*Krameria parvifolia* and *Lycium andersonii*) were apparently greater than those estimated in 1971. Shrub coverage in Rock Valley was recomputed using new data in Table 18. Differences between 1971 and 1974 were so slight for *Krameria* and *Lycium andersonii* that we did not modify previous cover estimates for these species. Table 19 sets forth revised (1974) cover estimates for six zones and the entire site. The new overall cover estimate (~ 24%) is about 20% higher than the 1971 estimate of 20% (see Turner et al. 1973:101).

Table 18. Comparisons of mean areas of eight species of shrubs in Rock Valley in 1971 and 1974

Species	1971 n	1971 Mean area (m^2)	1974 n	1974 Mean area (m^2)	% Change
Ambrosia dumosa	2394	0.148	264	0.180	+ 22
Ceratoides lanata	476	0.059	60	0.098	+ 60
Ephedra nevadensis	785	0.223	89	0.311	+ 40
Grayia spinosa	1192	0.112	128	0.195	+ 74
Krameria parvifolia	1478	0.282	172	0.266	- 6
Larrea tridentata	1048	0.417	145	0.479	+ 15
Lycium andersonii	710	0.577	83	0.596	+ 3
L. pallidum	457	0.503	64	0.628	+ 25

Table 19. Estimated coverage (%) of shrubs in six vegetative zones composing the Rock Valley site in 1974

	Zones						
Species	20	21	22	23	24	25	Entire site
Ambrosia dumosa	3.00	2.98	5.19	5.35	4.66	5.58	3.88
Ceratoides lanata	2.02	0.88	3.74	5.20	0.98	3.34	2.11
Ephedra nevadensis	0.13	0.80	0.08	1.47	0.41	0.86	0.41
Grayia spinosa	0.54	1.36	1.08	3.24	3.53	5.50	2.02
*Krameria parvifolia**	4.79	2.43	5.01	4.45	2.23	3.17	3.82
Larrea tridentata	5.10	3.93	4.73	4.24	4.44	4.24	4.66
*Lycium andersonii**	6.12	2.80	4.92	2.53	0.39	1.50	3.85
Lycium pallidum	0.57	4.77	1.79	3.06	5.15	4.78	2.65
Others*	0.05	0.17	1.33	0.60	1.15	0.40	0.40
Total cover	22.32	20.12	27.87	30.14	22.94	29.37	23.80

* No change relative to 1971

Table 20. Comparisons of mean volumes of eight species of shrubs in Rock Valley in 1971 and 1974

Species	1971 n	1971 mean volume (m^3)	1974 n	1974 mean volume (m^3)	Percent change
Ambrosia dumosa	2394	0.047	264	0.063	+ 34
Ceratoides lanata	476	0.023	60	0.047	+104
Ephedra nevadensis	785	0.107	89	0.166	+ 55
Grayia spinosa	1192	0.056	128	0.113	+102
Krameria parvifolia	1478	0.061	172	0.057	- 7
Larrea tridentata	1048	0.255	145	0.333	+ 31
Lycium andersonii	710	0.303	83	0.339	+ 12
L. pallidum	457	0.301	64	0.405	+ 34

From measurements of height and diameters, new shrub volumes were computed using Equation 1 (Turner et al. 1973:96). Mean volumes of eight species of shrubs measured in 1974 were compared with mean volumes of shrubs measured in the same quadrats in 1971 (Table 20). In all but one case (*Krameria parvifolia*), estimated 1974 volumes were conspicuously greater than those determined in 1971.

New estimates of total stem biomass were computed for seven shrubs in Table 20 that exhibited apparent increases in average volumes. These new values were obtained with earlier-reported regression equations (Turner et al. 1973:98). Total stem biomass was then used to estimate 1974 live stem standing stocks, based on estimated proportions of living material in these shrubs (Turner et al. 1973:106). For example, the average volume of *Grayia spinosa* in 1974 was 0.113 m^3. Total stem weight in this species (kg) is 2.002 x 0.113, or about 0.226 kg. The proportion of live stem to total stem weight in this species is 0.521. Hence, the mean live stem biomass of an individual *Grayia spinosa* in 1974 can be estimated as 0.226 x 0.521, or about 0.118 kg. The site-wide density of this species is 1149/ha, so the live stem standing stock of *Grayia* in 1974 may be estimated as 135 kg/ha, or about twice the estimate for previous years. Table 21 recapitulates site-wide density estimates for 21 perennials on the Rock Valley site as well as recalculated biomass values for the seven species just discussed. Because the average volume of *Krameria parvifolia* appeared unchanged in 1974, we used the older (1971) volume estimate for this species. We emphasize that the new calculations for 1974 assumed the same proportions of live:dead tissue determined in 1971; yet it is likely that new growth in 1973 increased relative amounts of live tissue in Rock Valley shrubs. To whatever extent this is true, the new calculations reported in Table 21 are underestimates of live-stem standing stocks.

Are the estimated increases in live stem biomass derived from apparent changes in shrub dimensions between 1973 and 1974 consistent with harvest estimates of new stem production in 1973? Table 22 compares new stem biomass estimated by harvest procedures (see Bamberg et al. 1974: Table 10) with live-stem increments implied by volumetric changes between 1973 and 1974. In all cases, the latter exceeded 1973 harvest estimates. However, Bamberg et al. (1974:31) have pointed out that harvest estimates of production are much lower than estimates based on gas exchange analyses. The data in Table 22 show some sizable discrepancies (e.g., *Ceratoides*, *Grayia* and *Lycium pallidum*). When small shrubs like *Ceratoides* and *Grayia* produce a few sparse shoots, volume estimates increase without corresponding increases in stem weights. It is possible that such an effect contributed to the differences reported for these species in Table 22.

Table 21. Site-wide density and live stem biomass of perennial plants in Rock Valley. Density data are based on an inventory in 1971. Biomass estimates for seven species have been revised in terms of new measurements in 1974

Species	Density (n/ha)	Live stem biomass (kg/ha)
Acamptopappus shockleyi	37	0.8
Ambrosia dumosa	2561	120.9
Atriplex confertifolia	103	27.7
Ceratoides lanata	449	21.6
Coleogyne ramosissima	20	25.0
Dalea fremontii	6	3.3
Encelia virginensis	1	--
Ephedra nevadensis	754	132.0
Grayia spinosa	1149	135.2
Krameria parvifolia	1417	116.7
Larrea tridentata	959	154.2
Lycium andersonii	725	343.9
L. pallidum	530	124.6
Machaeranthera tortifolia	52	0.4
Menodora spinescens	2	--
Mirabilis bigelovii	3	--
Opuntia echinocarpa	1	--
Oryzopsis hymenoides	124	0.1
Salazaria mexicana	8	--
Sphaeralcea ambigua	2	--
Tridens pulchellus	1	--
Totals	8904	1206.4

Table 22. Comparisons of direct estimates of 1973 stem production with estimates based on changes in average volumes of seven Rock Valley shrubs

Species	Live stem standing crops (kg/ha) estimated from shrub volumes		Δ B (kg/ha) 1973-74	Harvest estimates of new stem production in 1973 (kg/ha)
	1973	1974		
Ambrosia dumosa	81.9	120.9	39.0	21.4
Ceratoides lanata	10.5	21.6	11.1	4.5
Ephedra nevadensis	80.3	132.0	51.7	40.9
Grayia spinosa	65.1	135.2	70.1	8.8
Larrea tridentata	129.6	154.2	24.6	11.5
Lycium andersonii	304.8	343.9	39.1	30.2
L. pallidum	79.7	124.6	44.9	9.2

Table 23. Amounts of oven-dried material (g) used to estimate net production by seven shrubs in Rock Valley during 1974

Species	Dates	Old live stem	Dead wood	New stems	New leaves	Flowers	Fruits	Totals
Ambrosia dumosa	May 13	283.4	289.8	9.9	50.1	1.9	--	635
	May 24	274.4	204.9	11.4	64.1	--	0.3	555
Ephedra nevadensis	May 2	980.1	281.7	0.6	--	0.1	--	1263
Grayia spinosa	Apr 1	146.0	39.5	3.1	35.4	1.1	--	225
	Apr 29	188.5	104.9	8.7	48.8	--	2.6	354
Krameria parvifolia	May 20	279.3	77.4	8.7	71.4	4.6	--	441
	Jun 14	132.6	21.9	5.4	34.2	--	--	194
Larrea tridentata	May 15	1098.2	153.2	25.5	99.7	10.7	2.1	1389
	Jun 14	990.8	105.8	21.3	83.5	--	10.1	1212
Lycium andersonii	Apr 17	279.5	23.1	0.3	23.5	0.08	--	327
L. pallidum	Apr 11	235.9	59.0	0.01	35.4	0.04	0	330

Table 24. Coefficients for production of new parts in terms of old live stem weights for seven Rock Valley shrubs in 1974

Species	New stems a	New leaves b	Flowers c	Fruits d
Ambrosia dumosa	0.0415	0.234	0.0067	0.0011
Ephedra nevadensis	0.0002	--	0.0001	none
Grayia spinosa	0.046	0.252	0.00377	0.0069
Krameria parvifolia	0.041	0.256	0.0165	none
Larrea tridentata	0.0244	0.0677	0.0097	0.0102
Lycium andersonii	0.0011	0.084	0.0003	none
L. pallidum	0.00004	0.15	0.0002	none

Table 25. Estimated production (kg/ha) of new leaves, new stems, flowers and fruits by seven perennial shrubs in Rock Valley during the spring of 1974. Declines in production (relative to 1973) are indicated in the last two columns

Species	New leaves	New stems	Flowers	Fruits	Total new biomass	Decrease in 1974 with respect to 1973	
						kg/ha	Percent
Ambrosia dumosa	28.29	5.02	0.81	0.13	34.25	67.2	66.2
Ephedra nevadensis	--	0.03	0.01	none	0.04	54.1	100.0
Grayia spinosa	34.08	6.22	0.51	0.93	41.74	1.6	3.7
Krameria parvifolia	29.88	4.78	1.92	none	36.58	69.0	65.4
Larrea tridentata	13.52	3.76	1.50	1.57	20.35	33.6	62.2
Lycium andersonii	28.89	0.38	0.10	none	29.37	90.8	75.6
L. pallidum	18.68	0.01	0.03	none	18.72	36.3	66.0
Totals	153.34	20.20	4.88	2.63	181.05	352.6	66.1

Table 26. Estimates of net production by shrubs in Rock Valley for the years 1971-74, and allocations of production (%) among various plant parts

Year	Total net production by shrubs (kg/ha)	New leaves	New stems	Flowers	Fruits
1971	157	76.2	11.7	5.1	7.0
1972	183	62.9	14.6	11.3	11.2
1973	573	44.9	25.2	13.9	16.0
1974	181	84.7	11.2	2.7	1.4

Net production by shrubs in 1974 was estimated (as in previous years) by computing ratios of weights of new shoots, leaves, flowers and fruits to weights of old live stems (W). Then:

$$P = aW + bW + cW + dW$$

with a, b, c and d the appropriate coefficients for new parts.

These coefficients were estimated from branches of shrubs collected in the field during April, May and June. Portions of most shrub species were collected at two times during the season and sampling dates were chosen so as to coincide with various phenological peaks. Samples collected from a given shrub species were usually taken from 15-20 individuals and the total oven-dry weight of material ranged from around 0.5 kg (*Krameria parvifolia*) to over 2.5 kg (*Larrea tridentata*). This material was brought into the laboratory and separated into old live stems, dead wood, new stems, new leaves and (if present) flowers and fruits. Old leaves of *Larrea* were not included in estimates of new leaf production. All tissues were oven-dried and weighed.

Table 23 gives collection data for seven shrub species during 1974. The amounts of dead wood (relative to live material) in the samples represented in this table are not the same as those given previously (Turner et al. 1973:106) because samples used to estimate new production are selected living portions of plants, rather than the entire shrubs. For example, when entire *Larrea* bushes were dismantled, dead material made up about 69% of the total shrub weight. On the other hand, the material collected to estimate new production by this species in 1974 contained only about 11% dead material. Coefficients for flowers and fruits were computed from sampling data taken at the time of maximum development of these parts. If leaves and stems were collected at more than one time and the ratios of weights of new stems and leaves to old live stem weight were essentially the same (e.g., *Larrea tridentata*), new stem and leaf coefficients were based on combined samples. If ratios of weights of new stems and leaves to old live stem weight were higher at the second sampling, ratios were computed only from the data acquired at the later date (e.g., *Ambrosia dumosa*). (Table 24 gives coefficients derived from data in Table 23. Note that virtually no fruits were produced by *Ephedra nevadensis*, *Krameria parvifolia*, *Lycium andersonii* and *Lycium pallidum*. The few flowers produced by these species generally withered and fell without further development.

Table 25 summarizes estimates of net production by seven species of Rock Valley shrubs during 1974. Productivity by shrubs in 1974 was close to that observed in 1971 and 1972 and was distributed among various plant parts in a manner similar to that observed in those years (Table 26). Production of flowers and fruits was the lowest observed in four years. During drier years we may expect about 60-80% of the new production to be invested in new leaves, but in exceptionally good years this proportion is much lower. There is more variability between shrubs of the same species in a poor year than in a good year. Among the species studied in Rock Valley, the two species of *Lycium* show the greatest variation between individuals -- in terms of flowering, fruiting and total productivity.

Phenological observations of shrubs in Zones 20 and 24 were carried out in 1974 as in previous years (A3UTJ23). In both zones, from 15 to 20 individuals of each shrub species were marked and numbered. The proportions of shrubs in each phenophase were recorded every week during the growing season. The phenologies of shrubs in Zone 20 are indicated in Table 27; those of shrubs in Zone 24 in Table 28. Two or more dates are given for some of the phenophases in these tables. A pair of dates generally indicates the beginning and end of the phase in question. When phases were interrupted and resumed later in the season, another set of dates may be given. In the "fruit" phenophase, the second date is the time of mature fruit. The second date in the "color change" phase refers to the time of a definite change in leaf or stem color. The second date in the "leaf fall" phase indicates a change in the rate of fall. The "flower dying" category indicates flowers that died and did not produce fruit.

Table 27. Phenology of five important perennials in Zone 10 of the Rock Valley site in 1974

Phase	Ambrosia dumosa	Ephedra nevadensis	Krameria parvifolia	Larrea tridentata	Lycium andersonii
Leaf bud	Feb 25 Apr 13 Aug 7 Aug 20	Mar 11 Apr 25	Mar 26 May 10	Mar 18 May 2 Jul 29 Aug 7	Feb 4 Apr 18 Jul 29 Aug 7
Leaf	Feb 25 May 2 Aug 20		Apr 2 May 20	Mar 18 May 20 Jul 29 Aug 7	Feb 15 Apr 25 Aug 7
Stem	Mar 18 May 2	Mar 18 May 2	Apr 2 May 28	Mar 26 May 20 Aug 7 Sep 3	Mar 11 Apr 25
Flower bud	Apr 2 May 10	Mar 18 Apr 25	Apr 25 May 20	Mar 26 May 28	Mar 18 Apr 25
Flower	May 2 May 20	Apr 25	May 10 May 28	May 10 May 28	Apr 2 May 2
Flower dying	May 20 May 28	May 2	May 20 Jun 4	May 28 Jun 4	Apr 2 May 10
Fruit	May 10 May 28		May 20 May 28	May 20 Jun 28	Apr 13 May 2
Fruit fall	May 28 Jun 4		May 28 Jun 4*	Jun 28 Jul 16	May 2 May 10*
Color change	Apr 25 Sep 17	May 10 Sep 17 Nov 8	Jul 16 Sep 3	May 2 Oct 16	Apr 25 Sep 3
Leaf fall	May 20 Oct 1		Jul 16 Sep 3	May 2 Oct 16	Apr 25 Sep 3
Dormant	Jul 29 Oct 1 Nov 25		Nov 8 Dec 30		Jun 28 Jul 16 Sep 3 Sep 17

* Immature.

Table 28. Phenology of six important perennials in Zone 24 of the Rock Valley site in 1974

Phase	Ambrosia dumosa	Ephedra nevadensis	Grayia spinosa	Krameria parvifolia	Larrea tridentata	Lycium pallidum
Leaf bud		Mar 11 Apr 25	Feb 4 Apr 2	Apr 2 May 10	Mar 18 Apr 13 Jul 29	Jan 25 Mar 18 Jul 29 Aug 20
Leaf	Feb 25 Apr 13 Jul 29 Aug 20		Feb 25 Apr 13	Apr 2 May 20 Aug 7	Mar 18 May 20 Jul 29	Feb 4 Apr 2 Aug 7 Aug 20
Stem	Mar 11 Apr 25	Apr 2 Apr 25	Mar 11 Apr 13	Apr 13 May 28	Mar 26 May 28 Aug 7	Mar 11 Apr 2
Flower bud	Apr 2 May 28	none	Feb 25 Apr 2	Apr 25 May 20	Mar 26 May 20	Mar 11 Apr 2
Flower	May 2 May 10**	none	Mar 18 Apr 13	May 10 May 28**	May 10 May 20	Mar 26 Apr 2
Flower dying	May 20		Apr 13 May 10	May 20 Jun 4**	May 20 May 28	Mar 26 Apr 13
Fruit	May 10 May 20	none	Mar 26 Apr 25	May 28	May 20 Jun 28	Apr 2**
Fruit fall	May 20 May 28		Apr 25 May 20	Jun 4*	Jun 28 Jul 16	Apr 13*
Color change	Apr 13 Oct 1	May 10 Jul 16 Nov 8	Apr 25	Jul 16 Sep 3	May 10 Nov 8	Apr 13
Leaf fall	Apr 25 Nov 8		Apr 25	Jul 16 Sep 3	May 10 Nov 8	Apr 13 Aug 7
Dormant			Jul 16 Jul 29	Dec 17		Jun 4 Jul 16 Sep 3 Sep 17

* Immature.
** Rare.

In general, the 1974 spring growing season was poor in terms of flower and fruit production. Few *Lycium andersonii* produced flowers and *Ephedra nevadensis* produced virtually no new stems or flowers. Flower buds of *Ambrosia dumosa* generally dried up and only a few shrubs produced flowers and fruit. Fifteen of 20 *Lycium pallidum* produced flower buds, but most withered. Only two of 20 shrubs produced a few flowers. *Krameria parvifolia* produced a few flowers which usually dried. The few remaining fruits were converted to insect galls. Only *Grayia spinosa* and *Larrea tridentata* were able to produce moderate numbers of fruit.

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INVERTEBRATES

Ground-Dwelling Arthropods

E. L. Sleeper and D. B. Thomas

Arthropods were trapped in four areas during 1974 (A3UTJ30). The pitfalls in Plots 11 and 12 were used as in previous seasons. These are in 0.8-ha grids of 50 traps each on the validation site. Traps were activated during week 10 for a total of 5600 trap nights. All data used in density analyses were taken in Plots 11 and 12. Two new plots (70 and 71) were installed immediately adjacent to the site (see Fig. 1). Each of these circular plots had an area of 100 m^2 and contained 22 equidistantly placed pitfalls (trap interval $\sim$2.3 m) of the same type utilized in Plots 11 and 12. Plot 70 was immediately adjacent to Zone 20 of the site (Fig. 2). Plot 71 was adjacent to Zones 22 and 23. Plots 70 and 71 were set up as extinction-exclusion plots. Everything taken in the pitfall traps was removed and immigrants were excluded. None of the material removed was used in the capture-recapture studies but selected species were retained for weighing. Plots 70 and 71 were activated at the beginning of week 13 and were operated for the remainder of 1974. All data from all of the plots were recorded on IBM cards and stored on tape.

Table 29 summarizes numbers of arthropods (other than tenebrionid beetles) taken in pitfall traps in Plots 11 and 12 between 1971-74. The numbers captured in 1974 were generally less than those taken in other years. Exceptions were some spiders which are general predators not dependent upon specific food sources. The total for 1974 was only 14% of the largest yearly take (1973). The miscellaneous category (excluding 1973) contains many volant species which used the pitfalls as temporary shelter. Lepidopterous larvae of the families Sphingidae, Nymphalidae and Phalaenidae were encountered in large numbers in 1973 only. These families normally prefer annuals rather than shrubs.

There was a general trend toward later first appearance in 1974. Among detritivores, seven were later, one earlier and two about the same. Three predators were later, one earlier and two about the same. Two herbivorous forms appeared later. The later activity of the herbivorous forms cannot be attributed to plant phenology, because plant development was slightly accelerated relative to 1973. Although most species were apparently late in beginning activities, many were active later in the year. Most species were still present during the last two weeks of trapping effort.

Table 30 gives a breakdown of numbers of various species of tenebrionid beetles taken in Plots 11 and 12 between 1971 and 1974. Here again, numbers taken in 1974 were obviously reduced.

Table 31 gives seasonal activity intervals and associated trapping indexes (*I*) for arthropods other than beetles in Plots 11 and 12. Data are summarized for the years 1971-74. The indexes were calculated as follows:

Table 29. Total captures of arthropods (not including tenebrionids) taken in pitfall traps in Plots 11 and 12 during 1971-74

Taxon	1971	1972	1973	1974
Venezillo arizonicus	218	221	225	35
Scolopendra michelbacheri	23	29	19	21
Hadrurus arizonensis	35	36	46	17
Vejovis spp.	59	32	23	8
Eremobatidae	30	52	115	83
Psilochorus utahensis	204	320	216	51
Syspira synthetica	46	47	66	49
Apollophanes texanus	10	37	18	25
Loxosceles unicolor	5	3	1	0
Marpissa californica	4	35	19	11
Arenivaga sp.	28	26	17	27
Ceuthophilus fossor	37	40	30	33
Mutillidae	61	88	83	24
Reduvius sonoraensis	50	31	16	5
Herpyllus hesperolus	25	37	38	31
Eucyllus vagans	6	10	69	14
Miloderes sp.	10	21	28	14
Ophryastes varius	3	17	24	3
Calosoma sp.	0	0	103	0
Miscellaneous	391	777	4965	405
Totals	854	1859	6121	861

Table 30. Captures of tenebrionid beetles in pitfall traps in Plots 11 and 12, 1971-74

Species	1971	1972	1973	1974
Cryptoglossa verrucosa	109	95	82	69
Centrioptera muricata	81	84	266	22
Trogloderus costatus	87	73	93	16
Eleodes armata	34	29	30	18
Araeoschizus sulcicollis	122	183	196	59
Conibiosoma elongatum	11	24	21	19
Edrotes ventriocosus	32	33	20	17
Eusattus dubius	3	9	24	8
Asidina semilaevis	46	21	23	21
Philolithus pantex	15	19	19	15
Triorophus laevis	201	66	30	16
Metoponium sp.	11	22	9	8
Alaephus nevadensis	0	4	0	1
Eleodes grandicollis	4	0	5	1
Eupsophulus castaneus	1	0	0	1
Notibius puberulus	0	0	0	1
Helops attenuatus	0	0	3	0
Hylocrinus laborans	0	0	2	0
Trichiasida acerba	0	1	0	0
Anepsius brunneus	2	2	0	0
Auchmobius subboreus	9	13	1	0
Larvae	8	7	4	0
Totals	776	685	828	292

$$I = 100C/TN$$

with C the number of captures (see Table 29) and TN the number of trap nights registered during the time that a species was susceptible to trapping. For example, 33 *Ceuthophilus fossor* were taken between weeks 10 and 37, during which time 5600 trap nights accrued. Then:

$$I = 3300/5600$$

or 0.59. These trapping indexes are approximate measures of relative abundance during different years. Some of the arthropods in Table 31 (*Psilochorus utahensis*, *Hadrurus arizonensis* and *Venezillo arizonicus*) exhibited conspicuously lower trapping indexes in 1974 than during 1971-73.

The detritivorous camel cricket, *Ceuthophilus fossor*, remained at about the same level as recorded in Plots 11 and 12 in 1973 (Tables 29 and 31). As in previous years, more than 90% of individuals taken during the study period were adults. The pitfalls were opened for 2600 TN during October through December 1973, and for 800 TN from January through February 1974. During these periods, first and second instar nymphs were trapped during October, second and third in November, second, third and fourth in December, and third and fourth in January and February. No fifth instar individuals were encountered. Individuals taken from pitfall traps between October and December were preserved in alcohol. All specimens encountered in January and February were released. The population might have increased in 1974 if young had not been removed during late 1973. The apparently lower numbers in 1973 and 1974 may reflect soil moisture conditions. In 1972 (during the critical post-oviposition and diapause period from August through mid-September), soil moisture was higher than in 1971 or 1973. This higher moisture level may have prevented the essential desiccation and subsequent deterioration of the waxy coat over the exterior of the egg. This combination of factors would hinder embryonic development subsequent to diapause and successful hatching of eggs. The apparently low population in 1974 may reflect a paucity of reproducing adults in 1973.

Table 31. Seasonal activity intervals and trapping indexes for selected arthropods. Data for the years 1971-74 are given serially for each taxon

Taxa	Weeks active	Trap nights (hundreds)	Trapping index (I)	Food habits
ORTHOPTERA				
Ceuthophilus	16-38	44	0.84	Facultative
fossor	10-36	54	0.74	detritivore
	10-35	52	0.58	
	10-37	56	0.59	
Arenivaga sp.	21-38	36	0.78	Detritivore
	11-38	56	0.46	
	17-34	36	0.47	
	20-37	36	0.75	
ARANEIDA	–	–	–	
Apollophanes	10-32	46	0.80	Predator
texanus	11-33	46	0.39	
	10-23	28	0.89	
Psilochorus	16-38	46	4.43	Predator
utahensis	11-38	56	5.71	
	10-39	60	3.60	
	18-32	30	1.70	
Syspira spp.	19-37	38	1.22	Predator
	16-38	46	1.02	
	20-37	36	1.83	
	14-37	48	1.02	
SOLPUGIDA				
Eremobatidae	16-38	46	0.65	Predators
	12-38	52	1.00	
	10-37	56	2.05	
	13-36	48	1.73	
SCORPIONIDA				
Hadrurus	19-37	38	0.92	Predator
arizonensis	20-36	34	1.05	
	15-36	44	1.05	
	26-37	24	0.71	
ISOPODA				
Venezillo	16-38	46	4.74	Detritivore
arizonicus	12-38	54	4.09	
	11-39	58	3.88	
	19-37	38	0.92	
CHILOPODA				
Scolopendra	16-37	44	0.52	Predator
michelbacheri	10-38	58	0.50	
	12-37	52	0.36	
	13-34	44	0.48	

The detritivorous desert cockroach (*Arenivaga* sp.) apparently increased in abundance in 1974 (Tables 29, 31). This agrees with our earlier supposition that cooler, wetter weather during the critical months of January through March may strongly influence the first appearance and successful survival of this species. It is possible that cold, wet weather suppresses hatching and survival of early instars. Females of *Arenivaga* may overwinter and continue oviposition between December and March. Four female adults of 17 marked in October and November 1973, were retaken in December and February 1973-74. One unmarked female taken in mid-December was found with an egg case, which was released two days later. Most individuals taken in pitfall traps are late instars or adults, so early instars may be relatively immobile. First instar nymphs were taken by sifting beneath the bases of *Larrea* and *Atriplex* from March through May. Second and third instars were encountered in April-June.

The assassin bug (*Reduvius* sp.), which apparently declined in 1973, continued to diminish in numbers (Table 29), even though its major prey increased in abundance. No individuals were taken in the pitfall traps.

The ground beetle (*Calosoma* sp.) did not appear in large numbers in 1974 (Table 29). Two individuals were encountered in pitfall trapping and several others were observed scurrying over the surface of the ground. This mobile, opportunistic predator was an abundant transient in 1973 because of the abundance of suitable lepidopteran prey.

The spider, *Apollophanes texanus*, may have increased in abundance in 1974 (Tables 29, 31). However, this species has not approached the apparent abundance of the other two spiders listed in Table 31. *Psilochorus* is the most frequently trapped predatory spider in Rock Valley. In 1974, the apparent abundance of *Psilochorus* declined to about 47% of the 1973 level (Table 31). Numbers of the spider (*Syspira*) trapped also declined.

Trapping indexes of the remaining predators -- a scorpion, the solpugids (a complex of species) and a centipede -- were down 16%, down 32%, and up 1.33 times respectively. The first two (both arachnids) have higher moisture requirements and tend to be more quiescent in drier seasons. Both require large amounts of prey for normal activities.

The centipede (*Scolopendra michelbacheri*) has certain anatomical and physiological advantages over arachnids. These are the more efficient cuticle (higher transition temperature), the different type of respiratory system, and the strikingly different digestive tract. These enable the centipede to survive very dry periods. They have also been shown to have a greater foraging range in drier seasons. This latter factor may have been related to the more frequent trappings of these animals.

The activity of the isopod detritivore (*Venezillo arizonensis*) was dramatically reduced in 1974. The 1974 trapping index was only 24% of that in 1973. The reduced precipitation undoubtedly had the greatest influence on activity. Due to the moisture requirements of the respiratory system, the activities of this species are inhibited during prolonged dry periods.

Absolute densities of five tenebrionid beetles (*Asidina semilaevis*, *Centrioptera muricata*, *Cryptoglossa verrucosa*, *Eleodes armata* and *Trogloderus costatus*) were estimated for the years 1971-73 from capture-recapture data using a formula given by Overton and Davis (1969):

$$N = n/[1-(n/t)]$$

Here n is the total number of different individuals captured and t the total number of captures (i.e., all initial captures and recaptures combined). These data were given by Sleeper and Thomas (1974:38). In the 1974 report, data for *Asidina semilaevis* and *Eleodes armata* were drawn from Plots 1, 2, 11 and 12. In Table 32, we present data for the five species (for Plots 11 and 12 only) for the years 1971-74. Except for one *Cryptoglossa*, none of these beetles was captured in 1974.

Table 33 summarizes trapping data for six additional species of tenebrionid beetles for which capture-recapture data were lacking. Here we give data for the years 1971-73 as well as new information for 1974. In general, beetles were less abundant (or less commonly trapped) in 1974. Many of the trapping indexes showed sharp reductions relative to previous years (e.g., *Triorophus*, *Trogloderus*, *Araeoschizus*, *Centrioptera* and *Cryptoglossa*).

Araeoschizus sulcicollis, an ant mutualant, reached its apparent peak in 1973, and declined in 1974. This species is active throughout the season in Rock Valley. Temperatures do not seem to affect its activity. It is the second most frequently trapped darkling beetle in Rock Valley. Sleeper observed this beetle being groomed by ants of the genus *Crematogaster* in April 1975.

Other detritivores apparently declined from 26-90%, but the abundance of *Centrioptera muricata* was only 10% of numbers taken in 1973. In 1973, 311 individuals were taken in pitfall traps, but only 22 were captured in 1974. Thomas (1975) pointed out that "the sudden drop in abundance that occurred in 1974 was preceded by the only year in which the late summer rains failed . . . It also seemed apparent that the very high abundance (capture success is used here as an index of abundance) that was observed in the summer of 1973 was traceable to the high quantities of precipitation that fell the previous winter and spring. Further resolution was obtained from the 1974 data where it became apparent that it was the spring precipitation that was important since heavy winter rains during 73-74 did not prevent the crash that occurred the following summer."

Table 34 summarizes monthly captures of arthropods in Plots 70 and 71. The traps in these plots were used for a total of 12,320 trapnights. Because trapping did not begin until week 13 (March 26), numbers of some species may be lower

Table 32. Capture-recapture data and density estimates for five tenebrionid beetles taken in Plots 11 and 12 between 1971-74. The trapping area for Plots 11 and 12 is 1.6 ha

Species	Year	*n*	*t*	Density (n/ha)	Trapping index (*I*)
Asidina semilaevis	1971	46	48	685	3.29
	1972	21	22	288	2.10
	1973	23	24	342	2.40
	1974	21	21	--	1.75
Centrioptera muricata	1971	81	96	324	2.25
	1972	84	100	328	2.33
	1973	266	311	1147	5.78
	1974	22	22	--	0.69
Cryptoglossa verrucosa	1971	109	16	532	2.73
	1972	95	102	865	2.26
	1973	82	87	892	1.86
	1974	63	64	394	1.58
Eleodes armata	1971	34	38	204	0.77
	1972	29	31	281	0.50
	1973	30	31	582	0.56
	1974	8	8	--	0.39
Trogloderus costatus	1971	87	92	1001	1.89
	1972	73	76	1156	1.83
	1973	93	95	2761	1.79
	1974	16	16	--	0.62

Table 33. Seasonal activity intervals and trapping indexes for six tenebrionid beetles captured in Plots 11 and 12 between 1971-74. Data for the four years are given serially for each species

Taxa	Weeks active	Trap nights (hundreds)	Trapping index (*I*)
Araeoschizus sulcicollis	16-38	44	2.77
	10-38	58	3.15
	15-39	50	3.92
	11-37	54	1.09
Conibiosoma elongatum	16-38	48	0.23
	10-34	50	0.48
	16-39	48	0.44
	14-37	48	0.40
Edrotes ventricosus	24-38	30	1.07
	22-38	34	0.97
	18-39	44	0.45
	22-36	30	0.57
Eusattus dubius	17-27	22	0.14
	11-22	24	0.38
	11-23	26	0.92
	14-28	30	0.27
Metoponium sp.	16-34	38	0.29
	14-36	46	0.48
	17-36	40	0.23
	26-35	20	0.40
Triorophus laevis	16-34	38	5.28
	13-32	60	1.65
	11-36	52	0.58
	14-33	40	0.40

than they would have been had recording begun earlier in the year (e.g., *Eucyllus vagans*, *Miloderes mercuryensis*).

The species listed in Table 34 are those represented by at least 18 individuals taken during 1974. The larger tenebrionid beetles (*Asidina*, *Centrioptera*, *Cryptoglossa* and *Eleodes armata*) were each represented by three individuals taken during the entire 1974 sampling effort. Three individuals taken from an area of 200 m^2 would imply minimum densities of around 150/ha. This figure is less than indirectly estimated densities for these species between 1971 and 1974 (see Table 32). However, far fewer tenebrionid beetles were collected in 1974 relative to previous years (Table 30). Also, *Cryptoglossa verrucosa* and *Centrioptera muricata* would not be expected to occur in large numbers in Plots 70 and 71, for the gravelly soils of the enclosures are not favored by these species (Turner et al. 1972:44). The minimum density of *Trogloderus costatus* in Plots 70 and 71 (900/ha) is not greatly different from densities estimated indirectly in 1971 and 1972 in Plots 11 and 12 (1001/ha and 1156/ha), but less than the estimated 1973 density of 2761/ha. Recall that 1973 was an exceptionally good year (Table 30).

The minimum densities of the smaller (< 10 mm) tenebrionids (e.g., *Araeoschizus*, *Conibiosoma*, *Eusattus*, *Metoponium*) in Plots 70 and 71 are generally a great deal higher than indirectly estimated densities of larger tenebrionids (Table 32). Whether these are simply interspecific differences, or due to differences in techniques of estimation is not known. One might first inquire as to whether the differences could be due to increased trapping efficiency in the enclosures. Table 35 compares trapping indexes in Plots 70 and 71 and Plots 11 and 12 for 11 taxa. Some trapping indexes in Plots 70 and 71 are notably higher than those in the bigger plots (e.g., *Conibiosoma*, *Eusattus*, *Metoponium*), but we judge from Table 35 that differences in trapping efficiency (i.e., take per trap effort) were not enormously better in Plots 70 and 71 relative to Plots 11 and 12.

There may be an effect arising from the areas of reference ascribed to the trapping grids. In Plots 70 and 71, the 44 traps clearly sampled no more than 200 m^2 because the areas were enclosed. In Plots 11 and 12, it was assumed that the 50 traps in each plot sampled an area of about 0.8 ha. Tables 33 and 34 imply that the traps in Plots 11 and 12 were, in actuality, sampling much smaller areas. Thomas (1975) commented on this problem: ". . . the distance between traps should be less than the distance normally traveled by an individual of the population at risk during a trap period. Some scorpions, for example, do not travel more than a few meters per night . . . hence, traps 15 meters apart [as in Plots 11 and 12] run for only one night would not sample a portion of such a population." It is likely that traps spaced at 15-m intervals capture only fractions of total populations, but we are still unaware of how small these fractions may be.

Table 34. Monthly and total captures of major arthropod species in Plots 70 and 71 during 1974. Each plot has an area of 100 m^2

Taxon	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total captures	Minimum density (n/ha)
Scolopendra	1	6	0	4	3	6	0	1	1	0	22	1100
Venezillo	0	0	3	11	8	27	22	0	0	0	71	3550
Eremobatidae	7	42	32	39	29	29	4	10	23	6	221	11050
Vejovis	1	2	0	1	2	1	13	5	0	0	24	1200
Gnaphosidae	1	14	5	5	2	0	2	3	7	8	47	2350
Eucyllus vagans	3	35	3	4	2	0	0	1	2	1	51	2550
Ophryastes varius	0	10	12	24	12	9	4	5	0	0	76	3800
Ophryastes geminatus	6	32	30	16	1	0	0	0	0	0	84	4200
Miloderes	5	37	24	4	1	1	0	0	0	0	72	3600
Mutillidae	0	1	4	5	1	3	2	3	0	0	19	950
Araeoschizus	5	15	8	15	9	0	0	1	0	0	53	2650
Auchmobius	0	0	0	9	15	3	1	0	0	0	28	1400
Conibiosoma	1	48	18	18	8	12	19	7	0	0	131	6550
Edrotes	0	4	0	7	8	4	4	2	2	0	31	1550
Eusattus	6	39	30	21	0	0	0	0	0	0	96	4800
Metoponium	1	13	20	43	5	11	17	5	0	0	115	5750
Triorophus	1	5	7	6	18	15	5	1	0	0	58	2900
Trogloderus	2	2	1	1	2	2	4	4	0	0	18	900

Shrub-Dwelling Arthropods

E. L. Sleeper and M. E. Mispagel

Arthropods were taken from shrubs in Rock Valley by D-Vac as in previous years (A3UTJ34). Vacuum collections were made at regular intervals with 40 samples taken each week. The 24-hr sampling effort was discontinued. Sampling began in week 10 and was continued through week 35. A total of 1040 shrubs were vacuumed. Sampling effort was equally divided among *Ambrosia dumosa*, *Larrea tridentata*, *Lycium andersonii*, *Grayia spinosa* and *Krameria parvifolia*. These plants constitute nearly 80% of the cover in Rock Valley.

Overall Composition of the 1974 Collection

In 1974, 180 kinds of arthropods were collected by vacuuming in Rock Valley, fewer than encountered in previous years. Table 36 summarizes D-Vac data in terms of food habits and plant hosts. Only 16% of individuals taken could not be related to specific trophic function. Many insects unclassified as to food habits were either fungivores or nectarivores. Arthropods classified to trophic level and those unclassified may be fewer than the overall total, because some individuals were known to be nonfeeders (e.g., 17 specimens from *Larrea*). Comparison of Table 36 with comparable data given by Sleeper and Mispagel (1974: Table 3) shows that far fewer arthropods were taken from shrubs in Rock Valley in 1974 (2878) than in 1973 (12,618). More mites were taken from some shrub species in 1974, but other groups ranged from 17-41% of numbers taken in 1973. The sampling season in 1974 was two weeks shorter than in 1973 and 100 fewer samples were taken. However, we do not consider this to be the principal cause of the decline in 1974 numbers.

Table 35. Comparison of trapping indexes (*I*) of arthropods collected in Plots 11 and 12 and Plots 70 and 71 in 1974. Also given are the effective trap nights registered in Plots 70 and 71

Taxa	Effective trap nights (70, 71)	$\bar{I}$ (70, 71)	$\bar{I}$ (11, 12)
Venezillo	6776	1.05	0.92
Scolopendra	9856	0.43	0.48
Eremobatidae	11704	1.83	1.73
Mutillidae	9548	0.20	0.75
Eucyllus	7392	0.65	0.50
Araeoschizus	12056	0.40	1.09
Conibiosoma	8778	1.48	0.39
Edrotes	9856	0.31	0.57
Eusattus	4004	2.24	0.27
Metoponium	9548	1.20	0.35
Triorophus	8932	0.64	0.40

We observed apparent changes in relative proportions of certain categories of arthropods (values in parentheses in Table 36) relative to 1973. First, the relative abundance of insects to other arthropods declined from 98.5 to 85.2%. The relative abundance of mites increased over 10-fold. If the decline in relative abundance of insect predators and parasites between 1973 (4.8%) and 1974 (3.3%) was real, it was in large part due to the total absence of the beefly (*Mythicomyia*) from 1974 samples. The relative proportion of total phytophages decreased in 1974, primarily because of the dramatic decline in numbers of sap-feeders (85% of all

Table 36. Arthropods taken by vacuuming major shrubs in Rock Valley, Nevada, in 1974. Numbers indicated are totals for the season, with that total as a percentage of all arthropods taken on that shrub in parentheses

	SHRUB SPECIES					
	Larrea tridentata	Ambrosia dumosa	Lycium andersonii	Grayia spinosa	Krameria parvifolia	TOTALS
Total Arthropods	1994	455	113	102	214	2878
Total Insects	1650 (82.7)	443 (97.4)	95 (84.1)	91 (89.2)	173 (80.8)	2452 (85.2)
Mites	319 (16.0)	10 (2.2)	15 (13.3)	8 (7.8)	35 (16.4)	387 (13.4)
Spiders	25 (1.3)	2 (0.4)	3 (2.6)	3 (2.6)	6 (2.8)	39 (1.36)
All Predators & Parasites	158 (7.9)	19 (4.8)	15 (13.3)	11 (10.8)	28 (13.1)	231 (8.0)
Insect Predators & Parasites	53 (2.7)	15 (3.3)	8 (7.1)	6 (5.9)	13 (6.1)	95 (3.3)
Total Phytophages	1478 (73.9)	414 (91.0)	67 (59.3)	74 (72.5)	135 (63.1)	2168 (75.3)
Sap Feeders	1365 (68.5)	367 (80.7)	27 (23.9)	52 (51.0)	35 (16.4)	1846 (64.1)
Defoliators	113 (5.7)	47 (10.3)	40 (39.4)	22 (21.6)	100 (46.7)	322 (11.2)
Detritivores	4 (.20)	4 (.40)	2 (1.8)	0 (0.0)	15 (7.0)	25 (.86)
Unclassified to Trophic Level (insects)	98 (4.5)	1 (.22)	3 (2.6)	4 (3.9)	4 (1.9)	110 (3.8)
Unclassified to Trophic Level (mites)	239 (12.0)	8 (1.8)	4 (3.5)	6 (5.9)	26 (12.0)	283 (9.8)

Table 37. Analysis of the defoliators vacuumed from the major shrubs in Rock Valley in 1974. All forms consume solid plant material. The first line for each species of shrub is the percentage of the defoliating forms that this group represents on that shrub. The second line is the percentage of this group of total phytophages on the shrub

SHRUB SPECIES	Chrysomelidae	Curculionidae	Misc. Coleoptera	Total Coleoptera	Coleophoridae	Gelechiidae	Misc. Geometridae*	Phalaenidae	Yponomeutoidea	Misc. Lepidoptera Larvae	Total Lepidoptera Larvae *	Tanaocerus koebelei	Misc. Grasshoppers	Total Grasshoppers**	Misc. Gall-formers (Larvae)	Misc. Diptera	Misc. Hymenoptera	% defoliators of total Phytophagous Insects This shrub	Mites
Larrea tridentata	16.8	4.4	0.88	22.1	1.8	7.1	18.6	0.0	1.8	7.9	37.2	0.0	6.2	11.5	21.2	0.0	0.0	92.0	8.0
	1.3	0.3	0.1	1.7	0.1	0.5	1.4	0.0	0.1	0.6	2.8	0.0	0.5	0.9	1.6	0.0	0.0	7.0	0.6
Ambrosia dumosa	14.9	27.7	2.1	44.7	12.8	12.8	0.0	2.1	6.4	17.0	51.1	0.0	2.1	2.1	2.1	0.0	0.0	100.0	0.0
	1.7	3.1	0.2	5.1	1.4	1.4	0.0	0.2	0.7	1.9	5.8	0.0	0.2	0.2	0.2	0.0	0.0	11.4	0.0
Lycium andersonii	2.5	12.5	2.5	17.5	7.5	10.0	0.0	0.0	45.0	7.5	77.5	2.5	2.5	2.5	2.5	0.0	0.0	100.0	0.0
	1.5	7.5	1.5	10.4	4.5	4.5	6.0	0.0	26.7	4.5	46.3	0.0	1.5	1.5	1.5	0.0	0.0	59.7	0.0
Grayia spinosa	9.1	18.2	0.0	27.3	9.1	22.7	4.5	0.0	4.5	18.2	59.1	0.0	9.1	9.1	4.5	0.0	0.0	100.0	0.0
	2.7	5.4	0.0	8.1	2.7	6.8	1.4	0.0	1.4	5.4	17.6	0.0	2.7	2.7	1.4	0.0	0.0	29.8	0.0
Krameria parvifolia	0.0	2.0	9.0	11.0	1.0	2.0	2.0	3.0	72.0	1.0	81.0	1.0	1.0	2.0	2.0	0.0	2.0	98.0	2.0
	0.0	1.5	6.7	8.1	0.7	1.5	1.5	2.2	53.3	0.7	60.0	0.7	0.7	1.5	1.5	0.0	1.5	72.6	1.5

* This total includes the values for Semiothisa (from Larrea, with percentages of 17.7% and 1.4%

** This total includes the values for Bootettix (Acrididae) from Larrea, with percentages of 5.3% and 0.4%

Table 38. Analysis of the sap consumers vacuumed from the major shrubs in Rock Valley, Nevada, in 1974 only. These are divided into sap-sucking and the rasping forms (the latter thrips only). The first line for each species of shrub is the percentage of the sap-removing forms that this group represents on that shrub. The second line is the percentage this group is of the total phytophages on this shrub

SHRUB SPECIES	Lygaeidae	Miridae*	Misc. Hemiptera	All Hemiptera	Cicadellidae	Pseudococcidae	Misc. Homoptera	All Homoptera w/o Membracidae	Membracidae	Thysanoptera **	All Insects Sap-Sucking	All Insects this Shrub	All Arthropods this Shrub
Larrea tridentata	0.4	1.0	0.1	1.5	0.7	54.3	0.6	55.6	19.6	23.2	100.0	82.7	68.5
	0.4	0.9	0.1	1.4	0.7	50.1	0.5	51.4	18.1	21.4	92.4		
Ambrosia dumosa	0.3	0.5	0.0	0.8	1.9	15.8	0.5	18.2	----	80.9	100.0	82.8	80.7
	0.2	0.5	0.0	0.7	1.7	14.0	0.5	16.2	----	71.7	88.6		
Lycium andersonii	0.0	0.0	0.0	0.0	7.4	51.9	29.6	88.9	----	11.1	100.0	28.4	23.9
	0.0	0.0	0.0	0.0	3.0	20.9	11.9	35.8	----	4.4	40.3		
Grayia spinosa	1.9	0.0	0.0	1.9	0.0	63.5	3.8	67.3	----	30.8	100.0	57.1	51.0
	1.4	0.0	0.0	1.4	0.0	44.6	2.7	47.3	----	21.6	70.3		
Krameria parvifolia	0.0	2.9	8.6	11.4	5.7	34.3	14.3	54.3	----	34.3	100.0	20.2	16.4
	0.0	0.7	2.2	3.0	1.5	8.9	3.7	14.1	----	8.9	25.9		

* This percentage includes Phytocoris with values of 0.4 and 0.3 on Larrea only.

** Approximately 64% of the Thysanoptera were vacuumed during weeks 19-22.

Table 39. Proportions (%) of six groups of arthropods made up of membracids on *Larrea tridentata* in Rock Valley during 1974

Groups	Immatures	Centrodontus atlas	Multareoides bifurcatus	Multareis cornutus
Sap-feeders	18.0	0.5	0.6	0.5
Phytophages	16.6	0.5	0.5	0.5
Membracids	91.8	2.6	3.0	2.6
Homoptera	24.0	0.7	0.8	0.7
All insects	15.0	0.4	0.5	0.4
All arthropods	12.3	0.3	0.4	0.3

arthropods taken in 1973; 64% in 1974). Because of the reduction in numbers of sap-feeders, relative abundances of delfoliators and detritivores increased in 1974.

Defoliating Arthropods

Table 37 gives information relating to various defoliators collected during 1974. Defoliators are external consumers of solid food. These figures may be compared with comparable data given by Sleeper and Mispagel (1974:Table 4) for 1973. Relatively more defoliators were taken in 1974 (11.2%) than in 1973 (6.9%), but this was due to increases in relative numbers of larvae of the Gelechiidae and Coleophoridae, along with several other small families of lepidopterans. Larger larvae (e.g., cutworms and measuring worms, including *Semiothisa larreana*) were relatively less abundant.

Sap-Feeding Arthropods

In this report the term sap-feeder pertains to forms consuming almost exclusively fluids from shrubs. Tables 38 and 39 give the relative abundances of sap-feeding arthropods in Rock Valley during 1974. Comparable data for 1973 were given by Sleeper and Mispagel (1974:Table 5).

We have already commented on the sharp decline in relative abundance of sap-feeders in 1974. The relative abundance of hemipterans was greatly reduced in 1974, primarily because of the virtual disappearance of the lygaeid (*Nysius ericae*) so common in 1973. This bug has a very high reproductive potential and, while normally associated with annuals, will move to shrubs if a shortage of suitable food occurs. It frequently experiences enormous population increases when conditions permit.

The most conspicuous change in apparent abundances of various homopterans was the large relative increase (during 1974) of mealybugs collected from shrubs, particularly *Larrea tridentata* (Table 40). Saunier et al. (1968) have shown that: ". . . during water stress, protein synthesis [by shrubs] is slowed and proteolysis may occur, promoting an increase in . . . soluble nitrogen compounds such as amino acids, amides, and soluble proteins," and that there is an ". . . increased foliar accumulation . . . of proline and certain amino acids . . ." A large amount of sap removed by mealybugs and related groups is shunted past the main portion of the digestive tract after the nitrogenous compounds have been largely removed. White (1969) examined the relationship of psyllid outbreaks in Australia to weather-induced stress on plants. He pointed out that: "Known outbreaks of psyllids throughout Australia were strongly correlated with the sudden increasing high levels of this stress index. It is postulated that physiological stress of plants at these times increased the amount of nitrogenous food available to the psyllids, thus greatly increasing the chances of young surviving and reproducing." As shrubs in Rock Valley experience water stress they may become more attractive to mealybugs and survival of immature stages may be enhanced. We will return to these points later in a discussion of seasonal and annual changes in abundances of insects on *Larrea tridentata*.

The total number of leafhoppers (Cicadellidae) taken on shrubs in Rock Valley during 1974 was about 44% less than during 1973. The relative frequencies of these insects on various host shrubs were about the same as in 1973, though relatively more individuals were taken on *Ambrosia* and *Krameria* during 1974. According to Parker (1974), leafhoppers move to the undersides of leaves as the environment becomes drier. Leafhoppers may remain in these somewhat more humid situations for extended periods of time, but when conditions become too unfavorable (e.g., after leaf fall) they retreat to burrows at the bases of host shrubs. This may explain many of the captures of leafhoppers in pitfall traps in some years.

Thrips (Thysanoptera) generally occur on flowers in Rock Valley. Occasionally a predatory form is taken. In 1973, 1148 thrips were vacuumed from *Larrea* and more than 5800 from *Ambrosia*. In 1974, however, the number of thrips taken was only a small fraction of those collected in previous years. Fennah (1963) discussed some of the nutritional factors influencing thrips populations. Changes in chemical composition of saps or nectars associated with varying plant water balances may have important bearings on dynamics of thrips populations.

Insect Predators and Parasites

The relative abundance of these groups fell from 4.8% (of all arthropods vacuumed in 1973) to 3.3% in 1974. As mentioned previously, the beefly (*Mythicomyia*) was implicated in this decline. Figures 11 and 12 give data for all parasites and for *Mythicomyia* between 1971-74. Among parasitic groups in 1974, the Tachinidae, Braconidae and Ichneumonidae were only 5%, 32% and 10%, respectively, of 1973 levels. Other hymenopterous families were greatly reduced relative to 1973 abundances: Encyrtidae (—32%), Eulophidae (—41%), Myrmaridae (—26%) and Pteromalidae (—10%). Several families present in 1973 were not represented in 1974 samples. We judge the decline in numbers of parasites in 1974 to be linked to similar reductions in many of the hosts of these species.

Table 40. Numbers of mealybugs (Pseudococcidae) taken from shrubs in Rock Valley during 1973 and 1974

Shrub species	1973	1974
Larrea tridentata	24	741
Ambrosia dumosa	20	58
Lycium andersonii	10	14
Grayia spinosa	6	33
Krameria parvifolia	0	12

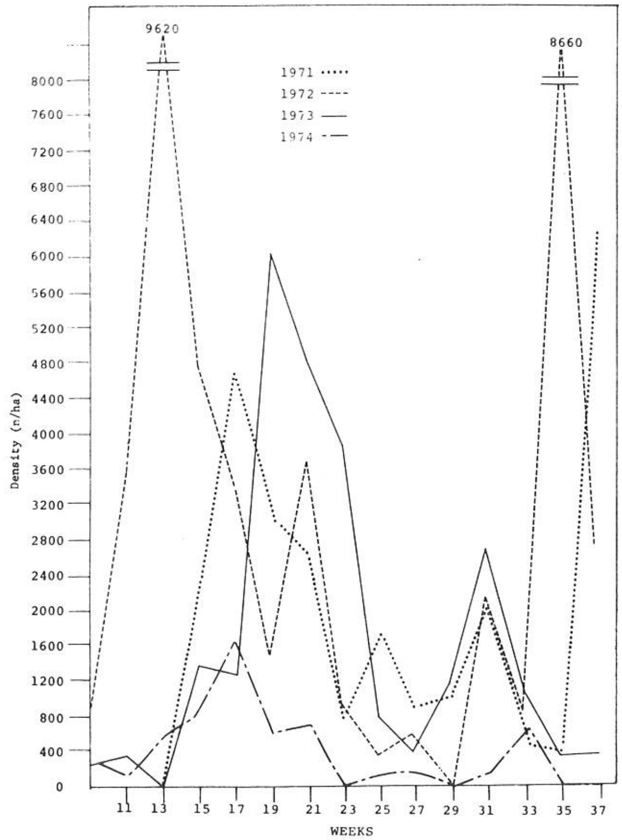

Figure 11. Estimated densities of all parasitic arthropods on shrubs in Plots 11 and 12 (Rock Valley), 1971-74.

Abundances of Arthropods on Larrea tridentata

Table 41 gives estimated combined densities of all phytophagous arthropods on *Larrea* between weeks 10 and 35 in 1974. Also given are estimated densities of all insects and all arthropods on this shrub. Data for weeks 11 through 33 were based on samples from 16 shrubs. Similar data were reported for 1973 (Sleeper and Mispagel 1974:42). Although the mean density of insects per week in 1974 (3915) was about the same as that in 1973 (3763), other components of Table 41 show declines relative to 1973.

Table 42 gives more detail regarding phytophagous species on *Larrea*. Nonfeeders in this table include nectarivores, pollinators, fungivores and adult forms which do not feed. A large proportion of the nonfeeders was made up of ants foraging on shrubs. The total phytophages include gall-forming types, stem borers, seed eaters, bud borers, etc., as well as defoliators and sap-feeders. Phytophagous types made up about 79% of all arthropods taken from *Larrea* in 1974 (Table 41). Sap-removing forms are by far the most abundant feeding types on *Larrea*, but this is not true of *Lycium andersonii* and *Krameria parvifolia*, where other types are more important.

Six groups of sap-removing arthropods are known to occur on *Larrea*: treehoppers (Membracidae), leafhoppers (Cicadellidae), mealybugs (Pseudococcidae), plant bugs (Miridae), thrips (Thysanoptera) and mites. Until 1974, treehoppers had been the only group of apparent significance -- in terms of amounts of sap removed. Numbers of thrips were sometimes enormous but their feeding activities were confined to flowers. In 1973, treehoppers made up 68% of the true sap-feeders (if thrips were excluded), but in 1974, treehoppers made up only about 20% of the sap-feeding types. As indicated earlier, the shift occurred because of the enormous numbers of mealybugs taken in 1974. In general, nymphs of three species (*Multareis cornutus*, *Centrodontus atlas* and *Multareoides bifurcatus*) were present in fairly large numbers (Fig. 13), but the numbers of adults taken were the lowest in four years of study (Fig. 14).

Phytophagous thrips were on *Larrea* in greatest numbers between the time of flower bud development (week 13) and when flowers started to die (week 23). Excluding thrips, other phytophages made up 79% of the total insects on *Larrea* and 65% of the total arthropods (cf. 74% and 71%, respectively, in 1973).

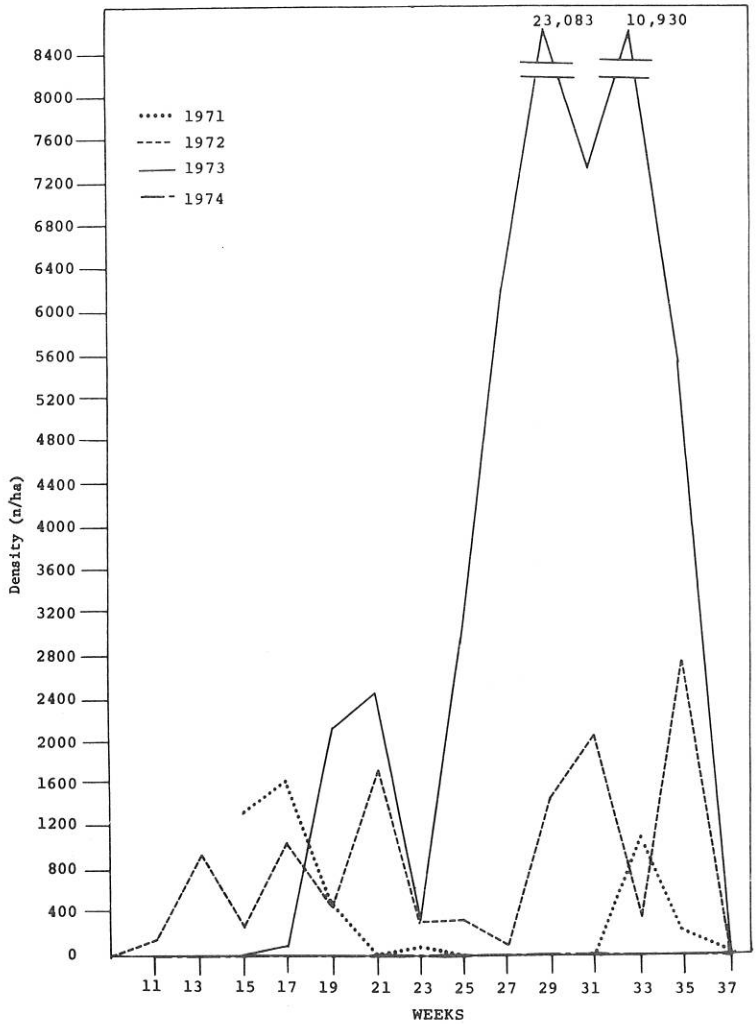

Figure 12. Estimated densities of bee-flies (*Mythicomyia* spp.) on shrubs in Plots 11 and 12 (Rock Valley), 1971-74.

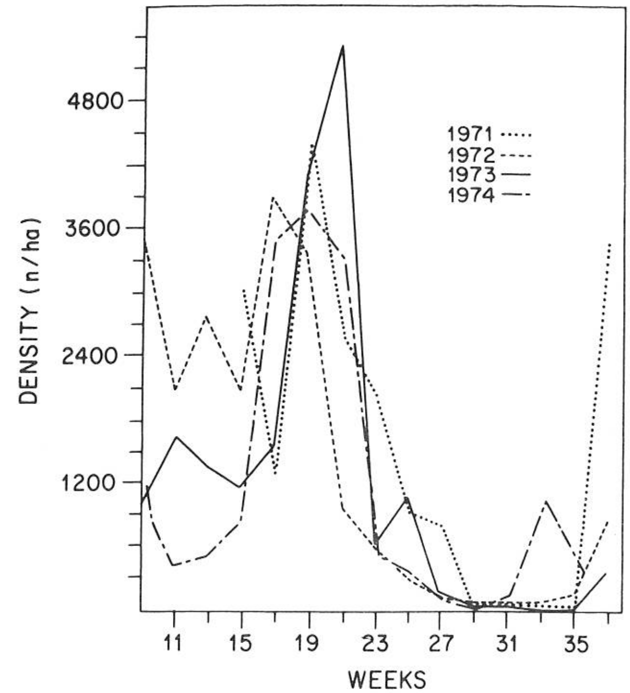

Figure 13. Estimated densities of immature stages of treehoppers (Membracidae) on *Larrea tridentata* in Plots 11 and 12 (Rock Valley), 1971-74.

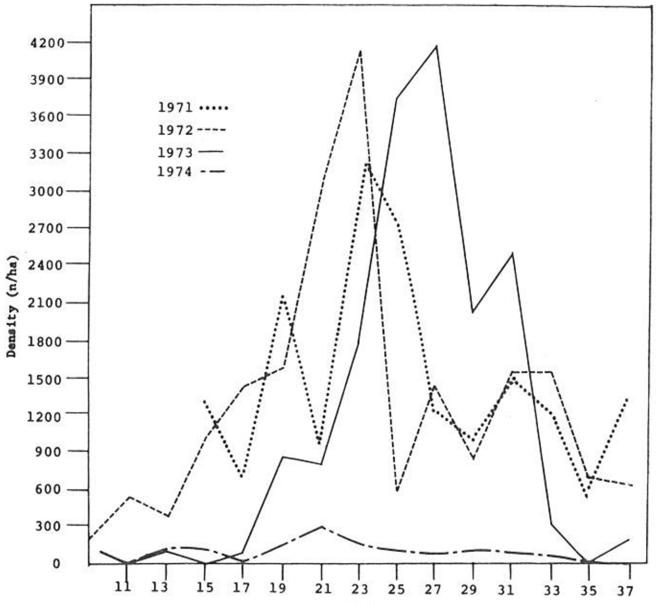

Figure 14. Estimated densities of adult treehoppers (Membracidae) on *Larrea tridentata* in Plots 11 and 12 (Rock Valley), 1971-74.

Figure 15 illustrates estimated densities (n/ha) of mealybugs taken from shrubs in Plots 11 and 12 between 1971 and 1974. White (1969) suggested that (for psyllids): ". . . wetter winters and drier summers lead to a positive stress index, and drier winters and wetter summers lead to a negative stress index."

This type of analysis may be done most effectively by comparing fluxes in numbers of mealybugs with changes in soil moisture content (a much better index of the likely physiological state of host shrubs). Preliminary work along these lines has indicated that the ups and downs illustrated in Figure 15 are inversely correlated with wetting and drying cycles of Rock Valley soils. For example, the very high density in the spring of 1974 occurred at about the time soil moisture contents began to fall (see Table 11).

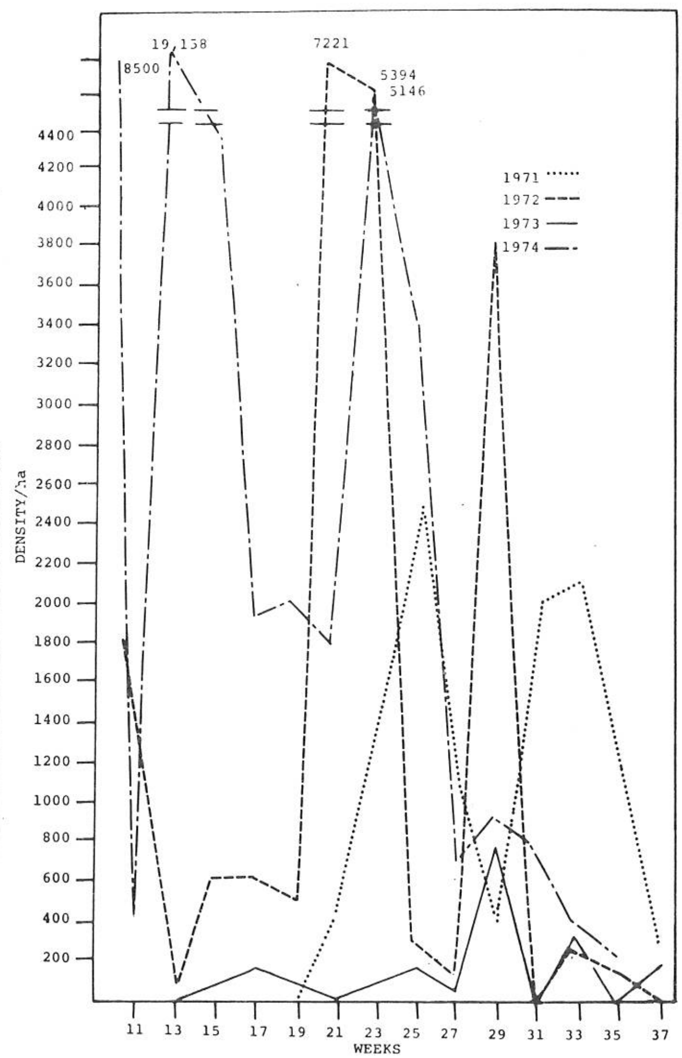

Figure 15. Estimated densities of mealybugs (Pseudococcidae) on shrubs in Plots 11 and 12 (Rock Valley), 1971-74.

Table 41. Relationship between numbers of phytophagous insects and total arthropods vacuumed from *Larrea tridentata*. Data based on samples taken in Plots 11 and 12 during 1974

Weeks	Total phytophages (n/ha)	Total insect phytophages (n/ha)	Total insects (n/ha)	Total insects other than thrips (n/ha)	Total arthropods (n/ha)
10	9875	9625	9750	9750	11625
11	1116	1116	1240	1240	1302
13	29388	29388	29760	20894	30070
15	6112	6112	6732	6422	6794
17	9490	9428	10644	8536	11474
19	8804	8370	9549	8185	15314
21	12477	12040	12474	6584	19268
23	6805	6368	6368	5872	11054
25	4712	4712	4898	4712	5084
27	992	992	1488	1488	1612
29	1674	1674	1860	1798	2108
31	2046	1984	2170	2108	2852
33	2666	2604	2914	2914	3100
35	1450	1450	1950	1825	2325
Mean total numbers (ha^{-1} $week^{-1}$)	3754	3687	3915	3163	4768
Mean total numbers ($shrub^{-1}$ $week^{-1}$)	3.8	3.7	3.9	3.2	4.7

Table 42. Densities of phytophagous arthropods vacuumed from *Larrea* in Plots 11 and 12 during 1974. The nonfeeding forms (all adults, that do not feed after reaching maturity) are for comparison

Weeks	Defoliators n/ha	Sap-removers n/ha	Total phytophages n/ha	Non-feeders n/ha
10	0	9625[p]	9875	0
11	124	930	1116	0
13	310	20026[p]	29388[pt]	0
15	62	5678[p]	6112	62[a]
17	252	6138	9490	124[a]
19	682	6262	8804	558[a]
21	806	5282	12477[t]	0
23	62	5810[p]	6805[p]	0
25	248	4278	4712[p]	62[a]
27	124	868[p]	992	372[a]
29	310	1302	1674	124
31	682	1116	2046	124
33	744	1860	2666	62[a]
35	325	1000	1450	0

[p] Pseudococcidae comprise more than 60% of this value.

[t] Thysanoptera comprise more than 30% of this value.

[a] Ants comprise more than 90% of this value.

Defoliators were of relatively less importance on *Larrea* in 1974. They made up only about 7% of all phytophages and insects and slightly less than 6% of all arthropods. The larger defoliators (in terms of body size and amounts of material consumed) were present at less than one-third the level observed in 1973.

Figures 16 and 17 illustrate seasonal changes in numbers of two major defoliators of *Larrea: Bootettix punctata* (an acridid grasshopper) and the larvae of the geometrid moth *Semiothisa larreana*. Apparent numbers of grasshoppers declined in 1974 to around 20% of densities estimated in 1973. The first immature individuals were taken in week 19 in both years. In 1974, adults were first taken in week 33 (cf. week 27 in 1973). In 1971-73, the time between first appearance of nymphs and first capture of adults was 6-8 weeks; in 1974 this interval was 14 weeks. Mispagel (1974) has discussed the phenology and abundance of this grasshopper in Rock Valley during the years 1971-73: "The maximum density of this grasshopper was estimated at 1440/ha which represents a biomass of 60.48 g dry weight per hectare. The population abundance and frequency can be related to soil temperature and soil moisture to break diapause and to insure adequate survivorship of the egg stage. The mortality of the nymphs is dependent upon air temperatures and precipitation which will regulate parasites and predators of this vulnerable stage. The adults were most prominent in late summer when air temperatures were above 30° C." One of the major parasites of the egg stage of *Bootettix* is the beefly *Mythicomyia*. This fly was not taken in 1974. In 1973, the peak abundance of *Mythicomyia* was estimated at around 23,000/ha.

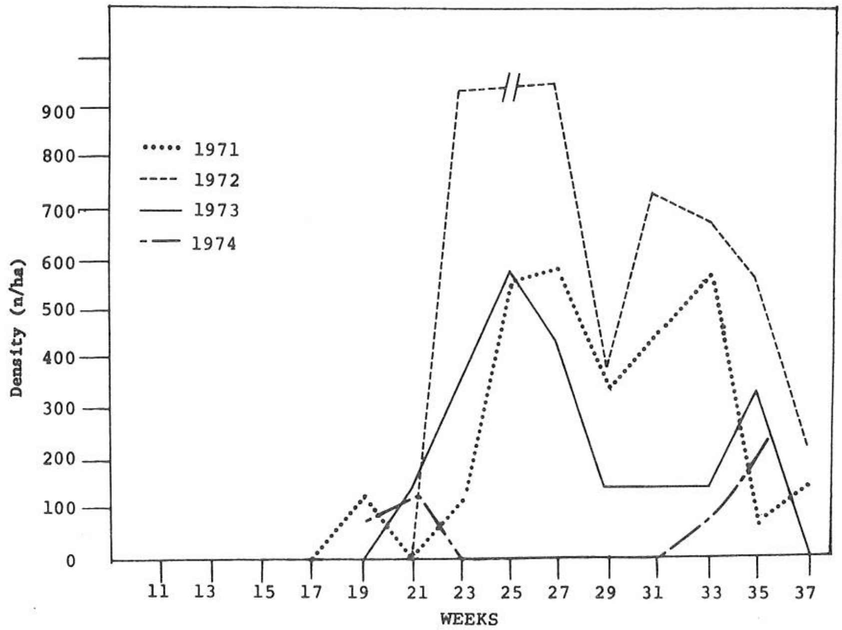

Figure 16. Estimated densities of the grasshopper, *Bootettix punctata*, on *Larrea tridentata* in Plots 11 and 12 (Rock Valley), 1971-74.

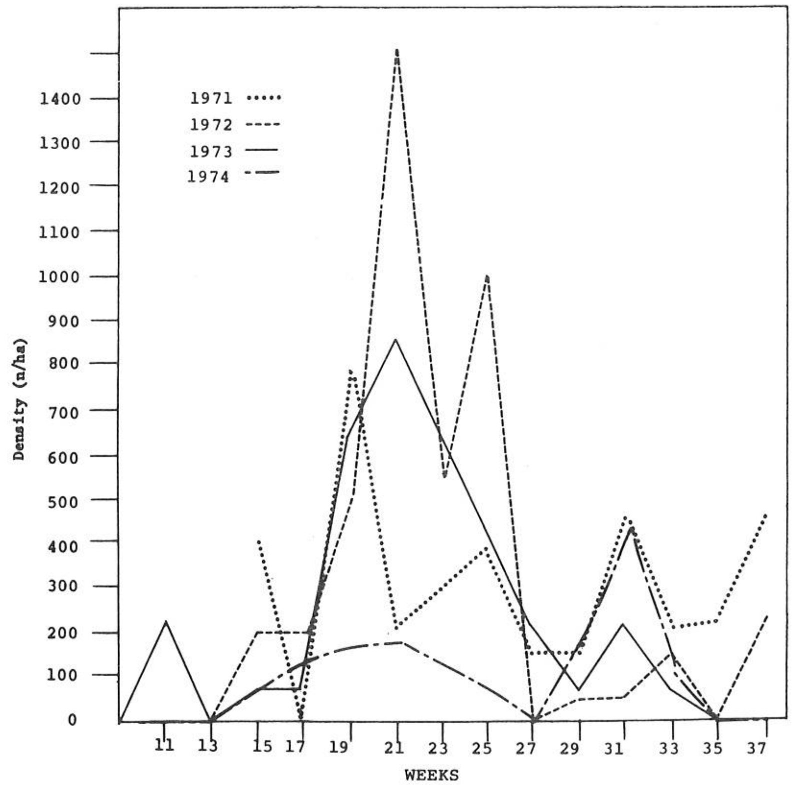

Figure 17. Estimated densities of the measuring worm (*Semiothisa larreana*:Geometridae) on *Larrea tridentata* in Plots 11 and 12 (Rock Valley), 1971-74.

The apparent decline in abundance of the measuring worm (*Semiothisa larreana*) continued in 1974. The estimated peak summer population was about 200/ha (cf. around 800/ha in 1973 and over 1500/ha in 1972). The first larvae were encountered two weeks later in 1974 than in 1973 and peak density was reached about week 21, as in previous years. Eulophid and pteromalid parasites of these larvae were greatly reduced in 1974.

Biomass

E. L. Sleeper, D. B. Thomas and M. E. Mispagel

Little informtion has been given in previous reports relating to the biomass of Rock Valley arthropods. Table 43 summarizes mean live and dry weights and percent moisture for 20 species of arthropods collected during 1974. Table 44 gives more extensive data for 38 species based on combined data from 1971-74. Species weighed only in 1974 are not repeated in Table 44. Although Table 44 summarizes four-year means, we reemphasize that significant year-to-year variations in mean body weights may occur (Table 45). Beetles reaching peak numbers during the hottest and driest part of the summer generally show significantly lower water contents. Sap-removing bugs normally exhibit water contents of less than 50%.

Mean dry weights and estimated densities may be used to estimate standing stocks of insects at times of peak abundance (Table 46). All of the species treated in Table 46 do not reach their peaks at the same time, but the standing stock manifested by just one tenebrionid beetle (*Cryptoglossa verrucosa*) is impressive. In fact, the estimated aggregate biomass of eight tenebrionids exceeded dry weight summer standing stocks of five species of lizards and seven to ten species of rodents combined between 1971 and 1973.

The data on *Bootettix* in Table 46 reflect the abundances in Plots 11 and 12 (Fig. 16), and these densities are not as great as those reported by Mispagel (1974) in other parts of Rock Valley (see p. 77). Except for 1974, peak numbers of *Bootettix* in D-Vac samples were expressed by second and third instar nymphs (with some fourth instars in 1972). In 1974, peak numbers in samples were adults (Fig. 16). Dry weights of nymphs in 1971-73 were around 0.02-0.03 g, while adult dry weights in 1974 were about 0.046 g (Table 44). We emphasize that the biomass estimates for *Bootettix* in Table 46 are based on apparent peak numbers, as reflected in D-Vac samples. Clearly, numbers of first instar nymphs exceeded those of later stages in 1971-73, and the adults captured in 1974 were remaining survivors of all immature stages. Hence, we do not know exactly when actual numbers and body weights combined to result in the peak biomass of *Bootettix* during the years in question. Further work on this problem is in progress.

Table 43. Mean weights of selected arthropods taken in Rock Valley during 1974

Species	n	Mean live weight (g)	Mean dry weight (g)	Percent water
Bootettix punctata (immatures)	6	.0595	.01855	69
Bootettix punctata (adults)	5	.1427	.04636	68
Semiothisa larreana	16	.0419	.01276	70
Centrodontus atlas	3	.002	.00124	38
Multareoides bifurcatus	26	.0023	.00121	47
Pachybrachis sp.	2	.0045	.00217	52
Cibloacris parviceps	2	.3815	.13179	66
Miloderes sp.	1	.0030	.00179	40
Ophryastes varius	1	.0380	.02056	46
Aphonopelma sp.	2	.6622	.19668	71
Triorophus laevis	1	.0235	.01034	56
Craniotus nevadensis	10	.0572	.01859	68
Eleodes armata	7	.9197	.36143	69
Eleodes grandicollis	6	1.8033	.71838	61
Auchmobius subboreus	2	.0370	.01503	60
Philolithus pantex	4	.3266	.09405	72
Metoponium sp.	1	.0135	.00751	44
Edrotes ventricosus	7	.0628	.02362	63
Trogloderus costatus	1	.0675	.02130	69
Cryptoglossa verrucosa	1	.6830	.35349	48
Centrioptera muricata	2	.3630	.16891	54

Table 44. Mean weights of selected arthropods taken in Rock Valley between 1971 and 1974

Species	n	Mean live weight (g)	S. D.	Mean dry weight (g)	S. D.	Percent water
Tenebrionidae						
Araeoschizus sulcicollis	5	0.0018	.0007	0.0010	.0002	45
Asidina semilaevis	65	0.5907	.1860	0.1677	.047	72
Auchmobius subboreus	3	0.0401	.006	0.0157	.0012	61
Centrioptera muricata	10	0.3993	.099	0.1988	.033	50
Craniotus nevadensis	10	0.0572	.023	0.0186	.0057	67
Cryptoglossa verrucosa	11	0.6533	.102	0.3186	.069	51
Edrotes ventricosus	43	0.0775	.018	0.0252	.007	67
Eleodes armata	71	0.8716	.267	0.3633	.120	58
Eleodes grandicollis	17	1.8564	.361	0.6606	.271	64
Philolithus pantex	11	0.3629	.076	0.1174	.025	68
Triorophus laevis	2	0.0492	.036	0.0198	.013	60
Trogloderus costatus	20	0.0929	.034	0.0509	.015	45
Myriapods						
Scolopendra michelbacheri	4	0.3535	.291	0.0809	.064	77
Venezillo arizonicus	12	0.0620	.012	0.0287	.0045	54
Arachnids						
Eurybunus riversi	3	0.3616	.078	0.0929	.047	74
Psilochorus utahensis	14	0.0046	.0021	0.0013	.0005	72
Loxosceles unicolor	3	0.0320	.0088	0.0088	.0007	73
Vejovis spp.	14	0.1950	.089	0.0598	.033	69
Hadrurus arizonensis	9	3.8843	1.557	1.2237	.551	69
Anuroctonus phaeodactylus	7	1.2188	.117	0.3929	.044	68
Orthoptera						
Cibloacris parviceps	12	0.2972	.128	0.1041	.049	65
Bootettix punctata	69	0.1317	.056	0.0401	.018	70
Tanaocerus koebeli	2	0.2495	.039	0.0659	.010	73
Ligurotettix coquilletti	1	0.1030	.	0.0331		68
Capnobotes fuliginosus	4	2.1135	.509	0.8374	.173	60
Insara covillae	1	0.1020		0.0331		68
Ceuthophilus fossor	1	0.1430		0.0419		71
Lepidoptera larvae						
Anacampsis sp.	8	0.0129	.015	0.0040	.005	69
Vanessa cardui	14	0.0798	.043	0.0108	.006	86
Hyles lineata	9	3.8106	1.549	0.6031	.256	84
Semiothisa larreana	17	0.0402	.035	0.0123	.010	70
Hemiptera						
Chlorochroa sayi	10	0.1515	.020	0.0927	.014	39
Dendrocoris contaminatus	2	0.0370		0.0159		57
Nysius ericae	60	0.0115	.0062	0.0086	.0026	25
Multareoides bifurcatus	43	0.0023	.0029	0.0012	.00006	48
Centrodontus atlas	28	0.0012	.0015	0.0007	.0024	42
Coleoptera						
Pachybrachis sp.	3	0.0046		0.0021		64
Diplotaxis moerens	18	0.0846	.078	0.0327	.0095	61

Table 45. Average dry weights and standard deviations of six species of arthropods taken from *Larrea tridentata* in Rock Valley between 1971 and 1974. Data are arranged serially for each species

Species	n	Mean dry weight, W (mg)	s_W
Bootettix punctata (males)	8	15.17	0.96
	3	14.62	1.05
	5	22.48	0.09
	-	-	-
Bootettix punctata (females)	7	27.00	3.43
	1	39.57	-
	5	64.60	0.006
	3	46.36	-
Semiothisa larreana (2nd instar)	7	0.066	0.005
	14	0.060	0.020
	9	0.063	0.008
	7	0.042	0.007
Hysteropterum sp.	18	1.59	0.19
	12	2.19	0.26
	3	1.85	-
	-	-	-
Centrodontus atlas	48	0.72	0.032
	52	0.73	0.035
	59	0.78	0.033
	3	1.24	-
Multareoides bifurcatus	37	0.89	0.019
	42	0.92	0.024
	28	0.94	0.019
	26	1.21	0.035
Phytocoris nigripubescens	16	0.93	0.11
	26	0.82	0.05
	9	1.11	0.09
	-	-	-

Table 46. Estimated biomass (g dry weight/ha) of selected arthropods in Rock Valley between 1971 and 1974. Data for *Bootettix* and *Semiothisa* are from Mispagel (1974); data for tenebrionid beetles are based on work of Thomas (1975)

Species or species group	1971	1972	1973	1974
Bootettix punctata, adults	10.0	27.7	15.9	13.9
Bootettix punctata, immatures	1.0	1.9	2.5	4.8
Semiothisa larreana (last instar)	2.4	1.1	1.4	1.5
Centrioptera muricata	64.2	65.2	228.2	22.1
Cryptoglossa verrucosa	169.2	275.3	283.9	94.6
Eight major detritivorous tenebrionids	354.7	541.4	661.9	198.0

Soil Arthropods

E. B. Edney

The abundance of various soil microarthropods in Rock Valley has been estimated by extractions from 500-cm² soil samples. Samples were taken weekly at nine positions adjoining each of four species of shrubs. Procedural details and a list of kinds of arthropods collected were given by Edney et al. (1975).

Analyses of numbers of microarthropods in various samples have shown no differences between the four shrub species (*Larrea tridentata*, *Ambrosia dumosa*, *Lycium andersonii* and *Krameria parvifolia*) in terms of the abundances of microarthropods. However, sample location (depth, or distance from shrub) has an important influence on microarthropod abundance, with the highest densities occurring near shrubs and in the upper 10 cm of the soil.

During 1974, numbers of microarthropods in samples increased between early February and early April -- during a time of high soil moisture content and rising soil temperatures. However, as soil temperature continued to rise and moisture content to fall, numbers of arthropods in samples declined between early April and the end of June (Edney et al. 1975).

Estimated numbers of microarthropods ranged from around 2000/m² in February (in the first 30 cm of the soil) to roughly 4000/m² during March and April. Localized densities (near the bases of shrubs) ranged from about 7000/m² in January to around 18,000/m² in March. Nonpredatory prostigmate mites were generally the most abundant group collected, often outnumbering all other mites and collembolans combined (Edney et al. 1975).

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VERTEBRATES

Reptiles

P. A. Medica, F. B. Turner

Selected species of reptiles were enumerated on the validation site and in two adjoining 9.1-ha fenced plots (Plots 1 and 2) during the spring of 1974. March densities of *Uta stansburiana* (A3UTJ40) were determined by absolute counts in an 0.8-ha area within Plot 12 (see Site Development). We worked with *Uta* in a manner similar to that described previously (Tinkle 1967, Medica et al. 1971). From two to four people walked back and forth systematically within the plots. When a lizard was observed, a numbered marker was dropped at the location. Then the lizard was noosed. After capture, *Uta* were placed in numbered plastic vials. The location, vial number and marker were recorded so that the lizard could be returned to the spot where it was captured. Sampling continued until the entire plot had been searched. All *Uta* were weighed to the nearest 0.1 g on a "Dial-a-Gram" balance, measured to the nearest millimeter, palped, toe-clipped if not already marked, and painted. Our experience has been that all of the resident *Uta* can be enumerated in this manner, and the spring density (as of March 1) is taken as a total roster of all different individuals registered. Numbers of leopard lizards (*Crotaphytus wislizenii*) and horned lizards (*Phyrnosoma platyrhinos*) captured in fenced Plot 1 and unfenced Plot 12, respectively, during 1974 have been used as estimates of minimal densities of these species (A3UTJ42, 44). These estimates include only animals at least 8 months of age and no attempt was made to record the abundance of hatchlings in the summer. Densities of *Cnemidophorus tigris* and *Callisaurus draconoides* were estimated in a 9-ha area (Plot 19) on the validation site (A3UTJ42, 44). Counts of these species were made on six occasions between May 14 and June 20. These counts included all age classes of *Callisaurus*, but only whiptail lizards at least 18 months of age. In our judgment, yearling whiptails ($\sim$ 8 months) are not recorded with the same efficiency as older individuals. The average count ($\overline{N}$) was then multiplied by an appropriate scaling factor. The scaling factor used for *Cnemidophorus* was 3.33; for *Callisaurus* 2.0 (see Medica et al. 1971). The resulting density estimate for *Cnemidophorus* was then adjusted to compensate for the absence of yearlings. Among 108 whiptail lizards of known age captured in fenced plots (1 and 2) during 1974, 86 (79.6%) were yearlings. The total spring density of whiptails (n/ha) was thus estimated as

$$3.33\,\overline{N}/(9 \times 0.204)$$

The estimated proportion of yearling *Uta* ($\sim$8 months of age) was based on 56 individuals from the validation site. The proportion of yearling *Cnemidophorus* was based on 108 lizards of known age captured within two fenced plots. The proportion of yearling *Crotaphytus wislizenii* was based on nine juvenile leopard lizards taken in fenced Plot 1. For other species, distinctions between yearlings and older animals were made on the basis of body size. We calculated an overall mean body weight for adult and yearling *Uta*, based on all animals taken during the spring of 1974. Estimated dry weights of all reptiles have been taken as 30% of live weight. Mean body weights of lizards were based on all animals captured during the spring of 1973 and 1974. These mean weights were combined with plot-specific density estimates to estimate the biomasses represented in various plots.

Twenty-one species of reptiles occurring on the Rock Valley site have been listed previously (Medica and Smith 1974:50). The herpetofauna of the area also includes three lizards which occupy the rocky hillsides surrounding the valley (*Sauromalus obesus*, *Xantusia vigilis* and *Crotaphytus collaris*). Two additional snakes may occur on the Rock Valley site: *Tantilla planiceps*, which has been found at the eastern end of Rock Valley and in Mercury Valley, and *Trimorphodon lambda*, which has been collected in Mercury Valley (Tanner 1969).

Table 47 gives estimated mean dry weights of six species of lizards. Dry weights of ten snakes were reported previously (Turner et al. 1973:171). Table 48 gives census data for *Cnemidophorus tigris* and *Callisaurus draconoides* from Plot 19 between May 14 and June 20, 1974. Note that although the estimated abundance of adult *Cnemidophorus* was only 7.8/ha, the density of the total spring population (including yearlings) was about 38/ha. Table 49 gives estimates of density and biomass for five species of lizards. Comparisons between 1972, 1973 and 1974 are given when possible. There was an increase in biomass of *Uta* in 1974, primarily due to the above-average reproduction during 1973 when some female *Uta* produced as many as seven clutches of eggs (Medica and Turner, in press). Density and biomass of *Cnemidophorus* increased between 1973 and 1974, and the proportion of yearlings in the 1974 spring population was markedly increased. Reproduction by *Crotaphytus* and *Phrynosoma* was good in 1973, but the 1974 spring populations exhibited poor survival of adults. The total biomass of five primary saurian species decreased about 5% between 1971 and 1972, but increased almost 25% between 1972 and 1973 (primarily because of the increased abundance of *Cnemidophorus* in 1973), and increased 15.7% in 1974 due to increases in *Uta*, *Cnemidophorus* and *Callisaurus*.

The dates of first appearance for adults of four species of lizards in Rock Valley or Mercury Valley in 1974 were: April 17 -- *Cnemidophorus tigris;* April 17 -- *Crotaphytus wislizenii;* March 21 -- *Phrynosoma platyrhinos*; and March 21 for *Callisaurus draconoides.* Comparable data for the previous five years are given by Turner et al. (1973:173) and Medica and Smith (1974:50).

Mammals

B. G. Maza, F. B. Turner

Mammals were trapped on the validation site during the spring (April 15-17) and summer (July 16-18) of 1974. Trapping was conducted in Plot 12 (see Site Development). This 2.7-ha plot contained 144 trap stations 15 m apart (with two traps per station). Trapping procedures and data

Table 47. Mean dry weights of six lizards found on the Rock Valley site during 1974

Species	Age	Sex	n	Minimum snout-vent length (mm)	Mean body weight (g)	Range
Uta stansburiana	adult	m	2	51	1.25	1.2 - 1.3
		f	5	46	0.92	0.9 - 1.0
	yearling	m	27	32	0.80	0.3 - 1.2
		f	29	32	0.59	0.4 - 1.2
Cnemidophorus tigris	adult	m	14	79	4.9	3.4 - 5.8
		f	8	81	4.7	4.2 - 5.6
	yearling	m	60	49	1.9	0.9 - 3.8
		f	26	51	2.0	0.9 - 3.4
Crotaphytus wislizenii	adult*	m	17	97	8.9	7.2 - 11.2
		f	4	107	13.8	11.6 - 17.8
	yearling	m	7	82	5.5	3.0 - 6.7
		f	2	97	7.8	6.5 - 9.2
Phrynosoma platyrhinos	adult*	m	20	77	7.0	4.7 - 8.7
		f	6	64	6.0	3.6 - 8.0
	yearling	m	5	39	1.6	0.9 - 2.1
		f	2	41	0.9	0.7 - 1.0
Callisaurus draconoides	adult*	m	22	64	4.9	2.4 - 6.7
		f	14	62	3.7	2.3 - 5.6
	yearling*	m	3	44	1.1	0.7 - 1.5
		f	2	35	0.6	0.4 - 0.8
Coleonyx variegatus	adult*	m	22	54	1.0	0.7 - 1.4
		f	10	55	1.2	0.9 - 1.9
	yearling*	m	17	46	0.7	0.3 - 1.0
		f	4	49	0.6	0.5 - 0.7

*Based on data from 1973.

management were the same as in previous years. A special trapping was undertaken to enumerate ground squirrels. At 54 of the 144 trap stations, 5 x 5 x 16 inch single door, wire fabric, noncollapsible live traps (Tomahawk Live Trap Co. #102) were placed. Each trap was equipped with an aluminum bait tray 3.5 x 2 x 1 inch wired to the back panel. A 12 x 12 x 3/16 inch masonite sheet was used as a heat shield. These traps were opened at 0800 and remained so until 1800. Traps were checked, data recorded and animals released at 1000, 1300, 1600 and 1800. The traps were then closed until the next morning. This procedure was carried on for three days in May (21-23) and August 19-21). Pocket gophers were estimated by direct observation of active burrow systems. Plot 12 was systematically walked by experienced observers -- twice in March and twice in August. The location of fresh mounding activity was recorded on maps of the plot. From these maps, burrow system locations were inferred and the number of pocket gophers estimated by assuming one animal per burrow system. All animals were considered to be adults, and a 1:1 sex ratio was assumed (Dingman and Byers 1974).

Table 48. Census data for adult (> 18 months) *Cnemidophorus tigris* and all *Callisaurus draconoides* obtained on the Rock Valley site during 1974

Date	*Cnemidophorus*	*Callisaurus*
May 14	21	14
May 16	26	16
May 24	16	11
June 14	0[1]	8
June 18	3[1]	11
June 20	1[1]	9
Totals observed	63	69
Mean	21	11.5
Estimated number (9 ha)	69.9[2]	23.0[3]
Estimated density/ha	7.8	2.6

[1] June *Cnemidophorus* sample not included

[2] Scaling factor of 3.33 for 1974

[3] Estimated scaling factor of 2

Table 49. Estimated densities and biomass (dry weight) of five reptiles in Rock Valley during 1974

Species	Plot	Size of plot (ha)	n/ha	g/ha	% change in biomass 1973-1974	Percent of population composed of yearlings
Uta stansburiana						
(1972)	12	0.8	40	44.7	-	71.9
	3	1.4	25	28.0	-	77.2
(1973)	12	0.8	47.5	43.8	+ 8.8	84.2
	3	1.4	21.4	19.8	-25.8	86.7
(1974)	12	0.8	78.8	57.2	+30.6	88.9
Cnemidophorus tigris						
(1972)	19	9.0	10.4	38.0	+17.6	31.3
(1973)	19	9.0	19.2	77.3	+103.4	44.4
(1974)	19	9.0	38.2	96.5	+24.8	79.6
Callisaurus draconoides						
(1972)	19	9.0	2.5	11.6	-22.3	-
(1973)	19	9.0	1.8	7.8	-35.4	-
(1974)	19	9.0	2.6	11.3	+44.9	-
Crotaphytus wislizenii						
(1972)	1	9.1	0.97	10.1	+18.7	0.0
(1973)	1	9.1	1.0	10.4	-10.0	22.2
(1974)	1	9.1	1.0	5.9	-42.6	100.0
Phrynosoma platyrhinos						
(1972)	1	9.1	1.7	12.4	+15.6	0.0
(1973)	1	9.1	2.3	9.4	-24.2	52.4
(1974)*	12	0.8	0.9	1.1	-88.0	100.0

*Minimal estimate.

Due to the differing vagility of the various species, the areas sampled were adjusted in terms of estimated home range sizes. Circular home range sizes have been estimated in the past for Rock Valley rodents, using the technique described by Maza et al. (1973). For each species, the effective area trapped was estimated by extending the boundaries of the trap grids (165 m x 165 m) the distance of three sigma.

Live body weights of animals were recorded in the field with a Pesola spring scale, read to the nearest gram. The mean live body weights of females were computed omitting weights of pregnant females obviously near term. Live body weights were converted to dry-weight equivalents by multiplying by 0.3 (Golley 1960).

Densities of various species during the spring and summer were estimated from the numbers of individuals registered during each of the three-day trapping periods and the effective trapping areas for each species.

Biomass values were calculated from the numbers of individuals trapped, the mean dry weights of each sex and age group, and the effective areas trapped for each species. For example, the biomass (g dry weight/ha) of *Dipodomys microps* on Plot 12 in April 1974, was estimated as

$$[(NMA \times WMA) + (NFA \times WFA) + (NMJ \times WMJ) + (NFJ \times WFJ)]/EA$$

with NMA the total number of adult males captured, WMA the mean dry weight in grams of adult males, NFA and WFA the corresponding values for adult females in the population, NMJ, WMJ, NFJ and WFJ the equivalent values for young-of-the-year, and EA the effective area trapped.

Twenty-one species of mammals known to occur on or near the validation site have been listed previously (Maza 1974:56). Table 50 gives numbers of various species trapped in Plot 12 during April and July of 1974 (A3UTJ50, 52). Data for gophers (*Thomomys bottae*) are given separately in this table. Data are broken down by sex and age groups. Table 51 gives mean body weights (g dry weight) for species collected during 1974. Tables 52 and 53 give estimated numbers (n/ha) and biomass (g dry weight/ha) for six rodents occupying the validation site during April and July 1974. In these tables information pertaining to four species (*Thomomys bottae, Neotoma lepida, Spermophilus tereticaudus, Dipodomys deserti*) are given collectively (OTHER) (A3UTJ52). Four species of heteromyids and the pocket gopher made up about 70% of the total rodent biomass in 1974.

Table 50. Small rodents trapped on Plot 12 during April (upper line) and July (lower line) of 1974. Data for *Spermophilus tereticaudus*, *Neotoma lepida* and *Dipodomys deserti* are grouped under OTHER

Species	Adults		Juveniles		Total	Percent
	Males	Females	Males	Females	captured	Juveniles
PERFOR	6	7	0	0	13	0
	6	5	0	0	11	0
PERLON	76	83	0	0	159	0
	67	74	0	0	141	0
DIPMER	5	8	1	3	17	29
	4	9	0	0	13	0
DIPMIC	13	12	4	6	35	29
	6	12	0	3	21	14
AMMLEU	3	11	0	0	14	0
	11	9	0	3	23	13
ONYTOR	3	3	1	0	7	14
	3	2	0	1	6	17
PERCRI	0	0	0	0	0	0
	0	0	0	0	0	0
THOBOT	3	2	0	0	5	0
	1	1	0	0	2	0
OTHER	2	1	0	0	3	0
	2	1	0	1	4	25

Table 51. Mean dry body weights (g) of small rodents trapped on three 2.7-ha plots on the validation site during April and July 1974, with data for all sites and trapping periods combined. Weights of pocket gophers were based on work of Dingman and Byers (1974)

Species	Adult Males			Adult Females			Young Males			Young Females		
	n	$\bar{x}$	Range	n	$\bar{x}$	Range	n	$\bar{x}$	Range	n	$\bar{x}$	Range
PERFOR	12	5.5	4.5-6.3	7	5.0	4.5-5.7	-	-	-	-	-	-
PERLON	98	2.1	1.8-2.4	56	3.6	1.8-2.4	-	-	-	-	-	-
DIPMER	6	12.6	10.8-13.2	12	11.7	9.3-13.2	1	10.8	-	3	9.6	7.8-11.4
DIPMIC	13	18.7	15.3-24.0	18	17.6	15.0-21.6	4	13.2	11.1-14.7	6	12.8	12.0-13.8
AMMLEU	22	27.4	24.0-28.5	14	26.5	22.2-28.2	1	18.0	-	3	18.6	17.4-20.4
ONYTOR	7	4.9	4.2-6.3	5	3.8	2.7-5.1	-	-	-	-	-	-
PERCRI	-	-	-	-	-	-	-	-	-	-	-	-
SPETER	-	-	-	2	22.8	22.2-23.4	-	-	-	-	-	-
NEOLEP	1	33.9	-	-	-	-	-	-	-	1	18.9	-
THOBOT	10	27.6	24.3-37.5	10	24.1	20.6-30.2	-	-	-	5	13.6	9.2-17.2

Table 52. Density and biomass of rodents trapped on the validation site (Plot 12) during April 1974

Species	Effective Area Trapped (ha)	Adult		Young-of-year		Total	
		n/ha	g/ha	n/ha	g/ha	n/ha	g/ha
PERFOR	6.62	1.96	10.27	-	-	1.96	10.27
PERLON	7.77	20.46	59.00	-	-	20.46	59.00
DIPMER	15.11	0.86	11.14	0.27	2.62	1.13	13.76
DIPMIC	10.49	2.38	43.31	0.95	12.35	3.33	55.66
AMMLEU	35.58	0.39	10.50	-	-	0.39	10.50
ONYTOR	23.22	0.26	1.12	-	-	0.26	1.12
Other	2.7	2.96	85.93	-	-	2.96	85.93
Totals		29.3	221.2	1.2	15.0	30.5	236.2

Table 53. Density and biomass of rodents trapped on the validation site (Plot 12) during July 1974

Species	Effective Area Trapped (ha)	Adult		Young-of-year		Total	
		n/ha	g/ha	n/ha	g/ha	n/ha	g/ha
PERFOR	6.62	1.66	8.76	-	-	1.66	8.76
PERLON	7.77	18.15	52.39	-	-	18.15	52.39
DIPMER	15.11	0.86	10.30	-	-	0.86	10.30
DIPMIC	10.49	1.72	30.83	0.29	3.66	2.01	34.49
AMMLEU	35.58	0.56	15.17	0.08	1.52	0.64	16.69
ONYTOR	23.22	0.22	0.96	0.04	-	0.26	0.96
Other	2.7	2.22	154.33	-	-	2.22	154.33
Totals		25.4	272.7	0.4	5.2	25.8	277.9

Discussion

In 1972 and 1973 we trapped rodents in three plots on the validation site (12, 15 and 16), and site-wide densities were computed assuming these plots to be representative of one or more of the six vegetation zones composing the site. However, trapping was restricted to Plot 12 in 1974. This plot has been considered representative of Zones 21, 24 and 25 -- an area of about 20.5 ha (see Fig. 2, Site Development). It is not obvious how estimated densities of four heteromyids and the grasshopper mouse in Plot 12 relate to overall site densities of these species. In 1972, Plot 12 densities of all but *Dipodomys microps* exceeded site-wide densities -- by anywhere from 30% (*D. merriami*) to over 200% (*Perognathus formosus*). In 1973, the Plot 12 density of *P. formosus* was about 40% greater than the site-wide density, but the densities of the other four species in Plot 12 were close to those estimated for the site as a whole.

In spite of the above problem, we can draw several important inferences as to the dynamics of rodent populations in 1974 from the Plot 12 data. First, the aggregate spring density (ca. 29/ha) and standing stock (211 g/ha dry weight) were high relative to the three previous years. This followed from the extremely high densities generated during the summer of 1973 (total of around 46.5/ha for ten species). Numbers of pocket mice and grasshopper mice declined between the summer of 1973 and the spring of 1974, but good survival, an appreciable influx of new individuals, and some reduction by kangaroo rats led to an apparent increase of these species. The increase in numbers of ground squirrels in the spring of 1974 was due to the special trapping effort. The new traps and trapping schedule greatly increased numbers of captures. The 1974 data should, therefore, be taken as the best estimate of the abundance of this species on the Rock Valley site.

Estimated production by winter annuals in the spring of 1974 (17.4 kg/ha) was far below that of 1973, but significantly greater than that observed in 1971 (4.9 kg/ha) and 1972 (3.2 kg/ha). Summer recruitment by mammals was poor in 1971, but better in 1972. Hence, judging solely on the basis of available food resources, one would expect good reproduction in 1974; stored food resources should have been high and new growth of annuals was sufficient. Yet, reproduction in 1974 was conspicuously poor -- at least during the spring and early summer. No young-of-the-year were recorded for either species of pocket mouse and only minimal signs of reproductive activity (in terms of external morphology) were observed. Reproduction by kangaroo rats and a few other species occurred, but at minimal levels.

As numerous workers have suggested (Reynolds and Haskell 1949; Reynolds 1958, 1960; McCulloch and Inglis 1961; McCulloch 1962; Chew and Butterworth 1964; Beatley 1969; Van De Graaff and Balda 1973; French et al. 1974), and we have previously emphasized (Turner and Maza 1974:59-60) rainfall levels, and the resultant presence or absence of primary production in the form of winter annuals, appear to greatly influence the dynamic nature of the demographic parameters of desert rodents. Plant estrogens (Pinter and Negus 1965), plant gonadotropins (Bodenheimer and Sulman 1946) and dietary water (Beatley 1969, Bradley and Mauer 1971) have also been suggested as some of the possible physiological mechanisms involved in triggering rodent reproductive activity.

It now seems important to consider more carefully the possible influence of rodent spring density on reproductive activity and success. During 1972 and 1973, Chew and his colleagues conducted several experiments with *Perognathus formosus* in the Rock Valley enclosures. The first experiments (1972) indicated significant density effects on reproductivity, with numbers weaned inversely related to density (Chew et al. 1973). Yet in 1973, when unusually high densities of *P. formosus* (ca. 27/ha) were artificially created in a Rock Valley enclosure, reproduction was **not** inhibited, and production of young was good (Chew and Turner 1974). This was in general keeping with events observed on the unfenced site (Maza 1974:59). The complicating factor in the experiment was the remarkable primary production in 1973, which seemed to override the previously documented density-dependent responses. The exact manner in which spring density and available food resources interact to influence reproductivity by *P. formosus* has not yet been worked out, but the mechanisms are apparently complex. Current work by Conley and his colleagues on reproductive strategies in desert rodents (Conley et al. in press) and a recent reexamination of the eight-year data base (1962-69) from Rock Valley by Conley and Maza (unpubl. manuscript) indicate that desert rodent populations are capable of rapid growth rates, and can survive extended periods of no reproduction and still remain ecologically viable. Some desert rodents (as exemplified by *Perognathus formosus*) do not conform to the current concept of r and K selection, but rather, exhibit a temporally dynamic strategy which allows switching between a relative r and a relative K strategy in response to the total complex of resource availability.

It is therefore clear that field experimentation will have to be planned with these complications in mind, although at least one of the factors to be evaluated (net primary production) may be hard to manipulate artificially.

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CALORIMETRY AND CHEMICAL ANALYSES

Nutrient element contents of perennial plants from the Rock Valley site have been analyzed by E. M. Romney and G. V. Alexander (A3UTJ21) and reported previously (Turner et al. 1972:37, Turner et al. 1973:201-202). Calorimetric contents of a limited assemblage of plants and animals have also been determined by James MacMahon and reported by Turner (1974:62).

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SOIL

Physical and Chemical Properties

Physical and chemical properties of soils of the Rock Valley site have been determined by E. M. Romney, V. Q. Hale and J. Childress (A3UTJ11) and summaries of this work may be found in earlier reports (Turner et al. 1972:21-23; Turner et al. 1973:203-210). Data pertaining to solar absorptivity, thermal conductivity, density-specific heat product, surface roughness and hydraulic conductivity may be found in Romney et al. (1974:63).

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