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ABSTRACT

This progress report discusses some aspects of nitrogen cycling and nitrogen transformations in the northern Mohave Desert with special attention to the Desert Biome Validation Site at Rock Valley. Since the study has been in effect less than a year, critical information regarding the objectives is still incomplete. Preliminary studies indicate much of interest. The acetylene reduction test for nitrogenase has indicated that the rhizosphere of several species of desert plants has some capacity for atmospheric nitrogen fixation and may be sufficient to supply an important part of the needs of a desert system. Soil from the desert had a significant capacity for nitrogen fixation provided an energy source was supplied. Algae was significant in that light resulted in considerably more fixation than did dark. The nitrogen concentration of leaves of many desert plant species is exceptionally high and one of the suspected reasons is a semisymbiotic or a symbiotic nitrogen-fixing relationship. The uptake of nitrate and ammonium nitrogen by several species of desert plants has been followed in solution cultures in the laboratory. Differences were noted, but in general both forms were readily available to the species. The C/N ratios in Rock Valley soils appear to be normal, but in some of the adjacent areas they are somewhat low. Reasons for this must be elucidated, but there are indications of little volatilization or denitrification losses. Nitrogen analyses of roots and shoots by season indicate possible uptake of N by some species during the dormant season and other changes related to phenological events. Some 25 to 80% of the nitrogen in leaves of most of the species seems to be returned to the plant before leaf abscission. The large flooding loss of nitrogen from the desert bajadas has resulted in considerable nitrate accumulation in profiles in areas at lower elevation. This phenomenon has considerable implications. Efforts will be continued towards accomplishment of the original objectives.

INTRODUCTION

The purposes of this project are numerous. One of the most important objectives is to obtain the rates of nitrogen movement between various compartments in the northern Mohave Desert and to provide information relating to nitrogen cycling in the system. Previous preliminary studies in this area (Wallace et al., 1971; Romney et al., 1973) indicate that: (1) under natural conditions there seems to be little nitrogen stress, (2) there seem to be significant inputs from atmospheric nitrogen fixation, (3) there was sufficient nitrogen lost from the system by flooding to cause accumulations in places where debris accumulated, and (4) there were some peculiar C:N ratios in some areas of the northern Mohave Desert. To date these observations have been enlarged upon, but the major emphasis has been in the establishment of experiments and procedures for obtaining the data necessary to determine rates of transfer of nitrogen. Our cyclotron procedure for assay of ^{15}N has proved troublesome because of interference from other elements and we are in the process of setting up equipment for optical emission assay of both ^{15}N and total nitrogen. It is hoped that the techniques will be available in time for significant contribution to the 1974 studies.

In the northern Mohave Desert, 1973 was better than average for primary productivity. Perhaps two to three times as much nitrogen became tied up in plant litter than for most years. The effects of this on subsequent years await to be seen. In desert studies, one may have to look for the unusual as a determinant. Seasons of unusually heavy rainfall may result in the washing away of several years of accumulated nitrogen in the bajadas. These are factors which cannot be ignored.

OBJECTIVES

1. To determine rates of biological N fixation in the desert systems studied via: (a) symbiotic relationships with higher plants; (b) symbiotic relationships with algal crusts and lichens; (c) free-living nonsymbiotic forms including semisymbiotic forms.
2. To determine losses from the ecosystem via: (a) volatilization of NH_4^+; (b) leaching; (c) runoff of litter, surface leaching or wind removal of litter; (d) denitrification.
3. To determine rates of transfer of nitrogen between various soil-plant compartments as influenced by: (a) soil moisture; (b) soil and air temperature; (c) salinity; and (d) soil pH; and to determine relationships among various compartment sizes and to other factors affecting nitrogen cycling under desert systems.
4. To determine rates of uptake of different forms of nitrogen by some desert plants.
5. To characterize and develop some reasons for variations in the C:N ratio of soils in the northern Mohave Desert.

METHODS

The methods for each experiment are given in more detail in the Results and Discussion section. Only information related to the DSCODES is given in this section.

Soil samples were collected from the rhizospheres of species native to the northern Mohave Desert, but grown in outside containers at UCLA under simulated desert conditions. These soil samples were subjected to the acetylene reduction test for nitrogenase activity and the results were calculated to nmoles acetylene reduced per gram soil per hour. Upon the assumption that the C_2H_2:N_2 conversion factor is 3:1 and that fixation occurred in 10 cm depth of soil weighing 1.33×10^9 g/ha and that a season is 90 days, data for g N/ha/hr and kg N/ha/season were calculated (DSCODE A3UWS02). Further assumptions on hectare basis are that a monoculture is involved and that N_2 was uniformly fixed throughout 10% of the hectare as it was in the rhizosphere. Neither assumption, of course, approaches reality.

Leaves of a large number of samples of desert plants from Rock Valley and adjacent areas were collected in April, May and June of 1973 and assayed for total nitrogen by the Kjeldahl method with use of the ammonium electrode. There were 28 species with sample sizes ranging from one per species to 50 per species. Means, standard deviations, ranges of concentrations of N, and other related data were obtained (A3UWS03).

Several species of desert plants were grown in solution culture at UCLA and the rates of uptake by the intact plants of nitrate nitrogen vs ammonium nitrogen were determined. The uptake was measured from 1700 ml solutions, and 10^{-3}N of KNO_3, $(NH_4)_2SO_4$, or NH_4NO_3 was used. Uptake after 4, 8, 24, 48, 72, and 96 hr was determined by monitoring the solutions with nitrate and ammonium electrodes. The results were calculated as μg/N taken up per g dry root weight and NO_3^- to NH_4^+-N ratios were also calculated (A3UWS04).

Organic N concentrations and C:N ratios in soil profiles of Rock Valley and adjacent areas have been determined by standard procedures (Romney et al., 1973). Data are reported here for 10 sites, together with some information on site description (A3UWS05).

The nitrate N concentration in the saturation extract of some profiles from areas near Rock Valley has been determined by standard means (Romney et al., 1973) and reported as meq/liter together with data for electrical conductance of the extracts (A3UWS06). The accuracy of the test was set only to find high values, and more work will be done in Rock Valley to find seasonal values in the root zones of plants.

Roots, stems and leaves of several species were collected at different time periods in the spring of 1972. The roots and stems were separated into different increments according to plant height or root depth. Nitrogen and mineral concentrations for each plant increment were determined and reported on a dry weight basis (A3UWS07).

Several plant species were sampled in 1972 and 1973 for leaves about to abscise as determined by the yellow senescent color (or those just abscised) and leaves still green (not near the time of abscission). Dry weight per leaf was determined. These leaves were analyzed for N and mineral elements and results presented per unit of dry weight and also as μg/leaf so that losses prior to abscission could be estimated (A3UWS08).

RESULTS AND DISCUSSION

The Nitrogen-fixing Ability in the Rhizospheres and Roots of some Desert Plants

The rhizospheres of nine species of desert plants growing in the Mohave and Great Basin Deserts have been shown to fix atmospheric nitrogen (Wallace et al., 1972). The present study identifies additional nitrogen-fixing desert plant species and attempts to measure the quantities of the nitrogen thus fixed.

The plants growing in the plots at the UCLA Horticulture Center were transplanted from the Mohave Desert some years ago. The plots were left unattended for a few months, resulting in fairly dry soil and weak plants. The plots were flooded and the water was allowed to drain away, leaving the soil at its field capacity. After 10 days the plants showed good signs of recovery and new growth, and the samples of rhizospheres and roots were then collected.

Three root-soil bores (15 cm) per plant were collected and placed in a plastic bag within which the sample was mixed thoroughly. For the root sampling, the whole plant was removed with soil attached and placed in a plastic bag. Just before use, the soil was carefully washed from the plant with tap water and 12 g of root-soil sample or 5 g of roots was introduced into a 38-ml serum bottle sealed with a rubber, sleeve-type stopper. Each bottle was flushed for 10 min with a gas mixture containing 19.96% O_2, 0.04% CO_2, and 80% Ar. Finally, 1.0 ml of acetylene was added to give a concentration of 3% in the gas phase. All bottles were incubated in a temperature-regulated laboratory at a fairly constant room-temperature of 23 C, and under a daily cycle of 12 hr darkness and 12 hr light from regular reading light bulbs for 8 days.

The amount of ethylene in the gas phase was measured by gas chromatography. The column was a 2.7 m x 3 mm glass tube filled with 80-100 mesh Poropak-R, operating at 40 C. The carrier gas was Argon. The moisture contents of the root-soil samples were also determined by drying overnight in an oven at 110 C.

Two replications per sample were prepared for the C_2H_2-C_2H_4 assay. The sample preparation before incubating in the gas mixture containing acetylene was done within 5 to 6 hr.

Root-Soil Samples

Among the 16 plant species tested for the reduction of acetylene to ethylene, eight showed positive effects. The amount of ethylene produced was expressed in nmole per g per fresh sample per hr. A conversion factor of 3 was used to estimate the amount of nitrogen fixed (C_2H_2:N_2=3:1). The weights of nitrogen fixed per ha per hr and per ha per season were calculated also. An assumption that the nitrogen fixation activity is present to a depth of 10 cm was made and that a ha 10 cm volume of soil was 1.33×10^9 g in weight and that all the soil is like the rhizosphere. The results of the nitrogen fixation activity of the root-soil samples are summarized in Table 1.

Table 1. Acetylene reduction by the rhizosphere from roots of desert species showing a positive test (A3UWS02)

Species	nm C_2H_4/g-hr	g N/ha-hr	Kg N/ha-season*
Atriplex canescens	0.168	2.11	0.46
Atriplex confertifolia	0.383	6.44	1.41
Coleogyne ramosissima	0.190	3.00	0.66
Ephedra nevadensis	0.004	0.05	0.01
Larrea divaricata	0.003	0.05	0.01
Lycium pallidum	1.378	22.62	4.94
Lycium shockleyi	0.074	1.35	0.30
Yucca schidigera	0.657	10.70	2.34

The above values are the average of two samples per plant species. The moisture content of the samples is between 14 to 19% by weight.

*See text for assumptions

The plant species which did not show reduction of acetylene are: *Artemisia tridentata*, *Cowania mexicana*, *Ceratoides lanata*, *Ambrosia dumosa*, *Larrea divaricata* (see Table 1), *Lycium andersonii*, *Prunus fasciculata* and *Yucca brevifolia*. The moisture contents of the samples were between 11 to 18% by weight.

Root Samples

The root samples of six plant species were tested for acetylene reduction. Only those of *Yucca schidigera* showed positive results of 0.0672 nmoles C_2H_4 produced per g fresh root per hr, amounting to about 0.078 g N/ha/hr or 0.168 kg/ha/season The root samples of the other five plants tested, *Cowania mexicana*, *Ceratoides lanata*, *Ambrosia dumosa*, *Prunus fasciculata*, and *Larrea divaricata*, did not reduce acetylene.

The rhizospheres of eight desert plant species growing in the plots at the Horticulture Center of UCLA were found to reduce acetylene into ethylene. Among the rhizosphere samples tested, those of *Lycium pallidum* and *Y. schidigera* showed greatest acetylene reduction activity with the former about 1.4 and the latter about 0.7 nmole C_2H_4 produced per g per hr. Projecting to a hypothetical field basis, one may expect an input of about 4.9 kg N/ha/season in a community of *L. pallidum* and about 2.3 kg N/ha/season from atmospheric N fixation in a community of *Y. schidigera*. Of the root samples examined, only those of *Y. schidigera* were able to reduce acetylene, but the rate of the reduction activity is about one-eighth of that of the rhizosphere. Aside from the fact that the main root systems of *Y. schidigera* are fleshy and swollen, there are no apparent nodule formations; probably some ectophytic microbials adhering to the root surfaces rather than endophytes inside the root are the agents for the nitrogen fixing activity.

The rate of acetylene reduction might have been two- to three-fold greater had the initial partial pressure of the acetylene gas inside the bottles been 0.05-0.1 atmospheres, because the apparent K_m value of the nitrogenase system is about 0.02 atmospheres of acetylene. The oxygen level inside the bottles during incubation might not have been a limiting factor for the reduction of acetylene, as the oxygen partial pressure at the end of 8 days of incubation is about 0.15 atmospheres, at which the nitrogenase enzyme still operates at its optimum. Since the incubating condition was aerobic, the organisms responsible for the ethylene formation activity are thought to be aerobic also. The part contributed by the anaerobic nitrogen-fixing organisms is not accounted for here.

It is possible that rhizosphere activity can supply much of the nitrogen needed for primary productivity. The assumptions, however, must be refined in future studies for more precise estimates. The nitrogen needs of the vegetation are met by a combination of symbiotic nitrogen fixation involving higher plants, fixation involving microorganisms without higher plants, mineralization of soil organic matter and other sources of decaying matter, and combined nitrogen coming with rain from the atmosphere. As yet the rates of entry from each source must be determined.

Isolation of Nitrogen-fixing Microbials from the Soils Associated with the Roots of Some Desert Plant Species under Aerobic Conditions

Nitrogen fixation activities in the rhizospheres of some desert plants have been detected and measured and the results recorded in the section above. This section of the study is an attempt to isolate and identify the organisms that may cause the nitrogen-fixing events in the rhizospheres.

Samples were obtained from the rhizophere soils of the desert plants growing in plots at the UCLA Horticulture Center. Approximately 1 g of rhizosphere soil was placed in 99 ml of sterile water and shaken with a magnetic stirrer for 5 min. Dilution series of 1/1000 were prepared. The numbers of possible aerobic nitrogen-fixing microorganisms were estimated by using the nitrogen-deficient medium: 5 g glucose, 0.2 g $MgSO_4 \cdot 7\ H_2O$, 0.04 g $FeSO_4 \cdot 7\ H_2O$, 0.15 g $CaCl_2$, 1 ml micronutrient solution, 15 g purified agar and 1000 ml distilled water. Two replicate Petri plates were inoculated with 1 ml of the dilution and 15 ml of molten medium (45 C) added. Plates were incubated at 23 C in an enclosure beneath a window and examined after 14 days.

Three types of colonies were found growing in the agar plates. The first type is creamy and slimy, with a diameter of about 2-3 mm; the second is dark green, about 1-3 mm in diameter and the third is whitish and mycelial with a diameter between 2-10 mm. The microorganisms in each colony type were examined under a microscope under H-P (1000x).

From the features of the colonies and the characteristics of the microbials within the colonies, three forms of microbials are suspected: (1) *Azotobacter*, (2) photosynthetic bacteria, and (3) Actinomycetes. *Azotobacter* is thought to form the creamy, slimy colonies, the greenish colonies are thought to be made up of the photosynthetic bacteria, and the actinomycetes form the mycelial colonies. The numbers of colonies per colony-type in each soil type are shown in Table 2.

Three forms of microorganisms have been isolated from the soils associated with the roots of the desert plants, using the N-deficient nutrient medium. These microorganisms are probably *Azotobacter*, photosynthetic bacteria and actinomycetes. One might suspect that the greenish colonies are blue-green algae, but the small size of the cells and the fact that they are unicellular may discount the presence of the filamentous nitrogen-fixing blue-green algae. However, since most of the photosynthetic bacteria are anaerobic, further evidence to confirm the presence of photosynthetic bacteria in the soil isolates is desirable. The presence of actinomycetes in appreciable amounts strengthens the notion that these microorganisms are responsible for nitrogen fixation despite the argument by some that actinomycetes do not fix nitrogen. The correlation between the abundance of the nitrogen-fixing microorganisms in the soil samples and the magnitude of the nitrogen fixation is not made here. The abundance of *Azotobacter* may reach a level of 38000 cells/g, that of photosynthetic bacteria 10000 cells/g and that of actinomycetes 3000 cells/g of fresh soil. These results are only preliminary to further information which will be

sought in the field.

Effect of a Readily Available Energy Source on the Nitrogen-fixing Ability of an Agricultural Soil and Desert Soils under Controlled Conditions

The aim of the experiment was to test (1) the effect of added sucrose and (2) the effect of light on the nitrogen-fixing ability of agricultural Yolo loam soil and of desert soils incubated in the laboratory.

The Yolo loam soil is the type regularly used in glasshouses at UCLA. The desert soils were collected in Mercury, Nevada, under shrubs and between shrubs. The soils were air-dried, ground and run through a 1-mm sieve. Three samples of 84 g from each soil type were put into individual 250-ml conical flasks. No sucrose, 0.5 and 1.0 g sucrose was added, into the first, second and third flasks of each soil type. The flasks were shaken and rotated for 1 min to allow distribution of random sucrose crystals in the soil samples. Distilled water (16 ml) was added with a syringe into the soil samples so that the moisture content was about 16% by weight. The opening of each conical flask was covered by plastic wrapping paper to reduce evaporation. The conical flasks were preincubated at 23 C and placed under a daily cycle of 12 hr darkness and 12 hr of light of about 40 ft-c light intensity.

After 10 days of preincubation, two 7 g replicate samples from each flask were transferred into a 27-ml serum bottle sealed by a rubber, sleeve-type stopper. Each bottle was flushed for 10 min with a gas mixture containing 19.96% 0_2, 0.04% CO_2 and 80% Ar. Finally, 0.5 ml of acetylene was added to give a concentration of about 2% in the gas phase. The bottles were incubated for 8 days in the laboratory, with the incubation conditions similar to those of the preincubation.

After 20 days of preincubation in the flasks, the soil samples were transferred into the serum bottles and incubated in the dark for 8 days. The incubation procedures and conditions were similar to those incubated in the light, except that 23 g of soil in 3 replicates from each flask was transferred into a 63-ml serum bottle for incubation. The volume of acetylene used was 1.0 ml per bottle, amounting to about 2% in the gas phase.

The amount of ethylene produced was measured by gas chromatography. The column was a 2.7 m x 3 mm glass tubing filled with 80-100 mesh Poropak-R, operating at 40 C.

The quantities of ethylene produced by the samples incubated with or without light are expressed as shown in Tables 3 and 4. A conversion factor of 3 is adopted to convert acetylene to nitrogen on the molar basis. From Tables 3 and 4 it is perceived that the rate of ethylene production increases with increased concentration of sucrose in samples of Yolo soil. A comparison of Tables 3 and 4 for Yolo soil samples shows that light did increase the amount of acetylene reduction.

The sample of soil between shrubs, when amended with sucrose, produced 1.65 nm C_2H_4/g/hr, or 44 kg N/ha/season (Table 3). Samples under shrubs did not reduce acetylene, while samples between shrubs produced between 0.5 to 1.5 nm C_2H_4/g/hr, when amended with sucrose (Table 4).

It appears that both light and an added energy source like sucrose have positive effects on the rate of fixation of atmospheric nitrogen in the Yolo soil type. Thus, a portion or the majority of the nitrogen-fixing organisms in the Yolo soil are probably photosynthetic, e.g., some blue-green algae and/or photosynthetic bacteria. The effects of light and sucrose amendment on the nitrogen-fixing ability of the desert soils are not conclusive, judging from the present data. However, once acetylene reduction is detected in the desert soil samples, the rates are high, up to 1.65 nm C_2H_4/g/hr (in the sample between shrub and amended with sucrose in the light). The same experiment on desert soils may be improved by

Table 2. Colony counts per plate of 1/1000 dilution (per gram fresh soil)

Soil sources	*Azotobacter*-like	Photosynthetic bacteria-like	*Actinomycete*-like
Atriplex canescens	6	-	3
Atriplex confertifolia	1	21	-
Coleogyne ramosissima	1	9	1
Ephedra nevadensis	10	4	8
Larrea divaricata	19	-	-
Lycium pallidum	0	10	10
Lycium shockleyi	-	-	30
Yucca schidigera	38	-	-
Yolo loam soil	30	-	1
Shrub in desert	8	-	18
Between shrub in desert	22	1	5
Average	12	4.1	7

Table 3. Soil samples incubated in the light. N-fixing ability is assumed to a depth of 10 cm/ha

Soil types	nm C_2H_4/g-hr	kg N/ha-season equiv.
Yolo	-	-
Yolo + sucrose (.5 g/100g)	0.076	2.0
Yolo + sucrose (1. g/100g)	0.506	13.5
Desert under shrub	-	-
" under shrub + sucrose (.5 g/100g)	-	-
" under shrub + sucrose (1 g/100g)	-	-
" between shrub	-	-
" between shrub + sucrose (.5g/100g)	-	-
" between shrub + sucrose (1.g/100g)	1.650	44.2

better mixing of the samples before incubation to reduce the probable localization effects of the nitrogen-fixing organisms in the soils. Nevertheless, it is probable, judging from the results of the present study, that nonsymbiotic nitrogen-fixing organisms are present and common in desert soil, and that their potential to increase the nitrogen content of the desert ecosystem should not be overlooked, especially when the conditions of the surroundings are favorable for nitrogen-fixing activities. From these preliminary studies more intensive studies will be planned including light and temperature gradients.

Table 4. Soil samples incubated in the dark. N-fixing ability is assumed to a depth of 10 cm/ha

Soil types	nm C_2H_4/g-hr	kg N/ha-season equiv.
Yolo	--	--
Yolo + sucrose (.5g/100g)	0.015	0.4
Yolo + sucrose (1.g/100g)	0.038	1.0
Desert under shrub	--	--
" under shrub + sucrose (.5g/100g)	--	--
" between shrub	--	--
" between shrub + sucrose (.5g/100g)	0.565	15.1
" between shrub + sucrose (1.g/100g)	1.550	41.6

Nitrogen Concentrations in Leaves of Desert Plants as an Index to Nitrogen Fixation Relationships

Plant species that have a symbiotic nitrogen relationship (having root nodules with endophytes which fix atmospheric nitrogen) are likely to have higher nitrogen concentrations in leaves than plants which do not. This would occur especially if amounts of nitrogen available were near limiting values. The same situation would occur with plant species having pronounced semi-symbiotic fixation relationships in the rhizosphere. In order to predict species of plants that would be promising for study of atmospheric nitrogen fixation, an evaluation of the characteristics of nitrogen concentrations of leaves of many species was made (Table 5).

The samples for this study were collected over a period of several weeks in April, May and June and therefore represent more than one phenological stage within each species. The methodology was planned in relationship with another study (Romney et al., 1973), but serves the purpose of this phase of the nitrogen transformation study. Several plant species present in Rock Valley have leaves in the early part of the year with especially high concentrations of nitrogen (over 3 and 4% of dry weight) when compared with agricultural crops which usually are around 2% with a range from 1.5 to 3%. The only leguminous plant in this study (*Dalea fremontii*) seemed to have leaves with high nitrogen concentrations during part of the year.

Table 5. Nitrogen concentrations in leaves of desert plants from Rock Valley and other locations at the Nevada Test Site (A3UWS03)

Species	No of samples	Mean N% of dry wt	Standard deviation % N	SEM* % N	CV** % N	Range of % N	Samples over 3.50% N %
Larrea divaricata	50	2.35	0.285	0.040	12.1	1.69-3.11	0
Spaeralcea ambigua	9	2.51	0.518	0.173	20.6	1.60-3.01	0
Krameria parvifolia	17	2.18	0.386	0.094	17.7	1.47-3.00	0
Lycium shockleyi	3	3.09	1.542	0.890	49.9	2.16-4.87	33
Lycium andersonii	40	3.34	0.788	0.125	23.6	1.65-5.34	45
Eurotia lanata	32	2.99	0.597	0.106	20.0	1.40-4.12	32
Grayia spinosa	30	2.70	0.807	0.147	29.9	1.62-5.29	10
Dalea fremontii	9	2.73	0.725	0.242	26.6	2.02-4.24	22
Lycium pallidum	14	2.80	1.015	0.271	36.3	1.12-4.32	36
Stanleya pinnata	9	3.14	0.770	0.257	24.5	1.96-4.20	44
Lepidium fremontii	4	3.23	0.994	0.497	30.8	1.83-4.08	50
Mirabilis pudica	12	3.38	1.115	0.331	33.0	1.42-5.54	33
Atriplex canescens	13	2.47	0.401	0.111	16.2	1.86-3.00	0
Artemisia spinescens	2	2.72	0.042	0.030	1.5	2.69-2.75	0
Acamptopappus shockleyi	32	2.48	0.617	0.109	24.9	1.48-3.87	3
Atriplex confertifolia	21	2.41	0.845	0.184	35.1	1.34-3.90	14
Coleogyne ramosissima	14	1.81	0.278	0.074	15.4	1.35-2.21	0
Ephedra funerea	5	2.84	0.684	0.306	24.1	1.79-3.38	0
Ephedra nevadensis	28	2.40	0.822	0.155	34.3	1.60-4.76	11
Menodora spinescens	12	2.37	0.515	0.149	21.7	1.82-3.21	0
Ambrosia dumosa	43	3.22	0.871	0.133	27.0	1.75-5.11	40
Hymenoclea salsola	3	4.17	0.329	0.190	7.9	3.87-4.52	100
Hilaria rigida	1	2.07	-	-	-		0
Oryzopsis hymenoides	30	1.16	0.441	0.081	38.0	0.37-2.32	0
Tetradymia glabrata	1	1.42	-	-	-		0
Kochia americana	1	4.14	-	-	-		100
Mirabilis bigelovii	1	2.28	-	-	-		0
Haplopappus cooperi	3	2.80	0.666	0.378	23.8	2.34-3.55	33

*Standard error of mean
**Coefficient of variation

Nitrate and Ammonium Nitrogen Uptake by Some Desert Plants

The ability of four desert plant species and a halophyte having some xeric characteristics to take up nitrate and ammonium nitrogen from solution culture was studied. Rooted cuttings of the plants were prepared (Wieland et al., 1971) and pregrown for 40 days in ¼-strength nutrient solution (renewed once) so that the plants would be in a state of low nitrogen at the beginning of the uptake tests. The species used were *Tamarix ramosissima*, *Atriplex canescens*, *Ambrosia dumosa*, *Lycium pallidum*, and *Galenia pubescens*.

The cuttings were transferred to 1700 ml of test solutions containing either 10^{-3}N KNO_3, $(NH_4)_2SO_4$, or NH_4NO_3. Each solution contained 10^{-2}N $CaCl_2$. Each treatment for each plant was done in duplicate. At the conclusion of the tests dry weights of plant parts were determined and the results reported on the root-weight basis, even though whole plants were involved. The rate of nitrogen uptake was determined by periodically (at 0, 4, 8, 24, 48, 82, and 96 hr) sampling the external solution and using an ammonium and a nitrate electrode (Orion) for the analysis.

The rate of uptake by the different species for the two nitrogen sources supplied separately are in Table 6, and in Table 7 when supplied together. In most cases the uptake of ammonium-N exceeded that of nitrate N after 96 hr, but at 4 and 8 hr this was not always the case when the sources were applied separately. When the sources were supplied together there was a tendency for the plants to use a substantial quantity of the ammonium-N before using much of the nitrate ions. Only with ammonium-N taken up by *G. pubescens* and *T. ramosissima* was the nitrogen essentially depleted from the test solutions during the experiment.

With nitrate supplied alone with *T. ramosissima* there

Table 6. Rate of (NO_3-N) and (NH_4-N) uptake from KNO_3 or $(NH_4)_2SO_4$ solutions, respectively, by some desert plants (A3UWS04)

Plant species	Source	Cumulative Uptake by roots at different time intervals, µg/g dry wt						
		0 hr µg/g	4 hr µg/g	8 hr µg/g	24 hr µg/g	48 hr µg/g	72 hr µg/g	96 hr µg/g
1. *Tamarix ramosissima*	NO_3-N	0	102	336	1859	4359	6415	7488
	NH_4-N	0	1851	2079	4351	10311	12832	12832
	NO_3-N/NH_4-N,ratio	0	.06	.16	.43	.42	.50	.58
2. *Atriplex canescens*	NO_3-N	0	962	7607	11902	18566	21396	23849
	NH_4-N	0	215	509	2515	2982	4909	6061
	NO_3-N/NH_4-N,ratio	0	1.87	14.94	4.73	6.23	4.36	3.93
3. *Ambrosia dumosa*	NO_3-N	0	4120	4530	8050	10170	20520	24150
	NH_4-N	0	1759	2896	6869	14138	18434	19310
	NO_3-N/NH_4-N,ratio	0	2.34	1.56	1.17	.72	1.11	.76
4. *Galenia pubescens*	NO_3-N	0	4355	8747	11249	13554	14711	15339
	NH_4-N	0	2099	4148	12911	28143	31000	31605
	NO_3-N/NH_4-N,ratio	0	2.07	2.11	.87	.48	.47	.48
5. *Lycium pallidum*	NO_3-N	0	1229	2833	3600	6916	8978	10602
	NH_4-N	0	630	1244	6148	13059	15300	17778
	NO_3-N/NH_4-N,ratio	0	1.95	2.28	.58	.53	.59	.60

Table 7. Rate of (NO_3-N) and (NH_4-N) uptake from NH_4NO_3 solutions by some desert plants (A3UWS04)

Plant species	Source of N	Cumulative Uptake by roots at different time intervals, µg/g dry wt						
		0 hr µg/g	4 hr µg/g	8 hr µg/g	24 hr µg/g	48 hr µg/g	72 hr µg/g	96 hr µg/g
1. *Tamarix ramosissima*	NO_3-N	0	462	836	1202	1855	2419	2751
	NH_4-N	0	1154	1672	3305	7718	10336	11511
	NO_3-N/NH_4-N, ratio	0	.40	.50	.36	.24	.23	.24
2. *Atriplex canescens*	NO_3-N	0	1457	2400	4743	10308	11571	14629
	NH_4-N	0	4857	6240	7588	14086	15737	201140
	NO_3-N/NH_4-N,ratio	0	.30	.38	.62	.73	.73	.73
3. *Ambrosia dumosa*	NO_3-N	0	2266	4480	6640	9840	12960	16533
	NH_4-N	0	3966	4480	7747	12027	13500	24000
	NO_3-N/NH_4-N,ratio	0	.57	1.00	.86	.82	.96	.70
4. *Galenia pubescens*	NO_3-N	0	1190	3024	6474	10824	13446	15040
	NH_4-N	0	850	5376	12616	21484	25596	27040
	NO_3-N/NH_4-N,ratio	0	1.4	.56	.51	.50	.52	.52
5. *Lycium pallidum*	NO_3-N	0	0	547	722	1961	3698	5043
	NH_4-N	0	1109	1461	4691	6239	7748	9217
	NO_3-N/NH_4-N,ratio	0	-	.37	.15	.31	.48	.55

appeared to be an induction period necessary for the N uptake. With *A. canescens* the same seemed to hold for ammonium uptake.

The results imply that both nitrate and ammonium nitrogen are available to the species studied and that the rates of uptake would not be limiting factors to utilization of available forms in the field. This type of study will be refined and more data obtained.

Table 8. C:N ratios in some profiles at the Nevada Test Site (A3UWS05)

SITE 7

Area - Mercury Valley. Most common species - *Grayia spinosa* and *Larrea divaricata*. Aspect S. Physiography - Bajada. Elevation meters 1049.

Profile type	Horizon	Depth	Organic N	C/N
		cm	%	ratio
shrub	A11	000-009	0.194	12.1
shrub	A12	009-042	0.030	15.0
shrub	C1	042-100	0.026	10.4
bare	A12	000-055	0.034	10.0
bare	C1	055-100	0.028	10.4

SITE 17

Area - Frenchman Flat. Most common species - *Eurotia lanata* and *Grayia spinosa*. Aspect NE. Physiography - Bajada. Elevation meters 994.

shrub	A11	000-009	0.117	12.1
shrub	A12	009-023	0.038	11.3
shrub	C1	023-045	0.024	11.7
shrub	C2	045-064	0.029	10.0
bare	A12	000-020	0.019	11.1
bare	C1	020-039	0.023	10.0
bare	C2	039-054	0.016	18.8

SITE 26

Area - Frenchman Flat. Most common species - *Atriplex canescens* and *Oryzopsis hymenoides*. Aspect SE. Physiography - Playa. Elevation meters 951.

shrub	A1	000-010	0.194	6.8
shrub	A2	010-020	0.044	9.3
shrub	C1	020-056	0.014	10.7
shrub	C2	056-093	0.014	10.7
shrub	C3	093 +	0.011	10.0
bare	A2	000-008	0.018	8.3
bare	C1	008-052	0.010	9.0
bare	C2	052-091	0.012	9.2
bare	C3	091 +	0.012	6.7

SITE 30

Area - Frenchman Flat. Most common species - *Atriplex canescens* and *Stanleya pinnata*. Aspect N. Physiography - Playa. Elevation meters 951.

shrub	A2	000-014	0.062	9.0
shrub	C1	014-029	0.041	9.3
shrub	C2	029-093	0.030	11.3
shrub	C3	093-130	0.026	11.2
shrub	C4	130-200	0.032	7.8

SITE 53

Area - Rock Valley. Most common species - *Ambrosia dumosa* and *Larrea divaricata*. Aspect NW. Physiography - Bajada. Elevation meters 1037.

shrub	A1	000-007	0.049	35.7
shrub	C1	007-016	0.046	10.2
shrub	C2	016-030	0.034	11.8
shrub	C3	030-040	0.039	12.8
shrub	C4	040-056	0.043	9.8
shrub	C5	056-070	0.031	11.2
bare	C1	000-013	0.025	9.2
bare	C2	013-027	0.024	12.5
bare	C3	027-063	0.028	11.4

C:N Ratios in Soils from Rock Valley and Adjacent Areas

Only preliminary information has been obtained on the C:N ratios and related transformations in soils at and near Rock Valley (Table 8). The nitrogen values in Table 1 and those used for calculation of the C:N ratios are organic nitrogen. The ratios are generally within the range of those commonly encountered throughout the world except for some in Yucca Flat. This is in the area which is more transitional to the Great Basin Desert than Rock Valley which is considered to be in the northern Mohave Desert. Even so there are many plant species in Rock Valley which generally grow in the Great Basin Desert so Rock Valley is also a transitional community type. In the areas where the C:N ratios appear to be low, *Grayia spinosa*, *Lycium andersonii* and *Coleogyne ramosissima* seem to predominate. If these low ratios are real for the area encountered, they will need considerable study. One implication is that volatilization and denitrification losses would be low. The ratios are to be further studied.

Nitrate Nitrogen in Some Soil Profiles in the Northern Mohave Desert

A periodic assessment of forms of soil nitrogen is needed, such as the study of Nishita and Haug (1973) in which various forms of nitrogen were determined for soil from near Mercury and Rock Valley. The needed data involve the labile forms in different profile parts in relation to the rhizospheres and non-root-occupied soil on a seasonal basis so that fixation of atmospheric nitrogen and plant depletion of labile nitrogen can be ascertained. We have yet to obtain these data although some of the samples have been collected.

The data in Table 9 comprise a different kind of information than that just described. They represent accumulation in profiles of supposedly large quantities of nitrates from the desert ecosystem in playa basins. After large desert storms we have observed the movement of litter and other debris from the bajadas to the playas. It is expected that, once deposited there and partially buried, decomposition and mineralization will occurr; it is also expected that rain causing runoff will remove soluble forms of nitrogen as well as transferring soil and organic matter to the basins. It is not surprising that nitrates accumulate at some run-in sites because of the apparent large rate of atmospheric

nitrogen fixation. Rates in excess of plant needs for a desert ecosystem will end up as losses from the system. We are planning to have comparative rate losses for flooding, volatilization and denitrification.

The results in Table 9 are preliminary. Some of the discrepancies are due to the fact that EC values and saturation extracts were made on different samples. A balance sheet for an entire closed basin in the Mohave Desert on gains and losses of nitrogen is planned. The sheet will show the rates at which nitrates can accumulate in the playas.

Nitrogen and Other Elements in Shoots and Roots of Desert Plants Excavated in February, March and May, 1972, from Rock Valley and Adjacent Areas

The analysis of roots and stems of desert plants on a periodic and seasonal basis could indicate something of the extent of nitrogen uptake by deciduous plants during the dormant season and also something of the dynamics of transport of nutrients from one plant part to another due to phenological events. The data reported in this section represent some preliminary attempts for determining answers of this type. More values need to be obtained through the dormancy, spring growth and maturation periods so that changes can be substantiated on a statistical basis.

There were indications for some species (Table 10), notably *Lycium pallidum* and *Ambrosia dumosa*, that there was a build-up of nitrogen in roots during the winter (February) and nitrogen depletion during the period of rapid new growth (March).

The data in Table 10 are also of value in assessing the size of the plant compartments in Rock Valley for nitrogen and other nutrients. More data of this type will be obtained.

Carbon and Nutrient Movement from Leaves to Stems before Leaf Abscission of Desert Plants

It has been suspected for several decades that in some, if not most or all, woody plants there is considerable retranslocation of nitrogen and other nutrients, notably phosphorus, potassium and perhaps carbon, from leaves to shoots before leaf abscission.

The migration of the inorganic compounds from the leaves of plants previous to their fall has been studied by Tucker and Tollens (1900), Otto and Kooper (1910), Michel-Durand (1913, 1932), Swart (1914), Serex (1917), Rippel (1921), Combes and Kohler (1922), Seiden (1926), Deleano (1932), Deleano and Bordeianu (1932, 1934), Echevin (1932, Komatsu and Ozawa (1932), McHargue and Roy (1932), Deleano and Andreesco (1931), Murneek and Logan (1932), Thomas (1932), Denny (1933), Polovrageanu (1933), Sampson and Samisch (1935), and others. Leaves studied included those from forest trees, fruit trees and shrubs. With the exception of the findings of McHargue and Roy (1932) for certain forest tress, all the investigators give data that indicate migration of some nitrogen, phosphorus, potassium, magnesium, and even some iron from leaves previous to their fall in autumn. The percentage of migration of a given element based on the maximal amount present during the life of the leaf has been termed

Table 8. (continued)

SITE 64

Area - Jackass Flats. Most common species - *Larrea divaricata* and *Oryzopsis hymenoides*. Aspect N. Physiography - Bajada. Elevation meters 1098.

Profile type	Horizon	Depth cm	Organic N %	C/N ratio
shrub	A11	000-016	0.073	10.4
shrub	A12	016-033	0.060	8.8
shrub	C1	033-058	0.038	8.4
shrub	C2	058-115	0.010	5.0
bare	A12	000-011	0.025	7.2
bare	C1	011-048	0.024	8.3
bare	C2	048-100	0.009	4.4

SITE 74

Area - Yucca Flat. Most common species - *Coleogyne ramosissima* and *Lycium andersonii*. Aspect E. Physiography - Bajada. Elevation meters 1268.

shrub	A11	000-005	0.224	16.4
shrub	A12	005-013	0.118	10.4
shrub	C1	013-024	0.066	12.0
bare	A2	000-007	0.041	10.0
bare	C1	007-029	0.045	10.0

SITE 77

Area - Yucca Flat. Most common species - *Stipa speciosa* and *Coleogyne ramosissima*. Aspect E. Physiography - Bajada. Elevation meters 1402.

shrub	A1	000-015	0.134	9.0
shrub	A3	015-046	0.069	5.1
shrub	B2	046-089	0.049	3.5
bare	A3	000-036	0.052	4.0
bare	B2	036-079	0.049	3.7

SITE 78

Area - Yucca Flat. Most common species - *Grayia spinosa* and *Stipa speciosa*. Aspect E. Physiography - Bajada. Elevation meters 1463.

shrub	A1	000-005	0.264	14.4
shrub	C1	005-031	0.049	6.5
shrub	C2	031-082	0.043	7.0
shrub	C3	082-112	0.038	6.1
bare	C1	000-026	0.044	4.8
bare	C2	026-076	0.043	5.6
bare	C3	076-108	0.039	5.9

SITE 79

Area - Yucca Flat. Most common species - *Grayia spinosa* and *Lycium andersonii*. Aspect E. Physiography - Bajada. Elevation meters 1341.

shrub	A1	000-007	0.176	7.2
shrub	C1	007-030	0.061	4.9
shrub	C2	030-059	0.058	5.3
shrub	C3	059-113	0.033	5.8
bare	C1	000-018	0.039	5.6
bare	C2	018-046	0.047	5.3
bare	C3	046 +	0.034	6.5

"reabsorption coefficient." The value of the reabsorption coefficient reported by various investigators has ranged from 1 to 90% for the different leaves and elements considered, but 25 to 50% is the range usually encountered.

Table 9. Soil profiles; some having sizeable quantities of soluble nitrates (A3UWS06)

SITE 1

Area - Mercury Valley. Slope 3%. Physiography - Bajada.

Profile type	Horizon	Depth cm	EC 25 mmhos/cm	Sat. ex. NO_3, meq/l
shrub	A1	000-005	3.48	0.05
shrub	C1	005-034	1.53	0.00
bare	C1	000-025	0.65	0.00

SITE 3

Area - Mercury Valley. Slope 3%. Physiography - Bajada.

shrub	A1	000-010	1.63	0.00
shrub	C1	010-048	0.68	0.00
bare	C1	000-042	0.39	0.00

SITE 6

Area - Mercury Valley. Slope 2%. Physiography - Bajada.

shrub	A1	000-008	5.22	0.00
shrub	C1	008-028	2.37	0.00
shrub	C2C	028-068	3.48	0.00
bare	C1	000-019	0.36	0.00
bare	C2C	019-048	0.64	0.00

SITE 8

Area - Mercury Valley. Slope 2%. Physiography - Bajada.

shrub	A11	000-011	2.80	0.00
shrub	A12	011-040	0.58	0.00
shrub	C1	040-060	0.65	0.00
shrub	C2	060-125	0.74	0.00
bare	A12	000-010	0.52	0.00
bare	C1	010-055	0.39	0.00
bare	C2	056-112	0.56	0.00

SITE 9

Area - Mercury Valley. Slope 1%. Physiography - Bajada.

shrub	A11	000-008	1.66	0.00
shrub	A12	008-018	0.78	0.00
shrub	A13	018-036	0.66	0.00
shrub	C1	036-062	0.50	0.00
shrub	C2	062 +	2.80	18.00
bare	A12	000-017	0.40	0.00
bare	A13	017-030	0.26	0.00
bare	C1	030-050	0.28	0.00
bare	C2	050 +	0.76	0.00

SITE 10

Area - Mercury Valley. Slope - 1%. Physiography - Bajada.

shrub	A11	000-007	2.53	0.00
shrub	A12	007-019	1.56	0.00
shrub	C1	019-040	0.58	16.00
shrub	C2	040-052	1.27	20.00
shrub	C3	052 +	4.09	74.00
bare	A12	000-015	0.36	10.00
bare	C1	015-033	0.31	0.00
bare	C2	033-044	0.30	0.00
bare	C3	044 +	0.29	0.00

Table 9. (continued)

SITE 12

Area - Mercury Valley. Slope - 1%. Physiography - Bajada.

Profile type	Horizon	Depth cm	EC 25 mmhos/cm	Sat. ex. NO_3, meq/l
shrub	A11	000-005	2.66	0.00
shrub	A12	005-011	3.33	13.00
shrub	C1	011-032	2.31	53.20
shrub	C2	032-050	0.79	8.00
bare	A12	000-012	1.00	0.00
bare	C1	012-029	0.40	0.00
bare	C2	029-040	0.30	0.00

SITE 13

Area - Mercury Valley. Slope - 3%. Physiography - Bajada.

shrub	A11	000-007	2.32	0.00
shrub	A12	007-015	1.96	30.00
shrub	C1	015-034	0.88	0.00
shrub	C2	034-063	1.55	34.00
bare	A12	000-018	0.52	0.00
bare	C1	018-039	0.37	0.00

SITE 17

Area - Mercury Valley. Slope - 1%. Physiography - Bajada.

shrub	A11	000-009	4.35	1.25
shrub	A12	009-023	3.30	2.50
shrub	C1	023-045	0.85	0.00
shrub	C2	045-064	0.87	0.00
bare	A12	000-010	0.30	0.00
bare	C1	010-048	0.31	0.00

SITE 18

Area - Frenchman Flat. Slope - 2% Physiography - Bajada.

shrub	A1	000-011	2.83	22.00
shrub	A2	011-021	1.00	8.00
shrub	C1	021-048	0.53	0.00
shrub	B1	048-117	1.28	16.00
shrub	C2	117-149	2.68	94.00
bare	A2	000-009	0.46	3.60
bare	C1	009-047	0.30	0.00
bare	B1	047-095	0.47	4.00
bare	C2	095 +	1.34	30.00

SITE 19

Area - Frenchman Flat. Slope - 1%. Physiography - playa.

shrub	A1	000-012	1.02	14.00
shrub	C1	012-047	0.57	4.00
shrub	C2	047 +	0.94	4.00

SITE 20

Area - Frenchman Flat. Slope - 1%. Physiography - playa.

shrub	C1	000-006	0.59	8.00
shrub	C2	006-065	0.50	7.00
shrub	C3	065-091	0.53	0.00
shrub	C4	091-113	1.38	2.60

SITE 21

Area - Frenchman Flat. Slope - 1%. Physiography - playa.

bare	C1	000-016	0.53	0.00
bare	C2	016-061	0.42	0.00
bare	C3	061-108	0.90	1.20
bare	C4	108-152	2.90	9.40

Table 9. (continued)

SITE 22

Area - Frenchman Flat. Slope - 1%. Physiography - Bajada.

Profile type	Horizon	Depth cm	EC 25 mmhos/cm	Sat. Ex. NO_3, me/l
shrub	A1	000-015	2.17	4.40
shrub	C1	015-043	1.30	3.10
shrub	C2	043-084	1.11	1.90
shrub	C3	084-118	3.48	81.20
shrub	C4	118-186	4.35	106.20
bare	C1	000-032	0.54	1.20
bare	C2	032-069	0.64	1.90
bare	C3	069-108	3.26	17.50
bare	C4	108-141	3.26	23.10

SITE 23

Area - Frenchman Flat. Slope - 1%. Physiography - Bajada.

shrub	A1	000-008	2.22	14.00
shrub	C1	008-037	0.82	10.00
shrub	C2	037-082	0.76	12.00
shrub	C3	082-137	1.46	30.00
shrub	C4	137 +	4.25	131.00
bare	C1	000-026	0.42	4.40
bare	C2	026-066	0.31	1.00
bare	C3	066-134	0.43	4.00
bare	C4	134 +	1.31	24.00

SITE 24

Area - Frenchman Flat. Slope - 1%. Physiography - Bajada.

shrub	A1	000-012	1.96	11.00
shrub	C1	012-045	0.85	7.00
shrub	C2	045-085	0.71	16.00
shrub	C3	085-128	3.64	116.00
shrub	C4	128-170	6.38	150.00
bare	C1	000-032	0.64	8.00
bare	C2	032-082	0.35	2.00
bare	C3	082-124	1.20	24.00
bare	C4	124-152	4.25	131.00

SITE 29

Area - Frenchman Flat. Slope - 2%. Physiography - Bajada.

shrub	A1	000-009	1.89	0.00
shrub	C1	009-028	0.96	0.00
shrub	C2	028-046	0.78	0.00
shrub	C3	046-067	0.75	0.00
shrub	C4	067-115	1.00	0.00
shrub	C5	115-150	3.92	285.00
bare	C1	000-019	0.70	0.00
bare	C2	019-047	0.64	0.00
bare	C3	047-077	0.67	0.00
bare	C4	077-112	2.83	85.00
bare	C5	112-145	3.64	285.00
bare	C6	145-193	5.10	222.50

SITE 38

Area - Frenchman Flat. Slope - 0%. Physiography - playa.

bare	A1	000-012	3.33	0.00
bare	A2	012-023	1.02	0.00
bare	C1	023-066	2.96	75.00
bare	C2	066-075	13.30	387.50
bare	C3	075-090	53.20	156.20
bare	C4	090-094	53.20	150.00
bare	C5	094-100	3.80	50.00
bare	C6	100-129	3.30	33.70
bare	C7	129-156	4.84	46.20

Table 10. Nitrogen and other elements in plant parts of several species of desert plants collected periodically; dry weight basis (A3UWS07)

Lycium pallidum February 15, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	over 30	25.00	1.61	0.091	0.34	1.78	0.15	0.013	0.08	54.2	1.4
Small stem	"	52.00	1.62	0.081	0.43	1.97	0.21	0.017	0.08	65.4	1.4
Large stem	15-30	61.00	1.37	0.071	0.36	2.02	0.12	0.010	0.08	61.2	1.4
Small stem	15-30	77.00	1.60	0.119	0.43	2.47	0.23	0.019	0.14	73.8	1.9
Large stem	0-15	201.00	1.72	0.306	0.56	2.63	0.23	0.062	0.78	82.3	12.4
Small stem	0-15	67.00	1.60	0.090	0.46	1.99	0.15	0.017	0.14	58.3	1.9
Large root	0-10	112.06	1.88	0.228	0.34	2.68	0.21	0.048	0.77	82.0	14.7
Small root	0-10	11.39	2.31	0.498	0.74	3.08	0.42	0.104	1.41	85.8	28.3
Large root	10-20	248.60	1.93	0.188	0.32	2.80	0.16	0.037	0.59	82.3	8.8
Small root	10-20	50.93	2.65	0.324	1.04	2.60	0.21	0.072	0.69	73.1	13.1
Large root	20-30	105.60	2.23	0.090	0.73	2.53	0.13	0.051	0.40	73.1	4.4
Small root	20-30	29.89	2.73	0.162	1.00	2.68	0.19	0.064	0.47	67.7	5.7
Large root	30-40	53.03	2.45	0.141	0.76	2.43	0.16	0.059	0.56	86.2	7.7
Small root	30-40	31.90	2.90	0.047	0.88	2.49	0.18	0.066	0.59	72.7	11.6
Large root	40-70	65.75	2.38	0.065	0.74	2.05	0.12	0.053	0.46	72.2	6.6
Small root	40-70	52.00	2.82	0.136	0.94	2.33	0.15	0.065	0.39	81.4	8.0

Lycium pallidum March 21, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	30-42	0.60	0.86	0.071	0.45	1.11	0.13	0.014	0.02	29.8	0.7
Small stem	30-42	0.40	0.95	0.064	0.64	1.59	0.2	0.018	0.03	45.2	1.1
Leaves	30-42	0.44	3.11	0.198	1.38	4.67	1.15	1.25	0.10	101.2	3.4
Large stem	20-30	4.40	1.12	0.084	0.42	2.84	0.13	0.012	0.03	69.6	1.1
Small stem	20-30	3.60	1.1o	0.076	0.62	3.16	0.24	0.021	0.06	72.6	1.6
Leaves	20-30	2.84	2.90	0.178	1.69	5.07	1.26	1.39	0.13	123.2	4.0
Large stem	10-20	5.35	1.07	0.071	0.33	2.54	0.09	0.011	0.11	60.0	1.9
Small stem	20-20	8.58	1.05	0.061	0.56	2.52	0.16	0.19	0.13	65.6	2.1
Leaves	10-20	2.98	3.14	0.13	1.69	5.42	1.14	1.28	0.13	145.2	4.5
Large stem	0-10	10.69	1.03	0.276	0.54	2.81	0.18	0.74	0.83	70.2	14.2
Small stem	0-10	7.57	1.08	0.057	0.34	2.92	0.09	0.008	0.04	66.8	0.9
Leaves	0-10	1.38	2.80	0.187	1.95	4.78	1.18	1.42	0.40	131.5	6.6
Large stem	dead stem	5.28	1.11	0.041	0.19	3.72	0.10	0.012	0.11	87.4	2.8
Small stem	"	2.22	1.17	0.047	0.09	2.02	0.08	0.007	0.10	46.4	1.6
Large root	0-10	23.56	1.45	0.417	0.86	4.96	0.30	0.080	1.04	125.5	17.9
Small root	0-10	3.52	1.93	0.174	0.95	4.95	0.24	0.053	0.31	117.8	5.2
Large root	10-20	3.79	1.74	0.236	0.30	2.50	0.20	0.027	0.56	79.8	5.4
Small root	10-20	5.70	2.28	0.273	0.98	5.11	0.23	0.055	0.39	112.7	5.9
Large root	20-50	9.90	1.97	0.229	0.75	2.54	0.23	0.045	0.45	74.8	3.3
Small root	20-50	3.86	2.15	0.267	0.90	3.83	0.29	0.0	0.47	105.3	8.2

Table 10. (continued)

Lycium pallidum May 8, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	30-50	25.79	1.37	0.026	3.38	2.13	0.15	0.016	0.18	54.1	2.2
Small stem	30-50	42.20	1.30	0.049	3.46	1.54	0.13	0.014	0.11	38.3	1.4
Leaves	30-50	6.47	2.52	0.024	5.78	5.18	1.36	1.33	0.22	108.7	4.5
Large stem	15-30	58.29	1.29	0.031	2.84	1.92	0.08	0.011	0.08	45.8	1.0
Small stem	15-30	35.43	1.51	0.053	3.24	1.82	0.12	0.013	0.08	43.6	1.0
Leaves	15-30	2.37	2.40	0.011	4.75	4.78	1.13	0.98	0.17	104.2	3.4
Large stem	0-15	68.17	1.30	0.020	3.29	1.69	0.08	0.022	0.44	46.1	5.3
Small stem	0-15	12.65	1.57	0.055	4.09	1.78	0.15	0.014	0.12	44.4	1.4
Leaves	0-15	0.29	2.75	0.07	6.22	3.89	0.88	1.10	0.43	98.5	7.2
Large root	0-10	65.76	1.66	0.248	3.10	2.92	0.19	0.31	0.001	72.7	22.0
Small root	0-10	1.74	1.99	0.086	6.04	2.20	0.07	0.039	0.22	59.8	2.5
Large root	10-20	46.47	1.87	0.066	4.03	2.49	0.15	0.050	0.97	66.1	13.9
Small root	10-20	24.12	2.80	0.201	4.15	2.11	0.10	0.040	0.55	54.6	5.1
Large root	20-30	42.74	2.51	0.016	3.26	2.46	0.09	0.033	0.52	78.6	7.0
Small root	20-30	15.75	2.85	0.005	3.76	2.21	0.12	0.044	0.66	70.5	8.6
Large root	30-40	11.92	2.31	-	4.01	1.93	0.10	0.038	0.64	64.8	8.7
Small root	30-40	5.37	2.44	0.005	3.57	2.76	0.12	0.044	0.63	72.9	8.7
Large root	40-50	18.87	2.32	0.046	3.39	1.52	0.09	0.031	0.36	46.2	4.8
Small root	40-50	7.87	2.55	-	4.34	2.33	0.12	0.046	0.55	68.3	6.9

Ambrosia dumosa February 15, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	above 20	16.25	0.86	0.094	1.78	1.12	0.32	0.016	0.13	31.9	4.5
Small stem	"	27.00	0.58	0.075	1.75	1.23	0.32	0.023	0.13	37.7	5.7
Large stem	0-20	72.00	0.57	0.085	0.71	0.79	0.21	0.026	0.40	24.1	7.7
Small stem	0-20	149.0	0.53	0.028	1.06	0.87	0.23	0.20	0.24	23.4	5.4
Large root	0-10	79.60	1.03								
Small root	0-10	1.00	0.72	0.267	1.06	0.98	0.32	0.122	0.001	42.1	34.0
Large root	10-20	36.48	0.84	0.054	0.83	1.35	0.25	0.064	0.81	46.4	16.6
Small root	10-20	4.76	1.33	0.266	1.22	1.82	0.37	0.081	0.73	47.1	14.5
Large root	20-30	29.03	1.04	0.206	0.92	1.47	0.33	0.065	0.62	35.1	12.3
Small root	20-30	4.41	1.14	0.526	1.63	1.66	0.45	0.101	1.06	31.9	17.8
Large root	30-40	7.45	1.14	0.232	1.10	1.81	0.33	0.071	0.83	43.8	14.3
Small root	30-40	18.17	1.02	0.348	0.76	1.78	0.37	0.083	1.05	43.8	14.3
Large root	40-70	20.99	1.20	0.238	0.85	1.95	0.26	0.057	0.64	41.2	17.0
Small root	40-70	16.73	1.62	0.151	1.04	2.34	0.321	0.071	0.90	65.2	14.5

Table 10. (continued)

Ambrosia dumosa March 21, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	0-10	10.36	0.74	0.034	1.37	1.26	0.37	0.071	0.40	35.4	11.3
Small stem	0-10	14.21	0.74	0.005	1.28	1.35	0.38	0.330	0.25	43.6	9.7
Leaves	0-10	2.61	2.53	0.202	2.25	2.30	0.65	0.085	0.35	47.3	11.1
Large root	0-10	16.82	0.46	0.005	0.85	1.14	0.38	0.056	0.57	42.6	17.7
Small root	0-10	0.51	0.58	0.013	2.01	1.06	0.36	0.098	0.31	37.4	23.7
Large root	10-20	12.44	0.67	0.028	0.84	1.37	0.26	0.079	0.33	38.8	8.8
Small root	10-20	7.37	0.64	0.005	1.14	1.31	0.34	0.099	0.51	38.8	12.8
Large root	20-30	1.88	0.74	0.005	0.68	1.59	0.35	0.083	0.51	38.2	9.6
Small root	20-30	1.79	0.70	-	1.29	1.60	0.33	0.520	0.38	41.2	9.9
Small root	30-50	0.21	0.94	0.005	0.99	1.66	0.49	0.650	0.60	39.7	9.8

Ambrosia dumosa May 8, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	0-20	23.60	0.69	-	2.34	0.84	0.38	0.027	0.52	40.8	6.7
Small stem	0-20	21.84	0.71	0.037	2.40	1.54	0.46	0.026	0.18	43.9	4.8
Leaves	0-20	14.13	1.87	0.316	2.16	5.69	0.69	0.056	0.70	107.0	10.8
Flower	0-20	1.76	2.21	0.164	2.49	1.76	0.30	0.032	0.43	37.4	5.7
Large root	0-10	10.90	0.57	0.172	2.25	0.67	0.29	0.053	0.64	31.9	16.0
Small root	0-10	1.10	0.79	-	2.66	0.68	0.36	0.031	0.59	33.3	6.8
Large root	10-20	4.14	0.83	0.005	1.87	0.43	0.21	0.022	0.40	25.1	6.7
Small root	10-20	4.05	1.02	-	2.86	0.48	0.35	0.032	0.47	27.4	5.0
Large root	20-30	2.14	0.89	0.023	2.24	0.56	0.26	0.036	0.33	27.4	5.8
Small root	20-30	2.56	1.35	-	3.15	0.76	0.30	0.040	0.30	31.3	3.4
Large root	30-40	1.14	0.91	-	2.87	0.44	0.38	0.067	0.75	33.9	8.9
Small root	30-40	1.30	1.21	-	3.05	0.58	0.30	0.065	0.42	23.8	8.3

Table 10. (continued)

Ephedra nevadensis February 15, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	20-38	10.21	0.85	0.035	0.32	3.27	0.29	0.013	0.20	108.7	9.0
Small	20-38	22.74	0.81	0.046	0.30	2.74	0.28	0.011	0.18	159.9	10.8
Large stem	0-20	71.00	0.62	0.243	0.26	1.84	0.15	0.036	0.75	38.4	9.2
Small stem	0-20	90.00	0.77	0.036	0.39	2.86	0.23	0.010	0.18	109.0	7.7
Large root	0-10	121.00	0.70	0.099	0.16	1.84	0.12	0.034	0.57	40.7	11.4
Small root	0-10	16.32	0.76	0.066	0.34	2.61	0.16	0.033	0.66	63.1	17.5
Large root	10-20	17.87	0.68	0.077	0.48	1.92	0.15	0.036	0.27	46.6	7.8
Small root	10-20	3.38	0.84	0.056	0.60	2.60	0.24	0.032	0.53	64.2	14.8
Large root	20-50	34.61	0.69	0.034	0.41	2.19	0.13	0.027	0.36	55.0	9.6
Small root	20-50	17.16	0.62	-	0.20	2.71	0.15	0.023	0.42	75.9	11.3
Large stem	30-55	2.81	1.09	0.026	0.52	2.52	0.22	0.022	0.32	58.3	6.1
Small stem	30-55	5.09	1.23	0.079	0.50	2.29	0.27	0.010	0.06	93.3	7.9
Large stem	15-30	7.36	0.87	0.005	0.33	2.03	0.10	0.011	0.24	35.5	4.9
Small stem	15-30	10.23	1.38	0.061	0.44	2.79	0.28	0.009	0.11	104.5	9.1
Large stem	0-15	24.38	0.84	0.583	0.72	1.89	0.40	0.159	0.001	34.5	34.0
Small wtem	0-15	6.48	0.68	0.005	0.16	1.36	0.80	0.008	0.19	31.5	4.4
Larte root	0-10	10.03	0.79	0.030	0.27	2.32	0.10	0.040	0.66	38.9	11.9
Large root	10-20	5.55	0.77	0.010	0.13	1.39	0.80	0.008	0.15	39.6	4.5
Small root	10-20	1.05	0.70	0.010	0.13	1.39	0.09	0.005	0.16	32.9	4.1
Large root	20~	7.16	0.75	-	0.21	1.61	0.11	0.019	0.46	43.1	10.4
Small root	20 ~	2.38	0.70	-	0.21	1.61	0.13	0.019	0.49	39.2	7.8

Ephedra nevadensis May 8, 1973

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	30-50	5.82	0.95	0.064	0.67	2.76	0.31	0.006	0.10	54.3	1.8
Small stem	30-50	12.43	1.33	0.068	0.98	2.57	0.33	0.008	0.12	79.5	3.2
Large stem	15-30	15.03	0.85	0.024	0.53	2.94	0.23	0.007	0.13	48.5	2.1
Small stem	15-30	35.45	1.00	0.040	0.58	2.96	0.29	0.007	0.10	80.6	3.0
Large stem	0-15	34.06	0.91	0.109	0.44	1.69	0.13	0.022	0.62	27.6	6.9
Small stem	0-15	29.00	0.86	-	0.38	3.87	0.48	0.020	0.42	73.1	4.9
Large root	0-10	21.25	1.07	0.060	0.42	1.53	0.13	0.028	0.72	21.0	5.7
Small root	0-10	0.96	0.93	0.020	0.35	1.50	0.07	0.008	0.20	21.6	2.7
Large root	10-20	8.38	0.87	0.044	0.42	1.71	0.09	0.006	0.21	21.3	1.5
Small root	10-20	4.02	0.98	-	0.42	1.64	0.12	0.018	0.39	27.6	3.8
Large root	20-30	13.57	0.85	0.095	0.31	1.45	0.07	0.008	0.11	21.3	1.9
Small root	20-30	19.01	1.26	-	0.23	2.17	0.08	0.018	0.36	49.9	5.5
Large root	30-40	14.07	1.29	-	0.12	2.25	0.08	0.010	0.42	55.1	4.8
Small root	30-40	7.60	1.55	0.195	0.66	2.04	0.09	0.022	0.49	49.1	5.8
Large root	40 down	1.74	1.80	0.009	0.25	2.36	0.07	0.010	0.19	56.8	3.3
Small root	"	3.87	1.56	0.019	0.42	2.23	0.07	0.010	0.19	52.0	3.9

Table 10. (continued)

Atriplex canescens February 15, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	over 30	3.84	0.96	0.038	1.58	0.89	0.47	0.006	0.06	31.3	1.4
Small stem	"	5.80	0.82	0.047	1.61	2.06	0.51	0.008	0.05	51.4	2.2
Large stem	15-30	13.41	0.95	0.048	1.24	0.75	0.42	0.003	0.03	27.4	1.0
Small stem	15-30	8.00	0.79	0.029	1.45	1.13	0.42	0.007	0.08	43.8	2.6
Large stem	0-15	28.37	1.38	0.194	1.07	1.84	0.57	0.052	0.46	64.2	7.0
Small stem	0-15	7.42	1.04	0.058	1.13	0.93	0.46	0.005	0.07	34.8	1.5
Large root	0-10	13.12	1.99	0.358	0.48	3.64	0.57	0.040	0.70	120.8	9.6
Small root	0-10	1.59	1.66	0.208	0.90	3.03	0.66	0.027	0.24	94.2	4.1
Large root	10-20	10.58	2.03	0.350	0.69	3.17	0.52	0.029	0.32	88.3	4.1
Small root	10-20	5.48	1.84	0.198	1.40	2.63	0.73	0.031	0.14	83.9	3.3
Large root	20-50	19.32	3.03	0.480	1.51	2.25	0.89	0.101	0.68	96.0	9.1
Small root	20-50	10.50	2.41	0.207	2.27	1.91	0.76	0.082	0.58	65.5	8.1

Atriplex canescens May 8, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	15-33	6.71	0.77	0.011	1.34	0.62	0.46	0.008	0.34	29.2	9.0
Small stem	15-33	14.86	0.75	0.014	1.49	0.93	0.41	0.007	0.10	28.4	8.2
Leaves	15-33	9.13	2.36	0.495	4.00	1.65	1.25	0.055	0.48	28.0	16.1
Large stem	0-15	32.09	0.95	0.074	1.32	0.92	0.57	0.019	0.40	22.8	8.6
Small stem	0-15	32.54	0.67	-	1.09	0.55	0.42	0.006	0.23	26.8	7.2
Leaves	0-15	7.07	2.37	0.653	3.82	1.83	1.34	0.060	0.73	28.3	20.7
Large root	0-10	15.39	1.68	0.105	1.50	1.46	0.69	0.042	0.76	38.3	9.4
Small root	0-10	2.77	1.17	0.032	2.91	0.97	0.82	0.046	0.20	31.7	10.1
Large root	10-20	8.34	1.22	0.171	1.54	1.27	0.59	0.024	0.35	41.1	7.2
Small root	10-20	6.73	1.28	0.067	2.61	0.87	0.88	0.078	0.40	31.8	12.1
Large root	20-30	12.15	1.47	0.074	2.42	0.86	0.68	0.054	0.22	34.8	6.3
Small root	20-30	11.25	1.31	0.005	2.49	0.76	0.78	0.44	0.20	30.5	7.8
Large root	30-40	2.65	1.21	-	2.70	0.69	0.82	0.49	0.40	41.9	12.3
Small root	30-40	2.54	1.49	0.056	3.03	0.73	0.71	0.095	0.16	29.6	7.0
Large root	40-70	4.61	1.46	0.050	4.49	0.58	0.80	0.68	0.20	32.6	5.3
Small root	40-70	5.70	1.30	0.005	3.40	0.51	0.80	0.79	0.28	28.2	8.2
Small root	70-120	2.14	1.41	0.019	3.99	0.44	0.83	0.96	0.29	23.8	5.6

Table 10. (continued)

Larrea divaricata February 15, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	over 10	2.07	1.14	0.081	0.84	0.90	0.31	0.041	0.54	32.2	6.6
Small stem	"	3.41	1.49	0.439	1.10	0.89	0.44	0.095	1.11	26.6	21.3
Large stem	0-10	7.72	1.11								
Small stem	0-10	6.62	1.20	0.521	1.09	1.03	0.52	0.107	0.001	44.6	25.9
Large root	0-10	5.49	1.27	0.113	0.92	1.65	0.17	0.047	0.40	40.4	7.3
Small root	0-10	0.16	1.26	0.265	0.78	1.09	0.11	0.019	0.21	32.0	3.0
Large root	10-20	4.55	1.48	0.054	0.83	1.35	0.25	0.021	0.81	32.0	3.0
Small root	10-20	1.73	1.32	0.102	1.17	1.42	0.28	0.056	0.40	39.1	4.4
Large root	20-40	3.46	1.11	0.097	0.71	1.95	0.25	0.046	0.48	40.9	8.0
Small root	20-40	3.91	1.45	0.214	0.73	1.29	0.19	0.055	0.61	44.9	11.1

Larrea divaricata March 21, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	30-40	8.29	0.92	0.078	0.58	1.06	0.12	0.015	0.14	35.2	3.3
Small stem	30-40	16.29	1.32	0.856	1.77	1.27	0.63	0.60	0.001	42.8	33.6
Leaves	30-40	57.34	1.68	0.545	2.07	1.30	0.59	0.138	1.24	36.6	13.6
Stem	20-30	17.77	1.02	0.136	0.52	1.16	0.13	0.017	0.20	37.2	2.4
Small stem	20-30	22.03	1.17	0.325	1.10	1.03	0.42	0.084	1.03	38.8	14.8
Leaves	20-30	60.15	1.68	0.783	2.41	1.48	0.63	0.59	1.48	47.8	28.9
Large stem	10-20	31.49	0.95	0.125	0.41	1.28	0.11	0.010	0.12	40.7	2.5
Small stem	10-20	13.99	0.99	0.239	0.73	0.99	0.28	0.066	0.65	39.3	12.0
Leaves	10-20	15.18	1.52	0.740	2.59	1.29	0.56	0.70	0.001	39.4	35.7
Large stem	0-10	40.16	1.30	0.865	1.36	1.91	0.42	0.58	0.001	58.6	32.8
Small stem	0-10	4.35	1.03	--	--	--	--	--	--	--	--
Leaves	0-10	0.88	1.21	0.745	4.12	1.36	0.78	1.43	0.001	35.9	57.7
Large root	0-10	23.89	1.11	0.165	0.55	1.38	0.12	0.031	0.37	42.1	5.6
Small root	0-10	2.04	1.28	0.194	0.63	1.56	0.13	0.015	0.16	47.7	2.7
Large root	10-20	33.09	1.43	0.201	0.70	1.68	0.12	0.011	0.09	55.3	3.1
Small root	10-20	10.56	1.68	0.166	0.82	1.73	0.16	0.024	0.33	64.1	6.2
Large root	20-30	14.00	1.63	0.162	0.71	1.68	0.13	0.016	0.23	63.6	4.0
Small root	20-30	5.25	1.49	0.131	0.85	2.34	0.23	0.029	0.40	82.6	11.3
Large root	30-40	4.77	1.49	0.138	0.65	1.71	0.15	0.019	0.19	69.7	5.0
Small root	30-40	1.58	1.47	0.121	1.12	2.07	0.24	0.051	0.60	82.2	10.7

Table 10. (continued)

Larrea divaricata May 8, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	45-70	16.74	0.99	0.020	3.20	1.05	0.06	0.006	0.12	33.6	1.3
Small stem	45-70	38.18	1.40	0.038	4.40	0.93	0.18	0.028	0.43	41.2	4.7
Leaves	45-70	60.66	1.66	0.168	5.64	0.99	0.24	0.051	0.54	27.5	5.2
Large stem	45-70	59.20	0.79	0.036	3.03	0.98	0.05	0.006	0.07	31.3	1.1
Small stem	30-45	44.76	0.94	0.035	3.88	0.71	0.12	0.036	0.38	30.1	4.0
Leaves	30-45	46.49	1.93	0.157	5.21	1.16	0.30	0.057	0.84	37.5	8.9
Large stem	15-30	130.19	0.68	0.005	3.24	0.50	0.04	0.006	0.12	14.6	2.2
Small stem	15-30	55.46	0.72	0.102	4.32	0.99	0.16	0.044	0.71	31.9	8.6
Leaves	15-30	20.36	1.71	0.070	6.67	0.99	0.31	0.088	0.90	41.3	11.3
Large stem	0-15	323.56	0.89	0.226	2.75	1.22	0.13	0.032	0.87	39.1	13.7
Small stem	0-15	77.92	0.69	0.073	2.77	0.83	0.11	0.026	0.63	24.6	9.9
Leaves	0-15	0.44	1.54	0.167	4.96	1.83	0.31	0.066	0.82	52.0	16.1
Large root	0-10	147.38	1.32	0.504	2.98	2.73	0.24	0.48	0.001	72.5	27.3
Small root	0-10	17.30	1.30	0.157	3.41	2.43	0.12	0.034	0.65	67.0	9.7
Large root	10-20	146.10	1.40	0.020	2.48	2.43	0.11	0.026	0.52	69.9	9.4
Small root	10-20	19.53	1.56	0.016	3.74	2.40	0.12	0.024	0.45	69.4	6.6
Large root	20-40	115.83	1.30	-	3.00	2.46	0.14	0.029	0.65	73.5	10.0
Small root	20-40	47.39	1.37	0.020	3.02	2.37	0.11	0.018	0.28	66.7	6.0
Large root	40 down	42.34	1.42	0.080	3.42	2.80	0.10	0.010	0.30	82.2	4.1
Small root	"	35.00	1.37	0.078	3.85	2.69	0.18	0.034	0.50	79.8	7.5

Lycium andersonii February 15, 1973

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	30-50	50.17	1.01	0.071	0.36	2.00	0.17	0.004	0.09	30.0	2.2
Small stem	30-50	50.59	1.22	0.091	0.50	2.45	0.25	0.013	0.16	38.1	3.0
Large stem	15-30	112.00	0.82	0.026	0.21	1.18	0.11	0.004	0.09	18.9	1.8
Small stem	15-30	126.00	0.95	0.020	0.44	1.71	0.16	0.021	0.36	26.1	7.2
Large stem	0-15	233.50	0.85	0.021	0.25	1.78	0.12	0.011	0.26	28.5	3.5
Small stem	0-15	128.72	0.95	0.050	0.31	1.65	0.14	0.137	0.31	27.0	5.0
Large root	0-10	268.50	1.11	0.137	0.24	3.24	0.16	0.401	0.67	56.0	13.2
Small root	0-10	15.27	1.01	0.094	0.40	2.35	0.21	0.035	0.58	41.4	9.3
Large root	10-20	33.45	1.31	-	-	-	-	-	-	-	-
Small root	10-20	14.19	1.43	-	-	-	-	-	-	-	-
Large root	20-30	60.00	1.26	0.083	0.24	1.75	0.06	0.014	0.23	24.4	2.5
Small root	20-30	28.52	1.66	-	0.20	2.14	0.13	0.014	0.34	35.3	5.5
Large root	30-40	90.00	1.32	0.053	0.18	2.52	0.04	0.008	0.16	24.8	1.4
Small root	30-40	26.37	1.81	0.079	0.47	2.52	0.16	0.033	0.50	45.6	9.9
Large root	40-50	40.60	1.26	0.027	0.24	2.28	0.06	0.013	0.31	26.4	10.9
Small root	40-50	15.25	2.10	0.249	0.63	2.28	0.18	0.061	0.79	39.5	15.9

Table 10. (continued)

Lycium andersonii March 21, 1973

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	%	%
Large stem	30-40	18.93	0.86	0.023	1.06	1.45	0.23	0.031	0.12	64.1	3.7
Small stem	30-40	24.91	0.96	0.068	1.16	1.97	0.22	0.030	0.03	81.6	3.4
Leaves	30-40	12.43	3.07	0.151	2.71	6.55	0.81	0.181	0.08	151.9	16.2
Large stem	15-30	71.85	0.81	0.063	0.75	1.75	0.20	0.022	0.05	65.1	2.4
Small stem	15-30	72.34	0.92	0.80	0.95	2.49	0.25	0.022	0.04	79.2	3.1
Leaves	15-30	28.56	2.89	0.116	2.42	7.52	0.95	0.181	0.22	166.9	19.6
Large stem	2-15	74.20	0.72	0.018	0.46	1.06	0.11	0.018	0.13	36.0	2.8
Small stem	2-15	47.96	0.89	0.049	0.70	1.44	0.14	0.016	0.04	46.7	2.4
Leaves	2-15	2.62	2.95	0.153	2.49	7.34	0.97	0.168	0.18	165.7	17.7
Large stem	0-2	17.50	1.30	0.292	0.80	2.58	0.23	0.070	0.98	87.7	15.3
Small stem	0-2	1.29	0.87	0.032	0.44	1.21	0.07	0.022	0.23	42.9	5.1
Large root	0-10	19.35	1.35	0.71	0.33	2.11	0.09	0.024	0.41	80.7	5.3
Small root	0-10	7.58	1.52	0.60	0.43	2.54	0.10	0.018	0.31	84.8	4.5
Large root	10-20	41.16	1.30	0.08	0.50	1.32	0.06	0.010	0.08	48.2	1.6
Small root	10-20	22.55	2.27	0.13	0.71	2.38	0.12	0.036	0.44	73.1	4.9
Large root	20-30	24.52	1.31	0.068	0.37	1.14	0.05	0.007	0.04	42.1	1.5
Small root	20-30	7.05	1.86	-	-	-	-	-	-	-	-

Lycium andersonii May 8, 1973

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	15-27	40.58	0.94	0.005	0.80	3.08	0.10	0.014	0.14	118.1	1.9
Small stem	15-27	62.85	1.00	0.029	1.15	2.71	0.14	0.020	0.15	106.2	1.5
Leaves	15-27	10.60	1.82	0.056	1.07	8.24	0.72	0.141	0.19	188.4	4.1
Flower	15-27	5.33	2.13	0.070	2.55	0.80	0.17	0.071	0.14	46.7	1.7
Large stem	0-15	94.69	1.43	0.010	0.57	1.82	0.09	0.015	0.25	85.6	3.5
Small stem	0-15	92.08	0.88	0.069	0.75	2.69	0.16	0.017	0.20	112.9	2.5
Leaves	0-15	9.78	0.74	0.521	1.38	4.90	1.17	0.161	0.001	164.3	40.8
Flower	0-15	0.64	2.24	0.199	2.24	0.88	0.32	0.084	0.34	32.8	5.1
Large root	0-10	46.60	1.14	-	0.34	1.84	0.08	0.027	0.70	93.6	7.4
Small root	0-10	2.99	2.21	0.203	0.73	2.41	0.22	0.048	0.99	85.3	11.9
Large root	10-20	36.00	1.77	0.122	0.38	2.66	0.07	0.015	0.36	111.3	2.1
Small root	10-20	13.39	2.26	0.227	0.72	2.49	0.20	0.030	0.76	88.9	9.7
Large root	20-30	29.92	1.69	0.171	0.41	1.93	0.08	0.010	0.18	85.6	1.8
Small root	20-30	25.14	1.83	0.170	0.57	2.31	0.12	0.024	0.41	94.3	5.7
Large root	30-40	15.66	2.27	0.220	0.55	2.38	0.10	0.025	0.63	119.8	5.9
Small root	30-40	17.16	1.99	0.043	0.32	0.95	0.05	0.011	0.20	54.9	1.3
Large root	40-50	6.33	1.78	0.143	0.50	2.40	0.07	0.019	0.33	106.1	1.3
Small root	40-50	2.88	1.90	0.103	0.55	2.20	0.82	0.014	0.21	85.3	2.2

Table 10. (continued)

Atriplex confertifolia February 15, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	15-37	105.00	0.76	0.040	0.69	3.51	0.48	0.086	0.15	82.9	17.6
Small stem	15-37	87.00	0.69	0.041	0.81	2.93	0.45	0.105	0.14	71.5	17.4
Large stem	0-15	219.00	0.66	-	-	-	-	-	-	-	-
Small stem	0-15	78.00	0.65	0.048	0.58	3.61	0.47	0.084	0.23	75.0	20.3
Large root	0-10	110.5	0.85	0.079	0.30	5.07	0.40	0.056	0.54	110.2	26.7
Small root	0-10	11.84	1.06	0.103	0.48	5.26	0.46	0.082	0.66	123.1	39.8
Large root	10-20	14.51	0.95	0.046	0.40	4.36	0.31	0.069	0.23	103.6	25.3
Small root	10-20	7.21	1.08	0.050	0.60	3.71	0.39	0.084	0.19	89.8	28.3
Large root	20-40	11.25	0.82	0.023	0.12	4.39	0.27	0.036	0.08	110.9	20.8
Small root	20-40	11.84	1.06	0.103	0.48	5.26	0.46	0.118	0.66	123.1	39.8

Atriplex confertifolia March 21, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	10-20	4.43	0.60	0.028	1.09	2.19	0.30	0.074	0.05	52.8	5.5
Small stem	10-20	9.90	0.59	0.043	0.44	1.56	0.10	0.008	0.07	31.3	5.9
Leaves	10-20	11.01	2.10	0.083	1.90	3.55	0.68	3.870	0.07	45.7	8.6
Large stem	0-10	30.20	0.80	0.019	0.65	4.39	0.33	0.530	0.26	97.2	8.8
Small stem	0-10	23.22	0.67	0.024	1.17	2.58	0.33	0.510	0.09	63.4	7.6
Leaves	0-10	10.20	2.06	0.080	1.77	3.65	0.72	3.280	0.35	54.4	12.0
Large root	0-10	14.57	1.07	0.165	0.50	5.06	0.50	0.58	0.64	118.2	20.7
Small root	0-10	1.48	1.16	0.247	1.00	2.56	0.66	0.64	0.73	66.9	17.4
Large root	10-20	5.78	1.13	0.235	0.43	4.59	0.56	0.57	0.61	115.3	20.3
Small root	10-20	1.91	1.20	0.081	0.75	2.78	0.62	0.55	0.20	72.5	10.3
Large root	20-30	3.83	1.15	0.175	0.57	3.41	0.66	0.57	0.50	89.3	10.7
Small root	20-30	5.29	1.19	0.142	0.90	2.08	0.78	0.53	0.38	57.0	8.6
Large root	30-50	1.25	1.07	0.041	0.43	2.95	0.54	0.44	0.42	93.9	7.0
Small root	30-50	3.72	1.40	0.159	0.65	2.37	0.74	0.53	0.42	59.4	10.8
Large stem	dead shoots	6.99	0.67	0.067	0.93	3.26	0.43	0.083	0.13	76.2	7.5
Small stem	" "	20.16	0.46	0.039	0.99	2.90	0.44	0.37	0.08	62.4	10.0
Large stem	dead crown	10.29	0.76	0.283	0.26	2.30	0.41	0.057	0.72	43.6	24.1
Small stem	" "	3.55	0.65	0.057	0.673	2.60	0.48	0.41	0.29	62.0	12.7

Table 10. (continued)

Atriplex confertifolia May 8, 1972

Plant part	cm from base	dry wt	N	P	K	Ca	Mg	Na	Si	Sr	Ba
		g	%	%	%	%	%	%	%	ppm	ppm
Large stem	0-18	25.05	0.74	0.050	1.38	1.53	0.50	0.078	0.29	49.6	16.8
Small stem	0-18	31.41	0.66	0.019	1.44	1.56	0.54	0.54	0.11	56.7	19.8
Leaves	0-18	30.11	1.53	0.335	3.43	3.33	1.29	4.24	0.73	74.0	43.4
Large root	0-10	5.65	0.76	0.085	0.56	3.53	0.27	0.037	0.17	94.6	45.2
Small root	0-10	1.50	0.85	0.059	1.35	2.43	0.66	0.56	0.09	80.2	22.1
Large root	10-20	4.43	1.00	0.113	1.12	2.51	0.44	0.36	0.21	79.3	29.5
Small root	10-20	3.20	1.40	0.042	1.89	1.89	0.71	0.62	0.26	72.5	20.6
Large root	20-30	1.74	1.26	0.102	0.64	2.55	0.30	0.046	0.15	87.0	38.4
Small root	20-30	2.04	1.84	0.058	1.64	1.85	0.70	0.84	0.47	64.6	28.5
Large root	30-40	1.17	1.05	0.096	0.85	1.78	0.34	0.38	0.11	54.9	25.4
Small root	30-40	1.03	1.43	0.134	1.63	1.25	0.91	1.13	0.21	56.1	34.1
Large root	40-60	1.48	1.08	0.153	0.98	2.14	0.38	0.47	0.05	63.3	16.7
Small root	40-60	2.23	1.60	0.179	1.63	1.20	0.83	1.43	0.41	44.7	14.9
Large root	60-90	1.93	1.28	0.170	1.06	1.62	0.46	0.68	0.07	45.5	7.8
Small root	60-90	0.47	1.67	0.168	1.35	1.13	0.67	1.30	0.18	33.9	4.0

Table 11. Nutrient status of leaves before and after leaf abscission (May 10, 1972) (A3UWS08)

Species	Abscised (A) or Green (G)	Dry wt	N	N	K	K	Ca	Ca	Mg	Mg	Na	Na	N	P	P
		mg/ leaf	%	µg/ leaf	%	µg/ leaf	%	µg/ leaf	%	µg/ leaf	%	µg/ leaf		%	µg/ leaf
Atriplex confertifolia	A	7.83	1.07	83.8	2.21	173	3.58	280	0.78	61.0	5.47	428	200	0.029	2.3
	G(fem)	8.83	1.66	146.6	1.84	162	2.69	238	0.77	68	5.75	508	200	0.071	6.3
	G(male)	8.73	1.75	152.8	2.29	200	1.92	168	0.62	54	3.50	306	200	0.082	7.2
Ephedra nevadensis	A	108	0.83	896	0.20	216	3.64	3931	0.13	140	0.0063	6.8	10	0.024	25.9
	G	290	1.71	4959	0.29	841	2.79	8091	0.38	1102	0.0058	16.8	10	0.076	220.4
Lycium pallidum	A	14.3	2.54	363	2.00	286	4.20	601	1.34	192	1.27	182	50	0.111	15.9
	G	20.0	1.97	394	2.41	482	2.46	492	1.05	210	1.49	298	50	0.081	16.2
Larrea divaricata	A	1.75	0.86	15.1	2.16	37.8	1.63	28.5	0.24	4.2	0.05	0.9	200	0.061	1.1
	G	2.50	1.86	46.5	2.20	55.0	0.68	17.0	0.13	3.3	0.03	0.8	200	0.147	3.7
Grayia spinosa	A	2.30	1.51	34.7	2.76	63.5	3.03	69.7	1.11	25.5	0.02	0.5	100	0.075	1.7
	G	4.60	1.67	76.8	4.29	184.5	1.67	76.8	1.19	54.7	0.52	23.4	100	0.052	2.4
Atriplex canescens	A	12.95	1.30	168	1.90	246	4.27	553	1.32	171	0.14	18	100	1.18	153
	G	15.11	1.74	263	2.88	435	2.57	388	1.23	186	0.16	24	100	1.38	209
Larrea divaricata	A	5.22	0.88	46	1.74	91	1.41	74	0.23	12.0	0.06	3.1	100	0.07	3.65
	G	7.62	1.45	110	1.82	139	0.74	56	0.15	11.3	0.04	3.0	100	0.12	9.1
Atriplex cuneata	A	17.91	3.52	630	1.99	356	2.08	373	0.72	129	2.00	358	100	1.20	215
	G	19.18	1.41	270	3.59	689	2.82	541	1.00	192	3.25	623	102	1.57	301

It has been observed by Hornberger (1882) for corn, Snyder (1893) for wheat, Wilfarth, Romer and Wimmer (1905) for a number of crop plants, Jones and Huston (1914) for corn, Burd (1919) for barley, and Miller (1937) for wheat, that there is a migration of certain elements, especially potassium, from the stem and leaves to the roots and then to the soil. Penston (1935) reviewed the early status of this subject matter.

The reabsorption from leaves of carbon compounds is not as clearly substantiated as that of inorganic elements. Unless the carbon can be demonstrated as actually transferred from leaves to stems, one cannot be certain of the event due to the complication of respiratory loss. It is suspected, however, that nitrogen transported from leaves to twigs before abscission is transported as amino acids. This would result in some carbon movement, but in no more than from 2 to 4% of the dry weight of the plant if N moves as amino acids.

Upon cessation of transport of regulators into the leaf and supposedly from the root in response to phenological events associated with senescence (Lavender et al., 1973), the process of proteolysis would exceed that of protein synthesis with a net build-up of amino acids in leaves. the transport of these from the leaves into the woody parts of the plant appears to be an adaptive mechanism which conserves the nutrient supply.

The purpose of the investigations reported in this section was to determine if retranslocation or readsorption before leaf abscission is an important phenomenon in perennial desert plants. It was also hoped that information could be obtained concerning the nature of the process.

Leaf samples were obtained both in the northern Mohave Desert and from the glasshouse at UCLA. Samples included leaves about to abscise (obviously yellow) and those still firmly attached to the plants. In some cases leaves recently abscised were collected. Usually from 100 to 400 leaves of each type were pooled into one sample. Leaves were counted, dried, and weighed so that weight per leaf before and after abscission could be obtained. Samples were assayed for N (Kjeldahl) and mineral elements (Wallace et al., 1971).

N, P and K in these woody species were translocated in varying amounts before leaf abscission (Tables 11-13). There was no evidence that these species were different from

Table 12. Loss of nutrients and dry matter from leaves to stems just prior to leaf abscission (percent of original levels in leaves)

Species	Dry wt	N	P	K	Ca	Mg	Na	Zn
Lycium andersonii	71.4	72.2	0.0	63.0	86.3	71.6	69.0	75.6
Lycium pallidum	39.2	45.3	72.1	5.9	34.9	58.8	34.8	39.2
Ephedra nevadensis	58.5	68.4	47.4	88.6	(+19.0)	37.0	66.8	61.5
Atriplex confertifolia	56.6	46.8	84.6	59.1	45.3	45.9	59.9	66.3
	56.6		89.6	71.3	33.1	33.6	63.9	87.9
	41.0		8.8	76.5	(+9.7)	(+11.6)	71.5	(+96.7)
Larrea divaricata	14.3	45.0	(+113.8)	65.6	(+54.3)	(+37.1)	(+81.3)	(+23.2)
	0.0		14.1	26.9	(+35.8)	(+55.0)	(+69.2)	(+87.5)
Atriplex canescens	10.6	55.9	28.0	18.3	(+1.1)	(+7.9)	(+31.3)	48.9
Grayia spinosa	30.6	59.4	57.0	32.2	28.5	17.7	(+10.45)	55.8
Means	37.9	56.1	27.8	50.7	10.8	15.3	8.5	22.8

Table 13. Nutrient status of leave about to abscise and not ready to abscise of desert plants grown in a glasshouse (A3UWS08)

Species*	About to abscise (A) or green (G)	Dry wt leaf mg	N %	K %	Ca %	Mg %	Na %	Si %	Sr ppm	Ba ppm	P %	N µg leaf	K µg leaf	Ca µg leaf	Mg µg leaf	Na µg leaf	P µg leaf
Atriplex linearis	A	6.55	0.83	2.08	1.84	0.84	7.43	0.25	40	35	0.18	54.4	136.2	120.5	55.0	487	11.8
	G	10.76	2.41	1.13	1.39	0.63	6.45	0.04	20	14	0.24	259.3	121.6	149.6	67.7	694.0	25.8
Atriplex confertifolia	A	19.56	0.84	1.59	1.37	1.21	2.79	0.03	22	21	1.12	164	311	268	237	546	219
	G	14.84	1.11	1.64	7.25	1.26	2.93	0.11	108	65	2.60	165	243	1076	187	435	386
Atriplex cuneata	A	16.36	1.21	1.53	4.25	0.79	3.62	0.04	59	34	1.78	198	250	695	129	592	291
	G	26.20	1.72	1.73	5.35	0.72	2.84	0.06	67	36	1.60	451	453	1402	189	744	419
Atriplex gardeneri	A	6.14	1.30	1.73	3.07	0.52	5.93	0.23	46	17	0.53	80	106	188	32	364	32.5
	G	7.63	2.03	1.71	1.78	0.64	5.74	0.14	27	11	1.14	155	130	136	49	438	87.0
Larrea divaricata	A	4.26	2.05	0.91	1.97	0.42	0.06	0.42	22	7	0.35	87	29	84	17.9	2.6	14.1
	G	6.22	2.48	1.82	1.43	0.36	0.05	0.23	17	5	0.63	154	113	89	22.4	3.1	39.2
Atriplex canescens SD	A	12.43	1.21	2.32	3.08	1.66	1.37	0.18	42	20	0.58	150	288	383	206	170	72
	G	20.50	2.85	1.86	2.78	1.23	1.02	0.08	34	18	0.61	584	381	570	252	209	125
Atriplex canescens	A	5.88	1.67	2.30	3.23	1.30	0.44	0.38	47	22	1.34	98	135	190	76	26	79
	G	5.42	3.31	1.66	3.34	1.08	0.07	0.23	45	16	0.90	179	90	181	70	4	49
Lycium pallidum	A	8.18	2.45	0.20	3.82	0.96	3.82	0.27	48	15	0.35	200	16	312	79	312	28.6
	G	12.18	4.68	0.72	2.21	0.62	3.59	0.16	27	8	0.51	570	88	269	76	437	62.1
Lycium andersonii	A	0.85	2.58	1.16	6.82	1.71	0.62	0.19	121	2.5	0.21	21.9	9.9	58.0	14.5	5.3	1.8
	G	1.20	4.01	1.71	3.37	0.99	0.91	0.13	42	1.5	0.33	48.1	20.5	40.4	11.9	10.9	4.0
Lycium shockleyi	A	2.08	2.40	0.31	1.83	0.76	7.39	0.39	23	5	0.50	49.9	-	-	-	-	-
	G	2.40	4.32	-	-	-	-	-	-	-	-	103.7	-	-	-	-	-
Atriplex hymenelytra	A	53.8	1.46	3.87	2.47	0.90	4.14	0.18	41	29	1.42	785	2082	1329	484	2227	764
	G	80.1	2.71	3.07	2.36	0.75	3.72	0.15	39	27	0.65	2170	2459	1890	600	2980	521
Atriplex hymenelytra #10	A	30.1	1.00	2.34	2.79	0.94	4.21	0.21	41	24	1.11	301	704	840	283	1267	334
	G	29.6	2.24	1.87	2.60	0.89	3.84	0.19	46	21	0.46	663	553	770	263	1137	136

other woody plants. Often from 50 to 80% of the N in leaves appeared to be returned to plants before leaf abscission; in some cases, however, there was little, if any transport apparent.

Carbon componds appear by these measurements to have been transported in sizeable quantities (25% of the leaf weight was lost before abscission). More critical studies must be done to determine if the carbon is actually conserved by the plants, all or in part, and to assess the fraction lost in respiration.

For the Na-accumulating species there was no evidence for retransport of Na or reverse transport to compensate for any loss of K.

EXPECTATIONS

Many phases of the study are being worked upon and information concerning them will become available throughout the coming year. One of the important goals is to fill in necessary gaps concerning transfer rates between compartments in the ecosystem representative of Rock Valley, Nevada.

The rate and mode of atmospheric nitrogen entry as fixed nitrogen into the system is of first concern. There are several possible routes and the magnitude of each must be ascertained. There are some leguminous plants in the area which have symbiotic fixation relationships as well as non-leguminous species which are thought to have such relationships. A search for nodulated plants is being made at the present time. There are several plant species which seem to have an intense rhizosphere nitrogen-fixing relationship. The magnitude of this is being assessed by acetylene reduction and a periodic study of forms of fixed nitrogen in the rhizosphere will add considerable information. The contribution of algal crusts and free-living nitrogen fizers is being ascertained.

A study of the rate of decay of various kinds of debris and litter in Rock Valley and also under controlled conditions is planned for the immediate future. The porous bag technique will be used in the field. Dry and ground material of known composition will be mixed with desert soil at different soil moisture, temperature and salinity conditions. The rates of loss of C and buildup of nitrogen fractions will be obtained.

The rate of mineralization of soil organic matter from different profiles and horizons will be determined under laboratory conditions. The same conditions as in the paragraph above will be used and appearance of mineral forms of nitrogen will be determined. Simultaneously a study of the rate of appearance in the field of the same forms will be made and abiotic conditions will be monitored.

The rate of uptake by plants of N forms will continue to be made in the laboratory and in the field. Tagging experiments will be made in the field.

Sources and rates of losses of fixed nitrogen from the system are to be studied. Estimates from litter accumulation and climatological records will be made of leaching and erosion losses. Volatilization and denitrification losses will be determined. Total loss will be determined under controlled conditions and that lost via volatilization will be determined by trapping the NH_4^+ in the dilute acid. Denitrification will be determined by difference. The study items will be flexible so that suggestions from Biome leaders or others can be incorporated into the project.

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