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IBP

RESEARCH MEMORANDUM

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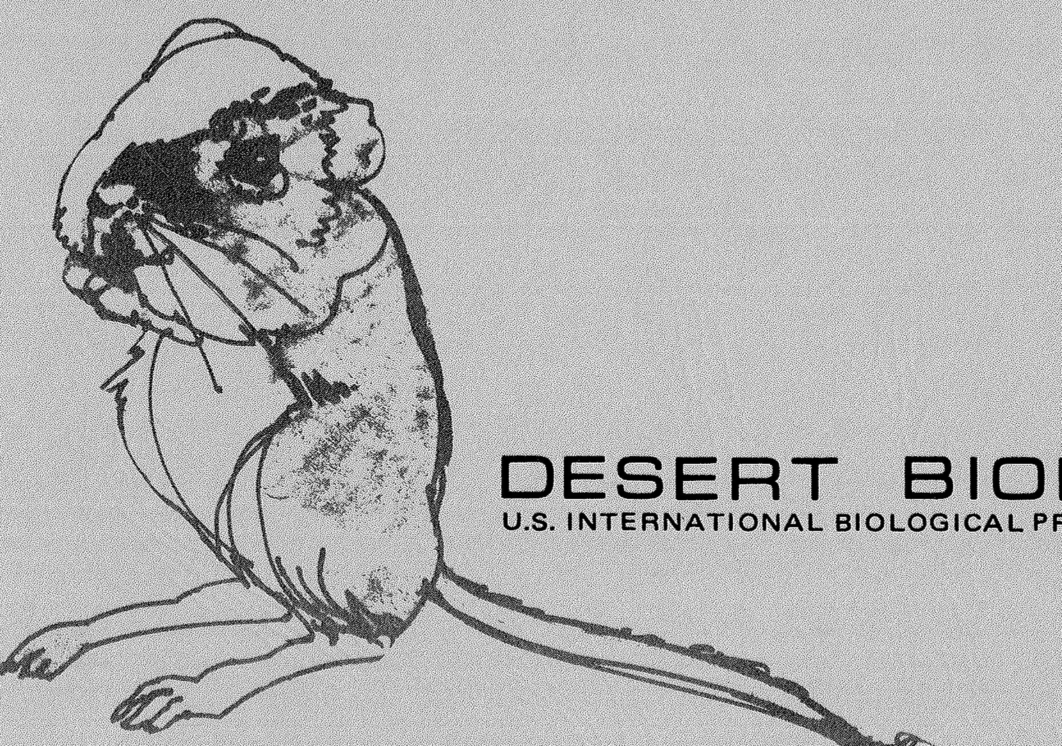

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1972 PROGRESS REPORT

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ABSTRACT

Survival and reproduction by the iguanid lizard, *Uta stansburiana,* was investigated in 0.4 ha enclosures near Mercury, Nye County, Nevada. The study was formally commenced in the spring of 1972, but for some aspects, observations have been drawn from three preceding years. Mayhew's hypothesis relating egg production by certain insectivorous lizards to production of winter annuals was examined in detail. Artificial augmentation of normal winter rainfall by the addition of 5 cm of water during November was shown to increase dry matter production by winter annuals (ca. 8 g/ m^2 vs. 0.5 g/m^2 in 1971-1972). Analysis of variance showed that lizards occupying irrigated areas registered greater body weight gains than those in non-irrigated areas in both years. This is interpreted as direct evidence of an increase of insect food for *Uta* as a result of additional winter rainfall.

The number of egg clutches produced was greater after irrigation during November -- approximately one additional clutch of eggs was produced by female *Uta* occupying irrigated areas during 1970 and 1972. Older females generally produced more clutches than yearling females. Clutch frequency (F) can be roughly predicted from November-December rainfall in cm (R):

$$F \text{ (yearlings)} = 0.34R + 0.47$$
$$F \text{ (older)} = 0.26R + 1.55$$

Analysis of variance involving the size of 46 first clutches laid in 1970 indicated pronounced effects due to both age and irrigation. A similar analysis based on 117 first and second clutches laid in 1972 indicated the age effect, but showed no influences owing to irrigation or density. Mean clutch size of yearling *Uta* was 3.19 in 1970, 3.65 in 1972. Mean clutch size of older *Uta* was 4.20 and 4.39, respectively, in these two years.

Annual survival of yearling and older *Uta* during three years was analyzed. There appeared to be differences between years. Survival of male and female *Uta* was very similar, but yearling lizards survived somewhat better than older individuals. When data from three years were combined there was an inverse relationship between percent annual survival (S) and density (d, per ha):

$$S = -0.0057d + 0.68$$

There is some suggestion that rates of survival observed in 0.4 ha enclosures may not be an adequate measure of mortality experienced in unrestrained populations.

INTRODUCTION

Uta stansburiana is a small insectivorous iguanid lizard, widely distributed in the western United States. Densities vary geographically, but values of around 40/ha have been observed in Texas (Tinkle, 1967) and southern Nevada (Turner et al., 1970). The functional importance of *Uta*, and of the more common lizards in desert environments, has not been adequately appreciated. It is true that the energy utilization of *Uta* is small when compared with total net primary production (Alexander and Whitford, 1968), but Chew and Chew (1970) showed that all of the small mammals in a southern Arizona desert utilize less than 2% of the net above-ground primary production. Hence, the energy utilization and production of *Uta* needs to be contrasted with that of some of the other vertebrates with which it coexists. The main point to be made from such comparisons is that secondary production by *Uta* in southern Nevada exceeds that of many coexisting mammals and probably most of the birds (Turner et al., unpubl.).

The size and composition of *Uta* in the Mohave Desert vary from year to year, owing primarily to annual differences in reproduction (Turner et al., 1970). Differences in egg production are related to winter rainfall, apparently in the manner suggested by Mayhew (1966a, 1966b) in connection with species of *Uma*. Mayhew's hypothesis is that sufficient winter rainfall promotes germination and growth of winter annuals, which in turn leads to increased food (arthropods) for some desert lizards, and hence greater egg production by these species. Among desert lizards of western North America, positive correlation between winter rainfall and egg production has been shown in *Uma notata* and *U. scoparia* (Mayhew 1966a, 1966b), *Xantusia vigilis* (Zweifel and Lowe, 1966) and *Uta stansburiana* (Hoddenbach and Turner, 1968). Similarly, Beatley (1969) has shown a positive relationship between winter rainfall and biomass of winter annuals. However, it has not been shown that increased biomass of winter annuals (or the conditions promoting this increase) actually leads to more food and available energy for lizards.

OBJECTIVES

The purpose of this study is to determine the functional relationships between reproduction and survival by *Uta* and whatever important independent variables may impinge on these two processes, e.g., population density, rainfall, and predation. These relationships can be utilized, then,to create a model capable of predicting time changes in the composition and size of populations of this desert lizard. The research during 1972 included analyses of reproduction and survival, as affected by rainfall and density. No work on predation was accomplished, but this will be done during 1973.

METHODS

Most of the work to be discussed in this report was done during 1972, and DSCODE A3UTJ72 refers to the 1972 Data Set. However, previous work during 1969, 1970 and 1971 has bearing on some of the findings to be reported here. Hence, the ensuing description of procedures will include not only what was done in 1972, but some of the earlier operations.

Study areas

During the winter of 1969 and during calendar 1970, work was conducted in five 0.4 ha enclosures 1.6 km west of Mercury, Nevada. These plots are about 45 x 90 m and enclosed by sheet metal fences 14 inches high buried 2-4 inches beneath the surface of the soil. Each plot was marked off in a rectilinear grid with numbered stakes. Further details are given by Medica et al. (1971). A sixth enclosure was constructed during 1971 and was used for the 1972 experiments.

Lizards

Field work usually began in mid-February and continued through mid-October. Lizards were captured by noosing, and conventional records of identity, sex, location, length, weight, and sexual condition maintained. Quick-drying paint patterns were applied to lizards to facilitate recognition in the field. Full details are given by Medica et al. (1971). During the breeding season we attempted to capture every female at least once a week. Detailed records were maintained on the reproductive state and body weights of these lizards. Clutch sizes were inferred from palpation and counts of follicles $\geq$ 5 mm in size. Hoddenbach and Turner (1968) showed that follicular atresia occurs only occasionally among yearling females and essentially not at all among older individuals. Clutch frequency was estimated on the basis of body-weight changes and palpation data (Turner et al., 1970; Medica et al., 1971).

Mortality was assessed 1) for hatchlings from shortly after birth until March of the following spring (i.e., over about the first eight months of life), 2) for yearlings between the age of 8-9 months in March to the age of about 20 months the following March, and 3) for older lizards from March to March. Hatchlings were not considered a member of the cohort to be analyzed unless they were $\geq$ 28 mm in size at time of marking (previous work has indicated that as hatchlings increase in age the likelihood of survival to the following spring increases). March rosters of yearling and older lizards included animals caught at least twice (in two different weeks) during March, and other obvious residents even though they were not registered until later in the spring.

Experimental treatments

Irrigation: Between October 28 and December 3, 1969, 5 cm of water were applied by rainbird sprinkler to one of the plots. Water was applied until it began to run off the surface. Time between applications averaged about 3 days. The maximum amount of water applied at one time was around 0.56 cm. The soil of this plot was kept permanently moist until 5 cm had been applied. Similarly, between November 8 and 21, 1971, 5 cm of water were applied with sprinklers to two of the plots (one of these was the same one irrigated in 1969). Natural winter rainfall was recorded in both years with a conventional rain gauge nearby.

Density manipulations: In February of 1972 densities of *Uta* were adjusted so that the 3 plots that formerly had high densities were lowered and those of low density were raised. These manipulations involved marked *Uta* of known age, and were completed by the end of February. The effect of these adjustments was to establish densities of around 74-86 lizards per ha in the dense plots and from about 30-50/ha in the low density plots. One leopard lizard was added to each of two plots (both unwatered) during March. Unfortunately these lizards did not stay in the plots and they were not seen after early May of 1972. Densities after manipulations were maintained through March. If individuals were no longer present in the plot at the end of March new known-age *Uta* were added to reestablish the desired densities. After March the populations within each of the plots were permitted to follow their natural courses.

Plants

During May of 1970 winter annuals were counted in the irrigated plot and one of the adjoining non-irrigated areas. In each plot 20 quadrats (20 x 20 cm) were randomly placed in bare areas and 20 quadrats beneath *Ambrosia dumosa*. All winter annuals were collected, dried and weighed. In late March of 1972 winter annuals were collected from both irrigated plots and from two non-irrigated ones. In each plot 20 quadrats were randomly distributed beneath *Krameria parvifolia*, 20 beneath *Ambrosia dumosa*, and 20 in open areas. Plants were dried and weighed as in 1970.

Statistical procedures

In considering relationships between survival and density and between egg production and winter rainfall, simple linear regressions were computed using one of the programs (BMD05R) in the library of the Health Sciences Computing Facility of the University of California at Los Angeles. Computations were carried out on a 360-91 computer at the UCLA Campus Computing Network via a Data 100 Remote Batch Terminal located in the Laboratory of Nuclear Medicine and Radiation Biology.

Mean clutch frequencies were regressed on 20 rainfall variables based on monthly precipitation recorded during the fall and winter preceding the breeding season. The variables tested were: single monthly totals between September and February (6), all two-month totals (5), all three-month totals (4), and all four-month totals (3) during this time; total rainfall between September and January, and total rainfall between September and February.

Factorial analyses of variance were done using one of the programs (BMDX64) in the library of the Health Sciences Computing Facility.

RESULTS

Rainfall and irrigation

Natural rainfall during the winters of 1969 and 1971 is shown in Table 1, together with amounts added artificially by irrigation.

Table 1. Natural rainfall and water added by irrigation to 0.4 ha enclosures in southern Nevada

	Natural rainfall (mm)		Water added by irrigation (mm)	
	1969-70	1971-72	1969	1971
September	2.03	0.51		
October	13.72	0.00		
November	10.67	1.02	50.80	50.80
December	0.00	39.88		
January	1.02	0.00		
February	18.80	0.00		

Winter annual biomass

In both 1969 and 1971 the additional water applied during November had obvious effects on germination and growth of winter annuals (Table 2). In 1970 about 75% of the material collected was the grass *Bromus rubens*. In 1972 *Bromus rubens* still dominated in plot 6 (ca. 37% of the total), but in the other watered plot the most important contributors were *Cryptantha recurvata, Festuca octoflora* and *Phacelia fremontii*. In the watered plots *Cryptantha nevadensis* was the major species by weight (20-34% of the totals). In both years the vast majority of annuals occurred beneath shrubs rather than in open areas.

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Weight changes in *Uta*

As mentioned previously, there has never been a direct connection established between increased biomass of winter annuals and improved food resources for insectivorous lizards in desert areas. Because the production of eggs by some desert lizards seems to be positively correlated with the abundance of winter annuals it has been inferred that this causal link exists. To actually show this directly by sampling arthropod abundance and observing the stomach contents of lizards would be a difficult task. However, some data have been acquired on body-weight changes in *Uta* which seem to be more directly related to the issue of food consumption than egg production per se.

The ensuing analyses pertain only to body-weight changes among yearling *Uta* between March and July (i.e., between the ages of about 8 and 12 months). The older lizards afforded small samples and, except for ovigerous females, usually did not exhibit pronounced changes in weight. Concentration has been on increments and decrements of individual lizards (rather than changes in group means). Table 3 summarizes data for yearling females in the spring of 1970. These data are restricted to females weighing between 1 and 2 g at the outset (i.e., unusually large or small females were not included in the analysis). A t test of the hypothesis that the mean weight changes for the watered (830 mg) and unwatered plots (506 mg) do not differ, yielded a t value of 2.29. With 20 d. f. the probability of a t value this large is about 0.03. Hence, the assumption is that the means <u>do</u> differ.

Table 2. Dry matter production by winter annuals in 0.4 ha enclosures in southern Nevada

Year	Plot	Combined dry weight of annuals (g/m^2)
1969-70	6 (watered)	7.98
	7	0.48
1971-2	6 (watered)	5.66
	13 (watered)	4.38
	7	0.11
	9	0.07

Table 3. Weight changes observed in 1970 among yearling *Uta stansburiana* in 0.4 ha enclosures in southern Nevada.

Plot	n	Mean initial weight (g)	Mean weight change (g)	Range (g)
6 (watered)	4	1.45	0.83	0.52 - 1.05
7	4	1.35	0.71	0.35 - 1.01
8	5	1.51	0.53	0.23 - 0.76
9	4	1.48	0.39	0.12 - 0.67
10	5	1.56	0.41	0.18 - 0.80
7-10	18	1.48	0.51	0.12 - 1.01

A similar approach was followed for 1972 but the analysis was expanded to include both sexes and to allow for a possible density effect. The basic data are given in Table 4. A 2 x 2 x 2 factorial analysis of variance gave the results set forth in Table 5 (with one d.f. in all cases). There were highly significant effects on weight changes owing to both irrigation and sex, but no effect on density. The difference between the sexes is thought to be associated with egg production, and the diversion of energy by females into eggs rather than into new somatic tissue. In both sexes there was apparently more energy available in the irrigated plots -- whether for reproduction or growth -- and this energy could only have come from more available food. These findings are interpreted as direct support for the previously assumed relationship between winter annual abundance and food available for ground-dwelling insectivorous lizards.

Table 4. Weight changes observed in 1972 among yearling *Uta stansburiana* in 0.4 ha enclosures in southern Nevada

Sex	Treatment	n	Mean change in wt. (g)	Mean initial weight (g)
Male	watered, low density	2	1.25	2.31
	watered, high density	4	0.60	2.91
	unwatered, low density	7	0.13	2.88
	unwatered, high density	9	0.30	2.92
Female	watered, low density	4	0.13	2.21
	watered, high density	4	0.16	2.24
	unwatered, low density	3	-0.50	2.76
	unwatered, high density	11	-0.28	2.48

Table 5. Results of a factorial analysis of weight changes among yearling *Uta stansburiana* in 1972

Factor	F	$F_{.05}$	$F_{.01}$
Water	23.57	4.11	7.39
Density	0.20		
Sex	28.88		
Water x density	3.87		
Water x sex	0.51		
Sex x density	2.06		
Water x density x sex	1.52		

Egg production

In assessing the possible influences of density and rainfall on reproduction by *Uta stansburiana* two aspects of egg production were considered: clutch frequency and clutch size.

Clutch frequency: The frequency with which iteroparous lizards lay eggs has traditionally been difficult to estimate (Turner, 1968; Turner et al., 1970). The procedure in southern Nevada involved the repeated capture and observation of marked cohorts of females (Turner et al., 1970; Medica et al., 1971). Clutch frequency is defined as the number of clutches produced by a female surviving for the entire period of reproduction, recognizing of course that not every female will live out the season. For modelling purposes it seems best to estimate potential clutch frequency and then adjust for losses due to mortality as a separate operation. Table 6 gives clutch frequency data for 1970 and 1972 based only on those females which survived the entire breeding seasons. These figures show a definite effect owing to irrigation in 1972 and apparently the same tendency in 1970 -- though less clearly expressed among the yearling females that year.

Table 6. Mean numbers of clutches produced by female *Uta stansburiana* occupying experimental 0.4 ha enclosures in southern Nevada

Year	Age	Treatment	n	Mean number of clutches	Range
1970	old	watered	2	3.00	3
		unwatered	8	1.75	1 - 2
	young	watered	9	1.11	0 - 3
		unwatered	32	0.94	0 - 2
1972	old	watered	4	4.00	4
		unwatered	7	2.86	2 - 3
	young	watered	8	4.25	3 - 5
		unwatered	19	2.57	1 - 4

Can the observed clutch frequencies (F) be quantitatively related to fainfall in cm (R) during the preceding fall and winter? Mean clutch frequencies of both yearling and older *Uta* were regressed on 20 possible fall-winter rainfall variables. For yearling females the highest observed positive correlation (0.89) was with December rain and the next highest was with November-December rainfall (0.76). For older *Uta* the highest positive correlation was with November-December rain (0.98). The November-December relationships are illustrated in Figure 1. The equation for the least squares fitted regression lines are as follows:

Older females: $F = 0.26\ (\pm 0.04)\ R + 1.55$ (1)

Yearling females: $F = 0.34\ (\pm 0.21)\ R + 0.47$ (2)

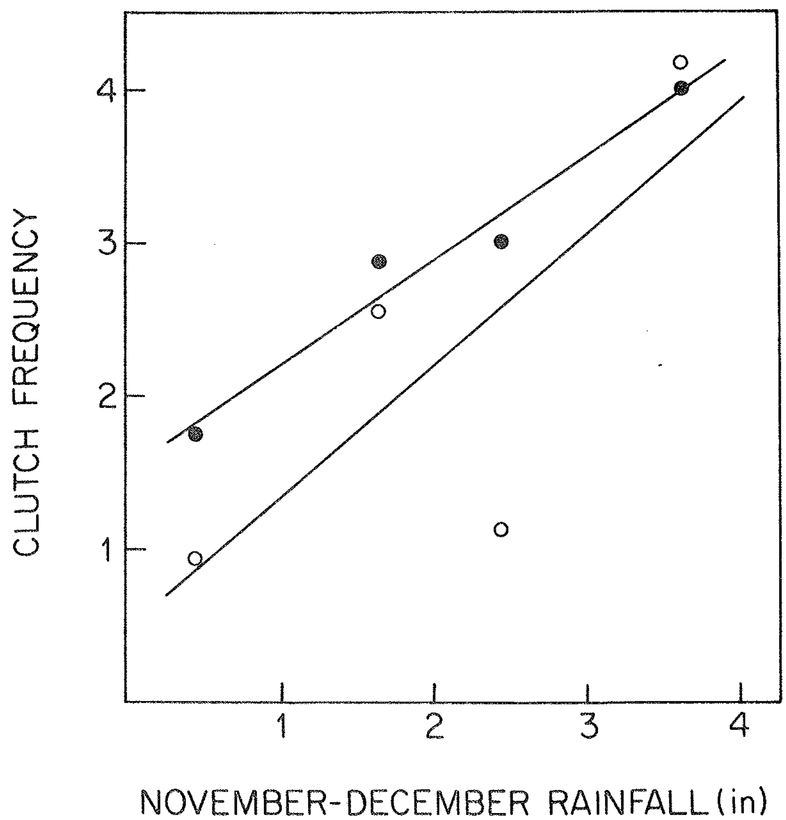

Figure 1. Relationship between the number of clutches of eggs laid by *Uta stansburiana* and rainfall during the preceding winter. Open circles (and lower line) pertain to yearling females; solid circles (and upper line) to older females.

In 1970 50 females started the breeding season in five 0.4 ha plots. Total egg production of these females was examined by simply adding up all the clutches produced by each individual. When a female known to be carrying oviducal eggs disappeared before the laying of eggs could be confirmed, deposition of half the estimated clutch size was assumed. Egg production by females dying during the breeding season was included in the analysis, so the totals reflect an interaction between clutch size and frequency as well as the disappearance rate of females. Mean total egg production in 1970 is given in Table 7. A 2 x 2 factorial analysis of variance of these data indicated highly significant effects owing to both age (F = 33.4) and irrigation (F = 13.2). The value of $F_{.01}$ (with 46 d.f.) was 7.21.

Table 7. Mean total egg production in 1970 by female *Uta stansburiana* occupying five 0.4 ha enclosures in southern Nevada

Age of female	Treatment	n	Mean number of eggs produced per female
Yearling	watered	10	4.30
	unwatered	29	3.55
Older	watered	2	10.50
	unwatered	9	5.89

A similar approach was followed with the 1972 data, except that egg production was also examined in terms of spring densities (Table 8). The conspicuously greater productivity in 1972 was clearly associated with the greater number of clutches produced that year. A slightly different arrangement of these data is given in Table 9. A 2 x 2 factorial analysis of variance indicated no effect on egg production owing to density and no significant interactions. However, the effects of age (F = 6.98) and irrigation (F = 9.57) were highly significant ($F_{.05}$ = 3.99; $F_{.01}$ = 7.04).

Table 8. Mean total 1972 egg production by female *Uta stansburiana* occupying six 0.4 ha enclosures in southern Nevada

Age of female	Plot density	Treatment	n	Mean number of eggs produced per female
Yearling	high	watered	12	10.36
		unwatered	27	7.17
	low	watered	6	9.73
		unwatered	10	6.99
Older	high	watered	3	15.17
		unwatered	10	9.11
	low	watered	3	11.50
		unwatered	3	10.00

Table 9. Total egg production by female *Uta stansburiana* in 1972

Category	n	Mean number of eggs produced per female
Older females	19	10.58
Younger females	55	8.11
Watered plots	24	10.95
Unwatered plots	50	7.69
Low density	22	8.76
High density	52	8.74

Clutch size: In a given year, clutch size of *Uta* is markedly influenced by age and to a lesser degree by season. In general, the first two clutches of the season are larger than those produced later (Hoddenbach and Turner, 1968). Table 10 summarizes clutch-size data in 1970, based on the first clutches produced by 46 females. In four cases, a female produced a clutch of eggs but there was no estimate of its size. In estimating total egg production a value was assigned to this clutch -- the mean of the group -- but none was assigned in analyzing clutch size. Hence, the discrepancy between the number of females represented in Tables 7 and 10. Analysis of variance indicated highly significant effects due to age (F = 26.2) and irrigation (F = 9.0). The value of $F_{.01}$, with 42 d.f., was 7.27. The overall mean clutch size for ten older females was 4.20, for 36 yearling females 3.19.

Table 10. Mean sizes of first clutches produced by *Uta stansburiana* in 1970

Age of female	Treatment	n	Mean clutch size
Yearling	watered	10	3.50
	unwatered	26	3.08
Older	watered	2	5.00
	unwatered	8	4.00

A similar analysis of 117 clutches produced by female *Uta* was made during 1972 in six experimental plots. The clutches used in this analysis were the first and second produced by a given female. Table 11 summarizes these data. The analysis of variance indicated a highly significant age effect (F = 21.5; $F_{.01}$ = 6.90), but no significant effects owing to density or irrigation. The overall mean clutch size for older females was 4.39, for yearling females 3.65.

Table 11. Mean sizes of first and second clutches produced by *Uta stansburiana* in 1972

Age of female	Plot density	Treatment	n	Mean clutch size
Yearling	high	watered	17	3.59
		unwatered	46	3.57
	low	watered	8	3.63
		unwatered	18	3.94
Older	high	watered	5	4.80
		unwatered	15	4.20
	low	watered	3	4.33
		unwatered	5	4.60

From the foregoing analyses the following conclusions are drawn: 1) irrigation increased egg production by both yearling and older female *Uta*, 2) the increase in egg production was brought about more by an increase in the number of clutches laid (roughly one more clutch in the irrigated plots) than by an increase in clutch size, 3) over the range of densities examined in 1972, there was no detectable density effect on clutch size or frequency, and 4) age (and size) of females had a pronounced effect on clutch size and a lesser effect on frequency.

Survival

Data on survival will not become available until 1973, and so are not included in this report. However, it is instructive to consider previously-acquired data relating to survival of *Uta* in 0.4 ha enclosures.

Annual survival of yearling and older Uta: The basic data, involving the years 1969-1972, are given in Appendix A. The reader is reminded of the rules adopted in deciding which lizards composed the initial cohorts (Methods section). The data given in Appendix A have been condensed and the possible differences examined in annual survival (March-March) associated with years, age and sex (Tables 12, 13 and 14).

Table 12. Annual survival of *Uta stansburiana* occupying 0.4 ha enclosures in southern Nevada during three years

Year	Number of plots analyzed	Initial numbers	Annual survival
1969-1970	2	55	0.18
1970-1971	5	142	0.30
1971-1972	5	86	0.44

Table 13. Annual survival of male and female *Uta stansburiana* occupying 0.4 ha enclosures in southern Nevada

Year	Sex	Initial numbers	Annual survival
1969	males	20	0.15
	females	35	0.20
1970	males	52	0.29
	females	90	0.31
1971	males	40	0.48
	females	46	0.41
All years combined	males	112	0.33
	females	171	0.32

Table 14. Annual survival of yearling and older *Uta stansburiana* occupying 0.4 ha enclosures in southern Nevada

Year	Age (months)	Initial numbers	Annual survival
1969	20+	18	0.11
	8	37	0.22
1970	20+	22	0.23
	8	120	0.32
1971	20+	46	0.37
	8	40	0.53
All years combined	20+	86	0.28
	8	197	0.34

The following conclusions are drawn from these figures. First, there appear to be year-to-year differences in the survival of yearling and older *Uta*. For the present, comment will be witheld on possible causation. Second, there is no important difference in the survival of males and females. This is in keeping with earlier findings (Turner et al., 1969a), which indicated sex ratios of 1:1. Third, survival of yearling *Uta* is consistently better than that of older lizards.

Figure 2 illustrates annual survival (S) of *Uta* as a function of initial spring density (d). With S expressed as percentage and d as numbers per ha, the equation for the least squares fitted line is:

$$S = -0.0057\ (\pm 0.0018)d + 0.68 \qquad (3)$$

The correlation coefficient associated with these data is -0.712. The F value, with 11 d.f., is 10.28, indicating a slope differing significantly from zero ($F_{.01}$ = 9.65). When data for 1970-1 (5 plots) and 1971-2 (5 plots) were examined separately the correlation coefficients were negative (-0.786 and -0.296, respectively), but the F values (4.86 and 0.29, respectively) did not indicate slopes differing significantly from zero ($F_{.05}$ = 7.71).

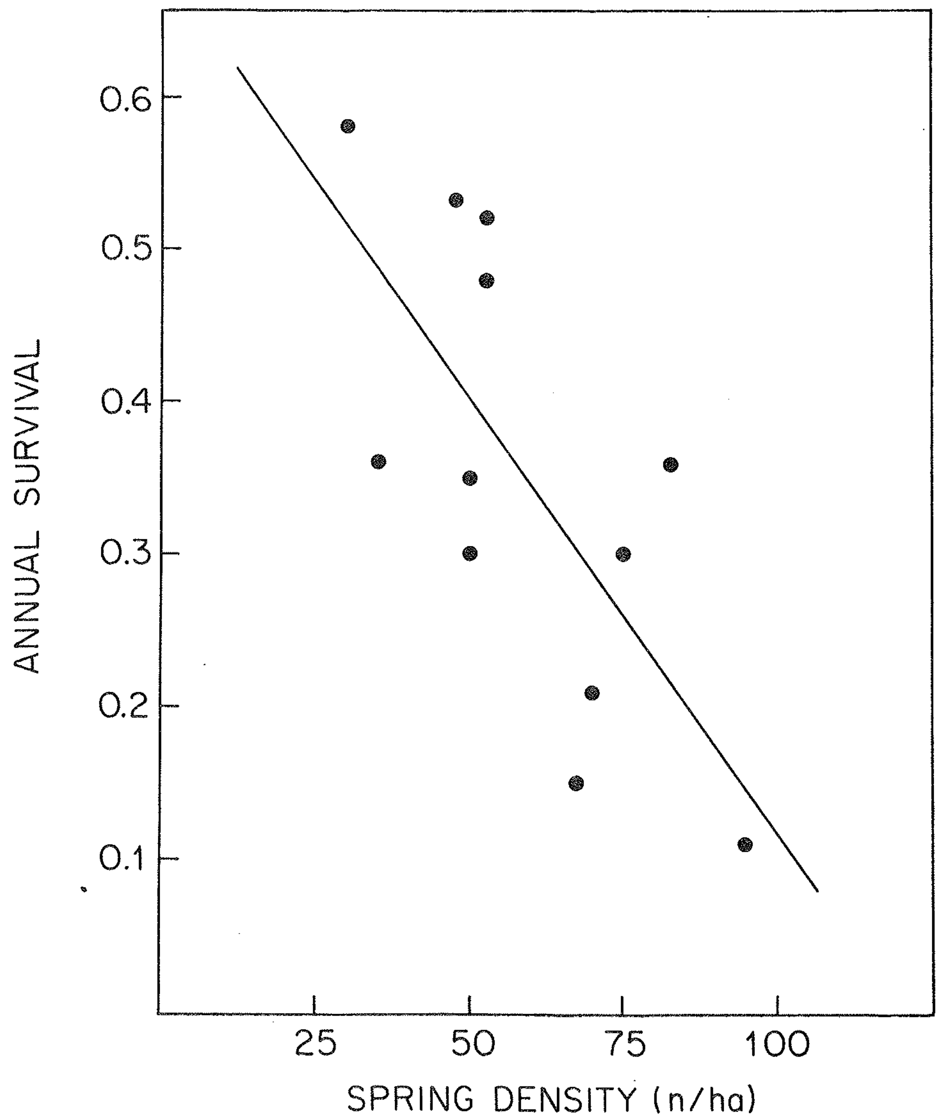

Figure 2. Relationship between annual survival and spring density of *Uta stansburiana* occupying one-acre enclosures in southern Nevada.

Eight-month survival of hatchling Uta: Prior to 1972 few hatchling *Uta* were marked in the experimental plots during the summer. Intensive registration was not begun until the spring. Summer registration of young *Uta* and recaptures the ensuing spring are indicated in Table 15. Except for the 1972 data, these figures pertain only to juveniles ≥ 28 mm in length at time of marking.

Table 15. Eight-month survival of hatchling *Uta stansburiana* occupying 0.4 ha enclosures in southern Nevada

Year	Sex	Hatchlings marked in July-August	Recaptured following February-March
1969	male	24	6
	female	24	10
1970	male	16	9
	female	16	11
1971	male	13	7
	female	21	16
1972	male	110	-
	female	116	-

DISCUSSION

The work with *Uta* in 0.4 ha enclosures during 1972 clearly confirmed the postulated correlation between winter rainfall and egg production. This relationship has been previously suggested for *Uta* (Hoddenbach and Turner, 1968), and a direct causal association between winter rainfall and germination and production of annuals has been demonstrated (Beatley, 1969). Better production of winter annuals also presumably leads to more insect food for *Uta*, but this step has not been demonstrated.

An investigation of body-weight changes during the spring among yearling *Uta* occupying irrigated and non-irrigated enclosures indicated significantly higher weight gains among those lizards in the irrigated aress. This is interpreted as direct evidence of more available food resources which were in some way promoted by winter irrigation.

The 1972 data, coupled with information acquired in 1969-70, indicated a high possitive correlation (0.98) between the number of clutches laid by female *Uta* 20 months and older, and the amount of rain during November and December. The comparable correlation for yearling females (0.76) indicated a similar functional relationship but explained far less of the observed variation. Yearling females occupying an irrigated plot in 1969-70 produced about the same number of clutches (1.1) as females in non-irrigated enclosures(0.9), while in 1971-72 yearling females in irrigated areas produced conspicuously more clutches (4.3) than females in plots which did not receive water (2.6)

A preliminary analysis of growth by hatchling *Uta* has suggested that heavy fall and winter rains inhibit activity and growth. If this is so, yearling *Uta* in the spring (ca. 8 months of age) would be relatively small following winter seasons with heavy rainfall, and larger after dry winters assuming comparable regimens of temperature. Reproduction does not begin until a threshold body size is attained, so the same factors which promote more available food in the spring may also delay growth and the initiation of egg production. Such an effect would be less marked among older females (20+ months old) for they would have already attained essentially maximum body size by their second winter. However, if such an inhibitory effect operated on yearling females in 1969-70, it does not appear to have been expressed in 1971-72.

Within the range of spring densities examined in 1972 (ca. 30-100/ha) a density effect on clutch size was not detected, though the expected difference between yearling and older females was clearly manifest. In 1970 clutch size was apparently increased by irrigation, but the 1972 data did not reveal such an effect.

Earlier work with hatchling *Uta* was not adequate to make definitive comments regarding their survival. There is some indication that 8-month survival following the summer of 1969 (when reproduction was good) was not as good as that following the summer of 1970 (when few young were produced). Annual survival of yearling and older *Uta* indicated a density effect when data from 3 years were combined. The limited observations relating to survival of hatchlings indicate better survival in the 0.4 ha enclosures (ca. 33-60%) than observed in 1.4 ha plots in Rock Valley where *Uta* are essentially unrestrained. Turner et al. (1970) reported around 20-25% 8-month survival of juvenile *Uta* in 1966 and 1967. Similarly, the annual survival rates of older *Uta* (from around 10% to almost 60%) in the 0.4 ha plots were generally higher than that observed among older *Uta* in Rock Valley between 1966-7 and 1967-8. Turner et al. (1970) reported annual survival rates of 25 and 16%, respectively, for these 2 years. The point is that the enclosures themselves may have an influence on the demographic parameters under observation. Gentry (1969) reported that enclosed populations of *Microtus pinetorum* exhibited abnormally high densities which, in his opinion, would not have been sustained in the absence of fencing. What appear to be unusually high densities of horned lizards in the 0.4 ha enclosures used for the *Uta* studies have also been observed (Medica et al., 1973).

EXPECTATIONS

Further irrigation experiments are not planned for 1973 because the effect of additional winter rainfall on annual production and reproduction by *Uta stansburiana* seems well established. Natural rainfall during the winter of 1972-73 will be recorded, and measurements of egg production and winter annual biomass during the spring of 1973 will be determined as in 1972.

Densities in four 0.4 ha enclosures will be experimentally altered during the early spring of 1973 in a manner comparable to that used in 1972. The main change in operations during 1973 will be another attempt to assess the impact of leopard lizards on survival of *Uta*. In 1972 it was found that these large predatory lizards could neither be restrained nor excluded by the low fencing surrounding the 0.4 ha experimental plots. Hence, predation pressure could not be controlled. In 1973 portions of two of the 8-ha enclosures in Rock Valley (Medica et al., 1971) will be used in a predation experiment. It is known from earlier work in these enclosures that adult leopard lizards are restrained by the fencing (Turner et al., 1969b). During 1972 Plot C was subdivided into two 4-ha semicircular plots (Chew, 1973). During the spring of 1973 all of the leopard lizards will be removed from one half of Plot C. A normal, or slightly augmented, density of leopard lizards will be maintained in adjoining Plot A. Studies of *Uta* reproduction and survival will be carried out in one 1.4 ha subplot in that portion of Plot C lacking *Crotaphytus*, as well as in a similar plot in Plot A (with a normal population of leopard lizards).

The work in 1973 will provide information on survival of lizards marked in 1972. Hatchling *Uta* will be marked in the summer of 1973 as in 1972. Survival of lizards marked in 1973 will be assessed by a final sampling in all plots during the spring of 1974. Attempts to derive quantitative expressions predicting egg production and mortality as a function of rainfall, density, predation and temperature will continue.

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APPENDIX A. Survival of *Uta stansburiana* in 0.4 ha experimental enclosures in southern Nevada

Time period	Age (months)	Sex	Plot 6		7		8		9		10		All plots	
March 1969-	20+	m	6	1	3	1								
March 1970		f	4	0	5	0								
	8	m	5	1	6	0								
		f	12	2	14	5								
Totals			27	4	28	6							55	10
March 1970-	20+	m	3	0	1	0	3	1	2	1	-	-		
March 1971		f	3	0	5	2	2	0	1	1	2	0		
	8	m	11	1	10	5	9	3	9	4	4	0		
		f	21	3	17	5	16	5	9	5	14	7		
Totals			38	4	33	12	30	9	21	11	20	7	142	43
March 1971-	20+	m	3	1	2	1	6	3	5	1	2	0		
March 1972		f	3	1	5	4	6	3	7	1	7	2		
	8	m	6	4	2	1	7	4	5	2	2	2		
		f	9	4	3	1	-	-	3	2	3	1		
Totals			21	10	12	7	19	10	20	6	14	5	86	38