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Activity of a Dipodomys ordii population using recapture methods

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ACTIVITY OF A *DIPODOMYS ORDII* POPULATION USING RECAPTURE METHODS

A Manuscript Presented
in lieu of a Thesis to the
Department of Zoology
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In Partial Fulfillment
of the Requirements for the Degree
Master of Science

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by

James R. Garcia

April 1975

This manuscript by James R. Garcia, is accepted in its present form by the Department of Zoology of Brigham Young University as satisfying the thesis requirement for the degree of Master of Science.

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Date

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I gratefully acknowledge the assistance of Brigham Young University, the Department of Zoology and particularly Drs. Clive D. Jorgensen, Melvin W. Carter and R. Ward Rhees in collecting and analyzing these data and in preparing this manuscript. A special thanks is due Dr. H. Duane Smith, for this research would not have been started without his inventive curiosity. I am grateful for the assistance of C. Ray Roeller, Gary H. Richins, Larry Pritchett, Sanford Porter and Ralph C. Holmgren with the field work. Finally, I wish to express my gratitude to my wife, Vikki, who has aided in ways far too numerous to enumerate here.

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Activity of a *Dipodomys ordii* Population Using Recapture Methods

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Abstract: Activity curves for *Dipodomys ordii* were developed from data obtained from a study utilizing an electrically monitored trapping grid. The curves for non-perturbated populations showed an initial post-dusk peak, followed by increasing activity and a large pre-dawn peak; but after ten dominant animals had been removed, the largest activity peak was post-dusk. Differences in activity patterns were not found among sex, age or reproductive classes. Rising ambient temperatures, falling barometric pressures, winds over 3.2 km/hr and the absence of the moon depressed capture numbers; while increasing humidity (relative and absolute), decreasing soil temperatures at 20 and 40 cm below ground level, rising barometric pressures, winds under 3.2 km/hr and clear periods with moonlight increased capture numbers; but only cloudy periods significantly altered the shape of the curves. Low statistical correlation indicated that other independent environmental variables, in addition to those considered, determined the observed activity patterns. Visual observations did not differ significantly from trap results.

INTRODUCTION

Scientists continually face a problem in determining small mammal diel activity cycles in natural environments, especially when it is necessary to use trapping procedures to study secretive and/or nocturnal species. Several techniques have been developed to determine activity (see Jorgensen and Hayward 1964; Bider 1968; Marten 1973; Garcia, Smith and Jorgensen 1974 for reviews), but results of the research to date have been deficient in one or more of the following areas: (1) number of recorded events per day, (2) timing of the activity event, (3) ability to assign the activity event to a certain individual and (4) correlation between the measured activity (*i.e.* laboratory measurements) and activity in *natural* environments.

Harling (1971) developed a new trapping technique by putting a switch in the trap door which closed when the trap door closed. The trap could then be connected electrically to a console, allowing accurate timing of captures. Captured animals could then be rapidly handled, marked and released and thus individual animal activity could be determined with relatively large quantities of captures accumulated from quasi-natural situations.

The object of this research is to determine the activity curves for a *Dipodomys ordii fetosus* Durrant and Hall (Durrant 1952, Hall and Kelson 1959) population using a data collection system modified from Harling (1971).

MATERIALS AND METHODS

Data to determine *D. ordii* activity cycles were collected at two sites Northeast of headquarters for the Desert Range Experimental Station in Millard County, Utah between Aug. 21 and Sept. 3, 1971 and June 25 and Aug. 27, 1973. The study sites were sandy and dominated by: Indian Ricegrass, *Oryzopsis hymenoides* (R. & S.) Riker; Rubber Rabbitbrush, *Chrysothamnus nauseosis* (Pall.) Britt.; and Russian Thistle, *Salsoa kali* L.; although *Ambrosia acanthicarpa* Hook, *Astragalus* spp., *Atriplex canescens* (Pursh) Nutt., *Gilia hutchinsifolia* Rybd. and *Hilaria jamesii* (Torr.) Benth. were also present (Welch and Moore 1973).

In addition to the materials and instrumentation previously reported (Garcia, Smith and Jorgensen 1974), a partial weather station was improvised 5 cm off the ground surface in the center of the grid. It included a Belfort Hygrothermograph[1] and a Weathermeasure three point Thermograph[2] with probes at 20, 40 and 60 cm below the ground surface.

DATA COLLECTION

Doors of the traps were opened and the traps baited with 5-10 grains of rolled oats each night. The control console was then connected with the power source and the indicator lights checked for malfunctions before switching to the operational mode. When a trap closed and the light went on at the console, the time was recorded and one of the two researchers investigated the capture and radioed the pertinent information by two-way radio to the other, who recorded it at the console site. Pertinent information included the reason for the door closing (small mammal capture, wind, insects, etc.); and when it was a small mammal, the genus and species, age (juvenile, subadult, adult), sex, reproductive condition (pregnant, lactating, estrus, vaginal plug, testes in scrotum, no apparent activity), and its identification mark (sequential toe clip). The animal was released after these data were recorded, and the time of release noted. The researcher checking traps counted the number of kangaroo rats observed in the trapping area but not in traps over time, and these numbers were used to prepare the visual estimate of activity patterns which were then compared with the patterns determined by trapping frequency. Concurrent with the time of capture, wind speed (Dwyer Wind Meter[3]) and barometric pressure changes (Short and Mason Altimeter-Barometer[4]) were recorded. Observations of cloud cover and lunar activity were made to assess changing light intensity effects. These data were entered on IBM punch cards, along with the time of sundown and sunrise (World Almanac 1971 and 1973), time of capture adjusted to sundown and absolute humidity.

The console was disconnected from the power source 45 min. after dawn, and the trap's doors closed to prevent daytime entries and death from heat prostration.

Absolute humidities were calculated from relative humidity and temperature data by the method proposed by Platt and Griffiths (1964). Vapor pressures of water in air saturated with water (e_s) were obtained from the Handbook of Chemistry and Physics (1963) for each temperature. Absolute humidities (χ) in gm/m^3 were then calculated with: $\chi = 217(\text{relative humidity})(e_s)/100(T)$, where T was the temperature in degrees Kelvin.

Data for *D. ordii* were collected for three weeks in 1973, after which ten of the animals presumed to be most dominant were removed from the activity grid. Criteria for selecting animals to be removed were that the animal be the only adult of a given sex captured within an area, or that it was caught in a single trap to the near exclusion of all others. Data collections were continued five days following removal.

ANALYTICAL METHODS

Ord Kangaroo Rat activity patterns for various categories (sex, age and reproductive condition) and independent environmental variables (wind, light and barometric pressure) were generated by dividing the capture period from sundown through the last capture into 20 periods (0.54 hour) and averaging the capture numbers during each period (see Jorgensen and Hayward 1964 for rationale of adjusting captures to sundown). Distributions of each class were then compared using Chi-square Tests of Independence to find the significant differences between categories and classes. Multiple regression was used to determine the influences of observed environmental parameters and their interactions on activity patterns, and which combination of independent variables was most effective in predicting activity patterns. Each independent variable's effect on the number of animals captured, was determined by varying each independent environmental variable in the regression equation while holding all other variables constant.

Chi-square analyses were also used to assess activity patterns of the Little Pocket Mouse, *Perognathus longimembris gulosus* Hall (Durrant 1952, Hall and Kelson 1959), the only other small mammal captured during this study. The Little Pocket Mouse patterns were compared to those of the Ord Kangaroo Rat's, but low capture numbers precluded further analysis of Little Pocket Mouse response to environmental fluctuations.

RESULTS AND DISCUSSION

Chi-square Tests of Independence were calculated on: the 1971 and 1973 activity patterns (Fig. 1), various animal categories and independent environmental variables to determine significant differences (Table 1). These activity patterns compare favorably with those of Reynolds (1960) for *Dipodomys merriami* without interspecific competition in the laboratory and those of Jorgensen and Hayward (1964) from trapping studies of *D. ordii*. Overall, there were no significant activity differences between sex, reproductive condition or age classes (Fig. 1) within either year, although the population was not evenly distributed among the classes. There were statistically significant differences between 1971 and 1973, which probably reflects the differences between a dry year (1971) and an unusually wet year during the 1973 growing season. Precipitation for the growing seasons (Oct. 1 -- Sept. 30) was 11.43 cm in 1971 and 20.50 cm for 1973, with the average for the last thirty years being 15.37 cm (Holmgren, personal communication). Although there were stastically significant differences between the activity patterns (males and females) for 1971 and 1973 (Table 1), there were no significant differences between the sex ratios ($\chi^2 = 0.10$, 1 d.f.). Significant differences in age distributions ($\chi^2 = 11.89$, 2 d.f.) indicated that the population had higher reproductive success when food was more plentiful. Thus, 1971 and 1973 activity curves were generated during unusual precipitation years, and may not reflect normal activity patterns with regards to magnitude, although most qualities of the curves such as the predawn activity peaks and increasing activity through the night, are unlikely to change.

The only statistically significant difference in activity curves within a year was between patterns for clear and cloudy nights (Table 1). The cloudy night activity pattern showed depression of the normal predawn activity peak (Fig. 2). This may be a consequence of early high humidity levels on cloudy nights which may have encouraged earlier seed gathering activities, with the seeds possibly having above normal moisture content or concurrent activity changes of predator species. The relationships between activity patterns and water metabolism are doubtlessly closely tied together and deserve further research.

Results of the regression analyses indicated that either independent variables other than those considered here (ambient temperature, relative humidity, absolute humidity, temperatures at 20 and 40 cm below the soil surface, barometric pressure changes, wind, sky condition and moon presence or absence) were more important in predicting capture frequency, or that there was a great deal of inherent variability within the rats themselves, since the highest R^2 was 19.96%. Regression equations with terms dropped from the full model with 11 interaction terms tested against the full model with F tests to determine significant differences. The regression equation with no interaction terms included, differed significantly from the full model ($F = 2.51$, 4 and 279 d.f.), indicating that significant amounts of the capture variation were due to the interactions. The effects of several independent environmental variables upon capture success became clearer by using the predictive equation determined by regression. Generally, as the ambient temperature increased captures declined, but as humidity increased captures rose. Captures vary directly with absolute humidity. The pre-dawn hours had the highest average relative and absolute humidities, and the lowest ambient temperatures, which correlated with the pre-dawn activity peak. Schmidt-Nelson (1964) found that kangaroo rats were active at night because of low ambient temperatures, high relative humidity and high absolute humidity. The overall activity curves show this same relationship (Fig. 1) of increasing activity as water (relative and absolute humidity) increases, with possible increases in the moisture percent of the seeds gathered, and when water losses from skin and respiratory evaporation would be lower. The pre-dawn period is also when the animals would be least likely to have to use water to maintain their body temperatures.

Temperature changes at 20 and 40 cm below the soil surface resulted in minor changes in the numbers of animals captured, with measurements at 60 cm excluded as they varied less than 2°C during the study. Falling barometric pressures depressed captures slightly while pressure increases resulted in slightly increased numbers relative to steady pressure. This behavior indicated a preference for post storm activity when humidities should be high and temperatures low. While holding other independent environmental variables constant, winds under 3.2 km/hr were accompanied with higher capture numbers than when winds were over 3.2 km/hr. These low wind conditions were most common during the pre-dawn hours. Although barometric pressure changes and the two wind speed classes predicted changing numbers of captures, results of the Chi-square Tests of Independence (Table 1) indicated that there were no concurrent changes in shapes of the activity curves. Finally, slightly more captures occurred during clear moonlit periods than during cloudy conditions, and there were also more captures when the moon was present than when the moon was new or set; indicating that nocturnal activity may not be based totally upon darkness for predator avoidance, but rather upon other variables and their interactions -- probably for physiological reasons, contrary to Blair's (1943) findings for Deer Mice and Jorgensen and Hayward's (1964) for Nevada Testsite animals.

Activity patterns determined by visual observations were not different from those determined by trapping (Table 1, Fig. 3). The high Chi-square total for the Test of Independence (Table 1), field observations that periods with high trapping success often had low observational frequencies and slope of the regression line for the percent trapped (Fig. 3); indicated that further study needs to be done to resolve the questions of whether visual data (Photographic, Infra-red, Red Light, etc.) monitor the same activity that trapping does and whether the equal trappability assumption is being satisfied in trapping studies. Removal of the ten animals presumed to be dominant resulted in statistically significant differences between the pre- and post- removal activity patterns (Table 2, Fig. 4). During the same time period, the population age structure also changed significantly ($\chi^2 = 15.74$, 2 d.f.), as many juveniles joined the trappable population, so it was not possible to ascribe all of the changes to the removal.

The role of dominant animals may be to repress early evening activities, which in turn, may benefit the population by postponing overall activity to more humid and cooler periods; thus, increasing the likelihood of survival. Another explanation of the activity pattern shift is that it may be due to "unschooled" juveniles, but this fails to account for the observed change in adult activity. Seven new adults were captured during the post-removal trapping, but all were captured on the grid borders, as would be expected if they were invading previously held territory, or if their home ranges were predominently outside of the grid and overlapped only the border.

Finally, *P. longimembris* activity patterns were the same for 1971 and 1973, but were different at all times from those of the Ord Kangaroo Rats (Table 3, Fig. 5). Little Pocket Mice cannot maintain activity during times of food deprivation (Bartholomew and Cade 1957) and would be especially susceptible to daily torpor (Lindberg and Chew 1964), particularly as the ambient temperatures decreased at night. In addition, if the two Heteromyid species' niches aren't completely separated by food preferences, they may be partially separated on the basis of peak time of activity (Jorgensen and Hayward 1964).

Acknowledgements.--This work was supported in part by the U.S.D.A. Forest Service, Intermountain and Range Experiment Station, in cooperation with Neil C. Frischkneckt, Project Leader and Brigham Young University. The authors wish to acknowledge the assistance of Tyler Rogers in constructing the console and C. Ray Roeller, Gary H. Richins, Larry Pritchett, Sanford Porter and Ralph C. Holmgren for their contributions to the field work.

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FOOTNOTES

[1] Belfort Instrument Co., Baltimore, MD 21224

[2] Weathermeasure Corp., Sacramento, CA 95841

[3] Dwyer Wind Meter, Michigan City, IN 46360

[4] Short and Mason, London, England

Table 1. Chi-square values for Tests of Independence on activity patterns for various *Dipodomys ordii* categories and independent environmental variables.

Variables	Degrees of Freedom	Chi Square	
All Classes Combined (1971 *vs* 1973)	19	131.37*	(Fig.1)
Sex			
Male *vs* Female (1971)	19	17.67	
Male *vs* Female (1973)	17	14.88	
Males (1971 *vs* 1973)	19	95.66*	
Females (1971 *vs* 1973)	19	51.41*	
Reproductive Condition			
Active *vs* Nonactive Males (1971)	18	20.11	
Active *vs* Nonactive Males (1973)	17	17.37	
Lactating *vs* Nonlactating Females (1973)	16	26.22	
Active Males (1971 *vs* 1973)	18	32.48*	
Nonactive Males (1971 *vs* 1973)	18	68.29*	
Nonactive Females (1971 *vs* 1973)	19	22.41	
Age			(Fig.1)
Preadults *vs* Adults (1973)	17	24.36	
Juveniles *vs* Subadults (1973)	16	8.04	
Adults (1971 *vs* 1973)	19	117.41*	
Light (1973)			(Fig.2)
Moon *vs* No Moon	9	15.39	
Clear *vs* Cloudy	9	19.96*	
Wind (1973)			
Less than 3.2 km/hr *vs* more than 3.2 km/hr	9	16.16	
Barometer (1973)			
Steady *vs* Unsteady	9	9.14	
Visual Observations (1973)			(Fig.3)
Trapped *vs* Visual	17	27.57	

*Statistically significant at $\alpha = .05$

Table 2. Chi-square values for Tests of Independence on activity patterns of various *Dipodomys ordii* categories following removal of ten dominant animals in 1973.

Variables	Degrees of Freedom	Chi Square	
All Classes Combined (Pre- *vs* Post-removal)	17	155.94*	(Fig.4)
Sex			
Male *vs* Female	17	20.21	
Male (Pre- *vs* Post-removal)	17	72.62*	(Fig.4)
Female (Pre- *vs* Post-removal)	17	76.51*	(Fig.4)
Reproductive Condition			
Active *vs* Nonactive Males	17	32.17*	
Lactating *vs* Nonactive Female	17	23.77	
Active Male (Pre- *vs* Post-removal)	17	47.02*	
Nonactive Males (Pre- *vs* Post-removal)	17	46.73*	
Lactating Females (Pre- *vs* Post-removal)	17	59.07*	
Nonactive Females (Pre- *vs* Post-removal)	17	34.41*	
Age			(Fig.4)
Preadults *vs* Adults	17	31.58*	
Juvenile *vs* Subadults	17	10.17	
Preadults (Pre- *vs* Post-removal)	17	71.37*	
Adults (Pre- *vs* Post-removal)	17	87.76*	

* Statistically significant at $\alpha = .05$

Table 3. Chi-square values for Tests of Independence on activity patterns of *Perognathus longimembris* and *Dipodomys ordii*.

Variables	Degrees of Freedom	Chi Square	
All Classes Combined			
P. longimembris (1971 *vs* 1973)	9	11.56	
P. longimembris (Total) *vs* *D. ordii* (1971)	19	67.09*	
P. longimembris (Total) *vs* *D. ordii* (1973, Pre-removal)	19	105.16*	(Fig.5)
P. longimembris (Total) *vs* *D. ordii* (1973, Post-removal)	18	39.43*	

* Statistically significant at $\alpha = .05$

LEGENDS FOR FIGURES

Figure 1. Activity curves for: (A) All *Dipodomys ordii* captured in 1971 and 1973; and (B) Juvenile, Subadult and Adult *D. ordii* in 1973.

Figure 2. Activity curves for *Dipodomys ordii* captured during cloudy or clear nights in 1973.

Figure 3. Activity curves for: (A) *Dipodomys ordii* visually observed of trapped; and (B) percent *D. ordii* trapped, of total seen or trapped in 1973. Slope of regression line is 1.71, Y intercept is 26.07, and R^2 is .3250.

Figure 4. Activity curves for: (A) All *Dipodomys ordii* trapped before and after removal of ten animals presumed to be dominant; (B) Males; (C) Females; and (D) Juvenile, Subadult and Adults for 1973, post-removal only.

Figure 5. Activity curves for: *Dipodomys ordii* captured in 1973 and *Perognathus longimembris* in 1971 and 1973.

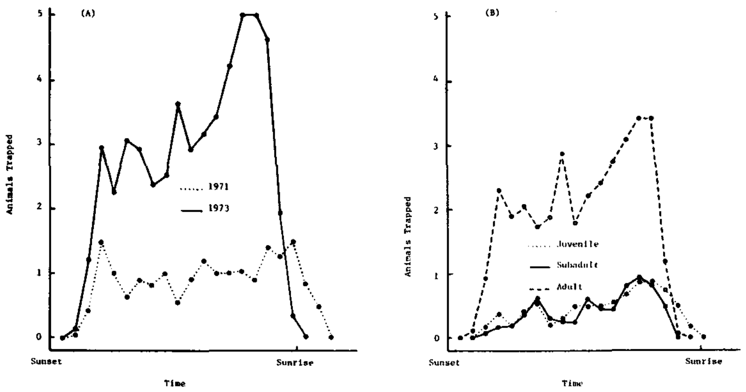
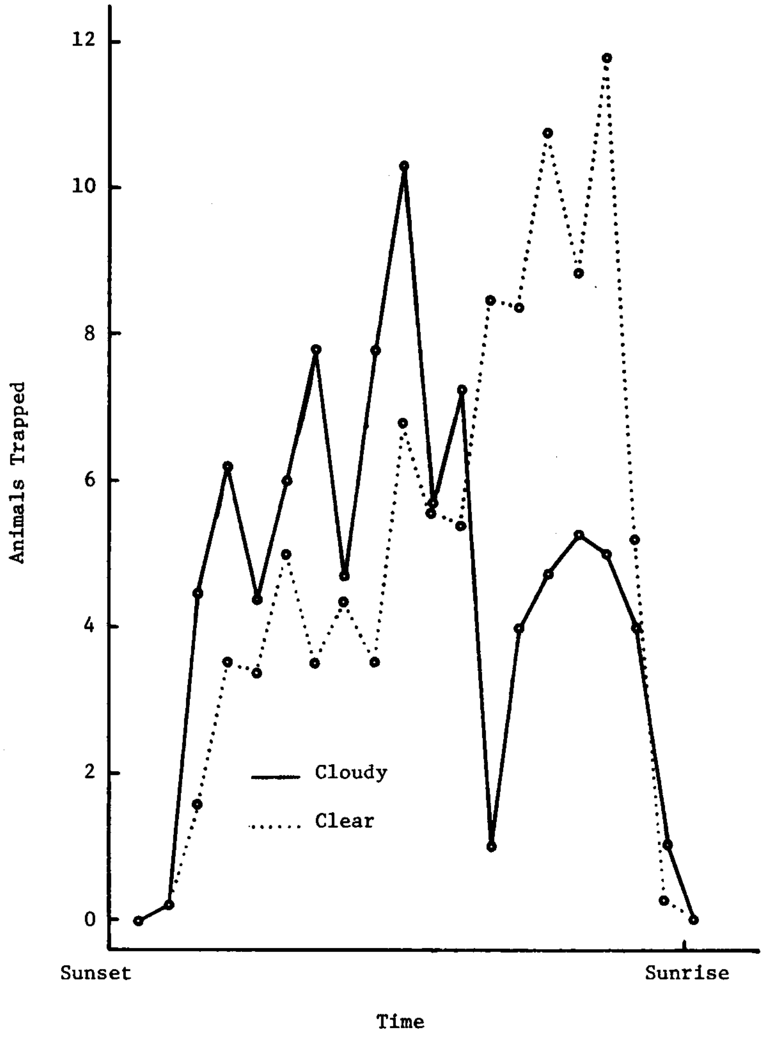

(A)
5
4
3
2
1
0
Animals Trapped
1971
1973
Sunset
Sunrise
Time
(B)
5
4
3
2
1
0
Animals Trapped
Juvenile
Subadult
Adult
Sunset
Sunrise
Time

Figure 1



12
10
8
6
4
2
0
Animals Trapped
Cloudy
Clear
Sunset
Sunrise
Time

Figure 2

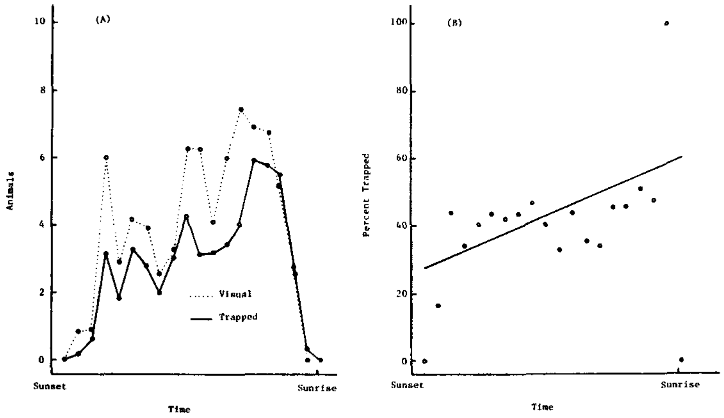

(A)
10
8
6
4
2
0
Animals
Visual
Trapped
Sunset
Sunrise
Time
(B)
100
80
60
40
20
0
Percent Trapped
Sunset
Sunrise
Time

Figure 3

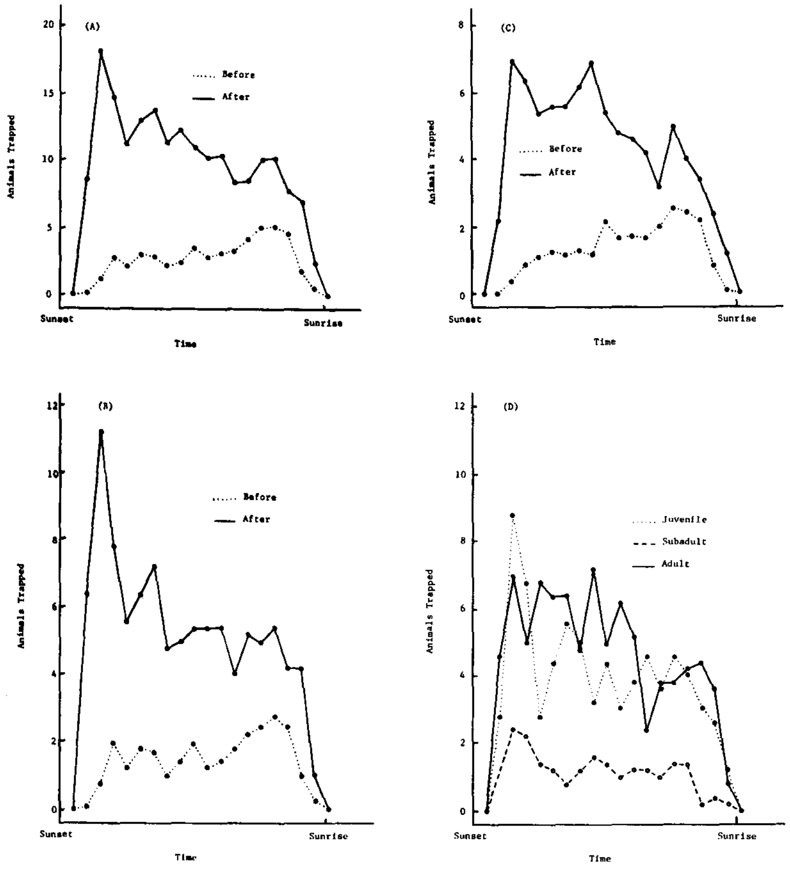

(A)
Before
After
Animals Trapped
0
5
10
15
20
Sunset
Sunrise
Time
(C)
Before
After
Animals Trapped
0
2
4
6
8
Sunset
Sunrise
Time
(B)
Before
After
Animals Trapped
0
2
4
6
8
10
12
Sunset
Sunrise
Time
(D)
Juvenile
Subadult
Adult
Animals Trapped
0
2
4
6
8
10
12
Sunset
Sunrise
Time

Figure 4

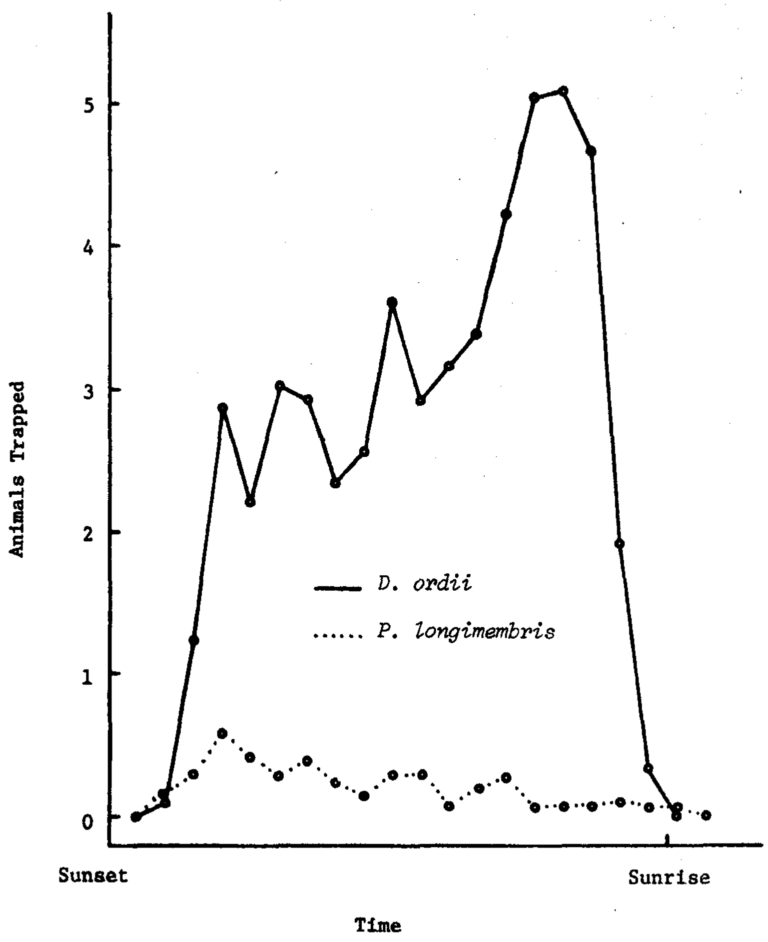

Animals Trapped
0
1
2
3
4
5
Sunset
Sunrise
Time
D. ordii
P. longimembris

Figure 5

ACTIVITY OF A *DIPODOMYS ODRII* POPULATION USING RECAPTURE METHODS

James R. Garcia

Department of Zoology

M.S. Degree, April 1975

ABSTRACT

Activity curves for *Dipodomys ordii* were developed from data obtained from a study utilizing an electrically monitored trapping grid. The curves for non-perturbated populations showed an initial post-dusk peak, followed by increasing activity and a large pre-dawn peak; but after ten dominant animals had been removed, the largest activity peak was post-dusk. Differences in activity patterns were not found among sex, age or reproductive classes. Rising ambient temperatures, falling barometric pressures, winds over 3.2 km/hr and the absence of the moon depressed capture numbers; while increasing humidity (relative and absolute), decreasing soil temperatures at 20 and 40 cm below ground level, rising barometric pressures, winds under 3.2 km/hr and clear periods with moonlight increased capture numbers; but only cloudy periods significantly altered the shape of the curves. Low statistical correlation indicated that other independent environmental variables, in addition to those considered, determined the observed activity patterns. Visual observations did not differ significantly from trap results.

COMMITTEE APPROVAL:

VITA