Peruvian Desert Mice: Water Independence, Competition, and Breeding Cycle near the Equator

Abstract. *The native mouse of the Peruvian coastal desert, near latitude 6°S, can survive on dry seed without drinking water, it bears young in winter, and it burrows in sand. House mice (which abound in other adjoining deserts) also tolerate dehydration, and in some areas may displace the native mice.*

Although the water economy of desert rodents from Africa, Eurasia, and North America (*1*) and Australia (*2*) has been intensively studied, the ecology of South American desert rodents is little known. The most equatorial, arid region of South America is the Sechura Desert of northwestern Peru, where the only native rodent is *Phyllotis gerbillus* Thomas, a cricetid mouse (*3*). Like most desert rodents, it is nocturnal, spends the day underground, and does not need to drink.

Between 14 July and 3 September 1967 our group (*4*) collected 32 museum specimens of *Phyllotis gerbillus* and examined 20 others from sites near Piura, Bayovar, and Reventazon, Department of Piura and Morrope, Department of Lambayeque, over a distance of 320 km, between latitudes 5°07′ and 6°42′S, at elevations below 60 meters. All collecting sites were mounded with loose sand, from drifts around dead bushes to dunes several meters high and half covered with low green shrubs, principally thick-leaved evergreens, *Capparis scabrida* and *C. avicennifolia*, and also a deciduous legume, *Prosopis juliflora*. Under many bushes the ground was littered with dry fruits and seeds. Barcanes of pure shifting sand bore no sign of mice. Similar habitat extends north and south for over 100 km beyond the known geographic range. About 70 km south, below the Saña River, we set traps on hillocks abounding in mouse tracks and caught only house mice (*Mus musculus*). In North America, house mice have not been observed in undisturbed deserts (*5*).

Knowing that some arid-zone rodents of other continents can live without succulent food or drinking water (*1*), we tested two South American mice for this ability. Mice (caught 90 km northwest of Chiclayo, 3 September 1967) were taken to Berkeley and placed in individual mesh-wire cages, each containing a can with cotton wadding for a nest (*6*). For 2 weeks the mice received a varied wet diet; water was then withdrawn, and the mice were fed only dry bird seed. The animals soon lost about 8 percent of their body weight, which then remained fairly stable until water was restored a week later. During a second deprivation, lasting 16 days, the mice lost weight for 3 days and then gained steadily (Fig. 1), as has been noted in Australian desert mice (*2*). When given water, the deprived Peruvian mice drank avidly and regained or surpassed their original weight in 1 day; one gained 7 percent in the first half hour. These mice can tolerate long periods of water deprivation, and at least 10-percent dehydration of their body water. Nevertheless, they are probably less able to live on dry food than are gerbils, jerboas (Dipodidae), kangaroo rats, and pocket mice (Heteromyidae), which rarely drink even when given water.

Since house mice occupy a similar habitat bordering that of *Phyllotis gerbillus*, we also tested the former for possible water independence. Two house mice, taken from dry grassland about 10 km east of Berkeley, were fed only dry bird seed for 19 days. These mice quickly lost weight (Fig. 1); one lost 13 percent in 3 days. Then they gained moderately; one surpassed its original weight 9 days after withdrawal. Unlike the Peruvian mice, when given water the deprived house mice did not drink immediately and, in fact, gained little in 2 days; however, in 6 days they gained 6 percent. House mice that have become adjusted to long dry periods—as in central California—can survive on a dry diet about as well as Peruvian desert mice can. Because house mice are adaptable and aggressive, they probably compete with and may displace *P. gerbillus* in marginal parts of its range. In its optimum range, the Sechura Desert, the native mouse dominates.

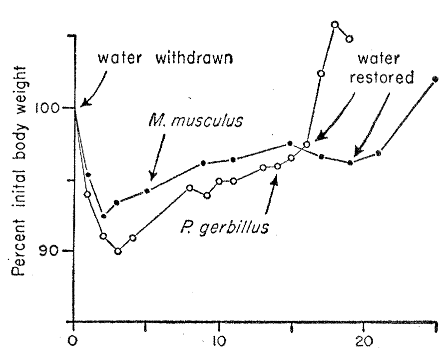

Fig. 1. The mean responses of body weight to water deprivation and restoration in two male *Phyllotis gerbillus* and two *Mus musculus* on a diet of dry bird seed. Initial weights of the gerbils were 17.9 and 13.6 g, and of the mice, 15.9 and 15.1 g. Ambient temperatures, 22° to 29°C; relative humidity, 55 to 67 percent; water content of food, 10 percent.

Some rodents reduce water loss, especially pulmonary evaporation, through aestivation at temperatures of about 25°C (*1*). No South American mammal is known to aestivate or hibernate, but some may have this ability as judged by one *Phyllotis gerbillus* which, during a night in a metal trap with little food, became torpid and, after warmed and force-fed, required half an hour to arouse completely. The caged mice did not become torpid. Aestivation, excess heat, or food scarcity might inhibit breeding in summer during which mean temperatures in the desert are about 26°C (February and March).

Mice in places with wide seasonal change in temperature usually breed in summer (*3*), but in arid regions near the equator they may breed in the dampest season. In coastal Peru, where annual rainfall is about 70 mm and irregular, the most humid season is winter when skies are overcast, nights are dewy, and temperatures are as low as 18°C. Of ten mature females taken from mid-July to early September 1967, all were pregnant or lactating. In July and early August we trapped juveniles weighing as little as 6 g. As judged by uterine bulges, scars, and embryos in nine mice, litter size was one to four. Weight at sexual maturity was about 14 g, as judged by minimum weight of pregnant females and of males with testes of maximum length (8 mm).

Two Peruvian mice were kept 1 month in an aquarium half filled with sand partly covered by hard clay. Many phyllotine mice use burrows, but none has been observed to dig them (*3*). Our mice, however, when placed in bright light without refuge, dug out of sight in loose sand in a few minutes, with about ten rapid, alternate strokes of the forefeet and a few hard, simultaneous thrusts of both hindfeet, thereby nearly plugging the burrow. In these holes the mice slept lying on one side, loosely curled. Like some other desert rodents they conserve body water by remaining in their cool, humid burrows until nightfall.

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References and Notes

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4. I thank R. B. Hamilton, F. C. McCollum, and R. B. Huey for their specimens, photographs, and field notes.
5. H. Haines and K. Schmidt-Nielsen, *Physiol. Zool.* **40**, 424 (1967).
6. I thank O. P. Pearson for maintaining and weighing the mice during October and November.

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Discriminative Control of "Attention"

Abstract. *Three pigeons were trained to discriminate between two tones differing in frequency in the presence of light of one color (A), and not to discriminate between the tones in the presence of light of another color (B). Generalization functions that were determined in the presence of light A showed control of behavior by the frequency of the tone; those determined in the presence of light B did not.*

Our experiments were done to find out whether "attention" to a dimension of stimuli can be brought under discriminative control. We adopt the noncommittal definition of attention suggested by Skinner (*1*). An organism is said to attend to a dimension of stimuli if variations in the value of the stimulus produce variations in behavior, otherwise he is said not to attend. Thus, whether a subject is or is not attending to a stimulus dimension can be determined by analysis of an empirical function relating stimulus values to behavior, such as a gradient of stimulus generalization. If the "stimulus generalization" function is a horizontal line, it indicates that the subject is not attending to the stimuli that are being varied; any other shape indicates that he is attending.

The subjects were three White Carneaux pigeons that had not been experimented upon before. They were trained to peck at two translucent disks located in a test chamber that also contained a loudspeaker and a device for presenting food. Two sets of stimuli were manipulated during the experiment: the two disks were illuminated from behind by either red or green light, and a sinusoidal tone having a frequency of either 300 or 1000 hz was sounded.

Training sessions were divided into a series of trials that were separated from each other by intervals ranging from 10 to 35 seconds. The onset of a trial was marked by the introduction of one of the four possible combinations of sound and light stimuli. For each of the stimulus combinations one of the disks was defined as correct and the other as incorrect. A single peck to either disk caused the removal of the visual and auditory stimuli and ended the trial. In addition, a response to the correct disk led to reinforcement, a 2.5-second period of access to a tray of mixed grain.

The general plan of the training procedure was as follows. When the disks had one color, the frequency of the tone determined which of the two responses was reinforced, but when the disks had the alternate color a response to only one of the disks was reinforced regardless of the frequency of the tone. For example, if the disks were red, a peck at the right-hand disk was reinforced only in the presence of the 1000-hz tone and a peck at the left-hand disk was reinforced only in the presence of the 300-hz tone. On the other hand, if the disks were green, a peck at the right-hand disk was reinforced regardless of which tone was present, whereas a peck at the left-hand disk was never reinforced. The two conditions will be referred to as tone relevant (TR) and tone not relevant (TNR), respectively. Which color was associated with conditions TR and TNR, and which disk (left to right) was correct for each frequency in condition TR, varied from subject to subject.

The discrimination was taught in stages. The subjects were first trained to discriminate between the colors in the presence of only one of the tones. Next they were trained to discriminate between the tones in the presence of the color used in condition TR. After this, the four combinations of color and tone were presented in a random sequence during each training session. All correct responses were reinforced until a stable asymptotic performance was attained. Then the number of reinforcements was gradually reduced until only 50 percent of the correct responses, selected at random, were reinforced.

The final part of the experimental procedure was a test for generalization along the dimension of tonal frequency. The method used in the generalization tests was identical with that just described for the very last stage of training, except for one modification: on those trials on which no reinforcement was given, the training tone was replaced by a tone having a frequency of 450, 600, 800, 1350, 1800, 2400, or 3200 hz. Generalization tests were done in four sessions during which each of the seven new tones was presented in combination with each of the two colors a total of 16 times.

The results for three birds are presented in Fig. 1, which shows the proportion of responses to the disk that was correct for the 1000-hz tone (under both conditions TR and TNR) plotted against the frequency of the tone. In the presence of the color used in condition TR, the frequency of the tone strongly influenced the proportion of responses to each of the disks, whereas in the presence of the color associated with condition TNR the frequency of the tone had no influence on the choice of disks. Clearly, attention to a stimulus dimension can be brought under discriminative control.

The sort of discrimination learned by our subjects is often referred to as

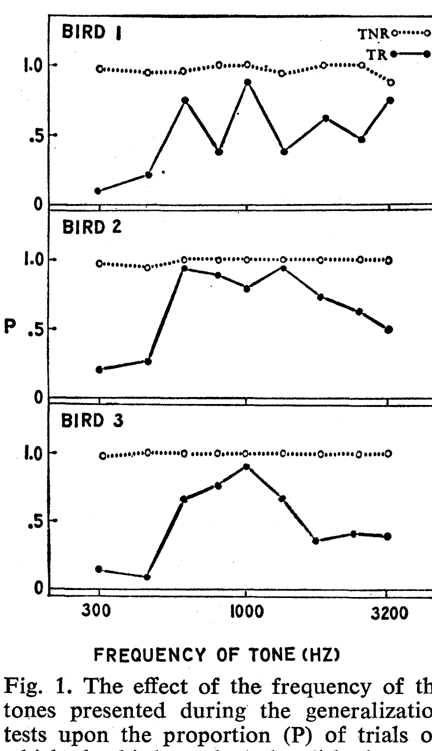

Fig. 1. The effect of the frequency of the tones presented during the generalization tests upon the proportion (P) of trials on which the birds pecked the disk that was "correct" for the 1000-hz tone. The points obtained when the disks had the color used in condition TR are connected by the solid line, those obtained when the disks had the color used in condition TNR are connected by the dotted line.