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Periodicity of Desert Rodent Activity

Abstract. *The radiation dose detected by microthermoluminescent dosimeters attached to pocket mice,* Perognathus formosus, *indicated the amount of time these animals were active on the surface of the ground. Radiation was from an elevated, partially shielded source in the center of the 8-hectare enclosure. The rodents are almost entirely inactive in midwinter but spend 30 to 40 percent of their time above ground in the summer months. Periods of activity increase gradually through the spring. These results support laboratory findings that members of this genus undergo periods of torpor in response to low ambient temperatures or food shortage. That this adaptation may enhance survival is indicated by the longevity of marked individuals of a related species.*

A microdosimeter of lithium fluoride has been developed to determine the amount of radiation to which small animals have been exposed in studies of radiation ecology (*1*). Thermoluminescent dosimeters made from this material are particularly valuable because they respond almost linearly to amounts of radiation ranging from a few milliroentgens to many kiloroentgens, and because their energy dependence is small (*2*). Microdosimeters are well suited to measuring radiation exposure and the dose absorbed by wild rodents living in irradiated areas (*3*). We have measured exposure of wild desert rodents (the pocket mouse, *Perognathus formosus*) to radiation from an artificial source, and with this information have evaluated seasonal changes in the daily activity cycle.

An 8-hectare circular area in the Mojave desert at the U.S. Atomic Energy Commission's Nevada test site is irradiated by a ^{137}Cs source supported 15 m above ground at the center of the area. The source is differentially shielded in order to reduce radiation intensity at ground level near the tower supporting the source. With increasing distance from the tower there is less shielding between the source and the ground. In this way the variation in dose rate with distance is reduced to approximately sixfold along the radius of the study area from 50 m to over 160 m (Fig. 1). Below the surface of the ground radiation decreases rapidly. At a depth of 15 cm the dose rate is less than 10 percent of the surface dose rate. At 30 cm it is less than 1 percent. Farther from the center of the area, the dose rate decreases more rapidly with depth because of the greater angle of incidence between the source and the ground. Rodents in their burrows are therefore shielded from the radiation.

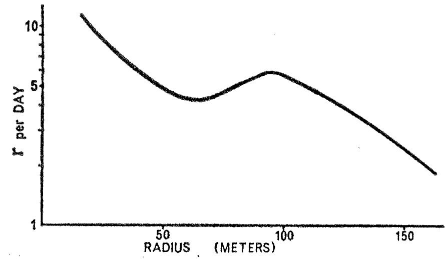

Fig. 1. Radiation dose rate at ground level along the radius of circular 8-hectare plot.

The microdosimeter, a sealed glass capillary tube 0.8 by 6.0 mm containing 0.6 mg of LiF crystals, is placed in a small piece of polyethylene tubing, and that in turn is placed into a piece of black electrical spaghetti. The assembly is fastened to the neck of the rodent with a single suture. Rodents are trapped at monthly intervals, and dosimeters are removed from the containers and replaced with unexposed units. Our results are based on the recovery of 136 dosimeters.

Radiation exposure is determined by the total time an animal spends on the surface of the ground, as well as by the location of the plot where it lives. These rodents normally move about an area approximately 20 m in diameter. The trapping records for an individual rodent indicate where it lives, and the plot of radiation dose rate tells the degree of exposure in that location. The fraction of the exposure period during which the animal was on the surface is obtained by comparing the total ground exposure with the exposure of the dosimeter (Fig. 2).

The average dose rate in roentgen per day received by rodents in the study area between 1964 and the present shows strong seasonal fluctuations (Fig. 2). Exposure varies from nearly zero in midwinter to over 1.25 r/day during the summer months. Integrated exposure in the first half (January through June) of 1966 was 50 percent higher (148 r) than for the same period in 1965 (95 r). The average annual radiation exposure to the rodents is approximately 350 r. These dose rates are not known to affect the natural behavior of animals in any measurable way. Comparison of each exposure with the surface dose rate where the animal was trapped shows the activity time of the animal. The variation in exposure between years, as well as the seasonal variation, resulted from changing activity of the animals, that is, the amount of time they spent on the surface. The average fraction of time on the surface (Fig. 2) indicates almost complete inactivity during 1 month in winter, whereas they spent 30 to 40 percent of the time on the surface in summer.

The rodents were 50 percent more active in the spring of 1966 than during the corresponding time in 1965. The cooler, wetter spring of 1965 probably suppressed surface activity of the animals. These conditions resulted in greater production of leaves, flowers, and fruits by plants. Reduced animal activity may have been a consequence of the abundant food supply.

Bartholomew and Cade (*4*) reported

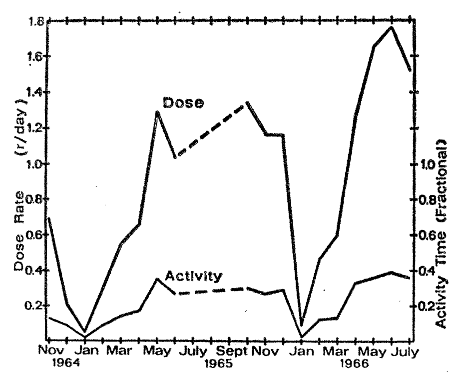

Fig. 2. Monthly mean radiation exposure to pocket mice, and fractional time active on the ground surface. The fraction 1.0 equals 100 percent of the time. The dotted lines cover a 4-month period during which no dosimeters were retrieved.

that periodic torpor (hibernation or aestivation) occurs in this and other species of the genus *Perognathus* as a response to low ambient temperature or absence of food. Tucker (*5*) reported torpor can occur daily in *P. californicus* when food supply is reduced. The amount of time in torpor varied inversely with the quantity of food available. Animals in the laboratory may undergo periodic torpor even with an abundance of food and normal ambient temperature (*6*).

During the period of our radiation dose measurements wild *P. formosus* were predominantly inactive and hence apparently torpid only when environmental temperatures were low. There was no indication of a shortage of food, even late in the year. The lengthening periods of activity during successive months in spring may be a response to increasing average temperatures or to increasing food supply. Since metabolic rate in these animals varies greatly with activity, two similar populations in two different years may have vastly different energy requirements.

The labile body temperature and metabolic rate in pocket mice is of great importance to survival in an environment characterized by unpredictable growing seasons, by prolonged drought, and by long periods of high temperatures. All members of the genus *Perognathus* that have been investigated respond similarly to changing environmental conditions, and these results may be relevant to the observed survival of another species. Our trapping records revealed surprisingly long survival times for the smallest species, *P. longimembris*, which as adults weigh only 6 to 8 grams. Twenty-five marked individuals survived between 3 and 5 years over a period of particularly severe environmental conditions. These observations suggest that increasing periods of torpor may prolong the life span, although the total activity time of these animals may remain unchanged.

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Holomicrography: Transformation of Image during Reconstruction a posteriori

Abstract. *Holomicrographs recorded through a microscope contain a hologram of the interior of the microscope, including the objective. During reconstruction of the microscopic image, modification of the aperture of the reconstructed objective produces the same alteration in the reconstructed image that would have occurred in the original image, if the actual objective had received the same modification. By this means, a single event holographed by bright-field microscopy may later be examined in reconstruction by dark-field, phase-contrast, or interference microscopy.*

A diatom, *Navicula lyra* Ehr., was holomicrographed (*1*) in light (wavelength, 6328 Å) from a Spectra-Physics model 125 helium-neon c.w. gas laser. The unmodified beam from the laser was passed through a beam splitter, reflected from a first-surface mirror through an objective, [10 ×, numerical aperture (N.A.) 0.30] used as a condenser, through the specimen, and through another objective (40 × N.A. 0.65) to the film plane of a 35-mm camera body, holding Eastman Kodak 649-F spectrographic film. The reference beam arising at the beam splitter was reflected obliquely from a first-surface mirror, passed through a 20 × objective at about the level of the view-

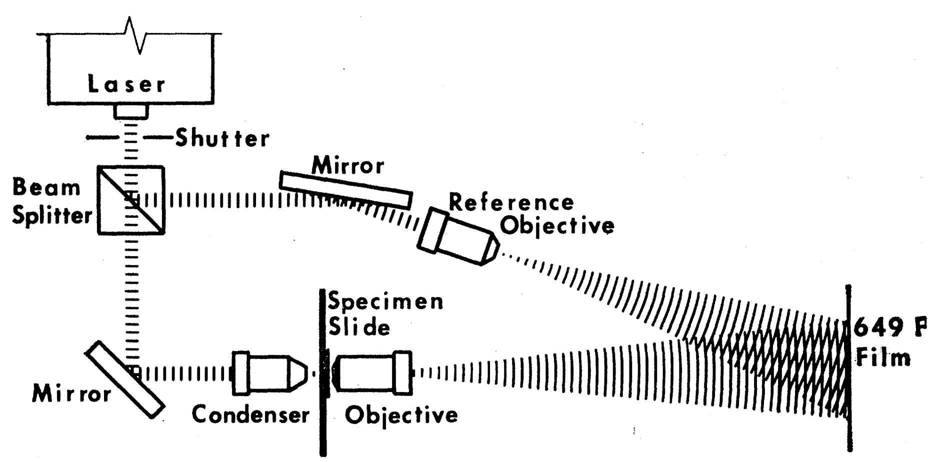

Fig. 1. Diagram of holomicrographic recording system in plan view.

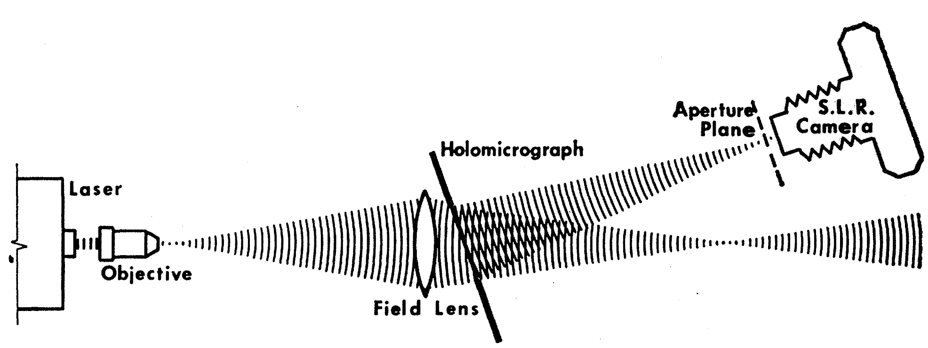

Fig. 2. Plan view of apparatus arrangement for photographing reconstructed images. The aperture plane designated is that of the reconstructed objective. With this aperture unmodified, the reconstructed image photographed is similar in all significant aspects to the original image available in the microscope at the time the hologram was recorded. Modification of this aperture as described in the text and Fig. 3 transforms the image.