and the Division of Radiological Health, Bureau of State Services, Public Health Service.

AILENE HERRANEN
Worcester Foundation for
Experimental Biology, Shrewsbury, Mass.

[1] Ross, W. C. J., *Biological Alkylating Agents* (Butterworths, London, 1962).
[2] Ord, M. G., and Stocken, L. A., *The Biochemical Lesion in Vivo and in Vitro in Mechanisms in Radiobiology*, **1** (Academic Press, 1961).
[3] Hagen, U., *Nature*, **18**, 187, 1123 (1960).
[4] Cole, L. J., and Ellis, M. E., *Rad. Res.*, **7**, 508 (1957).
[5] Herranen, A., *Fed. Proc.*, **21**, 424 (1962).
[6] Allfrey, V. G., Mirsky, A. E., and Osawa, S., *J. Gen. Physiol.*, **40**, 451 (1957).
[7] Webb, J. M., and Levy, H. B., *J. Biol. Chem.*, **213**, 107 (1955).
[8] Whitfield, J. F., and Rixon, R. H., *Exp. Cell Res.*, **31**, 140 (1963).
[9] Peacocke, A. R., and Preston, B. N., *Nature*, **192**, 228 (1961). Lloyd, P. H., and Peacocke, A. R., *Nature*, **200**, 428 (1963).
[10] Brookes, P., and Lawley, P. D., *Exp. Cell Res.*, Supp. 9, 521 (1963).
[11] Biesele, J. J., *Exp. Cell Res.*, Supp. 9, 525 (1963).

BIOLOGY

Responses of a New Hibernator (*Citellus variegatus*) to Controlled Environments

THE phenomena of hibernation and æstivation have both been recorded in the genus *Citellus*, and although it is not known whether the two phenomena are physiologically the same[1], nevertheless hibernation seems to be an adaptation to an unfavourable cold seasonal environment, and æstivation an adaptation to an arid hot environment with seasonal drought. It is of interest, therefore, to find that the rock ground squirrel, *Citellus variegatus*, the habitat of which is the arid south-west from Utah to southern Mexico[2], is capable of hibernating but does not appear to æstivate. Hibernation as used here refers to a mammal with a homothermic temperature of approximately 37° C, but which is able to lower this temperature to the environment and raise it again against the gradient.

In early June 1963, twelve animals of this species were trapped 10 miles west of Las Vegas, Nevada. They comprised seven adults and five juveniles. All survived well in captivity, and gained weight rapidly, the adults becoming extremely obese.

On August 5, one month after capture, groups of two animals were exposed to 3° C and 23° C environmental temperatures, with food ('Purina Chow') and water *ad libitum*, to determine whether spontaneous æstivation occurred as in *Citellus mohavensis*[3]. On August 15 two more groups of two were exposed to the same environmental temperatures, but only food was supplied. In the groups with food and water *ad libitum* no evidence of spontaneous æstivation was observed, and at the time of writing (December 1963) no evidence of spontaneous hibernation has been observed either. The latter is in contrast to *Citellus mohavensis* which æstivates and hibernates spontaneously[3] and *Citellus lateralis* which hibernates spontaneously[4]. The groups with food but no water lost weight gradually, but no drop in body temperature was observed in those in an environment of 3° C for 45 days when water was given, or the animals died. In those at 23° C there was no observed drop in body temperature for 50 days, but thereafter one animal did appear to become hypothermic on occasions for a few hours, body temperatures of 28° C and 31° C being recorded. During October food was denied to four more animals at an environment of 3° C, and in all cases they hibernated within 10 days. However, under these conditions the body temperature does not apparently fall to the environment like that of other hibernators[3,5] but is maintained at a low of 8° C in a 3° C environment. It seems that *C. variegatus* has some form of 'thermostat' set considerably above 0° C, which is confirmed by the fact that an animal in an environment of −18° C continues to hibernate successfully, but the body temperature is held at 8–10° C. The œsophageal temperature is slightly above the rectal.

This species also has a remarkable tolerance to dehydration. When free water is denied but food ('Purina Chow') permitted, the animals slowly lose weight, but some have survived more than 100 days at 23° C with no appreciable drop in body temperature. *C. lateralis* at the same season (that is, active one) will only survive some 20 days with no free water (Pengelley, unpublished results), but the percentage loss in weight before death is about 70 per cent in both species. There are, no doubt, differences in physiological adaptations to water deprivation in two such species (now being investigated), but there is an obvious behavioural difference. *C. lateralis* becomes highly active within 24 h of deprivation of water, whereas *C. variegatus* gives no response that can be observed and remains comparatively docile. Although the environmental conditions are probably not identical[6,7], *C. variegatus* may prove to have the longest survival time of any mammal yet examined which is unable to maintain body weight without free water (*Dipidomys merriami* can[6]); this is, of course, provided there is no lowering of body temperature in response to water deprivation.

The experimental results indicate that in *C. variegatus* the stimulus for entrance into hibernation is lack of available food, that æstivation does not occur spontaneously or in response to lack of water, and that while the animal is able successfully to lower its body temperature and raise it against the gradient, it does not in fact permit it to fall below 8° C. Thus, its behaviour is quite different from other species within the genus. Furthermore, it is possible to reason that the evolutionary adaptations to this animal's arid habitat are high tolerance to water deprivation during summer (the dry season throughout most of its range), and the ability to hibernate during winter in response to scarcity of food which it does not store, at least in captivity.

This work was supported in part by grant *G* 19295 from the U.S. National Science Foundation and grant 50 from the Kaiser Foundation. I thank Dr. James Deacon, University of Nevada, Las Vegas, for assistance in obtaining the animals.

E. T. PENGELLEY
Division of Life Sciences,
University of California,
Riverside, California.

[1] Hudson, J. W., *Symposia Arctic Biol. and Med.*, Geophys. Inst., Univ. Alaska, Part 3, 421 (1962).
[2] Hall, E. R., and Kelson, K. R., *Mammals of North America*, **1**, 352 (Ronald Press, 1959).
[3] Bartholomew, G. A., and Hudson, J. W., *Bull. Mus. Comp. Zool. Harvard Coll.*, **124**, 193 (1960).
[4] Pengelley, E. T., and Fisher, K. C., *Nature*, **180**, 1371 (1957).
[5] Pengelley, E. T., and Fisher, K. C., *Can. J. Zool.*, **39**, 105 (1961).
[6] Schmidt-Nielsen, B., Schmidt-Nielsen, K., Brokaw, A., and Schneiderman, H., *J. Cell and Comp. Physiol.*, **32**, 331 (1948).
[7] Hudson, J. W., *Univ. Calif. Publ. Zool.*, **64**, 10 (1962).

Liver Mitotic Rates and Weights in Young, Rapidly Growing Rats after Serum Injection

THE systems which seemingly demonstrate control of cell division in rat liver commonly involve change in the composition of the blood. For example, Stich and Florian[1] found that single injections of normal serum administered to partially hepatectomized rats inhibited mitosis, while serum from rats which had been partially hepatectomized stimulated mitosis following a single injection. Recently, Moya[2] reported that single injections of both normal and post-hepatectomy serum prepared from arterial blood inhibited mitosis in regenerating livers. Moreover, Smythe and Moore[3] reported that weights of regenerating livers were decreased by repeated injections of normal plasma. These results, obtained in adult rats, raise the question of whether treatment with serum injections has the same effects on livers of young, rapidly growing rats.