ABILITY OF THE GROUND SQUIRREL, *CITELLUS LATERALIS*, TO BE HABITUATED TO STIMULI WHILE IN HIBERNATION

It has been known since the work of René Dubois (Ann. Univ. Lyon, 25: 1–268, 1896) that hibernation in mammals was not continuous over an entire winter. However, only recently (Pengelley and Fisher, Canadian J. Zool., 39: 105–120, 1961) has it been demonstrated that complete arousals in hibernating ground squirrels are not only common but exhibit a regular frequency dependent upon ambient temperature. The higher the latter the more frequent the arousals, but at an ambient temperature of 0°C and a consequent hibernating body temperature of 1°C the arousals occur quite regularly at 12- to 14-day intervals during the central portion of the entire hibernation period (Pengelley and Fisher, Canadian J. Zool., 41: 1103–1120, 1963).

The theory proposed by Pengelley and Fisher to account for this phenomenon infers that an animal in hibernation with a body temperature of 1°C is capable of a coordinated response to minute internal physiochemical stimuli, and it has been demonstrated on several occasions (Lyman, J. Exp. Zool., 109: 55–78, 1948; Lyman and Chatfield, Physiol. Rev., 35: 403–425, 1955) that they respond to external stimuli usually by arousal. Since all evidence pointed to the conclusion that these normally homothermic (37°C) animals are fully neurologically coordinated while in hibernation (body temperature 1°C), it was of importance to determine whether the nervous system was capable of functioning at this low body temperature in such a way as to make possible a habituated response to a stimulus. The results of such an experiment are reported here.

The animals used were golden-mantled ground squirrels, *Citellus lateralis,* whose hibernating behavior had previously been well studied (Pengelley and Fisher, *op. cit.* 1963). They were taken from the wild during late summer, individually caged with food and water *ad libitum,* and transferred to a room held at 0°C with an artificial photoperiod of 12 hours in 24. Under these conditions the animals began to hibernate in a few weeks, and within 2 to 3 months exhibited the regular pattern of rhythmical arousals at 12- to 14-day intervals. The continuous state of hibernation was determined by the "sawdust technique" (Pengelley and Fisher, *op. cit.* 1963), which effectively informs the experimentor whether the animal has aroused between each observation, i.e., daily in this case. Such a technique, together with an understanding of the periodic arousals, are essentials for the experiment, because the stimulus employed was tactile and the response an arousal with subsequent re-entry into hibernation. Thus unless the spontaneous periodic arousals are considered there is danger of misinterpreting the results.

After the regular 12- to 14-day pattern of continuous hibernation had been established, several hibernating animals were removed from their nests, tossed once 2 to 3 ft in the air, caught, returned to their nests and the sawdust replaced in a pyramid on their dorsal surface. Such a stimulus invariably caused the animals to arouse as evidenced by observing them in the state of arousal some hours later or by the absence on the following day of the sawdust, which was then replaced on the animal that had re-entered hibernation. Using this procedure animals were stimulated daily until it was found that they responded to such a stimulus by not arousing until the next normal arousal was due. This clearly indicated that the animals were being habituated to the tactile stimulus while in hibernation, and subsequently the daily "tossings" were increased gradually until it became possible to repeat this procedure 100 times without causing the animal to arouse from hibernation. Admittedly this experiment is "crude," and in future studies the more accurately controllable electrical stimulus will be used. Nevertheless, the results are conclusive enough to establish the fact that with a body temperature as low as 1°C, the nervous system of these hibernating mammals is fully functional even to the point of establishing a habituated response to stimuli. Apart from the theoretical importance of this fact, there is a great advantage to be exploited from habituating animals in hibernation, namely that it may supply the investigator with a tool for studying on a continuous basis the "milieu interieur" of an animal in hibernation without causing it to arouse; the latter problem having plagued most investigators in the field.

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FOOD HABITS AND BURROW ASSOCIATES OF *PEROMYSCUS POLIONOTUS*

The term granivore has been applied to the oldfield mouse, *Peromyscus polionotus*, in previous studies at the Savannah River Plant (Caldwell, 1964; Davenport, 1964). However, Connell (1959) reported insect material in stomachs of *P. polionotus*. Investigations have shown that other species of *Peromyscus* are omnivores (Jameson, 1952; Williams, 1959; Whitaker, 1963. The present report concerns data collected over the past 5 years in South Carolina, Georgia, and Florida.

The oldfield mouse constructs characteristic burrows in well-drained, sandy soils (Smith and Criss, 1967). The burrow system is simple and easily excavated. Food items in the form of seeds, seed shells, and the hard exoskeletal remains of insects were collected at burrow entrances and from nest cavities. Items found around the burrow entrances appear to be the result of an annual spring cleaning of the nest. As the temperature rises in the spring, the mice tend to move material from the nest to the surface. However, there is also evidence that seeds and insects are eaten on the mound around the entrance hole.

The various food items were identified and are listed in Table 1. More seed fragments were found than animal parts. Most of the plant material consisted of empty shells that do not decay as fast as other materials. Many of the food items collected at the burrow entrance were also present in the nest cavity. It is apparent that the oldfield mouse obtains food from a large variety of sources. The southern harvester ant, *Pogonomyrmex badius*, collects and stores, in large quantities, the same species and variety of seeds (unpublished data). Therefore, considerable competition for food probably exists between the two species.

A variety of live animals was placed in cages with hungry oldfield mice. The mice had been without food for 24 hr. The live animals consisted of (1) invertebrates—black widow (*Latrodectus mactans*), Carolina wolf spider (*Lycosa carolinensis*), American cockroach (*Periplaneta americana*), German cockroach (*Blatella germanica*), camel cricket (*Ceuthophilus latibuli*), blind cricket locust (*Typhloceuthophilus floridanus*), common field cricket (*Gryllus assimilis*), and eastern lubber grasshopper (*Romalea microptera*); (2) vertebrates—southern toad (*Bufo terrestris*), oak toad (*Bufo quercicus*), six-lined racerunner (*Cnemidophorus sexlineatus*), scrub lizard (*Sceloporus woodi*), cotton mice (*Peromyscus gossypinus*), Florida deer mice (*P. floridanus*), and oldfield mice (*P. polionotus*). The three species of mice were one day old. All animals were eaten except the two species of toads. Live animals, such as cockroaches, were frequently fought over and seemed to be preferred over most seeds.

Invertebrates found within occupied burrows or in the entrance tube outside the sand plug and vertebrates from unoccupied burrows were identified (Table 2). These are data collected from approximately 1200 burrows. Invertebrates found only in unoccupied burrows were not identified since an unoccupied burrow was essentially only a hole in the ground and the invertebrates housed there would not necessarily bear any relationship to the oldfield mouse. The only animal that was regularly found in burrows with oldfield mice was the camel cricket (*Ceuthophilus latibuli*), which builds small lateral tunnels off the sides of the escape tube. The crickets must avoid the mice since they are readily eaten by them. Two blind cricket-locusts (*Typhloceuthophilus floridanus*) also were