Technology in the Study of the White-Footed Mouse

J.R. Charbonneau, R. Gaertner*, O.Z. Roy

National Research Council
Ottawa, Canada

This paper deals with a multidisciplinary investigation of the ecology and physiology of the white-footed mouse (*Peromyscus leucopus*) and is one in a series of experiments conducted at the National Research Council on acclimatized birds and mammals. The reasons for these studies are many but perhaps the most compelling of these is the avalanching concern over the quality of the environment and the interdependence of all the creatures within that environment. The truth of the statement that the earth does not belong to man but that man belongs to the earth has never been more evident.

This particular species which is one of the most widespread rodents on this continent, weighs from 15 to 30 grams and is perhaps the smallest mammal which has ever been studied so fully under "semi natural" conditions using telemetry. The questions which were to be answered concerned the seasonal energetics of *Peromyscus leucopus;* specifically, activity periods, food and oxygen consumption, heart rates and body temperatures. In other words, how *Peromyscus* has adapted to its environment.

For these studies to be of value, the stipulation was made that as far as possible the animal should be unrestrained and subjected to the stresses of natural climatic conditions. To achieve this, light-weight (3 gram) transmitters were built and implanted in mice which were trapped locally. Once the implant was made, the animals were released into a specially built enclosure (Fig. 1). The enclosure, although exposed to the elements, has a nesting area with an environment similar to that found in nature. This nesting area was the prime monitoring location for measuring oxygen and food consumption, periods of activity, and the amount of time the animal was directly exposed to weather extremes. The remaining parameters, heart rate and body temperature, could be determined over the entire enclosure by means of a large tuned loop antenna which encircled the whole area.

The circuit diagram of the heart rate, temperature transmitter is shown in figure 2. This transmitter is a low-frequency (490 kHz) pulsed carrier type with an average duty cycle of 10:1; i.e., 100 μsec ON, 1 msec OFF, and has an average current drain of 35 μA when powered with a 1.25 volt mercury cell. A 1-megohm thermistor is used to measure body temperature and forms part of the current-source biasing network for the oscillator stage. This determines the basic pulse repetition rate and gives one channel of information; the second channel containing the higher frequency electrocardiogram or heart rate information is obtained by an incremental modulation of pulse rate. With the components shown and a tuned loop antenna signals can be received at distances of up to 8 feet. However, because of the space limitations imposed upon the transmitter and hence upon the geometry of the transmitting antenna (L_1, L_2), the system is quite directive. For this reason care must be taken when implanting to position the transmitter loop so that it is coplanar with the receiving antenna. Since it is impossible to maintain a coplanar position under all circumstances, and especially during nesting periods, nulls will result. It has been found that the simplest way of minimizing loss of signal is to place a number of tuned loops, which are not physically connected to the main antenna or receiver, around the nesting enclosures. These additional loops are angled with respect to the main loop and act as reflectors. With the multi-loop system and a tuned amplifier as the receiver, a signal can be picked up over the entire 4 by 8 foot enclosure with the main antenna 6 to 8 feet above ground.

The physical size of the transmitter is shown in Fig. 3, as well as an animal with an implant. These animals weigh from 15 to 30 grams, while the total weight of the two-channel transmitter is 3 grams including a 36 mA-hour mercury cell and packaging. The packaging process is of extreme importance to the longevity of the transmitter and becomes an art in itself with a number of favorite procedures (1). The particular method used in these experiments is to encase the components in a paraffin - bees wax mixture and cover this with an external skin of a heat sensitive wax impregnate plastic material called Parafilm.* This combination is well tolerated by the animals and has enabled the implanted transmitters to function for periods of up to 2 months.

A large number of experiments have been conducted over a two-year period to obtain the seasonal behavior of these acclimatized animals. A detailed analysis of the results is beyond the scope of this paper; however, perhaps one observation can be made. Our studies under "semi-natural" conditions have shown that these animals have an adaptive mechanism which was previously unknown and that is a climatically controlled metabolic shutdown known as torpor. All previous experiments were conducted on non-acclimatized mice and these showed a torpor characteristic that could only be triggered by starvation; our results indicate that both the lack of food and climate can trigger torpor. A climatically triggered torpor record of heart rate and body temperature is shown in Fig. 4. This state has been maintained by these animals for periods of 10 hours and can occur on a daily basis. At the end of this period the furnace is fired up again, heart rate rises sharply increasing metabolic rate and body temperature. Thus the torpor

*Division of Biology, National Research Council of Canada.

*Parafilm 'M' American Can Co.

mechanism becomes a major factor in allowing the *peromyscus* to survive the rigours of a winter climate with the same energy expenditure it uses throughout the summer.

Reference

1. Mackay, R.S. Bio-medical telemetry. John Wiley and Sons, Chapter 4, page 91, 1968.

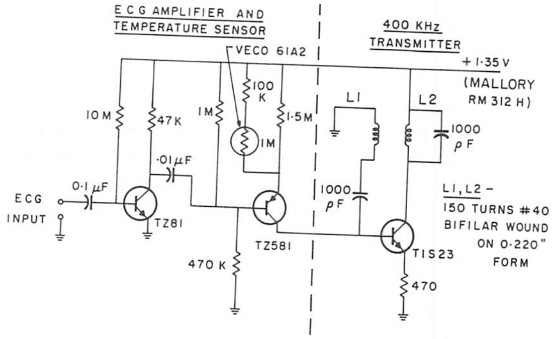

Fig. 2 Circuit Diagram of Two Channel Transmitter

Fig. 1. View of Environmental Enclosure

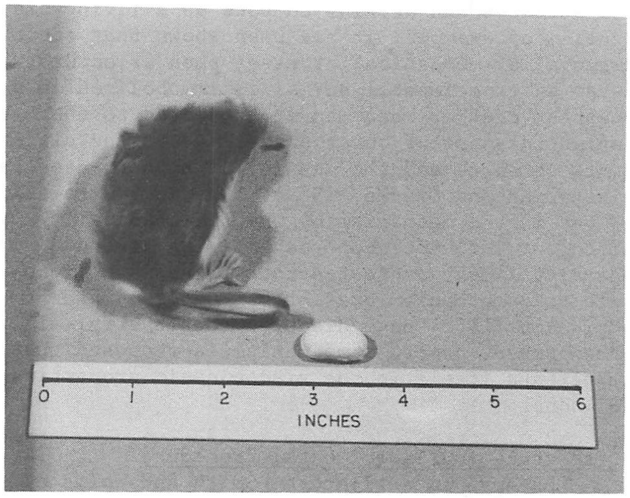

Fig. 3 Peromyscus Leucopus and Transmitter

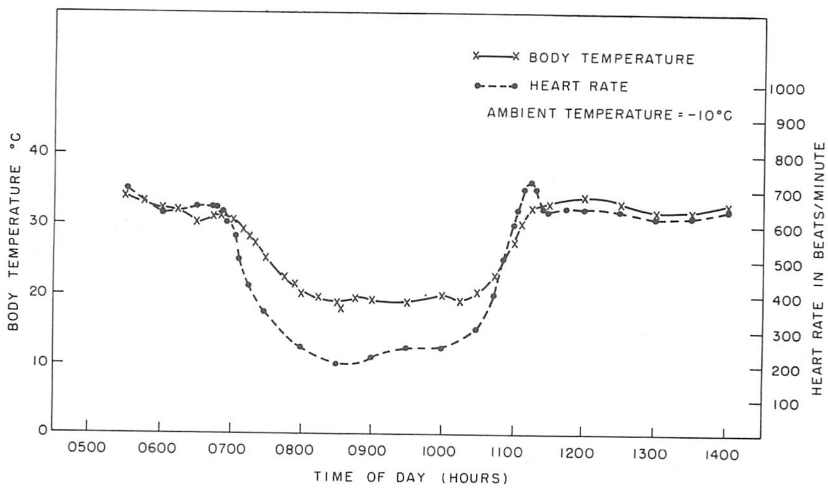

Fig. 4 Heart Rate and Temperature Response During Torpor