A RADIO-TRACKING SYSTEM FOR STUDYING MOVEMENTS OF DEER

JOHN R. TESTER, Museum of Natural History, University of Minnesota, Minneapolis
DWAIN W. WARNER, Museum of Natural History, University of Minnesota, Minneapolis
WILLIAM W. COCHRAN, Museum of Natural History, University of Minnesota, Minneapolis

Abstract: A six-transistor, superheterodyne, portable, directional receiver, utilizing a regenerative intermediate frequency detector at 5.0 megacycles, was designed and constructed to remotely monitor movements of deer (*Odocoileus virginianus*) marked with radio transmitters. Construction details and a circuit diagram of a new pulsing signal transmitter are given. Transmitters were slipped over the heads of two penned does and one fawn, and the movements of these deer, after release in the wild, were recorded for a 10-day test period in December, 1962, and again on February 5, 1963. During the test period, one doe moved about within an area slightly smaller than 1 square mile whereas the other two deer remained in the vicinity of the pen.

This paper reports on tests of radio-tracking equipment made in December, 1962, and February, 1963, and on the movements of three penned white-tailed deer after they were released in the wild.

We wish to thank the Minnesota Division of Game and Fish for the use of the facilities of the Carlos Avery Game Research Center and for providing the deer for release. Division biologists, B. A. Fashingbauer and J. M. Idstrom, assisted with the handling of the deer and provided valuable advice throughout the study. We also wish to acknowledge D. Raveling and D. Cline, graduate students of the University of Minnesota, who assisted in the field-tracking. Dr. W. H. Marshall critically read the manuscript and offered helpful suggestions.

The investigation, supported by the Louis W. and Maud Hill Family Foundation, is part of a long-range ecological study of the motile responses of animals to certain physical and biological factors of the environment. One of the objectives of the project has been to solve ecological problems by using an interdisciplinary team approach combining the fields of biology and the physical sciences. The basic tracking system is similar to that described by Cochran and Lord (1963). Project personnel made modifications in the design of the transmitter, including the new pulsing circuit, and developed a transistorized tracking receiver weighing only 1.5 pounds.

From the standpoint of the biology of white-tailed deer, it would have been desirable to capture and mark wild individuals. However, the release of pen-raised deer provides certain advantages in evaluating a radio-tracking system. For example, we could walk to within approximately 100 yards of these animals after they had been released into a natural habitat. This enabled us to determine the exact position of the radio-tagged animal in the field as a check on our remote determination of its location. In addition, we anticipated and found that these pen-raised deer remained in the vicinity of the research station where they had been held in captivity.

METHODS

Radio Equipment

A portable directional receiver, designated Museum of Natural History Model D-11, was designed and constructed by project personnel. It is a six-transistor superheterodyne, utilizing a regenerative intermediate frequency detector at 5.0 mc (megacycles). The receiver covers 26.550 mc to 26.650 mc in 10 channels with a fine tuning control for tuning over each channel. Details of construction of the receiver are given by Cochran and Nelson (1963).

The transmitter is mounted on a 1.0-inch-wide collar fabricated from 0.125-inch natural polyethylene, which is noted for its flexibility at low temperatures. Four Mallory RM3 batteries are paralleled to provide about 17,000 hours (2 years) of operation at 0.5-milliampere current drain. After the battery interconnections are made, the batteries are individually covered with plastic electrician's tape. They are then wrapped individually in aluminum foil, which cuts down losses due to the presence of the steel battery cases in the radio-frequency field of the loop antenna. A single turn of No. 22 stranded wire is wound on the collar and taped in place to serve as the antenna.

The batteries are taped to the collar over the loop in two pairs, with the pairs 2 inches apart. The ends of the loop antenna are in this space, and the transmitter components are assembled here according to the circuit diagram and parts list shown in Fig. 1. The capacitor, C1, is chosen to be about 5 $\mu\mu$f (micromicrofarad) larger than the optimum value as determined by substitution in each individual transmitter. This allows for final tuning by placing varying amounts of aluminum foil around the collar at the time of attachment to the animal. This foil is held in place by wrapping with plastic electrician's tape. Capacitor C2 determines the pulse length and pulse rate, which will be between 1 and 10 per second depending upon the characteristics of the individual transistor. The pulse rate decreases as the value of R1 is increased until oscillation stops completely. The power drain is least when R1 is made as large as operation will permit. Under actual field conditions, this value of R1 should not be used unless it is determined with the transmitter at the lowest temperature anticipated because a drop in temperature will cause the transmitter to stop.

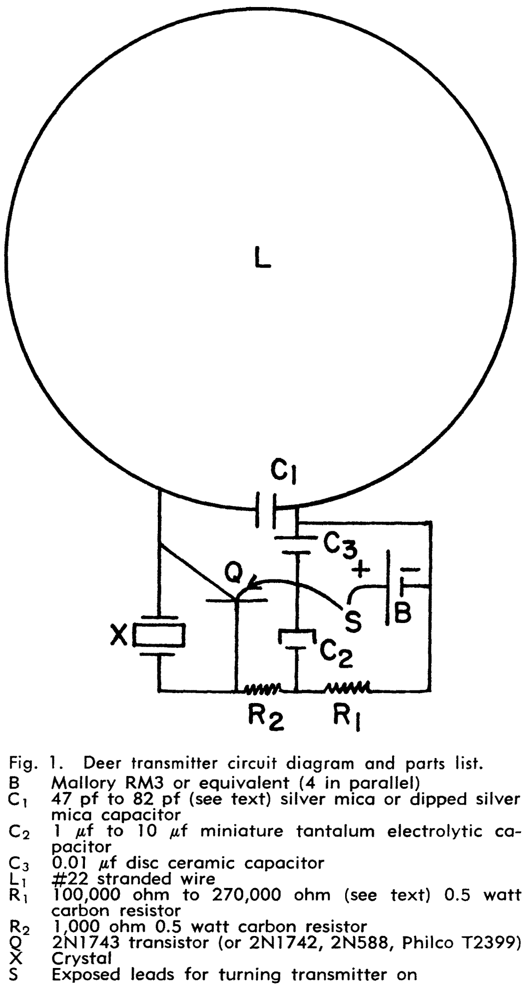

Fig. 1. Deer transmitter circuit diagram and parts list.

B Mallory RM3 or equivalent (4 in parallel)
C_1 47 pf to 82 pf (see text) silver mica or dipped silver mica capacitor
C_2 1 μf to 10 μf miniature tantalum electrolytic capacitor
C_3 0.01 μf disc ceramic capacitor
L_1 #22 stranded wire
R_1 100,000 ohm to 270,000 ohm (see text) 0.5 watt carbon resistor
R_2 1,000 ohm 0.5 watt carbon resistor
Q 2N1743 transistor (or 2N1742, 2N588, Philco T2399)
X Crystal
S Exposed leads for turning transmitter on

After the wiring is completed, the circuit is smeared with an epoxy resin (Eccobond No. 26) to prevent lead breakage or other physical damage to the components. Two layers of plastic electrician's tape complete the packaging except for final taping down of the turn-on leads and the aluminum foil. The weight of the collar and batteries and all transmitter components is approximately 180 grams. Cochran and Hagen (1963) give detailed instructions for construction of this transmitter.

One transmitter, designed for operation at low temperatures, has been on a penned deer from December 11 to February 28. During this period the transmitter functioned properly in air temperatures ranging from –15 F to +45 F. No tests were made at colder temperatures.

Biological

Numerous methods have been used to mark deer for individual identification. Plastic and aluminum collars have been described by Fashingbauer (1962). His findings indicated that a collar configuration for the radio transmitter would be satisfactory. Following the general size limits given by Fashingbauer, the components of the radio transmitter were assembled on a polyethylene collar as described above.

Each of two does was paralyzed by using a dart gun, with nicotine as the paralyzing drug. After a deer was knocked down, the transmitter collar was slipped over the head, orange-red fluorescent paint was sprayed on the flanks and tail to provide a visual means of identification, and the animal was transported by truck to the release point approximately 1,000 feet from the pen. Doe No. 1 was released inside a 4-acre pen and kept there for about 3 hours after recovery. She was then chased out of the pen and allowed to roam free. Doe No. 2 and Fawn No. 1 were released outside the fenced area and were free to roam upon recovery.

The radio-transmitter collar was placed on the fawn by merely slipping it over her head while she nibbled on an ear of corn held in the hand. This animal was then led to the release point.

Marked deer were located by triangulation. Two bearings were obtained from sites ½ mile or more apart each time an individual was located. A time lag of several minutes occurred between the taking of the bearings because we had to drive from one checkpoint to the next. This time lag did not appear to cause any significant errors in the movement data since the marked deer did not move long distances nor at a rapid rate. If one can accept this time lag between bearings, the entire tracking operation can be carried out by one person in the field. The effective operating range with the portable receiver is approximately ¾ mile. It is anticipated that the effective operating range will be 8–10 miles with the fixed receiving stations now being installed on 80- and 100-foot high towers.

On numerous occasions, the observers saw the marked deer in the woods after homing in on the radio signals with portable directional receivers. The exact location of the deer was determined for comparison with their location as fixed by triangulation. Deer ½ mile from triangulation sites were repeatedly seen within 150 feet of their radio-determined position.

Detailed cover maps scaled 8 inches per mile were made from aerial photographs and field observations. All triangulation checkpoints and deer locations made by triangulation and by field observation were plotted on these cover maps.

Weather data were obtained from the U. S. Weather Bureau Station at Forest Lake, 7 miles east of the study area, and from field observations.

DEER MOVEMENTS

Doe No. 1 was trapped near St. Paul, Minnesota, in 1960, when she was estimated to have been 1.5 years of age. She has been held with other deer in a 2-acre pen at the Carlos Avery Game Research Center since that time. The movements of this doe were recorded from the time of her release with a radio transmitter on December 4 until December 14, when field tests of the equipment were suspended. Her position was monitored continually for the first 72 hours after release and then periodically during the next 7 days. The radio-positioning data indicated that all movements during the test period were within an area slightly smaller than 1 square mile. A resumption of field tests on February 5 revealed that Doe No. 1 was about 0.3 mile from the release point, in the company of two wild deer. She could not be approached for observation, and her behavior was similar to that of the wild deer.

Doe No. 2, released on December 5, and Fawn No. 1, released on December 11, remained in the vicinity of the holding pen throughout the initial test period and were still in the same area on February 5. Both deer had been in captivity since birth and were accustomed to men. We believe this accounts for the fact that they did not leave the pen area.

LITERATURE CITED

COCHRAN, W. W., AND T. E. HAGEN. 1963. Construction of collar transmitters for deer. Minnesota Museum Nat. Hist. Tech. Rept. 4. 12pp. Mimeo.

———, AND R. D. LORD, JR. 1963. A radio-tracking system for wild animals. J. Wildl. Mgmt. 27(1):9–24.

———, AND E. M. NELSON. 1963. The model D-11 direction finding receiver. Minnesota Museum Nat. Hist. Tech. Rept. 2. 14pp. Mimeo.

FASHINGBAUER, B. A. 1962. Expanding plastic collar and aluminum collar for deer. J. Wildl. Mgmt. 26(2):211–213.

Received for publication May 27, 1963.

SAMPLING WHITE-TAILED DEER ANTLERS FOR STRONTIUM-90

VINCENT SCHULTZ, Division of Biology and Medicine, U. S. Atomic Energy Commission, Washington 25, D. C.

Abstract: The strontium-90 and calcium content of five portions of the left antler of four white-tailed deer (*Odocoileus virginianus*) was determined. There were no statistically significant differences among position averages for $\mu\mu c$ of strontium-90 per gram of ash, $\mu\mu c$ of strontium-90 per gram of calcium, and percent calcium per gram of ash. A 1-degree-of-freedom comparison of main beam versus point samples resulted in significant F-values. As a result of the relatively large variability among deer, other sources of variability inherent in field problems, and the relatively small difference among position averages, it is concluded that the segment of the antler sampled for strontium-90 is of no great consequence in many studies of strontium-90 accumulation in white-tailed deer antlers.

The accumulation of strontium-90 in cervid antlers, bones, or both has been reported on by Foreman et al. (1961), Hawthorn and Duckworth (1958), Hiyama (1961), Schultz and Longhurst (1963), Virkkunen and Vuorinen (1962), and others. Foreman et al. (1961) and Hiyama (1961) analyzed a fairly extensive series of antlers to study the accumulation of strontium-90 in the Cervidae.

Antlers have three decided advantages over bone samples: (1) antlers can be obtained without destroying the animal, (2) they are available in quantities, and (3) sample preparation is easier than for bone. Although it has not been substantiated, it has been postulated that the accumulation of strontium-90 in antlers is a reflection of environmental contamination during the period of antler development.