Technical Papers

An Electronic Method of Tracing the Movements of Soil-inhabiting Insects[1]

A. P. Arnason,[2] R. A. Fuller,[3] and J. W. T. Spinks[4]

Dominion Entomological Laboratory, Saskatoon, and *Department of Chemistry, University of Saskatchewan, Saskatoon, Canada*

Recently a new method of following the movements of soil-inhabiting insects has been developed, using a radioactive tracer technique. This new technique has been applied so far only to the larva of the prairie grain wireworm, *Ctenicera aeripennis destructor* (Brown), but it is applicable to many species.

Up to the present, information on wireworm movements has come from observations using other than natural environmental conditions (*1, 5*). Much information on movements of the wireworm population as a whole in response to seasonal and other environmental changes has been gathered by actually removing the larvae from their natural habitat and noting their position at time of removal (*2, 3, 4*). This has the disadvantage that the activity of individuals or groups of individuals cannot be followed. The use of a radioactive tracer seems to offer a method of studying wireworm behavior under approximately normal circumstances (*6*).

This tracer method involves making the larva radioactive in some way so that its movements may be traced, from above the soil, by means of a Geiger-Müller tube. The feeding of activity to the larva as a means of activation is not practical for several reasons, whereas attaching activity to the larva shows some degree of usefulness. However, external application is suitable only between molts, because the activity is shed at each ecdysis. Investigations to date have indicated that the most efficient means of activating the larva will probably be by the insertion of radioactive cobalt wire into the body cavity of the wireworm. Successful insertions, using inactive wire, have already been carried out, with a high survival rate of treated larvae for both wireworms and cutworms. No apparent abnormality or loss of movement was evident in the surviving wireworm larvae up to three months after treatment. The treated cutworms developed normally and shed the inserted wire with the last larval or pupal skin. Also, no harmful effects of the gamma radiation have been observed in larvae which have had activity attached to them for a period of at least two weeks. Radioactive cobalt 60 has been chosen for this work because its high energy gamma radiation (1.10 and 1.30 Mev) makes it easy to detect under several inches of soil, and because its long half-life (5.3 years) minimizes corrections for decay and thus permits observations over a long period of time.

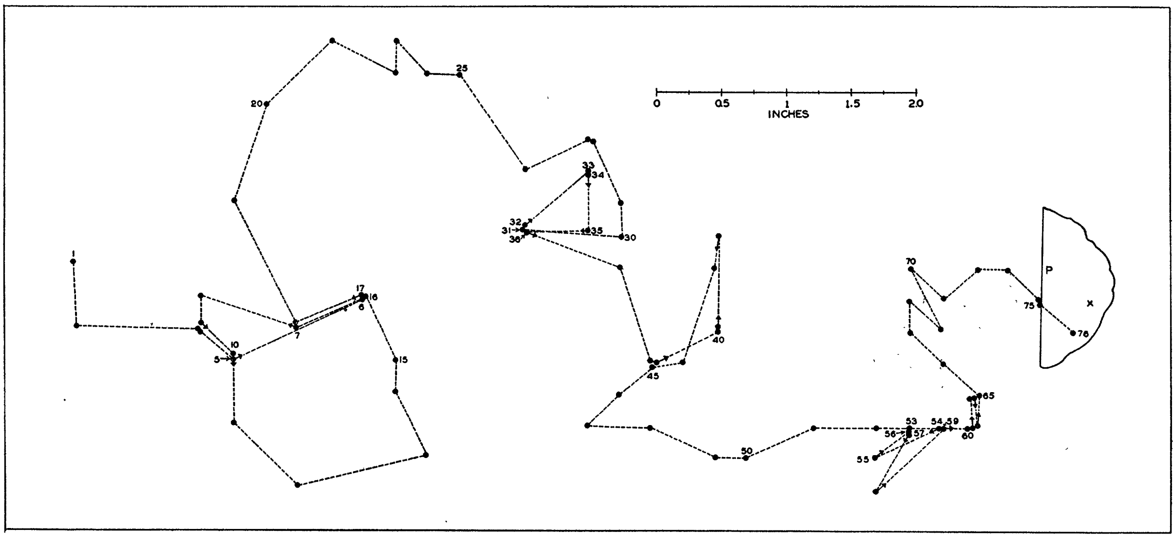

FIG. 1. Movement of a larva of *Ctenicera aeripennis destructor* (Brown): diagram of movement in horizontal plane; the dots represent the positions of the larva at consecutive readings.

[1] Contribution No. 2617, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada, in cooperation with the Department of Chemistry, University of Saskatchewan. The assistance of the National Research Council of Canada in supplying radiocobalt for the work and in the use of certain equipment is gratefully acknowledged.

[2] Officer-in-charge, Dominion Entomological Laboratory, Saskatoon.

[3] Senior Agricultural Assistant, Dominion Entomological Laboratory, Saskatoon.

[4] Head, Department of Chemistry, University of Saskatchewan.

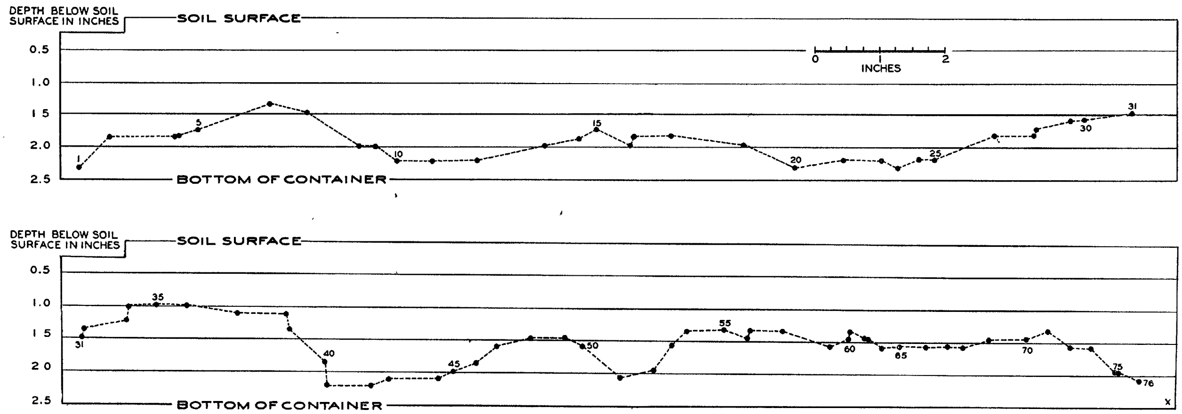

FIG. 2. Movement of a larva of *Ctenicera aeripennis destructor* (Brown): graph showing relationship of vertical and horizontal distances traveled. (The scale is only one-half of that used in Fig. 1, but the horizontal distances between points 1 and 2, 2 and 3, et cetera, represent the same distances as separate these points in Fig. 1.)

Since radiocobalt wire was not yet available, preliminary tracing of wireworm movement was done by placing a small piece (approximately 2 mg) of radioactive cobalt metal in the caudal notch of the larva and attaching it to the urogomphi and ninth segment with vinylite plastic. Once activated or "tagged," the larva was followed by using a Geiger tube, designed to count gamma radiation, in the form of a movable probe connected to a counting rate meter giving an almost instantaneous measure of the intensity of radiation at any given point. By moving the Geiger probe over the soil surface and determining the position of maximum counting rate, the wireworm was localized in the horizontal plane. By previously calibrating the instrument for varying soil depths, using a standard activity, the absolute counting rate of this maximum was used to locate the wireworm in the vertical plane. This is the first recorded method of following both horizontal and vertical movement at the same time.

By this method the movement of a wireworm has been successfully charted. One of the observations is illustrated in Figs. 1 and 2, in which the movement of a large (13-mm) larva of *Ctenicera aeripennis destructor* is depicted. Fig. 1 reveals the direction of movement, in the horizontal plane; Fig. 2 disregards direction and simply relates the horizontal and vertical components of the path traveled. In conducting this investigation, the larva was placed in one end of an 8 in. × 6 in. container filled with soil to a depth of 2½ in., and with a potato piece (P) at the opposite end. The temperature was 22° C, and the soil moisture was approximately 20% (oven-dry basis). Readings were taken every 10 min, but the general progress of the larva was under observation at all times. Numbers 1 and 76 represent the first and last readings, respectively. Six and one-half hours after the last reading, the larva had moved to position X inside the potato piece.

It is planned to extend this preliminary work and to study the movement of the larva in response to such factors as temperature, light, soil moisture, soil type, soil firmness, and general condition, as well as various foods and chemicals. Movement of a larva in respect to other larvae (group behavior) might also be studied. In addition, the effect, if any, of the radioactivity on the wireworm will be observed. The technique is not restricted to wireworms and it is planned that the movements of other soil-inhabiting insects, particularly certain species of cutworms, may also be studied.

A knowledge of such responses should be of material assistance toward the understanding of fundamental wireworm biology and behavior, and would thus be of use in developing sampling techniques and in improving both cultural and chemical control methods.

References

1. CROMBIE, A. C. and DARRAH, J. H. *J. exp. Biol.*, 1947, **24**, 95.
2. KING, K. M., ARNASON, A. P., and GLEN, R. *Saskatoon Ent. Lab. Leaflet*, 1933, **35** (D.F.C. & G.I., **86**).
3. SALT, G. and HOLLICK, F. S. J. *J. exp. Biol.*, 1946, **23**, 1.
4. TENHET, J. N. and HOWE, E. W. *U.S.D.A. tech. Bull.*, 1929, **659**.
5. THORPE, W. H. *et al.* *J. exp. Biol.*, 1947, **23**, 234.
6. TOMES, G. A. R. and BRIAN, M. V. *Nature*, Lond., 1946, **158**, 551.

Adrenal Cortical Hormones: Analysis by Paper Partition Chromatography and Occurrence in the Urine of Normal Persons[1]

Alejandro Zaffaroni,[2] Robert B. Burton, and E. Henry Keutmann

Departments of Biochemistry and Medicine, The University of Rochester School of Medicine and Dentistry, Rochester, New York

The technique of paper partition chromatography (*2*), modified by the use of nonaqueous solvent systems, has

[1] This investigation was supported in part by a research grant from the Division of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service.

[2] National Cancer Institute Postdoctoral Fellow.