References and Notes

1. G. W. Reed and A. Turkevich, *Nature* 176, 794 (1955); H. Hamaguchi, G. W. Reed, A. Turkevich, *Geochim. et Cosmochim. Acta,* in press.
2. E. N. Jenkins, *Analyst* 80, 301 (1955).
3. A detailed report is in preparation.
4. C. C. Patterson, *Geochim. et Cosmochim. Acta* 7, 151 (1955).
5. G. L. Davis, *Am. J. Sci.* 248, 110 (1950).
6. P. Reasbeck and K. I. Mayne, *Nature* 176, 186 (1955).
7. K. F. Chackett *et al., Geochim. et Cosmochim. Acta* 1, 3 (1950).

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Effects of Gamma Radiation on Collembola Population Growth

Relatively little work has been done on the effects of ionizing radiations on populations, in contrast to the considerable body of work devoted to their effects, physiological and genetic, on individuals. Because of the interest of this laboratory in the disposal of low-level radioactive wastes into the soil, some research emphasis is being placed on radiation effects on populations of different soil arthropods. The Collembola, which are small, primitive, ametabolous, wingless insects, were chosen because they are abundant in soil, where they play a role in the breakdown of organic materials in the biological cycle of soil formation. Also, they are easily reared in the laboratory, have a short life-cycle, and will multiply rapidly. The species used in these studies was *Proisotoma minuta* Tull. (*1*), which is a ubiquitous form, known from North America, Europe, and Australia.

The effects of radiation on population growth rate were examined in these experiments. Increase in population size was measured by bidaily counts of individuals at food points and by counts of total numbers at the termination of the experiment. If the magnitude of the doses used reduced the numbers, this reduction could be construed to be an effect on the future potential of the population. Since certain important internal population parameters, such as age distribution, longevity, and sex ratios, were not known, and since these experiments were carried through only about three generations, only a crude index of the effect on the intrinsic rate of increase can be obtained.

The experiments were started with 61 reproducing population units of ten individuals each. Three doses of gamma radiation from a cobalt-60 source totaling 3000 r, 5000 r, and 7000 r were given in single exposures (at a dose rate of 19 r/sec) to these units. Sixteen replicates were used for each dose level; the remaining 13 were not irradiated. The experiments were terminated after 16 to 30 days, at which time the individuals were sacrificed and counted. At the end of the experiments 42,504 individuals were present.

There was a significant difference ($P = 0.001$) in the total numbers between the control and irradiated populations. The means of the treatments appeared to be linearly related to dose. A negative linear regression was significant at greater than 0.001 probability, while the deviations from linearity were not significant. Means of the bidaily sample counts, with their standard errors, are given in Table 1. Grand means (not shown) were as follows: control, 65.6 ± 6.9; 3000 r, 58.6 ± 5.6; 5000 r, 43.2 ± 3.7; 7000 r, 33.5 ± 2.4. An analysis of variance shows the difference between treatments to be significant; this significance appears to be the result of differences between extremes (controls versus 5000 r and 7000 r; 3000 r versus 7000 r) rather than of differences between adjacent means.

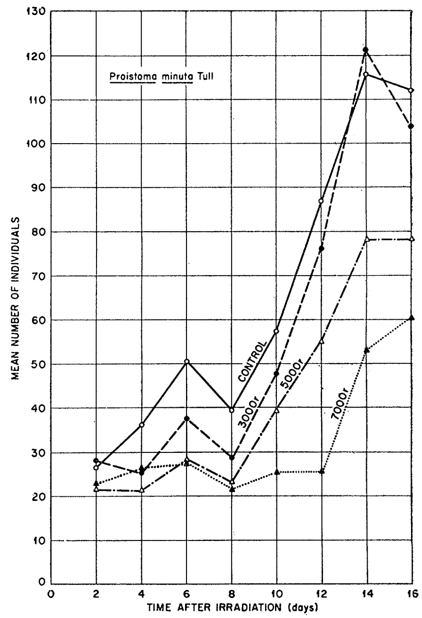

Fig. 1. The effect of acute gamma radiation on growth of Collembola population units as shown by bidaily counts of individuals at feeding points.

Table 1. Means of sample counts taken every 2 days after irradiation. Shown are means for 2, 4, 6, 8, 10, 12, 14, and 16 days post-irradiation, reading from top to bottom.

Control mean ($N_i = 13$)	3000 r mean ($N_i = 16$)	5000 r mean ($N_i = 16$)	7000 r mean ($N_i = 16$)
26.7 ± 9.7	28.0 ± 7.4	21.5 ± 5.3	23.0 ± 5.0
36.0 ± 7.7	25.2 ± 5.6	21.1 ± 4.5	26.6 ± 5.9
50.6 ± 14.4	37.5 ± 9.5	28.1 ± 5.9	27.5 ± 6.3
39.2 ± 9.9	28.7 ± 5.3	23.1 ± 3.5	21.6 ± 3.2
57.5 ± 12.5	47.8 ± 10.2	39.6 ± 9.4	25.2 ± 4.3
87.0 ± 24.6	76.2 ± 15.6	55.0 ± 11.7	25.8 ± 4.1
115.8 ± 26.4	121.3 ± 23.8	78.1 ± 13.4	53.0 ± 8.5
111.8 ± 25.2	103.8 ± 19.3	78.6 ± 12.9	60.2 ± 8.2

The bidaily counts at food points show that all the population units had an initial threshold period followed by the typical phase of exponential growth (Fig. 1). The effect of radiation seems to be chiefly one of lengthening the threshold period. When this lag phase has been passed, the population (with the possible exception of those units given 7000 r) then proceeds to multiply at the control rate. Until asymptotic levels are approached by all experimental cultures, the totals at any sampling point in time prior to reaching plateau reflect the lag effect.

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Note

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