method is clearly a useful approach to a study of the phytin fraction in soils, particularly where extremely small quantities are present.

A complete account of this work and the application of the method in qualitative and quantitative studies of the inositol phosphates present in soils will be published elsewhere.

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Earthworm Population Studies : a Comparison of Sampling Methods

IN 1947, Evans and Guild¹ described a new technique for the quantitative extraction of earthworms. This consisted of treating a known area with a solution of potassium permanganate (1.5 gm. per litre) at the rate of 6.8 litres per sq. metre. The method was said to recover a high proportion of the total population and has, since the initial description, been extensively used by these authors².

I found, however, that population estimates obtained by the permanganate technique were considerably lower than those suggested when a more laborious hand-sorting method was employed. In order to measure the relative efficacy of these techniques, permanent pasture on light soil of alluvial origin was sampled by both methods contiguously. The tests were made during September 1954, at the Durham County Council School of Agriculture, Houghall Farm.

Permanganate sampling was carried out according to Evans and Guild¹, except that the sample area was increased from 7.29 sq. ft. to 1 sq. metre. Soil samples for hand-sorting were extracted by means of a steel scoop of semicircular cross-section. This cut a core 283 sq. cm. in area and 20 cm. deep, thus needing thirty-five to complete a square metre. In each of ten loci chosen at random over the site, a permanganate sample was taken; and in every case the treatment was repeated after an interval of two hours. Five soil cores were removed from the adjacent but unaffected area of each permanganate sample.

The results are shown in Table 1 as the average number of worms per locus and sq. metre. These

Table 1. AVERAGE NUMBER OF WORMS PER LOCUS AND SQUARE METRE

Species	First permanganate treatment. Av. No. per locus and sq. m.	Second permanganate treatment. Av. No. per locus and sq. m.	Soil cores	
			Av. No. per locus	Av. No. per sq. m.
<i>Lumbricus terrestris</i>	5.0 ± 2.8	9.1 ± 4.7	9.3 ± 1.3	65.1
<i>Lumbricus castaneus</i>	3.2 ± 2.1	2.8 ± 2.2	7.8 ± 2.9	54.6
<i>Octolasion cyaneum</i>	0.2 ± 0.6	0.5 ± 0.7	1.5 ± 1.2	10.5
<i>Allolobophora terrestris</i>	19.8 ± 4.6	8.3 ± 3.4	21.4 ± 5.0	149.8
<i>Allolobophora caliginosa</i>	5.2 ± 2.4	5.0 ± 2.6	11.1 ± 3.9	77.7
<i>Eisenia rosea</i>	1.6 ± 1.9	3.7 ± 3.4	12.8 ± 5.6	89.9
Total	35.0 ± 10.2	29.4 ± 9.8	63.9 ± 9.8	447.6

Table 2. ANALYSIS OF VARIANCE. SNEDECOR'S F

Species	Soil cores First permanganate treatment		Soil cores First and second permanganate treatments	
	Between treatments d.f. 1:9	Between samples d.f. 9:9	Between treatments d.f. 1:9	Between samples d.f. 9:9
<i>Lumbricus terrestris</i>	0.00	0.74	11.28†	0.99
<i>Lumbricus castaneus</i>	4.35	2.41	2.35	2.08
<i>Octolasion cyaneum</i>	2.86	0.90	4.20	3.06
<i>Allolobophora terrestris</i>	53.81†	1.46	16.33†	1.87
<i>Allolobophora caliginosa</i>	2.48	2.41	0.69	2.82
<i>Eisenia rosea</i>	61.66†	1.61	52.72†	4.41*

* Significant at the 5 per cent level. † Significant at the 1 per cent level

units are the same for the permanganate treatments but not for the soil cores, where the number per locus must be multiplied by 7 to estimate the number per sq. metre.

While the fifty soil cores, completing 1.43 sq. metres, produced 639.5 worms, the permanganate samples of 10 sq. metres produced only 350 worms. Thus it is abundantly clear that the permanganate technique gave an unsatisfactorily low population estimate, although of the same order as those of Evans and Guild^{1,2}.

To determine whether or not the techniques extracted similar species ratios, analyses of variance were calculated for treatment-pairs. The percentage of species per locus was used for this purpose and the results, as Snedecor's *F*³, are given in Table 2.

In no case is there significant variance, at the 1 per cent level, between samples, which suggests an even distribution of the earthworm population and an intrinsic consistency of sampling method. Although all the techniques are consistent by themselves, they differ when compared with each other; and in three species significant variance occurs between treatments. Thus relative to the proportion from the soil cores, the first permanganate treatment produced more specimens of *Allolobophora terrestris* and fewer *Eisenia rosea* than expected. Conversely, the second permanganate treatment produced more specimens of *Lumbricus terrestris* and fewer *Eisenia rosea*. This correlation of effect with species is interesting in suggesting that potassium permanganate, in conjunction with a hand-sorting method, may be useful in determining the habits of different species.

The evidence discussed above shows that the permanganate method of sampling, used alone, is unsuitable for comparative population studies of earthworms.

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