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3.1.1 THE EXTRACTION FROM SOIL OF SMALL ARTHROPODS
BY THE DRY-FUNNEL METHOD

by

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Berlese invented the first method of extracting small invertebrates from soil using a funnel in 1905. His apparatus consisted of a funnel surrounded by a hot-water jacket. A wire tray containing the soil to be extracted was suspended in the funnel. The animals, which were

(Diagram not drawn to scale)

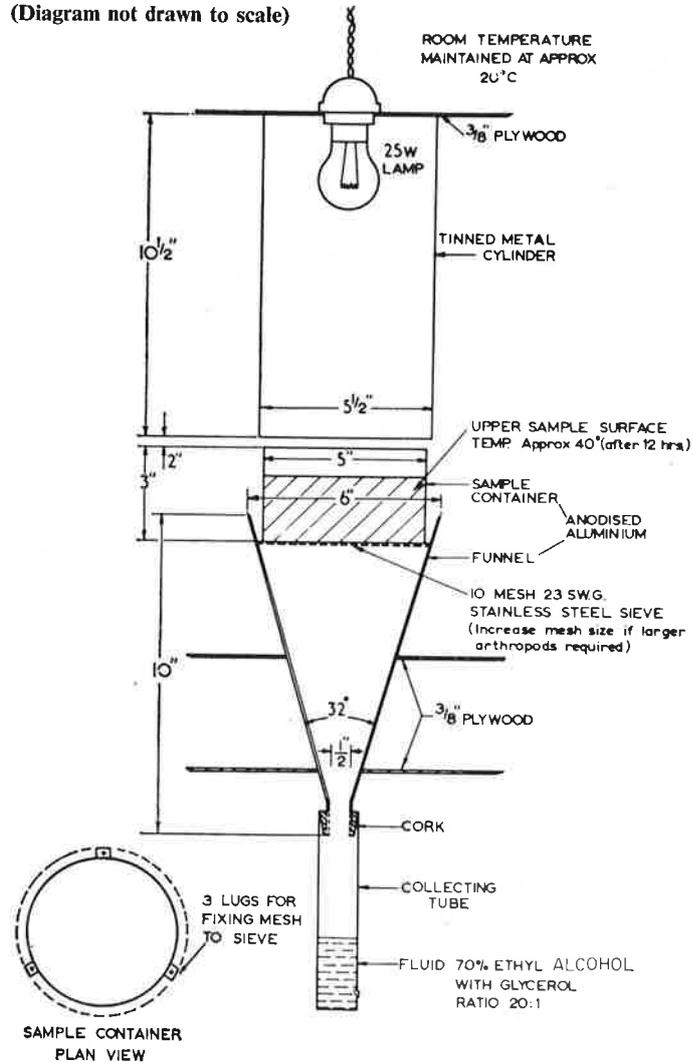


Figure 1. Modified 'Tullgren' extraction funnel for soil invertebrates.

activated by the heat and the desiccation of the soil, eventually reached the lower surface of the soil and fell through the wire tray, down the funnel and into a collecting tube containing alcohol. In 1918, Tullgren substituted an electric light bulb suspended over the sample for the hot-water jacket, adding the stimulus of light to that of heat and desiccation. Most modern techniques of dry-funnel extraction are based on this modified 'Tullgren' funnel (Fig. 1).

The Tullgren funnel was further modified by providing a gap between the sample container and the funnel, which lessened condensation in the funnel. In 1962-63, Macfadyen (6), and Kempson *et al.* (5), improved the efficiency of funnels by controlling both the temperature and the humidity gradients from the upper to the lower surfaces of the soil sample; this prevented animals becoming trapped in the soil when it was unevenly heated (Fig. 2).

METHODS	WOODLAND			GRASSLAND			FALLOW		
	ACARINA	COLLEMBOLA	OTHER INSECTA	ACARINA	COLLEMBOLA	OTHER INSECTA	ACARINA	COLLEMBOLA	OTHER INSECTA
Simple plastic funnels	*	*	*	*	-	*	*	*	-
Rothamsted Tullgrens (no heat)	*	*	*	-	-	*	*	*	*
Rothamsted Tullgrens	*	-	*	-	-	*	*	*	-
Murphy split funnels	*	*	-	-	-	*	H	*	-
Kempson infra-red extractor	*	-	*	-	-	*	*	*	-
Macfadyen high gradient canisters	*	*	-	*	*	*	*	*	*
Macfadyen air-conditioned funnels	H	H	H	H	H	-	*	H	H
Simple brine flotation	*	*	*	*	*	*	*	*	-
Salt and Hollick flotation	*	*	*	*	*	-	-	*	-
Heath and Edwards flotation	*	*	*	*	*	H	*	*	-
Grease film extraction	*	-	*	*	*	*	*	-	-

H = Highest mean numbers recovered
 - = Not significantly less than H at 1% level
 * = Significantly less than H at 1% level

Figure 2. Summary of comparison of extraction methods of small arthropods with silt-clay loam.

Tullgren funnels were designed originally to collect specimens for taxonomy and not for quantitative work. Users should be aware of the limitations of the apparatus for quantitative studies and that the relative numbers of animals recovered can depend on such factors as the water content of the soil, its compaction and handling.

Dry-funnel methods can be used to assess populations of most soil-dwelling arthropod pests. They will not recover eggs, pupae or animals in diapause, and are less efficient in recovering adults and larvae of the larger insects, such as Coleoptera and Diptera than the soil-washing methods.

1. Field sampling

Sites to be sampled usually depend on reports of damage but occasionally sites may be sampled before planting a crop to assess potentially harmful populations. The size of the sample and the number of samples taken depends on the size and number of animals causing damage that are to be extracted, and on their distribution in the soil both horizontally and vertically. Preliminary samples are necessary to determine the optimum number and depth of samples. At Rothamsted 16 soil samples per treatment 5 cm diameter and 10 cm deep are usually adequate for soil fauna other than earthworms or the larger insects (Fig. 3). The more samples examined up to an optimum number, the greater the accuracy of the results. Other

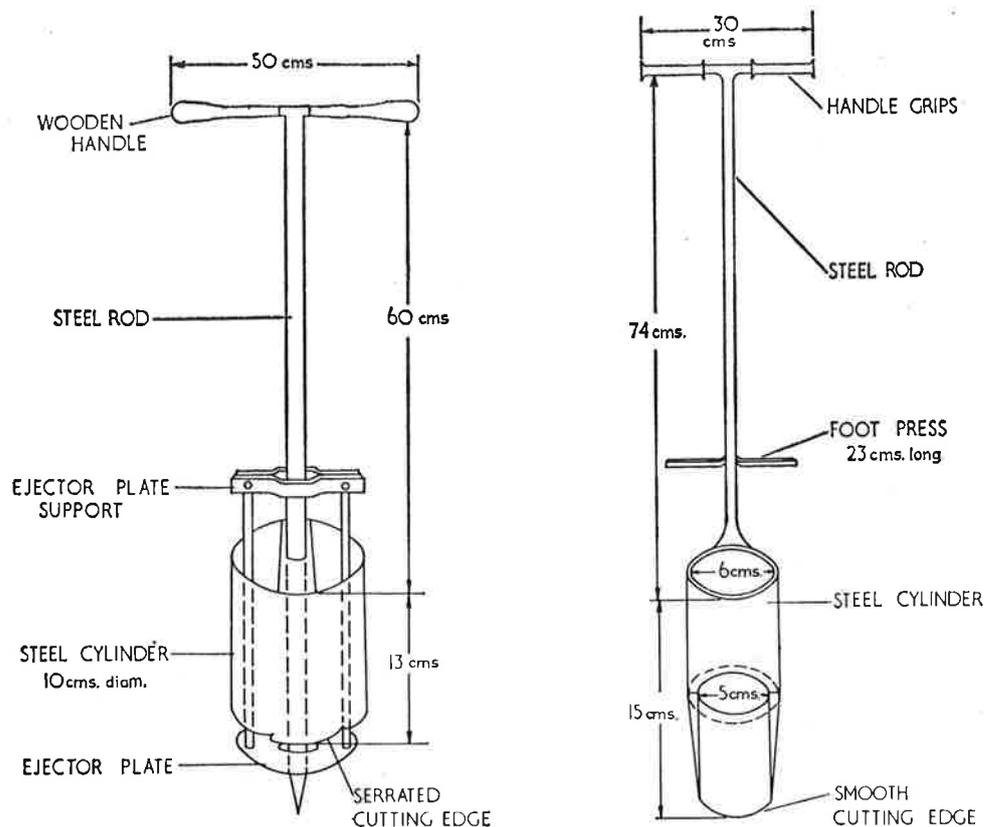


Figure 3. Types of soil samplers used at Rothamsted.

useful information to be recorded at the time of sampling includes kind of crop, previous cropping history, soil type, moisture content and organic content of the soil, time of year and growth stage reached by the pest.

The soil samples can be taken to the laboratory in labelled polythene bags or in screw-top tins. Containers should not be exposed to bright sunlight for long periods because heat may kill the animals, which then cannot be extracted.

2. Laboratory processing

Animals should be extracted soon after the soil samples have been taken. Samples stored for up to one week at 20°C change little, but after longer periods numbers of some groups of animals may change greatly.

When possible, the samples should be placed intact, but inverted, on the sieve of the sample containers over the funnels. Disturbing samples may compress the soil, when fewer animals will be recovered. Care must be taken when placing the sieve container over the funnel to prevent contaminating the collecting vessel with soil falling down the funnel and into the collecting tube. Sorting and counting are most conveniently done using a plastic dish with sloping sides, and a grid on the base, under a binocular microscope ($\times 25$) with incident lighting. Several keys to the identification of Acarina, Collembola and general insect pests are readily available (1, 2, 3, 4, 7).

3. Interpretation of results

Data may be expressed in terms of numbers per m^2 or per ha.

Statistical tests (on log-transformed data) for significant differences must be made as most soil animals are not randomly distributed or aggregated.

4. Sources of information

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