[SHORT COMMUNICATION]

Oribatid Mite Extraction Efficiency of the Fukuyama Apparatus, a Perpendicular-Type Extracting Apparatus Using a Commercial Disposable Heater

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INTRODUCTION

Oribatid mites are abundant in a range of environments and are therefore valuable as indicators in evaluating environmental biodiversity (Wallwork, 1976). Because the composition of mite communities at the sub-order level is relatively stable in identical environments (in terms of their vegetation, climate, etc.) (Maraun and Scheu, 2000; Osler and Beattie, 1999), comparison of these communities is useful for evaluating the effects of wildfire on soil zoological biodiversity.

Although soil organisms have to be alive to be extracted with Tullgren funnels, it is sometimes difficult to maintain live, field-collected mites back to the laboratory. To solve this problem, a portable extracting apparatus using a disposable heater as a heat source (the Fukuyama apparatus) (Fig.1) was developed to directly extract mites in the field (Fukuyama, 1994). In a comparative laboratory study, extraction efficiency was similar to that of a Tullgren funnel (Fukuyama, unpublished data). However, its efficiency had never been tested in the field. In this study, the efficiency of the Fukuyama apparatus was tested in the field by comparing it with the Tullgren funnel. Simulating an actual field survey, a comparison of the extraction efficiency of this apparatus was made with that of the Tullgren funnel, which included comparing the time required to transport funnels to the laboratory. Samples collected in Fukuyama et al. (1999) were used.

METHODS

Fukuyama apparatus

Four, 20×16 cm rectangular wire frames of 2 mm thickness were covered with 2 mm vinyl mesh. These frames were joined by fine wire (Fig. 1), and soil samples were sandwiched between disposable heat sources (Hokaron Lotte Co., Ltd.) (Fukuyama, 1994) (Fig. 2). In the field, these

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Fig. 1. Fukuyama apparatus (arranged from Fukuyama 1994).

Fig. 2. View of Fukuyama apparatuses set up in the field.

apparatuses were suspended from a rope stretched between standing trees (Fig. 3). The principle of extraction is fundamentally the same as that of the Tullgren funnel: heated soil dries and causes soil organisms to move away from the drying soil. By inserting mesh in the sample soil and suspending it perpendicularly, the Fukuyama apparatus differs from the Tullgren funnel in that soil organisms emerge from the side of the soil sample rather than from the bottom. This apparatus enables easier processing of specimens in the field because it does not require an electric power source, and the amount of soil that falls out compared with Tullgren funnels is reduced because soil samples are inserted perpendicularly.

Tullgren funnels

Tullgren funnels are made of aluminum with diameter 12 cm. The container into which soil samples were placed was an 11 cm diameter PVC plastic cup whose base had been cut off and replaced with 2 mm mesh. Each funnel had a 20 W filament lamp as heat source. Heating time was 48 hours.

Study sites

The study sites were located 40 km west-northwest of Yakutsk, Saha, Russia (62.13°N—129.10°E). The elevation of the sites ranged from 240 to 300 m, and the region was mostly flat. Soil type was sandy spodosol. The dominant tree species was *Larix cajanderi* Mayr, and the dominant forest floor species was *Vaccinium vitis-idaea* (Sawamoto et al., 2000).

Sampling method

Soil samples were collected at a depth of 5 cm using a 100 mL (20 cm² × 5 cm) core sampler from soil that contained an organic matter layer. For each extracting apparatus, 10 samples were randomly collected from within a 10 m × 10 m quadrat. Soil samples were immediately extracted with Fukuyama apparatuses for 48 hours in the field. Disposable heaters were replaced after 24 hours. Because of the distances involved, Tullgren funnel samples in core samplers were transported by car on the following day to the Yakutsk Biological Research Institute laboratory

Fig. 3. Relationship between individual numbers of each oribatid species extracted with Tullgren and Fukuyama apparatuses.

in Yakutsk, 40 km far from the sampling site, and extracted for 48 hours in the laboratory.

Mesofauna were identified at the sub-order level except for Oribatida. Oribatida were identified to morphospecies, except for those in the Brachychthoniidae and Suctobelbidae.

RESULTS AND DISCUSSION

Sixteen Oribatida species in total were extracted (Table 1). Nine dominant species (with more than 3 individuals/sample) were extracted using both methods. The correlation coefficient between individual numbers in each species extracted with the Fukuyama apparatus and Tullgren funnels was significant (correlation coefficient 0.81 $p < 0.001$) (Fig. 4) and there were no differences in individual numbers of each species extracted between methods, except for Brachychthoniidae spp. and *Diapterobates* sp.

Table 2 shows that there were no significant differences in individual numbers of any mesofauna, except for Collembola. However, numbers of individuals of Brachychthoniidae and Collembola extracted using the Fukuyama apparatus were significantly higher than those extracted by Tullgren funnels.

Numbers of individuals of *Diapterobates* sp. extracted using the Fukuyama apparatus were significantly lower (t test $p < 0.027$) than those extracted by Tullgren funnel (Table 1), suggesting

Table 1. Individual numbers of oribatid species extracted by Tullgren and Fukuyama apparatuses (*means significant difference)

Group	Species	Tullgren	Fukuyama	p (t test) n = 10
ENARTHRONOTA Grandjean, 1947	Brachychthoniidae spp.	38	*101	0.0227
DESMONOMATA Wooly, 1973	<i>Platynoethrus yamasakii</i>	0	1	0.3434
	<i>Camisia</i> sp.	0	1	0.3434
	<i>Trypochthonius</i> sp.	4	1	0.2390
BRACHYPYLINA Hull, 1918	<i>Allodamaeus</i> sp.	1	0	0.3434
	Damaeidae spp.	0	2	0.1679
	<i>Tectocephus</i> sp.	30	51	0.3113
	<i>Proteremaeus</i> sp.	6	2	0.1425
	<i>Oppiella nova</i>	102	115	0.8312
	<i>Moritzoppia</i> sp.	30	18	0.5254
	<i>Micropoppia</i> sp.	0	2	0.1679
	<i>Quadropoppia</i> sp.	6	1	0.1870
	Suctobelbidae spp.	1	7	0.3463
PRONOTA Balogh & Balogh, 1992	<i>Peloribates</i> sp.	2	0	0.3434
	<i>Ceratozetes</i> sp.	0	1	0.3434
	<i>Diapterobates</i> sp.	*13	3	0.0270

Table 2. Individual numbers of meso-fauna extracted by Tullgren and Fukuyama apparatuses (*means significant difference)

Meso-fauna group	Tullgren	Fukuyama	p (t test) n = 10
Collembola	140	*302	0.0153
Prostigmata	192	276	0.2556
Mesostigmata	51	88	0.2255
Astigmata	5	10	0.2858
Oribatida (include nymph)	258	368	0.3345

that the disposable heater should be improved.

Comparative tests in the laboratory (Fukuyama, unpublished data) showed similar results as mentioned above. However, handling time from sampling to extraction was about 24 hours less using the Fukuyama apparatus, and the Tullgren funnel soil samples also had to be transported approximately 40 km by car. I therefore conclude that the Fukuyama apparatus is almost as effective as Tullgren funnels in extracting mesofauna from soil samples. This study also demonstrated that soil sample data in field studies can be analyzed using both methods. It is also suggested that the Fukuyama apparatus is particularly useful for field sampling when distant from a laboratory and compensates for negative handling time effects.

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