Grasslands Research Centre, AgResearch, Tennent Drive, Private Bag 11008, Palmerston North, New Zealand

SHORT COMMUNICATION

BURROWING BEHAVIOUR OF THE NEW ZEALAND INDIGENOUS EARTHWORM *OCTOCHAETUS MULTIPORUS* (MEGASCOLECIDAE: OLIGOCHAETA)

Summary: Mature *Octochaetus multiporus* in pots of sieved soil created a network of burrows with a diameter of about 10 mm which did not open to the surface. Several chambers 15 to 20 mm wide and 20 to 50 mm long were found within the burrow network; some worms were found curled within these chambers which also contained a quantity of loose cast material. *Octochaetus multiporus* responded to the presence of plants by burrowing nearer to the surface under white clover and nearer to bottom of the pot under chicory.

Keywords: pastures; soil fauna; soil structure.

Introduction

Octochaetus multiporus (Beddard 1885) is a large indigenous New Zealand earthworm widely distributed in the lower North Island and in the South Island (Lee, 1959; Springett *et al.,* 1998; Yeates, 1991; 1993). Lee (1959) classified *Octochaetus multiporus* as a subsoil species, occurring below 150 mm where it makes an extensive burrow system and deposits casts into burrows and soil cavities, rarely coming to the surface. However, Smith (1893) described *Octochaetus multiporus* as common in a portion of old river bed near Ashburton, in the Canterbury Plains, where there were only a few inches of soil. Smith (1887) describes the burrows of this species as more commonly found running horizontally than perpendicularly or obliquely. Lee (1959) made laboratory measurements of casting behavior in a thin monolith, when a four inch thick, spongy surface layer of castings was produced. Our field observations in hill pastures (Springett *et al.,* 1998) confirm Lee's classification of *Octochaetus multiporus* as a deep burrowing earthworm, and gave information on the soil factors affecting distribution and abundance of this species. In order to gain more information on how *Octochaetus multiporus* responds to different forage plant species we carried out a laboratory experiment comparing *Octochaetus multiporus* burrowing under a fibrous and a tap rooted plant.

Methods

The distribution of burrows made by *Octochaetus multiporus* in soil was determined by placing a large mature specimen in sieved soil in a pot. The pots were 140 x 140 mm and 150 mm deep; soil from a low fertility hill pasture site (Typic Distrochrept, unfertilised since 1980, with a water content of 64 g / 100g) was packed into the pots to a dry bulk density of 1.17 g cm^{-3}. We measured the effect of plants on *Octochaetus multiporus* burrows by imposing three treatments:

1. tap rooted plant, chicory, (*Cichorium intybus L.)*
2. fibrous rooted plant, white clover, (*Trifolium repens L.)*
3. no plants

The experiment was replicated three times. A single earthworm (average weight 4.2 g and length 120 mm) was added to each pot in June 1995, and the pots were destroyed for analysis in November 1995. The distribution of burrows (8 to 12 mm diameter) was measured by dissecting the soil surface horizontally and recording the position (x,y,z coordinates) of burrows and casts at every 10 mm depth. The x,y,z coordinates were plotted using the software 'Rotater 3.0'[1] developed by Craig Kloeden (pers comm., Dept. Transport, Adelaide, South Australia) which allows the burrows to be viewed in

[1] Rotater 3.0 programme is accessible at: http://raru.adelaide.edu.au/rotater/

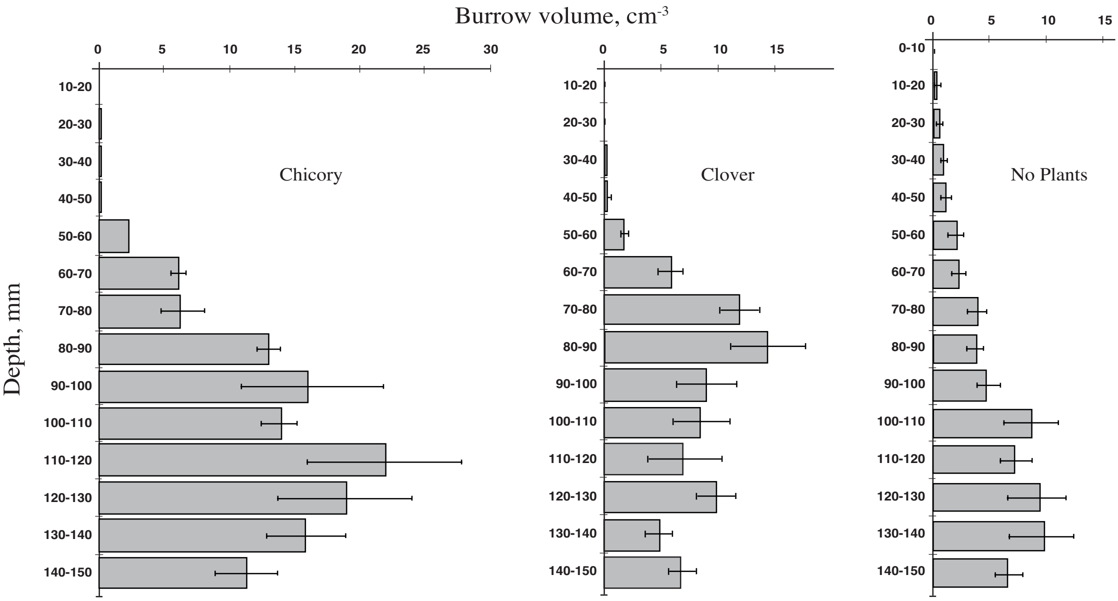

Figure 1: *Volume of burrows mean ± 1 s.e. in each depth, under white clover, chicory, or no plants at each 10 mm depth, in pots, in the glasshouse, (mean of three replicates).*

any orientation. Using known burrow diameter the total burrow volume in each horizon was calculated by assuming that burrows recorded in adjacent horizons were connected by a cylinder of 10 mm diameter. Parts of some burrows were filled or partially filled with cast material and these were recorded separately, however it is possible that some burrows had been back filled with casts which were indistinguishable from the surrounding sieved soil and were not recognised. It was also assumed that the first horizon in which a new burrow was recorded represented the upper limit of that burrow and all the volume of that burrow was below that horizon.

Results and Discussion

The volume of burrows at each 10 mm depth increment in the pots is shown in Figure 1. *Octochaetus multiporus* did not burrow in the top 20 mm of any of the pots. In the pots with white clover, the maximum volume of earthworm burrows was at a soil depth of between 70 and 100 mm. Both the chicory and no plants pots had maximum volume of burrows below 120 mm. There was a greater volume of burrows in the pots with chicory and clover than in pots with no plants. All the pots with *Octochaetus multiporus* had similar burrow networks, with a number of burrows and several larger cavities, which were partly filled with cast material.

Our observations in the laboratory of the burrows of *Octochaetus multiporus* confirm Lee's (1959) and Smith's (1887) description of their burrowing behavior in the field. This contrasts with Lee's (1959) laboratory measurements of casting behavior in a thin monolith, when a four inch thick, spongy surface layer of castings was produced. As this experimental observation does not conform with field observations we suggest that the result was caused by the restricted space in the thin monolith.

In the pot experiment *Octochaetus multiporus* appeared to respond to the presence of plant roots by increasing its burrowing activity, as has been recorded previously for some lumbricid species (Springett and Gray, 1997). At a soil depth of 100 mm more burrows were made in the presence of the fibrous rooted white clover plants than the tap rooted chicory plants. When no plants were present, burrows were more deeply distributed but fewer in number. This experiment could not determine whether plants could extend their roots more deeply into the soil when earthworm burrows were present.

Lee (1959) has described plant roots following *Octochaetus multiporus* burrows and states that burrows must facilitate the growth of deep rooting plants. We suggest that further work is needed to determine the effect of deep *Octochaetus multiporus* burrows on the distribution of plant roots and on other soil properties.

Acknowledgments

We wish to thank Craig Kloeden, in Adelaide for use of the Rotater 3.0 programme.

References

Lee, K.E. 1959. *The Earthworm Fauna of New Zealand*. New Zealand Department of Scientific and Industrial Research Bulletin 130, Wellington, N.Z.

Smith, W.W. 1887. Notes on New Zealand Earthworms. *Transactions of the New Zealand Institute 19:* 123-139.

Smith, W.W. 1893. Further Notes on New Zealand Earthworms, with Observations on the known Aquatic Species. *Transactions of the New Zealand Institute 25:* 111-146.

Smith, W.W. 1894. Further Notes on New Zealand Earthworms. *Transactions of the New Zealand Institute 26:* 155-175.

Springett, J.A.; Gray, R.A.J. 1997. Relationship between pasture plant roots and earthworm burrows. *Soil Biology and Biochemistry 29:* 621-625.

Springett, J.A.; Gray, R.A.J.; Barker, D.J.; Lambert, M.G.; Mackay A.D.; Thomas V.J. 1998. Population density and distribution the New Zealand indigenous earthworm *Octochaetus multiporus* (Megascolecidae: Oligochaeta) in hill pastures. *New Zealand Journal of Ecology 22:* 87-93.

Yeates, G.W. 1991. Impact of historical changes in land use on the soil fauna. *New Zealand Journal of Ecology 15:* 99-106.

Yeates, G.W. 1993. Influence of a sabbatical fallow on oligochaetes and nematodes in a hill country pasture. *In:* Prestige, R.A. (Editor)*, Proceedings 6th Australasian Grassland Invertebrate Ecology Conference* pp. 142-147.