Soil earthworm numbers under native and sown perennial grass-based pastures in northern New South Wales

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Earthworms are major consumers of dead and decomposing organic matter, and derive much of their nutrition from bacteria and fungi that grow on these materials. They fragment organic matter, make major contributions to recycling nutrients and can dramatically alter soil structure, water movement, nutrient dynamics, and plant growth (Edwards 2000).

While earthworms are not essential to all healthy soil systems, their presence is usually an indicator of a healthy system. Since they are readily recognised by producers and relatively easy to sample, they may also provide a guide to soil biological activity. Few data on earthworm numbers have been reported for pastures in Australia (e.g. Baker *et al.* 1992; White *et al.* 2000) and there are few reports for likely numbers in northern New South Wales (e.g. Lobry de Bruyn and King 1995; Lobry de Bruyn and Po 2000). No data have been published for native and sown pastures on the North-West Slopes of New South Wales.

Methods

Data collection was undertaken as part of the Sustainable Grazing Systems (SGS) program and full site and treatment descriptions were reported by Lodge *et al.* (2003*a*, *b*, *c*). Soils were sampled at each of 3 field sites on producer's properties at Nundle, Manilla and Barraba, NSW. At the Nundle site, (sown, fertilised Sirosa phalaris-subterranean clover pasture), sampled plots had been continuously grazed since spring 1997 at either 12.3 or 6.1 sheep/ha. The other 2 sites were native grass pastures, a redgrass-wiregrass-bluegrass-wallaby grass pasture at Manilla, and a redgrass-wallaby grass pasture at Barraba. For the native grass pastures, samples were collected from unfertilised plots, continuously grazed since spring 1997 (3.1 and 4 sheep/ha at the Manilla and Barraba sites, respectively), and fertilised plots oversown with subterranean clover and continuously grazed at 9.2-10.8 sheep/ha (Manilla), or 8 sheep/ha (Barraba).

Soils at the sown pasture site were predominantly brown chromosols and podsols, while at the Manilla site they were red chromosols and brown vertosols, with a red chromosol at the Barraba site. Both soil types were sampled at the Manilla site. To determine earthworm numbers, soil samples were collected in August and September 2000, after sufficient rainfall to ensure adequate moisture in the top 20 cm of the soil profile. Soils were excavated to a depth of 10 cm in 2 quadrats (20 by 40 cm) in 2 replicates of 2 contrasting treatments at each site described above and in Table 1. For each quadrat, earthworm numbers were counted, with earthworm liveweight also determined and species identified. Data for earthworm numbers were also presented by Lodge *et al.* (2003*b*, *c*) as part of a sustainability index for perennial pastures.

Results

For the phalaris-subterranean clover pasture, earthworm numbers in the top 10 cm were around 200 per m^2 (Table 1) and did not differ markedly between the 2 stocking rates. Earthworm numbers at both native grass sites were highest for plots on the red chromosol soil that had fertiliser and subterranean clover applied (mean value 94 per m^2, Table 1), and about 5 times the numbers in unfertilised plots. Fertiliser application and sowing subterranean clover had no marked effect on earthworm numbers for plots on the brown vertosol (mean value 8 per m^2, Table 1).

Table 1. Mean earthworm number (per m^2, 0-10 cm) $\pm$ standard error for sown and native pastures in contrasting treatments sampled in August-September 2000

Site and soil characteristics	Earthworm number (per m^2) Treatment 1	Treatment 2
Sown pasture	*6.1 sheep/ha*	*12.3 sheep/ha*
Nundle - Brown chromosol	198 ± 3.8	207 ± 5.1
Native grass pastures	*Cont. graze, no fertiliser*	*Cont. graze, fertiliser and subterranean clover*
Manilla - Red chromosol	14 ± 1.6	80 ± 1.3
Manilla - Brown vertosol	9 ± 1.4	7 ± 2.1
Barraba - Red chromosol	20 ± 3.3	108 ± 5.6

Discussion

In these studies, earthworm numbers were markedly influenced by pasture type (sown *vs.* native grass), the application of superphosphate and the oversowing of subterranean clover in native pastures on a red chromosol soil, and by soil type at the Manilla native pasture site. No effect of stocking rate on earthworm abundance was evident at the sown pasture site at Nundle.

The majority of earthworms at all sites were *Spenceriella macleayi* (a native species) with some *Aporrectodea trapezoides* (an introduced species) present in sown pasture samples. Interestingly, calculations of earthworm liveweights/ha, would give equivalent sheep stocking rates (based on a 45 kg sheep) of 9-11 sheep/ha at the sown pasture site, 0.15 to 1.8 sheep/ha at the Manilla native pasture site, and 0.7 to 4.3 sheep/ha at the Barraba site.

Earthworm numbers for the different pasture types on the North-West Slopes of NSW were similar to those reported for grazed and ungrazed pastures and shelter belts on the Northern Tablelands of NSW (~70-80 per m^2 in August-September, Lobry de Bruyn and King 1995; Lobry de Bruyn and Po 2000), and for sown pastures at Book Book in spring (White *et al.* 2000). However, the values from the current studies were below the maximum levels measured in southern pasture systems (up to 400 earthworms/m^2) by Baker *et al.* (1992), where soils may have consistently higher water contents in winter and early spring.

Low earthworm numbers in the brown vertosol at the Manilla native pasture site, probably reflected the moisture characteristics of this soil type since Lobry de Bruyn and King (1995) reported a positive association between earthworm abundance and soil moisture. In examining differences between the 2 soil types at the Manilla site, Murphy and Lodge (2001) noted that pastures responded more rapidly after rainfall and growth rates were generally higher on the red chromosol, while responses were slower and less on the brown vertosol. Also, calculations from field estimates (Murphy and Lodge 2001) indicated that for 0-30 cm depth the brown soil had 30% less plant available water than the red chromosol. Lower growth rates on the brown soil may have also resulted in less litter accumulation and the drier brown soil may have been less favourable for earthworms compared with the red soil.

Acknowledgments

I gratefully acknowledge the assistance of Brian Roworth and Michael Honess in collecting the samples. Earthworm species were identified by Geoff Baker. These studies were conducted as part of the Sustainable Grazing Systems (SGS) Key Program a joint collaboration between NSW Agriculture, Meat & Livestock Australia, Land & Water Australia and other agencies.

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