

A COMPARISON OF THE WINTER SOIL SURFACE FAUNA IN ORGANICALLY MANAGED AND CONVENTIONALLY MANAGED AREAS

K.M. KELLY* and R.R. SCOTT

Department of Entomology, Lincoln University, Canterbury

SUMMARY

The soil surface faunas of an organic and a conventionally managed apple orchard were sampled using pitfall traps between April and August 1989. The organic orchard consistently had a greater species number, species evenness and species diversity. A less extensive comparison of fallow blocks in organically and conventionally managed areas also showed more species and greater diversity in the organically managed area. The difference was not as great as that between the orchards. The organic orchard had more species and greater diversity than the organic fallow area.

INTRODUCTION

Since Carson's (1963) book there has been a gradual awakening of interest in reducing insecticidal inputs to primary production. Over the last 10 years in New Zealand a group of producers variously called organic or biodynamic growers (depending on the criteria they meet) has emerged. Leaders of this movement claim (R.A. Crowder pers. comm.) that organic methods of production result in a more diverse range of insects present in a crop, particularly predators and parasites which keep pest numbers in check.

In community ecology, there is considerable disagreement about how diversity should be measured (for discussion see Putman and Wratten 1984; Magurran 1988; Krebs 1989). Part of the reason for this is that there are two aspects to diversity: the variety of species present and the relative abundance of species. No study of diversity can be restricted to the variety of species (species richness) but must also incorporate a measure of the relative abundance. This study uses the Shannon Index (Magurran 1988) to investigate the species diversity of surface-active invertebrates in organically managed and conventionally managed areas in winter. The Shannon Index was selected because it is the second best discriminator between sites (Taylor 1978) and has the added advantage over the only better index (α from the logarithmic series) of allowing calculation of species evenness. In most communities a few species dominate and there is a larger number of species represented by only a few specimens. A measure of this is the species evenness. From the Shannon Index an index of the relative abundance, the species evenness, was also calculated.

METHODS

The four sample areas were all on the Horticultural Research Area, Lincoln University, where 9.6 ha comprise the Biological Husbandry Unit and approximately 20 ha comprise the conventionally managed area. Various crops including apples are grown in the Biological Husbandry Unit while the conventional area is principally devoted to tree crops. The organic orchard sample area consisted of a 40 x 40 m plot within an orchard of cv. 'Granny Smith' apples grown on the centre leader system. The conventional orchard sample area also consisted of a 40 x 40 m plot but the trees were more or less equally split between cv. 'Granny Smith' and 'Splendour' with half of each on the MM106 dwarfing rootstock and the others on the trellis training system. Bare ground was the policy in each orchard; this state was maintained by herbicide in the

*Present Address: 10 Cephas Close, Riccarton, Christchurch 4.

Proc. 43rd N.Z. Weed and Pest Control Conf. 1990: 104-108

conventional orchard and by straw mulch and hoeing in the organic one. During the sample period ground cover in each orchard consisted of fallen fruit and leaves, some grass, straw (organic area) and bare soil patches (conventional area). Conventional management here means the application of herbicides for ground cover control and insecticides such as azinphosmethyl for insect control. In 1989 the final spray application was azinphosmethyl (Gusathion 35 m) and captan (Captan 80) on 23 January. The organically managed fallow area had been used for student vegetable trials over the 1988-89 summer/autumn. Sampling was carried out within a 30 x 25 m plot. The conventionally managed area had been used for a number of annual crops and had the herbicide trifluralin (Treflan) applied in preparation for those crops as well as schedule spray treatments applied to each crop. Sampling was carried out within a 32 x 21 m plot. Both areas had been cultivated just before sampling started and remained largely free of vegetation during sampling.

Sampling was by 10 randomly placed pitfall traps in each sampled area. Where random placement would have interfered with tractor passage the trap was moved nearer the tree closest to the original position. The traps comprised 80 mm diameter plastic pottles containing Gault's solution with a few drops of detergent to reduce the water's surface tension, set flush with the soil surface. A metal rain cover was set approximately 100 mm above each trap. Traps in the orchard areas were cleared every 4 days from April 14 to August 11, 1989, except for June 27, July 1, July 26 and 31. The 4 day period was selected as a compromise between daily and weekly or greater periods to produce reasonable sized catches (M.R. Butcher, pers. comm.). Trapping in the fallow areas was restricted to May 11-23 and August 4-11; these traps were cleared daily or every second day. Daily trap catches have been summed to 4 day periods. It was not possible to execute all the work necessary to carry out an extended sampling of both pairs of sites.

Specimens were sorted to species level and identified wherever possible; Collembola were only identified to order. The Shannon Index, H' , was calculated from:-

$$H' = -\sum p_i \ln p_i$$

where p_i is the proportional abundance ($n_i \div \sum n_i \rightarrow x$) of the i th species. Collembola were not included in these calculations for two reasons. First, they dominated the numbers of organisms recovered comprising often over 95% of all individuals and the Shannon Index is sensitive to such dominance (Taylor *et al* 1976). More importantly, these specimens were not identified to the same taxonomic level as the others (Krebs 1989). Species evenness, E , was calculated from:-

$$E = H' / \ln S$$

where S is the total number of species recorded at a trap site. For all these calculations, data for each trap for the whole sampling period were used. The individual trap data were then combined for each area and overall indices calculated. Mean numbers were tested by the standard Student t test; diversity and evenness indices were similarly tested but utilised the variance formula for H' given by Magurran (1988) for the indices from the overall data.

RESULTS AND DISCUSSION

The 4 day mean numbers of species per trap in the two orchards are given in Fig. 1. For just over the first 4 weeks (i.e., mid April to mid May), there were significantly ($P < 0.05$) more species per trap in the organically managed orchard. After the third week of May there was no consistent pattern except that from the end of June there was a steady decline in numbers of species per trap in both areas. This decline largely followed the decline in soil minimum temperatures (maxima in the 4 day periods showed no consistent pattern). The difference in number of species in the two orchards from mid April to mid May can be explained by the presence of three species: European harvestman (*Phalangium opilio*), the common woodlouse (*Porcellio scaber*) and an unidentified millipede. In the organic orchard there were 105, 33, and 46 specimens

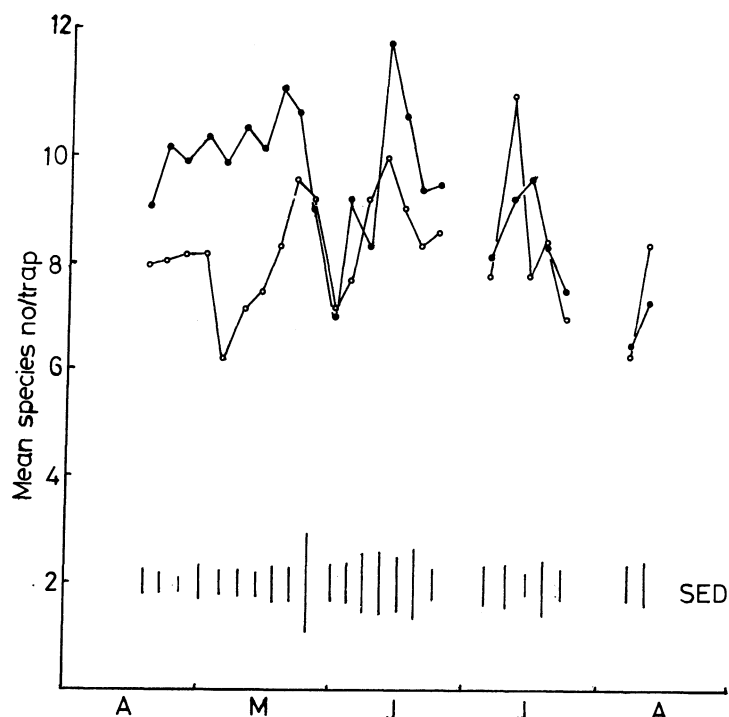


Fig. 1: The mean number of species per trap (10 traps) at 4 day trapping intervals between April and August 1989 in an organically (●---●) and in a conventionally (O---O) managed apple orchard.

respectively compared with 11, 0, and 1 from the conventional one. European harvestman, as a predator, fulfills the claims of the organic advocates. Similar support might be claimed by those advocates for the presence of six metallic green rove beetle (*Thyrocephalus orthodoxus*) and three metallic green beetle (*Megadromus antarcticus*) in the organic orchard compared with none in the conventional orchard. However, an unidentified hymenopteran parasitoid was, within sampling variation, equally common in each area (141 and 129 from the organic and conventional orchards respectively) and conversely, one unidentified spider was more numerous in the conventional orchard (307 individuals trapped compared with 196). Other species more numerous in the conventional orchard were the Collembola and an unidentified sciarid dipteran larva which were approximately three and four times more numerous in the conventionally managed orchard. The differences are apparently more complex than organic advocates would have us believe. It is difficult to make generalisations without the benefit of more survey data from a wider annual and geographical range.

Collating the data from all traps, the species richness in the organic orchard (44) was greater than in the conventional orchard (36) (regarding Collembola as one species). The mean species richness per trap in the organic orchard (31.0) was significantly greater ($P < 0.05$) than for the conventional orchard (26.8). This difference in species richness is the result of small numbers (generally < 10 over the sampling period) of a range of species, i.e., no species other than the common slater which comprised a significant proportion of the fauna in the organic orchard was missing from the conventional one. There were often large changes in a species' rank order, e.g., the unidentified millipede dropped from fifteenth (out of 44) in the organic orchard to

thirty-third equal (last equal) (out of 36). One species, an unidentified dipteran (four specimens), was present in the conventional orchard samples but not in the organic orchard.

The 4 day mean numbers of species per trap in the two fallow areas were all slightly lower than for the corresponding time in the orchard areas. In May there were significantly ($P < 0.05$) more species caught in the organic area but in August there was no significant ($P > 0.05$) difference though the conventional area results were higher.

Collating the data from all traps, the species richness in the organic fallow (40) was greater than that in the conventional area (30) (regarding Collembola as one species). The mean species richness per trap in the organic fallow (19.3) was significantly greater ($P < 0.025$) than for the conventional fallow (14.8). The greater difference between the overall value of richness and the mean trap value compared with the orchards illustrates that where samples cover a limited time then individual trap results should be combined in order to gain a better idea of a community's richness and also meet the assumptions of the Shannon Index. None of the species contributing to the difference between the two areas was represented by more than two specimens and so cannot contribute much to the community or to the control of pests. The number of European harvestman recovered was again much greater from the organic area, 48 compared with nine. The orchard areas had greater species richness than the corresponding fallows.

The diversity indices and species evenness for the two orchards and two fallow areas are given in Table 1. The organic orchard had a significantly ($P < 0.001$) higher diversity and species evenness than the conventional orchard whichever way the indices were calculated. The organic fallow area was also significantly ($P < 0.001$) more diverse than the conventional area but the species evenness was the same. The differences in the indices derived by the two different ways emphasises the point made by Magurran (1988) that care must always be taken in using diversity indices to compare data collected in an identical way. These differences also support the point made above that samples collected over a short time should be combined to calculate the diversity index.

TABLE 1: The mean (from 10 separate estimates) and the combined overall values of the diversity index, H', and species evenness, E, of the soil surface fauna from organically and conventionally managed orchard and fallow areas.

	Orchard		Fallow	
	Organic	Conventional	Organic	Conventional
Mean H'	2.76	2.19	2.60	2.28
Mean E	0.82	0.68	0.91	0.91
Overall H'	2.87	2.28	3.00	2.76
Overall E	0.77	0.65	0.49	0.52

CONCLUSIONS

The winter soil surface species diversity of organically managed areas is greater than that of comparable conventionally managed areas. Some predators are either lacking or, in the case of European harvestman, much less common in areas subjected to conventional management involving pesticides. For some species, however, either no differences were apparent or there were greater numbers in the conventional orchard.

Further work in other locations and covering an annual cycle needs to be carried out to see if the difference in trapping frequency observed in late autumn in this study was established the previous spring at the onset of regular pesticide use. Specific predation tests, particularly with European harvestman, need now to be done to establish any effect these predators have in controlling pests in organic areas.

ACKNOWLEDGEMENTS

The supervisor of the Horticultural Research Area, Mr Keith McIntosh, and the Area's staff are thanked for making the sample blocks available.

REFERENCES

- Carson, R., 1963. *Silent Spring*. London, Hamish Hamilton. 304p.
- Krebs, C.J., 1989. *Ecological Methodology*. New York, Harper Row. 654p.
- Magurran, A.E., 1988. *Ecological Diversity and its Measurement*. Princeton, Princeton University Press. 179p.
- Putman, R.J. and Wratten, S.D., 1984. *Principles of Ecology*. Beckenham, Croom Helm Ltd. 388p.
- Taylor, L.R., Kempton, R.A., and Woiwood, I.P., 1976. Diversity statistics and the log-series model. *J. Anim. Ecol.* 45: 255-272.
- Taylor, L.R., 1978. Bates, Williams, Hutchinson — a variety of diversities. *In Diversity of Insect Faunas: 9th Symposium of the Royal Entomological Society* (eds.) L.A. Mound and N. Waloff, Blackwell, Oxford, pp. 1-18.