THE ROLE OF ANTS IN DEGRADED SOILS WITHIN DRYANDRA STATE FOREST

J.D Majer, T.C Walker and F. Berlandier, School of Biology, Curtin University of Technology, Kent Street, Bentley, W.A. 6102

Introduction

The soils of the W.A. wheatbelt have become degraded as a result of unsound farming practices (Conservation and Environment Council, 1983). Degradation can occur through compaction of soil by the passage of heavy farm machinery, trampling by stock or through changes in microclimate due to reduction in shading by plants. Degradation of soils is further exacerbated by the depletion, or elimination, of large soil animals which are of crucial importance in maintaining soil structure (Abbott **et al.** 1979).

Ants have recently been shown to play a key role in the maintenance of soil structure (Cowan **et al.**, 1985) and their importance in soil turnover in parts of eastern Australia has been found to exceed that of earthworms (Humphreys, 1981). Ants are of particular interest in degraded soils since they are one of the earliest groups to colonise disturbed land (Majer, 1981). In this paper we report some preliminary investigations on the abundance and role of ants in degraded farmed land within Dryandra State Forest.

Methods

Two plots within Dryandra State Forest were selected for this investigation which was carried out in March 1986. These were an unfarmed woodland control and an adjacent farmed paddock. The woodland was vegetated by wandoo trees (**Eucalyptus wandoo**) with an understorey of **Gastrolobium microcarpum**. The farmed area which was about 100m to the east, had previously supported a similar plant community but was now thinly covered with dried pasture species and weeds. The soil in both plots ranged from clayey- to sandy-loam and the farmed area was currently grazed by sheep.

A 30 x 30m study plot was marked out in both areas. Recordings of soil physical variables were taken in both plots although ants were only sampled in the paddock. The ant fauna within native vegetation at Dryandra had earlier been surveyed (Majer, 1985).

The farm plot was carefully inspected for ant nests which were then marked. The area was searched so that representative ants could be collected for identification.

Soil inpenetrability, or compaction, was determined using a penetrometer. This measures the pressure required for a 2.5mm spike to penetrate the soil to a depth of 5cm. Forty random measurements were taken from both the farm and woodland plots.

Rate of water infiltration was measured using an infiltrometer. This involved hammering a hollow, 155mm diameter metal cylinder firmly into the ground so that it was sealed at ground level. It was then filled with water (1416cm3) to a fixed depth. The time itaken for this water to percolate into the soil was recorded. Ten recordings were taken from both the farm and woodland plots. In addition, a set of recordings was taken with the infiltrometer placed over ten nests of each of the four commonest ant species in the farm plot

Soil moisture content was determined by taking scoops of soil to a depth of 10cm and obtaining the difference between wet and dry weights of the soil. This was then expressed as a percentage of the total dry weight. Once again, ten samples were taken from both the farmland and woodland plots

The mean values of the physical parameters recorded in each plot were calculated. These were compared between plots by the Mann- Whitney U-test.

Table 1 Comparison of soil physical characteristics in the field and wandoo (**Eucalyptus wandoo**) woodland plot.

Soil Characteristic	Farm (x±S.E.)	Woodland (x±S E.)	Significance of difference
Soil impenetrability (compaction) (kPa)	4395±179	4068±348	n.s.
Soil moisture (%)	1.9±0.3	2.9±0.2	*
Infiltration rate (min/l)	27.2±3.9	15.1±4.5	*

* significantly different at $p < 0.05$; n.s. not significant.

Results

Mean soil inpenetrability was slightly greater in the field than in the woodland although the difference was not significantly different (Table 1). It is interesting to note that the variability was lower in the farm than in the woodland indicating the more homogeneous nature of the soil in the farmed plot. A number of woodland sites were either more, or less penetrable than the range exhibited by the farmland soils (Fig. 1).

Soil moisture values were significantly lower in the farm than in the woodland plot (Table 1)

Water infiltration was, on average, almost twice as rapid in the woodland as in the farmland soil and the differences between the means was statistically significant (Table 1)

Numbers of ant nests of the various species found are shown in Table 2. Six species were found in the plot although other, less common or conspicuous species may also have been present. **Pheidole** sp. 1 was the most abundant species, comprising almost half of the total nests (46%). **Tetramorium** sp. 1 and **Melophorus** sp. 1 were the least abundant (1.8%). The previous survey (Majer, 1985) indicated that at least 16 species occurred in wandoo woodland plots of similar area to that studied here. The **Pheidole** spp. and **Monomorium** sp which were common in the farmland were not common in the native vegetation.

TABLE 2. Density of nests of various ant species observed in the 900m^2 farm plot.

Subfamily	Species	Number of nests	%
Ponerinae	**Rhytidoponera inornata**	14	8.4
Myrmicinae	**Monomorium** sp. 1	45	27.1
	Pheidole sp. 1	77	46 4
	Pheidole sp. 2	24	4.4
	Tetramorium sp. 1	3	1.8
Formicinae	**Melophorus** sp. 1	3	1.8
Total		166	100.0

The water infiltration rates on the nests of the four most abundant species are shown in Table 3. Nests of **Rhytidoponera**, the largest of the four ants, had the fastest infiltration rate (5.6 min/l) while **Monomorium** nests had the slowest rate (11.2 min/l).

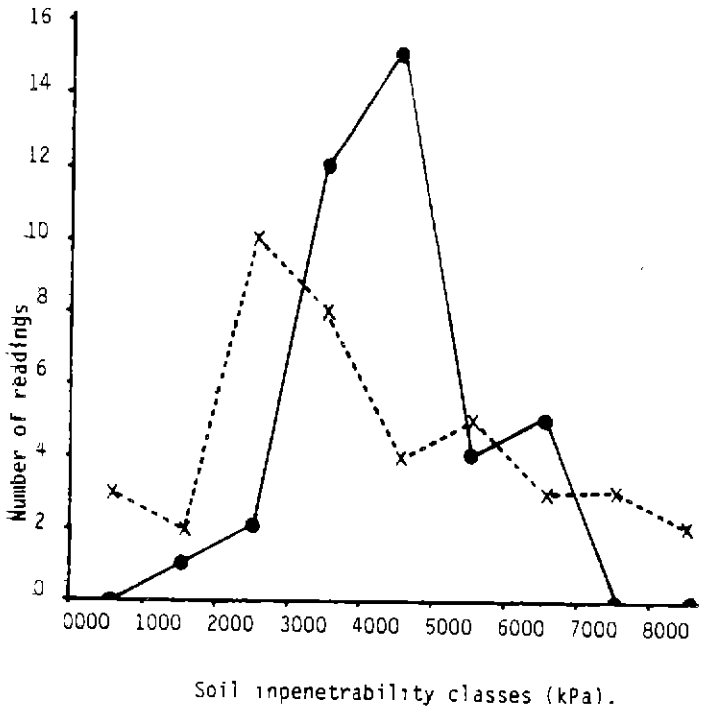

FIGURE 1. Frequency of soil impenetrability values in 1000 kPa range classes for farm (●____●) and woodland (x----x) soils (n = 40).

TABLE 3. Comparison of water infiltration rates on nests of the common ant species in the farm plot.

Ant Species	Infiltration rate (ml/l) (x ± S.E.)
Rhytidoponera inornata	5.6 ± 2.5
Monomorium sp. 1	11.2 ± 2.8
Pheidole sp. 1	8.6 ± 2.8
Pheidole sp. 2	7.7 ± 2.2
Mean of all species	8.3 ± 5.4

Discussion

This study has confirmed the findings of earlier studies that farmland soils are of inferior physical quality to that under native vegetation. The farmland soil was generally more difficult to penetrate indicating that it was more compacted and/or more cemented than much of the soil under the wandoo woodland (Fig. 1). The soil was also more uniform in this regard than that of the woodland suggesting that there are fewer opportunities for organisms which require either hard or soft soil to survive.

The lower water infiltration rate of the farmland soil was probably a reflection of the compacted nature of this soil and also of the paucity of channels made by burrowing animals or plant roots. Evidence for these poor infiltration characteristics could be seen in the presence of shallow erosion gulleys across the surface of the soil. The low infiltration of water could also explain the low soil moisture levels in the farmland soil. However, the absence of shade in the farmland would lead to higher soil temperatures and hence faster evaporation rates. This would also contribute to low soil moisture levels.

This investigation, which concentrated on only one component of the soil mesofauna, indicates that ants are present, and relatively abundant in the farmland soil - at least 5.4 nests per m2. The diversity of ants in the farm is lower than that of the woodland areas (cf. Majer, 1985) but nevertheless, their nests are a conspicuous part of the environment.

That they were at least in part responsible for the mixing of soil strata at Dryandra, was indicated by the fact that the soil of the ant nest mounds was of a lighter colour than the surrounding surface soils. The presence of ants also had beneficial effects on the water infiltration characteristics of the soil, with infiltration rates on soil around ant nests being more than three times as rapid as in the surrounding soil ($p < 0.001$ using the Mann-Whitney U-test). Thus, although ant nests cover just over 0.14% of the total soil surface (assuming a mean nest diameter of 10cm), they contribute at least 0.48% to the total water infiltration in the farmland soil.

Although these results are from a preliminary study, they do highlight the deteriorating structure of agricultural soils and some of the benefits which ants can bring about. Further investigations are clearly needed to confirm and extend these findings. However, even at this stage it is clear that agriculture might benefit if steps were taken to encourage the colonisation and survival of ants and other animals in farmland soils. If this were done there would doubtless be improvements to the quality of the soils in these farmlands.

References

Abbott, I., C.A. Parker, and I.D. Sills. 1979. Changes in the abundance of large soil animals and physical properties of soils following cultivation. **Australian Journal of Soil Research**, 18, 343-352.

Conservation and Environmental Council. 1983. **A Conservation Strategy for Western Australia.** Western Australian Department of Conservation and Environment Report No. 12, 88 pp.

Cowan, J.A., G.S. Humphreys, P.B. Mitchell, and C.L. Murphy. 1985. An assessment of pedoturbation by two species of mound building ants, **Camponotus intrepidus** (Kirby) and **Iridomyrmex purpureus** (F. Smith). **Australian Journal of Soil Research**, 22, 95-107.

Humphreys, G.S. 1981. The rate of ant mounding and earthworm casting near Sydney, New South Wales. **Search**, 12, 129-131.

Majer, J.D. 1981. The role of invertebrates in bauxite mine rehabilitation. **Western Australian Forests Department Bulletin**, No. 93, 29 pp.

Majer, J.D. 1985. Invertebrate studies on disturbed and pristine habitats of Dryandra State Forest. **Western Australian Forests Department Research Paper**, No. 80, 11 pp.