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# Distribution of Manganese in a Bio-Topo Sequence of Southeastern Iowa Soils

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# Distribution of Manganese in a Bio-Topo Sequence of Southeastern Iowa Soils[1]

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*Abstract.* Manganese extractable by sodium hydrosulfite was determined for 9 soil profiles of a bio-topo (vegetation and drainage) sequence in southeastern Iowa. The distribution of manganese in the soils studied is influenced by vegetation, drainage, and pH. Under prairie vegetation the manganese is evenly distributed with depth in the well drained soil, but with increasing wetness of the soil profile, manganese is apparently lost from the $A_1$ horizon and accumulates in the lower part of the B horizon. Manganese accumulates in the $A_1$ and $A_2$ horizons of the well drained soils developed under forest vegetation, but in profiles of increasing wetness the amount of manganese in the $A_1$ and $A_2$ horizons decreases and the amount of manganese in the lower B horizon increases. The distribution of manganese in the transition prairie-forest soils was intermediate between soils developed under prairie vegetation and those developed under forest vegetation.

Daniels *et al.* (1960) studied the distribution of manganese in 21 Iowa soil profiles and found that the distribution of manganese was characteristic of soils at the great soil group level. However, insufficient information was available to evaluate properly the influence of drainage (topo) and vegetative (bio) regimes on the distribution of manganese in soils developed from the same parent material.

## SOIL PROFILES STUDIED

Nine soil profiles forming a bio-topo sequence were selected for study of the influence of vegetation and drainage on the distribution of manganese in soils developed from the same parent material. The morphological description, percent clay, pH, and percent extractable iron of the soils studied have been reported by Corliss (1958). The sequence relationships of the profiles studied are shown in Figure 1. The soil profiles studied included topo-sequences of the Taintor (P412), Mahaska (27533), and Otley (P262) profiles developed under prairie vegetation; the Rubio (P610), Givin (P611), and Ladoga (P612) profiles developed under a forest vegetation that has encroached upon prairie vegetation, hereafter called transition prairie-forest vegetation; and the Rushville (Berwick) (P423), Keomah (P613), and Clinton (P126) profiles developed under forest

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vegetation. All the soils studied have developed from Wisconsin loess in the Mahaska-Taintor soil association area in southeastern Iowa (Simonson *et al.,* 1952).

## Method

Manganese was extracted by the sodium hydrosulfite ($Na_2S_2O_4$) method discussed by Daniels *et al.,* (1960).

## Observations

**Effects of drainage.** In the topo-sequence (Taintor-Mahaska-Otley) of profiles developed under prairie vegetation, the natural drainage improves from the poorly drained Taintor profile to the well drained Otley profile. The amount of extractable manganese in the $A_1$ horizon of the topo-sequence increased from the poorly drained (Taintor) to the well drained (Otley) profiles (Figure 1). The profile distribution of manganese becomes more uniform as the drainage improves. The increase of manganese in the $A_1$ horizon from the poorly drained to the well drained soil is paralleled by a decrease of manganese in the lower B horizon (Figure 1). The increase of manganese in the B horizon of the Taintor profile is interpreted as translocation of manganese from the A to the B horizon.

Under forest vegetation the amount of manganese in the $A_1$ horizon increased from the poorly drained Rushville (Berwick) profile to the well drained Clinton profile of the topo-sequence (Figure 1).

Soil profiles of the topo-sequence developed under transition prairie-forest vegetation are intermediate between those profiles developed under prairie and those developed under forest vegetation. The accumulation of manganese in the lower B horizon decreases from the poorly drained Rubio profile to the well drained Ladoga profile (Figure 1).

**Effects of vegetation.** In the bio-sequence (vegetation) of soil profiles developed under poor drainage (Taintor-Rubio-Rushville), the amount of extractable manganese in the $A_1$ and/or $A_2$ horizon(s) increased from the Taintor profile, developed under prairie vegetation, to the Rushville profile, developed under forest vegetation (Figure 1). The increase of manganese in the $A_1$ and/or $A_2$ horizon(s) was associated with a proportionate decrease of manganese in the lower B horizon.

Under imperfectly drained conditions of the bio-sequence (Mahaska-Givin-Keomah) the amount of manganese in the $A_1$ and/or $A_2$ horizon(s) increased from the Mahaska profile, developed under prairie vegetation, to the Keomah profile, developed under forest

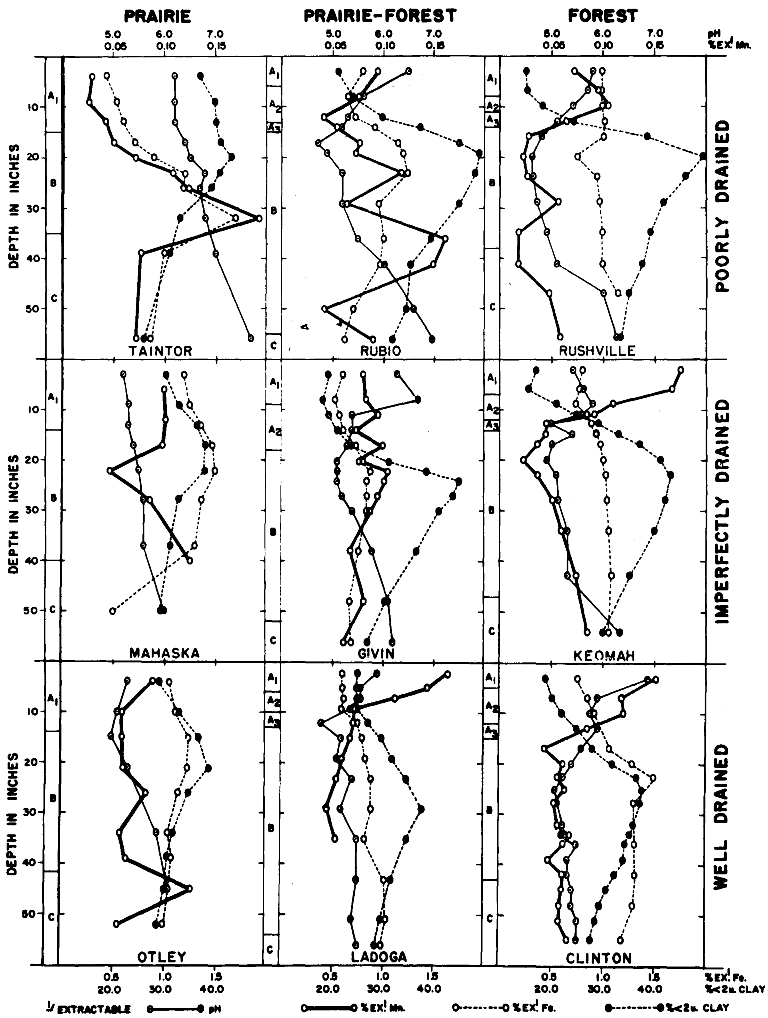


Figure 1. Distribution of extractable manganese, pH, extractable iron, and clay with depth in nine soils of a bio-topo sequence.

vegetation. The distribution of manganese in the Givin profile is more like the distribution of manganese in the Mahaska than the Keomah profile (Figure 1).

Soils of the bio-sequence developed under well drained conditions (Otley-Ladoga-Clinton) have profile distributions of manganese similar to those soil profiles developed under imperfect drainage. Daniels *et al.,* (1960) found similar results from some soils developed under transition prairie-forest vegetation. The distribution of manganese in the Ladoga profile, developed under transition prairie-forest vegetation, is similar to the distribution of manganese in the Clinton profile, developed under forest vegetation.

The profile distribution of manganese in the transition prairie-forest soils apparently is indicative of the degree or extent of forest vegetation under which the soils have developed. The Givin profile shows less influence of the encroachment of forest than the Rubio or Ladoga profiles. The Ladoga profile shows more influence of the encroachment of forest than the Rubio profile.

**Effects of pH.** A pH lower than about 5.5 is favorable for the reduction and movement of manganese in the soil profile in the divalent form, and a pH greater than about 5.5 is favorable for the biological oxidation and precipitation of manganese in the soil profile in the oxidized form (Leeper, 1947). Manganese is oxidized chemically only at a pH of 8 or above. Thus, movement of manganese would be expected to occur from areas of the soil profile where the pH is below 5.5, and accumulation of manganese would be expected in areas where the pH is above 5.5.

In the soils studied the pH ranged from 4.6 to 7.7 (Figure 1), but only in the well drained soils did the distribution of manganese and pH tend to be parallel. In the imperfectly and poorly drained soils the effect of pH is masked by drainage and vegetative effects.

**Iron and manganese comparisons.** The maximum accumulation of extractable or free iron and clay is associated with the minimum accumulation of manganese in the imperfect and well drained soil profiles (Figure 1). Simonson *et al.* (1957) found similar results for the iron and clay accumulations. The poorly drained soil profiles, except for Rushville, have accumulated both iron and manganese in the B horizon.

Winters (1940) found that iron sols are positively charged and that manganese sols are negatively charged. Since clay is negatively charged, it is interpreted that the iron content would tend to parallel the clay content and that the manganese content would tend to be the lowest where the clay content was the highest.

## Discussion

The results of this study show that the distribution of manganese in the soil profile is influenced by drainage, vegetation, and pH. Drainage (topo) affects the accumulation of manganese in the lower B horizon of the poorly drained soils but appears to have little influence on the distribution of manganese in the imperfectly and well drained soils. The accumulation of manganese in the lower B horizon of the poorly drained soils may be due to differences in oxidation and reduction potentials between the A and B horizons, but additional information is needed before the process involved can be identified.

Extractable manganese always is greater in the A horizon of soils developed under forest than the associated member of the biosequence developed under prairie. Thus, the influence of vegetation on the distribution of manganese depends upon the type of vegetation. Apparently forest vegetation recycles more manganese than prairie vegetation. Other factors, such as the amount and kind of decomposition products from prairie and forest vegetation, may have an influence on the distribution of manganese under different types of vegetation. Although it can be demonstrated that the distribution of manganese is influenced by the kind of vegetation, the exact mechanisms involved are unknown and require additional study.

The profile distribution of manganese may be a useful diagnostic measure of the degree of forest influence on the transition soils developed under tree-encroached prairie vegetation.

The effect of pH on the distribution of manganese is best expressed in the well drained soils of the bio-topo sequence. The manganese tends to be lowest in the horizons of lowest pH and highest in the horizons of highest pH.

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