Nutrient and Biotic Properties of Mormoder and Leptomoder Humus Forms in the Coastal Western Hemlock Zone

Introduction

In British Columbia, humus form identification is widely use to infer the level of plant-available soil nutrients. This identification is based on field-observable (morphological) features. We recognize three major humu forms: Mors, Moders, and Mulls - which are differentiated according to the type of F horizon, and the presence/absence of organic matter-enriched Ah horizons.

Mors represent humus forms where decomposition is dominated by fungi, with slow decomposition rates and accumulations of organic matter on the soil surface. Mors are characterized by the presence of a Fm (m - mycogenous) horizon. In contrast, Mulls represent humus forms with high rates of decomposition and faunal activity resulting in organic matter being intimately incorporated into the upper mineral soil layer instead of accumulating on its surface. Intermediate on the humus form gradient from Mors to Mull are the Moders. Moders are similar to Mors in that they have accumulations of organic matter on the surface of the mineral soil but decomposition is not fungus dominated, so they lack the diagnostic Fm horizon. The central concept of the Moder is represented by the Leptomoder, which is characterized by a Fz (z - zoogenous) horizon with an active population of soil meso- and microfauna, fungal mycelia are not present or present in small amounts. When both fungal mycelia and faunal droppings can be found, but neither clearly predominate over the other, an Fa (a - amphimorphic) horizon results. Fa horizons are characteristic of Mormoders, an integrade between Mors and Moders.

Considering the prevalence of Mormoders and Leptomoders in B.C. and the difficulties in identifying Fa horizons, the aim of this study was to determine whether the morphological features used to differentiate these two Moder humus forms reflects differences in their physical, chemical and biotic properties.

Study Stands

The study was conducted in the submontane variant of the Very Wet Maritime Coastal Western Hemlock (CWHvm1) subzone. The study stands represented the stem exclusion and understory reinitiation developmental stages on sites with fresh soil moisture regime, medium soil nutrient regime, and good soil aeration). Two stands were located in each of three adjacent watersheds (Capilano, Seymour, and Coquitlam), for a total of 6 stands.

Differences in field-observable properties

Mormoders and Leptomoders were differentiated by the presence of Fa and Fz horizons, respectively (Figure 1). In Fz horizons, recognizable plant residues are aggregated in a matted structure with a tenacious consistency and fungal mycelia and fine roots are abundant. In Fa horizons partly decomposed plant residues are aggregated into a weak to moderate, non-compact matted structure and both fungal mycelia and faunal droppings are present but neither dominate.

No significant differences were detected in the thickness of LF and H horizons between the two humus forms: the mean thickness of the LF and the H horizon, respectively, was 3.4 and 5.1 for Mormoders, and 3.6 and 5.0 cm for Leptomoders.
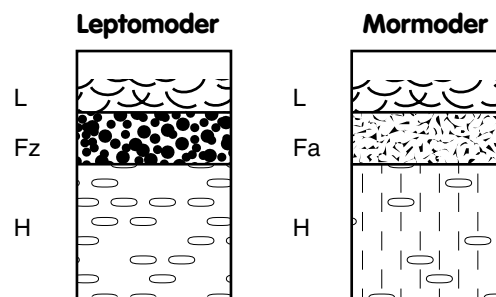

Figure 1. Humus form profiles of a typical Leptomoder and Mormoder.

Differences in nutrient and biotic properties

Nutrients

Mormoders are nutrient-poorer than Leptomoders. Two indices of easily available plant nutrients - C:N ratio and mineralizable-N - which were strongly correlated, accounted for most of the differentiation. In Mormoders, the C:N ratio was significantly higher and concentrations of mineralizable-N significantly lower. Mormoders also had significantly higher total C concentrations in H horizons than Leptomoders.

Fungi and Bacteria

In the LF horizon, Leptomoders had greater bacterial biomass than Mormoders. Fungal biomass was not different, even though fungal presence (*i.e.* Fa horizon) is used as a diferentiating feature between the two Moders. Mormoders had significantly higher amounts of fungi in the H horizon, which is not a diagnostic feature for identification. The discrepancy between estimates of abundance of fungal mycelia from visual examination and analytical determination may be due to the subjective nature and inaccuracy of visual inspection.

Biota

Thirty-one major groups of soil fauna were extracted during three sampling periods, with no significant differences in faunal density between sampling times. Roundworms were the most abundant group in both humus forms, followed by mites and springtails — these 3 groups accounted for approximately 97% of the total number of soil fauna. Some differences between the Moders were observed in the less abundant groups. For example, spiders were only observed in Mormoders, the density of pseudoscorpions was higher in Leptomoders, and the density of annelids (Enchytraeidae) was slightly higher in Mormoders.

Relationship between biotic and nutrient properties

In the LF horizon there was a correlation between the fungal:bacterial biomass ratio and the nutrient properties; the fungal:bacterial biomass ratio was higher in Mormoders. This ratio was strongly positively correlated with C:N ratio and inversely related to mineralizable-N:total N ratio, an expression of plant-available soil N. These relationships confirm that fungus-dominated humus forms have slower litter decomposition and greater nutrient retention.

Can field-identified Mormoders and Leptomoders be seggregated by their nutrient and biotic properties ?

The chemical and biotic properties of the 24 plots (12 per humus form: 3 stands x 4 samples per stand) were used in a cluster analysis. Three clusters were idendified. Cluster 1 (11 plots) included most of the Leptomoders (10 plots) and only one Mormoder plot. Cluster 3 contained only Mormoders (9 plots). Cluster 2 (4 plots) was the smallest cluster, containing the same number of Mormoders and Leptomoders (2 plots each). Based on the memberships in each cluster, we considered that 83% of Leptomoders in cluster 1 and 75% of Mormoders in cluster 3 had well defined morphological, chemical, and biotic properties, and hence could be well segregated by any of these properties. However, 17% of samples identified as Leptomoders (2 plots) and 25% of samples identified as Mormoders (3 plots) had similar nutrient and biotic properties.

Summary and Conclusions

Mormoders and Leptomoders identified by visual examination were different in their nutrient and biotic properties; however, the differentiation based on these properties was not completely successful as 25% of the study samples overlapped in their nutrient and biotic properties. This implies that there is an imperfect relationship between field-observable and biotic properties; however, biotic properties appear to be closely linked to nutrient properties. These results suggest some improvement of visual identification criteria would be beneficial, such as developing measures for more precise estimates of fungal and bacterial biomass in the both F and H horizons.

Reference

Fons, J. and K. Klinka. 1998. Chemical and biotic properties and temporal variation of Moder humus forms in the rain forest near Vancouver, British Columbia. Geoderma 86: 83-98.