

Effects of Decaying Wood on the Weathering of Soils in Coastal British Columbia, Canada

Introduction

Large accumulations of coarse woody debris (CWD) on the forest floor in the form of downed boles (i.e. downed by natural events such as windstorms that uproot trees) are common in forests not having a history of frequent fires (Harmon et al. 1986). These accumulations of CWD may have an influence on the soil development of forest ecosystems by increasing eluviation and the loss of some soil nutrients (McKeague et al. 1983; Yavitt and Fahey 1985; Harmon and Sexton 1995). This study tests whether CWD affects soil weathering in coastal British Columbia. I used chemical properties of the mineral soil directly under the organic substrates as an integrator of the effects of woody and non-woody forest floor substrates.

Methods

Three study sites were established north of Vancouver, British Columbia, Canada on well-drained soils identified as Orthic Humo-Ferric Podzols (Agriculture Canada Expert Committee on Soil Survey 1987) or Typic Haplorthod (Soil

Survey Staff 1975) in old-growth forests composed of an overstory of Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western redcedar (*Thuja plicata*). The climate is characterized as cool temperate, summer wet (Cfb by Köppen), and is delineated by the Coastal Western Hemlock zone. Within each of the three sites, 12 soil pedons of 1x1m were systematically located on a 30-m grid. Each pedon consisted of one side with a forest floor layer that had a decay class IV or V log (Maser et al. 1988) at least 60 cm across, and the opposite side of the pedon consisting of a prevailing humus form (either Humimor or Mormoder, Green et al. 1993) without a large accumulation of decaying wood (Figure 1). From each of the opposite sides of the pedon (i.e. the two different substrates) samples were taken of the forest floor substrate, the underlying Ae horizon, and the Bf horizon to a depth of 10 cm.

For the forest floor, and the Ae horizon and B horizon soil samples, the following chemical analyses were undertaken using the methods outlined in Carter (1993): pH, total C, and total

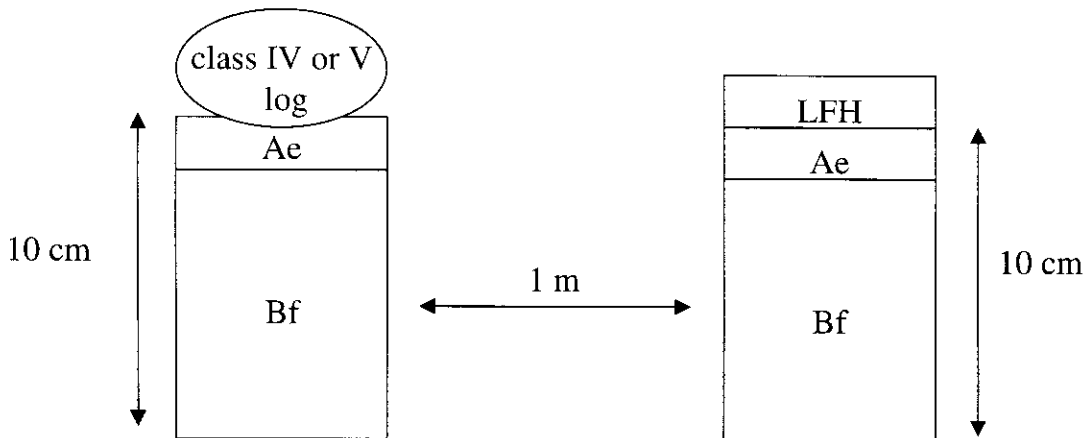


Figure 1. An example of a profile pair sampled from under each of the two substrates. The forest floor substrate was a decay class IV or V log from one side of a soil pit, and the prevailing humus form (LFH) from the other side of the soil pit. The Ae horizon and the underlying Bf horizon to a depth of 10 cm were sampled under both forest floor substrates.

N. Additionally, the mineral soil samples were analyzed for: sodium pyrophosphate-extractable Fe and Al to give the concentration of the organically complexed Fe and Al; oxalate Fe and Al to give the concentration of poorly crystalline Fe and Al; and dithionite-citrate extractable Fe and Al and Si to give the concentration of total free Fe and Al that are not included in silicate minerals. Forest floor samples were subjected to sequential fractionation (Lowe 1975) to yield C in humic acid and fulvic acid fractions. Statistical comparisons of the forest floor and mineral soil chemical measures were made between the non-woody and woody sides of the pedons using a complete block design (pedon pairs as blocks) replicated three times (three sites).

Results

There were significant ($p < 0.05$) differences between the means of the two forest floor substrates for all the chemical properties (Table 1). For the Ae horizon directly under the two substrates, a significant difference in the depth of Ae horizon between the non-woody and woody substrates was not detected; neither were significant differences in any of the other chemical properties detected. For the upper Bf horizon, only a small difference in the C:N ratio was detected.

Discussion

Despite large differences in the chemical properties between the non-woody and woody forest floors, there are generally no significant differences between the soils directly under these substrates. The decaying wood was slightly more acid than the prevailing forest floor, but had lower concentration of fulvic acids. Fulvic acid is the main constituent of organic material responsible for chelation of Fe and Al and the subsequent downward movement of this organo-metallic complex (Schnitzer 1969). The lower concentration of fulvic acid in decaying wood suggests that it may have less eluviation potential than non-woody humus forms. Yet none of the measures of soil weathering—especially the pyrophosphate extractable Fe + Al, the ratio of pyrophosphate to dithionite extractable Fe + Al, and the ratio of oxalate to dithionite extractable Fe—showed significant differences. Considering the differences between the two forest floor substrates themselves, this small difference in the impact on the soil directly beneath is puzzling. This small difference is due either to, or a combination of: (1) a large buffering capacity of the soil; (2) lateral soil water flow mixing with the vertical flow from the substrates; and/or (3) the leachate from each of these forest floor substrates are the same despite differences

TABLE 1. Differences in chemical properties between the non-woody humus form and the decaying wood (woody), and between the mineral soil beneath the substrates. An asterisk (*) indicates significance at $p < 0.05$ without any significant interaction effect. HA = humic acid; FA = fulvic acid; pyro = sodium pyrophosphate extractable; dithio = dithionite-citrate extractable.

Forest Floor			Mineral Soil Horizons				
	non-woody	woody	Ae		upper B		
			non-woody	woody	non-woody	woody	
			depth (cm)	3.5	3.8		
pH	3.72*	3.41	pH	4.00	3.95	4.42	4.36
total C (%)	48.87*	58.84	total C (%)	2.94	3.55	5.43	5.17
total N (%)	1.58*	0.62	total N (%)	0.16	0.15	0.23	0.19
C:N	31.1*	104.4	C:N	22.5	27.3	25.3	27.9*
C in HA (%)	12.73*	15.11	pyro-Fe + Al (%)	0.559	0.447	1.568	1.429
C in FA (%)	10.23*	6.57	oxalate Fe+Al	0.634	0.532	1.836	1.710
HA:FA	1.28*	2.52	dithionite Fe + Al (%)	0.894	0.804	2.474	2.414
			<u>pyro - Fe + Al</u>	0.435	0.435	0.626	0.603
			dithio - Fe + Al				
			<u>oxalate - Fe</u>	0.471	0.485	0.623	0.642
			dithionite - Fe				

in the substrates themselves. Lysimeter and soil column studies are currently being carried out by the author to further investigate the joint effects, or lack of effects, of these two organic substrates.

Conclusions

Based on the similarity of the depth of Ae horizon and the chemical weathering indices, it appears that on well-drained sites the degree of acidification and increased eluviation under decaying wood are the same, or even somewhat less, than

under the non-woody forest floor, the prevailing humus form in coastal British Columbia.

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