A COMPARISON OF ORGANIC SOIL HORIZONS UNDER OAK AND ALDER CANOPY TREES

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Abstract. (WLO) The depth and composition of the organic soil horizon depends heavily on fallen leaf matter. We compared the depth of the three organic layers - O_a, O_i, and O_e layers - of two high-elevation, forest sites with different canopy tree cover, one predominantly alder (*Alnus acuminata*), the other oak (*Quercus costaricensis*). We hypothesized there would be a deeper organic layer under the oak canopy area because we expected the tannins in oak leaves to slow decomposition. However, there were no significant differences in of any of the organic layer depths between the oak and alder canopy areas. This may have been due to the steep slope environment sampled in this study, which may have eliminated organic horizon differences.

INTRODUCTION (AVB)

Organic soil horizons are produced by the breakdown of organic matter by bacteria and fungi. Because these microbial processes are often limited by nitrogen, we hypothesized that leaves with high nitrogen content would break down rapidly, whereas leaves in the litter with high concentrations of quantitative defenses, such as cellulose, tannins, and lignins, would break down more slowly. This would lead to different amounts of organic matter in the soil under canopies dominated by the two different leaf types.

On the east side of the Mirador Trail of the Albergue Querici Biological Station, we observed an organic soil horizon of approximately 0.5 m. The canopy of this area is dominated by oak (*Quercus costaricensis)* , which is a late successional species. It is likely that oaks will have higher concentrations of quantitative defenses in their leaves than an early successional species, such as alder (Coley 1983).

Alder (*Alnus acuminata*) trees dominate the canopy of the second growth forest in the study area. They have nitrogen-fixing nodules on their roots, enabling them to grow in nitrogen poor soils. This adaptation might also increase levels of nitrogen in the leaves, facilitating leaf breakdown by bacteria.

We hypothesized that the leaves of a late successional species, like oak, would take longer to break down into soil than the leaves of an early successional species, such as alder. Assuming that input rates of leaves from both trees would be the same, we expected to see a deeper organic soil horizon in the area dominated by oak, and a shallower soil horizon in the area where alder is dominant.

METHODS (WLO)

We sampled on the southeast-facing ridge off the Mirador Trail in Cerro de la Muerte, near Alberque Querici, Costa Rica on 26 January 1995. The canopy on the western side of the ridge consisted primarily of alder trees while the eastern side was predominantly oak. Both sites were on steep slopes (alder=43.6°; oak=41°), with canopy trees measuring >50 cm DBH (diameter at breast height).

Five 1 m^2 plots were sampled in 5 m intervals along a transect on each side of the ridge (approximately 20 m below the top of the ridge). The oak canopy transect was interrupted by alder trees and few large boulders, and therefore had a 20 m gap in the middle which was not sampled. Within each plot, we dug a pit 25 cm in diameter to the mineral horizon where the soil was deepest. In each soil pit, we measured the depth of each organic layer: Oa (surface leaf litter), O_i (intact leaf fragments), and O_e (darker humic soil with no leaf fragments above the mineral horizon).

RESULTS (WLO)

The total organic horizon averaged 20.8 cm under alder canopies and 18.4 cm under oak canopies; however the two depths were not significantly different (t=1.12, df=4, P=0.32). The O_i layer was the deepest of the three layers with an average of 12.8 cm under alder canopies and 9.3 cm under oak canopies (Fig. 1), this difference was also not significant (t=2.08, df=4, P=0.11). The O_a layer was the next deepest (alder O_a=4.1 cm; oak O_a=5.7) followed by the O_e layer (alder O_e=3.9; oak O_e=3.4). There were no significant differences between the depths of the O_a layer (t=2.64, df=4, P=0.06) or the O_e layer (t=0.85, df=4, P=0.45).

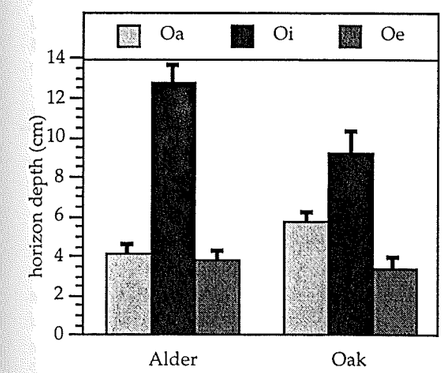

FIG. 1: Average depths (in cm) of the O_a, O_i, and O_e organic layers under oak and alder canopies (mean ± SE).

DISCUSSION (CDC)

We found no significant difference in the overall organic horizon profile between the oak canopy transect and the alder canopy transect. While there was a marginally significant trend toward a greater litter layer (O_a) under the oak canopy (P=0.057), the trend toward a deeper O_i and total O horizon under the alder canopy was contrary to our expectations. Oak leaves were presumed to have higher tannin content and lower nitrogen content than alder leaves, which lead to the hypothesis that oak leaves would decompose slower and form a deeper O_a and O_i horizon.

The close proximity of the two transects (about 40 m) eliminates some potential biases due to physical differences between the transects. The only obvious difference between the two habitats was an increase in ground vegetation in the oak transect. The average slope of the transect areas differed by only 2.6°, and had approximately the same south-facing aspect (differing by 15°).

The potential for high rates of debris flow on the >40° slope seems to preclude the establishment of a deep O_a and O_i horizon on either transect. The soil horizons in all of our plots contained an extremely varied mixture of rocks and soil, indicative of continued soil profile disturbance. All of our plots sampled areas that would tend to lose rather than accumulate gravitationally-transported litter debris (none of the plots fell on the up-slope side of trees or logs). We feel that differences in the organic soil horizon depth due to differential breakdown rates of alder and oak leaf litter may have been eliminated in this dynamic steep slope environment.

The comparison of the organic horizon depth between two different canopy species is best facilitated with a study that limits other confounding factors (such as differences in temperature, moisture, and slope). Though our study site precludes some of these differences due to the close proximity of the two canopies, we feel that the steep slope environment we sampled may have eliminated potential organic horizon differences. Preliminary soil pits in a higher elevation oak dominated stand to the east revealed a organic horizon depth several times that of the oak transect we sampled (approximately 0.5 m). Further studies are warranted to re-examine this hypothesis in an environment with a less steep slope.

LITERATURE CITED

Coley, P. D. 1983. Herbivory and defensive characteristics of tree species in a lowland tropical forest. Ecological Monographs 53: 209-233.