Vannote, R. L., G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. The River Continuum Concept. Canadian Journal of Fish and Aquatic Science. 37: 130-137.

Litter accumulation by buttressed trees

C. R. E. DALLISON, M. A. NOVELLO, AND C. E. T. PAINE

Abstract: We tested the litter trap theory, which proposes that buttressed trees collect more organic material than trees without buttresses. We found that within 50 cm of the bole, buttressed trees amassed significantly more leaf litter and had a thicker O horizon than non-buttressed trees. As well, we examined whether this increased organic matter altered the physical environment and supported a higher density of decomposers. There was no difference in pH, temperature, or soil respiration rate (an indicator of decomposer biomass) between the two types of trees. Although buttresses do not affect the rate of decomposition, they do increase the nutrient supply rate by increasing the organic matter pool available to the tree.

Key Words: litter trap theory, microhabitat, Monteverde, soil respiration

INTRODUCTION

Most research on buttresses has focused on Richards' (1952) hypothesis that they are structural adaptations to the stresses of wind and gravity. Down-hill oriented buttresses appear to relieve stress on roots and support trees on soils that afford poor anchoring (Henwood 1973). Bansak et al. (1993) found more down-slope buttresses in areas of greater wind and steeper slopes.

Carson et al. (1995) proposed that buttresses function both for support and litter catchment. However, this hypothesis has not been directly tested. We hypothesized that trees with cross-slope buttresses would have more leaf litter and a thicker O horizon than non-buttressed trees. We further predicted that this accumulation would alter the pH, moisture and temperature of the soil, and increase the decomposition rate.

METHODS

On 22-23 January 1999, we surveyed six buttressed trees 30 cm DBH and six non-buttressed trees approximately 0.5 km east of Estación Biologica Monteverde, Costa Rica. We haphazardly sampled buttressed trees on a 36° slope between 1550 m and 1650 m elevation on the Pacific side of the continental divide. We paired each buttressed tree with the closest non-buttressed tree with a similar DBH (±5 cm). We defined buttressed trees to be those whose cross-slope width at the ground was at least twice their DBH. Non-buttressed trees had similar DBH and ground level diameters.

We laid out three 150 cm transects from the center of the uphill side of the bole of each tree. The center transect extended directly upslope, and the two side transects were 45 degrees either side of the center transect. We measured the thickness of the leaf litter at 25, 50, 100 and 150 cm from the bole on each transect. At 50 cm along the center transect, we collected all leaf litter (excluding twigs and bark) in a $0.11m^2$ quadrat. We air dried the litter samples for 24 hrs to obtain the dry mass.

To determine the thickness of the layer of partially decomposed organic matter (O horizon), we took soil cores (2.5 cm diameter x 40 cm) along the center transect at 50, 100 and 150 cm from the bole. The O horizon was distinguished as the top layer of dark brown, fibrous soil, bounded beneath by the A-horizon, which was clay-rich and tan colored. When the O horizon thickness was greater than 40 cm (the length of the soil corer), we dug a hole and cored again from the bottom of the hole.

We measured the moisture and pH of the O horizon with a Demetra System Soil Tester, and temperature with a Sensortek Model Bat-12 thermometer, at 25 and 50 cm along each transect. We collected a sample from the O horizon at 50 cm along the center transect, and measured soil respiration rate, an indicator of decomposition rate. Respiration flasks (20 ml) were assembled, with a bottom layer of soda lime (2 cm), a middle layer of absorbent cotton (2 cm) and 2-7 g of soil. Each flask was capped with a rubber stopper, lubricated with Vaseline for a tight fit. A 10 ml glass pipette was inserted through the stopper approximately 1 cm into the tube, and 2-3 ml of water was placed inside the pipette. Flasks were maintained at room temperature for 45 min, and the change in volume of O_2 consumed by decomposers was

recorded. Respiration rates were calculated as ml of O_2 consumed per g of soil per min.

RESULTS

The litter layer was thicker under buttressed trees than non-buttressed trees at 25 and 50 cm from the bole (Fig. 1; 2-way ANOVA, F=13.28, df=1, P=0.0004) but was similar at >50 cm. Dry weight of leaf litter was greater for buttressed than non-buttressed trees (Fig. 2; ANOVA, F=9.43, df=1, 10, P=0.01). At 50 cm from the bole, the O horizon was thicker under buttressed trees than under non-buttressed trees (Fig. 3; 2-way ANOVA, F=7.57, df=1, P=0.01). There was no difference between tree types in the thickness of the O horizon or leaf litter at 100 and 150 cm.

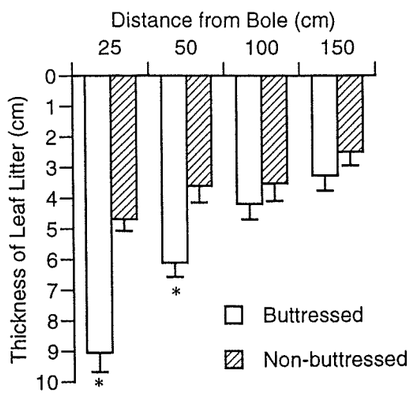

Fig. 1. Litter thickness as a function of distance uphill from the bole from buttressed and non-buttressed trees at Estación Biologica Monteverde, Costa Rica (Means-1 SE). Asterisks indicate pairs that are significantly different (t-test, 25 cm, P<0.0001; 50 cm, P=0.0007; >50 cm, P>0.28; see text for details).

Except for moisture, the physical characteristics (pH and temperature) of the O horizon did not vary with distance or type of tree (ANOVA, temperature, F=1.95, df=1,69, P=0.12; pH, F=0.25, df=1,71, P=0.62). Moisture content of the O horizon was greater for non-buttressed trees than buttressed trees (38% ± 4.5 vs. 26% ± 2.9. ANOVA, F=4.85, df=1, P=0.003). O horizon respiration rates were similar between buttressed and non-buttressed trees (ANOVA, F=0.03, df=1,20, P=0.87).

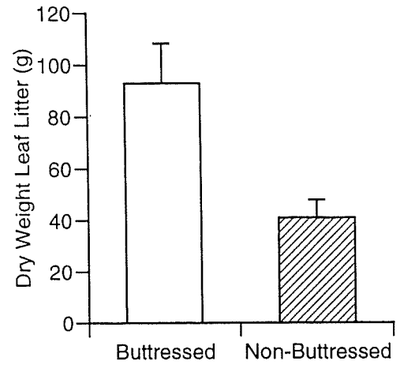

Fig. 2. Dry weight leaf litter in 0.11 m^2 quadrats 50 cm uphill from buttressed (n=6) and non-buttressed (n=6) trees at Estación Biologica Monteverde (Means+1 SE). (ANOVA, F=9.43, df=1,10, P=0.01).

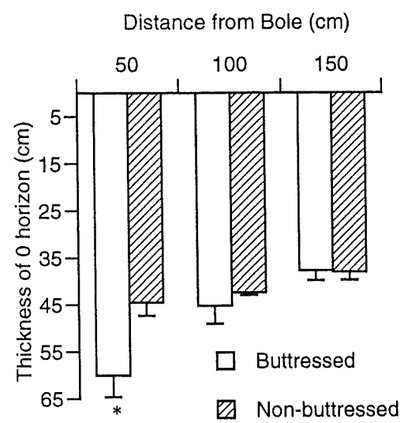

Fig. 3. O horizon thickness as a function of distance from the bole uphill from buttressed and non-buttressed trees at Estación Biologica Monteverde, Costa Rica (Means-1 SE). Asterisks indicate pairs that are significantly different (t-test, 50 cm, P=0.0007; >50 cm, P>0.50).

DISCUSSION

Buttresses clearly do collect organic matter on the uphill side of trees. The thickness and dry weight of the leaf litter under buttressed trees was almost twice as great as under unbuttressed trees. As well, the O horizon was significantly thicker under buttressed trees. However, these effects were localized to within 50 cm of the bole. Thus, buttressed trees may have better performance than non-buttressed trees in areas or times of low nutrient availability because they collect more organic matter than non-buttressed trees.

Respiration rate, pH and temperature were similar between the two types of trees, suggesting that buttresses do not alter the microhabitat for soil fauna. The cause of the greater moisture content of the O horizon at non-buttressed trees remains unclear.

Although buttresses do not affect the rate of decomposition, they do increase the nutrient supply rate by increasing the organic matter pool available to the tree.

LITERATURE CITED

Bansak, T. S., A. A. Blue, and C. R. Preuss. 1993. The relationship between tree buttressing and stresses due to wind and gravity. Pages 38-42 *in* J.L. Dudycha and A. B. Shabel, editors. Dartmouth Studies in Tropical Ecology. Hanover, NH. USA.

Carson, C. D., I. J. Stewart, and N. E. Perlroth. 1995. Why Buttress? The Litter Trap Theory. Carter D. Wray editor. Dartmouth Studies in Tropical Ecology. Hanover, NH. USA.

Henwood, K. 1973. A structural model of forces in buttressed rain forest trees. Biotropica 5: 83-93.

Richards, P. W. 1952. The Tropical Rainforest: An Ecological Study. Page 145 *in* D. H. Janzen editor. Costa Rican Natural History, University of Chicago Press, Chicago: 1983.