Forest Sciences

Prince Rupert Forest Region

Extension Note # 40
February, 2000

The Effect of Refuge Trees on a Paper Birch Ectomycorrhiza Community

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Introduction

Wildfires over interior forests of British Columbia are sometimes quite large, greater than 10,000 ha. in size, but rarely burn uniformly, usually leaving scattered live trees and small stands. These 'refuge' trees (also known as wildlife trees), are considered important habitat for vertebrates, insects, mosses, lichens and soil organisms. Ectomycorrhiza (ECM) communities are sensitive to disturbance, and large reductions in fungal richness and inocula have usually been found after forest harvesting. ECM colonization is thought to depend on hyphal contact for many fungal species, so refugia populations could be important for maintaining localized sources of ECM within large disturbed areas. The possible benefits of refuge trees were examined at the Date Creek research forest, where birch seedlings were examined for ectomycorrhiza both next to and away from mature birch trees in clearcuts and forests.

Methods

I used three replicated forested and clearcut sites, logged in 1992, positioned between 3 to 7 km apart. The forested sites had some tree removal, about 60% of the canopy, mostly in gaps of varying sizes.

Figure 1. Refuge birch trees in a clearcut.

Clearcuts were 12 to 25 ha in size, with approximately 1 paper birch refuge tree per ha. I located three single mature birch trees per site on mesic microsites, with three birch seedlings ('tree' treatment) located within 5 m of the tree. Three birch seedlings ('no tree' treatment) were also taken 25 to 50 m away from the mature tree, in roughly the same interspacing as the seedlings next to the refuge tree (5 to 10 m apart). In the forest, I chose seedlings on relatively undisturbed microsites within the partial-cut matrix, rather than in openings caused by logging. The undisturbed microsites had continuous moss cover, with none of the herbaceous growth that characterized more open, disturbed microsites. The 'no tree' forest seedlings were outside of root contact with birch trees, but were surrounded by western hemlock and western red cedar. The 'tree' forest seedlings were in root contact with birch trees along with western hemlock and western red cedar. The clearcuts were planted with lodgepole pine and hybrid white spruce, so 'no tree' and 'tree' clearcut seedlings were surrounded by young (6 years old) coniferous trees (root contact in clearcuts was likely minimal because of the small size and wide spacing of the planted white spruce and lodgepole pine). All birch seedlings selected were naturally regenerated, 2 to 4 years old, and approximately 20-30 cm tall.

I distinguished the different morphotypes by their macroscopic and microscopic characteristics, such as colour, shape, size, and texture of the root tip, as well as emanating elements, if present. The root tips were examined at 400X and 1000X magnification for characteristics of the mantle layers and emanating elements such as mantle type, ornamentation, cell contents, clamp frequency, and lengths and widths of hyphal cells.

Results

I found a total of 47 morphotypes on the birch seedlings, and the percent root colonization and frequency of occurrence by treatment is listed for most of the morphotypes (Table 1). Average morphotype richness was highest with refuge trees, with no significant difference between clearcuts and forests (Table 2). The decrease in richness for 'no tree' treatments was more pronounced in clearcuts than forests (38% decrease in clearcuts compared to 15% in the forest) . A total of 40 morphotypes were found in the clearcut/tree treatment, followed closely by 36 and 34 morphotypes for the forested treatments, and was lowest, at 23 morphotypes, for the clearcut/no tree combination. Seedlings next to refuge trees had significantly more diverse and more even distributions (Shannon-Wiener index) of ECM morphotypes than seedlings outside root contact.
Overall, the clearcut/no tree seedlings had the steepest species-importance curve, with one or two morphotypes relatively more abundant, typical of ECM communities in young forests (Figure 2). The refuge trees a had relatively more diverse and more even distribution of morphotypes, typical of ECM communities from mature forests.

Discussion

Refuge trees were effective in maintaining ECM communities, and seedlings next to refuge trees in clearcuts had similar levels of diversity and morphotype distributions as seedlings in forests. The results from the study also showed that patterns of ECM fungal disperal differed for the types we found. This dispersal of fungi, which tells us about patterns of succession after disturbance, demonstrated how ECM communities are well adapted to disturbances, at least in these small clearcuts.

For example, fungi such as *Thelephora terresteris* and ITE-2, were relatively more abundant and frequent away from refuge trees, which shows how they can spread quickly from spore inocula. Other fungi, such as *Leccinum scabrum*, #32, and #102, were less abundant and frequent away from refuge trees, which suggested that these fungi disperse more readily through hyphal contact than by spores or sclerotia. Lastly, some fungi, such as *Cenococcum geophilum*, and #70, were relatively equally abundant on seedlings, regardless of their position to refuge trees or disturbance.

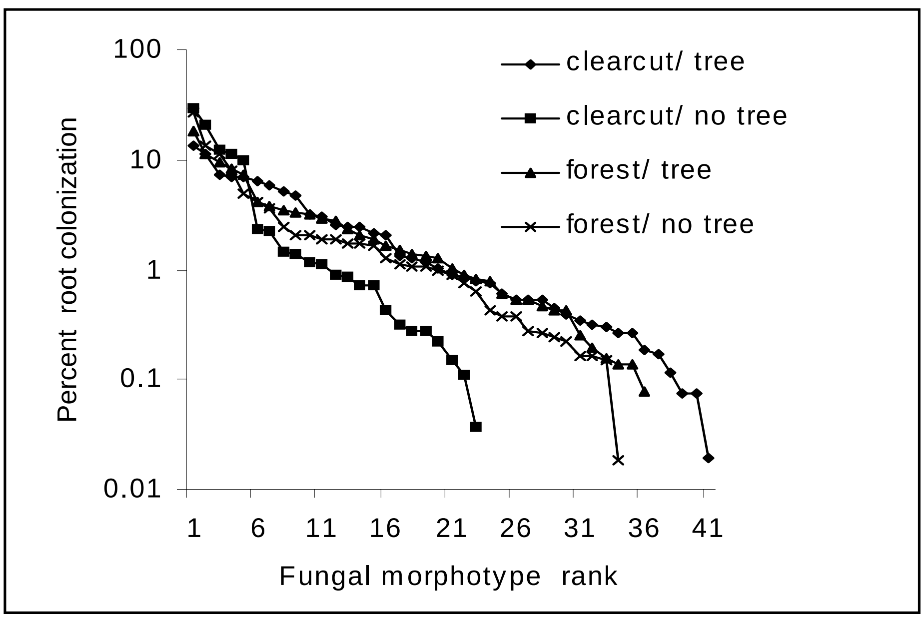

Figure 2. Species-importance curves for the morphotype communities by treatment combination (n = 27 for each curve).

Table 2. Average morphotype richness and evenness for ECM communities across treatment combinations (SE in brackets)

	Clearcut		Forest	
	Tree	No tree	Tree	No tree
Morph. richness	13.3 (0.5)a	8.3 (0.5)c	12.4 (0.5)a	10.6 (0.5)b
Shannon-Weiner	8.83 (0.4)a	5.55 (0.4)c	7.74 (0.4)ab	7.00 (0.4)b
Total morphotypes	40	23	36	34

* columns separated by letters within a row are significantly different ($p < 0.05$)

These were some fungi, such as #34, #62, and #110, that were not found on seedlings in clearcuts away from refuge trees. These types of fungi occupy a small proportion of root systems, but contribute many species to the overall community of ectomycorrhiza. The inability of these fungi to disperse initially across disturbances means they will establish only later in stand succession, perhaps after canopy closure. Refuge trees will play an important role in succession by maintaining small populations of these fungi that can then spread as the plantation matures.

When collecting the seedlings for this study, I noticed many species of mushrooms fruiting beside refuge trees in clearcuts. Perhaps refuge trees also play a role in disturbances as sources of spore inocula for fungi, rather than as only sources of root contact for ECM dispersal. The contribution of refuge trees to ecosystems would likely increase over larger disturbances with less proximity to intact forest, or with increasing extent of seral stands in the landscape. In either case, the supply of ECM inocula would likely decrease without refuge trees. The current British Columbia biodiversity guidelines, which outline targets for refuge tree density and diversity across varying scales of landscape disturbance, should facilitate the recovery of ECM communities after harvesting.

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Table 1. Root colonization (%) and frequency (%) of occurrence (in brackets) of morphotypes across treatments. Twenty-seven seedlings per treatment combination.

	Clearcut			Forest	
Morphotype	Tree	No tree		Tree	No tree
Thelephora terresteris	4.7 (22)	20.6 (70)		1.7 (11)	4.9 (19)
ITE-2	2.5 (19)	11.3 (49)		2.8 (15)	11.0 (70)
MRA	13.3 (67)	30.2 (96)		18.1 (89)	26.5 (89)
Cenococcum geophilum	11.0 (81)	12.5 (59)		9.6 (67)	13.7 (78)
#70 (*Russula*-like)	6.8 (26)	10.0 (22)		10.7 (37)	8.0 (22)
Leccinum scabrum	7.7 (33)	2.2 (15)		8.6 (33)	2.0 (7)
#32	7.3 (52)	1.4 (15)		3.5 (30)	1.0 (7)
#102	6.3 (33)	1.2 (4)		3.6 (19)	0.9 (11)
Lactarius glyciosmus	6.0 (33)	2.4 (15)		3.6 (22)	1.8 (7)
#90 (*Inocybe*-like)	2.4 (15)	0.9 (15)		4.3 (26)	4.1 (22)
#76 (*Russula*-like)	0	0		3.0 (19)	3.6 (15)
Piloderma fallax	0.1 (4)	0		1.8 (7)	1.3 (19)
#34	0.8 (7)	0		2.0 (15)	2.0 (15)
#62	0.9 (7)	0		1.4 (7)	2.4 (4)
#18	0.6 (4)	0.1 (4)		0.5 (7)	0.2 (4)
#44 (*Cortinarius*-like)	1.3 (11)	0.2 (7)		3.1 (22)	1.1 (7)
#14	1.3 (7)	1.5 (7)		0.8 (4)	0
#40	3.0 (19)	0		0.2 (7)	0.3 (7)
#42	2.0 (26)	0.9 (11)		1.3 (19)	0.8 (11)
#43	0.5 (11)	0.3 (7)		0.9 (19)	1.9 (11)
#104	0.4 (7)	0.7 (7)		0.4 (4)	0.4 (4)
#114	0.4 (7)	0.3 (7)		0.7 (11)	0.4 (4)
#54	2.1 (7)	1.1 (7)		0	0.1 (4)
#56	0	0.3 (4)		7.0 (19)	1.7 (4)
#110 (*Hebeloma*-like)	0.7 (4)	0		0.5 (7)	1.7 (7)
#51	0.4 (4)	0		2.2 (19)	1.1 (7)
#64	0.2 (4)	0		0.1 (4)	0.4 (4)
#71	2.4 (7)	0		0.2 (4)	0
#75	5.1 (11)	0		0.5 (7)	0.1 (4)
#93	3.1 (7)	0		0.8 (7)	0
#94	0.3 (4)	0		0.8 (4)	0
#111	0.6 (4)	0		1.0 (4)	1.9 (4)
#112	0.5 (11)	0		2.8 (19)	0.2 (7)
#16	0.3 (7)	0		0.2 (4)	0.2 (7)
#19	0.8 (4)	0		0	1.1 (7)
#41	0.2 (4)	0		0	0
#36	1.0 (7)	0		0	0
#77	0.3 (4)	0		0	0
#45	0	0		0.1 (4)	0
#46	0	0		1.2 (4)	0
#47	0	0.4 (4)		0	0.3 (4)
#92	0	0		0.4 (4)	0