Fungi in Burned and Unburned Chaparral Soils

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Abstract

Soil samples from a pine plantation and from chaparral before and after burning were studied to determine fungus populations and distribution. Of the 42 species groups of soil fungi recovered, more occurred under chapparral than in pine plantations, and flash burning had little effect on the populations recovered from disturbed soils.

Introduction

In 1964 a relatively small area in the chaparral at the southwest base of Mt. Shasta, Siskiyou Co., Calif. in the Shasta-Trinity National Forest, was planted with pine trees following crushing of the chaparral shrubs by bulldozer and flash-burning using back fires to control the blaze. A set of 40 samples of soil from the chaparral both before and after it was disturbed, from the disburbed area both before and after it was burned, and from a nearby pine grove planted in more laboriously cleared chaparral in 1937, was obtained in April, 1964.

The literature on the "ecological effects of forest fires" has been reviewed by Ahlgren and Ahlgren (1960). Their review includes 358 titles, which may be a nearly complete list of publications relating to this subject. In a section on the "effect of fire on living organisms", five papers are reviewed in a short paragraph on fungi. All of these articles refer to the larger fungi which produce obserbable fleshy, mushroomlike fruit bodies. The paragraph is concluded with the categorical statement: "no detailed studies of the effect of fire on the smaller, non-fleshy fungi were available".

Later, Ahlgren and Ahlgren (1965) studied the effect of fire on the smaller fungi. While no attempt was made to identify the organisms, plate counts of bacteria, streptomycetes, and fungi were obtained, and results compared with data on respiration studies. The effect of fire was an immediate reduction in microbial number, except for fungi. This was followed by a sharp increase in microbial activity after rains which occurred during the first growing season. The extent of these changes was altered by the intensity of the fire, rainfall, and the type of microorganisms involved.

Near, Wright and Bollen (1965) found that, on the basis of total counts on peptone-glocuse agar acidified to pH 4.0, following

autumn slash burning of various intensities and related to amounts of slash burned at any one point, numbers of colonies on plates were significantly reduced, in most instances. Variations occurred in relation to moisture qnd temperature.

Soils, Climate, and Habitat

The following data on soils and climatic conditions were furnished by J. W. Lachenmyer, Sacramento District, Shasta-Trinity National Forest. The soil series is Shasta loamy sand, varying in depth from one to three feet with an average of two feet. This soil is derived from andesite lava. The pH averages 6.5. The elevation of the area in which the burn took place is 4,500 to 4,800 feet above sea level, with a slope of 10 to 20% facing west. Precipitation at the nearest weather recording station, Mount Shasta, averages 38 inches per year, most of which is received between October and May. The shrub species in this chaparral stand were: *Arctostaphylos patula* (approximately 75%), *Ceanothus velutinus, Castanopsis sempervirens, Prunus subcordata, P. emarginata, Ceanothus prostratus,* and *Amelanchier pallida.*

Methods

Grab samples of soils were obtained using new plastic snap-cap 16-dram vials, with care not to contaiminate the soil of one horizon with that of another. The vials were shipped from Cincinnati to Mount Shasta and return by parcel post.

In the undisturbed chaparral, and in a plantation of *Pinus ponderosa* planted in chaparral in about 1937, pairs of samples were obtained of litter, and of soils at the 0- to 2,- 2- to 6-, and 6- to 12-inch levels. Samples from the area to be burned were collected the day of the burn, and the day after the burn, at the three levels mentioned above. The flash burn of 44 acres, controlled by a backfire, of bulldozer crushed chaparral shrubs, took place at about 5: 00 P. M., April 28, 1964.

In the laboratory, all samples were diluted by adding 15 ml. soil or litter to 135 ml distilled water with shaking at 150 oscillations per minute on a rotary shaker for a half hour. Then 1 : 1000 dilutions using distilled water were poured using neopeptone-dextrose-rose bengal-Aureomycin agar. Plates were incubated at room conditions of temperature and light for seven days, after which fungal colonies were counted and inventoried. Unknown colonies were held on neopeptone-dextrose agar slants until identifications could be completed.

Oven-dried weights of duplicate soil and litter samples were obtained and used to correct colony numbers to a dry weight basis.

Results

Corrected estimated average number of fungal colonies for each sample are given in Table 1. A list (Table 2) of 42 categories of filamentous fungi and yeasts was obtained. Some of these categories include unknown species in a genus as well as unknown filamentous fungi or yeasts. Of the 42 categories, 19 species appeared in only one habitat of the 14 which were sampled, while two species, *Penicillium janthinellum* and *P. lilacinum*, appeared in all 14. One species was confined to the litter layer, which is usually very thin; 10 species were confined to the 0- to 2-inch layer of soil, two species to the 2- to 6-inch layer, and seven species to the 6- to 12-inch layer. The confinement may be artificial since a certain amount of mixing took place in preparing the chaparral for the flash burning procedure. One species, *Thysanophora striatospora* Barron & Cooke, was described as new to science from the litter in the older pine plantation.

Discussion

Of the fungi isolated from this set of samples, 27 species came from undisturbed chaparral sites while only 20 species came from the pine plantations. Possibly this reflects the diversity of plant species in the chaparral in contrast with the single dominant species in the pine plantations. However, a larger number of colonies was found under the pines, which may indicate a more moist soil and greater activity, resulting in larger amounts of food supplies. Since there was no indication that the soil came from near the roots of the pine trees, nothing can be said about the possibility of greater amounts of rhizosphere activities. In the disturbed areas, where the thin layer of chapparral litter became mixed with the soil in the crushing operation, 22 species of fungi were isolated before the burn and 21 species after the burn. There was a decline in the number of colonies of fungi present in the surface soil, while at lower depths there was a slight increase in colony numbers after the burn. It cannot be determined whether this reflects a response to the temporary heating of the soil which could activate spore germination in the presence of adequate nutrients, or whether it is related to different sampling locations, even though the difference may be only a few feet.

Apparently the chaparral burning practices used have little effect on the soil fungus populations present, as demonstrated by samples tested from the experimental area described above. Neither numbers of colonies nor numbers of species were significantly affected by this type of heat treatment.

References

Ahlgren, I. F. and C. E. Ahlgren, 1960: Ecological effects of forest fires. The Botanical Review 26: 483—533.

Ahlgren, I. F. and C. E. Ahlgren, 1965: Effects of prescribed burning on soil microorganisms in a Minnesota jack pine forest. Ecology 46: 304—310.

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Table 1. Numbers of Fungi at various levels and in differnt habitats

Location	Number of Replicates	Number*) of colonies per gram dry weight Soil layer			
		Litter	0—2″	2″—6″	6″—12″
Undisturbed chaparral	2	58.5	19.0	20.0	16.0
Pine plantation	2	59.5	27.5	11.4	8.4
Disturbed area before burning	4		32.5	11.9	5.3**)
Disturbed area after burning	4		20.4	12.6	7.8

*) All values times 10^4.
**) One of the four samples lost.

Table 2. Distribution of Fungus Species in Varying Habitats and Soil Depths

Species	Depth and Habitat													
	L**		0—2″				2—6″				6—12″			
	P***C P≠U	P U	P	C C	B	P	U	C	B	P	C U	C	B
Penicillium janthinellum Biourge	* *	* *	*	* *	*	*	*	*	*	*	*	*	*
Penicillium lilacinum Thom	* *	* *	*	* *	*	*	*	*	*	*	*	*	*
Aspergillus sp.	* *	*	*	* *	*	*	*	*	*	*	*	*	*
Unidentified molds	* *	*	*	* *	*	*	*	*	*	*	*	*	
Penicillium spp.	* *	*		* *	*	*	*	*	*	*	*	*	*
Leptographium spp.	* *	* *	*	* *	*	*		*	*	*		*	*
Aspergillus niger van Tieghem	* *			* *	*		*	*	*		*	*	*
Mucor spp.	* *	* *	*	*		*		*	*			*	*
Trichoderma viride Pers. ex Fr. sensu lato	* *	* *	*	*		*	*	*				*	
Rhizopus spp.			*			*	*	*	*				*
Absidia spinosa Lendner		*					*	*	*		*		*
Fusarium spp.	* *			*				*			*		
Aspergillus flavus Link	*	*							*	*			*
Phialocephala dimorphospora Kendrick	*	*	*	*									
Rhinocladiella mansonii (Castellani) Schol-Schwarz	*	*				*					*		
Aspergillus fumigatus Fresenius			*		*		*		*				
Penicillium nigricans (Bainier) Thom			*	*				*	*				
Unidentified white yeasts				*			*				*	*	

	Depth and Habitat												
	L**		0–2″			2–6″				6–12″			
	P***C	P		C		P		C		P		C	
Species	P≠U	P	U	C	B	P	U	C	B	P	U	C	B
Aspergillus versicolor (Vuillemin) Tirobashi	*		*								*		
Aspergillus sydowii (Bainier & Sartory) Thom & Church						*				*			*
Aureobasidium pullulans (de Bary) Arnaud	*			*									
Cephalosporium sp.					*							*	
Scopulariopsis canadensis Morton & Smith										*	*		
Thysanophore striatospora Barron & W. B. Cooke	*												
Monodictys laevis (Wiltshire) Hughes			*										
Penicillium herquei Bainier & Sartory			*										
Scopulariopsis brevicaulis Bainier			*										
Ulocladium sp.			*										
Cladosporium herbarum (Persoon) Link		*											
Curvularia geniculata (Tracey & Earle) Boedijn				*									
Curvularia lunata (Wakker) Boedijn					*								
Gilmaniella humicola Barron											*		
Paecilomyces sp.					*								
Rhodotorula sp.					*								
Roselinia arctispora (Ell. & Ev.) Ell. & Ev.					*								
Paecilomyces varioti Bainier							*						
Penicillium commune Thom									*				
Gliocladium deliquescens Sopp										*			
Gliomastix murorum (Corda) Hughes var. *felina* (March.) Hughes													*
Penicillium kapuscinskii Zaleski										*			
Penicillium ochrochloron Biourge										*			
Periconia sp.										*			

* Indicates presence of listed species.
**: L — Litter
***: P — Pine plantation
***: C — Chaparral
≠ : U — Undisturbed chaparral
≠ : C — Crushed chaparral area
≠ : B — Burned chaparral area