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INTERNAL REPORT 135

TERRESTRIAL DECOMPOSITION: A SYNOPSIS

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During Biome 2 (1972) our primary objective was to estimate frequency and distribution of major fungal populations. A secondary objective was the development of a decomposition model suitable for integrating and directing decomposer research. A position paper defining and reviewing the decomposition process submitted by R. Fogel for the fall Watershed 10 modeling effort was used by Mary Ann Strand and Chuck Grier in developing such a first generation decomposition model. A formal presentation of the decomposition model was made at the PNW Science Meeting on March, 1973.

FUNGAL POPULATION STUDY AREA

The study area was adjacent to Reference Stand 2 on the H. J. Andrews Experimental Forest. This stand has been defined by Dyrness and Hawk (1972) as a Tshe/Rhma/Bene type. The overstory consisted of 450-year-old Pseudotsuga menziesii and 150-year-old or younger Tsuga heterophylla with a poorly developed Rhododendron macrophyllum and Berberis nervosa understory. The intermittent herbaceous layer consisted mainly of moss, Viola sempervirens, and Linnaea borealis. Elevation was ca 2100 ft (640 m), aspect north, and topography concave. The sides and upper edge of the area had shallow (less than 1 m deep) soils with many stones. Soil at the lower edge of the area was finer textured and relatively free of large stones.

METHODS AND RESULTS

Gravimetric soil moisture of A_o and F layers was determined after drying soil samples at 60°C for 60 hours (Fig. 1). The soil moisture samples were collected whenever the stand was visited, usually weekly or biweekly. The moisture content of three 1-m-deep profiles was also measured during May, August, and November (Table 1). This information has been keypunched and filed with the Oregon Data Bank. A few moisture measurements for logs in various stages of decay have also been filed. During maximum moisture stress, logs in certain decay stages were perched water tables containing up to 70% water by wt. Air temperature and soil temperature at 20 cm was also obtained from Don Zobel.

Floristic composition, litter depth, and epigeous sporocarp production on Reference Stand 2 were examined by constructing a 20 x 30 m grid subdivided into 10 m^2 quadrats then 2 m square subplots. Percent-cover maps of over- and understory stems, herbs, mosses, logs, and forest floor depth classes were then constructed. Cover by wood decay classes (Table 2) is presented in Table 3. Total cover including standing dead was 22.2%, with a generally direct relationship between cover and stage of decay, i.e. Class 1

(1.16%) to Class 5 (9.81%). The percent cover values for log Classes 2 and 1 (3.12% total) agree very well with the 4.06% figure obtained by cutting out logs outlined on the Watershed 10 stem map and comparing their weight to the weight of the complete stem map.

Forest floor standing crop, excluding large woody litter, was estimated to be 55.65 MT ha^{-1} (Table 4) by multiplying surface area of a litter depth class by its biomass. Such a calculation neglects the heterogeneous composition of the forest floor demonstrated by Table 5 and enormous variations in depth centered around large Douglas-fir boles (Fig. 2).

Preliminary measurements of log nutrient content are given in Table 6. The well-known examples of nitrogen accumulation and an increase in lignin content in the later stages of decay occured (Alexander, 1961).

Expressing weight loss by the parameter k, defined for continuous litter fall as input divided by standing crop, the value for total litter excluding large woody litter would be 0.11 (Olson, 1963). Respective turnover time (1/k) was 9.09 years. Kendrick's (1959) analysis gave an independent but similar residence time estimate of 11.1 years for Douglas-fir needles. The k value for total litter is less than half that of the Thompson Research Site (Washington) (k=0.27) which indicates that decomposition may be much slower in Reference Stand 2 than at the Thompson Site (Edmonds, 1972).

More than 3321 epigeous fungal sporocarps were collected on the grid (55361 ha^{-1}) of which 356 (5935 ha^{-1}) were produced by suspected mycorrhiza forming fungi. Translated into biomass, production totaled 4.9 kg ha^{-1} yr^{-1} including 3.87 kg ha^{-1} yr^{-1} for fruiting bodies of probable mycorrhizal fungi.

A number of other estimates were obtained by using various excavation methods. From 10 cm^3 soil samples, it was estimated that the standing crop of Cenococcum graniforme sclerotia was 148-209.2 kg dry wt ha^{-1}, root biomass (<1 cm diam) 1.53-1.98 MT $_{-1}$ dry wt ha^{-1} excluding mycorrhizae, and 5.15 to 5.42 MT dry wt ha^{-1} for ectotrophic mycorrhizae in the top 10 cm of soil.

Excavation of 50 x 25 cm soil monoliths 100 cm deep provided additional information. Hyphal biomass of soil fungi was preliminarily estimated to be 4.04 MT dry wt ha^{-1} using the Jones and Mollison (1948) slide technique. Colonization of rose bengal soil tubes by

fungi was also studied by Earl Nelson, Forestry Sciences Laboratory---Corvallis. Root biomass was 41.11 MT ha^{-1} excluding roots less than 0.5 mm in diameter. Most of the root biomass was represented by the larger roots since there was only 7.92 MT ha^{-1} of roots ranging in size from 0.5 to 5 mm.

PROPOSED RESEARCH

During 1973 some research projects started during Biome 2 will be further expanded, and studies felt to be more pertinent to analysis and testing of the first generation decomposition model will be added.

A large litter bag study to determine weight loss and changes in nutrient content with time will be done in cooperation with Kermit Cromack. Three vegetation types, ranging from Cash to Tshe/Pomu, and four substrates, conifer needles, bark, twigs, and female Douglas-fir cones, will be used in this study. John Turner's litter bag study on the Thompson site and our study will permit comparison of the Andrews with the Thompson site for decomposition rates.

Forest floor moisture content will be measured gravimetrically at two week intervals; predictions of litter temperature based on litter moisture and ambient air temperature will be attempted. The environmental data will be used in conjunction with litter bag data to test the decomposition model and hopefully develop a second generation model. The environmental data should also be useful in designing certain compartments in the hydrological model.

If time allows, nitrogen fixation in the forest floor and log interiors will be studied in cooperation with K. Cromack using the acetylene reduction technique. A more accurate estimate of log standing crop will be made this year due to the potential size of the log nutrient pool. Samples of various log decay classes will be submitted to the central laboratory at Corvallis for chemical analysis after determination of moisture content. Subsamples will also be tested for lignin and cellulose content by Jim Sedell's group.

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TABLE 1. Gravimetric soil moisture for Reference Stand 2. Oven dried at 60° C for 60 hours.

1972 Date	15V	16V	18V	16VIII	17VIII	21VIII	14XI	15XI	15XI
Depth									
L	60.8	63.8	68.2	27.1	62.9	40.9	70.7	64.8	68.2
F	58.3	62.0	63.9	21.2	44.2	42.4	63.2	64.3	59.8
0-5 cm	29.9	23.5	27.3	13.4	21.5	18.8	29.2	30.7	29.0
5-10		22.3	25.4	14.9	16.6	17.9	29.8	25.6	25.2
10-15		21.3	24.0	14.6	21.3	19.7	29.1	24.3	25.0
15-20		21.6	22.9	14.3	22.3	21.0	29.3	23.7	26.2
20-25		22.4	23.7	17.6	23.5	22.9	30.5	24.3	27.5
25-30			21.2	24.9	23.3	23.6	30.7	25.4	27.9
30-35				19.2	22.9	23.2	29.9	27.3	28.2
35-40				20.4	22.5	23.8	29.6	28.4	27.1
40-45				21.5	23.9	24.2	30.9	29.6	27.8
45-50	28.2	26.9	23.8	22.1	24.8	25.2	30.1	30.5	27.0
50-55				22.3	23.1	24.8	32.6	29.8	27.2
55-60				22.6	25.6	25.6	31.1	29.2	27.1
60-65				23.3	26.4	26.0	30.1	29.4	27.5
65-70					27.2	27.2	30.9	30.7	28.5
70-75				24.2	27.8	27.4	30.7	30.6	28.7
75-80				23.8	28.6	27.9	31.7	29.9	29.3
80-85				24.1	28.9	28.9	31.0	28.3	28.9
85-90				23.4	29.4	29.3	31.7	28.3	30.3
90-95				23.5	28.4	29.5	31.6	28.3	30.2
95-100	28.4	30.7	33.1	22.8	30.0	30.2	31.7	24.8	31.0

Table 2. Decay classification of Douglas-fir (*Pseudotsuga menziesii*) logs.

	CLASS				
	5	4	3	2	1
Bark	absent	absent	trace	intact	intact
Twigs <3 cm	absent	absent	absent	absent	present
Specific gravity	0.046	0.222	0.420	------	0.474
Texture	soft, powdery	soft, small blocky pieces	hard, large pieces	intact, partly soft	intact
Color of wood	red-brown to dark brown	reddish or light brown	reddish brown or original color	original color	original color
Epiphytes	*Vaccinium*, moss, Tshe seedlings	*Vaccinium*, moss, Tshe seedlings	conifer seedlings	none	none
Invading roots	*Tsuga* and shrub, some large	*Tsuga* and shrub smaller	conifer seedlings	none	none
Fungi fruiting	*Cortinarius* *Collybia*, *Cantharellus*	*Cortinarius*, *Mycena*, *Marasmius*	*Polyporus*, *Polyporellus*, *Pseudohydnum*, *Fomes*	*Cyathus*, *Tremella* *Mycena*, *Collybia*, *Polyporus* *Fomes*, *Pseudohydnum*	Similar to Class 4.

Table 3. Surface area (5) covered by various substrates on Reference Stand 2.

	Stage of log decay					Standing	Total dead	Live	
Plot	5	4	3	2	1	dead		stems	Total
1	3.95	1.04	1.67	0.83	0.21	0.05	7.75	2.92	10.67
2	11.50	8.76	2.79	1.33	0.38	0.85	25.60	0.53	26.13
3	7.10	3.30	4.75	1.95	0.25	0.06	17.41	0.41	17.82
4	17.18	0.28	0.68	3.58	1.36	3.32	26.40	0.68	27.08
5	11.15	4.22	0.00	1.77	4.56	0.40	22.10	2.68	24.78
6	7.96	6.04	14.56	2.28	0.20	2.28	33.86	1.36	35.22
Mean %	9.81	3.94	4.08	1.96	1.16	1.25	22.19	1.43	23.62

Table 4. Dry weight of forest floor on Reference Stand 2.

Depth class	% cover	$m^2\ ha^{-1}$	$kg\ m^{-2}$	$MT\ ha^{-1}$
0 to 25 mm	21.3	2130	3.54	7.54
25 to 50	56.2	5620	5.60	31.47
50 to 75	18.0	1800	7.60	13.68
75 to 100	1.8	180	10.40	1.87
100 to	0.7	70	16.00	1.09

TABLE 5. Composition of 0.25 m^2 forest floor sample from Reference Stand 2.

L-Layer	g dry wt	% total layer wt
Psme & Tshe needles	218.5	38.7
Thpl leaves	3.1	0.6
Gash leaves	3.8	0.7
Lichens	0.6	0.1
Cones		
♀ Psme (11 total)	40.3	7.1
♂ Psme	0.2	0.04
♀ Tshe (6)	1.9	0.3
♀ Thpl (1)	0.3	0.05
Twigs with bark		
>3 mm diam	149.1	26.4
<3 mm	36.4	6.4
Twigs minus bark		
>3 mm diam	74.8	13.2
<3 mm	2.4	0.41
Bark	3.8	0.7
Unidentifiable	29.9	5.3
Total	565.1	100.0
F-Layer		
Needles	38.4	10.9
Twigs minus bark	12.0	3.4
Cones and scales	7.4	2.1
Bark	35.9	10.2
Wood fragments	24.3	6.9
Fine roots	7.4	2.1
Stones	101.3	28.8
Unidentifiable	125.2	35.6
Total	351.9	100.0

Table 6. Log nutrient content

Log class	percent				ppm			
	P	N	cellulose	lignin	Na	K	Ca	Mg
5	0.0189	0.34	18.45	81.54	102.5	61.3	2070.3	424.5
4	0.0052	0.19	30.15	70.44	41.0	*	573.0	294.0
3	*	0.07	56.65	43.46	22.7	*	268.7	33.0
2	*	0.04	60.28	39.71	10.0	*	882.5	71.5
2	0.0027	0.16	ND	ND	30.5	*	3567.0	92.0
1	ND	ND	63.30	36.70	ND	ND	ND	ND

* below detection

FIG. 1. SOIL MOISTURE ON REFERENCE STAND 2, H. J. ANDREWS. DRIED AT 60° C.

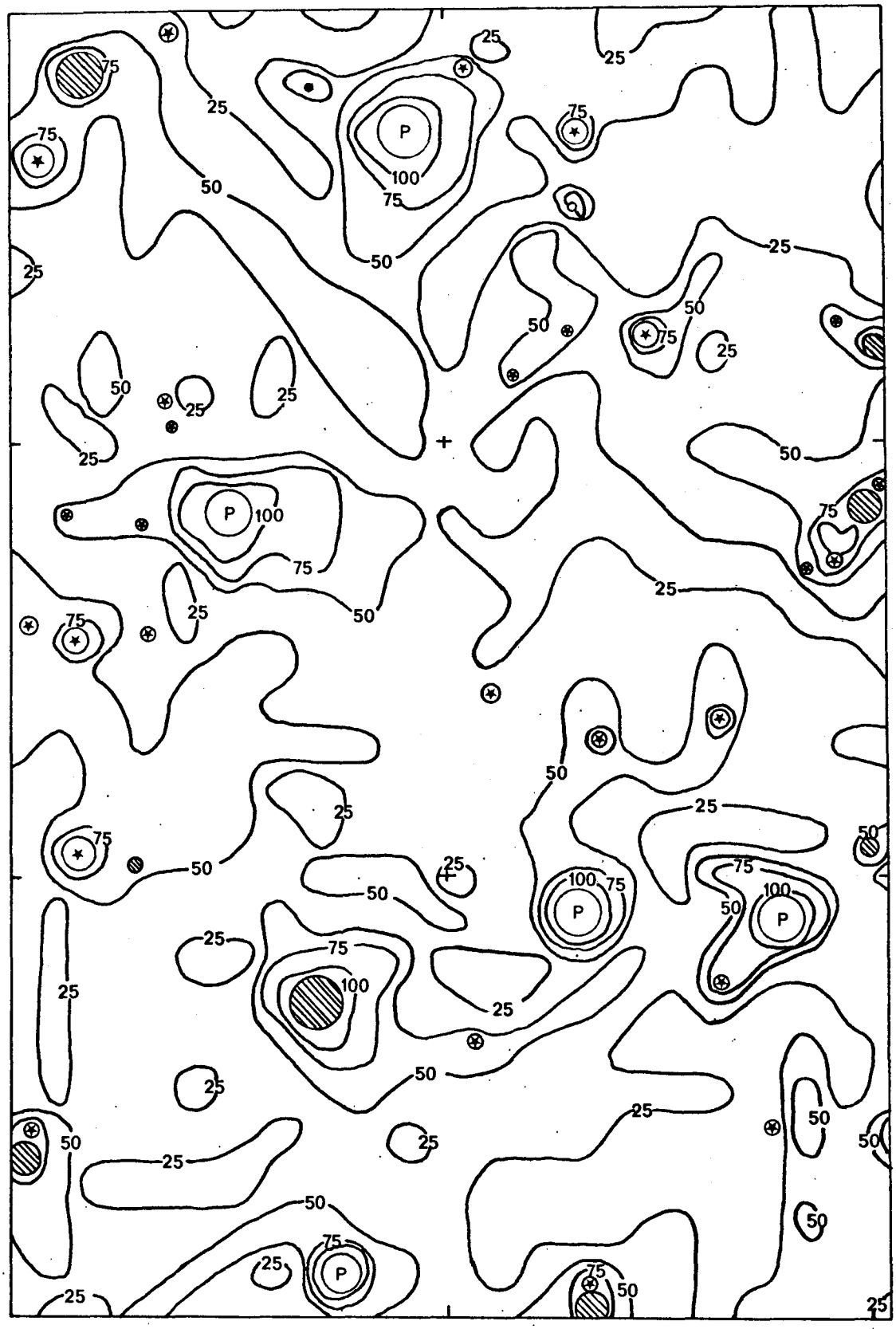

FIG. 2. Distribution of forest floor by depth class: 0-25 mm, 25-50, 50-75, 75-100, 100+. (P) Psme, (*) Tshe, (▨) standing dead. 20 x 30 m area on Reference Stand 2.