PALEOECOLOGY OF A PEAT DEPOSIT IN EAST CENTRAL WASHINGTON

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Introduction

The semi-arid climate of east central Washington during the post-Pleistocene has apparently limited the amount of hydrarch succession and the resultant deposition of organic sediments suitable for pollen analyses. The Wisconsin ice of the Pleistocene glaciation extended between 16 and 20 miles south and southwest of Spokane (Flint, 1937). This represents only a slight encroachment upont he Columbia Plateau. During glacial retreat, the great volume of meltwater flowed away from the ice front in a general southwesterly direction, in both preglacial and proglacial channels, and possibly in sheet floods

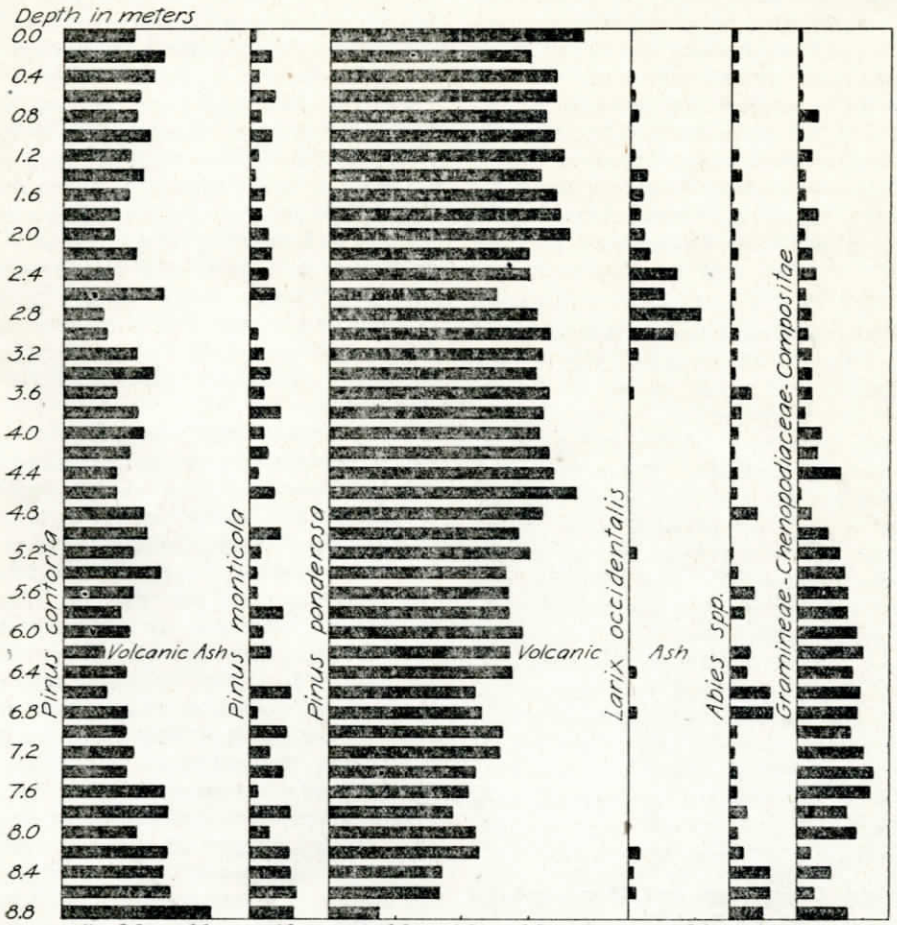

Fig. 1. Pollen Profiles. Cheney, Washington.

(Bretz, 1923). This glacio-fluvial action resulted in the formation of the peculiar land form known as the channeled scablands. The scabland tracts vary in size from preglacial valleys to strips 10 to 20 miles wide, in which the Palouse soil has been entirely removed from the basalt. A vast network of anastomosing channels has been cut in the basalt. These channels are known as coulees and may be dry or carry permanent or intermittent streams. Rock basins are of frequent occurrence and lakes are present in many of them. In former stream channels ponding of water by various types of glacio-fluvial deposits has also taken place. Quarrying and plucking of basalt at the base of rapids and falls formed plunge basins, many of which retain standing water which has supported limited hydrarch plant succession. The linear arrangement of lakes indicates the pattern of the former stream drainage.

Many of these lakes, of various genesis, support hydroseres of sedge, cattail, bulrush, and other types of swamp plants. Some of the more shallow ponds have been entirely filled by organic sedimentation. These sediments are often of a mucky character, and microscopic examination has shown them to contain little or no pollen. Some of the lakes are alkaline, and peat-forming plants have been largely absent. Still other lakes, especially those formed in rock basins, have vertical shores composed of columnar basalt, and the water is too deep to permit the rooted swamp plants to invade. It is fortunate, therefore, that a deep peat deposit was located at the northern margin of Fish Lake, about 3 miles northeast of Cheney, Washington.

Origin, Chronology, and Characteristics of the Peat Deposit

Fish Lake was apparently ponded in a plunge basin at the south base of rapids in a drainage channel of the Wisconsin glacier. This channel was previously occupied by an ice-tongue which coalesced with others upon the scabland to the south between Cheney and Spangle. As the ice retreated from the Fish Lake channel, an outwash plain was formed, sloping southward into the Fish Lake basin. It is this gradual shore profile that has enabled hydrarch plant succession to reach a stage where a stratum of peat 8.8 meters in depth accumulated. The other shores of Fish Lake are rather precipitous and unfavorable for advanced stages of hydrarch succession. The unevenness of the bottom underlying the peat is shown by the occurrence of rock ledges at different levels, encountered in boring for peat samples. The ponding of Fish Lake in a basin occupied by Wisconsin ice, and later used by meltwater draining from that glacier, dates the sediments as being post-Wisconsin. It is not possible to estimate the amount of time that elapsed between glacial retreat and the origin of the sediments. The considerable depth of the peat, accumulated under dry climatic conditions, however, suggests that a major portion of postglacial time is here represented.

Peat samples were obtained at 2-decimeter intervals with a Hiller peat borer. The peat is underlain with glacial gravel resting upon bedrock basalt. The lowest level of pollen-bearing sediments is composed of fine silt, grading upward into clay. The clay in turn is succeeded by sedimentary peat, which grades into fibrous peat at 3.2 meters, the latter being present to the surface. A considerable amount of Gastropod marl is present from 6.0 to 3.2 meters. A stratum of volcanic ash is present at 6.2 meters, and glass fragments range above and below for several levels. Layers of volcanic ash, probably synchronous in origin and of the same source, are present in all bogs that have been sampled in this area. A bog at Newman Lake, about 20 miles east of Spokane, one in northern Idaho a few miles west of Priest Lake, another in northern Idaho near Bonners Ferry, and others in northeastern

Washington all contain a single layer of ash. The stratigraphic position of the ash in each case is proportionate in its position in the peat deposit. That this ash had its origin from the same volcanic activity is very probable, and it serves as a valuable chronological correlator in the several bogs of the region. The fibrous peat is composed of Hypnum moss, sedge, cattail, water smartweed, pondweed, pond lily, and plants of the submerged hydrosere. In the preparation of the peat for microscopic examination, the potassium hydrate method was used. In order to remove the crystals of calcium carbonate from the Gastropod marl, a few drops of nitric acid were added, while to remove excess volcanic glass, a weak solution of hydroflouric acid was added. This facilitated easier and more accurate pollen identification. From 100 to 200 pollen grains were identified from each horizon. In the separation of pine pollen, the size range method was used. No attempt was made to separate the fir pollen, although in the lower levels almost 100 per cent consisted of the smallest of the fir pollen; namely, alpine fir **(Abies lasiocarpa).**

Vegetation in Adjacent Areas

Fish Lake lies within but near the edge of the timbered Arid Transition life area (Piper, 1906). This area does not generally extend south of the Spokane and Columbia Rivers, but a small peninsula of it projects southwest of the city of Spokane for a distance of about 25 miles. The most important arboreal species in this timbered peninsula is western yellow pine **(Pinus ponderosa).** This species is one of the most xerophytic conifers of Pacific Northwest forests, and ranges farther down and out upon the Columbia Plateau than any other species. Farther north, lodgepole pine may be abundant, especially on the terraces along the Spokane River. As the elevation increases to the north and east, Douglas fir **(Pseudotsuga taxifolia)** and western larch **(Larix occidentalis)** become abundant, while continued increase in altitude provides favorable conditions for western hemlock **(Tsuga heterophylla),** western red cedar **(Thuja plicata),** lowland white fir **(Abies grandis),** and western white pine **(Pinus monticola).** The highest forests are composed largely of Engelmann spruce **(Picea engelmanni)** and alpine fir. The last two groups have not been abundant within range of pollen dispersal to the site of the sediments during post-Pleistocene time. The peninsula of the timbered arid Transition, forested largely with yellow pine, is bordered to the east, south, and west with the timberless Arid Transition. This area supports the "Palouse" or bunchgrass prairie, the principal species of which are **Agropyron spicatum, Koeleria cristata, Festuca idahoensis, Poa secunda, Stipa columbiana, Balsamorhiza sagittata, Wyethia amplexicaulis,** and various species of Lupinus, Astragalus, and Lomatium. Many other species of forbs and grasses are present. About 20 miles to the west of the timbered Arid Transition, beyond the bunchgrass prairie, lies the eastern border of the principal body of the Upper Sonoran life area in Washington. One of the most conspicuous plants of this zone is sagebrush **(Artemisia tridentata).** Other characteristic shrubs are antelope brush **(Purshia tridentata),** rabbit brush **(Chrysothamnus nauseosus** and **C. viscidiflorus),** wingscale **(Atriplex canescens),** hop-sage **(Grayia spinosa),** winterfat **(Eurotia lanata),** squaw currant **(Ribes cereum),** serviceberry **(Amelanchier utahensis),** horsebrush **(Tetradymia canescens),** and grease-wood **(Sarcobatus vermiculatus).** Herbaceous plants include silver saltbush **(Atriplex argentea),** poverty-weed **(Iva axillaris),** seepweed **(Suaeda depressa),** sage **(Artemisia dracunculoides),** Russian thistle **(Salsola pestifer),** and several species of Eriogonum, Erigeron, and Penstemon. In addition there are many grasses common in the Upper Sonoran life area. There are few species of trees in this zone, but an occasional specimen of white alder

(Alnus rhombifolia), peachleaf willow **(Salix amydaloides),** and hackberry **(Celtis douglasii).** The names of the more common plants are mentioned so as to indicate the possible sources of the pollen preserved in the peat.

Daubenmire (1942) classifies the area between the peninsula of yellow pine, in which the site of the sediments lies, and the higher elevations to the east as the Festuca-Agropyron association, the area to the west as the Artemisia-Agropyron association, and that to the south has the Agropryon-Poa association. The Upper Sonoran and timberless Arid Transition in Washington are included in the grassland climax by Clements (Weaver and Clements, 1938). Halophytic communities of greasewood and its associates are present in alkaline areas, on the poorly-drained, flat coulee floors where intermittent inundation and evaporation brings the alkali of the residual basalt to the surface. The mean annual precipitation at Cheney, the nearest station to Fish Lake, is almost 17 inches. The precipitation decreases west and south toward the Upper Sonoran area, while it increases north and east as the elevation increases. The site of the sediments lies within a climatic province designated as subhumid, microthermal, with adequate precipitation at all seasons (Thornthwaite, 1931). It is located extremely near the border of this province, however, with the adjacent province to the west classified as subhumid, microthermal, with inadequate precipitation at all seasons. The direction of the prevailing wind is from the southwest, but this apparently has had little influence in increasing the amount of grass, composite, and chenopod pollen in the peat profile, in spite of the fact that the regions to the southwest are predominantly covered with species of these families of plants.

Postglacial Plant Succession

The most abundantly represented species at the bottom of the profile is lodgepole pine, with a proportion of 44 per cent of the pollen present (Fig. 1). Lodgepole is usually the predominantly recorded species in the lowest horizons of Pacific Northwest peat bogs, but often with much greater proportions. In some cases it is recorded to almost 90 per cent. Western yellow and western white pine show 15 and 13 per cent respectively in the lowest level, while the total of grasses, composites, and chenopods is also 15 per cent for this level. Other conifers represented at the bottom are mountain hemlock **(Tsuga mertensiana)** with 3 per cent, and alpine fir with 1[0] per cent. The latter probably came from higher elevations to the north and east. From its maximum of 44 per cent at the bottom, lodgepole pine decreases to its lowest proportion of the profile of 12 per cent at 6.2 meters. It then fluctuates between 12 and 35 per cent to the surface. Western yellow pine shows a general and gradual increase from its minimum at the lowest level to the surface, where it is recorded to its maximum of 76 per cent. White pine declines from its maximum of 13 per cent at the bottom to nothing at 6.4 meters, from which level it fluctuates between this and 10 per cent to the surface. Grasses, composites, and chenopods decrease from the bottom to 4 per cent at 8.2 meters, then show an increase to their maximum of 23 per cent at 7.4 meters. They then decline gradually to only 1 per cent at 4.6 meters, from which level they are recorded to low proportions upward to the surface. The greatest proportions of fir are in the lower third of the profile, although this genus is represented at most horizons to the surface, where it shows 1 per cent. Western larch, which is not represented in the lower level of the profile makes its appearance at 8.6 meters with 2 per cent. This species is sporadically and sparsely represented upward to 3 meters, where it attains a proportion of 13 per cent. At the next higher level it is recorded to its maximum of 21 per cent, and then it gradually declines to 1 per cent at 1.2 meters, from which level it remains insignificant to the top. Other

conifers represented sporadically and in small proportions throughout the profile are Douglas fir, western hemlock, mountain hemlock, and Engelmann spruce. The pollen of these species probably drifted from higher elevations to the north and east of the accumulating sediments. Non-coniferous species represented by varying amounts of pollen are alder, birch, maple, sedge, cattail, and water lily. None of these groups or species are represented by significant quantities of pollen.

Interpretations of the Pollen Profiles

The comparatively low proportions of lodgepole pine in the lower levels of the profile suggest that the environmental conditions brought about by glacial retreat were not so unfavorable to western yellow pine as in regions to the north farther within the glaciated region. In a bog at Newman Lake, 20 miles east of Spokane, pollen of yellow pine was absent in the lower two horizons, but after making its appearance gained gradually to predominance upward in the profile (Hansen, 1939a). In a montane peat deposit at Boneparte Lake, in the Okanogan highlands of north central Washington, yellow pine likewise was not represented in the lowest level, but gradually gained predominance as post-Pleistocene time progressed (Hansen, 1940). Both of these bogs lie within the yellow pine forests. In northern Idaho, lodgepole was predominant early in postglacial time, but surrendered its position to white pine and larch in the upper part of the profile (Hansen, 1939a). Even in a bog located in the Upper Sonoran life area, far removed from present day forests, lodgepole was predominant in the lower levels, suggesting that glaciation to the north and west had afforded favorable conditions for lodgepole as well as the lack of competition by other species (Hansen, 1941). The early decline of lodgepole and the converse increase of western yellow pine and grasses, composites, and chenopods suggest amelioration of the conditions left in the wake of the glacier, and possibly the warming and desiccation of the climate. The invasion of grasses, composites, and chenopods in the region about Cheney, apparently came slightly earlier than an invasion by similar groups of species in the region about Newman Lake, about 35 miles to the northwest. In the bog of this study, this invasion is represented some time before the volcanic activity that is represented by the volcanic ash stratum at 6.2 meters. As previously stated, the maximum of these groups is 23 per cent at 7.4 meters, more than a meter below the position of the ash. Significant proportions of these species are maintained, however, to 3.2 meters, where they record 13 per cent, and then decline to less significant proportions. In the Newman Lake bog, with a depth of 7.3 meters, the volcanic ash stratum appears at about 4.5 meters. The maximum of grass occurs at 5.5 meters, while the maximum of chenopods and composites together is at 4.5 meters, the ash horizon. The total of the three groups in the Newman Lake bog at 5.5 meters is 46 per cent, the maximum of the profile. Significant percentages of these three groups are maintained to 1 meter, slightly higher than in the bog of this study. Thus, there seems to be a significant chronological correlation between these indicators of warming and drying in the two profiles.

The appearance of western larch pollen in appreciable proportions in the profile is rather significant. Because larch has thick bark and is better able to resist fire than the other conifers, its influx may be interpreted as an indicator of fire. This species is extremely intolerant of shade and cannot compete with other species as long as there is no disturbance by fire. The occurrence of fire, however, which destroys other species, permits larch to expand due to lack of competition. As the other species regain lost ground, they gradually replace the more intolerant larch. The recorded influx of larch, a species which at present exists at considerable distance from the site of the sediments,

is very suggestive of a fire which provided conditions favorable for the increase and persistence of this species for a short period of time. Lodgepole suffered immediately from this fire, but it later increased at the expense of larch as the conditions caused by the fire were modified. This is reflected by a sharp increase in lodgepole immediately above the larch maximum at 2.8 meters. In the bog at Newman Lake, larch shows an early increase to significant proportions followed by a decline, and then a second influx, suggesting the occurrence of a series of fires. In a bog near Bonners Ferry, Idaho, larch likewise is recorded as having made two invasions during the post-Pleistocene, and the relative contemporaneous fluctuations of western white and lodgepole pine pollen suggest a series of fires that destroyed the forests of these species to the extent of permitting an influx and persistence of larch for an appreciable period. The importance of larch fluctuation is amplified because it produces little pollen compared with the species of pine with which it is associated.

Climatically, the pollen profiles of this study and their interpreted plant succession, suggest a gradual warming and drying of the climate from almost the beginning of the post-Pleistocene, which reached a degree persisting until after the volcanic activity responsible for the deposition of the ash in the accumulating sediments. This is borne out by other profiles in the region, as well as in other areas east of the Cascades in both Washington and Oregon. (Hansen, 1940, 1942a, 1942b). The maximum of warming and desiccation was succeeded by cooling and an increase in moisture in more recent time that has persisted to the present. This is also borne out by pollen profiles and interpreted plant succession in many parts of the Pacific Northwest.

Summary

Pollen profiles of a post-Wisconsin peat deposit at the north end of Fish Lake, about 3 miles northeast of Cheney, Washington, in a western yellow pine forest, show that lodgepole pine was not as abundant during the early postglacial as in other areas of the Pacific Northwest. Western yellow pine gained early predominance and is recorded as generally increasing all the way to the surface. In the lower third of the profile, grasses, composites, and chenopods are abundantly represented, but decline toward the surface. Western larch is recorded as having sharply expanded at a time represented in the upper half of the peat profile. This suggests a fire or series of fires that destroyed the less fire resistant species for a short time.

Climatically, the abundance of grass, composite, and chenopod pollen in the lower third of the profile denotes an early warming and drying of the climate, followed by some cooling with more moisture to a degree which has persisted to the present. This is in close agreement with the indicated climatic trends as recorded by a peat profile located about 35 miles to the northeast.

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