31

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Introduction

The well drained topography of northern Idaho has limited the number of lakes and ponds affording hydrarch succession and development of peat bogs suitable for pollen analysis. This region was glaciated by several stages of the Pleistocene glaciation. Most of the lakes are large, such as Lake Pend Oreille and Priest Lake, and there has been insufficient organic sedimentation for pollen studies. Most of the smaller lakes that may support the later stages of hydrarch succession on their borders are inaccessible. That part of Idaho north of the Clark Fork River and Lake Pend Oreille is very rugged, the principal mountain ranges being the Selkirk, Cabinet, and Purcell of the northern Rocky Mountain range (Fenneman, 1931). The Selkirks are separated from the other two ranges by the Purcell Trench, which carried a tongue of the Wisconsin ice southward to Lake Pend Oreille (Flint, 1937). The Purcell Trench extends from Lake Pend Oreille to the Kootenai River, and then it carries this stream northward across the International Boundary. The valley floor is covered with fluvio-glacial sediments which are somewhat knolled and kettled. Apparently there has been little modification since the ice melted. The higher peaks of the Selkirk Range to the west reach an elevation of over 7,500 feet, and those of the Cabinet and Purcell Ranges to the east attain altitudes of more than 6,000 feet.

Location and Characteristics of the Bog

The bog of this study is located on the floor of the Purcell Trench, about 2 miles south of the town of Naples and 10 miles south of Bonners Ferry, on the Priest Lake quadrangle, Idaho. It lies in section 13 of T. 60 N., R. 1 W., at an elevation of about 2,000 feet. The bog has apparently been formed in a small, deep kettle pond in the valley floor. The lake occupies an area of about 5 acres, and is surrounded by well-defined zones of hydrophytic vegetation. The innermost zone of a submerged stage is composed chiefly of bladderwort (*Utricularia vulgaris*), water milfoil (*Myriophyllum spicatum*), and stonewort (*Chara* sp.). This sere is followed landward by a floating stage composed of yellow pondlily (*Nymphozanthus polysepalus*) and watershield (*Brasenia schreiberi*). In shallower water near shore is a zone of cattail (*Typha latifolia*) and bulrush (*Scirpus occidentalis*), succeeded shoreward by a sere of cattail, purple marshlocks (*Potentilla palustris*), and sedge (*Cyperus* sp.).

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On yet higher ground, this is followed by a zone of marshlocks and bog birch (*Betula glandulosa*), while farthest away from open water is a sere composed of birch, willow (*Salix* sp.), and mountain alder (*Alnus tenuifolia*), which in turn grades into the forest on higher ground.

The depth of the peat in the area of sampling is 7.5 meters, and samples were obtained at quarter-meter intervals. The peat is underlain with gravel which grades upward into silt and then clay. The clay in turn grades into a whitish-gray peat composed of a high percentage of calcium carbonate, which was assimilated by the alga, stonewort. The white calcareous peat gradually becomes tan and then brown upward in the profile, with an abundance of carbonate present to the 3-meter horizon. The upper 3 meters of peat are fibrous in texture. A stratum of volcanic ash occurs from 5.75 to 5.6 meters, while glass fragments are present upward as high as 5 meters in the profile. Most post-Pleistocene peat profiles in Washington and Idaho contain a layer of volcanic ash, the origin of which may be Glacier Peak in northern Washington. The stratigraphic position of the ash in relation to the depth of the peat is consistent with that of other peat profiles. The ash stratum usually occurs about three-quarters of the way down from the top. The six-inch layer is thicker than that in most bogs, the only other thicker layer being observed at Newman Lake, near Spokane, Washington (Hansen, 1939b), where it is almost one foot. The usual thickness is one or two inches. Where it is thicker, the ash was probably carried into the pond or lake by incoming streams.

In the preparation of the peat for microscopic analysis, the usual potassium hydrate method was used. In order to eliminate the calcium carbonate assimilated by the alga, stonewort, concentrated nitric acid was added drop by drop until there was no evidence of further effervescence. This facilitated much easier and more accurate identification of the pollen, because the carbonate crystals were so abundant as to obscure the pollen grains. From 100 to 200 pollen grains of forest trees were identified from each level. In separating the species of pine pollen, the size range method was employed (Hansen, 1941a).

Forests in Adjacent Areas

The bog is located near the lower edge of the Canadian life zone. It lies within the larch-pine forest, which is designated as a transition forest between the coast and montane climaxes (Weaver and Clements, 1938). This region is also classified as being forested with a western pine forest type (Larsen, 1930). Western white pine (*Pinus monticola*) is one of the principal species in northern Idaho, and often occurs in almost pure stands, although the climax dominants are western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), and lowland white fir (*Abies grandis*) (Huberman, 1935). White pine has been able to persist abundantly as a subclimax species due to fire in the past and lumbering in more recent time. If the forest succession is uninterrupted for several centuries, the dominants gain control, and white pine is found only as old, decadent, and diseased individuals sparsely scattered throughout the stand. In the extensive areas of repeated burns, heavy invasions of lodgepole pine (*Pinus contorta*) and western larch (*Larix occidentalus*) occur. These two species do not usually thrive together in the same stand. The former occupies the dry knolls and exposed ridges toward the upper part of the white pine zone, while larch thrives best on north and east exposures where there is a greater abundance of soil moisture (Larsen, 1929). Both lodgepole pine and larch possess characteristics which permit them to invade and thrive in areas denuded by severe and recurring fire. Lodgepole not only reproduces at an extremely early age, but its seeds are retained in the cones for many years until a fire causes them to open and release tremendous quantities of seeds. Lack of competition then causes this species to develop rapidly until more shade-tolerant species regain a foothold. Larch is long-lived and resistant to fire because of its thick bark and less inflammable foliage. Thus, it will survive several fires, and the large trees result in rapid restocking, if the soil is not too warm and dry.

The temporary stands of lodgepole pine and larch are slowly replaced by western white pine and Douglas fir (*Pseudotsuga taxifolia*) if no further fires occur. These two species also invade and thrive after a single fire that destroys the climax forest, or forests of white pine or Douglas fir (Larsen, 1929). After a period during which the forests are undisturbed by fire, the white pine stands mature, but seedlings of this species fail to develop in the shade. The climax dominants in the meantime have invaded and eventually replace the white pine in the absence of further fire. At higher elevations in the Hudsonian zone occur Engelmann spruce (*Picea engelmanni*), whitebark pine (*Pinus albicaulis*), mountain hemlock (*Tsuga mertensiana*), and alpine fir (*Abies lasiocarpa*). At lower elevations on favorable sites western yellow pine (*Pinus ponderosa*) may be found. Broadleaf species in the valley are mountain alder (*Alnus tenuifolia*), cottonwood (*Populus trichocarpa*), aspen (*P. tremuloides*), mountain maple (*Acer glabrum*), and several species of willows.

The bog is located in a climatic province classified as being humid, microthermal, with adequate precipitation at all seasons (Thornthwaite, 1931). The mean annual precipitation in the region forested with the hemlock-cedar-lowland white fir association in northern Idaho ranges from 27 to 44 inches (Larsen, 1930).

Post-Pleistocene Forest Succession

Lodgepole pine is recorded as having been the predominant, pioneer, postglacial arboreal invader in areas within range of pollen dispersal to the site of the sediments. It shows 77 per cent at the bottom horizon (Fig. 1). Western white pine is the next most abundant forest tree, being represented by 18 per cent of the pollen in the lowest level. Other conifers recorded by 4 per cent or less are western yellow pine, Engelmann spruce, and fir. Lodgepole pine increases upward from the bottom to attain its greatest proportion of 81 per cent at 6.5 meters, and then with several fluctuations it declines to its minimum of 20 per cent at 2.5 meters. With further rather sharp reversals of trend, it generally increases to the surface where it is recorded to 33 per cent.

Western white pine is portrayed as generally increasing upward from the bottom, superseding lodgepole pine at 4.75 meters, and attaining its maximum of 53 per cent at 3.25 meters. It then remains generally constant to the surface with the exception of an abrupt decrease at 1.5 meters. At the uppermost horizon it shows 42 per cent, the greatest of any species recorded. Pollen of western larch, the third species represented by significant proportions, was not observed until 6.25 meters. The pollen profile of this species is marked by two trends of precipitate increase succeeded by abrupt decrease (Fig. 1). It increases from 5 per cent at 4.5 meters to 30 per cent at 3.75 meters, its maximum proportion of the profile, and then decreases to 6 per cent at 3.5 meters. It shows another significant increase from 4 per cent at 1.75 to 24 per cent at 1.5 meters, then it declines to 6 per cent at 1 meter, and is not represented in the upper two horizons.

Fir is the only other conifer represented by its pollen at every level of the profile. Its maximum is 10 per cent at 2.5 meters. Most of the fir pollen is that of lowland white fir, with some from alpine fir which grows at higher elevations. Western yellow pine is represented at most levels, and attains its greatest proportion of 15 per cent at 1.75 meters. Douglas fir played a minor role in postglacial forest succession, and reaches its peak of 12 per cent at the 5.5 meter horizon. Engelmann spruce also was of minor importance in the forest complex during the post-Pleistocene, and records its maximum proportion of 10 per cent at 7.25 meters. Western hemlock and mountain hemlock are only sporadically recorded, and do not exceed 2 per cent at any level. Broadleaf species represented at many levels are alder, birch, and maple.

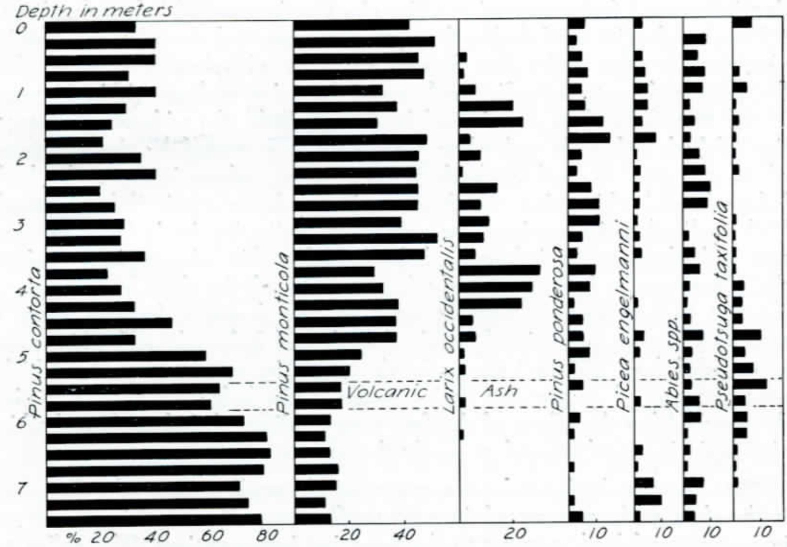

Fig. 1. Pollen profiles, northern Idaho.

Herbaceous species whose pollen is present are grasses, composites, sedges, cattail, and water lily; the last three marking the progress of hydrarch succession. Grasses and composites are so limited in their representation as to offer no significance.

Interpretation of the Pollen Profiles

The predominance of lodgepole pine in the pioneer postglacial forests is consistent with that revealed by pollen analyses of bogs in many other deglaciated areas of the Pacific Northwest (Hansen, 1939a, 1939b, 1940a, 1940b, 1941, 1942, 1943a). The early seed-bearing age of lodgepole and its aggressiveness in invading edaphically disturbed areas were probably responsible for its persistence and mobility under the physiographically unstable conditions that must have existed before an oscillating ice-front. Its decline upward in the profile suggests stabilization of the edaphic and physiographic conditions favorable for the invasion and ecesis of other species. Lodgepole pine could not compete with these species because of its short life span and intolerance for shade. An abundance of western white pine in the pioneer postglacial forests of the Pacific Northwest is also disclosed by pollen profiles from the glaciated region (Hansen, 1939a, 1939b, 1940a, 1941, 1943a). This species reproduces well on mineral soil and being longer-lived and more shade tolerant than lodgepole, it eventually replaces the latter. As white pine is not climax, however, it is also supplanted if forest succession is not interrupted by fire or other factors.

The relative trends of larch and lodgepole and white pine during the time represented from 4.75 to 3.5 meters suggest the occurrence of a series of fires that interrupted forest succession (Fig. 1). The increase of lodgepole pine at 4.5 meters after its rapid decline from its maximum, and the cessation of white pine increase suggest fire that favored an influx of lodgepole pine. Further fire, apparently more extensive and severe, following perhaps within 20 years of the first, favored an invasion of larch that marks the widespread destruction of both lodgepole and white pine. This is portrayed by the maximum of 30 per cent attained by larch at 3.75 meters, where it supersedes both lodgepole and white pine. As these species gradually regained lost ground, larch declined to its previous low proportion, indicating its inability to compete with them as the influence of fire waned. White pine rapidly regained the supremacy it had temporarily lost because of the fires, and remained constant to 1.75 meters. Another series of fires, however, brought about a somewhat similar successional trend of larch and lodgepole and white pine, as recorded from 2.25 to 1 meter. Larch sharply increased to its second highest proportion of 24 per cent at 1.2 meters, while lodgepole and white pine decreased. After the effects of the fires were ameliorated, lodgepole and white pine again increased upward to nearly the surface.

The fact that larch produces a comparatively small amount of pollen, and is therefore under-represented in peat profiles, magnifies the significance of its increase and lends support to the foregoing interpretations. The pollen of western larch occurs in most peat profiles east of the Cascades in Washington and northern Oregon, but it usually is not present in great enough quantities to depict successional trends. In a montane bog near Bend, Oregon, on the east slope of the Cascades, it is recorded in large enough proportions in the lower levels to denote fire just prior to the beginning of sedimentation (Hansen, 1942). In a subalpine bog in the Blue Mountains of northeastern Oregon, an influx of larch pollen occurs in sufficient proportions to warrant an interpretation of fire as the cause (Hansen, 1943b). It is also recorded as high as 30 per cent in the lower levels of a bog near Spokane, Washington (Hansen, 1939b).

Although western hemlock, western red cedar, and lowland white fir are the chief dominants of the climax forest in northern Idaho, there is no evidence in the pollen profiles for a trend toward the climax. Apparently the hypothetical fires, as reflected by the pollen profiles of larch, white pine, and lodgepole pine, were too severe and extensive for the development of a climax trend in areas within range of pollen dispersal to the site of the sediments. Such a trend, however, is depicted by pollen profiles of another bog in northern Idaho (Hansen, 1939a). This bog is located a few miles west of Priest Lake and about 28 miles west of the bog of this study, in an area with similar floristic and climatic characteristics. In a 12-meter profile, western hemlock, Douglas fir, and lowland white fir are recorded to a total of 47 per cent at 2.5 meters, while white and lodgepole pine show sharp and significant declines. A rapid increase of white pine immediately above suggests a single fire that was not sufficiently severe to permit an invasion by lodgepole pine or larch, although it did interrupt the climax successional trend. Another climax trend is marked by an increase in hemlock in the uppermost levels. Larch is sparsely represented in the profiles, and there were evidently no fires of sufficient magnitude during the postglacial to favor an invasion by this species. White pine superseded lodgepole pine about one meter above the volcanic ash stratum, the same as in this study. There seems to be little evidence for post-Pleistocene climatic trends in the pollen profiles here. Apparently forest succession was largely controlled by competition and the influence of forest fires.

Summary

Pollen profiles of a peat bog in northern Idaho reveal that the predominant, pioneer, postglacial, arborescent invader was lodgepole pine. It was gradually superseded by western white pine early in the profile, the latter remaining generally predominant to the present. Two periods of severe and recurring fires are reflected by the relative trends of western larch and lodgepole and western white pine. A marked increase in the proportions of larch and a decline in those of lodgepole and white pine about one-third up in the profile are indicative of several fires occurring in close succession. Subsequent increase of lodgepole and white pine suggests the amelioration of the effects of the fires and the replacement of larch because of its shade intolerance. A second similar trend of these three species is disclosed higher in the profile, denoting the influence of another series of fires. A final increase of lodgepole

and white pine to the present followed the second influx of larch. The climax forest of this region is composed of western hemlock, western red cedar, and lowland white fir, but there is no evidence in the profiles for a climax trend. Apparently the fires were so severe and occurred so frequently as to prohibit the development of the climax forest. There is no evidence in the pollen profiles for climatic trends.

REFERENCES

FENNEMAN, N. M. 1931—Physiography of western United States. New York.

FLINT, R. F. 1937—Pleistocene drift borders in eastern Washington. Bull., Geol. Soc. Am. **48**:203-232.

HANSEN, H. P. 1939a—Pollen analysis of a bog in northern Idaho. Amer. Jour. Bot. **26**:225-228.

———1939b—Pollen analysis of a bog near Spokane, Washington. Bull. Torrey Bot. Club **66**:215-220.

———1940a—Paleoecology of a montane peat deposit at Bonaparte Lake, Washington. Northwest Science **14**:60-69.

———1940b—Paleoecology of two peat bogs in southwestern British Columbia. Amer. Jour. Bot. **27**:144-149.

———1941—Further pollen studies of post-Pleistocene bogs in the Puget Lowland of Washington. Bull. Torrey Bot. Club **68**:133-148.

———1942—The influence of volcanic eruptions upon post-Pleistocene forest succession in central Oregon. Amer. Jour. Bot. **29**:214-219.

———1943a—A pollen study of two bogs on Orcas Island, of the San Juan Islands, Washington. Bull. Torrey Bot. Club. **70**:236-243.

———1943b—A pollen study of a subalpine bog in the Blue Mountains of northeastern Oregon. Ecology **24**:70-78.

HUBERMANN, M. A. 1935—The role of western white pine in forest succession in northern Idaho. Ecology **16**:137-152.

LARSEN, J. A. 1929—Fires and forest succession in the Bitterroot Mountains of northern Idaho. Ecology **10**:67-76.

———1930—Forest types of the northern Rocky Mountains and their climatic controls. Ecology **11**:631-673.

THORNTHWAITE, C. W. 1931—The climates of North America according to a new classification. Geog. Rev. **21**:633-655.

WEAVER, J. E. AND F. E. CLEMENTS. 1939—Plant Ecology. New York.

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