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POLLEN ANALYSIS OF A VALLEY FILL NEAR UMIAT, ALASKA

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ABSTRACT. Microfossil analysis of a valley fill near Umiat, Alaska, has yielded a pollen chronology, consisting of an herbaceous pollen zone, a birch pollen zone and an alder zone, that can be correlated with the established chronology of the central Brooks Range. The boundary between the lower two zones has a radiocarbon age of between about 7,500 and 8,000 years, and the boundary between the upper two zones an age of about 6,000 years.

The bottom ten feet of the valley fill consists of clay, silt, sand and gravel without primary fossils or organic matter. The upper 25 feet consists of silt and peat and apparently began to accumulate under cold climatic conditions. Deposition of silt and peat continued for about 2,000 years, while the climate warmed to approximately its present temperature, and then ceased.

Correlation with pollen profiles of the central Brooks Range indicates that the postglacial thermal maximum occurred at about the same time in arctic Alaska as it did in the rest of the world. Correlation with pollen profiles of the central Brooks Range indicates that glacier retreat from the Eight Lake (Eschooka) position occurred about 8,000 years ago.

INTRODUCTION

In an earlier paper (Livingstone, 1955) a three-zone pollen stratigraphy was established for the central Brooks Range in glaciated northern Alaska. This contribution extends the same stratigraphy to the unglaciated foothills north of the Brooks Range. The new pollen profile comes from a deposit sufficiently rich in organic matter for radiocarbon dating, and the age of three levels has been estimated. The earlier profiles were from inorganic silts which could not be dated in this way.

Samples were collected by field workers of the Physical Research Laboratories of Boston University at the suggestion of Dr. John Cantlon. The author is very much obliged to Dr. Charles M. Matthews and Dr. Ralph Fellows of Boston University for an opportunity to examine the material for pollen.

Analysis of the core was carried out during tenure of a National Research Council of Canada post-doctorate fellowship at Dalhousie University, Halifax, Nova Scotia.

METHODS

Cores eight to ten inches long were taken with a light rotary drill rig having a four-inch barrel, and were shaved in the field to a thickness of two inches while still frozen solid. They were wrapped in aluminum foil, tied up in cotton bags and then placed in wooden boxes to melt and drain. By the time samples were picked out for pollen analysis the material was air-dry.

Quantities weighing about five grams were boiled briefly in a small beaker with a little five percent KOH. After boiling the material was strained through a seive with 200 meshes to the inch and washed with water into a large beaker. After standing for at least twenty-four hours the samples were decanted and transferred to a 40 ml. tapered centrifuge tube. They were then rinsed in acetone and suspended in an acetone-bromoform mixture of specific gravity 2.0. A pinch of anhydrous $CuSO_4$ was added to most samples to prevent the formation of coacervates. The material was run through the bromoform method of Frey (1951) in the usual way, after which it was transferred to a 15 ml. tapered centrifuge tube, acetolyzed, and run through the method of Frey one more. Finally it was boiled briefly in KOH and washed repeatedly in water until all the dispersable colloidal material was removed.

Following this treatment the small amount of material remaining was sucked up in a drop of water and mounted in safranin-stained glycerine jelly on a micro-slide. Examination was carried out at a magnification of 430 times, except for a few almost empty slides, which were searched for pollen at a magnification of 100 times. Identification of difficult grains was carried out with an oil-immersion apochromatic objective.

DESCRIPTION OF THE SAMPLING LOCALITY

The core was taken from a fill in the valley of Bearpaw Creek, about three miles north of Umiat, at 69° 24′ 35″ N., 152° 6′ 15″ W. Bearpaw Creek appears to have been recently rejuvenated and is actively eroding headward, with a nick-point just below the sampling locality. Above the nick-point the bed of the creek is choked with 35 feet of fibrous peat, silt and sand, grading into silt with bits of shale and siltstone near the bedrock. The material composing this deposit can be seen in section at the nick-point and consists of coarsely bedded horizontal layers of peat and silt.

Several cores were taken at this locality. The one analyzed for pollen was Boston University number 33U, taken at a spot a little to the east of the aggraded stream bed, where the valley floor is a few feet above stream level. From the core samples it was evident that the material in this place was of the same sort as that exposed at the nick-point, but the topographic relations suggested that it was an older deposit which had been subjected to less reworking.

The vegetation of the Umiat region has been described in detail by Churchill (1955). Briefly, it is low-arctic tundra with alder bushes and willows approaching tree size in favored localities. The climate is cool in summer and cold in winter, with light precipitation. There is perennial frost under all of the land surface and only the upper foot or so of the ground thaws out in summer.

Valley fills accumulate by the deposition of a creeping mantle of peat and vegetation from the surrounding slopes. This material probably creeps slowly down the valleys and it is occasionally thawed out and removed very rapidly by stream down-cutting. It is such a phase of active erosion that is currently in progress in Bearpaw Creek below the coring station.

Presumably both the process of creep which deposits the valley fills and the process of stream down-cutting which removes them are favored by warm and wet summers, but there is no reason to believe that they are both influenced to the same extent. The balance between deposition and erosion of the valley deposit is likely to depend on a rather complex and delicate interplay of climatic forces.

STRATIGRAPHY

Gross and microscopic stratigraphy are summarized in figure 1. The lowest pollen spectrum was obtained by dissolving a few silt-stone pebbles in

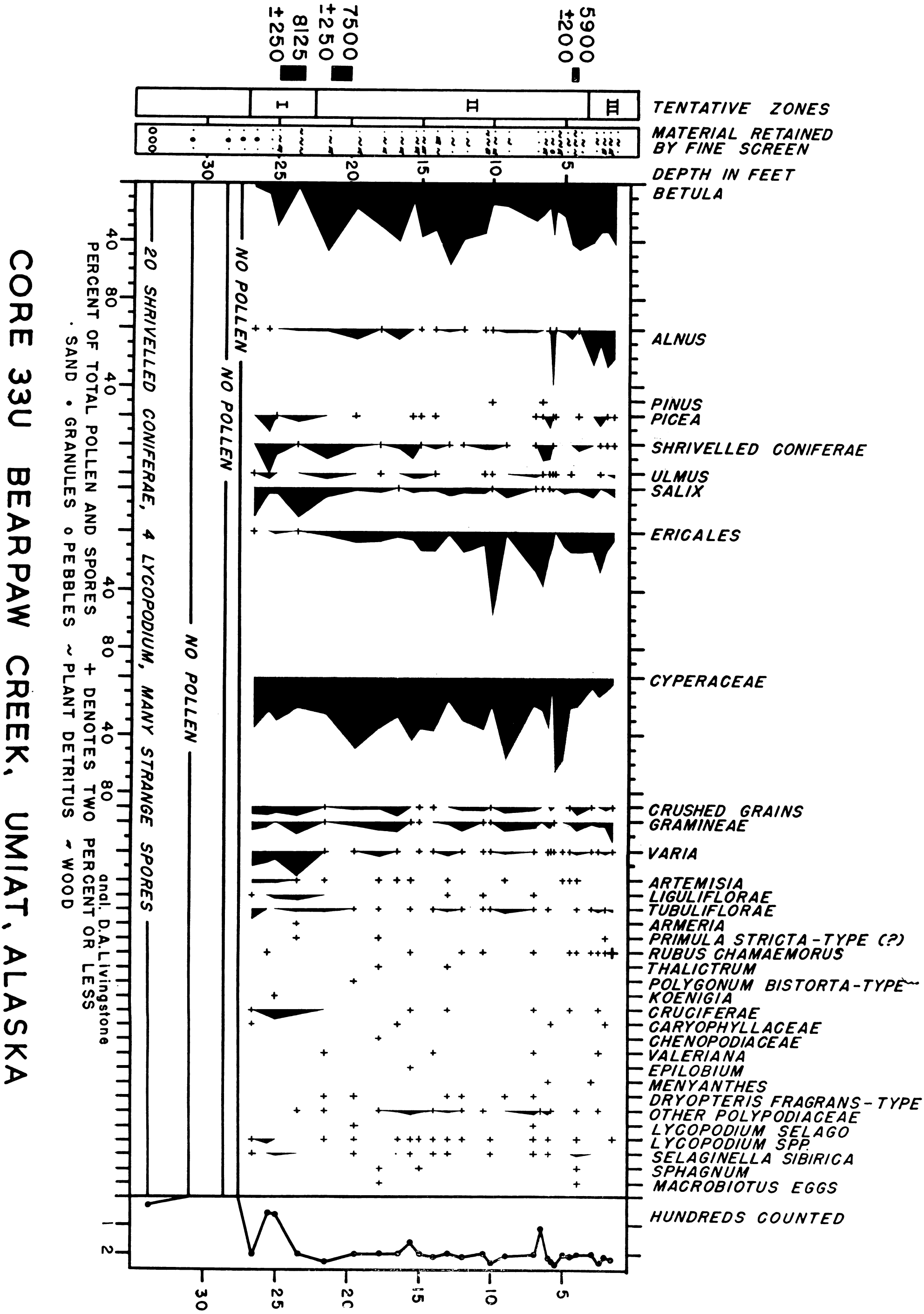

Fig. 1. Core 33U Bearpaw Creek, Umiat, Alaska.

hydrofluoric acid, so it is representative of the fossil flora in the silt-stone bed from which the pebbles came, and does not properly belong with the rest of the diagram.

From the bottom of the core to the 26.5 foot level no pollen was present. The material here consisted mostly of expanding clays. One sample swelled to about twenty times its dry volume when it was boiled in KOH. The complete absence of pollen suggests that this material, if derived from polliniferous sedimentary deposits, has been subjected to prolonged oxidative weathering. If the clay were mechanically broken siltstone which had not been oxidized it would have contained some of the microfossils abundant in the bottom sample of the core.

Above the 26.5 foot level pollen is uniformly present, although the amount in four samples below 20 feet was too low to permit the calculation of reliable percentages. These samples have been omitted from the diagram.

The most striking features above 26 feet, 6 inches are general uniformity combined with short sharp flucuations of no apparent significance. *Betula* (birch) pollen is abundant at all levels, except near the bottom and *Cyperaceae* (sedge) pollen is abundant at all levels except near the top. *Alnus* (alder) is present in trace amounts except in the upper six feet, where it is rather abundant. *Picea* (spruce) is intermittently present throughout the diagram. Ericales show some tendency to be less abundant at the bottom of the diagram than they are generally.

Most of the minor constituents are so scarce that it is not possible to see any trend in their abundance. Only a few follow a consistent pattern. *Rubus chamaemorus* (bake-apple) is more abundant in the upper part of the diagram than the lower. A number of types—*Salix* (willow), Compositae (*Artemisia*, other Tubuliflorae, Liguliflorae), Cruciferae and Varia—are all significantly more abundant in the bottom of the diagram than elsewhere. The category Varia consists of a number of grains which could not be identified with certainty and were tentatively referred to the families Rosaceae, Leguminosae, Saxifragaceae and Umbelliferae.

VEGETATIONAL INTERPRETATION

The bottom level of the pollen diagram, based on grains and spores dissolved out of the siltstone, appears to represent a vegetation in which coniferous trees were very important. The proportion of unfamiliar spores is so high that it would be unsafe to say more about it. Many of the spores are very bizarre and so different from anything that occurs in Pleistocene deposits of the arctic and north temperate zones that the siltstone must be very old. Possibly it comes from the Cretaceous strata in the immediate vicinity, or it may originate in the early Tertiary beds which occur in nearby parts of northern Alaska. The latter possibility is suggested by the fact that Payne, et al. (1951) gave siltstone as a common facies of the Tertiary beds, but did not mention it in their discussion of the Cretaceous. In either case it is evident that the siltstone flora is at least a complete order of magnitude older than the bulk of the valley fill.

Above 26.5 feet only tundra vegetation appears to be represented in the pollen diagram. *Pinus, Picea* and *Ulmus* are the only genera present which are reliable indicators of forest. The slides were made up at the beginning of the spring flowering season, when a good deal of *Ulmus* pollen was in the air, and it was evident from the freshness and the excellent state of preservation of the *Ulmus* grains that they were atmospheric contaminants. The same is true of the two pine grains that were encountered.

The spruce grains were fossil ones but small amounts of wind-blown spruce are characteristic of the pollen rain all over the north slope of Alaska at the present time. A trace of spruce is usual through most of the postglacial section in the Brooks Range, due apparently to long-distance transport by the wind.

Disregarding the three above mentioned genera, the core seems to indicate the same three-fold vegetational history as is exhibited in the Brooks Range. At the bottom there is evidence of tundra vegetation with many indicators of open ground. In the middle there is strong evidence of tundra with fewer open ground species but with more dwarf birch shrubs. At the top alder becomes important.

The major pollen curves fluctuate considerably. Such fluctuation is more pronounced in the arctic than elsewhere, but it is not usually this strong. Perhaps some of the irregularities are due to the nature of the deposit. Unlike a lake, which integrates the pollen rain from a wide area, an accumulating deposit of terrestrial peat and silt will reflect minor fluctuations in the local vegetation. The sedge maximum at 5 feet, for example, may be due to the inclusion of a few sedge flowers in the sample analyzed.

It is quite evident that some secondary deposition of old microfossils has occurred during the accumulation of this deposit. There are spores throughout the polliniferous section that have been derived from pre-Pleistocene sedimentary deposits and there is also a considerable amount of shrivelled coniferous pollen of the types abundant in the siltstone sample. The proportion of this coniferous pollen is plotted on the diagram to give an indication of the amount of contamination from one kind of old deposit.

The thinness and weak development of the alder zone is worthy of note. In the Brooks Range the birch and alder zones were of approximately equal thickness. Here the alder zone is much the thinner and shows no sign of the internal differentiation which suggested a thermal maximum at Chandler Lake. This indicates that deposition has been very slow or absent during most of alder time at Bearpaw Creek.

The pollen diagram has been divided into zones I, II and III, in accordance with the Brooks Range sequence, but there are a few rather disquieting differences in the stratigraphy of the two localities. In particular, zone I is not well developed here. It includes a good deal of birch and shows no trace of internal differentiation into high-sedge and low-sedge sub-zones. Despite these reservations, however, it appears that the vegetational sequence covered by this profile is roughly the same as that covered by the long profile from Chandler Lake: first, tundra with many indicators of open ground;

next, tundra in which dwarf birch shrubs were more important; finally, tundra with enough alder bushes to influence the pollen rain.

STRATIGRAPHIC CORRELATION

If we assume that the vegetational changes reflected in this pollen diagram were synchronous over the entire North Slope of Alaska, then the easiest and most direct correlation which can be established is between this core and the ones from the Chandler Lake region. The two sampling localities are separated by only about ninety miles and are both in the same low-arctic vegetational province, so pollen correlation between them is fairly safe. In assuming synchrony of zone boundaries, however, it must be remembered that the herbaceous-birch transition at Bearpaw Creek is not sharply defined, nor is the herbaceous zone well developed. This makes correlations depending on the lower transition less reliable than ones depending on the upper.

The Chandler Lake zones have previously (Livingstone, 1955) been correlated with the drift stratigraphy of Detterman (Péwé et al., 1953). By this correlation the herbaceous-birch transition marks the time of retreat of the Brooks Range glaciers from the Eight Lake (Eschooka) position. Detterman has correlated the Eschooka glaciation with the Kenai Peninsula Naptowne glaciation which has a radiocarbon age of less than 14,000 years and greater than 8,000 years.

By this rather tenuous thread of argument the lowermost polleniferous deposits at Bearpaw Creek ought to be at least 8,000 years old. It is very reassuring to have the information (personal letter from J. L. Kulp to C. M. Matthews, 1955) that the peat just above the 25 foot level, in zone I, has a radiocarbon age of 8,125 ± 250 years. A layer just above the transition between zones I and II gives a date of 7,500 ± 250 years.

A third determination, a sample taken in the neighborhood of the birch-alder transition, gave a radiocarbon age of 5900 ± 250 years. Accepting the correlation with Chandler Lake, this sample lies somewhat below the post-glacial alder maximum, which the author interprets as the local manifestation of the world-wide thermal maximum. The thermal maximum has been radiocarbon dated in Europe (Flint and Deevey, 1951) at 3,000-6,000 years ago. Apparently the alder maximum was not only climatically equivalent to the thermal maximum, but was contemporaneous with it.

DISCUSSION

In addition to extending the Brooks Range pollen chronology to the foothills and providing three radiocarbon dates for it, the Bearpaw Creek core has some geomorphic interest.

It appears from the pollen record that deposition of silt and peat in the valley began under a climate a good deal colder than the present and that it ceased with the onset of climatic conditions approximately like those now prevailing. During thermal maximum time there may have been a certain amount of erosion, though not necessarily at the location of this core: the stream may have cut into the valley fill elsewhere during thermal maximum time and later aggraded to its present level. Under present conditions the deposit which occupies the stream bed is being degraded.

The relation between temperature and deposition of the valley fill can hardly be a simple one. If it were only a matter of deposition during cold times and erosion during warm ones, then one would expect to find in the valley the deposits which accumulated during the cool time at the end of the last interglacial or major interstadial. There is no trace of them. One is forced to conclude that active erosion goes on not only under unusually warm conditions but under periglacial conditions as well. Precipitation is probably involved but present knowledge of paleoclimate in northern Alaska does not include the information on precipitation necessary for complete understanding of the aggradation-degradation balance in the valley.

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