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Palynological Analysis of a Peat Core from Imnavait Creek, the North Slope, Alaska

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ABSTRACT. The pollen record of a 160 cm peat core from Imnavait Creek, a small upland basin in the northern foothills of the Brooks Range, Alaska, reveals a history of vegetation change from the early Holocene to the present. The *Alnus* rise within the region occurred after 8500 yr B.P. *Betula* and Cyperaceae are the major floristic elements throughout the diagram, and this, along with the significant levels of *Salix* and *Ericaceae*, suggest that the area was characterized by a mosaic of herb and shrub tundra communities, dependent on variations in terrain and moisture availability.

Key words: palynology, peat, North Slope, Alaska, pollen, Brooks Range, vegetation history, Holocene

RÉSUMÉ. L'analyse du pollen du coeur d'une tourbière 160 cm dans la vallée d' Imnavait, petit bassin montagneux dans la partie nord des basses collines de Brooks Range, en Alaska, relate l'histoire de changements de végétation du commençement de la période holocène jusqu'a aujourd'hui. La naissance de L'Alnus dans cette région est survenue après 8500 ans B.P. Le Betula et Cyperaceae sont demeure l'élément floral prédominant et ce, conjugué à un niveau significatif de Salix et d'Ericaceae, nous amène à penser que ce territoire est caracterisé par une mosaique d'herbes et d'arbrisseaux de toundra, dépendant des variations de terrains et du taux d'humidité ambiant.

Mots clés: "Paleontologie", tourbière, pente nord, Alaska, pollen, Brooks Range, histoire de la végétation, holocène

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АННОТАЦИЯ: Анализ пыльцы торфяного ядра толщиной 160 см из Имнавитного (Imnavait) ручья, малого горного бассейна у северного подножия хребта Брукса на Аляске, выявляет историю изменения растительности с раннего голоцена до настоящего времени. Присутствие *Alnus* в пределах региона увеличивается после 8500 года до н.э. *Betula* и Cyperaceae остаётсь главным элементом флоры по всей диаграмме, что, наряду со значительным содержанием *Salix* и Ericaceae позволяет уверенно предположить, что для этой территории было характерно чередование травянистых и кустарниковых сообществ, зависящих от топографии и наличия влаги.

Ключевые Слова: палинология, торф, Аляска, пыльца, хребет Брукса, история растительности, голоцен

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INTRODUCTION

The pollen analysis of a core from a peat deposit at Imnavait Creek was undertaken as a preliminary step to further studies into the potential of such deposits as reliable indicators of past climatic and vegetation change. The pollen stratigraphy represents vegetational changes from the early Holocene to the present. The sediments are composed largely of organic materials, well preserved because of the perennially frozen ground. This paper reports new evidence for the timing of the *Alnus* rise on the North Slope and demonstrates that a regional signal is obtainable from continuous peat deposits in eastern Beringia.

The Imnavait Creek basin (68°40'N, 149°20'W; elevation 875-945 m) lies 10 km north of Atigun Gorge and 3 km south of the Dalton Highway in the foothills of the central Brooks Range. The watershed boundary is formed by hill crests covered with Sagavanirktok Glaciation till deposits dated to the Middle Pleistocene (Hamilton, 1986). Such basins are typical of much of the northern foothills and are commonly the site of wet, sedge-dominated mires in which organic and inorganic materials accumulate.

Imnavait Creek originates in a string-bog, which accounts for 5% of the total basin of 210 ha (Fig. 1). A beaded stream, consisting of pools connected by narrow channels, is beginning to erode the upper basin area. The drainage basin is water tight because of underlying permafrost. Numerous drainage flows (called water tracks) cross the valley, episodically carrying dissolved organic material into the stream system (Oswood *et al.*, 1989). The vegetation is dwarf *Betula*-Cyperaceae tussock tundra, actually consisting of a complex mosaic of plant communities (Walker *et al.*, 1989). Dry dwarf shrub/fructicose-lichen tundra, moist dwarf-shrub tundra, and wet Cyperaceae tundra associations are all part of the modern watershed system. The lower hill slopes and valley bottom of the Imnavait watershed site have accumulations of organic peat that vary from 10 to 20 cm thick to deeper sediments of greater than 160 cm, with bottom ages of greater than 11 000 yr B.P. During reconnaissance sampling, conspicuous horizons of vegetation change were noted in shallow test pits; at one site the surface sphagnum peat overlay a 5 cm layer of sedge peat.

METHODS

In order to explore the potential that the headwater basin might have for retaining Holocene biostratigraphic records, K.R. Everett (Byrd Polar Research Center, The Ohio State University) took a 160 cm peat core in May 1987, using a Haines drill with a 1 m core barrel. The drilling was terminated for mechanical reasons, and the basal sediments were not reached.

Pollen samples from this core were uniformly prepared by standard methods (Faegri and Iverson, 1975) followed by bromoform separation (Frey, 1955). A summary pollen diagram is presented in Figure 2. Cyperaceae and *Equisetum* grains are not included in the pollen sum. Concentration and influx data

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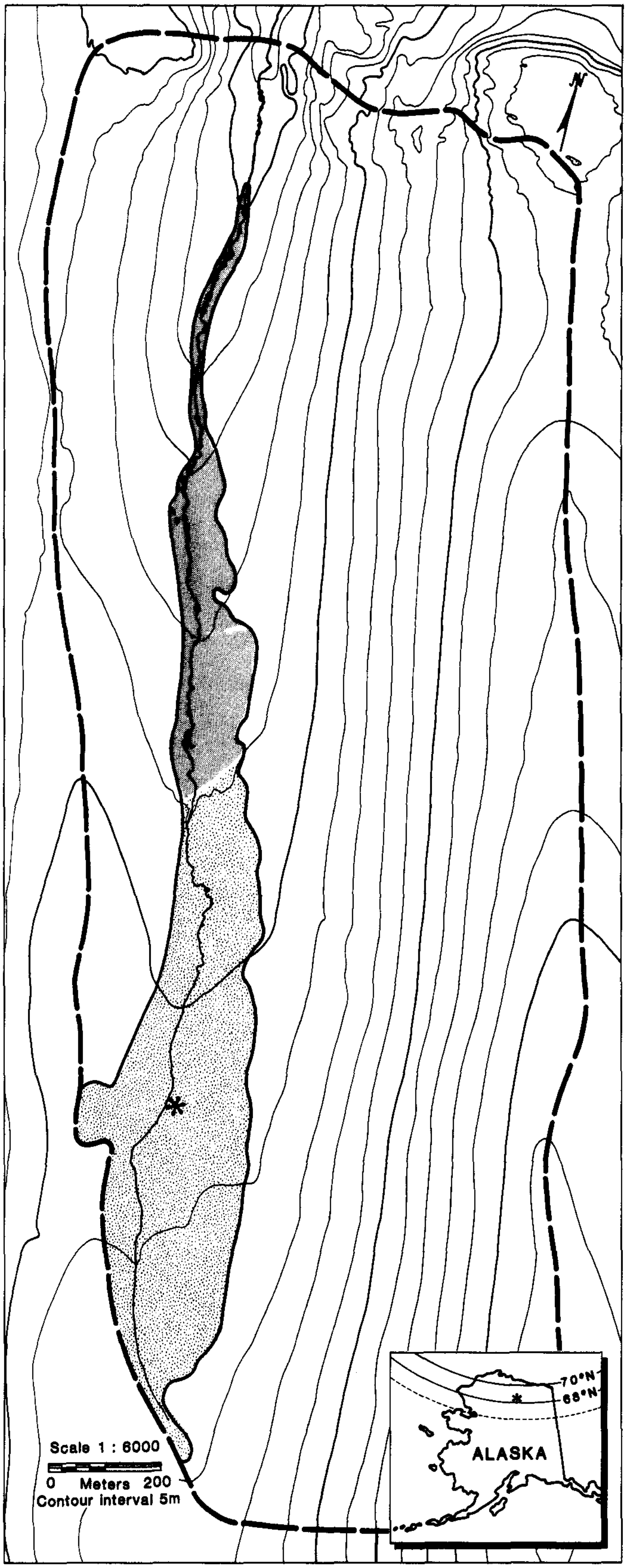

FIG. 1. Imnavait Creek drainage basin in Sagavanirktok drift surface. Shaded area shows floodplain. Asterisk indicates core site.

are not presented, despite reasonable dating control, because high levels of ice and obvious variations in stratigraphy indicate that caution is needed in the interpretation of the peat deposition rate.

RESULTS AND DISCUSSION

The pollen diagram is divided into two zones: IM-1 and IM-2. Zone IM-1 is typical of *Betula* zone spectra from sites in northern Alaska and northwestern Canada, with very high percentages of *Betula* and lesser amounts of *Salix* and herb pollen. The shrub tundra elements of the early Holocene were already fully developed at the beginning of this record.

Betula and Cyperaceae persist as the dominant floristic element in both zones, and this, along with significant levels of Gramineae, *Salix*, and Ericaceae, suggest that the area has been dominated by a tundra mosaic of herb and shrub assemblages throughout the Holocene. The persistence of the herb pollen taxa until 4500 yr B.P. is notable. In comparison, herb assemblages decline after 8000 yr B.P. in pollen diagrams from the Black River region of northeastern Alaska, which are interpreted as indicative of a floristically diverse vegetation cover (Anderson *et al.*, 1988). The separation of local and regional pollen is not possible in this study, but an analogous situation to the modern vegetation cover — a mosaic of plant community types, based on terrain and moisture availability — probably existed at Imnavait Creek in the past. Most of the pollen taxa in Figure 2 represent a variety of plant species that would have occupied the entire spectrum of moisture regimes within the Imnavait Creek system, rendering a local reconstruction questionable. The high percentages of *Equisetum* spores in Zone IM-1 are notable, since *Equisetum arvense* is the only representative of this family in the present landscape and has a very specific range on the revegetated dry grasslands of the study site.

The radiocarbon dates for the high ice zone (Fig. 2) indicate the difficulty of interpreting the stratigraphy. The anomalous date at 110-115 cm of 7950 ±110 yr B.P. could be an effect of the high ice content of this portion of the core. This date and the radiocarbon date at 95-110 cm of 8550 ±120 yr B.P. may be synchronous because of a greater likelihood of sediment mixing during this interval. The significance of the high ice zone is not clear, although the presence of bubbles in the ice indicates that melting subsequent to formation did not take place. The dates for the high ice section represent the youngest possible age limit, since redeposition of organic material from upslope till deposits could only increase the age of the sediment.

Pollen zone IM-2 is dated from 8500 yr B.P. to the present. Zonation is determined by the rise of *Alnus* pollen to >10% of the pollen sum. *Alnus* accounts for 20% of the pollen sum at 80 cm, which is dated to 4570 ± 70 yr B.P. This is a threshold level for distinguishing between the long-distance transport of *Alnus* pollen and the presence of the shrubs (Anderson and Brubaker, 1986). *Alnus* is not represented on the local Imnavait landscape today, although it does occur as part of the high shrub communities along river floodplains in the foothills region (Brown and Kreig, 1983). The rise in *Alnus* percentages at 8500 yr B.P. is a reflection of the establishment of *Alnus* as a sporadic floristic element in the region, while the second rise indicates the attainment of present-day distribution levels.

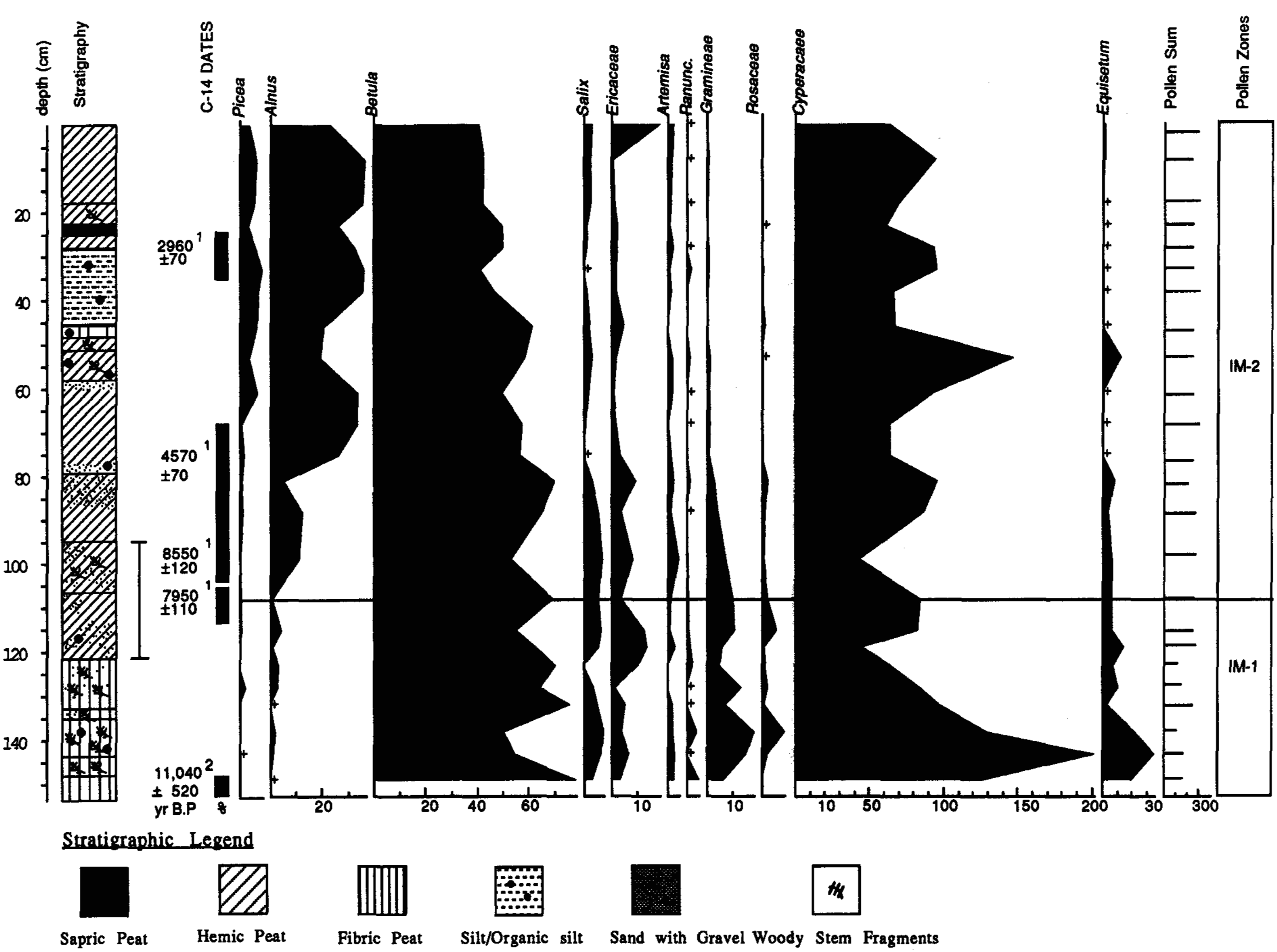

FIG. 2. Summary pollen percentage diagram of Imnavait Creek peat core. Pollen sum includes all identified, unidentifiable, and unknown grains. Cyperaceae and *Equisetum* grains are not included in the pollen sum but are expressed as percentages of the pollen sum. Note change in scale. Bracketed area delineates estimated area of 70-85% ice (highest ice content). Radiocarbon date sources: [1]D.M. Schell, pers. comm.; and [2]Geochron.

The *Alnus* rise has been traced from western Canada to Alaska (Barnosky *et al.*, 1987), and the Imnavait core agrees with the arrival dates at Hanging Lake in the northern Yukon at 8500 yr B.P. (Cwynar, 1982), Ped Pond in the Yukon lowlands at 8000 yr B.P. (Edwards and Brubaker, 1986), and in the Central Brooks Range by *ca.* 7000 yr B.P. (Brubaker *et al.*, 1983). The earlier date of 9500 yr B.P. (Bergstrom, 1984) for the rise in *Alnus* at Toolik Lake, 10 km south of Imnavait Creek, does not fit this pattern. Spruce pollen rises at 5000 yr B.P. in the diagram but remains under 10% of the pollen sum, representing long-distance transport that should not be taken as significant to tree-line migrations (Anderson and Brubaker, 1986).

The Imnavait core stratigraphy (Fig. 2) shows a complex record of mineral deposition and organic accumulation and decomposition over the last 11 000 yr. Preliminary comparisons of these changes with the pollen record raises the question of whether climate change was a primary factor affecting peat growth during the Holocene. The disruption of peat growth at about 45 cm and the overlying sapric, or highly decomposed peat, is not accompanied by varying pollen percentages, suggesting that this was a local event. The occurrence of this sharply defined humified layer overlain by a regrowth of peat, dated here at 2960 ±70 yr B.P., appears similar to recurrence surfaces found throughout northern Europe. Until recently, these were grouped into a single "Grenshorizont," allegedly caused by a major climatic change, and used as an absolute datum point. A reduction in peat accumulation rates at about 3000 yr B.P. has been noted in subarctic sites in northwestern Canada (Zoltai and Tarnocai, 1975; Ovenden, 1982, 1990). It would be premature to invoke a climatic explanation for the peat stratigraphy of the Imnavait core. Reappraisal of the European phenomenon has shown that the age of the humified layer can vary considerably within a single peat bog, which cautions against the invocation of climate as the only forcing agent (Frenzel, 1983). The macrofossil and pollen analysis of a peat section in the northern Yukon demonstrated that care is needed in reconstructing climatic events without data on edaphic processes (Ovenden, 1982). A transect of cores correlating changes in hydrology, vegetation, and climate, as proposed for future analysis, may clarify the processes that initiated peat humification.

Palynological data from lake cores are crucial to global climate modeling, but there is a lack of fine temporal and geographic control in arctic lake records because of a shortage of suitable sites, low organic levels, which limit dating precision, and the high influx of extra-regional pollen (Ager and Brubaker, 1985; Anderson, 1982). In the tussock tundra of the North Slope these problems are exacerbated by the lack of sensitive climatic and edaphic indicators. The Imnavait peat core demonstrates that a regional climatic signal can be obtained from peatlands. With good chronological control and careful evaluation of regional and local pollen spectra, it should be possible to reliably correlate lake sediment records with peat records.

Reviews of the vegetation history of eastern Beringia have suggested that since the pollen data reveal strong regional variations, research designs should emphasize meso-scale rather than global- and continental-scale reconstructions (Anderson, 1988; Ritchie, 1984). Peatlands offer records of site-specific phenomena, such as paludification, through which one may study the dynamics of arctic vegetation at the plant community level. The questions raised by the Imnavait peat core analysis emphasize the advantage of studying the dynamics of arctic vegetation history during the Holocene from the perspective of the ecosystem.

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