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Vegetation Response to Temperature Change on the Rwenzori Slopes, Western Uganda: Preliminary Results from Pollen Analysis

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Abstract

Several climatic periods, cooler than today, were evidenced on the Rwenzori Mountains, by the accumulation of moraines deposited by glaciers that advanced to lower altitudes on the mountain slopes. This paper provides evidence from pollen analysis that between ca. 9300 and ca. 6400 yr. B.P., *Hagenia abyssinica* and Ericaceae, trees typical of the junction bamboo-zone-ericaceous belt (altitude 3000 m), were distributed in significant abundance in the vegetation surrounding bog 2 (altitude 2500 m). This lowering of vegetation belts suggests climatic conditions cooler than today by about 3 ^{0}C. The co-existence of ericaceous vegetation and montane forest evidenced from ca. 9300 to ca. 6400 yr. B.P. is in agreement with the Omurubaho glaciation reported to have occurred on the Rwenzori from ca. 10 000 to ca. 5000 yr. B.P.

Keywords: Rwenzori, Moraines, Lapse rate, Omurubaho glaciation

1. Introduction

The sediment core 3 discussed in this paper was recovered by Dr. Henry Osmaston from a bog situated on the northern dipping ridge of the Rwenzori Mountain, Western Uganda. In one of the valleys on the ridge, at a point where the Bwamba Pass crosses the ridge at 2500 m, are found five almost circular depressions containing *Carex* and *Sphagnum* bogs. It is from one of these bogs that the sediment core 3 analysed for pollen presented in this paper was recovered. The location of core 3 is latitude 0^0 41' 16" N 30^0 07' 57", longitude 30^0 07' 57" E and altitude 2500 m. The ridges surrounding the bog are 15 to 10 m high in the south and east while in the west the ridges rise to 30 m. To the north, a rise of 1 m separates the cored bog from another bog. A small v-notch in the eastern side provides a small overflow of the water from the bog (Osmaston, personal notes).

1.1 Climate of the Rwenzori Region

Due to its location near the equator, the inter-tropical convergence zone (ITCZ) lies close to the mountain range for most of the year and supplements it with orographic rainfall. The southeast monsoon dominates in the region from April to October while the northeast monsoon dominates from October to March. There are incursions of moist westerly winds and dry northerly ones or occasionally southerly ones. Rainfall data is scares. Measurements have been done by Hauman (1933) and Osmaston (1965). The mean monthly rainfall in dry season June – July is less than 127 mm. The average monthly rainfall during the wet season August – December is 203 mm. The temperatures have been measured by Abruzzi (1907), Hauman (1933), Bergstrom (1955), Temple (1961) and Osmaston (1965). All these workers agree with a lapse rate of 2^0 C per 305 m.

1.2 Vegetation of Mount Rwenzori

Mount Rwenzori, though located in a Rift Valley, rises to 5109 m. Its vegetation communities display a zonal distribution linked to altitude and therefore to rainfall and temperature conditions. From the Rift Valley (619 m) is a dry savannah that passes upwards into Combretaceae woodland. Above 2000 m on the Rwenzori slopes, the woodland is replaced by a moist montane forest up to about 2400 m, bamboo zone from 2400 to 3000 m, heath vegetation from 3000 to 3800 m, afroalpine zone between 3800 and 4400 m, above which is the snow-cap (Eggeling, 1947, Hedberg, 1951, 1952, 1995).

The ridge top on which the cored bog is located is mainly bamboo forest dominated by *Arundinaria alpina* with scattered small trees and numerous ferns. The lower slopes to the east and west of the bog are occupied by *Prunus* moist montane forest, often with gaps occupied a tangle of climbers and Impatiens. Some parts of the lower slopes support a dry type of forest dominated by *Terminalia brownii*. Bamboo trees overhang the edge of the bog. Water of about 30 m deep form the outer zone of the bog. From here inwards is a belt of *Curex* sp. Juncus sp. Sphagnum sp. Orchidaceae, Asteraceae shrubs and *Stellaria* sp.. The Cyperaceae occupy the centre of the bog. The other plants growing on the bog are Labiatae, *Miscanthidium, Osmunda* and *Polypodium* (Osmaston, personal notes).

1.3 Materials and methods

Henry Osmaston cored the bog in August 1960 with a Jarret auger. Sampling was done as soon as the core was retrieved in the field and the sediments were put in glass bottles. The sampling interval is 5 or 10 cm. The sediments at the base of the core are fine silts alternating with layers of peat. Above 9400 cm it is stiff peat with much wood and other vegetation remains.

The chemical treatment that concentrated the pollen was done by S. Kyeyune following the Erdtman' method (1943). Pollen identification was based on a collection of reference slides made by Osmanston and publications (Bonnefille, 1971a, 1971b, Hamilton, 1976, Riollet and Bonnefille, 1976, Bonnefille and Riollet, 1980. A "Carl Zeiss D-7082 microscope was used for pollen identification and counting. In all samples analysed, the minimum counts of 200 grains of regional origin and at least 400 grains of total taxa were achieved. The only exceptions are levels 7.5 m and 76 m with 123 regional taxa out of 281 total pollen and 221 regional taxa out of 327 total pollen respectively. On the pollen diagram, the percentages of spores and aquatic taxa are calculated with respect to the pollen sum of all the identifiable pollen and spores. The percentages of arboreal, herbaceous and undifferentiated taxa (including unknowns) are calculated with respect to a sum of identifiable grains from which the spores and aquatic taxa have been excluded.

1.4 Dating

Beta-analytic (Florida, USA) provided a carbon-14 date of 8790 + 100 yr. B.P. for level 9.2 m. It was obtained by accelerator Mass Spectrometer analysis (Standard-AMS). Ages can be estimated on the sediments of this core using a date obtained on a volcanic tuff aged 4030 + 40 yr. B.P. located 1500 mm above the top of this core.

2. Results

Twenty-nine levels of short core 3 have been analysed and the spectra of the main taxa are shown in the pollen diagram (Figure 1). The later is divided into three zones. Zone 1 (10.45 to 10.35 m) is characterised by the scarcity of arboreal taxa, high abundance of grass pollen and small amounts of aquatic taxa.

Zone 2 (10.35 to 9.55 m) is marked by an increase in the abundance and diversity of taxa. The tree taxa: *Olea, Celtis, Macaranga, Chlorophora excelsa, Alchornea, Rapanea melanophloes, Schefflera, Croton* and *Ilex mitis* occur in significant abundance. *O*ccasionally, *Prunus africana, Dombeya, Afrocrania volkensii* and *Opilia* are significant. The non-arboreal and aquatic taxa are relatively abundant.

Zone 3 is characterised by the occurrence in significant amounts of the pollen of *Hagenia abyssinica* and Ericaceae. The pollen of *Olea* dominates the arboreal taxa followed *by Celtis*, *Macaranga, Chlorophora excelsa* and *Alchornea. Rapanea melanophloes, Schefflera, Croton*-type*, Afrocrania volkensii* and *Opilia* are occasionally significant. The non-arboreal taxa particularly the grass pollen, Urticaceae and *Tubuliflorae* are abundant. The aquatic taxa and spores are significant.

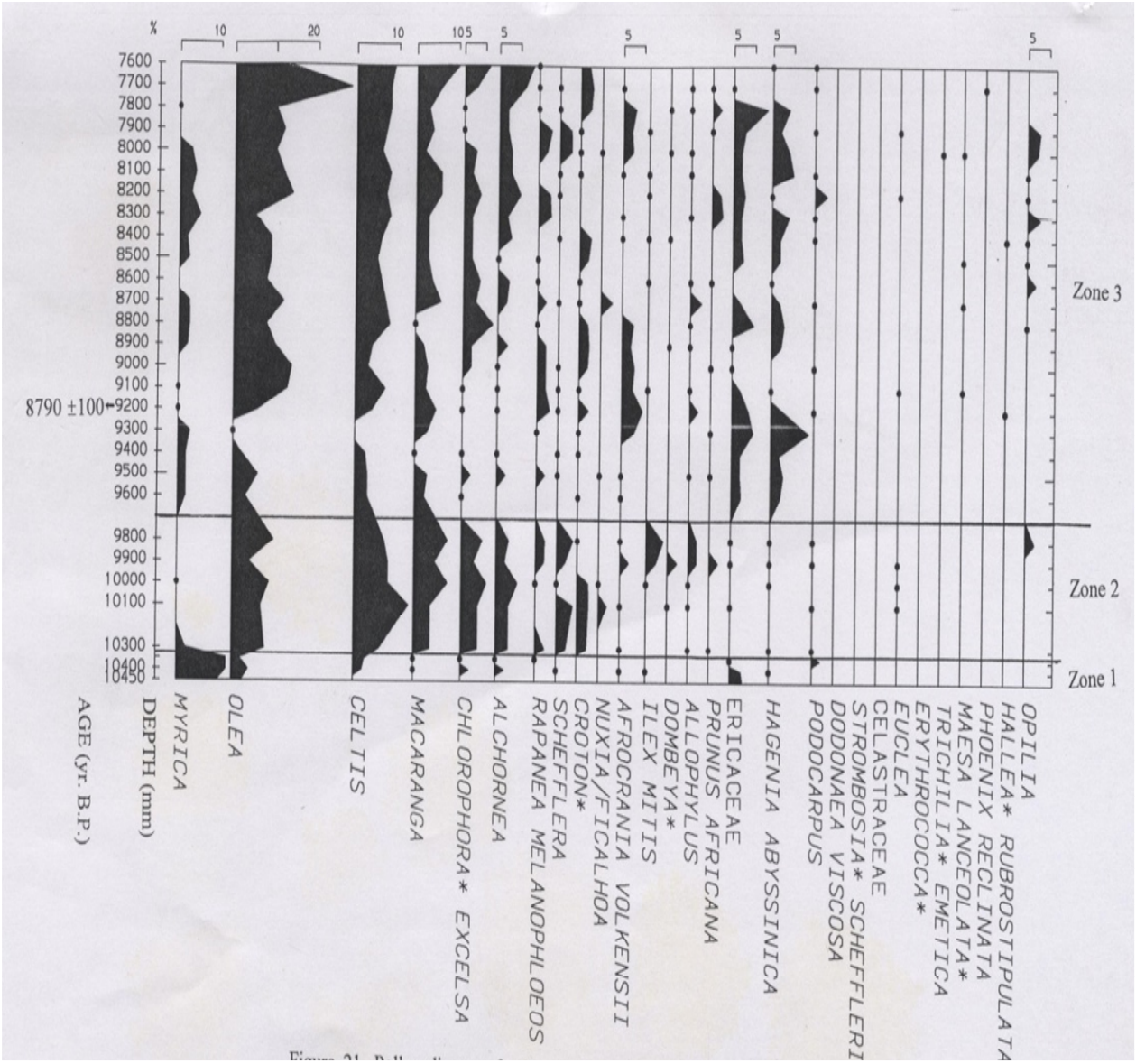
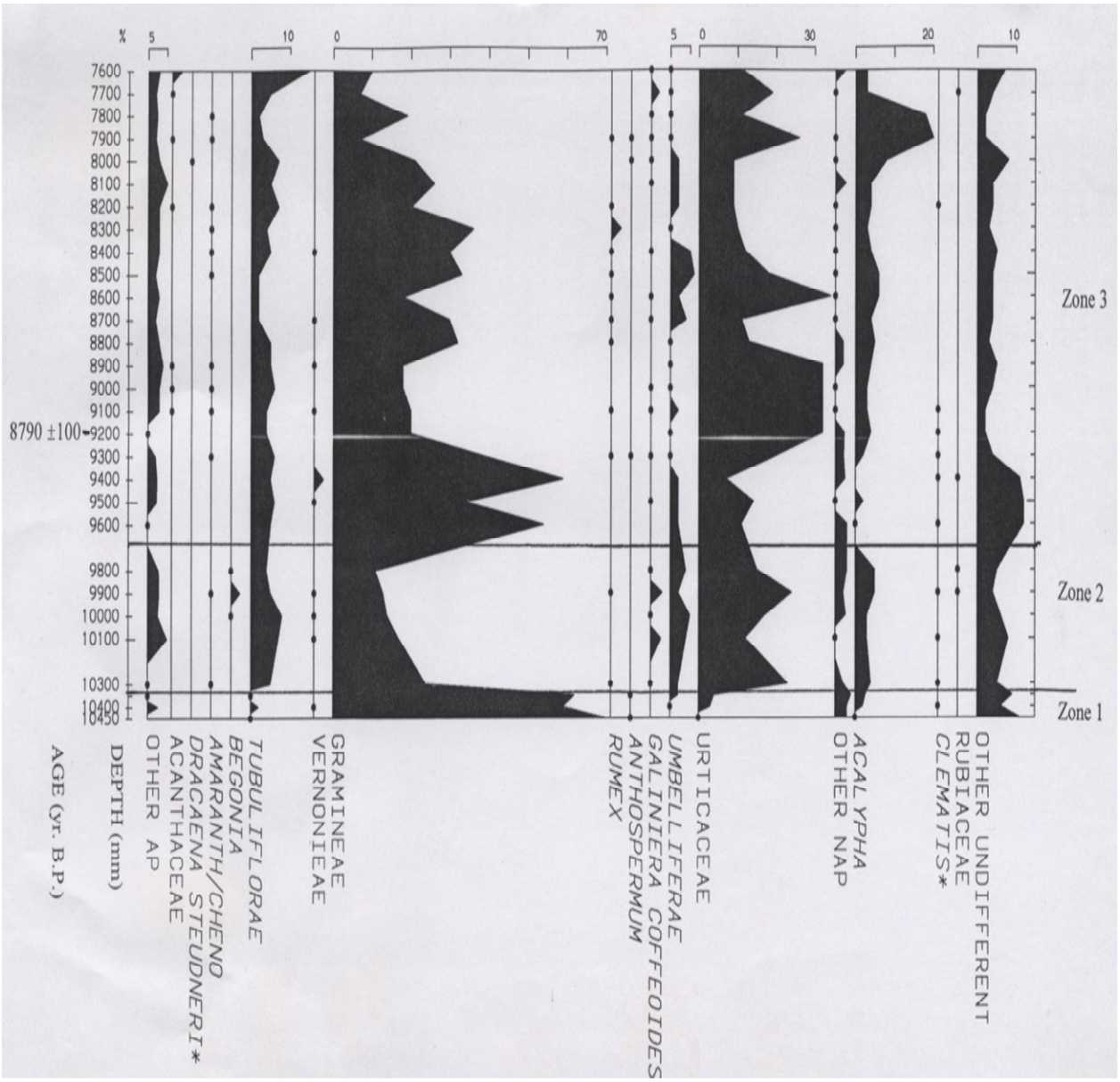


Figure 1. Pollen diagram. For aquatics and spores, the percentages are calculated using the sum of identifiable pollen and spores. For AP, NAP and Undifferentiated taxa the aquatics and spores are excluded from the sum.



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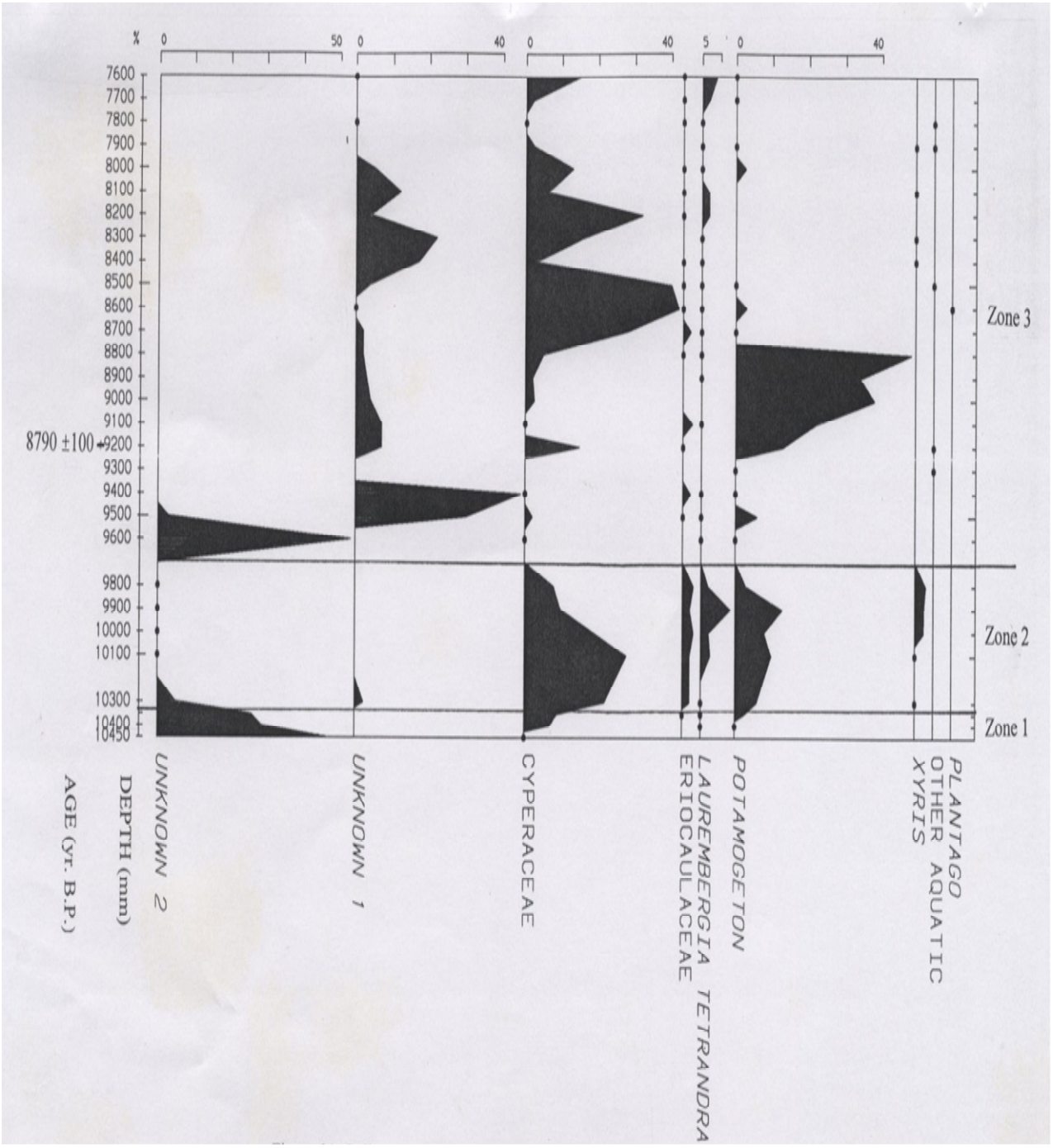

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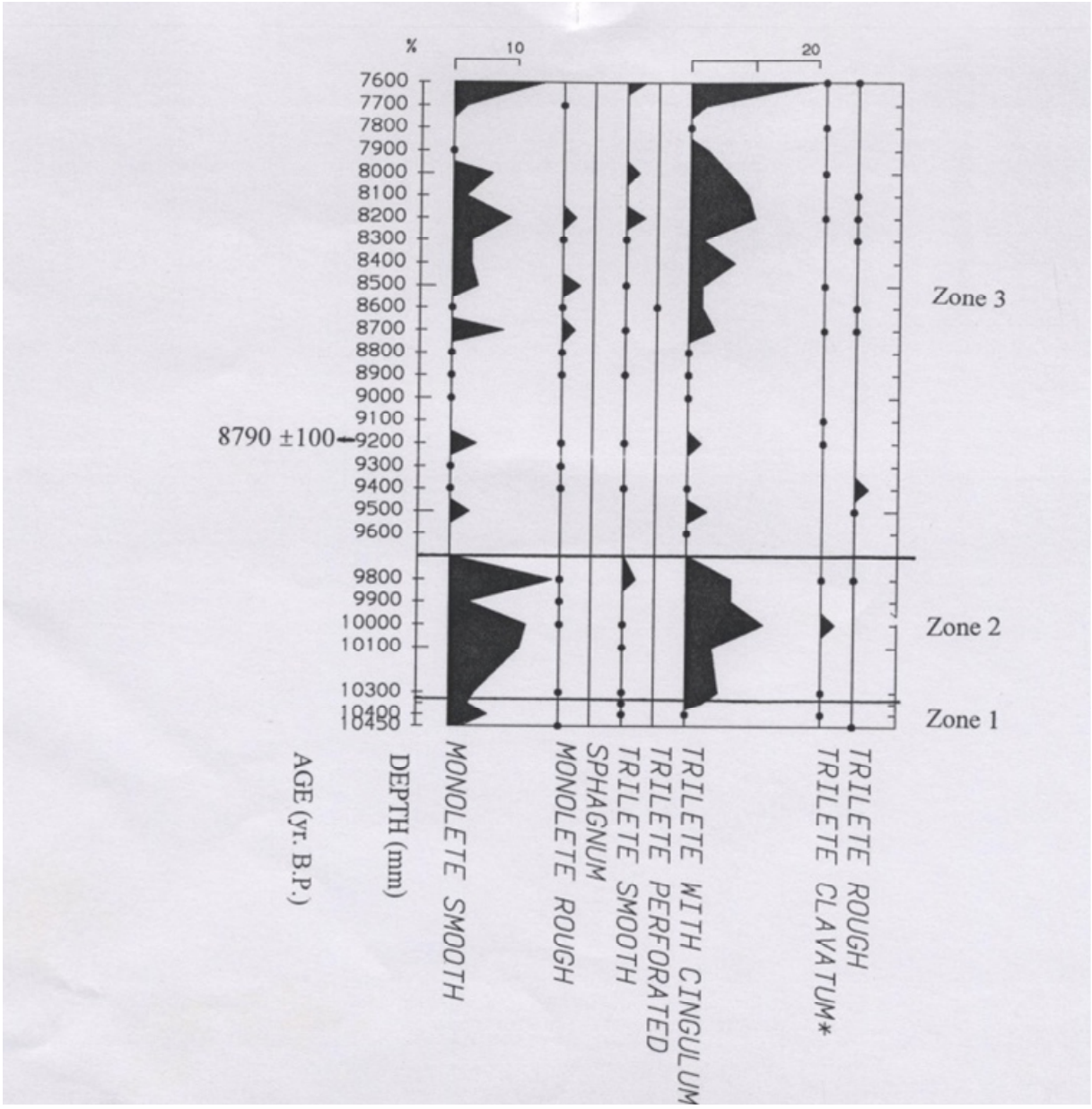

Figure 1. Pollen diagram. For aquatics and spores, the percentages are calculated using the sum of identifiable pollen and spores. For AP, NAP and Undifferentiated taxa the aquatics and spores are excluded from the sum.

3. Interpretation

Zone 1 (ca. 10700 to ca. 10500 yr. B.P.). The very low abundance of tree taxa suggest an open vegetation environment. The tree formations were greatly reduced and located far from the bog. *Myrica salicifolia*, being versatile, does not provide valuable information on ecology or climate of the time. The very high abundance of the unknown pollen 1 and 2 suggest that the plants that produced these pollens were most likely growing on the bog at the time. The grass pollen attests to an open vegetation environment on the Rwenzori slopes. The pollen data associated with rarity of aquatic taxa and Urticaceae infer a dry climate. The silty nature of the sediments supports this hypothesis.

Zone 2 (ca. 10500 to 9300 yr. B.P.). The trees in this zone attain 50% suggesting a significant geographic extension of forest around the bog. The occurrence of Umbelliferae may signify that local openings still existed in the stature of the montane forest. The sedimentological change from grey silt at 10.3 m to very slushy peat between 10.3 and 9.8 m supports the development of more vegetation cover and confirms the hypothesis of a more humid climate.

Zone 3 (ca. 9300 to 6400 yr. B.P.). During this time the existence of the montane forest near the cored site is evidenced by the presence of *Olea*, *Afrocrania volkensii, Croton*-type*, Prunus Africana* and *Schefflera.* The presence in significant abundance, of *Hagenia abyssinica* and Ericaceae at ca. 9300 yr. B.P., indicates occurrence at altitude 2500 m of taxa growing today at 3000 m. From that time until ca. 6400 yr. B.P., the bog was situated at the junction bamboo zone-ericaceous belt where *Hagenia abyssinica* grows. The occurrence of the *Hagenia* and Ericaceae at an altitude 500 m lower than their present level implies cooler climatic conditions than the previous period. Comparing with the present situation, the descent of 500 m in altitude and a lapse rate of 2 ^{0}C /305 m (Osmaston, 1965, 1989) suggests a reduction in temperature of about 3.2 ^{0}C. The high occurrences of non-arboreal taxa which include Umbelliferae indicate an open stature of the forested vegetation formations during this period. A sub-humid climate, cooler than today by about 3 ^{0}C is inferred. Probably the reduced evapo-transpiration contributed to this humidity.

4. Conclusion

During cold periods, the vegetation growing at high altitudes on Rwenzori Mountain is slowly redistributed into the vegetation at lower levels. Complete replacement may depend on the duration of the cold period. Various sites within the region evidence temperature decrease during the last glaciation and not for the early Holocene. Nevertheless, this date of ca. 8790 + 100 yr. B. P. is in agreement with the Omurubaho glaciation (Osmaston, 1967). More work on well dated cores will clarify these issues.

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