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CONTRIBUTIONS TO THE HOLOCENE VEGETATION HISTORY OF SOUTH TYROL: SCHNALSTAL - VAL SENALES

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ABSTRACT - *Contributions to the Holocene vegetation history of South Tyrol: Schnalstal - Val Senales* - Il Quaternario *Italian Journal of Quaternary Sciences* , 9(2), 1996, 649-652 -This study presents pollen analyses from sediments of an alpine basin (2,434 m a.s.l.) at Schnalstal, South Tyrol, that developed from a lake to a fen at the turn from Atlantic to Subboreal. Subalpine forest probably never reached this altitude, yet during Atlantic *Pinus* must have occupied extensive areas at little lower altitudes. Two main oscillations – known from adjacent Austrian Alps – may be recognized within the pollen diagrams: the late Atlantic "Rotmoos"-oscillation and the middle Subboreal "Löbben"-oscillation. The latter marks also the beginning of increasing anthropogenic influence. Since the beginning of Subatlantic the extensive pure *Larix* forests of Schnalstal have probably been favoured due to human activities.

RIASSUNTO - *Contributi alla storia vegetazionale del Sud Tirolo: Schnalstal - Val Senales* - Il Quaternario *Italian Journal of Quaternary Sciences* , 9(2), 1996, 649-652 - Questo studio presenta delle analisi polliniche di sedimenti di un bacino alpino di altitudine 2.434 m s.l.m.presso Schnalstal nel Sud Tirolo, che si è evoluto da lacustre a palustre al passaggio dall'Atlantico al Subboreale. La foresta subalpina non raggiunse mai tali altezze, per quanto durante l'Atlantico larghe zone ad altitudini di poco inferiori dovevano essere popolate da *Pinus*. Da quanto osservato nelle adiacenti Alpi austriache, nei diagrammi pollinici possono distinguirsi due oscillazioni principali: l'oscillazione detta "Rotmoos" in età tardo-Atlantica e qualla detta "Löbben" nel corso del Subboreale medio. Quest'ultima segna anche l'inizio dell'influenza umana. A partire del'inizio del Subatlantico, le estese foreste di *Larix* dello Schnalstal sono state probabilmente previlegiate a causa dell'attività antropica.

Keywords: Vegetation history, Holocene, pollen analysis, palynology, Schnalstal, South Tyrol
Parole chiave: Storia vegetazionale, Olocene, analisi pollinica, palinologia, Schnalstal, Sud Tirolo

1. INTRODUCTION

The postglacial vegetational development of the Alps shows a complicate horizontal and vertical pattern. Thus a dense grid of pollen analyses is important in order to get an adequate impression of immigration routes, succession and distribution of plants. According to Wahlmüller (1993) no palynological investigations have been done within Schnalstal and adjacent areas. These investigations are necessary to fill the gap between the well researched Ötztaler Alpen in North Tyrol (*e.g.* Bortenschlager, 1984) and the area of Brixen (*e.g.* Seiwald, 1980) and Bozen (*e.g.* Wahlmüller, 1990).

2. STUDY AREA

Schnalstal, a side valley of Vinschgau, is situated in northwestern South Tyrol between Ötztaler Alpen and Salurnkamm (Fig. 1). The area belongs to the eastern central alpine zone which is characterized by siliceous rocks (gneiss and schist) and by continental climate. Kurzras (2000 m a.s.l.), *e.g.*, at the end of Schnalstal has an annual precipitation of 661 mm (Pitschmann *et al.*, 1980).

The investigated site "Oberes Lazaunmoos" (46°45' N lat.; 10°45' E long.; max. diameter 70x40 m) is located WSW from the settlement Kurzras at an altitude of 2434 m a.s.l. The fen is developed in a 3.1 m deep basin at the foot of a moderately tilted plane in front of two low hills which act as barrier dividing the streams from the Lazaunglacier. Today there is no evidence of a direct flow of the glacier stream to the fen. The vegetation of the fen consists mainly of *Eriophorum angustifolium* and *Carex spp.*

The vegetation of the surroundings is dominated by low drained alpine grassland rich in sedges. The whole area is moderately to heavily grazed by cows, sheep and horses. Due to anthropogenic impacts by grazing and cutting, the present-day forest line formed by Siberian cedar (*Pinus cembra*) corresponds to the potential at few places only. According to own observations and literature from Ötztaler Alps (Schiechtl, 1970) the potential altitude of *Pinus cembra* forest covers up to 2200 m a.s.l. Common larch (*Larix decidua*) forms almost pure subalpine forests at lower altitudes. Due to low precipitation spruce (*Picea abies*) just grows on few places at altitudes below 1400 m a.s.l. (Pitschmann *et al.*, 1980). Dwarf shrubs (*Rhododendron ferrugineum, Vaccinium spp.*) occupy extensive areas between forest and alpine grassland.

3. METHODS

The corings have been done using a Russian sampler with a chamber length of 50 cm and a diameter of 4 cm in the centre of Oberes Lazaunmoos. There the basin reaches its maximum depth. In addition the first 50 cm have been dug.

One or 2 cm^3 material has been taken from the centre of the core at an interval of usually 5 cm. After adding exotic marker for absolute countings the samples have been treated by standard methods (described, *e.g.*, in Moore *et al.*, 1991). Samples with prevailing clay have been treated using ultrasonic tub. Finally the sam-

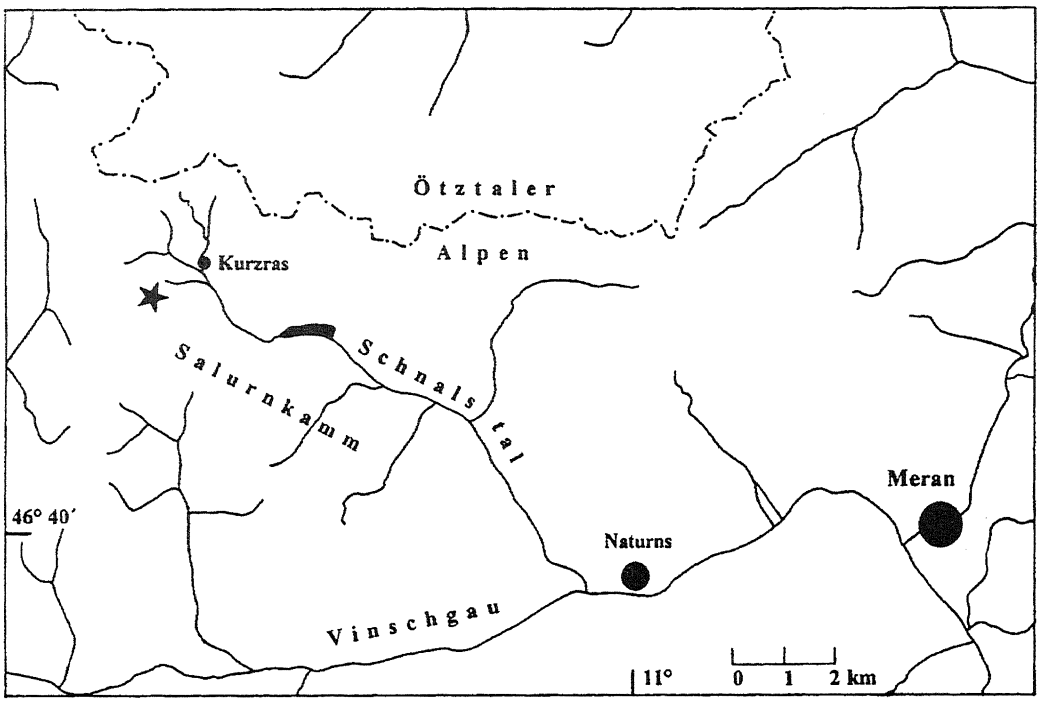

Fig. 1 - Map of NW South Tyrol. The investigated fen "Oberes Lazaunmoos" (2434 m a.s.l.) is indicated by an asterisk.

Cartina del Sud Tirolo nordoccidentale. L'area della palude di "Oberes Lazaunmoos" (2434 m s.l.m.). è indicata da un asterisco.

ples have been mounted in glycerine jelly.

The slides have been counted generally on 800 arboreal pollen grains supported by a computer program (Stumböck & Müller, 1996). The pollen diagrams have been plotted using "POLPROF" (Tranquillini, 1988). The pollen diagram in Figure 2 shows percentages calculated on the basis of all pollen and spore types excluding typical lake and fen vegetation *(Cyperaceae* and *Sparganium*). Figure 3 shows the corresponding concentration diagram.

The nomenclature of pollen types follows Moore *et al.* (1991). Pollen of *Pinus cembra* have been determined according to Klaus (1972). Yet it has to be pointed out that only distinctly recognizable pollen grains have been determined to *Pinus cembra.* Thus this pollen curve represents minimum values. For determination of pollen types the collection of the Botanical Institute of the University Innsbruck has been used.

The radiocarbon dates have been made at the R.J. Van de Graaff Laboratorium, University Utrecht, The Netherlands, using Accelerator Mass Spectrometry (AMS). The conventional ages below surface are:

3744 ± 40 a BP at 67.5 cm (UtC-Nr. 4116) – peat
4622 ± 44 a BP at 156.5 cm (UtC-Nr. 4117) – org. C
7250 ± 90 a BP at 221 cm (UtC-Nr. 3627) – seeds
7010 ± 50 a BP at 260.5 cm (UtC-Nr. 4118) – org. C

3.1 Palynostratigraphy

Six local pollen assamblage zones are recognized based on the percentage diagram:

LPAZ 1 has highest *Pinus* values. Other arboreal pollen and non arboreal pollen are low.

LPAZ 2 is characterized by decreasing *Pinus* and increasing *Picea* pollen. Non arboreal pollen types are low. *Sparganium* pollen are registered.

LPAZ 3 shows an expansion of non arboreal pollen based on *Poaceae.*

LPAZ 4 is characterized by decreasing values of *Poaceae* yet other non arboreal pollen types are comparatively high. *Cyperaceae* reach maximum values.

LPAZ 5 shows a peak of *Poaceae.* Other non arboreal pollen types are low.

LPAZ 6 shows highest *Alnus* values. *Larix* is increasing and *Pinus cembra* and *Picea* are decreasing. Non arboreal pollen types are continuously high. *Cyperaceae* are decreasing.

4. RESULTS AND DISCUSSION

The general features of "Oberes Lazaunmoos" resemble those gained from investigated fens of the Austrian Ötztaler Alpen, especially "Rotmoos" on 2260 m a.s.l. (Bortenschlager, 1970; 1984; Rybnicek & Rybnickova, 1977).

4.1 Tree line fluctuations

The timberline within most regions of the Central Alps did not rise above 2400 m a.s.l. during Holocene thus exceeding the recent potential timberline just 100–200 m (Bortenschlager, 1984; Lang, 1994). According to this the surroundings of "Oberes Lazaunmoos" never had any forests and up to now no evidence, *e.g.* needles or wood, has been found in its sediments. Yet according to high pollen contents in the diagrams *Pinus* grew at little lower altitudes. The *Pinus* curve summarizes all pines and separation between species is doubtful.

Just *Pinus cembra* may be recognized under favourable conditions (cf. Klaus, 1972). Yet according to altitude of "Oberes Lazaunmoos" the treeline species *Pinus cembra* and the shrubby *Pinus mugo* contribute most of *Pinus* pollen.

From very high percentages during the Atlantic, *Pinus* decreases to 50% at 190 cm followed by a short increase.

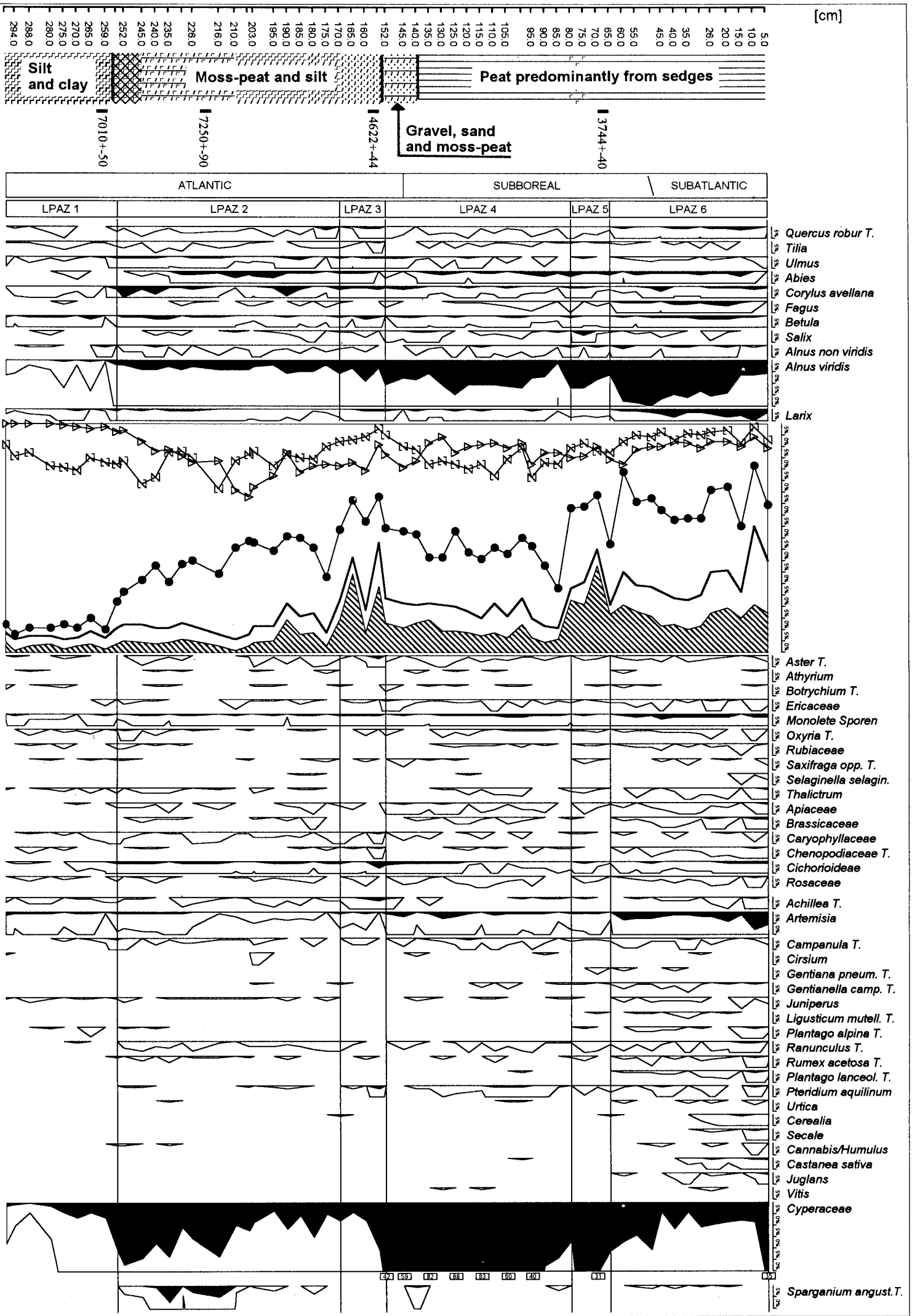

Fig. 2 - Simplified pollen percentage diagram of "Oberes Lazaunmoos". The percentages are calculated on the basis of all pollen and spore types excluding *Cyperaceae* and *Sparganium*. Main diagram: Δ = *Picea*; ● = *Pinus* total; Z = *Pinus cembra* ; the bold continuous line divides arboreal from non arboreal pollen; dashed area = *Poaceae*.

Diagramma pollinico percentuale semplificato del "Oberes Lazaunmoos". Le percentuali sono calcolate sulla base di tutti i tipi di pollini e spore presenti ad esclusione di Cyperaceae *e* Sparganium. *Diagramma principale:* Δ = Picea; ● = Pinus *(totale);* Z = Pinus cembra; *la linea continua in grassetto divide i pollini arborei dai non arborei; area tratteggiata* = Poaceae.

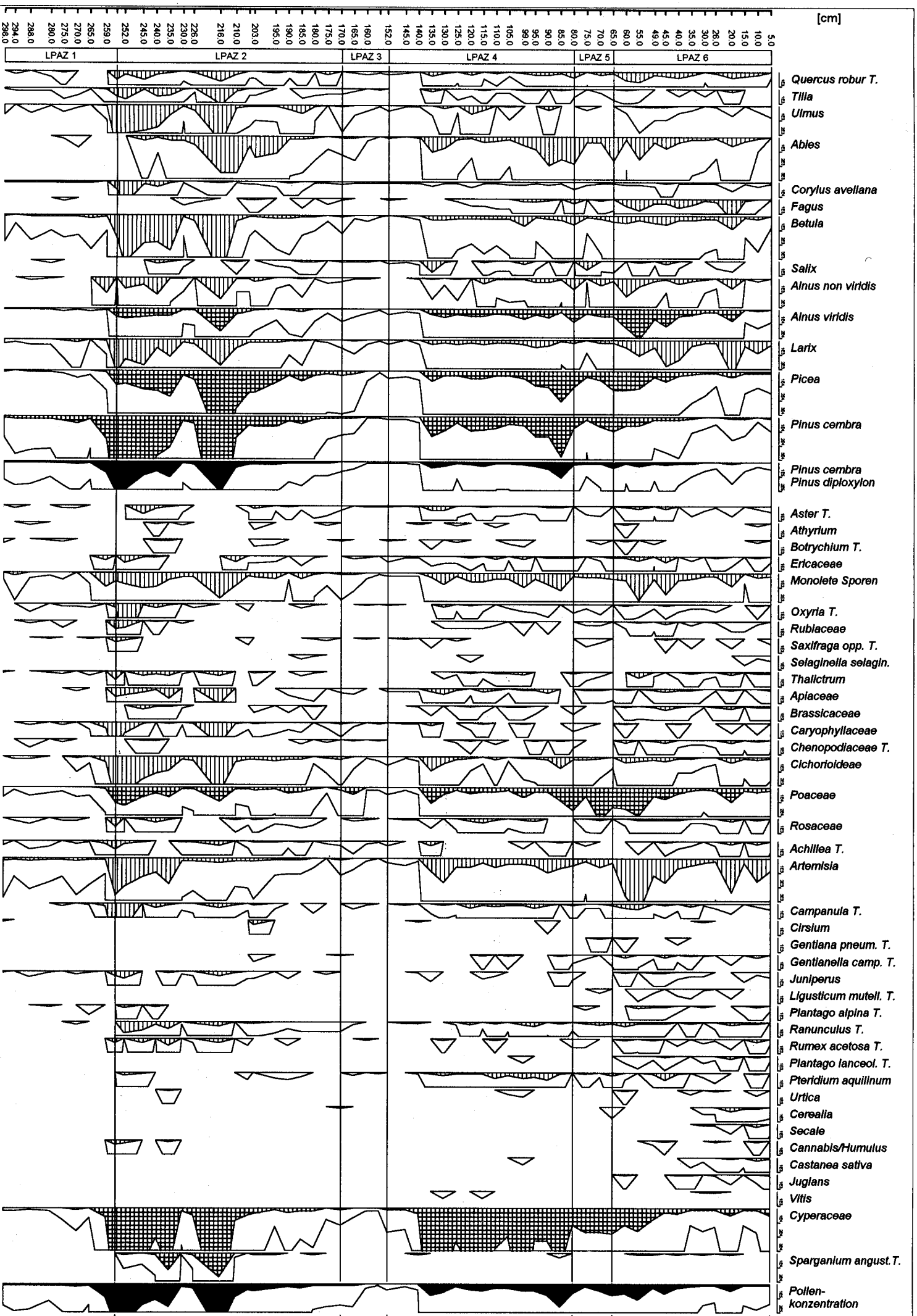

Fig. 3 - Simplified pollen concentration diagram of "Oberes Lazaunmoos". Dashed area = 1,000 pollen/cm^3; Squared area = 10,000 pollen/cm^3; Black area = 100,000 pollen/cm^3.
Diagramma semplificato della concentrazione di polline relativo a "Oberes Lazaunmoos". Area tratteggiata = 1.000 pollini/cm^3; area quadrettata = 10.000 pollini/cm^3; Area in nero = 100.000 pollini/cm^3.

The subsequent extreme decline of *Pinus* and other arboreal pollen and the increase of *Poaceae* around 4622 a BP may be attributed to the "Rotmoos"-oscillation. This oscillation has been described by Bortenschlager (1970) and Patzelt (1973) first from Rotmoos. According to these authors two climatically-induced oscillations (Rotmoos I and II) occured between 5500 and 4500 a BP depressing the timberline about 50 m in the Eastern Alps (Patzelt, 1975). The percentage diagram of "Oberes Lazaunmoos" shows two peaks of *Poaceae* at 155 cm and 165 cm. Yet within the concentration diagram just the peak at 165 cm is confirmed. The sediments consist mainly of gravel and sand. This may be assessed as a hint to changing environmental conditions caused by advancing glaciers.

After a time of raised timberline during early Subboreal another oscillation ("Löbben"-oscillation) at about 3500 a BP is described from Patzelt (1975), depressing the timberline within the Eastern Alps about 100 m. This oscillation may be recognized in the percentage and concentration diagram at 70 cm (3744 a BP) expressed by increasing *Poaceae* pollen. Several other oscillations (Patzelt, 1975) cannot be separated adequately within "Oberes Lazaunmoos".

The percentage and concentration diagram of "Oberes Lazaunmoos" show the expansion of *Picea* between 252 and 245 cm (around 7000 a BP). This is in accordance with Kral (1979) who states that *Picea* — coming from east — immigrated into this part of South Tyrol at the border from Boreal to Atlantic. To what extent *Picea* inhabited Schnalstal during Holocene may not be derived from the diagram. Yet the peak at 205 cm with more than 25% seems to show *Picea* at lower altitudes.

Nowadays *Picea* is restricted to few moister sites whereas pure *Larix* stands cover extensive areas of Schnalstal. The latter feature may not been found in adjacent Austrian Alps and the corresponding pollen diagrams show no continuous *Larix* curve (*e.g.* "Rotmoos" and "Schönwies" in Bortenschlager, 1984).

Pitschmann *et al.* (1980) claim that in contrast to other regions in the Alps the frequent occurrence of the light demanding *Larix* within Schnalstal is not due to cutting *Picea* but is caused by dry climatic conditions which prevent *Picea* and favour *Larix.*

Yet not only climatic conditions but human influence may have contributed to the pure *Larix* forest of Schnalstal. This is deduced from the percentage diagram which presents within the uppermost 65 cm a decrease of *Picea* and *Pinus cembra* combined with an strong increase in *Larix* pollen. The concentration diagram points out this *Larix* increase even more. *Larix* pollen are largely under-represented in pollen diagrams. Thus few percentages already give evidence for occurence in the area (Firbas, 1949; confirmed by others authors, *e.g.*, Ammann & Wick, 1992). Combined with growing human influence — as described below — the anthropogenic induced coming up of extensive *Larix* stands in Schnalstal since the beginning of Subatlantic seems to be evident.

4.2 Anthropogenic impact

An obvious hint at what time and to what extent the nearer surroundings of "Oberes Lazaunmoos" have been used for grazing by cattle may not be derived from the diagram. Yet the growing human influence at adjacent areas seems to be evident at least after the middle Subboreal (latest Neolithic period). After the above mentioned changes in the pollen diagram at 70 cm which are assigned to the Löbben-oscillation pollen types such as *Chenopodiaceae, Plantago lanceolata* and *Rumex acetosa* occur continuously. These taxa are characteristic anthropogenic indicators which might be expected around summer settlements. At 60 cm a secondary maximum of non arboreal pollen types occurs. These types show highest amounts throughout Subatlantic. From about 40 cm the anthropochorous *Castanea* and *Juglans* come up consistently and mark the beginning of historical time.

The obvious human influence expressed within the pollen diagram of "Oberes Lazaunmoos" coincides with investigations from adjacent Austrian Central Alps which show distinct anthropogenic activities from about 3200 a BP (Vorren *et al.*, 1993).

4.3 Development from a lake to a fen

During early Atlantic a lake existed at "Oberes Lazaunmoos". This is deduced from the almost pure silty and clayey lacustrine sediments. Pollen of *Cyperaceae* have low percentages and may derive from adjacent alpine grasslands as well as from the peaty border of the lake. Later pollen from water plants of *Typha angustifolia* type are registered. This type includes also different species of *Sparganium* (Punt, 1975). *Sparganium angustifolium* — characteristic for oligotrophic lakes — is the only one occuring in subalpine areas. Therefore it may be concluded that this species populated the lake during early and middle Atlantic. This opinion is supported by a distribution map of Biologisches Landeslabor (1991) and own observations which show this water plant nowadays in an adjacent lake.

At the end of Atlantic the basin is filled up with sediments to such an extent that intensive growth of *Cyperaceae* takes place starting from a time of rapid deposition of sand and gravel poor in pollen.

Subsequently the sediments consist of peat predominantly from *Cyperaceae* and reach accumulation rates of approximately 1 mm/a during early and middle Subboreal. This period coincides strongly with the highest *Cyperaceae* pollen percentages. The decline of *Cyperaceae* pollen up to recent times might be due to deteriorating growth conditions because of hydrological reasons or increasing grazing pressure.

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