Transhumance in Mountain Areas : Additional Interpretation of Three Pollen Diagrams from Norway, Portugal and Switzerland

Abstract

Three selected pollen diagrams from three different mountainous areas in Europe have been re-interpreted. Evidence of former endo- and epizoic transport of lowland weed-pollen into areas at and above the treeline is found. The amounts of such pollen in such areas are, to a great extent, dependent of the movements of domestic animals from low to high altitudes, while the influence of grazing and wind dispersal is, in general of less importance.

For the three localities studied, a general increase in animal movements is seen around the birth of Christ.

Introduction

Several pollen diagrams from high altitudes have been published in the last few years as part of various kinds of present or past vegetation studies, often in interdisciplinary projects (e.g. Moe, 1973, 1978; Ammann, 1976; Indrelid and Moe, 1982; Van den Brink & Janssen, 1985; Moe *et al.*, 1988). Pollen of agricultural weeds that are commonly found in lowland pollen diagrams, are often encountered in these mountain pollen diagrams above the altitudinal limits of weeds today, sometimes as isolated grains and sometimes as continuous curves over several spectra. With some exceptions, such finds have been interpreted as wind-transported pollen from lowland areas. Moe (1973), however, proposed an alternative hypothesis, namely endo- and epizoic spread of pollen from weeds and fodder plants, and illustrated the idea with a pollen diagram from the Norwegian mountains above the treeline.

In this paper, the hypothesis of endo- and epizoic pollen transport is reconsidered in the light of this diagram (Ustetind loc. 11, Norway (Moe, 1973)), a pollen diagram from Portugal (Lagoa Comprida 2 (Van den Brink and Janssen, 1985)), and a pollen diagram from Switzerland (Oberaar P2 (Ammann, 1976)).

Endo- and epizoic pollen transport

The three diagrams, Ustetind loc. 11, Lagoa Comprida 2 and Oberaar P2, have been chosen because of consistent location in mountain areas, figure 1, above or close to the present tree-line, and the presence of several pollen types derived from weeds (e.g. *Plantago lanceolata, P. major, Artemisia, Urtica, Chenopodium*) and from Cerealia growing in lowland areas but not in the mountains today, in the following named « lowland weed-pollen » (in short LWP). The establishment of endo- and epizoic pollen transport is based primarily on these types. An additional interpretation of these and other diagrams in terms of endo- and epizoic pollen transport is based on pollen types from other weeds or crop plants growing in lowland areas (table 1). Isolated occurrences of LWP grains resulting in discontinuous curves are present in most pollen diagrams from mountainous areas. Wind transport of LWP from the valleys at lower altitudes into the mountains always plays a role and is in many cases the only or the most important component. This can also be the case near seters (i.e. summer-farming settlements ; see e.g. Fjellset loc. 7 in table 1, where LWP values are not or hardly higher than in localities away from the seters and mountain trackways). This is explained as the combined result of wind transport and endo- and epizoic transport.

An indirect effect of endo- and epizoic transport can be the transport of seeds, some of which are able to germinate in the mountains and produce flowers and pollen for a season or two. In table 1, Hein loc. 14, is exceptional in that the LWP curve is continuous but a main track nearby is not known, but it might have been there in former times.

Moe (1973) discusses another possible source of LWP in the mountains, namely plants producing this pollen growing above their usual altitudinal limits. This occurs from time to time and is probably mainly due to endo- and epizoic transport of seeds. However, the plant populations originating in this way are usually scarce, small and short-lived. This is shown today in the Hardangervidda, a high mountain area in Norway in which the flora is well-known and the vegetation is partially mapped (Lid, 1959).

In earlier periods of the Holocene, the Boreal and the Atlantic (Moe *et al.*, 1988) when the climate was warmer (especially Boreal) than at present, the altitudinal limits of weeds may have been somewhat more higher. Additional possible sources LWP in the diagrams could be contamination in the laboratory and reworking from other deposits, but these can be safely excluded.

Pollen studies of sheep's faecal pellets (Moe, 1983) and of wool (Moe and Balle, 1981) show a great variation in compostion, depending on the pollen content in the sheep's fodder in relation to season and to grazing patterns of the sheep. The sheep's stomachs contain great quantities of pollen from the lowland, especially from the fodder plants, in spring when the flocks are moved up the mountain. The droppings of the first days after leaving the lowlands contain more LWP than those of later days, since the turn-over of the stomach content is 3-5 days. LWP percentages at a mountain or a high mountain locality can therefore be assumed to be increased by the number of « first visits » by domestic animals from the lowland, but not by the number of animal grazing or « grazing-days » (number of animals x days of grazing) there during the summer. On the other hand, the effect of grazing on the local vegetation depends, of course, on the number of « grazing days », and does not depend on the number of « first visits ».

Concentrations and percentages of LWP are therefore expected to be higher along paths and trackways in the mountains coming from the lowlands, and lower away from these tracks and also near summer-farming settlements, where limited numbers of animals are kept throughout the summer. As an illustration of the last may be mentioned the following. During a phytosociological study in the mountain area, Stigstuv, ca. 30 km SW of Ustetind mountain, Table 1, at 1310 m a.s.l., the absence of lowland weeds in the vegetation was confirmed and the presence of grazing animals throughout the summer was observed during a 5 year period (IBP-project, Lye and Lauritzen, 1975). Interestingly, LWP is virtually absent in the superficial samples of Stigstuv loc. 24, a locality situated within the studied grazed area (Moe, 1978).

Pollen of many sheep fodder plants cannot be identified to specific or generic level, e.g. Gramineae (excl. Cerealia) and Compositae liguliflorae. Plant species producing these pollen types grow both at low and at high altitudes. For this reason, pollen occurrences of such plants cannot be very informative about endo- and epizoic pollen transport. On the other hand, pollen occurrences of plants having an altitudinal limit below the tree-line or close to it and producing pollen which can be identified to species or generic level, such as *Plantago lanceolata* and Cerealia, can be very informative. Most informative in many instances is *Plantago lanceolata*, since the plants are very common in lowland dry meadow hay pastures and they are a most suitable fodder plant for sheep (who also disperse the seeds). Its pollen can be well presented in faecal pellets. As an example, *P. lanceolata* pollen reached 23 % of total pollen in fresh sheep dropping collected in the lowlands during spring (Moe, 1983).

Localities and available data

1. *USTETIND loc. 11* (Moe, 1973). Norway : Hardangervidda, alt. 1310 m a.s.l., 1,2 km NE of the mountain Ustetind.

The site is located 200-250 m above the present tree-line near the old mountaintrack « Den nordlige Nordmannslepa » crossing the mountain from west to east. The trackway was used for sheep and cow transport into the mountain in spring and back into the lowlands in the autumn. The trackway was also one of the official « main roads » crossing this part of the country. Except for this track, no historical records of former land use or archaeological sites are known from this area, in spite of archaeological searches. Percentages of *P. lanceolata* in the diagram, figure 3, exceed those in nearby diagrams from the same altitude away from the track. They exceed even those in diagrams from sites 200-250 m lower, situated within the present-day climatic tree-line (e.g. Ustetind loc. 9, Bog loc. 13, and Halnefjord loc. 14 (Moe, 1978)). *P. lanceolata* pollen and other LWP are also absent in Fjellsetergrend loc. 7 (Moe, 1978) situated in the tree-line and near to a seter at 1140 m a.s.l. This seter has been in continuous use every summer for the last 300 years up to 1950. The altitudinal limit of *P. lanceolata* plants in the area is 1000 m a.s.l.

The mountain track was almost certainly used in recent historical times, but the use of the track dates most likely back to 1,400 B.P. or earlier, based on finds of *P. lanceolata* pollen inferred to have been transported endo- and epizoochorically.

2. *Lagoa Comprida 2* (Van den Brink and Janssen, 1985). Portugal : Serra Estrêla, alt. 1600 m a.s.l.

No information is available for the archaeology in the area. In the Serra da Estrêla, traditional movements of large sheep flocks from the lowlands into the favourable summer pastures in the mountains are recorded (Martinho, 1978, 1980; Ribeiro, 1940-41), but the tracks used are unfortunately not mapped.

Trees are very scarce due to heavy grazing, but the present-day tree-line is formed by *Quercus pyrenaica* a typical feature and seem to be situated at ca. 1500 m (Braun-Blanquet *et al.*, 1952). However, according to Delvosalle and Duvigneaud (1962) it may have been higher (up to 1600 m) and depressed later by excessive grazing. LWP is present, figure 4, especially *Plantago lanceolata* ; the species has an altitudinal limit several hundred metres below the site. Pollen of *Halimium alyssoides* might be indicative of the presence of mountain tracks, since the most abundant occurrence of the species today is in over-grazed heathlands were most of the soil is eroded, such as along these tracks. *Secale* is in the Serra Estrêla exceptional in its cultivation up to 1600 metres and even nearby the site today.

3. *Oberaar P2* (Ammann, 1976). Switzerland : eastern part of the Berner Alps, near the mountain Finsteraarhorn, 6 km SW of the Grimsel Pass, alt. ca. 2320 m a.s.l.

No information is available on the historic or prehistoric use of the area, but in figures 1 and 2 in Ammann (1976) a mountain track named Gletscherweg is marked on the northern side of the Oberaar valley. This trackway passes near the site only a few metres away. The local vegetation is described by Ammann (1979). The flora and vegetation are influenced by the nearby glacier, Oberaargletscher, and vary from different kinds of pioneer vegetation to a poorly developed *Juniperus-Arctostaphylos* dwarf-shrub heath. The tree-line in the area is c. 2000 m (Hess *et al.*, 1967). Fossil wood

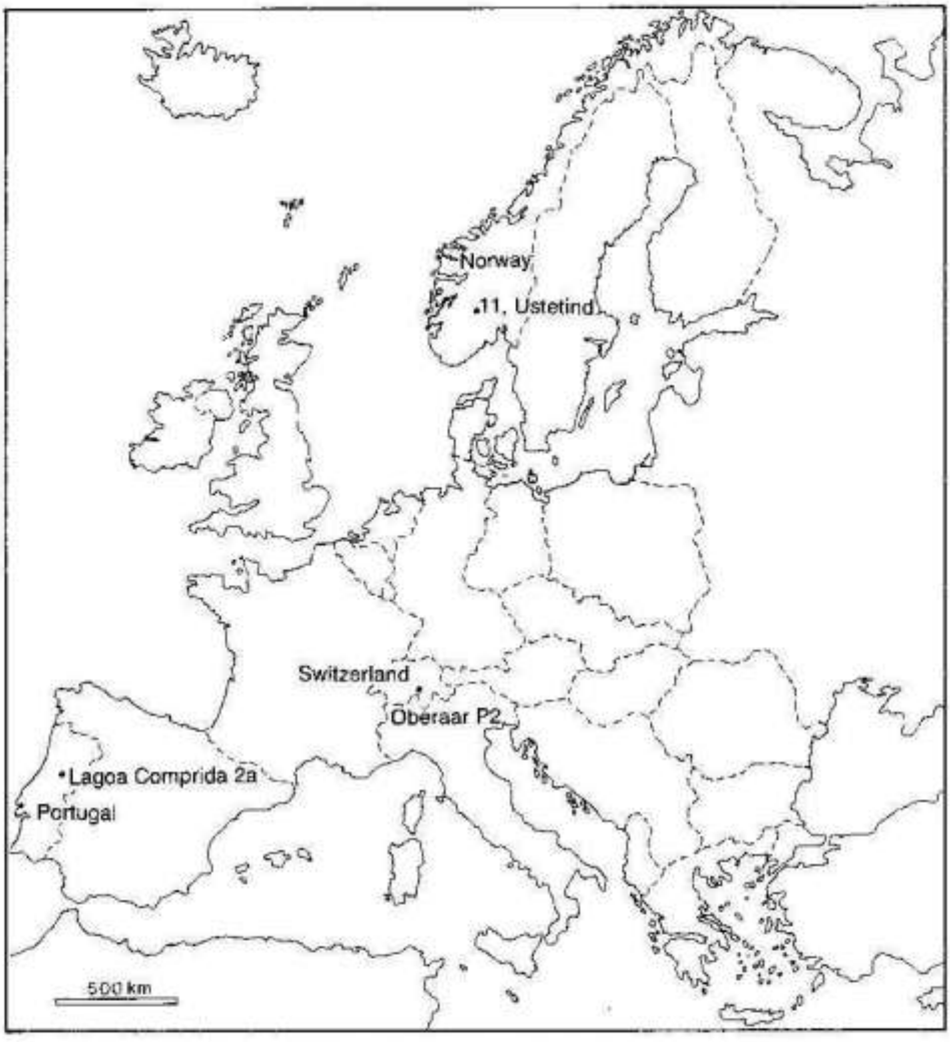

Fig. 1. Map of Europe indicating the sites discussed.

of *Pinus cembra* from the Oberaar valley above the present tree-line has been dated 4,600 ± 80 B.P. (Ammann, 1976). Ammann concluded in the discussion of this most impressive pollen diagram, figure 5, that a number of pollen types (*Chenopodium* type, *Plantago lanceolata, P. major*, Cerealia, *Urtica dioica*) indicate agricultural activities at lower altitudes. In his opinion, this pollen is transported in some way from the lowland up into the mountain areas. The altitudinal limits for natural growth of the relevant weeds and of cereals are well below the site.

Interpretation

The three pollen diagrams discussed here are considered as case studies

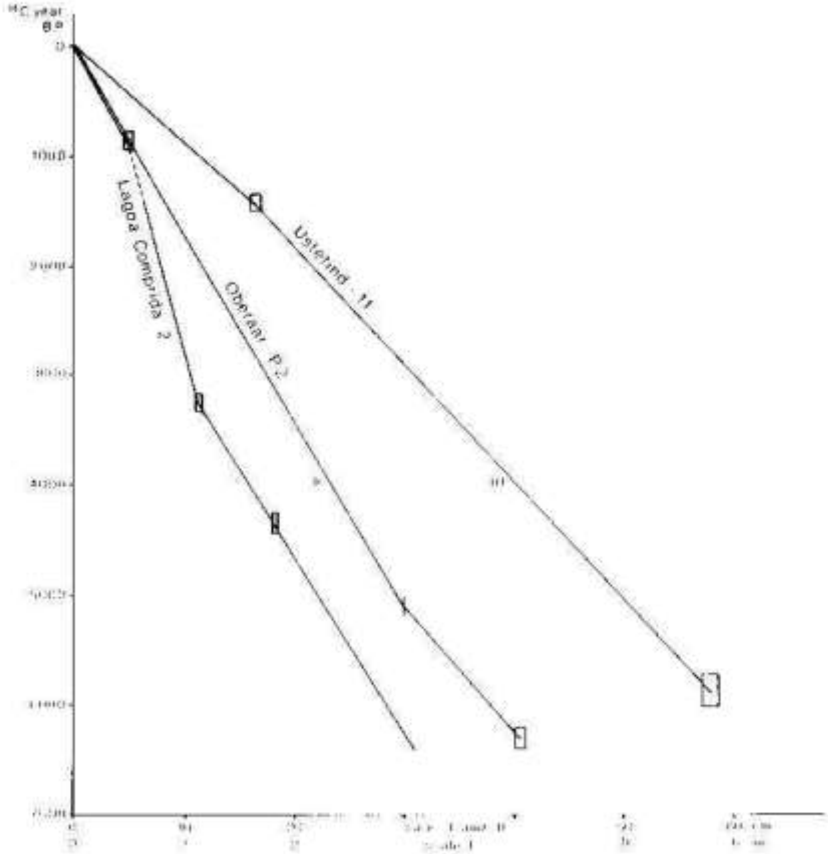

Fig. 2. Accumulation curves for the three diagrams discussed. Note the differences in scale on the X-axis.

from three different mountain areas. The areas were used by man in historical times, but are probably different in past human impact.

1. *Ustetind loc. 11* (Norway), figure 3.

Past human impact has been studied in detail in the Halne area as well as the whole Hardangervidda area (e.g. Moe *et al.*, 1988) near the Ustetind loc. 11 site. Periods were established with different grazing intensities, based on a large number of archaeological sites, artefacts, datings, and on LWP (*Plantago lanceolata, P. major, Urtica, Artemisia* and Cerealia). Relatively high values in the LWP curve are interpreted as periods with endo- and epizoic pollen transport from lowland areas. These periods were dated (1) c. 4,000-c. 3,500 B.P. (2) a short period around 3,000 B.P., and (3) c. 2,200 B.P.-A.D. 1,900. Endo- and epizoic pollen transport appeared to have been most intensive in several intervals during the last two millennia. When the curve of *Artemisia* alone is interpreted along the same lines as the LWP taxa

Loc. 11. Bog, 1310m.s.m., 1,2km NE of Ustetind, Hol, Buskerud, UTM MN512038.

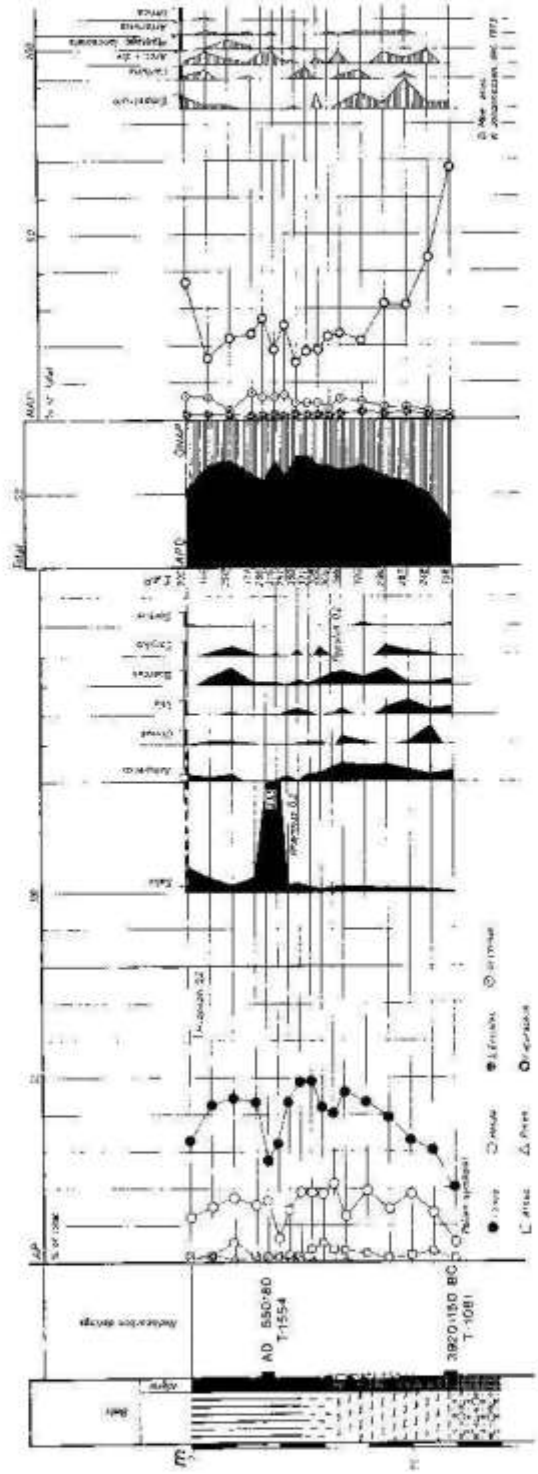

Fig. 3. Simplified diagram for Ustetind Loc. 11, Norway. (After Moe, 1973).

together, additional periods of activity between 5,000 B.P. and 3,500 B.P. can be suggested.

2. *Lagoa Comprida 2* (Portugal) figure 4.

Van den Brink and Janssen (1985) concluded that vegetation types heavily grazed by domestic animals are represented in the two upper zones, 7 and 8 (see Janssen and Woldringh 1981). Some minor changes in the diagram, not discussed by Van den Brink and Janssen, are interpreted here in terms of past human impact and endo- and epizoic pollen transport.

The first, weak indication of human influence is reflected at the transition from zones 4 to 5, close to 5,400 B.P., by the increase of *Erica arborea* and *E. australis* pollen types, suggesting local grazing. An increase of Gramineae and Ericaceae pollen in zones 5 and 6 also point to local grazing. But only in zone 7 are there indications of possible endo- and epizoic transport of LWP up the mountain.

The datings are rough estimates based on the accumulation curve, figure 2. The occurrence and increase of *Plantago lanceolata* and other types at 55 cm are dated to 1,700 B.P. Based on the curve for *P. lanceolata*, a period of endo- and epizoic pollen transport starts around 1,700 B.P., continuing to the present day. Increasing values of *Halimium* pollen at 55 cm may also indicate the presence of a mountain track near to the site. The interpretation of the increasing pollen values of *Secale* at c. 3,300 B.P. and the resumption at ca. 2,200 B.P. are more uncertain. Local occurrence of *S. cereale* combined with endo- and epizoic spread of pollen, or a general change in the vegetation, human economy, and land use are all possible.

3. *Oberaar P2* (Switzerland) figure 5.

Ignoring the isolated occurrence of *Chenopodium* type in the spectra below 12 cm and the peak of *Plantago lanceolata* pollen at the bottom layer, a general start of several LWP types, although in low percentages, is observed at 12 cm. At 8 cm occurrences of LWP types can be observed ; four spectra have values of more than 0,5 % of LWP (calculated on pollen sums generally of above 1100 grains). The interpolated age of the level of 12 cm is around 2,000 B.P., and that for 8 cm is around 1,300 B.P. It seems most likely that the traffic along the mountain track passing near the site has not only influenced the local vegetation through opening-up of the vegetation cover and the soil and through the introduction of seeds, but has also influenced the pollen deposition close to the track through endo- and epizoic pollen transport.

Final comments

Endo- and epizoic spread of pollen takes place, both at low and at high altitudes. This enables us to use palynology in the study of historic and

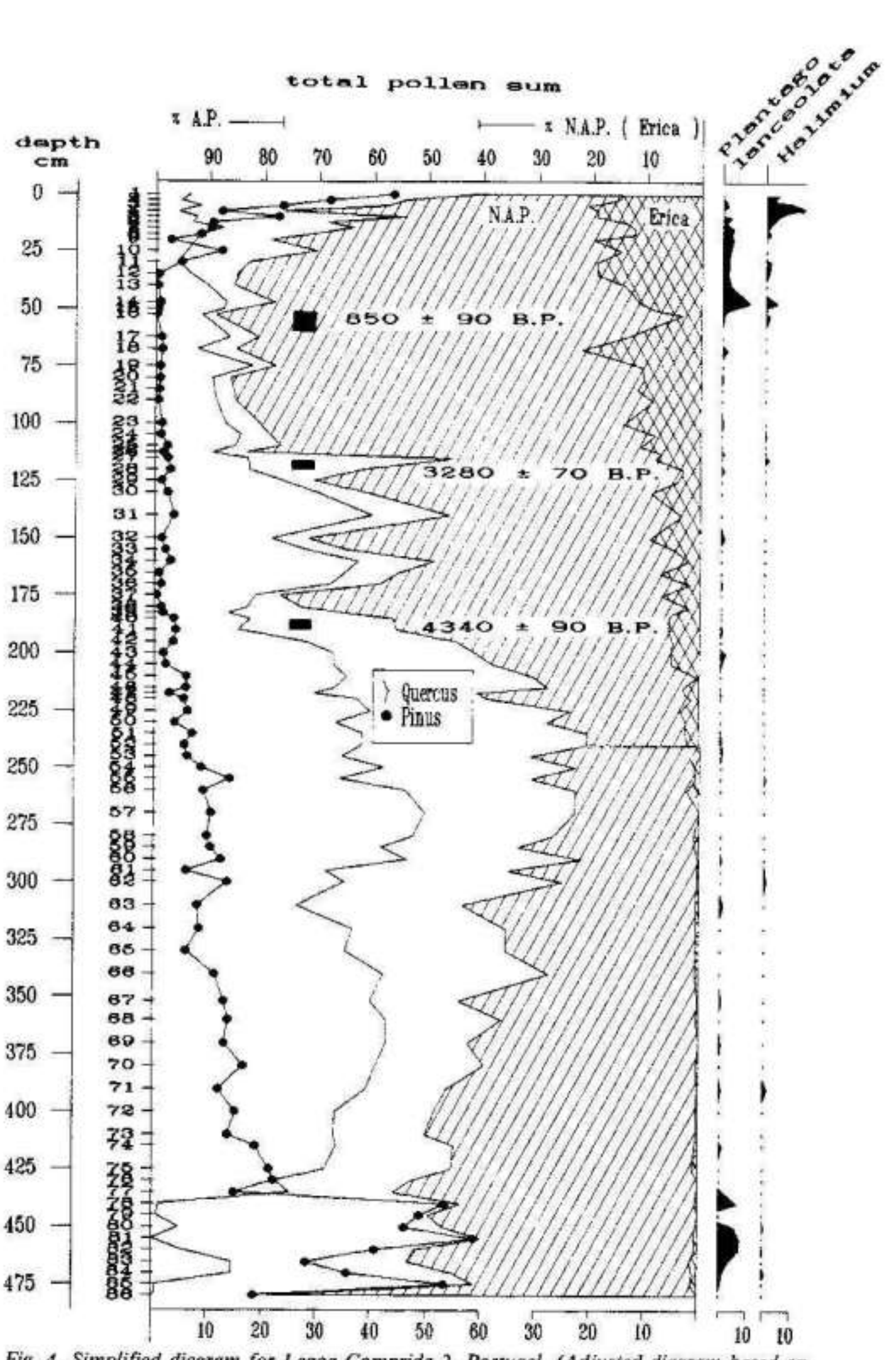

Fig. 4. Simplified diagram for Lagoa Comprida 2, Portugal. (Adjusted diagram based on Brink and Janssen 1985).

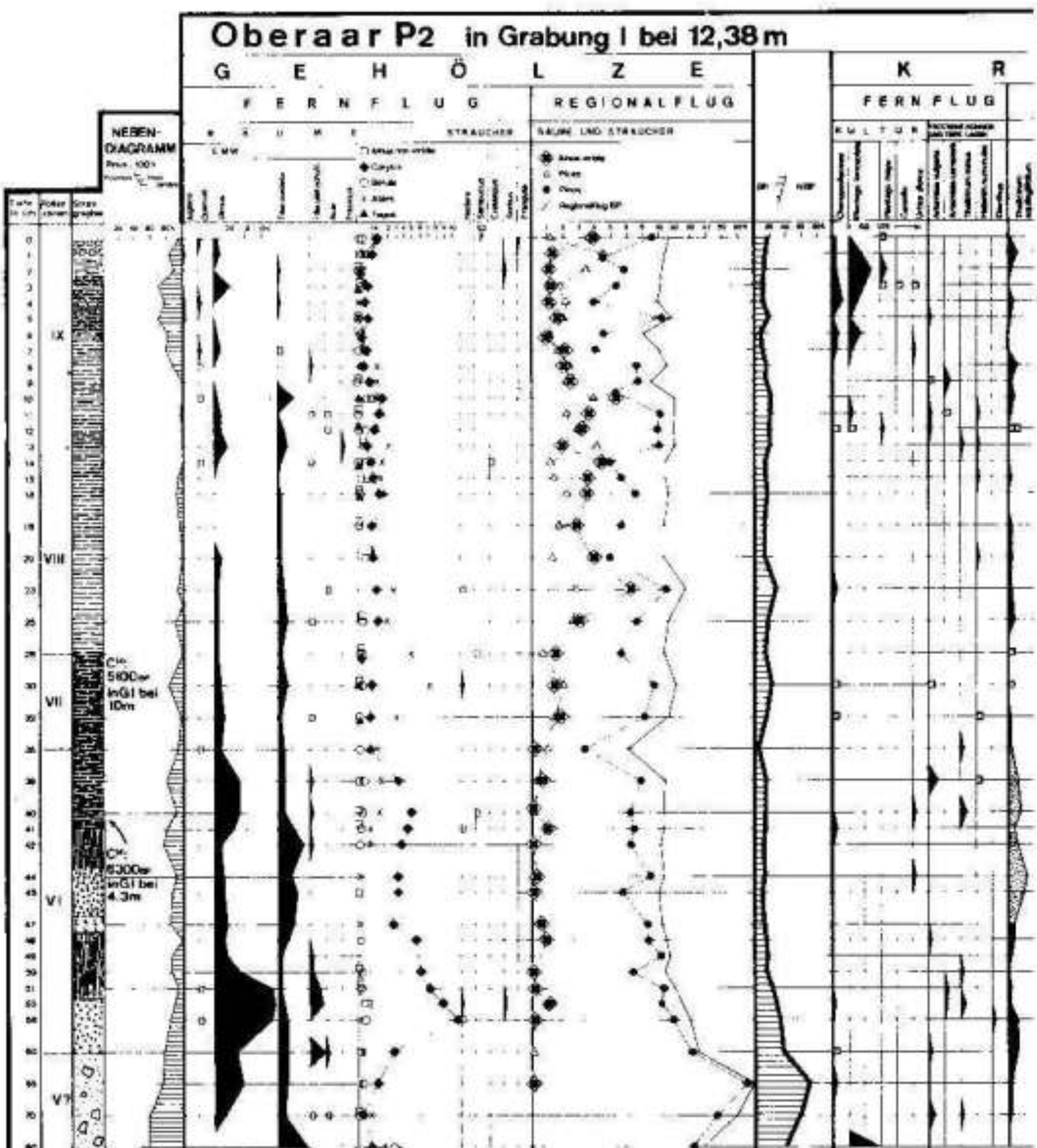

Fig. 5. Simplified diagram for Oberaar P32, Switzerland. (After Ammann, 1976).

prehistoric use of so-called marginal areas. Requirements for tracing by means of palynology the earlier movements of domestic animals are knowledge of past local vegetation and past altitudinal limits of weeds, fodder plants and other plants, knowledge of flowering seasons, and the ability to identify many pollen types to specific or generic level.

High percentages in diagrams from mountain areas at or above the tree-

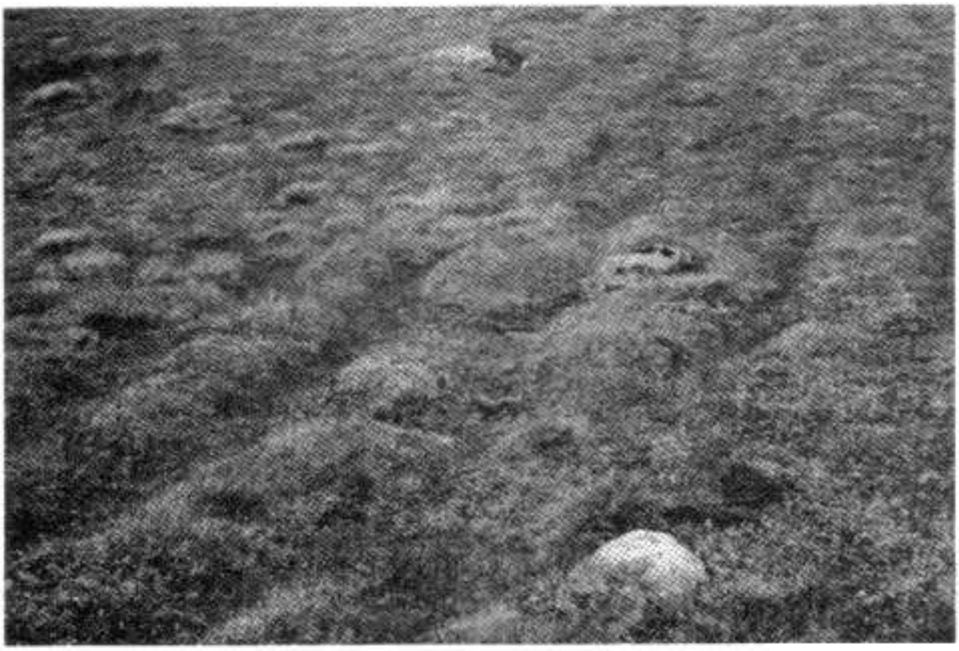

Fig. 6. The old trackway, « Den nordlige Nordmannslepa » at Hardangervidda, South Norway easily visible after nearly 100 years out of use. (From the Ustetind area).

line of pollen of weeds and cultivated plants restricted to the lowlands today can indicate the presence near the site of mountain trackways coming from the lowland, and need not directly be associated with intensively used areas in the mountains themselves. For that reason, archaeological sites need not be associated with such high pollen percentages.

The ideas presented here may be useful to distinguish between heavily grazed mountain areas, little grazed mountain areas, and mountain tracks for domestic animals, - often little grazed too.

ACKNOWLEDGMENTS

We would like to thank dr. Klaus Ammann and prof. em. Knut Faegri for comments and information, Mrs. Siri Herland for preparation of the illustrations, and prof. H.J.B. Birks for comments and linguistic improvements.

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Table 1.

The amount of lowland weed pollen (LWP) in next-to-surface samples taken less than 100 m from sites with known historic and prehistoric human activity. The sites all lie in the Norwegian mountain area of Hardangervidda. Next-to-surface samples are used instead of surface samples because of recent changes in land use and construction of a new railroad through the area in this century. Most sites are described in Moe (1978).

Explanation of sign used : * = also described in Indrelid and Moe (1982), references for other sites are given in parentheses ; t = known main track nearby ; s = seter (summerfarm) nearby. Sometimes the ending *set* means seter) ; a = archaeological site nearby ; LWP = lowland weed pollen, including *Plantago lanceolata*, type, *P. major*, *Urtica*, *Artemisia*, and some isolated grains of *Chenopodium* and *Centaurea cyanus* ; + = occurrence of LWP in slides outside the counting ; c = continuous registration of LWP in the adjacent spectra below the next-to-surface sample ; A.P. = arboreal pollen (tree pollen).

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