Tree-Line and Human Influence in the Serra da Estrela, Portugal

The recognition, in pollen diagrams, of the former tree-line and past human influence at different altitudes in the Serra da Estrela, Portugal.

Preliminary results

A long-term project at the Laboratory of Palaeobotany and Palynology (Utrecht) aims to study the vegetational development of four contrasting West European mountain ranges. The Serra da Estrela in Central East Portugal constitutes the southern-most mountain range within the study area. It is a granitic mountain range up to 1992 m high and is characterized, when compared with the three other mountain ranges, by a definite mediterranean mountain flora and climate. Peat deposits and lake sediments suitable for palynological and macro-palaeobotanical research are present in the central part of the mountains from 1400 m upwards.

The history of vegetation since the last glaciation was studied, by means of palynology, from deposits at a series of sites along an altitudinal transect located within a relatively small area. Interpretation in terms of past vegetation is enhanced by studying of patterns in present day pollen deposition in relation to vegetation together with the subfossil pollen in the deposits. Recent pollen deposition and vegetation have been studied along a transect 32 km long and c. 3 km wide across the mountain ranges for which the altitudinal vegetation zones have been described. Palynological research on deposits from seven sites at 1400 m, 1650 m (three sites), 1725 m, 1790 m and 1830 m is now almost complete.

The deposits have been studied in great detail, for both pollen and macro-fossils. A pollen diagram for the site at 1400 m (Candeeira) serves as a standard for the entire area, since it covers the period from the Late-Glacial up to the present day.

Construction of the comparative diagram

1. Sites

Complete pollen diagrams covering most of the last c. 10,000 years were made for sites at three different altitudes : 1400 m, 1650 m and 1830 m. These were used to construct a comparative diagram.

2. Pollen sum

The choice of pollen sum is important, since it determines the validity and meaning of pollen percentages comparisons between sites. Types which have been excluded from the pollen sum are derived predominantly from aquatic plants (mainly *Ranunculus* subgenus *Batrachium*, *Potamogeton* spp., *Sparganium* spp. and the amphibian grass *Antinoria agrostidea*) and types derived from mire plants (mainly Gramineae and Cyperaceae species, *Potentilla erecta, Galium saxatile, Betula celtiberica, Dryopteris* and *Athyrium*).

The curves of most of the excluded types differ strongly between sites. This is related to differences in former local conditions such as water depth, presence of mire vegetation around the lakes studied and the character of the local mire vegetation. Types included in the pollen sum are derived exclusively from upland plants. The trends in these pollen curves seem to be dependent solely on changes in upland vegetation and independent of local changes in lake levels and mire vegetation. Among those excluded from the pollen sum several types are probably also produced in rather large quantities by upland plants, for example Gramineae (many common upland species) and *Galium* type (*G. hercynicum*, abundant in both wet and dry habitats), but they had to be excluded because of their high (in many cases non-synchronous) percentages in parts of the diagrams.

3. Chronology

The chronology of the 1400-m diagram is based on 16 radiocarbon dates. The events in this diagram are therefore well-dated. Since the 1650-m and 1830-m diagrams are less well-dated (3 and 5 radiocarbon dates respectively), the chronological correlation of the diagrams is only partially based on radiocarbon dates. Additional chronological correlation is based on common trends in regional pollen types, such as parts of the curves for *Pinus, Alnus, Pteridium, Asphodelus, Cerealia, Olea, Fraxinus excelsior*.

It was noted in other mountain areas, such as the Vosges and the Forez (both in France), that vegetational events in one part of an area were reflected in deposits in other parts of that area so that the pollen diagrams showed a number of common trends. With the help of these trends, autochthonous and allochthonous elements in pollen deposition could be separated out and the pollen assemblages from different sites correlated in time. For the 1650-m and 1830-m Serra da Estrela diagrams, as far as was possible, levels synchronous with levels in the 1400-m diagram were traced.

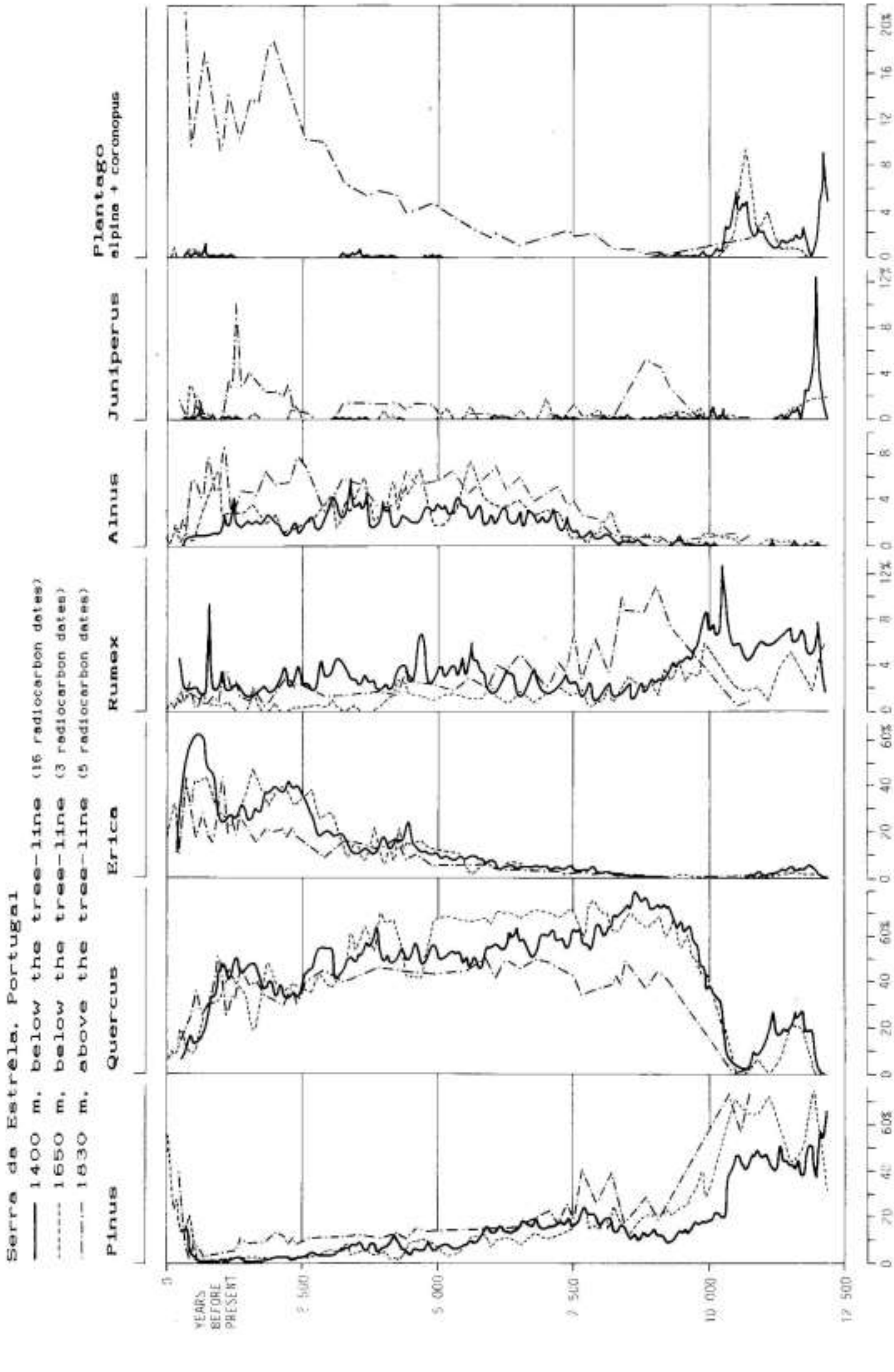

Fig. 1. Comparison of sites at different altitudes. Chronological correlation based on radiocarbon dates and common trends in regional pollen types.

The levels from the 1400-m diagram have been used as a relative time scale in the comparative diagram.

Discussion of the comparative diagram

QUERCUS. A comparison between the *Quercus* curves shows that a decline in *Quercus* forest is apparent at 1400 m and 1650 m but not at 1830 m. The timber line has always been situated between 1650 m and 1830 m : *Quercus* trees have, in the past, grown around the sites at 1400 m and 1650 m, but never around the site at 1830 m. The highest historically-documented occurrences of *Q. pyrenaica* are from 19th century at an altitude of 1750 m.

ERICA (Incl. *E. arborea*, *E. australis* and *E. umbellata*, distinguishable by pollen type). The *Erica* curve shows a continuing opening up of the forests. The site at 1830 m is above the general, upper limit for *Erica*, so pollen deposition there must be regional. The sites at 1400 m and 1650 m are within the *Erica* zone, and the increased *Erica* values in the upper few spectra indicate the final destruction of the *Quercus* forests.

PINUS. The similarities in the pollen percentages for the sites at 1400 m, 1650 m and 1830 m indicate that *Pinus* grew outside the study area. The late-glacial *Pinus* forests apparently never completely disappeared.

ALNUS. *Alnus*, like *Pinus*, apparently grew outside the area, as it still does today. The differences in *Alnus* percentages between the sites are not well understood.

HUMAN INFLUENCE. In the 1400-m diagram, the first indications of human influence are visible even before the *Quercus* forests reached their maximum expansion around 8,700 years B.P. These are the simultaneous appearance of Cerealia, *Asphodelus* and *Pteridium* pollen. Former human influence above the timber line (site at 1830 m; probably grazing and burning, as is the practice today) is reflected in a strong decline in local *Rumex* plants and in an increase in local *Plantago alpina/P. coronopus* plants. A similar, though weaker pattern, is obvious at 1650 m. At 1400 m, *P. alpina/P. coronopus* plants seem to have disappeared with the spread of *Quercus* forests while *Rumex* plants were diminished to a low but constant abundance. Today, plants of *Rumex acetosella* grow abundantly around all three sites. In spite of the differences between their pollen curves, plants of *Plantago alpina/P. coronopus* today around all three sites today, although in increasing abundance towards higher altitudes.

Discussion of pollen diagrams for 1400 m, 1650 m and 1830 m (not included).

Human influence in the vicinity of the sites (« local » human influence) is reflected in the curves for *Rumex* (*R. acetosella*), *Erica, Calluna, Cerealia, Genista, Sarothamnus, Merendera, Halimium (H. alyssoides), Juniperus, Plantago alpina*, and *P. coronopus*. However (1), the ways in which these pollen types reflect local human influence are different for different altitudes, and (2) the form and intensity of human influence during a particular period is often different for different altitudes. This is shown in the following interpretations :

In the 1830-m diagram, the rise in *Juniperus*, *Plantago alpina* and *P. coronopus* at a depth of 155 cm (cf. 1400 m : 300 cm) is interpreted as the establishment of regular grazing practices above the timber line. The fall in *Juniperus* and *Rumex acetosella* values at a depth of 85 cm (cf. 1400 m : 130 cm) are interpreted as the start of over-grazing and burning in this area; while increased *Erica* values at the same level probably have their origin in the establishment of regular grazing practices and deforestation at lower altitudes, i.e. on the plateau between 1600 m and 1750 m (where *Erica* species are now abundant). At 1650 m and 1830 m, no clear response by *Juniperus, Plantago alpina* and *P. coronopus* to (over-) grazing was observed in the diagrams, while the response of *Erica* is much stronger in the 1650-m than in the 1830-m diagram.

Merendera pyrenaica, which is *Colchicum*-like in appearance, is today found on stony soils. It is found mainly on heavily trampled, thin (1-10 cm) soil layers, which are poor in organic material and directly overly granitic bedrock. It is especially abundant at the resting places for flocks of sheep and goats, and is therefore indicative of grazing and local over-grazing. At 1830 m, *Merendera* pollen first appears at 220 cm (cf. 1400 m : 420 cm).

Additional indications of grazing at this level are the decrease in *Rumex acetosella* values and the increase in *Calluna* and *Erica* values. At 1400 m, *Merendera* does not appear until a depth of 320 cm, which is some 700 years after its first appearance at the 1830-m site. Here it also coincides with an increase in *Erica* values, although *Rumex* and *Calluna* values remain unaffected. At 1650 m, *Merendera* was not distinguished from other pollen types.

At 1400 m, a slight rise in *Genista* and *Sarothamnus* values at a depth of 550 cm coincides with a marked, but temporary, fall in Cerealia. This points to an abandonment of *Secale* fields and an overgrowth of these fields with brooms (*Genista, Cytisus, Sarothamnus*). *Erica* values at this level are constant or decrease slightly.

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References

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