

**PALYNOLOGICAL AND PALEOECOLOGICAL INVESTIGATIONS
IN THE VOSGES (FRANCE):
A RESEARCH PROJECT**

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SUMMARY

In order to reconstruct the Late- and Post-glacial vegetation development of a west-eastern belt in the Vosges (France) palynological and paleo-ecological investigations were made.

One map and five simplified diagrams are shown and will be discussed. The map shows the area in study. On basis of differences in geology and relief the area has been divided into five regions. In this paper the central region receives most interest.

A diagram of surface samples taken on a mountain summit, shows the local and/or regional deposition of several pollentypes. These results are used for the interpretation of pollendiagrams and it is possible to base a zonation on regional pollentypes as far as late Post-glacial pollendiagrams are concerned. In two diagrams the trends in the curves of some regional pollentypes have been correlated to historical events and it also seems possible to reconstruct fluctuations of the upper forest limit.

Figure 6 shows differences in pollen percentages in profiles of two bogs, which may be due to the existence of a vegetation zonation in the older Post-glacial.

INTRODUCTION

In 1966 a long-term palynological project started in order to reconstruct the Late- and Postglacial vegetation at various altitudes above sealevel in adjacent regions across the main chain of the Vosges mountains in eastern France. The key to the past is the present and thus insight in the composition and structure of the actual vegetation is necessary to understand the composition of past plant communities. Much of the development of the vegetation depends on, among other things, soils and glacial history.

For these reasons the palynological and paleoecological research is carried out in a team ("Werkgroep Voegen". State University, Utrecht) engaged in studies on the present vegetation and studies on soils and glacial geomorphology.

**SELECTION OF THE AREA, GENERAL
CHARACTERISTICS OF VEGETATION
AND ENVIRONMENT**

A west-eastern belt, ca. 70 km long and 30-40 km wide across the mountains was selected as the principle area of study (fig. 1).

Due to differences in elevation, climate, parent material and soils a large variety of vegetation types exists.

From north-west to east the following regions may be distinguished:

1. In the northwest, towards the Paris basin, calcareous soils on Muschelkalk prevail at altitudes around 300 m above sea level. On account of the fertility of the soil much of the original plant cover has been removed and replaced by fields. In vestigial woods *Quercus robur*, *Ulmus carpinifolia*, *Carpinus betulus* and *Tilia cordata* are the dominant trees.
2. A belt of sandstones of Triassic age. At present this area is occupied by pine plantations, but prior to 1820-30 heath prevailed (G u i l l e t, 1971; D i o n, 1970).
3. A large area of acid hercynic rocks. In the western most part patches of sandstone are present on top of the hills but elsewhere these sediments were removed long ago. On account of altitude and differences in precipitation the diversity in the vegetation is large. This area may be subdivided tentatively into 4 subregions:
 - a.) a subregion west of the main chain of the Vosges, up to ca. 1000 m altitude. The eastern boundary of this region would be approximately the valley of the Chajoux and Lac de Longemer. In general the forest vegetation is a montane, mixed *Abies alba-Fagus sylvatica* forest. In the upper altitudinal reaches *Fagus* becomes more important and penetrates the forest as an equal of *Abies*. However it never becomes the sole constituent in the treelayer. In many localities plantations of *Picea abies* have replaced the original forest since the 19th century.
 - b.) A central subregion with altitudes up to 1360 m. Precipitation is around 2200 mm/year. In our research area three main mountain chains may be

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Fig. 2
Simplified pollen diagram of surface samples, Kastelberg.

KASTELBERG

SURFACE SAMPLES
TRANSECT B

Main vegetation types

Sample nrs.

Distance (m)

REGIONAL POLLEN

TYPES

Quercus

Carpinus

Tilia

Ulmus

LOCAL POLLEN TYPES

Fagus

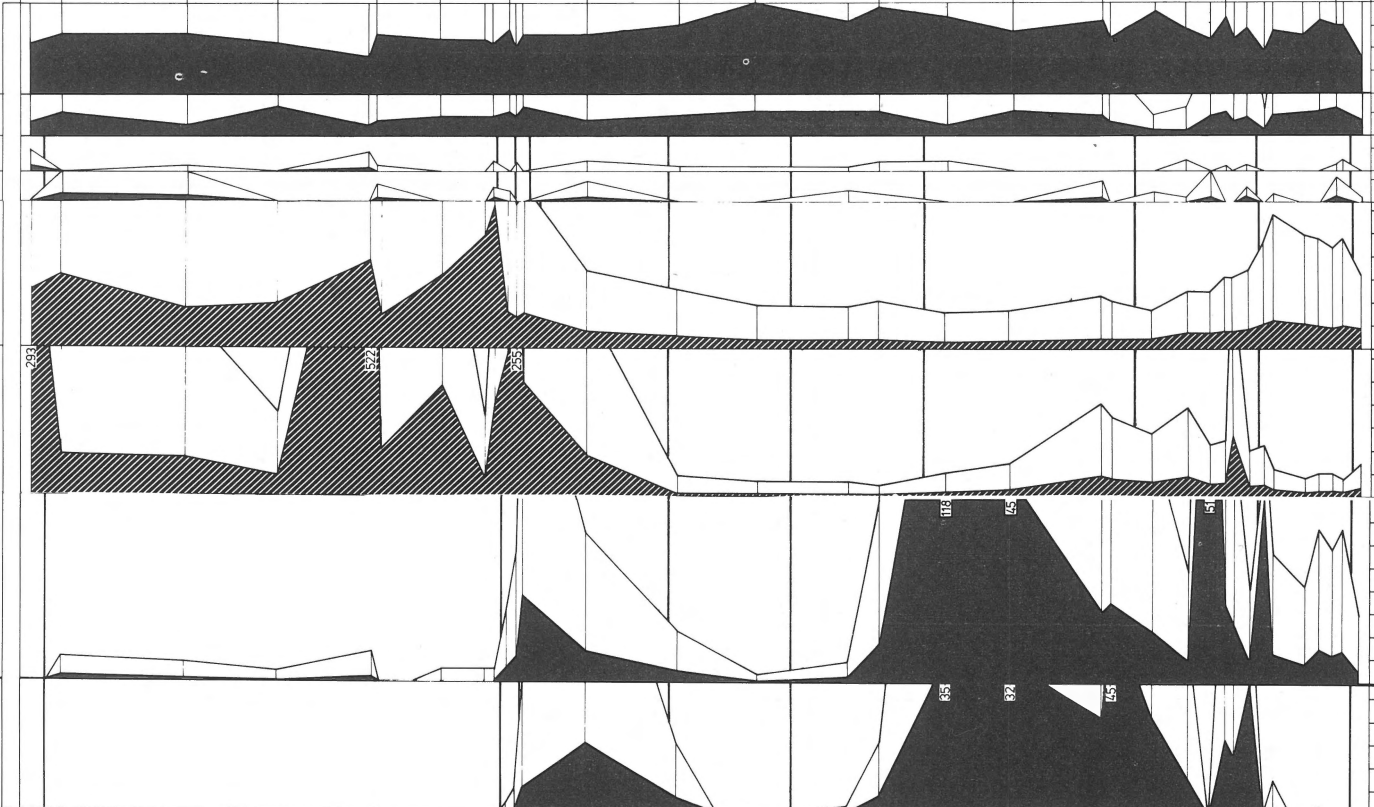
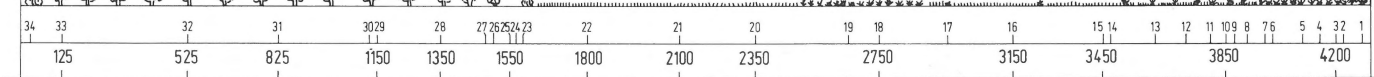
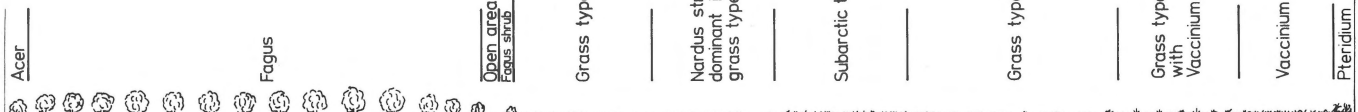
Dryopteris type

Galium type

Melampyrum

FAGUS FOREST — KRUMMHOLZ

MEADOWS



reduced scale

recognized, from west to east: the Tête des Cerfs, the Tête du Pt. Artimont, and the main chain of the Hohneck- Kastelberg complex. In the upper reaches of these mountains *Abies* is no longer present and the forest consists of *Fagus sylvatica* with *Sorbus aucuparia* and *Acer pseudoplatanus* (Aceri-Fagetum).

In the Hohneck-Kastelberg area *Fagus* becomes increasingly stunted towards the top of the mountains (Krummholz) and gradually gives way to extensive subalpine meadows.

- c.) The eastern slopes of the main chain. Here the sequence of major vegetation types is, with increasing altitudes, roughly similar to that on the western slopes, but due to rapidly decreasing altitudes (down already 500 m in the Fecht valley) and decreasing precipitation, the forest communities are less fully developed, occupy a smaller area and have a somewhat different species composition than those along the western slopes.

In the Fecht valley thermophilous trees such as *Carpinus betulus*, *Juglans regia* and *Castanea sativa* are found and deciduous forests of *Fagus* and *Quercus* occupy the lower slopes.

More to the east, beyond Münster, vineyards occur on south facing slopes.

- d.) The area of the Pt. Ballon complex. Altitudes up to 1250 m.

Again meadows are present on top of the mountains but the forest types listed for the Kastelberg-Hohneck region are often absent. The forests east of the main chain are differently managed than those in the western part of the belt across the mountains. As a result the original vegetation has often been replaced by *Picea* and *Pinus* plantations. This region is much cultivated.

A rather narrow area defined by faults along the Upper Rhine plain shows an intricate pattern of small areas of Triassic limestone and Permian sandstone. Altitudes are between 300-600 m. On sandstone *Fagus*, *Quercus petraea* and *Pinus* are the dominant forest trees.

The forest on limestone is a *Quercus pubescens* forest, very rich in species.

5. The region of the Upper Rhine plain, largely on Tertiary and Quaternary deposits. Precipitation down to an almost continental low of 500 mm/ year. This region is much cultivated.

OBJECTS OF STUDY

Objects of study are materials of lakes, bogs and soils. Lakes occupy the bottom of the cirques or are present behind moraines in valleys. Because of a relative high precipitation, bogs are numerous in the western part of the belt. East of the main chain major bogs seem to be virtually absent, probably because of the diminishing precipitation

and strong erosion along the generally steep slopes.

However the extensive peat deposits in the Upper Rhine plain north of Colmar are an important counterpart of the bogs in the western part of the Central Vosges.

SURFACE SAMPLES

Surface samples studied by Tamboer – van den Heuvel along the slopes of the Kastelberg revealed that the pollen deposition at any point consists of a constant regional deposition of pollen, transported from distances beyond ca. 100 m from the pollen source and a varying local deposition superimposed on the regional component depending on the vegetation of the sample point. (see also J a n s s e n, 1966, 1973).

Fig. 2 shows the pollen curves of the regional components *Quercus*, *Carpinus*, *Tilia* and *Ulmus* and the local values of *Fagus*, *Galium*, *Melampyrum* and Polypodiaceae along a transect that covers *Fagus* Krummholz/forest and subalpine meadows.

Fagus and Polypodiaceae show not only high pollen values immediately at the pollen source but also raised values a little away from the source. However most of the other pollen types show only raised values when the plant is present at the site itself.

Studies like these are useful to interpret the pollen values found in cores from small bogs and from soils, in that they register the pollen deposition of a small segment of the vegetation.

Of course studies on such a small scale have to be supplemented by analysis of the regional pollen deposition. It is possible that the entire belt across the mountains can be characterized in a segment of time by one pollen assemblage. After all the belt is only 70 km long and mixing of pollen may occur to such an extent that no separate pollen assemblages can be distinguished. On the other hand the subregions listed above are quite different and it may be possible that the total area of the belt can be subdivided into a number of regions that will show different pollen assemblages.

Perhaps there is also a strong difference between pollen assemblages from the valley floor and from the top of the mountains, but to what extent this effect obscures the possible regional differences between the subregions is not known.

In order to define the subregions and to establish their boundaries pollenanalytically, some 60 surface samples in the entire belt were analysed by Janssen but the definition of these areas on the basis of pollen assemblages proved to be difficult because in many cases it was not possible to get away from the influence of trees close by. Many more samples along with quantitative data of the forest vegetation will be necessary.

DETERMINATION OF POLLEN DEPOSITION/YEAR

All pollen counts are done with the addition of a known amount of exotic pollen in order to be able to calculate the concentration per unit weight of sediment. When pollen diagrams are properly dated these concentration values can be converted into values that show the deposition in numbers of pollen grains per unit time (Davis, 1967). In this way the trends of the individual pollen curves will be independent of each other.

For this purpose bogs are less suitable than lakes, because small gaps in the peat accumulation may go unnoticed, distorting the real deposition values. However, we hope to bring sufficient detail in the pollen diagrams to overcome some of these problems.

In order to compare the past deposition values calculated from cores with recent deposition values, a number of modified Oldfield pollen traps will register the regional pollen deposition per year in the various subregions across the mountains. These traps have been placed as much as possible in open situations away from the immediate influence of trees.

LATE- AND POSTGLACIAL VEGETATION HISTORY

Due to the abundance of lakes and bogs in the western part of the belt, the vegetation history can be inferred by pollen analysis of cores from sites at many different altitudes above sealevel in some of the subregions.

To reconstruct the regional pollen assemblages, data from at least one large bog or lake in each region are desirable. However such a situation rarely exists in mountainous regions. The number of small bogs is large but large basins on watersheds on top of the mountains (important because these would give insight in the trends of the pollen curves, independent of the varying vegetation) are rare. Along the line of the cross-section in fig. 1. no large bog is present in the Hohnneck-Kastelberg area. However, the large Tanet bog a few kilometres to the north may be large enough to register a regional deposition. Another watershed bog investigated by Kalis is on the Tête des Cerfs. Large valley bogs are fortunately less rare.

In order to trace a possible spatial diversity in the vegetation during the Late- and Postglacial it is of utmost importance to determine the levels in the various pollen diagrams that are synchronous. It is our intention to define the pollen assemblages formally, to date their upper- and lower contacts, and to trace their lateral extent followed by an interpretation in terms of vegetation. Cushing (1967) following the code of stratigraphic nomenclature did this for a much larger area and after careful dating he was able to demonstrate migration of phytotaxa. The area studied here is much smaller and we doubt that migration will show up in the various pollendiagrams. On the other hand, mountains often show sharp ecotones depending on the local climate

and this may give rise to altitudinal migration of elements on a much smaller scale than latitudinal migration. C-14 dating of the various assemblage zones is essential because this is the only independent parameter to detect a possible dischrocity of similar assemblage zones and thus the existence of vegetation belts in the mountains. Indeed it is not well possible to establish a zonation in the vegetation when fossil pollen assemblages are considered to be a priori synchronous.

In the literature reconstruction of mountain vegetation of the past often has been subject of research. In Europe the three most extensive studies dealing with a small area are those of Welten (1952), Kral (1971) and Zoller (1960) in the Alps. In the Vosges Teunissen en Schoonen (1970) attempted to reconstruct the vegetation at various altitudes on the basis of their Grand Etang diagram and the diagrams of Firbas et al. (1948). In these studies there is, however, no sufficient support of C-14 dates.

The main postglacial pollen assemblages are shown in a simplified pollen diagram of the Feigne d'Artimont (fig. 3). In this diagram the Subatlantic is not represented in detail. For the trends of the pollen curves during this time we refer to fig. 4.

In zoning the diagrams we only partly follow the concepts laid down in the code of stratigraphic nomenclature. According to the code, zones are bodies of rock that must be named by one or more of the fossils it contains. We feel that at the present stage of investigation ties with known zonation schemes established earlier can not be severed, lest comparison with the diagrams in the literature will be impossible. Therefore we temporarily designate zones by a letter- (from the site, to stress the local character of the zone) number (leaning towards the Firbas (1949) scheme of zonation) combination. When a sufficient number of pollen diagrams is available, these local zones can be replaced by other ones which are independent from any existing scheme.

The Late- and Postglacial may be divided into two periods:

The Late Postglacial

A period from somewhere in the Subboreal up to recent times.

In the late Atlantic – beginning Subboreal *Fagus* and *Abies*, at present the dominant tree species in the montane vegetation zone, begin to penetrate into the Vosges (fig. 3). From that time on the pollen assemblages found in cores can be compared with those from modern analogues, still present in the recent vegetation. The majority of pollendiagrams, prepared so far, comes from sediments deposited in this period. It appears possible to indicate a number of pollen curves that show similar trends and thus may reflect events that apply for a larger region.

These events are connected with the general culture history of the region. The trends of the curves of the NAP, *Carpinus*, *Juglans*, and *Castanea* are similar in all the diagrams

FEIGNE d'ARTIMONT

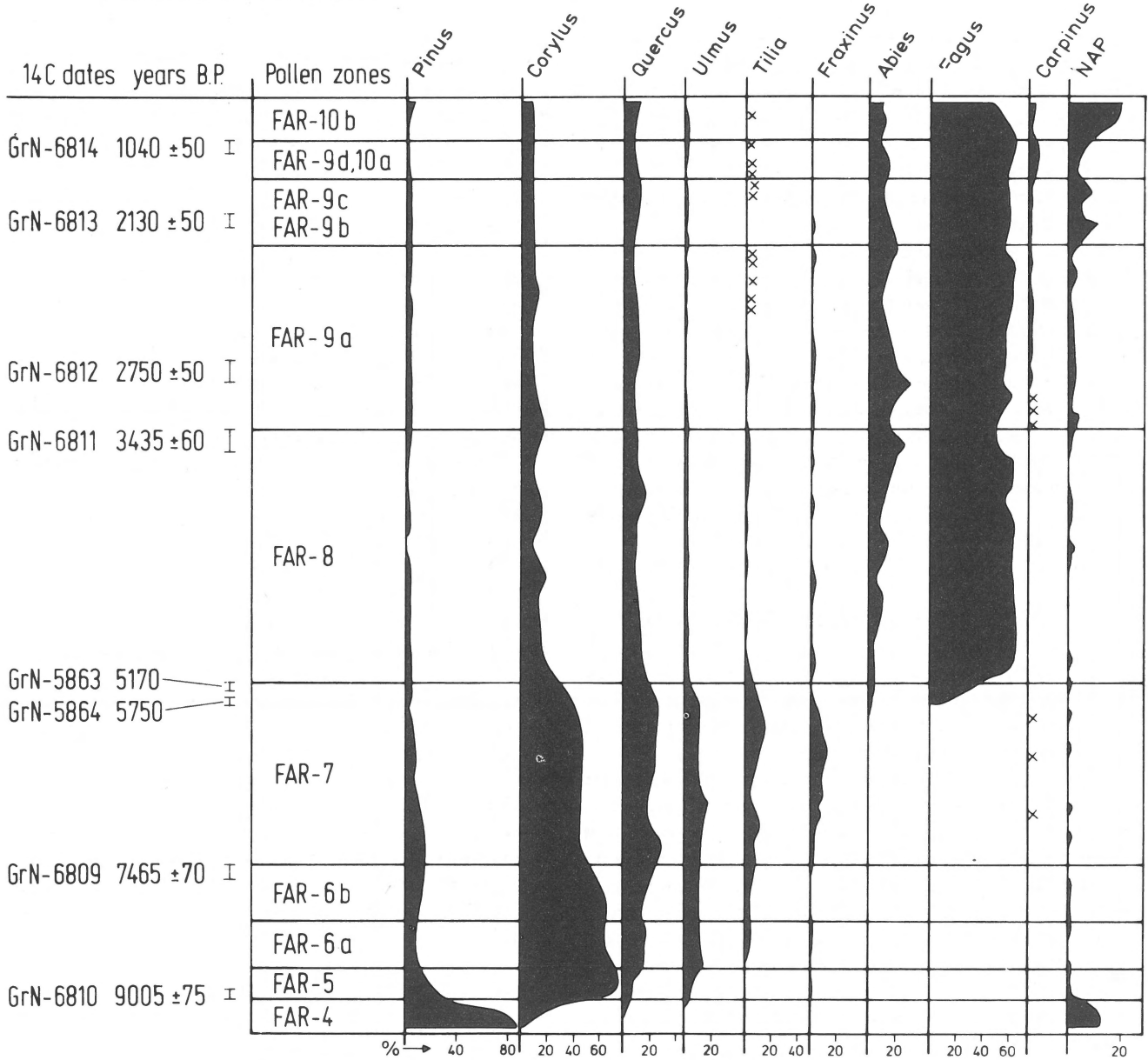


Fig. 3
Simplified pollen diagram of the Feigne d'Artimont.

available. At present these species do not occur on top of the mountains, but their pollen is transported from lower elevations where man exerted a stronger impact on the vegetation.

On the basis of the trends of these pollen types a regional pollen zonation can be established.

Fig. 4 shows a simplified pollen diagram from the Tanet bog (Janssen and Janssen-Kettlitz, 1972) on the watershed of the main crest. The zonation is based mainly on the curves of the NAP, *Carpinus*, *Juglans* and *Castanea* and

related to landoccupation. Also the curves for *Corylus*, *Alnus* and *Pinus* can be used, although to a lesser extent, for a correlation in time. *Corylus* and *Alnus* may have been present at high elevations in the mountains as they are today, but the trends of the curves of these types are so similar that we assume that most of the pollen of these trees comes from the valley floor.

- The following subzones can be recognized:
- Subzone TAN-10c modern time
 - TAN-10b late-medieval time

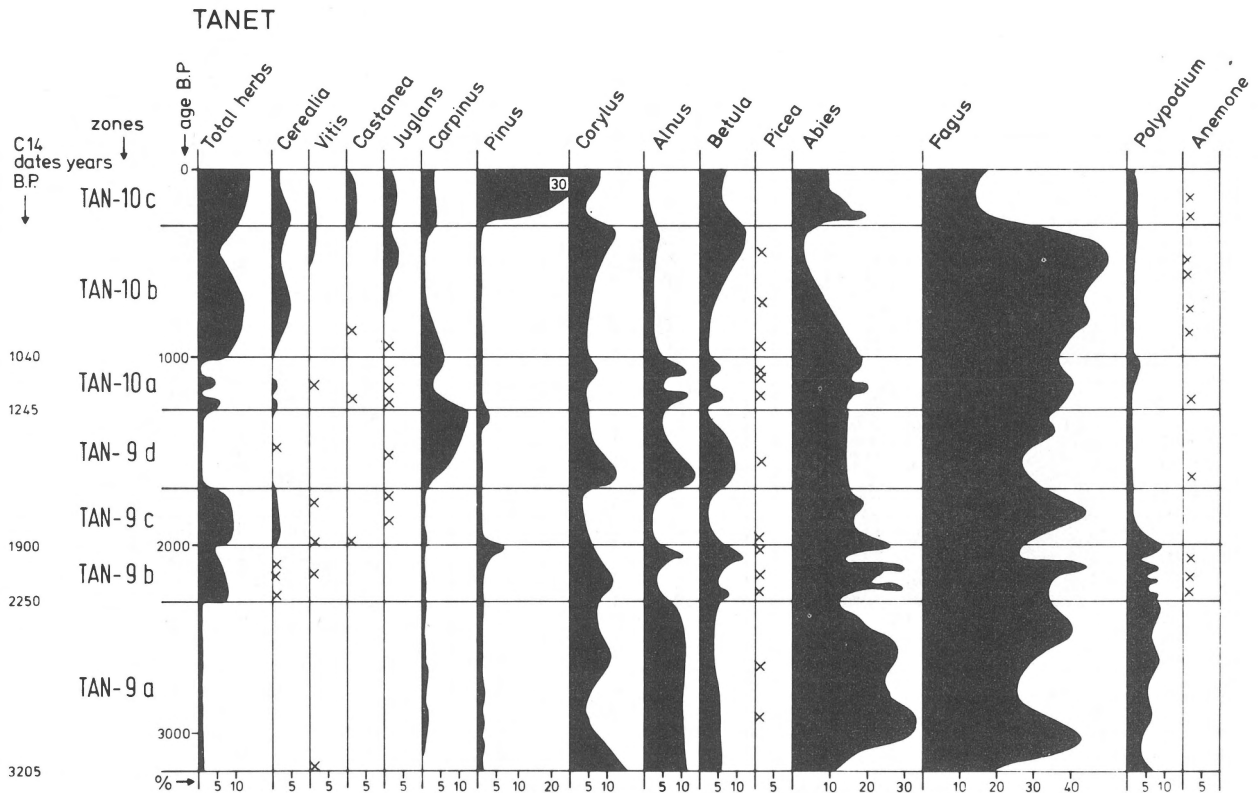


Fig. 4
Simplified pollen diagram of the tourbière du Tanet.

- TAN-10a early medieval time
- TAN-9d period of the Migrations
- TAN-9c Roman occupation
- TAN-9b preroman-Celtic time
- TAN-9a preceltic time

C-14 dates support the notion that these subzones indeed are time correlative.

Some remarks on the forest limit of the Kastelberg. A small mire on the east side of the "Grande Crête" has been investigated by de Valk. It is located in region 3c in the *Fagus sylvatica* - *Abies alba* vegetation belt of the Kastelberg in the Wormsawald, at an altitude of 1040 m above sealevel (fig. 1).

Like the pollen diagram of the Tourbière du Tanet, the diagram of this mire (see summarized diagram: fig. 5) only covers the late-postglacial, characterized by the presence of *Fagus* and *Abies* pollen.

The zonation of the diagrams is based on fluctuations in the values of the same "regional" pollentypes (see above) and therefore we believe that a synchronism of similar (sub-) zones is most likely. So far however only C-14 dates of the Tanet bog are known and more C-14 dates will be necessary in order to confirm this opinion.

Peat growth started about 900 B.C. and continued, with an interruption somewhere between 650 A.D. and 850 A.D., up to the present. This interruption is probably caused by the deposition of a sandy layer at the transition zone WSWA-9/WSWA-10. Fig. 5 shows that three sandy layers are present all coinciding with maxima in the NAP (16-25%). These maxima point to maxima in agricultural activities, indicated by pollen grains of *Plantago lanceolata*, *Rumex acetosella*, *Cannabis*, *Humulus*, *Secale* and that of other *Cerealia*. Especially the values of the first two taxa are very high. Above and below each sandy layer the values of the NAP decline rapidly; they never exceed 12%. Also in the Tanet core where sand is completely lacking the percentages of the NAP in the pollen diagram (see fig. 4) never exceed 12%. At present the taxa listed above are growing in valleys at lower elevations (up to 900 m.). Furthermore *Plantago lanceolata* and *Rumex acetosella* together with among others *Trifolium repens*, *Trifolium pratense* and *Stellaria media* are present in the upper altitudinal reaches of the *Fagus* shrub and on the Hautes-Chaumes in relative eutrophic places such as spring areas, where in the summer cows quench their thirst.

The number of local pollen types below the first sandy layer in zone WSWA-9 does not indicate clearly the charac-

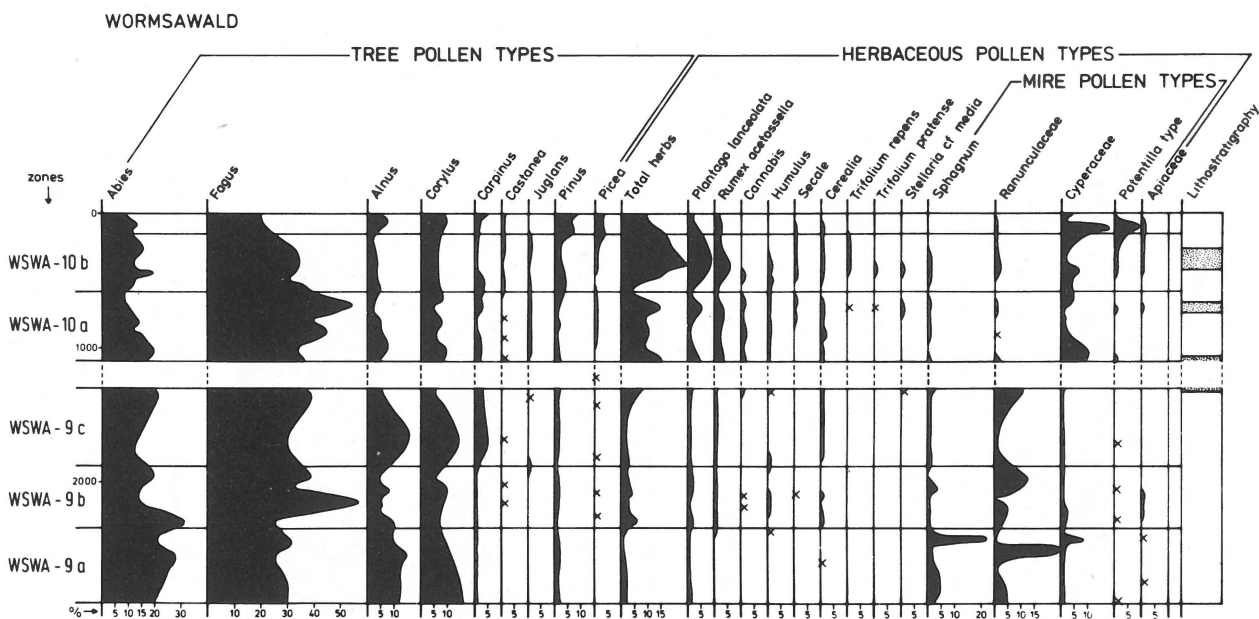


Fig. 5
Simplified pollen diagram Wormsawald.

ter of the local mire vegetation. At any rate *Sphagnum* and Ranunculaceae must have been present since pollen of these taxa occur abundantly in the core. Above this layer in zone WSWA-10 we find Cyperaceae-peat with pollen grains of *Potentilla*-type and Apiaceae. The change in the local vegetation may indicate that the sandy layer was deposited over a sizable part of the mire surface by a broad stream. The "source" of this stream probably must be looked for in the upper altitudinal part of the Kastelberg. At the levels of the two other sandy layers no essential change in the local vegetation takes place. We can only assume that the way of deposition was similar.

From this we believe that "the bulk of the pollen of the NAP comes from lower elevations" (Janssen & Janssen-Kettlitz, 1972). However the high values of *Plantago lanceolata* and *Rumex acetosella* pollen in the sandy layers might be explained by assuming that part of this pollen comes from the upper reaches of the Kastelberg.

An alternative but less likely explanation would be to assume that part of the pollen of these taxa has a more local origin.

In conclusion we believe that human- and/or cattle-activities may have devastated or even depressed the upper limit of the *Fagus* shrub resulting in an expansion of the Hautes-Chaumes and a strong decrease of the evapotranspiration of the vegetation. In this way a surplus of water will flow down the slopes of the Kastelberg, causing erosion of soil-material. This sandy material will be deposited at the foot of the slopes and on the mire together with pollen grains such as *Plantago lanceolata*, *Rumex acetosella*, *Trifolium* sp.

and *Stellaria media*. Climatic changes also may cause the same phenomena.

In our opinion additional pollenanalytic studies from bogs and soils at various elevations will be necessary in order to say more on the character of the forest limit on the Kastelberg.

The Lateglacial and the early Postglacial

After the open landscape during the Lateglacial, successive migration of the various forest elements took place, giving rise to vegetation types for which no modern analogues are available. In contrast to the younger Postglacial it is not yet possible to indicate regional pollen curves, that reflect vegetational events traceable over a large area. Here we are completely dependent on C-14 dating. It is difficult to imagine how the spatial relationships of vegetation types were in presubboreal times. It is quite possible that vegetation zones existed just like today. Questions such as in what areas and at which altitude a migrating element got its first foothold and where in the mountains such an element was pushed out of part of its areal in later time because of the introduction of new species, by a change in climate or by the impact of man, these questions we hope to answer by means of detailed pollen analysis of many cores in our relatively small area.

Evidence for the existence of vegetationbelts in the pre-Subboreal. The Holocene forest-development of the "Forêt

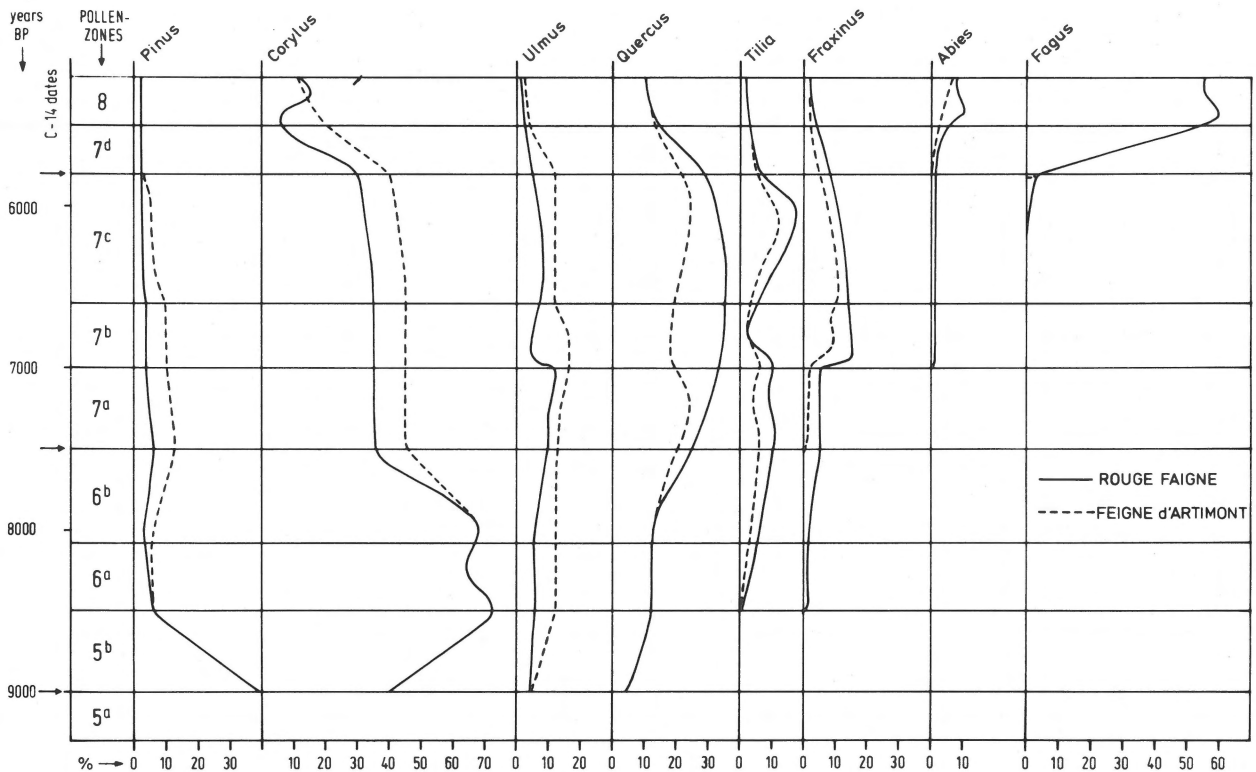


Fig. 6
Comparison of pollen curves in zone 5-8 from the Rouge Faigne and the Feigne d'Artimont.

communale de la Bresse" (area 3b in fig. 1) is investigated by Kalis by means of phytosociological studies of the recent forest and palynological studies of bogs.

The phytosociological study is done in order to reconstruct past communities by:

1. application of present-day sociological amplitudes of the forest species to pollen assemblages of the past.
2. extrapolation of the present distribution pattern of the various forest types to the past. Thus we assume that some of the present day boundaries between vegetation types existed already early in the Holocene, despite a quite different species composition. This applies especially to boundaries determined by sharp transitions between forest-types, which are associated with relative stable factors such as exposition, altitude, location along the slopes etc.

The most striking vegetation-boundary in the area is the transition between the montane *Abies-Fagus* mixed forest belonging mostly to a *Luzulo-Fagetum*, *Abieto-Fagetum* complex, and the sub-alpine *Fagus* forest belonging to the *Aceri-Fagetum*.

Since the Subboreal *Fagus sylvatica* and *Abies alba* are the dominating trees in the Central Vosges (fig. 3). Firbas et al. (1948) showed already that from that time on, *Fagus* dominated over *Abies* in the highest parts of the mountains, but that *Fagus* and *Abies* take an equal share in the forest at lower elevations, just like today. Thus it seems that the

present vegetation belts existed since the Subboreal. But were vegetation belts also present in pre-Subboreal times? Figure 6 shows a number of pollen curves from diagrams from two sites with contrasting upland vegetations: the Rouge Faigne, TRF, (Kalis, unpubl.) and the Feigne d'Artimont, FAR, (Janssen et al., unpubl. manusc.), calculated on the basis of a similar pollen sum.

The slopes around the Feigne d'Artimont (1100 m) are almost completely covered by sub-alpine *Fagus* forest from 1100 to 1300 m. The Rouge Faigne (1150 m) is surrounded by montane forest types at elevations from 800 to 1150 m. In order to establish a spatial diversity in the vegetation, the zones established for the two sites must be synchronous. No C-14 dates for the Rouge Faigne are available yet, but dates from other sites in the Vosges indicate that the pollen zones established here are time-correlative. From the Preboreal on, the following features are recognizable (fig. 6):

- subzone 5b: pollen values similar.
- subzone 6a: most pollen values equal. *Ulmus* however is more important in FAR.
- subzone 6b: at FAR the values for *Ulmus*, *Pinus* and *Corylus* are higher than those at TRF, and in TRF the values for *Quercus* and *Tilia* exceed those at FAR. At TRF the *Fraxinus* curve is continuous.
- subzone 7a: the trends of zone 6b continue. Now the *Fraxinus* curve is also continuous at FAR.

subzone 7b: all curves change their levels: in both diagrams the values for *Tilia* decrease and those of *Fraxinus* increase. The values of *Quercus* decrease at FAR but not at TRF. The values for *Ulmus* increase at FAR and decrease at TRF. From this zone on *Abies* is present in very low percentages at TRF.

subzone 7c: the pollen curves are stabilised but the same differences as in subzone 7a remain. The differences between the *Quercus* curves stand out more clearly.

subzone 7d: all the percentages of the Quercetum mixtum decrease, those of *Abies* increase and *Fagus* appears.

A striking feature is the subdivision of zone 7 into two relative stable phases of subzone 7a and 7b, and an intermediate subzone where the curves change their levels. Similar features have also been found in Denmark by Iversen (1973). We suppose that a correlation is possible with the so-called "Misoxer Kaltphasen" recognized by Zoller (a.o. 1966) in the Alps. If so, subzone TRF-7b could be the beginning of the "Misox Kaltphaze". However, C-14 dates are essential.

Do the differences of the pollen curves indicate the existence of vegetation belts in the pre-Subboreal?

Ulmus: From the beginning of the Boreal *Ulmus* is present at FAR on a stable and more elevated percentage than in TRF.

This may indicate that in zones 6 and 7 more *Ulmus* trees were present in the forest surrounding the Feigne d'Artimont. Even nowadays some rare stands of *Ulmus glabra* still can be found in specific localities at altitudes between 1150 and 1200 m.

Quercus: In (sub) zones 5b, 6a, 8 no differences in the low percentages of *Quercus* can be found. Probably because at this time *Quercus* was not present in the forests in the immediate vicinity of the bogs. However in zone 7 *Quercus* seems to be present, especially in the forest surrounding the Rouge Faigne.

Tilia: The *Tilia*-curves behave much like those of *Quercus* with the exception of subzone 7b. In this (probably cold) period *Tilia* seems to have disappeared from the area around these bogs.

Fraxinus: This tree was entering this area in a relatively late phase: subzone 7b. When present, *Fraxinus* seems to be more important in the forest surrounding the Rouge Faigne.

In conclusion: In the pre-Subboreal period the vegetation of the areas surrounding the two bogs differed. These differences may be probably due to the existence of a vegetation-zonation. In order to bring detail in the pre-Subboreal vegetation pattern additional cores will be analysed.

SUCCESSION OF PEATLAND VEGETATION TYPES

Many of the objects of study are bogs and therefore the most detailed piece of information comes from mire vegetation types. Stratigraphic groups of pollen types, and macrofossils (seeds, leaves, wood etc.) will be compared with the recent composition of mire communities. So far only a core of the Feigne d'Artimont has been subjected to such an integrated study, but a larger project has been started by H.J. Edelman with cores in a number of mire types northwest of Gerardmer (Goût-Loiselot).

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