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A PALEOBOTANICAL STUDY OF SOME BOGS IN WESTERN BRITTANY (FINISTERE), FRANCE

(Pl. XXXVIII–XLVII, figs. 31–32)

Introduction

In the summer of 1958 a number of peat profiles were sampled in the western part of Brittany (Fig. 31a). Although a study of the environment of prehistoric man and the interference of man with the vegetation was the primary aim, full attention will be paid to other aspects of this study.

Before proceeding to a discussion of the results of this investigation a short description of the sites where the samples were taken will be given. With one exception the peat profiles to be discussed in this paper were sampled with a modified Dachnowsky borer, the inner diameter of which amounts to 3.7 cm.

The sites

The bog of Saint-Michel-de-Brasparts. The bog of Saint-Michel-de-Brasparts, also called Yeun Ellez, is situated on the territory of the municipalities of Brasparts, Botmeur, La Feuillée and Brennilis, at the foot of the Mont Saint-Michel-de-Brasparts, one of the highest peaks of the Montagne d'Arrée. The drainage of this bog area takes place by branches of the Ellez river. As a consequence of peat digging the greater part of the bog has disappeared, so that only a few remnants have been left.

A profile from this bog was studied palynologically by G. and C. Dubois (1945). Their paper gives only a summary description of the results, and no diagram.

The profile Saint-Michel-de-Brasparts I (in future called Brasparts I) was sampled in the western part of the bog, about 1.5 km east-northeast of the Mont Saint-Michel-de-Brasparts. At this spot the profile was as follows:

  0– 25 cm Disturbed peat.

25–105 cm Highly humified *Sphagnum* peat with many roots of Monocots; between 25 and 45 cm *Eriophorum*. The transition with the underlying peat layer is very gradual.
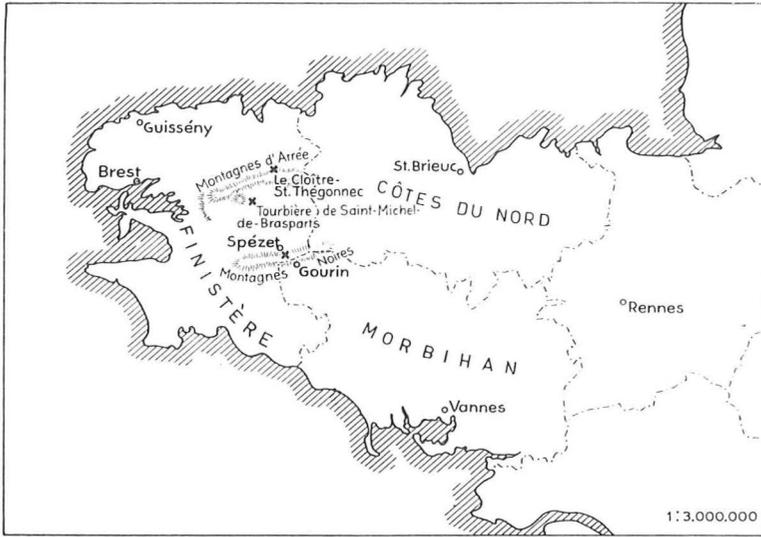
Fig. 31a. Map of Brittany showing the sites discussed in this paper.
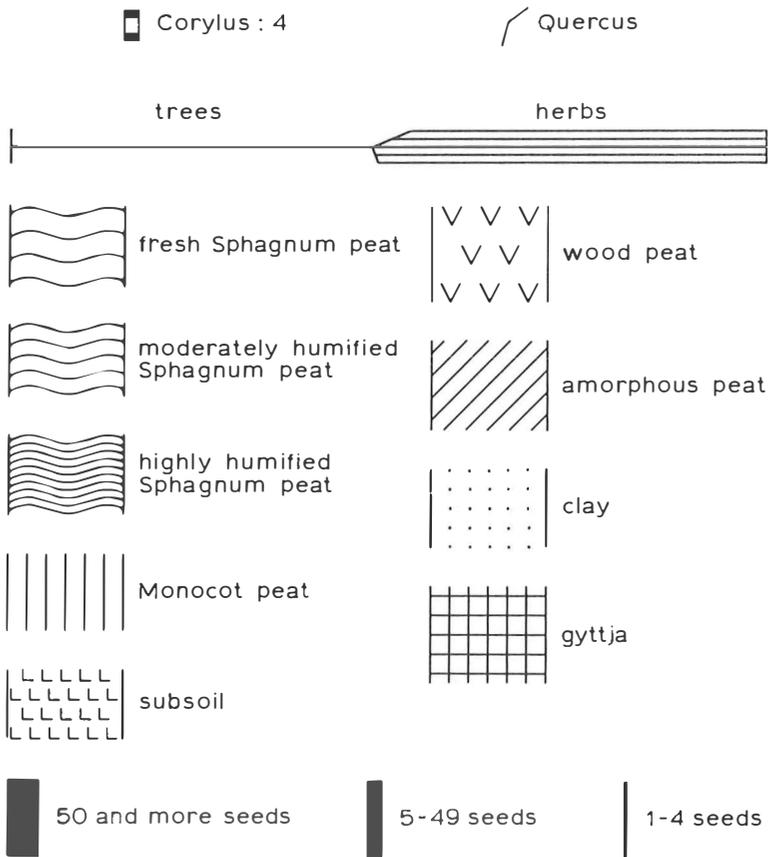

Fig. 31b. Key to the symbols employed in the pollen diagrams.

105–185 cm Monocot peat, among others with rhizomes of *Phragmites*.
185–205 cm Wood peat.
205–212 cm Highly humified, amorphous peat.
212–221 cm Detritus *gyttja*.

A second profile from this bog to be discussed in this paper (Brasparts III) was sampled at the northern edge of the bog, about 2 km south of the village of Botmeur. In this case a peat wall showing a section over some length was present. The samples were taken in sample tins which were pushed into the peat wall. At this locality the following stratigraphy was recorded:

 0–15 cm Moderately humified *Sphagnum* peat with recent roots.
15–34 cm Moderately humified *Sphagnum* peat.
34–56 cm Highly humified *Sphagnum* peat.
56–80 cm Monocot peat.

Of a third profile (Brasparts II) only the clay layer underneath the peat will briefly be brought into the discussion here.

The bog of Menez-Cam. The bog of Menez-Cam is situated in the 'Montagnes Noires', between Spézet and Gourin, about 2 km southwest of Roc-Toulaëron. This bog, which was formed in a rather deep valley is drained by a left tributary of the Aulne river. There were no clear indications that at least in the immediate vicinity of the spot where a series of samples was collected (the Spézet profile) peat had been removed. In contrast to the other bogs discussed in this paper this site showed a rather well developed bog vegetation. However, the palynological results indicate that the uppermost part of the peat deposit must have disappeared. At the spot where the samples were taken the following stratigraphy could be recorded:

 0– 40 cm Moderately humified *Sphagnum* peat with remnants of Ericaceae and roots of Monocots.
 40–100 cm Highly humified *Sphagnum* peat with remnants of Ericaceae, some wood and many roots of Monocots.
100–220 cm Wood peat with many roots of Monocots.
220–253 cm Wood peat.
253–260 cm Humous clay.

The bog of Le Cloître – St.-Thégonnec. In the valley of one of the branches of the Squiriou river, about 15 km south-southwest of Morlaix, and about 5 km southwest of Le Cloître – St.-Thégonnec, a bog could develop. This bog has been virtually cut away, so that only in a small block of peat which was left a profile could be sampled.

  0– 15 cm Disturbed peat.
 15– 33 cm Moderately humified *Sphagnum palustre* peat.
 33– 48 cm Fresh *Sphagnum palustre* peat.
 48– 73 cm Monocot peat with some wood.
 73–108 cm Wood peat with many roots of Monocots.
108–123 cm Humous clay with roots of Monocots and wood.
123–128 cm Clayey Monocot peat.

Discussion of the ΣAP diagrams

For each of the profiles Brasparts I, Spézet and Le Cloître a classical tree pollen
diagram, in which all frequencies are expressed as percentages of the tree pollen
sum (ΣAP), is reproduced in Plates XXXVIII, XXXIX and XL. These make it
very clear that this type of diagram is hardly adequate to present the results of re-
fined palynological research in any convenient form. Moreover, it is a not incon-
siderable disadvantage that it becomes very difficult if not impossible to recalculate
the original data from the diagram. And it is just those data which enable others to
make the best possible use of the study concerned. In this paper some groups of
pollen types will be lifted out of the total data and will be discussed more in detail.
It is not unlikely that others will likewise want to examine certain aspects of palyn-
ological research more closely. For such a study it is often very desirable that one
can include other people's data. Present-day palynological research consumes so
much time that it would not be justified to use the results only for the author's own
purposes, and to leave them more or less inaccessible to others. It is for that reason
that, apart from any diagrams, it would be recommendable to publish the results
in tabular form. Therefore, the complete data of the profiles Brasparts I, Spézet and
Le Cloître are shown in this paper in Tables 2, 3 and 4.

    As certain aspects of this study will be submitted to a more detailed examination
below the discussion of the ΣAP diagrams will confine itself to a few points.

Brasparts I diagram (Plate XXXVIII). At the spot of the Brasparts I profile peat for-
mation started in the course of the Atlantic period (zone VII*a* after Godwin 1940).
It is true that in the lower samples the *Alnus* percentages are insignificant, but the
equally low *Pinus* percentages and the high values for *Quercus* and *Ulmus* point to
an Atlantic age for the lower part of this peat deposit. From a depth of 130 cm on
a marked decline in the *Ulmus* curve can be observed, at which level the Atlantic/
Subboreal (VII*a*/VII*b*) border is usually laid. The still low *Fagus* values in the upper
samples of the diagram suggest that the Subatlantic period is lacking here.

The decline of Ulmus. As for the elm decline, this phenomenon appears to be less synchronous than the first radiocarbon measurements suggested. Godwin (1960) published a list of all C-14 dates of this horizon known up to the middle of 1960. From this list it appears that the dates scatter between 2500 and 3800 B.C., with a concentration between 3000 and 3400 B.C. The dating of 3450 ± 60 B.C. for the elm decline in the Brasparts I profile tallies well with the other dates of that level.

The considerable scattering of the C-14 dates for the elm decline gives rise to the question in how far this phenomenon actually constitutes a reliable palynological border. At present it is still too early to give up the elm decline as a zone border. We need C-14 measurements of a great number of samples, chosen with the utmost care, before we shall be able to judge in how far this phenomenon can be maintained as a criterium for the transition from the Atlantic to the Subboreal.

Low Alnus percentages in Atlantic time. Some special attention will be paid to the very low *Alnus* values in the bottom part of the Brasparts I diagram. The diagram 'Marais Vernier' (Elhaï 1959) shows likewise low *Alnus* percentages for the greater part of zone VII*a* (Atlantic). According to Elhaï this is due to the circumstance that at the time of formation of this part of the deposit the whole area would have been brackish. The brackish environment of the 'Marais Vernier' did not provide suitable habitats for alder. A similar explanation cannot be applied to the area of the bog of Saint-Michel-de-Brasparts, as this was never exposed to the direct influence of the sea. The low alder percentages in samples 1 to 12 suggest that this tree was present at some distance, but that for one reason or another it could not expand in the area.

What can be the cause of the delayed expansion of alder? The lower part of the Brasparts I diagram shows high values for *Betula*, while birch seeds were also common in this part of the profile. This birch swamp suggests that the local conditions were too poor for alder, which prefers a somewhat better soil. In contrast to the Brasparts profile those of Spézet and Le Cloître started with a humous clay deposit, and already in the lower part of the diagrams (Plates XXXIX and XL) high *Alnus* values can be observed. No doubt, these clayey deposits constituted a suitable environment for alder.

It is not unlikely that originally the upper courses of the rivers were only subject to erosion. Later, as the drainage stagnated somewhat and the current decreased, sedimentation could also take place. It has already been remarked that the bog of Saint-Michel-de-Brasparts is traversed by branches of the Ellez river, and one may suppose that it was not until the late Atlantic period that the river valleys could provide suitable growing conditions for alder here. The eustatic rise of the sea level cannot be held responsible for a certain damming up of the water in the areas of the bogs concerned as these are situated too high above sea level. The cause of the

decrease of the current upstream and the subsequent deposition of clay must be
sought in a gradual filling up of the river valleys downstream.

A comparable behaviour of *Alnus* is demonstrated in the diagram Via Mansuer-
isca IV from the 'Hautes Fagnes', Belgium (Dricot 1960). In contrast to Dricot the
present author is of the opinion that the part of the diagram designated as zone VII
belongs to the Atlantic. For *Pinus* shows low values, whereas those for *Quercus* and
Ulmus are relatively high. Although not as low as in the Brasparts I diagram in the
Via Mansuerisca diagram the *Alnus* values are likewise inconsiderable during the
early Atlantic; it is not until later that the *Alnus* curve shows a strong increase.
Here again at the end of the Boreal period *Alnus* was present at some distance, but
it did not expand in early Atlantic times.

According to the present author Nilsson (1960), too, places the Boreal/Atlantic
border too high in his diagrams from the Somme valley. On account of the course
of the *Pinus* curve on the one hand and that of the curves for *Quercus* and *Ulmus*
on the other hand in the diagrams Long and Belloy-sur-Seine this transition has
to be laid at a depth of about 5.50 and 2.10 m respectively. The extremely low
Alnus values during the larger part of the Atlantic period in both these diagrams
would then be quite comparable with those in the Brasparts I diagram. The pro-
files studied by Nilsson are no brackish water deposits, so that Elhaï's explanation
for the low *Alnus* values in the Marais Vernier diagram cannot be applied to these
diagrams from the Somme valley either (*cf.* Kubitzki 1961).

Spézet diagram (Plate XXXIX). From the low *Ulmus* values and from the discon-
tinuous occurrence of *Fagus* in the lower part of the Spézet diagram it may be con-
cluded that peat formation started here in Subboreal times. In the upper part of
this diagram the *Fagus* percentages are relatively high, indicating a Subatlantic age
(zone VIII after Godwin).

As for the transition from the Subboreal to the Subatlantic period, this gives
some difficulties in the Spézet diagram. Although there are various criteria by
which—depending on the region in question—the Subatlantic can be distinguished
from the Subboreal, the palynological border between the two periods is often still
rather vague. As it is customary to let the Subatlantic period begin at 600–800 B.C.
it would not be wise to place that border in the Spézet diagram at about 300 A.D.,
at which level the first important increase of *Fagus* takes place. From the C-14 dates
in the Spézet diagram this transition should be laid at a depth of about 135 cm, *i.e.*
at the beginning of the continuous *Fagus* curve. In this respect one may wonder
whether so much weight should be laid on the absence of *Fagus* in sample 22, and
whether it would not be more correct to let the continuous *Fagus* curve start at a
depth of 170 cm. In that case the beginning of the continuous *Fagus* curve would
not coincide with the Subboreal/Subatlantic transition. It is perhaps better to leave

the question of the palynological border between the Subboreal and the Subatlantic in Breton diagrams undecided until we shall have more material at our disposal.

Le Cloître diagram (Plate XL). The Le Cloître diagram shows fairly good resemblance with that of Spézet. The deposition of organic material started in the course of the Subboreal period. The high values for *Secale* in the upper samples of the diagram suggest that this part of the profile was not deposited before mediaeval times.

Hedera in the Breton diagrams

Since Iversen's (1944) paper on the behaviour of *Hedera* in the course of the Postglacial much attention has been paid to this subject. In Table 1 (p. 180) the mean *Hedera* percentages for the various periods are represented. On the supposition that ivy will preferably have grown on the higher soils the *Hedera* frequencies are not expressed as percentages of the total tree pollen sum, but of the sum of *Quercus*, *Fraxinus*, *Ulmus*, *Tilia*, *Fagus*, *Carpinus*, *Taxus* and *Acer*, the so-called *Quercetummixtum sensu lato*. Moreover, in this way there is no chance that as a consequence of the often high and strongly fluctuating quantities of *Betula* and *Alnus* pollen the *Hedera* values would be influenced too much.

As the mean *Hedera* values for the various periods will be compared together, it is necessary to delimit these periods accurately for this purpose. It is self-evident that the Atlantic/Subboreal (VII*a*/VII*b*) transition must be laid at the elm decline. It has already been mentioned that the border between the Subboreal and the Subatlantic periods (VII*b*/VIII) is less clear. In order to enable a comparison of the Breton *Hedera* values with those in other parts of western Europe, the VII*b*/VIII zone border in the Spézet diagram has been placed at the level dated at about 800 B.C. As for this zone border in the Le Cloître diagram, the course of the *Fagus* curve in this diagram cannot be compared in detail with that in the Spézet diagram. No more do the curves for the other pollen types allow of a more detailed comparison between the two diagrams, this with the exception of the upper part. Fortunately the relation between tree and herbaceous pollen in the diagrams of Plates XLIII and XLIV (see discussion on pp. 169–70) is of some help in this respect. From the curves for this relation in these diagrams it may be concluded that the level between samples 9 and 10 in the Le Cloître diagram corresponds approximately to the level at which in the Spézet diagram the Subboreal/Subatlantic border was laid (between samples 23 and 24). As in the Brasparts I diagram the Subatlantic is lacking for this period the upper part of the Brasparts III profile was used.

From Table 1 it appears that in the Brasparts diagrams the *Hedera* percentages do not show significant differences in the various periods. This in contrast to the Spézet diagram, in which the mean *Hedera* value for the Subboreal is much higher

than that for the Subatlantic. However, it would be premature to conclude that in the vicinity of the bog of Menez-Cam the conditions for ivy would have been more favourable during the Subboreal than during the succeeding period. In the ΣAP diagram of Spézet (Pl. XXXIX) a marked decline of *Hedera* takes place between samples 19 and 20. From the bog plants diagram of Spézet (Pl. XLVI) it appears that this decline in the *Hedera* curve coincides with the transition from a birch-alder to a more oligotrophic birch swamp forest. It seems not unlikely that ivy did occur in the birch-alder swamp, and that the high mean *Hedera* percentage in the Subboreal part of the Spézet diagram is due to a local production of pollen of this species. Consequently, the much lower *Hedera* value for the Subatlantic period would not be caused by a considerable decline of *Hedera* on the higher soils, but by the disappearance of the local pollen source. If so, the method of expressing the *Hedera* frequencies as percentages of the *Quercetum-mixtum s.l.* would be based on a hypothesis which for the Spézet diagram is incorrect. However, with the tree pollen sum as the basis of calculation the result would not have been different, whereas in many other peat deposits the ΣAP is less suitable in this respect.

In spite of the circumstance that the lower part of the Le Cloître profile is composed of birch-alder forest peat, the mean *Hedera* value for the Subboreal part of the diagram is lower than that for the upper Subatlantic part. The present author will refrain from trying to give an explanation for this contradictory behaviour of *Hedera* in the diagrams of Spézet and Le Cloître.

Summarizing we may conclude that it is likely that during the second part of the Post-glacial a regional decline of *Hedera* did not take place. Of course it must be kept in mind that as a consequence of the activities of man ivy will have diminished considerably in the course of time. The conclusion that *Hedera* did not show a decline means that on the habitats which were available this plant did not decrease.

In the western part of Brittany the mean January temperature varies from 6° to 7° C (Le Lannou 1950, fig. 6). This is so much above the minimum below which ivy does no longer occur (Iversen 1944) that fluctuations in the mean January temperature of about 1° to 2° C will not have exercised a noticeable influence on the *Hedera* frequencies. Consequently, the results of the palynological investigation are in accordance with what might be expected on account of the mean January temperature in this region.

The Late-glacial in the bog of Saint-Michel-de-Brasparts

Underneath the peat deposit of the Brasparts I profile a 9 cm thick *gyttja* layer was present. This *gyttja* turned out to be rich in rather well preserved pollen. The diagram in question (Pl. XLI: 1) is composed according to the method introduced by Iversen (1942). Although a not unimportant part of the pollen of Gramineae and

Cyperaceae will have been of local origin nevertheless both these families are in-cluded in the pollen sum.

The low *Pinus* values suggest that the *gyttja* was deposited before the second part of the Allerød period. More or less characteristic Late-glacial pollen types are *Epilobium*, *Armeria*, *Plantago spp.*, *Helianthemum* and *Ephedra*. Besides, in this *gyttja* deposit pollen of *Quercus* and *Corylus* is not rare, while *Ulmus* was met with twice. However, it must by no means be concluded from this that these thermophilous trees were actually present here during the Late-glacial. It is very likely that these pollen grains are derived from the Post-glacial peat on top of the *gyttja*. This hypo-thesis is supported by the results of a palynological examination of samples from a clay layer at the basis of the Brasparts II profile, *viz.* a 14 cm thick layer of more or less dark coloured clay with some pebbles. In this deposit, which according to the pollen contents is of Late-glacial age, no pollen of *Quercus* and *Corylus* was met with.

Returning to the diagram of Pl. XLI : 1 it is thus not likely that the pollen of *Quercus*, *Ulmus* and *Corylus* is of primary origin. It is possible that the high *Betula* value in the upper sample is partly caused by infiltration of *Betula* pollen, but it would certainly go too far to assume that the whole increase of birch would be due to this source of contamination. The increase of *Betula* could indicate the beginning of the Allerød time.

As for the infiltration of Post-glacial pollen, this could have taken place especi-ally during the first stages of peat formation, when a birch swamp forest con-stituted the local vegetation. In consequence of the penetration of roots into the Late-glacial sediment and perhaps likewise of the activity of animals Post-glacial pollen could have arrived in the *gyttja*.

During the first part of the Late-glacial there must have been a lake on the spot. In the course of the Late-glacial the deposition of *gyttja* came to an end, and it was not until thousands of years later that on the same spot peat formation started. The circumstance that the deposition of *gyttja* did not gradually pass into the for-mation of fen peat could indicate that the lake dried up suddenly. This drying up could have been caused by the disappearance of permafrost which must then still have been present during the first part of the Late-glacial. This hypothesis is not in accordance with the opinion of Poser (1948, fig. 6) who assumes a maritime tun-dra climate without permafrost for Brittany during the Full-glacial. On the other hand, the study of Tricart (1956) would point to the presence of a permafrost in Brittany during the last glaciation.

Palynological evidence for human activity

For the study of the environment of prehistoric man and of the interference of man with the vegetation the traditional tree pollen diagrams are less suitable. A so-called total pollen diagram, too,—in which all trees and wind-pollinated herbs are included

in the sum—would not serve the purpose. This is due to the great proportion of pollen produced by the bog vegetation itself in the pollen rain. In order to provide a better impression of the vegetation on the higher soils and of the effect of human activity on the vegetation one has to construct diagrams in which the local pollen has been eliminated as much as possible.

Construction of the diagrams. In the diagrams to be discussed below *Quercus, Tilia, Ulmus, Fraxinus, Fagus, Carpinus, Acer* and *Taxus, i.e.* the components of the so-called *Quercetum-mixtum s.l.,* are the first to be included in the pollen sum. Although introduced by man *Juglans* and *Castanea,* too, form part of this sum. Of the trees *Alnus, Salix* and *Betula* have been excluded. It is true that *Betula* will also have grown on the higher soils—and certainly during the regeneration of forest it will have played an important part—but most of the birch pollen by far will have originated from trees growing on or along the bog. *Corylus,* on the other hand, is included in the sum, but the numbers of pollen grains of this species have been divided by 4. This has been done in order to prevent a strong overrepresentation of *Corylus,* which tree produces much more pollen than the components of the *Quercetum-mixtum s.l.* The basic sum further includes various wind pollinated herbs such as *Plantago, Rumex* and *Artemisia* and the spores of *Pteridium.* It would have been logical to include the Gramineae as well, but a greater or smaller part of the Gramineous pollen will have been produced by grasses which formed part of the bog vegetation (see also the discussion on pp. 177–9). In addition to the pollen of the wind pollinated *Secale,* that of other cereals and of the insect pollinated *Fagopyrum* and *Trifolium repens* is likewise included in the sum.

The diagrams of Plates XLI : 2–XLIV show the result of this way of calculating the percentages. All pollen types represented in the diagram have thus been included in the pollen sum. The main diagram shows among others the relation between the tree pollen and the herbaceous pollen (the hatched part). As for the separate curves, in case of low values an additional curve has been drawn to a scale 5 : 1 (broken line).

These diagrams certainly do not serve the purpose in every respect, among others because Gramineae and *Betula* had to be left out. However, they give a better impression of the vegetation on the higher soils than the tree pollen diagrams do. Moreover, it has to be kept in mind that pollen diagrams never truly reflect the vegetation, but can only give a picture that is in some degree out of focus.

Brasparts I diagram (Plate XLII). So far as the activity of prehistoric man is concerned, in the upper part of the Brasparts I diagram a marked increase of *Plantago lanceolata* and *Pteridium* can be observed. A similar behaviour is shown in the Spézet diagram at a depth of 200 cm. Undoubtedly, this is the type of land occupation

described by Iversen (1941). A fairly large area was cleared, while only a small part of the clearing was in use as arable soil. The rest would have served as pasture for the numerous cattle, which will have found plenty of food in the grasses and other herbs which covered the area after the deforestation. The people who must be held responsible for this forest destruction consisted of herdsmen who arrived in western Brittany between 1800 and 2000 B.C. When the area no longer provided enough food for the cattle they passed on. The stay of these herdsmen will not have lasted merely a few weeks or months, but perhaps a number of years, so that it would be preferable to speak of semi-nomads instead of nomads.

It cannot be ruled out that in Brittany this type of land occupation was exercised by tribes of the late Neolithic Seine-Oise-Marne culture which had its centre of distribution in the Paris basin. On the other hand, P. R. Giot (*cf.* van Zeist 1963, foot-note 1) is of the opinion that the constructors of the '*allées couvertes*' which are the Armorican variant of the Seine-Oise-Marne culture, must have been present in Brittany already before 2000 B.C. According to Giot it is well possible that in the region of the Montagne d'Arrée and the Montagnes Noires the semi-nomadic pastoralism discussed above must be ascribed to the builders of the numerous Bronze Age tumuli.

Although only the topmost samples of the Brasparts I diagram show relatively high percentages for *Plantago lanceolata*, pollen of this weed is likewise present in the rest of the diagram, even if in very small numbers and discontinuously. In various diagrams from western and northwestern Europe *Plantago lanceolata* is present in very low percentages from the level of the elm decline on, together with some pollen grains of Cerealia. This represents the type of land occupation arrived at by Troels-Smith (1953, 1955) after a detailed palynological study of the first farmers in Denmark (Ertebølle culture) as well as in Switzerland (Michelsberg and early Cortaillod culture). Besides the growing of cereals and perhaps some other crops these early Neolithic farmers had a modest stock of cattle. For the cattle little or no pasture would have been available—the low *Plantago* values!—and the cows would have been kept in stalls or at least within an enclosure. The feeding of the cattle would have depended to a high degree on the foliage of various trees such as elm, ash and lime.

It seems justified to assume that in Brittany similar agricultural practices were followed in early Neolithic times. It has already been mentioned that in general the type of land occupation described above started at the level of the elm decline. Various authors are of opinion that this decrease of *Ulmus* would be due to the practice of cutting the leafy branches. Although the C-14 date for the elm decline in the Brasparts I diagram lies within the range of the dates quoted by Godwin (1960), this date is yet a few hundreds years earlier than those for that level in many other pollen diagrams from western Europe. If the elm decline was effected by the

activity of Neolithic man, this would imply that in western Brittany farmers would have been active at about 3400 B.C. This would be in accordance with the dating of a charcoal sample from a settlement of the *Néolithique Primaire Armoricain* on the beach of Curnic en Guissény at 3380 ± 60 B.C. (*cf.* Giot 1960, corrected date).

Origin of Plantago below the decline of Ulmus. What is the meaning of the *Plantago* pollen below the level of the elm decline? This could imply that in this area even before about 3400 B.C. farmers were present. It is true that for these farmers there is no archeological evidence so far, but that need not be a decisive argument against the hypothesis of Neolithic man before 3400 B.C. Should this hypothesis be correct, then it would be conceivable that these farmers did not follow the practice of cutting foliage or that they were exclusively agriculturists.

Another possible explanation for the occurrence of *Plantago lanceolata* below the level of the elm decline is that of a Late-glacial relict. Of *Ephedra distachya*, which species had a wide distribution during the Late-glacial, some pollen grains were likewise met with in the Post-glacial of western Brittany (Brasparts I, Subboreal; Brasparts II, Subatlantic). At present this plant does not occur in the interior of Brittany, but can be found along the Atlantic coast as far as Finistère (Stapf 1889). Apparently when, in Post-glacial times, more or less dense forests developed everywhere, this heliophyte found a refuge in the open vegetation of the dunes. One might ask whether the few pollen grains of *Ephedra* met with in the Brasparts profiles could point to a sporadic Post-glacial occurrence of this plant in the interior of Brittany. On the other hand, long distance transport of *Ephedra* pollen from the coastal region is also possible. The distance from the bog of Saint-Michel-de-Brasparts to the nearest find spot of *Ephedra* amounts to about 70 km. Long distance transport is assumed in order to explain the occurrence of *Ephedra* pollen in Postglacial deposits in Minnesota, in the midwest of the U.S.A. In that case the distance to the nearest find spots of *Ephedra* is no less than about 1000 km! However, Welten (1957) arrived at the conclusion that the dispersal of pollen of *Ephedra distachya* is very poor.

However this, at not too great a distance from the interior of the Breton peninsula at least one Late-glacial plant could maintain itself during the Post-glacial. Consequently, it is conceivable that the same is true for other Late-glacial heliophytes, such as *Plantago lanceolata*. In this connection it must be mentioned that in the Late-glacial *gyttja* of the Brasparts I profile one pollen grain of *Plantago lanceolata* was met with.

For the occurrence of *Plantago lanceolata* below the level of the elm decline in the Brasparts I diagram two explanations can thus be put forward. First that of the presence of Neolithic farmers at a very early date (4000–4500 B.C.). On the other hand, it cannot be ruled out that in this region *Plantago lanceolata* could persist locally during the Post-glacial.

Spézet diagram (Plate XLIII)[1]. The meaning of the relatively high herbaceous percentages in samples 11–16 in the Spézet diagram has already been discussed on p. 166–7. It is likely that the presence of a pollen grain of *Secale* and of *Fagopyrum* in sample 11 is due to contamination, so that no special value must be set on the occurrence of both pollen types in this sample.

After the first increase of herbs *Plantago* and *Pteridium* show lower values in samples 17 to 28. This must correspond with the greater part of the Bronze Age. During that period the population was probably more sessile than the tribes of herdsmen discussed on p. 167. The still relatively high *Plantago* values suggest that the grazing land must have been rather extensive. From sample 28 on the tree pollen decreases considerably suggesting a great activity of prehistoric man during the Iron Age. It is not unlikely that during that period the population density was rather high.

The low herbaceous percentages in samples 35, 36 and 37 constitute a striking phenomenon. A radiocarbon date of 285 ± 60 A.D. for the level of sample 36 shows that a marked decline of human activity took place during the Roman occupation.

The appearance of pollen of *Castanea* in sample 36 is worth mentioning. This confirms the hypothesis that this tree was introduced here by the Romans.

In the upper samples of the Spézet diagram a strong decline of tree pollen can be observed, suggesting that a large part of the forest was converted into fields and pastures.

Le Cloître diagram (Plate XLIV). The lower part of the Le Cloître profile was probably deposited very slowly, so that compared with those in the Spézet diagram the curves are rather compressed. It is likely that the herbaceous maximum in sample 7 is to be ascribed to the activity of the herdsmen in the late Neolithic or early Bronze Age.

With its minimum of herb pollen sample 12 must again represent the period of Roman occupation. Indeed the *Fagus* values are lower than those in the Spézet diagram at the level of the Roman period. On the other hand, in the Le Cloître diagram the rise of *Secale* can be observed directly above sample 12, while the *Humulus/Cannabis*-type as well, soon shows a continuous curve reaching a relatively high value in sample 18. On account of the relation between tree and herbaceous pollen in general and that of the curves for *Secale* and *Humulus/Cannabis* in particular it may be concluded that sample 12 of the Le Cloître diagram corresponds with samples 35, 36 and 37 of the Spézet diagram. It seems that the higher soils

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[1] The number of *Pteridium* spores counted in sample 18 was extremely high. For that reason in this sample the percentage for bracken has been corrected from the values for this fern in samples 17 and 19.

in the vicinity of the bog near Le Cloître were less favourable for beech than those in the vicinity of the bogs of Menez-Cam and Saint-Michel-de-Brasparts.

Brasparts III diagram (Plate XLI: 2). The activity of man during the Middle Ages is demonstrated in the Brasparts III diagram. In the upper part of this diagram which probably has a hiatus between 40 and 50 cm, high herbaceous values can be observed. *Secale* shows relatively high percentages, while pollen of the *Humulus/Cannabis*-type is common. Unfortunately, it is not possible to separate the pollen of *Humulus* from that of *Cannabis*. Both plants have an economic value; hop for the manufacture of beer, hemp because of its fibres. P. R. Giot informed the present author that in the interior of Brittany much hemp was grown between the Middle Ages and the Second Empire. Hop on the other hand, would have been of little importance.

The decrease of *Fagus* in the upper samples is probably also due to the activity of man who preferred the timber of oak to that of beech, for which reason the growth of oak was promoted.

Origin of the 'landes'. The so-called landes which at present cover most soils not in use for agricultural or forestry purposes, constitute a type of open vegetation with among others *Calluna vulgaris*, *Erica spp.*, *Ulex europaeus* and *Pteridium aquilinum*. Le Lannou (1950) wonders whether this vegetation type came into existence after the deforestation in prehistoric and historic times or whether it can be considered as an original plant community which only expanded considerably after the interference of man with the vegetation. The results of this study suggest that before man took up farming there the interior of Brittany was nearly completely covered with forest. However, it is well possible that on very unfavourable spots such as the wind-swept hill-tops a treeless vegetation was present already before human interference. In case they were never covered with forest these summits could have served as a refuge for Late-glacial plants (*cf.* p. 168).

In connection with the 'landes' the behaviour of *Ulex* is also of interest. The palynological results demonstrate that in Brittany this shrub, which prefers open habitats, was already present before the serious influence of prehistoric man on the vegetation started (Pl. XXXVIII). Simultaneously with the expansion of the deforested area an increase of *Ulex* can be observed (Plates XXXIX and XL).

Bog vegetation

Construction of the diagrams. It is self-evident that, just as in the discussion of the activities of prehistoric man, the pollen types which can provide information on the

local bog vegetation must be taken together as a separate group. The frequencies of the pollen types concerned are expressed as percentages of the sum of bog plant pollen types.

In determining what must be reckoned to the bog and swamp plants difficulties inevitably arise. The uncertainty about the Gramineous pollen has already been mentioned. It is without doubt that in the profiles of Spézet and Le Cloître a considerable part of the grass pollen came from vegetation types on the higher soils. For that reason, in the bog plant pollen diagrams of Spézet and Le Cloître, Gramineae have been left out of the basic sum. In the upper samples of the Brasparts I diagram, during which period an increase of grasses on the higher soils can be expected, on the contrary a marked decline in Gramineae takes place. As here the share of grass pollen from the higher soils was apparently of little importance and was moreover, confined to the upper samples, in this diagram grasses are included in the sum.

The pollen of trees and shrubs which may have formed part of the bog vegetation (*Alnus*, *Betula*, *Rubus*, *Frangula*, *Sorbus*, *Salix*) is not included in the basic sum. One reason for this is the circumstance that *Alnus* and *Betula* not only have a large pollen production but also a good dispersal. Birch and alder can have contributed to a great extent in the pollen rain on parts of the bog where these trees did not occur themselves. This is not equally true for *Salix*, *Sorbus*, *Frangula* and *Rubus*, but for the sake of uniformity these types are likewise left out of the pollen sum.

In the diagrams the types not included in the pollen sum are represented to the right of the column with the sums. Moreover, these curves have been hatched, in contrast to the curves for the other pollen types which are black.

As for the types included in the sum, for many of them there will be little doubt that they belong to this category (*Calluna*, Cyperaceae, *Triglochin*, *Dryopteris*, *Sphagnum*, etc.). Of some others one could wonder whether it is justified to incorporate them in the group of bog and swamp plants. In such a case the quantities of pollen found in one or more profiles sometimes turned the scale. Thus, the relatively high values for *Melampyrum* in a number of samples suggest that this plant will have grown on the bog. *Osmunda* does still occur on the bog of Saint-Michel-de-Brasparts. Compositae now and then show relatively high values, among others in the diagrams Brasparts II and III not represented in this paper. This suggests that representatives of this family will have formed part of the bog vegetation. Of various pollen types it is likely that they will not have originated from bog plants exclusively. If it was reasonable to suppose that the pollen type concerned had been produced mainly by bog plants it is included in the sum. As the present author does not feel competent to separate with certainty the Ericaceous pollen types except *Calluna*, the others have been lumped (other Ericaceae).

Seed analysis. It is clear that besides the microfossils, *i.e.* the pollen grains, the macrofossils likewise can provide important information concerning the local bog vegetation. For that reason the material left over after the samples for pollen analysis and eventually radiocarbon dating had been taken, has been examined for its seeds. As the diameter of the core segments amounted to about 3.5 cm, for practical reasons a complete segment of 20–25 cm length mostly had to be treated as one sample. If for a radiocarbon measurement much material had been used it was necessary to take the remainder of two core segments together. The vertical scale of the samples analysed for seeds can be read from the diagrams of Plates XLV–XLVII.

 Before processing the samples were soaked in a weak nitric acid solution for some days. After that the material was strained through three sieves of different mesh. With a few exceptions both coarse fractions were analysed completely under a binocular stereomicroscope. Of the fine fraction, in which mainly seeds of *Juncus* and Ericaceae were present, in general only a part was analysed. If a fraction was examined partially the numbers of seeds were multiplied with the appropriate factor in order to make them comparable with the rest of the sample.

 In representing the results of seed analysis three categories have been distinguished, *viz.* 1–4, 5–49 and 50 or more seeds. It should be stressed that to a much greater degree than with pollen, selective preservation seems to have affected the seed contents.

 In working out the results of pollen and seed analysis it turned out to be a not inconsiderable disadvantage that our knowledge of the peat stratigraphy was insufficient. This is due, among other things, to the circumstance that the profiles had to be sampled with a borer, which handicaps a proper distinction between peat layers showing much mutual resemblance. Moreover, during the sampling a more detailed study of the subfossil bog vegetation itself was not yet envisaged. A number of borings within a limited area would already have provided more information concerning the local peat stratigraphy. A better knowledge of the successive peat layers would undoubtedly have facilitated the interpretation of the seed analytical results.

 Before proceeding to a discussion of the separate profiles, first some general remarks will be made. A very welcome addition to the palynological results is constituted by the circumstance that in contrast to pollen, seeds of *Juncus* are preserved. The study of Körber-Grohne (1964) demonstrates that at least the seeds of the Westeuropean species of this genus can be separated.

 The prospects for a palynological distinction within the Cyperaceae are not very encouraging. On the other hand, the seeds of the sedge family are more promising in this respect although an identification up to the species is not always possible. Of the *Carex* nuts, for instance, only a number of types could be distinguished. In contrast to the pollen the caryopses of the grass family show enough mutual differences

in order to enable a species identification. It was likewise Körber-Grohne (1964) who prepared a key for the identification of the caryopses of the grasses from western Europe. In the Breton profiles only *Molinia* and *Agrostis* were met with. It is not impossible that on account of selective preservation the caryopses of some other species had disappeared.

In general the wings of the *Betula* seeds had been seriously damaged or had even completely gone, so that only for a limited number of seeds a species determination was possible. As the identifiable seeds turned out to be of *Betula pubescens* it is likely that all birch seeds belong to that species.

Brasparts I profile (Plate XLV). It has already been explained that in the Brasparts I profile there is a considerable hiatus between the *gyttja* at the basis and the overlying peat. As, moreover, in the *gyttja* only one *Carex* nut was met with, this Lateglacial deposit will be left out of consideration.

In the lower part of this profile only a few seed types were found. The occurrence of seeds of *Betula* agrees with the high percentages for birch pollen. Here peat formation will have started with an open vegetation of Gramineae, Cyperaceae and *Sphagnum*, which vegetation type, within not too long a time, passed into a birch swamp forest. In this forest *Juncus cf. bulbosus* (on account of the poor preservation a reliable species identification was not possible), *Melampyrum* and *Dryopteris thelypteris* (undoubtedly most of the *Dryopteris* spores were of *D. thelypteris*) will have been common weeds, while *Sorbus* and *Salix* also formed part of the bog vegetation. In the course of time this birch swamp was succeeded by open vegetations with many Gramineae and *Juncus*. In spite of the large numbers of grass pollen a caryopsis of *Molinia* was found only twice. Besides, between 105 and 185 cm rhizomes of *Phragmites* were present. From a depth of 145 cm on, seeds of *Calluna* and *Erica* were found. In this connection it should be mentioned that although the *Calluna* pollen percentages are much higher than those for the other Ericaceae, the seeds of *Erica* were more numerous than those of *Calluna*. The upper part of this deposit was formed by an Ericaceae-*Sphagnum* vegetation in which grasses also must have been common. Between 25 and 45 cm a fairly large number of *Rhynchospora* seeds was counted while the fibrous sheaths of *Eriophorum* were also present. The occurrence of macroscopic remains of *Eriophorum* and *Rhynchospora* is in accordance with the increase in Cyperaceous pollen in the upper part of the profile.

In samples 24 and 25 *Alnus* as well as *Betula* shows high percentages. However, this does by no means suggest a temporary expansion of these trees over the whole bog. Neither of *Betula* nor of *Alnus* even one seed was found in the corresponding part of the profile.

The section in which seeds of *Potentilla erecta* occurred is characterized by relati-

vely high values for the *Potentilla* pollen type. Of *Melampyrum* no seeds have been found although in a number of samples the pollen of this genus was common.

Spézet profile (Plate XLVI). A considerable part of this deposit has been formed by swamp forest vegetations. The palynological results suggest that the alder swamp was succeeded by a birch-alder swamp. Marsh-fern (*Dryopteris thelypteris*) will have played an important part in these swamp forests in which also *Juncus effusus* was present. The regular occurrence of *Rubus* pollen in the lower part of the diagram is in accordance with the presence of seeds of this genus in the corresponding part of the profile.

In the long run the mesotrophic swamp forest gave way to more oligotrophic vegetations. A clear indication of increasing acidity are the higher *Sphagnum* percentages. Above a depth of 160 cm no more *Alnus* seeds were met with. On the other hand, birch seeds remain rather common for the time being, indicating that the section between 100 and 160 cm was formed by a birch swamp. It is striking that in the transitional zone between the birch-alder and the birch swamp the pollen of *Sorbus*, *Frangula* and *Salix* was counted in fairly large numbers. The disappearance of *Alnus* seeds goes with a marked decline of *Dryopteris*.

The high *Alnus* percentages in samples 21–23 are not accompanied by the occurrence of alder seeds in the corresponding part of the profile. This suggests that in spite of the high values for *Alnus* pollen this tree did not form part of the local bog vegetation at that time. A similar phenomenon has already been observed in the Brasparts I profile.

Judging from the nature of the core segments the lower part of this profile was formed by a dense swamp forest, whereas the part between 100 and 220 cm showed less wood. At that time the swamp forest will have been rather open.

In the birch swamp *Erica* and *Calluna* appeared as the forerunners of the raised bog vegetations which formed the upper part of the profile. The highly humified moss peat contained many roots of Monocots suggesting that Gramineae and/or Cyperaceae will have played an important part in the vegetations concerned. *Osmunda* must have been a common plant in the raised bog, while the occurrence of wood indicates that at first some birches will have grown in the Monocot-Ericaceae-*Sphagnum* vegetations. The upper part of the profile, in which no more wood was present, yielded among others seeds of *Anagallis tenella*, *Scirpus caespitosus* and *Rhynchospora* while pollen of *Narthecium* was also met with. The seeds of *Potamogeton cf. polygonifolius* point to the presence of open water in the raised bog.

As for the *Carex paniculata*-type it is not likely that throughout the whole peat formation the same *Carex* species continued. It has already been remarked that a species identification of the *Carex* nuts was not possible. The *Carex paniculata*-type includes *Carex paniculata* as well as *C. remota*, *C. disticha* and *C. echinata*. Thus in

the lower part of the profile *Carex paniculata* could be the species concerned, whereas in the upper part such a species as *Carex echinata* is more likely.

A not inconsiderable part of the grass pollen will have originated from the higher soils, and there is little doubt that the maximum in samples 11 and 12 must be ascribed to the expansion of grasses in the vicinity of the bog. On the other hand, the very high Gramineous percentages in samples 19–25 will largely be due to grasses on the bog itself. This supposition is confirmed by the circumstance that in the corresponding part of the profile a fairly large number of *Molinia* caryopses was met with. For a more detailed discussion of the origin of the grass pollen we may refer to pp. 177–9.

Le Cloître profile (Plate XLVII). The vegetational development in the Le Cloître profile shows much resemblance to that in the Spézet profile. For a rather long time an alder swamp constituted the local bog vegetation. Again *Dryopteris thelypteris* will have played an important part in the herbaceous vegetation of the alder swamp. In view of the clayey character of the lower part of this deposit the marsh vegetation will not infrequently have been flooded at first.

The birch-alder swamp forest again shows a development in a more oligotrophic direction. The disappearance of *Alnus* seeds is accompanied by a decline of *Dryopteris*, a coincidence which was also observed in the Spézet diagram.

Above 73 cm much less wood was found than in the underlying peat, and it is likely that between 48 and 73 cm we are concerned with a *Juncus*-Cyperaceae-Gramineae vegetation with scattered birches. The occurrence of a large number of *Sphagnum* spores in this part of the profile suggests an increasing acidity of the local conditions.

As for the seeds, between 48 and 73 cm a conspicuously large number of types was met with. The occurrence of *Urtica dioica* and *Polygonum persicaria* points to a local accumulation of nitrates, perhaps as a consequence of the deposition of organic debris during periods of flooding.

The most striking transition is that between the Monocot peat and the overlying *Sphagnum* peat. Various species disappear, whereas more or less characteristic representatives of the raised bog vegetation, such as *Erica tetralix*, *Calluna vulgaris* and *Narthecium ossifragum*, are present from now on.

In the Le Cloître profile between 61 and 126 cm seeds as well as pollen of *Potamogeton* have been met with. The relatively high pond-weed percentages in samples 13 and 14 coincide with a greater number of seeds of this plant. In the upper part of the diagram *Potamogeton* pollen does not occur, that of *Triglochin*, on the other hand, shows high percentages. Although the pollen of both genera shows a fairly great mutual resemblance a separation is well possible. Especially under the phase-contrast microscope the differences come out clearly. It is somewhat astonishing
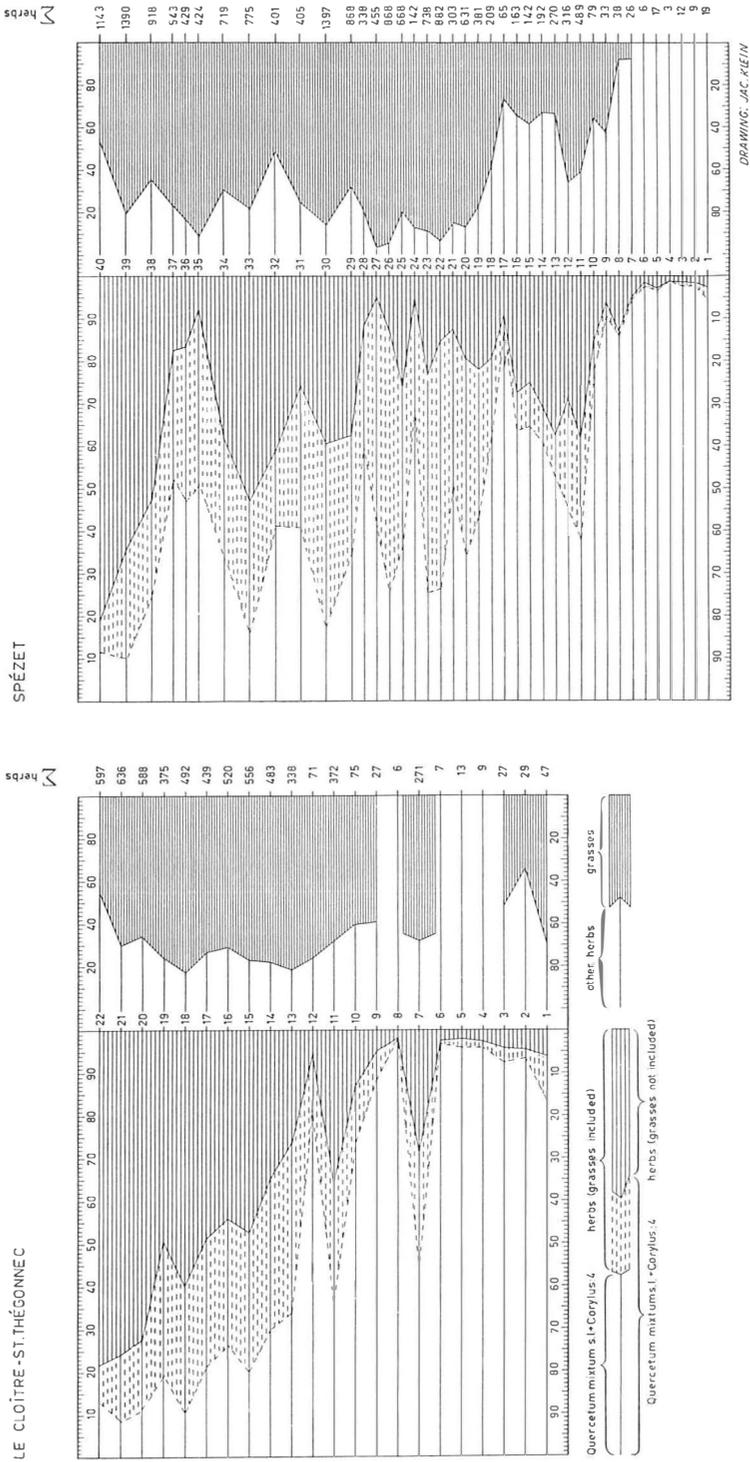
Fig. 32. Relation between Gramineae and *Quercetum-mixtum s.l.* (left), and between Gramineae and herbs (right) in the profiles from Spézet and Le Cloître. For explanation see text.

that in the upper part of the Le Cloître profile seeds of *Potamogeton* do occur but no pollen, whereas in the lower part of this profile both were present. This cannot be explained by assuming that in the two parts of the profile different species of *Pota-mogeton* were concerned, for throughout the whole deposit the same type of seed, *viz. Potamogeton cf. polygonifolius* has been found.

Origin Gramineous pollen

It has already been remarked that Gramineous pollen can have originated as well from the higher soils as from the bog. In order to obtain some idea of the local and regional share in the total of the Gramineous pollen the diagrams of Fig. 32 were constructed. The left part of each diagram shows the relation between the *Querce-tum-mixtum s.l.* and *Corylus:*4 on the one hand and the total herb pollen, with and without Gramineae respectively, on the other hand. The same herbs as have been included in the basic sum of the diagrams of Plates XLIII–XLIV are involved here. Consequently, the left part of the diagrams of Fig. 32 is a partial repetition of the middle part of the diagrams of Plates XLIII–XLIV. To the right the relation be-tween the Gramineae and the other herbs included in the left part of the diagram is represented. If here the sum was less than 25 this relation is not shown for that particular sample.

In the lower part of the Spézet profile Gramineous pollen is present in small numbers. This suggests that grasses will not have played an important part in the nearly untouched forest vegetation on the higher soils. The bog vegetation likewise did not produce noticeable quantities of grass pollen at that time. During the first part of the period of land occupation (samples 11 and 12) the share of Gramineae is high. This is not surprising as in consequence of the activity of prehistoric man grass-es will at first have expanded more than *Pteridium*. For bracken is no pasture plant, but expands rapidly on abandoned fields. Although in samples 13–16 the total of the non-arboreal pollen remains high the share of Gramineae is much lower again. This is perhaps an indication for the establishment of an equilibrium between the grazed (Gramineae, *Plantago*, *Rumex*) and the abandoned part (*Pteridium*) of the deforestated area.

Between samples 17 and 28 lower herbaceous percentages can be observed, this with exception of the Gramineae, which show a marked increase. This suggests that during this period much grass pollen must have been produced by the bog vegetation itself.

During a reduction of the herbaceous vegetation on the higher soils the share of the grass pollen in the total of the herbs will increase. The reverse can be expected during an expansion of the herbs on the higher soils. Thus, above sample 28 an increase of non-arboreal pollen can be observed, whereas the share of Gramineae in

the total herb pollen decreases. The grass pollen produced by the bog vegetation did not increase, in consequence of which the total of the grass pollen increased less than the rest of the herbaceous pollen did. The low percentages for herbs in samples 35, 36 and 37 are accompanied again by relatively high values for Gramineae.

It is undoubtedly precarious to try to calculate what part of the Gramineous pollen originated from the higher soils and what part from the bog. Nevertheless, with the help of a few examples an attempt will be undertaken. From samples 13–17 it may perhaps be concluded that in the vicinity of the bog of Menez-Cam 40% of the herb pollen produced on the higher soils was of Gramineae. As it has been assumed that in these samples the amount of grass pollen produced by the bog vegetation can be neglected, this 40% constitutes a maximum value.

In samples 20–27 the herbaceous pollen without the grasses amounts to about 10% of the total of herbs and grasses. Starting from the hypothesis that of the herbaceous pollen produced on the higher soils 40% is of Gramineae, it can be deduced that to this 10% 'other herbs' there belong about 7% grasses. The remainder of the Gramineous pollen, that is about 83% of the total herb pollen or about 92% of all grass pollen, must have originated from the bog vegetation itself.

As for a comparison with the results of seed analysis, it can be remarked that from about sample 19 onwards caryopses of *Molinia* were met with. This is in accordance with the conclusion that the greater part of the grass pollen above sample 17 would have been produced by the bog vegetation.

In the corresponding diagram of Le Cloître the picture is less striking. It is not impossible that in this area the share of the Gramineous pollen in the total herb pollen produced on the higher soils amounted to about 60% (samples 9 and 10). The relation between grasses and other herbs need not be the same everywhere. Soil conditions will have been of much importance in this respect. Wet sites, for instance, would have been less favourable for an expansion of *Pteridium* than drier habitats. However, the possibility cannot be excluded that a part of the grass pollen in samples 9 and 10 did originate from the bog vegetation. On the other hand, the virtual absence of grasses in samples 4, 5, 6 and 8 suggests that during the deposition of that part of the profile apparently Gramineae were of little importance in the bog vegetation.

The same kind of calculation as carried out above leads to the conclusion that in samples 13–18 of the Le Cloître profile about 40% of the total herb pollen or about 50% of the total grass pollen must have been produced by Gramineae which formed part of the bog vegetation. This conclusion is confirmed by the results of seed analysis (Pl.XLVII). Although in the lower part of the Le Cloître profile a few *Agrostis* caryopses were already met with, these were more numerous between samples 12 and 19. The decline in the share of Gramineae in the upper samples goes together with an absence of caryopses in that part of the profile.

It must thus be left undecided in how far a more or less reliable calculation of the share of Gramineous pollen produced by the bog vegetation is possible. However, the diagrams of Fig.32 certainly can provide a rough impression of the fluctuating share of the local grasses in the total herb pollen.

Radiocarbon dates

Brasparts I   51– 59 cm: 1820 ± 55 B.C. (GRN 2175)
Brasparts I 126–134 cm: 3450 ± 60 B.C. (GRN 1983)
Spézet   41– 49 cm: 285 ± 60 A.D. (GRN 2315)
Spézet   131–139 cm: 815 ± 45 B.C. (GRN 2165)
Spézet   201–209 cm: 1980 ± 75 B.C. (GRN 2161)

ACKNOWLEDGEMENTS

REFERENCES

DRICOT, E.-M. 1960. Recherches palynologiques sur le plateau des Hautes-Fagnes. *Bulletin de la Société Royale de Botanique de Belgique* **92**, 157–96.

DUBOIS, G. et C. 1945. Tourbière de Saint-Michel-de-Brasparts (Finistère). *Compte Rendue Sommaire des Séances de la Société Géologique de France*, 204–5.

ELHAÏ, H. 1959. Analyse pollinique de deux tourbières Normandes. *Pollen et Spores* **1**, 59–76.

GIOT, P. R. (in collaboration with J. L'HELGOUACH and J. BRIARD) 1960. *Brittany*. London.

GODWIN, H. 1940. Studies of the Post-glacial History of British Vegetation. III. Fenland pollen diagrams. IV. Post-glacial changes of relative land- and sea-level in the English fenland. *Phil. Trans. Roy. Soc. London* B **230**, 239–303.

GODWIN, H. 1960. Radiocarbon dating and Quaternary history in Britain. *Proceedings of the Royal Society B*, **153**, 287-320.

IVERSEN, J. 1941. Landman i Danmarks Stenalder. *Danmarks Geologiske Undersøgelse*. II. Raekke. Nr. 66.

IVERSEN, J. 1942. En pollenanalytisk Tidsfaestelse af Ferskvandslagene ved Nørre Lyngby. *Medd. Dansk. Geol. For.* **10**, 130–51.

IVERSEN, J. 1944. Viscum, Hedera and Ilex as climate indicators. *Geol. Fören. Förhandl.* 66, 463–83.

KÖRBER-GROHNE, U. 1964. Bestimmungsschlüssel für subfossile Juncus-Samen und Gramineen-Früchte. In the press.

KUBITZKI, K. 1961. Zur Synchronisierung der nordwesteuropäischen Pollendiagramme (mit Beiträgen zur Waldgeschichte Nordwestdeutschlands). *Flora* **150**, 43–72.

LE LANNOU, M. 1950. *Géographie de la Bretagne.* Rennes.

NILSSON, T. 1960. Recherches pollenanalytiques dans la vallée de la Somme. *Pollen et Spores* **2**, 235–62.

POSER, H. 1948. Boden- und Klimaverhältnisse in Mittel- und Westeuropa während der Würmeiszeit. *Erdkunde* **2**, 53–68.

STAPF, O. 1889. Die Arten der Gattung Ephedra. *Denkschr. d. Akad. d. Wiss. Wien* **56**, 2. Abt., 1–112.

TRICART, J. 1956. Cartes des phénomènes périglaciaires quaternaires en France. *Mém. Carte Géol. de la France.* Paris.

TROELS-SMITH, J. 1953. Ertebøllekultur-Bondekultur. *Aarbøger for Nordisk Oldkyndighed og Historie* 1953, 5–62.

TROELS-SMITH, J. 1955. Pollenanalytische Untersuchungen zu einigen schweizerischen Pfahlbauproblemen. In: *Das Pfahlbauproblem.* Basel. 11–58.

WELTEN, M. 1957. Über das glaziale und spätglaziale Vorkommen von Ephedra am nordwestlichen Alpenrand. *Ber. Schweiz. Bot. Ges.* **67**, 33–54.

VAN ZEIST, W. 1963. Recherches palynologiques en Bretagne occidentale. *Norois* **10**, 5–19.

TABLE I

Occurrence of *Hedera* in Breton profiles

	samples	$\sum$ Fagus Carpinus Quercus Ulmus Tilia Fraxinus Acer Taxus	number of pollen	percentage
Brasparts III Subatlantic . .	6–12	1078	10	0.92

Brasparts I
  Subboreal . . .
  Atlantic . . . .
	18–37
	1–17
		7148
		7409
			61
			55
				0.85
				0.74

Spézet
  Subatlantic . .
  Subboreal . . .
	24–40
	1–23
		4826
		5790
			49
			261
				1.02
				4.51

Le Cloître
  Subatlantic . .
  Subboreal . . .
	10–22
	1–9
		1554
		1709
			41
			17
				2.64
				0.99