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# THE INTERGLACIAL OF FRECHEN I/RHEINLAND - A SECTION OF THE TIGLIAN A-TYPE - [1]

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## ABSTRACT

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Palynological investigations of earliest Pleistocene deposits at Frechen, some ten kilometers west of Cologne permit the dating of these sediments in terms of the Dutch biostratigraphic scale. Of special interest is a newly discovered interglacial period, termed the 'Frechen I Interglacial', which indicates a more complicated development of vegetation during the early Tiglian than was hitherto thought.

## INTRODUCTION

West of 'die Ville', Rheinland (South Lower Rhine region) the so called Erft-Scholle is subsiding, thus creating a huge sedimentary trap (Fig. 1). In it very thick Pliocene and Pleistocene deposits of the river Rhine or of its predecessors are present (Fig. 2). The upper Pliocene and lower Pleistocene deposits are exposed in the brown-coalmines, as e.g. in the coal mine of Frechen, of the Ville. Sedimentological and biostratigraphical analyses as well as palaeomagnetic research have been carried out repeatedly on these strata (KOWALCZYK, 1969; BOENIGK ET AL., 1974).

It has been shown by BOENIGK ET AL. (1972) that the transition from a stable heavy-mineral association, (especially tourmaline, zircon and staurolite) to a heavy-mineral spectrum, dominated by unstable minerals (especially garnet, epidote, alterite and green hornblende) occurs in the sequence of the clay beds A1/A2 of the Ville-section during the Reuverian B (Figs. 2 and 4). A corresponding change of heavy-mineral composition also occurs in the Reuverian B beds at the type locality of the Reuver clay (BOENIGK, 1970). Consequently, in the region of the Lower Rhine Basin this

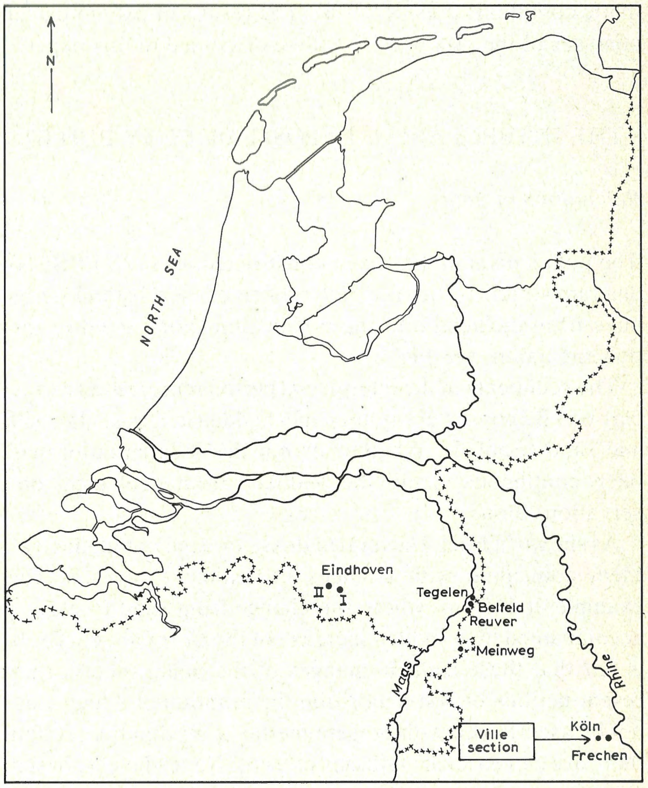


Fig. 1
General map, showing locations of dutch type-localities and site of the Frechen brown coal mine.

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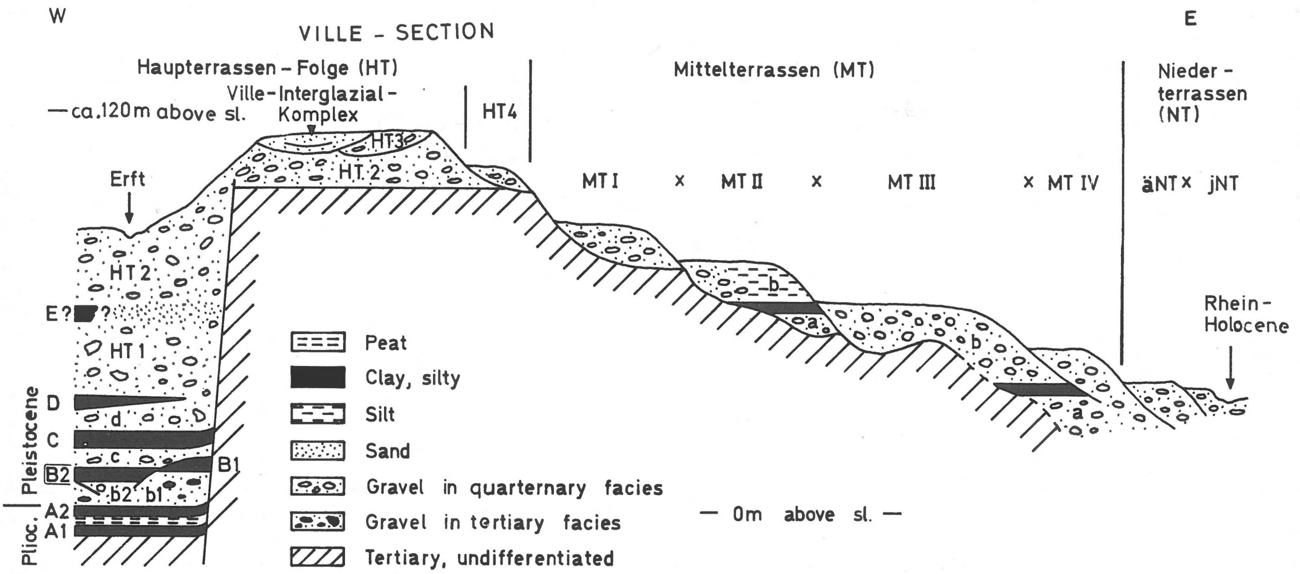


Fig. 2
Scheme of the lithologic succession of the Ville-section (see: Boenigk et al., 1972).

change is believed to occur during the upper Pliocene and not during the earliest Pleistocene as thought earlier.

Younger than the clay layers A1/A2 are the clay beds B1 and B2. Recent pollen-analytical investigations have contributed to a better understanding of the then prevailing climatic conditions (URBAN, 1978). The results of palynological analyses of the clay bed B2 will be discussed in this paper.

## THE INTERGLACIAL DEPOSIT OF CLAY BED B2

### *Palynological data*

The pollen diagram has been constructed as an IVERSEN-diagram (Encl. I), i.e. the pollen of trees, shrubs and herbs have been included into the pollen sum (For legend to the pollendiagram, see Fig. 3).

The sediments of the interglacial period represented by the clay bed B2 consist of rhythmically bedded layers of clay, silt and sand (Encl. I). Whether or not the sedimentation has been continuous cannot be deduced from geological observations alone.

As shown in Encl. I several hiatusses are indicated, most of them coinciding with changes of sediment types as for example at 165 cm, where the change from sand to clay is accompanied by a sudden increase of the *Carpinus*-curve. It is felt that these sudden changes of the pollenspectra represent periods of non-deposition the duration of which cannot be ascertained with present methods. Within the section there are eleven such hiatusses present. Nevertheless, based on various pollen assemblages, the section is subdivided into seven pollen zones (Encl. I). These zones are described below in ascending order.

*Zone F 1: Pinus-Picea Zone* – The basal part of the diagram is characterized by the preponderance of *Picea,* alternating with *Pinus*. Amongst the elements of the Quercetum mixtum *Ulmus* is of minor importance. The arboreal pollen (A.P.) is predominant from the very bottom of the diagram. It is unfortunate that the sequence of re-immigration of the tree species in the period following that of the preceding cold climate is still unknown.

*Zone F 2: Betula-Pinus-Picea Zone* – Relatively high frequencies of *Betula* and lower percentages of *Pinus* and *Picea* are characteristic of stage F 2. A peak in the *Quercus* curve, which might be of secondary origin, causes an increase of the Quercetum mixtum curve. The presence of *Nyssa* pollen, which, according to the well preserved state of the pollen grains, may be considered to be autochthonous, is worth mentioning.

*Zone F 3: Picea-Pinus-Quercetum mixtum-Fagus Zone* – The small increase of *Fagus,* which will be discussed subsequently, is associated with a new increase of *Pinus* and *Picea*. The percentage of Quercetum mixtum remains constant. One pollen grain of *Liquidambar,* a plant characteristic of Pliocene deposits, should be noted (in sample III 38). Its presence may be assumed to be autochthonous for the same reason stated earlier for *Nyssa*.

*Zone F 4: Tsuga-Pinus Zone* – The stage F 4 may be defined by a very characteristic *Tsuga-Pinus* pollen assemblage, which enables correlation with other deposits as will be discussed later. Because of a hiatus at 420 cm it is not possible to establish the transition between the zones F 3 and F 4. At the latter depth an interruption in the normal development of the

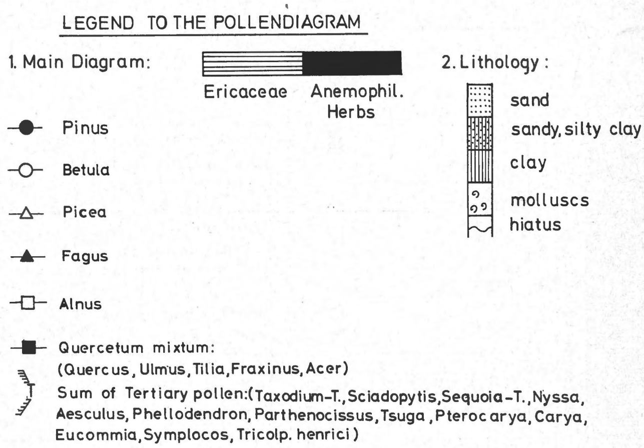


Fig. 3
Legend to the pollendiagram.

vegetation is noticeable in the diagram.

*Zone F 5: Pinus-Alnus Zone* – Zone F 5, which appears to represent the longest phase of the interglacial period under consideration, is characterized by the dominance of *Pinus* (subzone F 5 a) and an increase of *Alnus (Alnus glut.*-type) in the upper part of the diagram (subzone F 5 b). This is associated with an increase in the *Carpinus* curve in the uppermost part of the subzone F 5 b.

Because several hiatusses occur within zone F 5 more detailed subdivisions have not been made.

Of special interest are two well preserved pollen grains of the genus *Symplocos* (samples III 28 and III 20, Encl. I). *Symplocos* pollen are known from earliest Pleistocene sediments i.e. from the type locality of the 'Nordende' – warm period (MENKE, 1975). Its optimal occurrence in central Europe experienced *Symplocos* however, during the lower and middle Tertiary. During the Reuverian the pollen percentage of *Symplocos* appears to have declined strongly.

*Zone F 6: Fagus-Carpinus-Pinus Zone* – The very small amount of non-arboreal pollen (N.A.P.) and the high frequencies of spores of Polypodiaceae point to closed forests. *Pinus, Fagus* and *Carpinus* are well represented. The amount of *Ostrya*-type has increased, although in this respect the shape of the *Carpinus* curve should be taken into consideration because it is invariably difficult to distinguish reliably, between a triporate *Carpinus betulus* pollen-type and a pollen-type referred to as *Ostrya*-type.
The elements of the Quercetum mixtum and *Alnus glut.*-type are less significant and apparently diminish in zone F 6 time.

*Zone F 7: Picea-Pinus-Betula Zone* – The uppermost part of the diagram represents another expansion of coniferous forest vegetation. *Picea* predominates in most of the samples, whereas *Betula* and *Pinus* are of minor importance. Evidently the type of vegetation has changed rapidly; the low percentage of N.A.P., however, still indicates a forested area.

Summarizing it may be stated that the diagram reveals a temporate forest vegetation on terrestrial habitats, which may be compared at best with the present day *Fagus grandiflora-Acer saccharum-Tsuga canadensis* hard-wood forests of North America (MENKE, 1975). It is characteristic of a humid climate type with short but warm summers (mean temperatures of the warmest month: 20° C) long, cold winter periods (frost period about 6 month), and a precipitation rate in the range of 900 mm (data according to climate diagram of Ottawa in WALTER & LIETH, 1967).

*Gastropods of clay bed B2*

For a better evaluation of the prevailing local conditions the remains of gastropods, obtained from a gravel lense embedded in clay bed B2, may provide additional information. Ložek (in KOWALCZYK, 1969) described the following species (Fig. 4):

Aquatic animals:
*Viviparus* sp. *('diluvianus-viviparus')*
*Valvata piscinalis* MÜLLER
*V. goldfussiana* WÜST
*Lymnea* sp. (aff. *ovata* DRAP.)

Terrestrial animals:
*Cochlostoma* sp.
*Succinea 'putris-elegans'*
cf. *Vitrea* (?? *crystallina)*
*Aegopinella* cf. *pura* ADLER
*Aegopinella* sp.
cf. *Oxychillus*
*Clausilia pumila* C. PFEIFFER
*Perforatella* cf. *bidentata* GM.
*Monachoides incarnata* MÜLLER
*Trichia* aff. *sericea* DRAP.
cf. *Euomphalia strigella* DRAP.
*Helicigona lapicida* L.
*Arianta arbustorum* (L.)

*Cochlostoma, Monachoides incarnata* MÜLLER and the two species of the genus *Aegopinella* are species characteristic of interglacial periods and they point to a forested landscape. The natural habitats of *Perforatella, Arianta* and *Clausilia pumila* C. PFEIFFER are riverine forests.

Although a major part of the shells has been considerably damaged, a fauna of early Pleistocene character could be recognized. Terrestrial species are predominant (Ložek in KOWALCZYK, 1969).

*Botanical macrofossils of clay bed B2*

In addition, the macrofossils of botanical origin should be

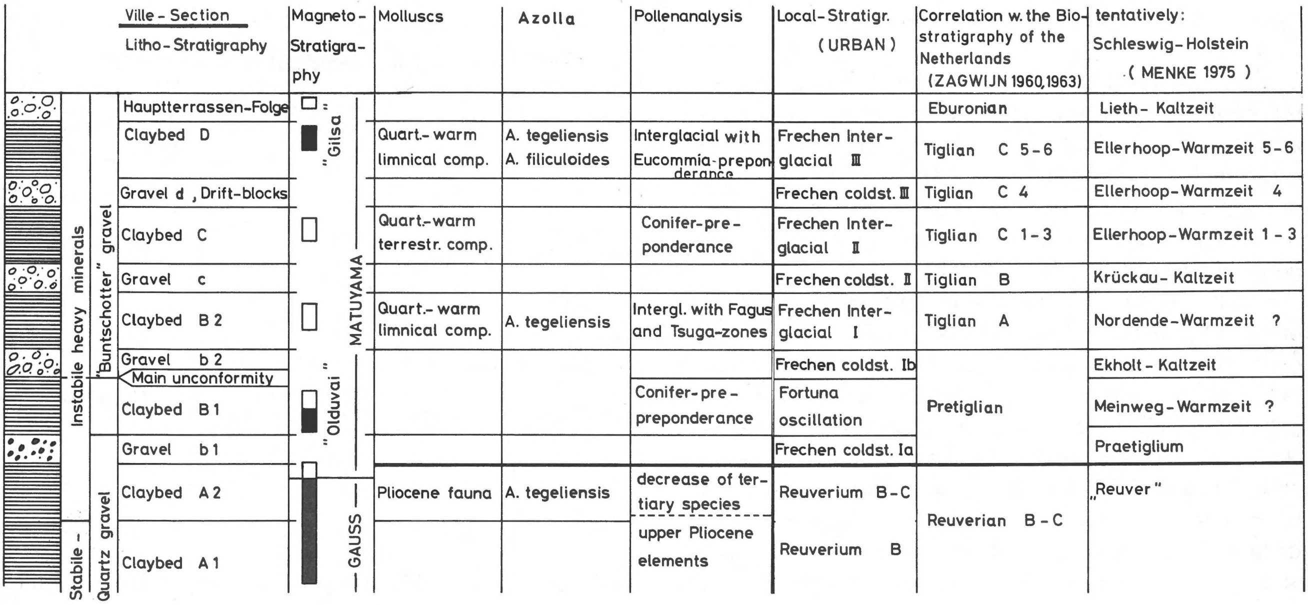


Fig. 4
Diagrammatic representation of the work on the Ville-section and correlations.

taken into consideration (Kempf in KOWALCZYK, 1969):

*Acer* +
*Vitis* sp.
*Corylus* sp. +
*Carpinus* sp. +
*Picea* sp. +
*Lycopus* sp.
*Scirpus* sp.
*Chenopodium* sp. +
*Carex* sp.
*Azolla (Rhizosperma) tegeliensis* FLORSCHÜTZ
*Selaginella* sp. +
*Typha* +
*Alisma*

Pollen has been found of the species marked with +.

According to FLORSCHÜTZ (1938) *Azolla tegeliensis* is typical of Tiglian beds, whereas *Azolla filiculoides* also occurs in younger deposits (DOPPERT & ZONNEVELD, 1955; ZAGWIJN, 1960). Following the conclusions of ZAGWIJN (1960) *Azolla tegeliensis* is restricted to the Tiglian.

## CORRELATION

For the correlation between the Frechen Interglacial I and other lower Pleistocene sequences of North-West and Middle Europe, *Fagus* is apparently of decisive significance.

(1) The considerable percentages of *Fagus*-pollen in the Frechen Interglacial I are worth mentioning because the *Fagus* tree was lacking during most of the Pleistocene in Western Europe.

A period characterized by *Fagus* has been shown previously by VAN DER VLERK & FLORSCHÜTZ (1953) in a diagram of the Belfeld Clay, exposed in the JANSSEN-DINGS sand- and claypit (Fig. 1). These authors considered the Belfeld Clay to be of Pretiglian age. Subsequently ZAGWIJN (1960) placed these deposits on palynological grounds in the Tiglian, and the *Fagus*-phase was assumed to be of Early Tiglian age (Tiglian A: ZAGWIJN, 1963). It should be emphasized that the pollen sequence of the Frechen Interglacial I compares fairly well with that of the Belfeld Clay.

Of particular significance, however, is the close similarity between the pollen flora of the Frechen clay bed B2 and that of part of the Eindhoven II well-section in The Netherlands (ZAGWIJN, 1963).

The Eindhoven II pollen zone TA (= Tiglian A) is characterized by the curves of *Fagus* and *Tsuga* which simultaneously form two peaks, whereas the maxima of *Fagus* and *Tsuga* in the Frechen Interglacial I occur in two different pollen zones (Encl. I). However, it should be considered that the Frechen pollen sequence is much more complete than that of the Eindhoven II borehole; a correlation between these diagrams appears to be feasible, although the *Carpinus*-zone F 6 of the Frechen diagram (Encl. I) is missing in Eindhoven II. Based on palynological investigations of the Lieth-section in Schleswig-Holstein (northern Germany), MENKE (1975) suggested that the Nordende warm period belonged to the Tiglian A-complex (Fig. 4). This was based primarily on the occurrence of *Fagus*-pollen in the uppermost part of the Nordende warm period. A comparison between the pollen zones of the Frechen Interglacial I, and those of the Nordende warm period of the Lieth-section does not show distinct similarities and thus the correlation presented by MENKE (1975) remains questionable.

The coal measures of Buchenau (Hessen) (LESCHIK, 1951) may possibly also be correlated with strata of Tiglian A age. This view is favoured on account of the high numbers of *Fagus*-pollen and the nearly complete absence of Tertiary elements in the Buchenau section (Flöz I). It should be noted, however, that LESCHIK (1951) suggested an upper Pliocene age for the above mentioned deposits.

MAI, MAJEWSKI & UNGER (1963) have described an early Pleistocene flora and fauna at Rippersroda (Thüringen). The pollen flora of Rippersroda resembles, in some respect, that of the Frechen Interglacial I. Therefore the layers concerned may be of the same age. Remains of plants characteristic of a Tertiary vegetation, like *Phellodendron, Symplocos* and *Sciadopitys* are of special interest in the deposits of Rippersroda. They have also been found in beds of the Frechen Interglacial I.

(2) A comparison between pollen diagrams of the Frechen Interglacial I and the Tiglian C time (ZAGWIJN, 1960, 1963) shows that *Fagus* is absent in the latter time. Moreover the Tiglian C is in contrast with the Frechen Interglacial I characterized by high amounts of *Pterocarya, Alnus glut*.-type, Quercetum mixtum and *Carpinus*. The change in vegetation from a Tiglian A to a Tiglian C type may at best be described as a transition from a *Fagus- (Carpinus-Tsuga)* coniferous forest of relatively dry habitat to a riverine vegetation with a predominance of decidous trees. Changes in the river systems during Tiglian C time presumably caused by a climatic change may have been responsible for the change in vegetation. Moreover, after the cold spell during the Tiglian B (ZAGWIJN, 1963: Eindhoven I and II) a re-immigration of *Fagus* did not take place.

(3) If the Frechen Interglacial I is correlated correctly with the Tiglian A the following considerations are of significance. The oldest interglacial observed in the Ville-section is the Frechen I Interglacial (Fig. 4). The beds of this interglacial are underlain by a gravel horizon of Quaternary facies (Buntschotter) b 2 and the clay bed B 1 (BOENIGK ET AL., 1974). The clay bed B1 (URBAN, 1978) contains a coniferous assemblage of typical Quaternary composition, which may be referred to as the 'Fortuna oscillation'. A similar type of assemblage has not yet been found in other deposits of Pretiglian age. Yet, according to its stratigraphical position beneath the Tiglian A and due to its Quaternary type of vegetation, the clay bed B1 must be dated as Pretiglian in terms of the Dutch stratigraphy.

The above mentioned considerations pose some problems regarding the correlation of the Ville-section with the earliest Pleistocene deposits of The Netherlands.

The clay horizon A (A1/A2) of the Ville-section, which is proved to be of Reuverian age, is overlain unconformably by the Pleistocene gravel-horizons b1 and b2 (Fig. 2). These layers are seperated from one another by the clay bed B1. Since the clay bed B2 correlates with Tiglian-A beds at the type-site of the Tiglian A, the sequence between the Frechen Interglacial I and the clay layer A is correlated with the 'Pre-Tiglian' (sensu VAN DER VLERK & FLORSCHÜTZ, 1950). It is worthwile noting that the so-called 'Fortuna oscillation' (clay B1), mentioned above, is represented by a pollen assemblage which points to coniferous forests of Pleistocene type; the pollen assemblage contains a minor amount of N.A.P. This phase does not correspond to the Pretiglian as known from the type-section of Meinweg (ZAGWIJN, 1960). Since, however, the Ville-sequence (gravel-horizon b1, clay B1 and gravel-horizon b2) definitely belongs to the earliest Quaternary, it may be concluded that the Pre-Tiglian may be subdivided tentatively as shown in figure 4. The correlations discussed previously are also shown in this figure.

Last but not least, it should be stressed that the clay beds C and D in the upper part of the Ville-section belong to the Tiglian-complex, as indicated by the occurrence of *Azolla tegeliensis* and results of palynological examination. Based on unpublished observations (URBAN, 1978) these clay beds represent two different interglacials, i.e. Frechen II and III. They are separated from each other and from the preceding interglacial Frechen I by the cold stages Frechen III (gravel-horizon d) and by the cold stage Frechen II (gravel-horizon c), respectively.

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