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GRONINGEN RADIOCARBON DATES VI

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INTRODUCTION

This list contains dates related to the chronology of the last glaciation in Europe. Since several of the older results which already have appeared in print need correction or re-interpretation it was considered necessary to incorporate as many of them as possible into this list. Notably the dates published by de Vries (1958) are included here and reconsidered in the light of our present understanding of the climatic succession. It is noteworthy that, although the interpretation may have changed slightly, most of those measurements are still as valid today as they were eight years ago.

Taken as a whole and with due regard for the uncertainties involved in dating of very old material, a remarkably consistent pattern of the last glaciation seems to be evolving.

Unless otherwise stated, all samples were pretreated with acid and alkali to remove carbonates and infiltrated humic material. Results are given in conventional radiocarbon years before 1950.

SAMPLE DESCRIPTION

A. The Netherlands

Dieren series, Netherlands

Peat bed at ca. 5 m below surface and 8.10 m above sealevel in construction pit for sluice at Dieren, province of Gelderland (52° 0′ N Lat, 6° 08′ E Long). It is intercalated in coarse fluvial sand and gravel of Lower Terrace. Pollen-analytically it belongs either to end of Eemian or beginning of Weichselian. Coll. and subm. 1956 by F. Florschütz, Velp.

GrN-1215. Dieren SD 1 **> 48,000**

5 to 10 cm from top of peatbed.

GrN-1224. Dieren SD 2 **> 50,000**

15 to 20 cm from top of peatbed. *Comment:* results in accordance with pollen-analytical dating.

GrN-2039. Wanssum, Netherlands **> 49,000**

Wood (Alder and Birch) from peat bed in boring near Wanssum, province of Limburg (51° 32′ 40″ N Lat, 60° 04′ 48″ E Long), at 8.00 to

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8.20 m depth. Level dates from Zone EW IIb of Amersfoort Interstadial (Zagwijn, 1961). Coll. 1959 by J. C. van den Toorn and W. H. Zagwijn; subm. by W. H. Zagwijn, Geol. Survey, Haarlem. *Comment:* date as expected.

Amersfoort series, Netherlands

Eem valley near Amersfoort (52° 09′ N Lat, 5° 24′ E Long), province of Utrecht, which originated as a Saale glacial basin, was covered by sea during Last (Eemian) Interglacial and subsequently filled with sediment. In 1956-1957 a number of borings was made by Geol. Survey of Netherlands, in order to provide samples for radiocarbon dating and pollen-analysis. Furthermore, construction pit for a tunnel offered good opportunity for studying a section in detail.

The Early Weichselian deposits contain two interstadial horizons, Amersfoort and Brörup Interstadials respectively and are covered with Weichselian Pleniglacial beds. In western part of basin Late-glacial beds occur at surface. From these latter deposits samples were also collected for dating. For pollen-zonation see Zagwijn (1961). See also Andersen, de Vries and Zagwijn (1960). Samples subm. by W. H. Zagwijn.

GrN-1268. Amersfoort XII **>53,000**

63,500 ± 900

GrN-1397. Amersfoort XII, enriched **61,550 B.C.**

42,500 ± 900

GrN-1328. Amersfoort XII, humus fraction **40,550 B.C.**

Large lumps of *Pinus* found in top of bed of interstadial podsol at ca. 6.25 to 6.65 m depth in tunnelpit excavation. Stratigraphically it marks Pollen-zone EW IIb of Amersfoort interstadial. *Comment:* exposure was on border of basin, on relatively high ground with deep groundwater table. Bands of infiltrated humus occurred as far down as interstadial podsol, but prolonged pretreatment with acid and alkali would have extracted most of it. However, alkali soluble "humus" fraction (GrN-1328) did contain C^{14} (0.5% of modern carbon), probably infiltrated from higher pleniglacial and late-glacial peat beds (see GrN-1276, below) and possibility of contamination in GrN-1397 cannot be excluded (see de Vries, Haring, Kistemaker and Vogel, in preparation). C^{14} in sample GrN-1397 was concentrated by isotopic enrichment by factor of 15.33 ± 0.70 before measurement. C^{14} content was 0.037% of that of modern carbon; error given includes uncertainty of enrichment factor.

GrN-1221. Amersfoort I **> 50,000**

Peat in Boring 1 at 8.87 to 8.95 m below surface. Pollen-zone EW IIb of Amersfoort Interstadial.

GrN-1244. Amersfoort IX **> 50,000**

Carex-peat in Boring 2 at 8.00 to 8.15 m below surface. Second Stadial of Early Weichselian; Pollen-zone EW III.

GrN-1285. Amersfoort XIV **> 53,000**

Alder wood from wood peat in Boring 3 at 7.00 to 7.12 m below surface. Pollen-zone EW IVb of Brörup Interstadial.

GrN-1276. Amersfoort XI, insoluble fraction **34,950 ± 500**
33,000 B.C.

GrN-1106. Amersfoort XI, humus fraction **20,710 ± 230**
18,760 B.C.

Loamy peat from highly cryoturbatic horizon within beds of Pleniglacial A in tunnelpit section. Depth ca. 4.10 m. Pollen-analytically a tundra phase. *Comment:* though pretreated with acid and alkali, some infiltrated humus may have remained and GrN-1276 should be considered minimum date. Activity of extracted humus indicates that it partly came from Late-glacial peat bed somewhat higher in section.

GrN-811. Amersfoort X **11,780 ± 150**
9830 B.C.

Hypnaceae-peat at 1.44½ to 1.46½ m below surface in tunnelpit in middle of Late-glacial bed and dating top of Early Dryas Stadial (end of Pollen-zone LW Ic). *Comment:* date agrees well with following dates from section of Usselo: base of Alleröd K-547 (11,700 ± 140), GrN-921 (11,800 ± 100); top Early Dryas, GrN-926 (12,065 ± 120), K-541 (11,770 ± 140) (Groningen II; Copenhagen IV).
General Comment: from data obtained at Amersfoort it is clear that Early Weichselian dates from before 50,000 B.P. Until several more dates are obtained, 63,500 B.P. for Amersfoort Interstadial must be treated as minimum age.

Lunteren series, Netherlands

Two samples from boring on E rim of Eem valley, near Lunteren, province of Gelderland (52° 05′ 0″ N Lat, 5° 37′ 40″ E Long) (Zagwijn, 1961) Coll. 1956 and subm. by W. H. Zagwijn.

GrN-1842. Lunteren A **> 44,000**

Hypnaceae-peat and clay-gyttja at 6.20 to 6.37½ m below surface. Weichselian pleniglacial in age.

GrN-1708. Lunteren B **> 45,000**

Carex-Hypnaceae peat at depth of 15.14 to 15.34 m below surface. Dates from second stadial of Early Weichselian, just below Brörup Interstadial. *Comment:* date is beyond normal range, according to expectation.

38,920 ± 450

GrN-2629. Roozendaal, Netherlands 36,970 B.C.

Wood from peat bed in excavation near Roozendaal, province of Noord Brabant (51° 32′ N Lat, 4° 27′ E Long). Pollen-analytically probably an Early Weichselian interstadial. Coll and subm. 1959 by M. van Oosten, Soil Survey, Bennekom. *Comment:* date obviously too young.

Farmsum series, Netherlands

Peat bed of late Eemian age in excavation for sluice at Farmssum (53° 19′ N Lat, 6° 56′ E Long) province of Groningen. Pollen diagram in Zagwijn (1961). Coll. 1955 and subm. by S. Jelgersma and W. H. Zagwijn.

37,600 ± 700

GrN-569. Farmsum I (acid treatment only) 35,650 B.C.

43,900 ± 700

GrN-1324. Farmsum I 41,950 B.C.

Sphagnum-peat from base of peat bed, ca. 8.30 m below sealevel; thickness of peat bed ca. 0.50 m. *Comment:* infiltration of younger humus is very likely, as a Holocene peat bed was found only 1 m higher (Jalgersma, 1961). Even date GrN-1324 obtained after pretreatment with alkali is much too young. Evidently all infiltrated humus has not been removed.

33,500 ± 400

GrN-1278. Farmsum IIa (acid treatment only) 31,550 B.C.

38,100 ± 1000

GrN-1279. Farmsum II, insol. fraction 36,150 B.C.

30,200 ± 500

GrN-1133. Farmsum II, humus fraction 28,250 B.C.

Upper side of same peat bed as GrN-1324. *Comment:* dates indicate an even greater amount of humus infiltration from superjacent beds.

Hengelo series, Netherlands

Ancient glacial basin of Saalian glaciation near Hengelo, province of Overijssel (52° 14′ N Lat, 6° 48′ E Long), has since been filled with variety of sediments permitting study of Last Interglacial (Eemian) and Last Glacial (Weichselian) stratigraphy. Weichselian sediments consist of sands (aeolian and niveo-fluvial) and two intercalated loamy horizons in part rich in organic material.

Palaeobotanic data indicate tundra conditions prevailing both during deposition of sand as well as during formation of loamy beds. (*cf.* van der Vlerk and Florschütz, 1950, 1953). Time sequence involved is called Weichselian Pleniglacial. From pollen-analytic studies (Zagwijn, in preparation) it appears that two or three phases of slight climatic ameliora-

tion occurred during this part of Weichselian. The earliest, not yet clearly established, however, has been found within lower of loam horizons; the later two named Denekap and Hengelo Interstadials occur within upper one. See also van der Hammen and others (1967). Samples subm. by W. H. Zagwijn.

GrN-1762. Hengelo I, Town Hall Construction Pit **27,920 ± 270 25,970 B.C.**

Peat from cryoturbate base of Upper loam-bed at ca. 2 m below surface in center of town of Hengelo. Pollen-analytically at very base of Hengelo interstadial. Prevailing vegetation was a tundra. Coll. 1958 by S. Jelgersma. *Comment:* date must be too young as it was discovered later that tree roots from surface penetrated peat bed. See GrN-2504 below.

GrN-2504. Hengelo III, Town Hall Construction Pit **38,700 ± 400 36,750 B.C.**

Seeds of aquatic plants *(Potamogeton, Myriophyllum, Hippuris, Batrachium, Menyanthes)* carefully selected from same peaty level as Hengela I (GrN-1762), though at different spot of building pit. Material has been freed from all adhering plant remains under binocular microscope and can be considered free from recent rootlets. Stratigraphic and pollen-analytical situation same as in Hengelo I; depth 2.69 to 2.72 m. Covering beds consist of ca. 1 m of loam and 1.50 m of man-made arable soil. Coll. 1959 by W. H. Zagwijn. *Comment:* date obtained after pretreatment with acid and alkali from this selected material can be considered very reliable; it dates beginning of Hengelo interstadial. It should be noted that in Zagwijn (1961, p. 37, table p. 45) description of this sample has been erroneously interchanged with that of Hengelo II (GrN-1763).

GrN-2685. Hengelo IV, Construction Pit KNZ **36,600 ± 600 34,650 B.C.**

Seeds, mainly of *Batrachium,* selected and cleaned as Hengelo III. Locality is 2400 m due S of Town Hall. In this construction pit for an office building, Upper Loam-bed of Hengelo basin was exposed in thickness of ca. 3 m, its top nearly reaching the surface. Seeds from gyttja band 2.05 to 2.15 m below surface. Pollen-diagram reveals two interstadials, one (Denekamp interstadial) at top of loam-bed (from this level no suitable material from dating could be collected), the other at 1.70 to 2.10 m below surface. Oscillation seems to be same as that found in Town Hall Pit and Hengelo IV has exactly the same stratigraphic position as Hengelo III, at base of Hengelo interstadial. Coll. March 1959 by W. H. Zagwijn. *Comment:* this very reliable material was only treated with dil. acid and result may be too young (compare GrN-2504 above and GrN-1763 below).

38,350 ± 550

GrN-4828. Hengelo XI, Construction Pit KNZ 36,400 B.C.

Peat, from same construction pit as Hengelo IV, from a somewhat deeper level, 2.92 to 2.97 m below surface. Just below Hengelo interstadial. *Comment:* in accordance with Hengelo III (GrN-2504).

37,500 ± 650

GrN-1763. Hengelo II, Brickyard Rientjes 35,550 B.C.

Loam, rich in plant debris containing abundant leaves and twigs of tundra plants: *Salix herbacea, Salix polaris, Salix reticulata, Dryas octopetala, Betula nana* (Tralau and Zagwijn, 1962). In the pit ca. 3000 m N of Town Hall, this organically rich layer occurs as thin band at base of Upper Loam-bed of Hengelo basin, ca. 3 m below surface. Pollen-analytically Hengelo interstadial.

General Comment: the above dates suggest that Hengelo Interstadial began at ca. 38,000 to 39,000 yr B.P. The oldest date (Hengelo III) naturally is given the most weight in the estimation because of the ever-present possibility of contamination by younger material.

GrN-2688. Hengelo V, Boring LGM 9062 (acid only) 34,950 ± 400 33,000 B.C.

43,600 ± 1850

GrN-3221. Hengelo V, Boring LGM 9062 41,650 B.C.

Gyttja from Lower Loam-bed of Hengelo basin in boring 1000 m S of Town Hall, 6.45 to 6.51 m below surface. Covering beds consist of sand and, nearer the surface, the Upper Loam-bed of Hengelo. Pollen-diagram points to tundra vegetation. Coll. 1959 by W. H. Zagwijn. *Comment:* date obtained after thorough pretreatment with acid and alkali (GrN-3221) can be considered rather reliable. As groundwater table in area is high, recent root penetration down to sample is regarded improbable.

45,600 ± 1900

GrN-3177. Hengelo VI, Boring 1 43,650 B.C.

Clayey Hypnaceae-peat, from top of Lower Loam-bed, in boring 2000 m S of Town Hall, 6.95 to 7.06 m below surface. Overburden consists of succession of beds similar to that for Hengelo V and a more or less identical stratigraphic position can be assumed. Pollen-diagram is similar. Coll. April 1961 by W.H. Zagwijn. *Comment:* result obtained after full pretreatment shows expected agreement with GrN-3221 above.

GrN-4252. Hengelo IX, Boring 2 50,000 $^{+4000}_{-2400}$

Carex-Hypnaceae peat from top of peat bed in boring near Boring 1 at 9.95 to 10.05 m depth. Peat belongs to same horizon as Lower Loam-bed.

GrN-4289. Hengelo VII, Boring 1 **> 51,600**

Clayey peat from Lower Loam-bed in Boring 1 at 7.50 to 7.69 m depth.

General Comment: pollen diagrams for layers dated by latter four samples indicate tundra vegetation almost devoid of trees. Existence of organic remains, however, may suggest a slight improvement in climate during this period. Conditions are similar to those during formation of lower peat bed at Moershoofd (below).

Denekamp series, Netherlands

In Dinkel river valley near Denekamp (52° 23′ N Lat, 7° 01′ E Long) 8 km N of Oldenzaal, province of Overijssel, detailed study of glacial deposits has been made by T. van der Hammen and co-workers. Peat beds representing interstadials and Late-glacial climatic changes have been studied pollen-analytically and dated with radiocarbon (Vogel and van der Hammen, 1967; van der Hammen *et al.,* 1967). Subm. 1964-65 by T. van der Hammen, Geol. Inst., Univ. of Leiden.

10,010 ± 60

GrN-4722. Denekamp 6, wood **8060 B.C.**

10,030 ± 60

GrN-4731. Denekamp 7, wood **8080 B.C.**

10,040 ± 60

GrN-4724. Denekamp 10, peat **8090 B.C.**

Wood and peat from lower part of peaty beds formed on Younger Coversand; exposed in new Dinkel canal. Pollen-analytically representing end of Younger Dryas. *Comment:* relative C^{13} content with respect to PDB standard: $\delta C^{13} = -29.1‰, -29.2‰, -27.8‰$ resp.

10,300 ± 60

GrN-4723. Denekamp 9, wood **8350 B.C.**

Wood from band in Younger Coversand exposed in new canal representing Younger Dryas. *Comment:* $\delta C^{13} = -26.7‰$.

11,240 ± 65

GrN-4901. Denekamp 5, peat **9290 B.C.**

11,390 ± 65

GrN-4527. Denekamp 8a, root **9440 B.C.**

Thin peat band in Younger Coversands pollen-analytically representing Alleröd or Bölling Interstadial. *Comment:* dates imply Alleröd age. $\delta C^{13} = -29.0‰$ and $-28.7‰$ resp.

11,630 ± 65

GrN-4899. Denekamp 1, peat **9680 B.C.**

11,630 ± 90

GrN-4900. Denekamp 2, peat **9680 B.C.**

Peat bed, 20 to 30 cm thick, at 3 to 4 m depth in Coversands. *Com-*

ment: date implies Alleröd age for peat bed. $\delta C^{13} = -29.5‰$ and $-29.6‰$ resp.

28,860 ± 260

GrN-4528. Denekamp 12 **26,910 B.C.**

Isolated peaty material at ca. 2.5 m depth in canal exposure near Bentheimerdijk, deposited on bottom of erosion gully in Older Coversand I and covered in turn by loamy coversand. Sample provides terminus ante quem for Denekamp Interstadial. *Comment:* $\delta C^{13} = -27.2‰$

29,300 ± 300

GrN-4349. Denekamp 13c **27,350 B.C.**

30,100 ± 300

GrN-4348. Denekamp 13a **28,150 B.C.**

Uppermost and lowermost portions of Denekamp Interstadial peat from 2.10 to 2.14 m and 2.36 to 2.40 m depth respectively, in exposure near Laarhuis. Pollen-analytically representing advanced stage of Interstadial. *Comment:* $\delta C^{13} = -26.4‰$ and $-26.3‰$ resp.

30,400 ± 450

GrN-4324. Denekamp 3 **28,450 B.C.**

Upper part of gyttja-like peat with Hypnaceae from ca. 4 m depth in canal exposure, NW of Denekamp, near old Almelo-Nordhorn canal. *Comment:* $\delta C^{13} = -26.8‰$.

32,200 ± 500

GrN-4343. Denekamp 4 **30,250 B.C.**

Grab sample of peat from bottom of canal exposure representing lower part of peat layer, NW of Denekamp, near old Almelo-Nordhorn canal. These two samples correspond pollen-analytically to onset of Denekamp Interstadial. *Comment:* $\delta C^{13} = -26.8‰$.

38,700 ± 1100

GrN-4366. Denekamp 15a **36,750 B.C.**

Hypnaceae peat from borehole Mekkelhorst at 5.43 to 5.67 m depth; pollen-analytically and stratigraphically representing Hengelo Interstadial. *Comment:* $\delta C^{13} = -26.3‰$.

GrN-4350. Denekamp 14 **> 48,000**

Peat from borehole 20 at ca. 6 m depth; pollen-analytically representing tundra phase and stratigraphically representing level lower than that of GrN-4366 (Denekamp 15a). *Comment:* $\delta C^{13} = -27.3‰$.

General Comment: on basis of Late-glacial dates, transition from Younger Dryas to Pre-boreal (Pleistocene-Holocene boundary) should be placed between 10,300 and 10,000 B.P. (cf. van der Hammen and Vogel, in preparation). Compare also Schelphoek (GrN-2137) below. Pleniglacial dates place Denekamp Interstadial between ca. 32,000 and 29,000 B.P. (van der Hammen *et al.,* 1967). Compare also Breda etc. below.

Breda series, Netherlands

Town of Breda, province of Noord-Brabant (51° 35′ 47″ N Lat, 4° 45′ 13″ E Long), is in valley of river Mark which occupied broad riverplain in Early Weichselian. Later during Glacial Period greater part of plain was abandoned and covered with lake-clay, cover-sand and loess. An excavation made for construction of new sewerage system exposed upper part of Weichselian beds. Sequence from surface down is as follows: coversand and loess, lake-clay, coversand, and at the base the upper beds of the braided-riverplain stage. Megafloral and microfloral remains permit comparison with Weichselian deposits from Hengelo basin, though some difficulties present themselves through presence of derived interglacial pollen. General character of vegetation was that of pleniglacial tundra, with two phases of climatic amelioration (Hengelo and Denekamp interstadials), very similar to those observed within Upper Loam of Hengelo (Zagwijn, in preparation.) Four samples from excavation have been dated by radiocarbon. Coll. March 1959 and subm. by W. H. Zagwijn.

29,900 ± 460

GrN-2141. Breda P24a **27,950 B.C.**

Peaty clay and thin bands of peat, from top bed of lake clay stage, at 2.01 to 2.06 m below surface. Covering deposits consist of loess and coversand up to surface. Sample taken at spot where no rootlets from surface could be detected but recent humus infiltration cannot be excluded. Pollen-analytically a very cold tundra phase, following phase of climatic amelioration (Denekamp interstadial).

32,000 ± 400

GrN-2007. Breda P25a, insol. fraction **30,050 B.C.**

30,200 ± 350

GrN-2008. Breda P25a, humus **28,250 B.C.**

Clay-gyttja (lake-clay) from upper part of lake-clay; 2.29 to 2.40 m below surface at same site as Breda P24a. Recent rootlets could not be observed in sample. Pollen-analytically lower part of Denekamp interstadial. In pollen-diagram corrected for presence of secondary pollen according to Iversen's method (Iversen, 1936), oscillation is shown by a temporary increase of Betula. *Comment:* fully pretreated. As humus fraction is only slightly younger than remaining organic material, it seems likely that only a very small amount of infiltrated humus was present and GrN-2007 is considered reliable. There is also good agreement with GrN-2141, above.

37,000 ± 600

GrN-2515. Breda P10a **35,050 B.C.**

Sieved plant material (0.6 to 1.4 mm) from coarse detritus-gyttja at base of lake clay deposits, at 3.32 m below surface. Apart from wood fragments bed contained a tundra flora. Wood is thought to be of interglacial origin, as indicated by macrofloral content of still deeper beds

in section and by GrN-2508 below. In order to get rid of bulk of derived interglacial wood fragments only the fraction 0.6 to 1.4 mm was dated, consisting chiefly of fragments of Cyperaceae, mosses etc. No recent rootlets were observed, nor is much infiltration of recent humic compounds probable. Collected at a few meters distance from previous samples. Pollen-analytical sample marks base of Hengelo Interstadial. *Comment:* from sampling data quoted above, as well as from fact that recent humus infiltration in these beds seems to have been slight (cf. GrN-2008), date is considered reliable.

GrN-2508. Breda P17b, wood **> 50,000**

Wood of *Picea* or *Pinus* isolated from lens at 3.92 m below surface, containing drifted plant remains consisting of mixture of tundra species and derived interglacial elements. It is supposed that wood also has been derived from interglacial beds. Lens is developed in coversand. *Comment:* date in good accordance with view that wood has been derived from older beds.

General Comment: dates present good agreement internally. GrN-2141 marks end of Middle Pleniglacial and can be compared with GrN-4528, Denekamp 12, above and GrN-3035, Elsloo and GrN-2963, Noord-Oostpolder, below. GrN-2515, at beginning of temporary climatic amelioration agrees with GrN-1784 and GrN-2685 at Hengelo. The date GrN-936: 32,240 ± 900, Breda, Ganzeweide (Groningen II) came from section outside Mark valley and cannot be connected in detail with section discussed here. It, however, also came from Middle Pleniglacial peat underlying loess and coversand of Upper Pleniglacial (van Dorsser, 1956).

Moershoofd series, Netherlands

Section found in boring at Moershoofd, province of Zeeland (51° 14′ 50″ N Lat, 3° 30′ 45″ E Long), has been discussed by Zagwijn (1961). It is situated in area of former "Valley of Genth", filled by river deposits and aeolian sand in late Pleistocene times. Weichselian Pleniglacial beds reach from surface down to 6.50 m and consist of aeolian sand (coversand) with two intercalated horizons of peat and gyttja, indicating phases of temporary decrease of periglacial aeolian action. Latter occur at 2.15 to 2.38 m and 3.10 to 4.70 m respectively. Pollen-diagram from these beds points to tundra-like vegetation. High groundwater table and absence of holocene peat beds at any higher level, make it unlikely that root penetration or humus infiltration had a great influence, especially in deeper levels. Coll. 1958 by S. Jelgersma and F. van Rummelen, Geol. Survey, Haarlem.

35,600 ± 900

GrN-1852. Moershoofd I **33,650 B.C.**

Hypnaceae peat from upper peat bed, 2.15 to 2.35 m below surface. *Comment:* date published by Zagwijn (1961) under same number is to be corrected.

43,500 ± 1000

GrN-1715. Moershoofd II **41,550 B.C.**

Hypnaceae peat from top of lower peat bed, 3.10 to 3.40 m below surface.

46,250 ± 1500

GrN-1718. Moershoofd III **44,300 B.C.**

Gyttja and Hypnaceae peat from base of lower peat bed, 4.20 to 4.70 m below surface.

General Comment: date from upper peat bed (GrN-1852) is somewhat younger than other Hengelo-age dates, but still within limits of possibility. Those from lower one (GrN-1715, GrN-1718) are in close correspondence with GrN-3221 and GrN-3177 from lower loam horizon at Hengelo and support view that tundra phase of Lower Peniglacial started sometime before 50,000 B.P. and lasted until ca. 43,000 B.P.

Coentunnel series, Netherlands

In deep excavations made for construction of Coentunnel, Amsterdam, province of Noord-Holland (52° 26′ N Lat, 4° 50′ E Long), Weichselian beds were exposed below some 12 m of Holocene peat and tidal flat deposits. Below Late-glacial and Upper Pleniglacial coversand, three loam and peat horizons, alternating with sand, were found. Pollen-analysis suggests pleniglacial age, the uppermost bed correlating with Denekamp interstadial (Zagwijn, in preparation; van der Hammen *et al.*, 1967). Coll. and subm. 1962-63 by W. H. Zagwijn.

22,900 ± 300

GrN-4681. Coentunnel (Northern Pit) I **20,950 B.C.**

Loam from uppermost cryoturbatic loam bed, 14.20 to 14.25 m below sealevel. Lower peat of Holocene (Atlantic) age is some 2 m higher, and roots penetrate down into loam bed. Pollen-analytically Denekamp interstadial. *Comment:* result is too young, as could be expected.

37,300 ± 600

GrN-4569. Coentunnel (Southern Pit) II **35,350 B.C.**

Gyttja from middle cryoturbatic loam bed at 15.40 m below sealevel. No root penetration from above observed, but humus infiltration possible. *Comment:* date suggests correlation with Hengelo interstadial.

45,000 ± 2300

GrN-4849. Coentunnel (Northern Pit) III **43,050 B.C.**

Loamy gyttja from lowermost loam horizon, 16.90 to 17.10 m below sealevel. *Comment:* date agrees with dates from lower loam bed at Hengelo (GrN-3221, GrN-3177) and Moershoofd (GrN-1715, GrN-1718).

Ruigekluft series, Netherlands

Boring made on N rim of former Saalian ice-marginal valley of Vecht River, near hamlet of Ruigekluft, province of Drenthe (52° 44′

30″ N Lat, 6° 16′ 55″ E Long). During first half of Weichselian this part of valley was occupied by branch of river Rhine (IJssel); later deposition by the river was replaced by one of local niveo-fluviatile brooks, and still later (Pleniglacial B), coversand formation was predominant. In boring a gyttja-bed occurs at junction of river sand and local brook deposits. Pollen diagram indicates tundra-vegetation, which is temporarily replaced by steppe-tundra increase of *Artemisia* and Chenopodiaceae, pointing to rise in temperature (Zagwijn, in preparation). Sandy beds covering gyttja-bed reach to surface. Coll. 1960 by M. W. ter Wee and W. H. Zagwijn; subm. by W. H. Zagwijn.

39,600 ± 900
GrN-2704. Ruigekluft I **37,650 B.C.**

28,840 ± 440
GrN-2934. Ruigekluft I (acid only) **26,890 B.C.**

Gyttja, slightly sandy, 3.52½ to 3.59½ m below surface. Marks beginning of steppe influence. *Comment:* evidently infiltrated younger humus has influenced GrN-2934. Date obtained after full pretreatment is much older and more reliable.

40,500 ± 1500
GrN-3055. Ruigekluft II **38,550 B.C.**

34,750 ± 800
GrN-2937. Ruigekluft II (acid only) **32,800 B.C.**

Gyttja, from base of gyttja-bed, 3.72½ to 3.82½ m below surface. *Comment:* though acid-pretreated material already gave older date than GrN-2934, infiltration seems slightly less; the more thoroughly treated material gave date considerably older and in good agreement with GrN-2704.

General Comment: dates prove steppe climatic phase to be of Hengelo Interstadial age.

33,030 ± 500
GrN-1364. Eefde, Netherlands **31,080 B.C.**

28,530 ± 400
GrN-1582. Eefde, humus fraction **26,580 B.C.**

Twigs of tundra shrubs from bed with tundra flora, at depth 4 to 5 m near Eefde, province of Gelderland (52° 08′ N Lat, 6° 10′ E Long). (Florschütz, 1958). Wood of *Picea* formerly found at site has, however, not been dated. Coll. 1955 and subm. by F. Florschütz. *Comment:* presumably belonging to tundra phase between Hengelo and Denekamp Interstadials; compare Amersfoort IX, GrN-1276.

38,320 ± 500
GrN-1359. Wierden, Netherlands **36,370 B.C.**

Twig fragments from niveo-fluviatile sand bed with tundra flora rich in steppe elements (Florschütz, 1958) at depth of ca. 6 m below surface near Wierden, province of Overijssel (52° 22′ N Lat, 6° 35′ E

Long). Contrary to statement of Gross (1958) no *Picea* wood was dated, but twigs from tundra shrubs. Coll. 1949 and subm. by F. Florschütz. *Comment:* date is in remarkable agreement with GrN-3007 for lens containing same flora at Velsen (see below) and presumably belongs to Hengelo Interstadial.

38,300 ± 900

GrN-3007. Velsen 45, Netherlands **36,350 B.C.**

Twigs and wood fragments from lens containing drifted tundra plant-remains at 18.90 to 19.10 m below sealevel in Velsen Tunnelpit, exposed 1953 (52° 27′ 45″ N Lat, 4° 39′ 15″ E Long). Lens was intercalated in cross-bedded sands, bed IV of the "Lower terrace" as described by Bennema and Pons (1957). According to Florschütz (1957) these beds contain tundra-flora rich in steppe elements, similar to the one found at Wierden. Coll. 1953 by J. G. Zandstra; subm. 1961 by W. H. Zagwijn. *Comment:* in close agreement with date of similar flora of Wierden, above. Layer must be ascribed to Hengelo Interstadial. Compare steppe flora of Ruigekluft, above.

26,180 ± 380

GrN-3035. Elsloo, Netherlands **24,230 B.C.**

27,580 ± 200

GrN-2671. Elsloo, acid only **25,630 B.C.**

Sandy Hypnaceae peat from 2.39 to 2.50 m below surface, marking junction between fluvial brook deposits (Middle Pleniglacial) and "Older Coversand" (Upper Pleniglacial) at Elsloo, province of Friesland (52° 56′ 00″ N Lat, 6° 14′ 45″ E Long). Pollen diagram indicates treeless tundra vegetation (Zagwijn, in preparation). No recent rootlets found. Infiltration of young humus cannot be excluded. Coll. 1959 by M. W. ter Wee and W. H. Zagwijn; subm. by W. H. Zagwijn. *Comment:* the fact that both the less pretreated sample as well as the thoroughly pretreated one, give about the same date, indicates that infiltration of younger humus has had no influence. Good agreement with other dates marking junction of fluviatile and lacustrine beds from Middle Pleniglacial with aeolian deposits of Upper Pleniglacial. (GrN-2141, GrN-4528, GrN-2963). This is youngest date from Middle Pleniglacial Weichselian beds obtained so far in Netherlands. It is remarkable that prolonged search for organic remains in beds of Upper Pleniglacial has been unsuccessful. This explains lack of radiocarbon dates covering period of 26,000-14,000 B.P. in this country (van der Hammen *et al.*, 1967).

30,800 ± 400

GrN-2963. Emmeloord, Netherlands **28,850 B.C.**

32,500 ± 600

GrN-2938. Emmeloord (acid only) **30,550 B.C.**

Peat from 10.55 to 10.67 m depth at Emmeloord, Noordoostpolder (52° 43′ N Lat, 5° 45′ E Long). Peat bed occurs at junction of coarse fluvial beds of "Lower Terrace" (below) and aeolian sand. Stratigra-

phically at transition of Middle to Upper Pleniglacial. For details see Wiggers (1955). Subm. 1960 by A. J. Wiggers, Free Univ., Amsterdam. *Comment:* compares well with less precise date GrN-390: 29,000 ± 5000 (Groningen II), which came from same bed at site near present sample and with other dates from transition Middle to Upper Pleniglacial (GrN-2141, GrN-3035).

27,900 ± 670
GrN-2371. Sittard II, Netherlands **25,950 B.C.**

Shells of land snails carefully selected from loess section near Sittard, province of Limburg (51° 0′ N Lat, 5° 52′ E Long) from junction between cryoturbatic "Middle Loess" and homogeneous "younger loess." Subm. by G. C. Maarleveld, Soil Survey, Bennekom. *Comment:* shells pretreated with dil. acid. Date suggests that "younger loess" belongs to Upper Pleniglacial and cryoturbatic "Middle Loess" to Middle Pleniglacial.

De Hamert series, Netherlands

Peat bed below river dune sand and on river sand at De Hamert, province of Limburg (51° 30′ N Lat, 6° 11′ E Long). Pollen diagram suggests a Late-glacial, Alleröd age. Two borings (5 and 5a) were made. Coll. 1964-65 and subm. by D. Teunissen, Univ. of Nijmegen.

10,870 ± 100
GrN-4786. DeHamert 402 **8920 B.C.**

Peat from Boring 5a, depth 3.03 to 3.07 m.

11,900 ± 100
GrN-4508. De Hamert 3 **9950 B.C.**

Peat from Boring 5, depth 3.12 m.

12,210 ± 90
GrN-4787. De Hamert 410 **10,260 B.C.**

Peat from Boring 5a, depth 3.27 to 3.30 m.

12,760 ± 150
GrN-4478. De Hamert 5 **10,810 B.C.**

Peat from Boring 5, depth 3.25 m. *Comment:* dates suggest both Alleröd and Bölling interstadials are present.

11,920 ± 80
GrN-2891. Clinge I, Netherlands, seeds **9970 B.C.**

12,000 ± 110
GrN-2993. Clinge II, peat **10,050 B.C.**

Near Clinge, province of Zeeland, at Dutch-Belgium border (51° 15′ 35″ N Lat, 4° 4′ 50″ E Long) a peat bed occurs over rather large area, which, according to pollen analysis, dates from Bölling Interstadial. Bed is covered by ca. 4 m of coversand. Clinge I consisted of ca. 15 g (moist) of seed material *(Menyanthes, Carex)* selected from ca. 7 kg of peat.

Clinge II comes from level 7½ to 9½ cm below top of peat bed and marks late part of Bölling Interstadial. Coll. 1960 by F. van Rummelen and W. H. Zagwijn. *Comment:* results compare well with other dates for Bölling deposits (e.g., Witów, Poland, K-706, 11,900 ± 180, end of Bölling; K-707, 12,260 ± 140, oldest part of Bölling; Usselo Ba III, GrN-927, 12,595 ± 170; K-543, 12,200 ± 140; Copenhagen IV, V, Groningen II).

GrN-4087. Alblasserdam, Netherlands **11,770 ± 120**
9820 B.C.

Drifted plant-remains at 17.68 to 17.88 m depth in Boring LGM near Alblasserdam, province of Zuid-Holland (51° 50′ 45″ N Lat, 40° 40′ 0″ E Long). Intercalated in fluvial sands and associated with pumice from Eifel volcanic eruptions. Plant-remains indicate interstadial age. Subm. 1962 by W.H. Zagwijn. *Comment:* date indicates Alleröd interstadial age.

GrN-2136. Haskerveenpolder I, Netherlands **11,600 ± 70**
9650 B.C.

GrN-3585. Haskerveenpolder, II **11,750 ± 100**
9800 B.C.

Peat from different sampling stations of same bed in coversand in excavation Haskerveenpolder, province of Friesland (52° 58′ 50″ N Lat, 5° 52′ 30″ E Long). Pollen-analytically Alleröd interstadial (Cnossen and Zandstra, 1965). Subm. by J. Cnossen, Soil Survey, Bennekom. *Comment:* date in agreement with pollen-analytical dating.

GrN-2269. Haskerveenpolder III, Friesland **30,300 ± 800**
28,350 B.C.

Peat from bed intercalated in pleniglacial fluvial sand, in same excavation as GrN-2136, 3.58 to 3.60 m below surface. Pollen-analytically representing a warmer (interstadial) phase within Weichselian Pleniglacial (Cnossen and Zandstra, 1965). Subm. by J. Cnossen. *Comment:* date proves correlation with Denekamp (Paudorf) interstadial.

GrN-2500. Ermelo, Gelderland **10,680 ± 240**
8730 B.C.

Charcoal from bleached soil in coversand found at Ermelo, province of Gelderland (52° 15′ 40″ N Lat, 5° 40′ 50″ E Long) at 3 m depth (Maarleveld, 1962). Subm. by G. C. Maarleveld. *Comment:* date confirms suggested Alleröd age.

GrN-2137. Schelphoek, Netherlands **10,690 ± 90**
8740 B.C.

Gyttja with freshwater molluscs found at Schelphoek, province of Zeeland (51° 41′ 12″ N Lat, 3° 50′ 20″ E Long), from depth of 20.90 to 20.97 m. According to pollen diagram at transition Late-glacial (Late Dryas Stadial) to Holocene (Preboreal). Subm. 1960 by W. H. Zagwijn. *Comment:* this was first date for transition to Holocene in Netherlands.

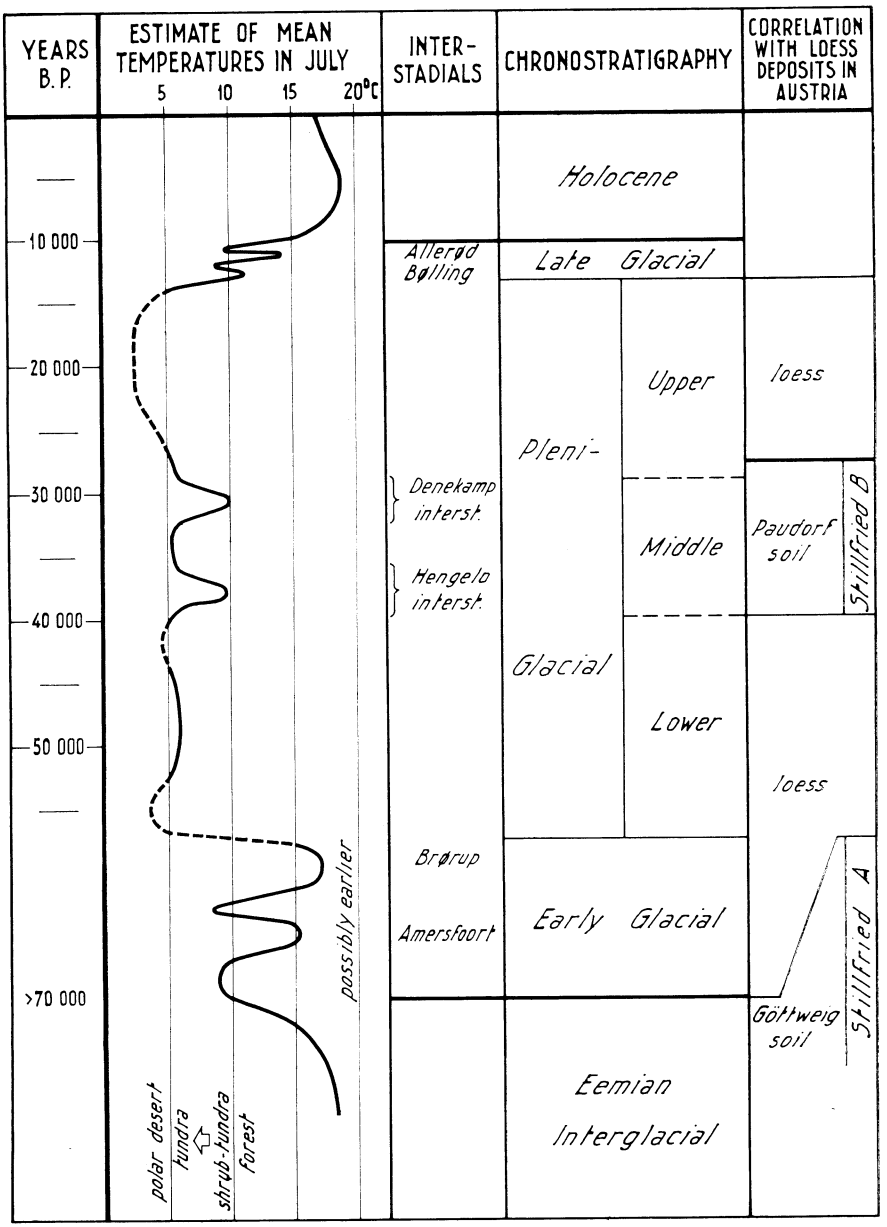

Fig. 1. Climatic curve and stratigraphic subdivision of the Last Glacial in the Netherlands, compared with the loess stratigraphy of Austria. After van der Hammen *et al.*, 1967, Fig. 8.

Compare K-111 bis, 10,500 ± 350, obtained from same stratigraphic level at Bölling, Denmark (Copenhagen III). See also Denekamp series, above.

General Comment on section A: from available evidence it has been

possible to reconstruct in some detail climatic events of Last Glacial in Netherlands (van der Hammen *et al,* 1967). A time-scale is provided by dates presented here, and curve thus obtained is reproduced in fig. 1. Temperatures are expressed as mean July temperature in °C.

In Early Weichselian two interstadials of temperate character have been recognized, the Amersfoort and Brörup interstadials, both dating well beyond 50,000 B.P. In Middle Weichselian (Pleniglacial) several fluctuations occurred. Two well-defined phases of climatic amelioration, witnessing a shrub tundra, are Denekamp and Hengelo interstadials. They have been fixed at between 32,000 and 29,000 B.P. and between ca. 39,000 and 37,000 B.P., respectively. Complete absence of datable material, despite large number of known exposures in time-span between 27,000 and ca. 13,000 B.P. is correlated with existence of polar desert climate during prolonged temperature minimum lasting some 15,000 yr in later part of Glacial. Two suggested earlier phases of polar desert climate in lower part of Pleniglacial, may bracket another relatively mild phase dating from shortly before 50,000 to 43,000 yr B.P. It must be stressed, however, that conditions during that phase still remained severe, since pollen-analytic data indicate tundra conditions, and failed to reveal traces of shrub tundra. Period was therefore colder than during Hengelo and Denekamp Interstadials.

As for Late-glacial, dates now available give the following dating of boundaries: End of Late Dryas, ca. 10,300-10,000 B.P.; Alleröd Interstadial, 11,800-11,000 B.P.; Bölling Interstadial, 12,400-12,000 B.P.

B. Belgium

Zelzate series, Belgium

Tunnelpit at Zelzate (51° 127′ N Lat, 3° 47′ E Long), province of Oost Vlaanderen, has revealed sequence of Glacial and Holocene deposits similar to several exposures in Netherlands (Vanhoorne and Paepe, 1966). Samples coll. and subm. 1966 by R. Paepe, Geol. Survey, Brussels.

GrN-4782. Zelzate 2 **12,300 ± 100**
10,350 B.C.

Peat at 3.50 m depth in coversand. *Comment:* Bölling age suggested by date is in agreement with stratigraphic position.

GrN-4783. Zelzate 3 **28,200 ± 700**
26,250 B.C.

Peat from cryoturbatic level at 11 m depth. *Comment:* date suggests correlation with Denekamp interstadial in Netherlands and confirms original interpretation of submitter.

GrN-4781. Hoboken 1, Belgium **32,490 ± 440**
30,540 B.C.

Peat from railroad tunnel excavation at Hoboken near Antwerp (51° 13′ N Lat, 4° 26′ E Long), 7 m below surface. Holocene peat was found ca. 3 m above. Stratigraphic position of cryoturbatic bed suggests

Pleniglacial age (Vanhoorne and Paepe, 1966). Coll. and subm. 1966 by R. Paepe.

45,600 ± 1500

GrN-4856. Poperinge 1, Belgium **43,650 B.C.**

Peat, slightly cryoturbatic, in brick-yard at Poperinge, West-Vlaanderen (50° 51′ N Lat, 2° 43′ E Long). From wet-cold lower part of Last Glacial. Coll. and subm. 1966 by R. Paepe.

C. Great Britain

GrN-1292. Chelford, Great Britain **> 52,000**

60,800 ± 1500

GrN-1475. Chelford (enriched) **58,850 B.C.**

Wood found at Chelford, Cheshire (53° 15′ N Lat, 2° 14′ W Long), in bed of organic mud intercalated in sand. Sample from upright stump of *Picea*. According to Simpson and West (1958) stratigraphic and pollen-analytic evidence points to Early Weichselian interstadial—mud-band presumably correlated to Brörup interstadial of Denmark. Above bed is boulder clay thought to be associated with first main ice advance of Last Glaciation, the Irish Sea Glaciation, which therefore post-dates Chelford Interstadial. Coll. 1957 by R. G. West, Combridge; subm. by H. T. Waterbolk. *Comment:* GrN-1475 enriched by factor of 8.12 prior to measurement. Result compares well with Brörup Interstadial in Denmark, below.

GrN-595. Upton Warren, Great Britain (acid only) **42,520 ± 1300** **40,570 B.C.**

42,100 ± 800

GrN-1245. Upton Warren **40,150 B.C.**

GrN-1063. Upton Warren, humus fraction **> 40,000**

Organic material from cryoturbatic band No. 2 found in gravel pit at Upton Warren, Worcester County (52° 18′ 15″ N Lat, 2° 05′ 40″ W Long). Full description of site in Coope *et al.* (1961). Organic band is one of several intercalated in river-gravel of terrace of river Salwarpe. It is thought that deposition of gravel was connected with retreat of Irish Sea Glacier, which had reached its farthest southerly position ca. 20 m N of Upton Warren. Floral and faunal remains indicate treeless landscape, but climate prevailing was comparable to that of S Sweden (Coope *et al.*, 1961). Subm. by F. W. Shotton, Birmingham. *Comment:* since date obtained after acid pretreatment only is essentially same as after full pretreatment and since extracted humus was also old, infiltration of recent humus is improbable (de Vries, 1958).

38,200 ± 700

GrN-1269. Fladbury, Great Britain **36,250 B.C.**

Peat-like material from base of ca. 10 m of gravel at Fladbury, ca. 15 km SE of Worcester, (52° 11′ N Lat, 02° 13′ W Long). Gravel is as-

signed to No. 2 Terrace of river Avon and has been connected with retreat of Irish Sea Glacier, like terrace gravel of Upton Warren. For full details see Coope (1962). Insect fauna bears close resemblance to that of Upton Warren, but indicates more severe, subarctic-to-arctic conditions. Subm. F. W. Shotton, Birmingham. *Comment:* date compares well with those of Upton Warren, above. Correlation of river gravel with *retreat* of Irish Sea Glacier is, however, not beyond doubt.

Kirkmichael series, Great Britain

Glacial and fluvio-glacial deposits on beach at Kirkmichael (54° 17′ N Lat, 4° 35′ W Long) on Isle of Man contain peat which provided excellent material for dating. Samples coll. and subm. 1958 by G. F. Mitchell, Dublin.

12,210 ± 120
GrN-1616. Kirkmichael A **10,260 B.C.**

Peat from kettlehole N of Glen Balleira near Kirkmichael covered by 2.25 m of sand. Pollen-zone IV or earlier. *Comment:* Late-glacial age as expected.

12,210 ± 120
GrN-1631. Kirkmichael D **10,260 B.C.**

Peat exposed in cliff near Kirkmichael below 4 m of terrace gravel and on 2 m of gravel on top of boulder clay. Pollen-analytically formed under treeless conditions. *Comment:* originally a Würm interstadial age was suspected but date suggests Late-glacial age.

11,310 ± 90
GrN-1639. Kirkmichael C **9360 B.C.**

Peat exposed in cliff near Kirkmichael covered by terrace gravel and fluvio-glacial material totaling 14 m. Formed under treeless conditions according to pollen analysis. *Comment:* Würm interstadial age expected but date points to Alleröd age.
General Comment: obviously sediments formed in Late-glacial time and not earlier as their massiveness suggested.

D. Denmark

Brörup Hotel Bog series, Denmark

In a depression in Saalian boulder clay at Brörup Hotel, Jutland, Denmark (55° 25′ N Lat, 8° 50′ E Lat) complete series of Eemian interglacial and Early Weichselian lake deposits is found. As S. T. Andersen (1957, 1961) was able to demonstrate presence of two interstadials on top of Eemian interglacial, a comparison with results obtained at about the same time at Amersfoort, Netherlands was called for (Andersen *et al.,* 1960). Thus lower interstadial, called Rodebaek, compares with Amersfoort interstadial; the upper more pronounced one has been called Brörup in both areas. Already at an early stage C^{14} datings were at-

tempted at this site, but serious problems concerning effect of younger humus infiltration were encountered (Tauber and de Vries, 1958).

Samples were all specially and carefully taken for the purpose. For all details concerning boring numbers, pollen diagrams, stratigraphy etc. reference is made to Andersen's monograph (1961). Coll. 1954-58 and subm. 1957-58 by S. T. Andersen, Geol. Survey of Denmark, Charlottenlund.

GrN-1264. Brörup Hotel Bog BP 1, Zone W3d-e > 51,000

Mud (gyttja) from depth of 2.85 to 2.90 m (Pollen-zone W3d-e) in Boring BP 1. First part of Brörup interstadial.

GrN-1263. Brörup Hotel Bog BP 1, Zone W3c-d > 49,000

Peat from depth of 3.37 to 3.48 m (Pollen-zone W3c-d) in Boring BP 1. First part of Brörup interstadial.

GrN-1256. Brörup Hotel Bog BP 1, Zone W2a > 49,000

Mud, gyttja from depth of 6.81 to 6.91 m (Pollen-zone W2a) in Boring BP 1. First stadial of Weichselian.

57,700 ± 700

GrN-1729. Brörup Hotel Bog BP 1a, Zone W3c 55,750 B.C.

Mud and herbaceous peat from depth of 3.28 to 3.50 m (Pollen-zone W3c) in Boring BP 1a. First part of Brörup interstadial. *Comment:* date obtained after isotope enrichment by a factor of 13.89. Final corrections have changed figure published in Andersen *et al.* (1960) slightly (cf. de Vries *et al.,* in preparation).

GrN-1471. Brörup Hotel Bog BP 2, Zone W5b-c > 52,000

Vaginatum peat from depth of 2.64 to 2.70 m (Pollen-zone W5b-c) in Boring BP 2. Second half of Brörup interstadial.

59,100 ± 700

GrN-1470. Brörup Hotel Bog BP 2, Zone W4 57,150 B.C.

GrN-1472. Brörup Hotel Bog BP 2, Zone W4, humus > 50,000

Herbaceous peat from depth of 3.22 to 3.30 m (Pollen-zone W4) in Boring BP 2. About middle of Brörup interstadial. *Comment:* date obtained after isotope enrichment by factor 9.92. Final corrections have changed figure previously published (cf. de Vries *et al.,* in preparation.) *General Comment:* all datings point to an age beyond 50,000 B.P. in accordance with other Early Weichselian datings. The enrichment dating GrN-1470 indicate that Brörup Interstadial occurred at least 59,000 yr ago. Compare dates for Amersfoort, Odderade, Chelford and also Grossweil and Zell am Inn (all this list).

E. Germany

Loopstedt series, Germany

Samples from interglacial and superjacent interstadial peat beds at Loopstedt near Schleswig (54° 30′ N Lat, 9° 37′ E Long), Schleswig-Holstein were investigated by de Vries. Interstadial pollen-analytically identified by Kolumbe (1955; unpub.) is generally considered equivalent to Brörup Interstadial. Results, already discussed by de Vries (1958), indicate how easily recent rootlets or humus can make samples appear much too young. Coll. by E. Kolumbe; subm. 1956 by H. Schwabedissen, Intitut für Ur-und Frühgeschichte, University, Cologne.

GrN-1254. Loopstedt d **> 52,000**

Peat from 4.50 m depth. Age: top of Eemian.

40,000 ± 1000

GrN-1242. Loopstedt e **38,050 B.C.**

Peat from 3.65 m depth. Age: interstadial.

37,850 ± 1000

GrN-1234. Loopstedt f **35,900 B.C.**

Peat from 3.00 m depth. Age: interstadial.

36,900 ± 500

GrN-1270. Loopstedt g **34,950 B.C.**

35,300 ± 400

GrN-1290. Loopstedt ga **33,350 B.C.**

Peat from 2.40 m depth. Age: interstadial. *Comment:* GrN-1290 only treated with acid.

45,600 ± 1500

GrN-1329. Loopstedt G **43,650 B.C.**

46,000 ± 2000

GrN-1337. Loopstedt G_a, humus **44,050 B.C.**

Peat coll. from same level as Loopstedt g by de Vries, Kolumbe, Andersen and Waterbolk. *Comment:* rootlets mechanically removed before pretreatment. GrN-1337 is less mobile fraction of humus extracted from GrN-1329.

$53{,}000\ ^{+\ 4000}_{-\ 2500}$

GrN-1365. Loopstedt G, charcoal **51,050 B.C.**

Charcoal from top of interstadial, carefully checked under microscope for rootlets. Coll. 1958 by de Vries.

General Comment: according to de Vries rootlets were detected in all samples except the charcoal (GrN-1365). This explains too-recent dates for peat samples. GrN-1365 proves interstadial to be beyond 50,000 yr old and is compatible with dates for Brörup Hotel Bog (above).

Odderade series, Germany

Borings at Odderade (54° 9′ N Lat, 9° 10′ E Long) 10 km NE of Meldorf, Schleswig-Holstein have revealed Early Glacial peat layers in thick sands. From detailed palynological studies of cores F. R. Averdieck has established existence of Brörup Interstadial overlain by a further interstadial he has named Odderade Interstadial (Averdieck, 1966). Samples from Cores 1 and 5 coll. and subm. 1962 by F. R. Averdieck, Institut für Ur- und Frühgeschichte Universität Kiel.

GrN-4099. Odderade 1-1 **> 42,000**

42,000 $^{+3700}_{-2500}$

GrN-4156. Odderade 1-1, humus **40,050 B.C.**

56,700 ± 800

GrN-4157. Odderade 1-1 (enriched) **54,750 B.C.**

Pinus wood from upper peat layer in Core 1 at 3.60 to 3.65 m depth in upper part of *Pinus* phase of Zone FW6 (Odderade Interstadial). *Comment:* fully pretreated and enriched by factor 11.74 prior to measurement (GrN-4157). High apparent age of humus extract (GrN-4156) shows little influence of recent infiltration. Figure published in Averdieck (1966) for GrN-4157 was incorrect.

GrN-4609. Odderade 1-2 **> 52,000**

GrN-4627. Odderade 1-2 **> 54,000**

58,100 ± 650

GrN-4671. Odderade 1-2 (enriched) **56,150 B.C.**

Sphagnum-peat from upper peat layer in Core 1 at 3.50 to 3.90 m depth covering whole *Pinus* phase of Odderade Interstadial (Zone FW6). *Comment:* ca. 250 g of peat extracted with acid and cold alkali gave 183 L CO_2, two portions of which were measured in normal way (GrN-4609 and GrN-4627) and the rest enriched by a factor 12.69 prior to measurement (GrN-4671).

GrN-4186. Odderade 1-4 **> 51,700**

51,100 ± 400

GrN-4178. Odderade 1-4 (enriched) **49,150 B.C.**

Sphagnum peat from top of 2nd peat layer in Core 1 at 5.85 to 6.00 m depth covering upper phase of Brörup interstadial (Zone FW4) with *Pinus, Picea* (also *P. omorikoides)* and *Alnus. Comment:* ca. 350 g of peat extracted with acid and cold alkali gave 154 L CO_2, one portion of which was measured in normal way (GrN-4186) and rest was enriched by factor of 12.46 prior to measurement (GrN-4178).

GrN-4100. Odderade 5-8 **> 53,000**

Sphagnum peat from top of upper peat layer in Core 5 at 6.60 to

7.10 m depth. Same phase of Odderade Interstadial as Odderade 1-2, above (Zone FW6).

54,500 ± 600

GrN-4698. Odderade 5-12 (enriched) 52,550 B.C.

Sphagnum peat from top of 2nd peat layer in Core 5 at 8.85 to 9.45 m depth. Same phase of Brörup Interstadial as Odderade 1-4, above (Zone FW 4). *Comment:* ca. 500 g of peat treated with acid and cold alkali gave 144 L CO_2 which was enriched by factor 11.52 prior to measurement.

General Comment: during time when samples were enriched trouble was experienced with lab. contamination (cf. de Vries *et al.,* in preparation). This may explain why stratigraphically deeper-lying samples Odderade 1-4 and Odderade 5-8 are younger than the rest. Results indicate that Odderade Interstadial dates back 58,000 yr *or more.* Compared with dates for Brörup Interstadial (above) this suggests two phases followed shortly on each other.

Albersdorf series, Germany

Profile at Albersdorf (54° 09′ N Lat, 9° 16′ E Long) 6 km E of Odderade, Schleswig-Holstein, shows two fossil soil horizons; lower considered by submitter equivalent to Brörup Interstadial and upper to Göttweig or Paudorf Interstadial. Coll. and subm. 1959 by A. Dücker, Geologisches Landesamt, Kiel.

45,080 ± 800

GrN-2647. Albersdorf II 43,130 B.C.

Organic matter in soil sample from upper horizon.

46,570 ± 1000

GrN-2646. Albersdorf I 44,620 B.C.

Organic matter in soil sample from lower horizon. *Comment:* in both cases soil was pretreated with acid and then combusted as a whole. Carbon analyzed was therefore mainly from humus and results are to be considered minimum. Soils therefore probably belong to Early Glacial period.

Geesthacht series, Germany

Excavation at Geesthacht (53° 26′ N Lat, 10° 23′ E Long) ca. 28 km SE of Hamburg, revealed complete section of Last Glacial and Interglacial. Three interstadial horizons were selected for dating. Coll. and subm. by R. Schütrumpf and H. Schwabedissen.

10,390 ± 80

GrN-1507. Geesthacht II 8440 B.C.

Soil with some charcoal thought to represent Alleröd Interstadial. Subm. 1955. *Comment:* published by deVries (1958). Since humus content was very low (1%), date may be affected by infiltration from above, though it is more or less according to expectation.

27,100 ± 300

GrN-1515. Geesthacht III **25,150 B.C.**

Loamy sand with humus from soil at ca. 4.30 m depth representing a pre-Alleröd interstadial (Bölling?). Subm. 1955. *Comment:* published by de Vries (1958). Results suggest correlation with Denekamp Interstadial. Because of poor carbon content of sample, infiltration from above can easily have made it somewhat too young. If interpretation is correct, this is only date for Denekamp-Paudorf Interstadial from Germany.

GrN-2594. Geesthacht IV **> 49,000**

Wood from upper part of peat bed ca. 5.50 to 6.00 m depth and several meters above Eemian peat. Pollen spectrum suggests correlation with Brörup Interstadial *(Pinus-Picea* phase). Subm. 1959. *Comment:* result in agreement with pollen-analytical dating.

48,500 ± 2000

GrN-1219. Lebenstedt, Germany **46,550 B.C.**

GrN-1453. Lebenstedt **> 50,000**

55,600 ± 900

GrN-2083. Lebenstedt (enriched) **53,650 B.C.**

Gyttja and humus from excavation at Salzgitter-Lebenstedt 18 km SW of Braunschweig, Niedersachsen. Depth 5.05 m; overburden sand and gravel. Gyttja beds correspond to level of Palaeolithic settlement and are placed in Early Weichsel (Würm). Faunal and floral remains indicate tundra climate. For further details see Tode *et al.* (1953). Coll. 1952 by A. Tode; subm. 1958 by H. Schwabedissen. *Comment:* GrN-1219 published by de Vries (1958). As new analysis (GrN-1453) proved older than 50,000 yr 132 L CO_2 was prepared and enriched by factor 10.06 prior to measurement GrN-2083. Result is to be considered minimum.

GrN-4197. Göttingen, Germany **> 44,600**

Charcoal from 1.2 m depth in building pit at Göttingen "Am Toppe" (51° 33′ N Lat, 9° 57′ E Long), Lower Saxony. Found in slightly transported *Schwarzerde* lying on brown decalcified loess (B horizon ?) and covered by loess-lime and limestone debris. Coll. 1961 by H. Rohdenburg; subm. 1962 by F. Scheffer, Bodenkundliches Institut, Universtät, Göttingen. *Comment:* date proves black earth to be older than Pleniglacial interstadials (Denekamp and Hengelo, cf. sec. A) and not of Alleröd age as held by Ackermann (1954).

GrN-4196. Niedervellmar, Germany **> 35,000**

Charcoal from 7.0 m depth in brickyard at Niedervellmar, Kassel (51° 19′ N Lat, 9° 30′ E Long), Hessen. Found in A horizon of a lessivé (pseudo-gley soil), overlain by loess. Coll. 1961 by H. Rohdenburg; subm. 1962 by F. Scheffer. *Comment:* sample contained insufficient carbon to

make more precise measurement, but result proves fossil soil to be older than Denekamp Interstadial. Compare Ötmannshausen, below.

GrN-4101. Ötmannshausen, Germany **> 43,700**

Charcoal from 4.6 m depth in brickyard N of Ötmannshausen (51° 10′ N Lat, 10° 0′ E Long), ca. 7 km SW of Eschwege, Hessen. Same stratigraphic position as GrN-4196, above. Coll. 1961 by H. Rohdenburg; subm. 1962 by F. Scheffer. *Comment:* sample is older than Pleniglacial interstadials (cf. sec. A) and therefore confirms view that this fossil soil, which is found underlying loess in many sections in the region (Niedervellmar, Göttingen, above), is Inter- and/or Early Glacial and is parallel with Göttweig loam horizon and Stillfried A complex (see below).

GrN-4236. Aachen, Germany **35,550 ± 650**
33,600 B.C.

Soil at 2.0 to 2.5 m depth in building pit of Library for Technical University, Aachen (50° 47′ N Lat, 6° 5′ E Long). The *Schwarzerde* occurs between two layers of flint gravel overlain by loess. Coll. 1962 by H. Langguth; subm. by H. Breddin, Geologisches Institut, T. H. Aachen. *Comment:* 70 g of sample was pretreated with acid and cold alkali and insoluble material used for analysis. At only 2 m depth it is very likely that recent rootlets were present and result is minimum. Soil is clearly older than Denekamp Interstadial and probably belongs to Early Glacial.

GrN-2167. Wegberg, Germany **32,140 ± 750**
30,190 B.C.

GrN-2188. Wegberg, humus **33,800 ± 700**
31,850 B.C.

Soil from fossil soil (Moorboden) at 2.60 to 2.63 m depth intercalcated in sandy loam in brickyard at Wegberg (51° 10′ N Lat, 6° 19′ E Lat), 9 km N of Erkelenz, Lower Rhine. Horizon believed to represent Göttweig Interstadial. For details see Paas (1962). Subm. 1960 by P. Woldstedt, Bonn. *Comment:* after treatment with dil. acid, result GrN-2167 was obtained; humus subsequently extracted with alkali gave result GrN-2188. Owing to shallow position humus infiltration from above must be considered likely and results must be considered minimum. If correlation with nearby Erkelenz (below) is correct, horizon must belong to Early Glacial Period.

GrN-2675. Erkelenz, Germany **49,000 $^{+2000}_{-1700}$**
47,050 B.C.

Humus extracted from fossil soil at 6.20 to 6.55 m depth in loess section of brickyard Gillrath at Erkelenz (51° 05′ N Lat, 6° 19′ E Long), Lower Rhine. Redeposited soil considered to have originated from Göttweig soil found later in original position some 15 m away. For details

see Paas (1962). Coll. by W. Paas; subm. 1960 by P. Woldstedt. *Comment:* as dates obtained from humus extract tend to be too young result must be considered minimum (cf. Oberfellabrunn, below). It nevertheless proves that soil is older than Denekamp and Hengelo Interstadials (cf. sec. A) and should be placed in Early Glacial Period.

50,400 $^{+2600}_{-1900}$

GrN-2677. Brühl, Germany **48,450 B.C.**

Humus extracted from a soil (Parabraunerde) at 10.20 to 10.55 m depth in loess section of brickyard Garzen II at Brühl (50° 49′ N Lat, 6° 55′ E Long), Lower Rhine. Soil referred to as Göttweig and overlain by several less pronounced soils (Remy, 1960). Coll. by H. Remy; subm. by P. Woldstedt. *Comment:* although result is only to be considered minimum (see Erkelenz, above) it proves that soil is older than Denekamp and Hengelo Interstadials and probably must be assigned to Early Glacial Period.

35,800 ± 350

GrN-2679. Kitzingen, Germany **33,850 B.C.**

Humus from upper level of a soil at ca. 10 m depth in brickyard Korbacher at Kitzingen (49° 44′ N Lat, 10° 10′ E Long) on river Main, Bavaria. Soil is described by Brunnacker (1956) as Riss-Würm interglacial and Early Würm, and by submitters as Göttweig. Subm. 1960 by H. Remy and P. Woldstedt. *Comment:* result obtained on humus extracted with alkali must be considered minimum. As other dates from what is apparently same horizon (Dolní Věstonice, Senftenberg, Wetzleindorf, etc., below, and Brühl, Erkelenz, above) are greater than 50,000 yr, there must have been younger contamination present.

Zell am Inn series, Germany

At Zell (48° 4′ N Lat, 12° 13′ E Long) on Inn River 1.5 km NNW of Wasserburg, Bavaria, brown coal (Wasserburg Schieferkohle) is intercalated in lower part of terrace gravels overlain by Würm moraine. Peat considered to represent Early Glacial Interstadial. Samples coll. 1961 by O. Fränzle; subm. 1962 by C. Troll, Geografisches Institut, Universität Bonn.

GrN-4117. Zell am Inn 1 **> 54,000**

57,000 ± 900

GrN-4742. Zell am Inn 1 (enriched) **55,050 B.C.**

Peat and wood from top of layer at 8.20 m depth. *Comment:* 500 g pretreated with acid and warm alkali gave 150 g residue which produced 135 L CO_2, portion of which was measured as GrN-4117. Rest enriched by factor 10.43 and measured as GrN-4742.

GrN-3174. Zell am Inn 2 **> 44,600**

$65{,}400\ ^{+\ 3500}_{-\ 2600}$

GrN-4104. Zell am Inn 2 (enriched) **63,450 B.C.**

Peat and wood from bottom of layer at 8.80 m depth. *Comment:* ca. 500 g pretreated with acid and warm alkali gave 220 g residue which produced 155 L CO_2, portion of which measured as GrN-3174 and rest enriched by factor 10.54 and measured as GrN-4104.

General Comment: F. Firbas (1927) reported pollen of *Fagus* with *Corylus, Quercus, Fraxinus, Acer plantanoides* and *A. pseudoplatanus* in same layer at Schambach near Zell. Since *Fagus* is unknown in Central and N. Europe during Last Interglacial and Last Glacial periods it seemed important to check whether our samples did indeed contain the species. Both samples investigated by W. H. Zagwijn showed pollen mainly of *Pinus* and *Picea* with small percentages of *Abies, Alnus* and *Betula* but no *Fagus*. Both *Picea excelsa* and *Picea omorikoides* were present, proving that peat is not Interglacial but Early Glacial. Pollen spectrum found by Firbas thus seems not to belong to this peat layer. At time of his investigation site was not accessible and he used museum samples. Samples may have become interchanged with Holocene peat.

Pollen spectra of our samples suggests correlation with interstadials at Grossweil (see below). Date also in accordance with Grossweil date $\left(69{,}100 \pm {}^{+\ 2300}_{-\ 1900}\right)$ indicating age of at least 64,000 yr for this interstadial.

Grossweil series, Germany

At Grossweil, 6 km E of Kochel (47° 42′ N Lat, 11° 23′ E Long) in Upper Bavaria the 2.5 m Schieferkohle seam covered by some 30 m of gravel has long been mined. Pollen-analytical investigation by H. Reich (1953) showed seam to represent end of Last Interglacial and two Early Glacial interstadials considered now to be equivalent of Amersfoort and Brörup Interstadials.

GrN-1422. Grossweil **> 53,700**

Wood from upper bed (Pollen-zone 13) dating youngest of two interstadials. Coll. and subm. 1957 by H. Gross, Bamberg.

$69{,}100\ ^{+\ 2300}_{-\ 1900}$

GrN-4031. Grossweil 4 (enriched) **67,150 B.C.**

Pinus wood from same layer as GrN-1422. Coll. 1959 by A. Bertsch at 2.50 m from base of seam ca. 700 m from entrance of mine; subm. by F. Firbas, Systematisch-Geobotanisches Institut, Universität Göttingen. *Comment:* sample thoroughly pretreated and radiocarbon from 216 L CO_2 concentrated by factor 12.91 by isotope enrichment prior to measurement. Activity of original sample was $(0.19 \pm 0.05)‰$ that of recent standard. This is highest age hitherto obtained with radiocarbon dating.

If correlation with Brörup Interstadial is correct, result suggests other dates (Brörup, Lebenstedt, Odderade, above) for this interstadial to be some 10,000 yr too young. Other possibility is that wood is derived from deeper layer, but as pine pollen forms only a few percent of pollen assemblage during Interglacial this seems unlikely origin for the sample.

GrN-4001. Grossweil 3 (enriched) **25,160 ± 300 / 23,210 B.C.**

GrN-4187. Grossweil 3 **> 50,400**

GrN-4185. Grossweil 3 (enriched) **45,800 ± 300 / 43,850 B.C.**

Picea wood from oldest interstadial (Pollen-zone 11 with *Picea omorikoides*). Coll. 1959 by A. Bertsch at 1.5 m from base of seam at same place as Grossweil 4, above; subm. by F. Firbas. *Comment:* GrN-4001 was enriched by a factor 13.46 prior to measurement. As sample was apparently contaminated in lab. Another portion was measured without enrichment (GrN-4187) and subsequently enriched by factor 9.29 (GrN-4185). Comparison of results shows that new enriched sample was again contaminated. For details see de Vries *et al.* (in preparation).
General Comment: A. Bertsch also took pollen samples and established correct position of radiocarbon samples by comparison with pollen-diagram of H. Reich. Level of sample Grossweil 4 contained mainly *Picea excelsa* and *Pinus,* while level of sample Grossweil 3 also contained *Picea omorikoides.*

GrN-1277. Karrestobel, Germany **29,060 ± 300 / 27,110 B.C.**

Peat from Karrestobel near Baindt (47° 50′ N Lat, 9° 40′ E Long) 8 km N of Ravensburg, Württemberg. According to de Vries (1958) and Gross (1958) peat layer is below Würm till and on top of varved clay. It is not identical with any beds investigated by K. Bertsch (1925). According to Gross samples coll. later by A. Bertsch showed very little pollen, mostly *Pinus,* but further details are lacking. Coll. by F. Weidenbach; subm. 1957 by H. Gross. *Comment:* date suggests correlation with Denekamp-Paudorf Interstadial, but as long as stratigraphic position is uncertain, result is of little value.

GrN-4406. Raschwassertal, Germany **40,800 $^{+4400}_{-2800}$ / 38,850 B.C.**

Pressed wood found by P. Ergenzinger 2.3 m down in Würm-age boulder clay in Raschwassertal near Finsterau (48° 56′ N Lat, 13° 35′ E Long), 40 km N of Passau, Bavaria. Subm. 1962 by P. Ergenzinger and J. Hövermann, Geogr. Inst., Free University, Berlin.

Hörmating series, Germany

Section in gravel pit at Hörmating (47° 56′ N Lat, 12° 01′ E Long) ca. 8 km N of Bad Aibling, Upper Bavaria, described by Ebers (1960).

In S part of section a thin peat bed (5 to 20 cm) at ca. 7 m depth is intercalated in lake deposits which are covered by fluvioglacial gravel and, on top, Würm boulder clay. Interpreted by Ebers to be connected with beginning of weathering phase visible further to N. Weathering zone interpreted as Würm interstadial. About doubtful stratigraphic significance of dates for peat bed see Brunnacker (1962). Coll. and subm. 1959 by E. Ebers, Haunshofen, Upper Bavaria.

	46,000 ± 1200
GrN-2593. Hörmating, peat	**44,050 B.C.**
GrN-2595. Hörmating, wood	**> 51,000**

Peat and *Picea*-wood from thin peat bed. *Comment:* as peat cannot be pretreated as thoroughly as wood, greater age found for wood must be considered more reliable. No evidence was seen that wood could be derived from older beds. More plausible explanation for difference in age is that peat still contained a small amount (0.35%) of recent material and that bed is older than 50,000 yr. Result does not show whether peat-bed dates from Early Würm interstadial or from Riss-Würm interglacial.

F. Switzerland

Signau series, Switzerland

At Signau (46° 55′ N Lat, 7° 42′ E Long) in Emmental 20 km E of Bern, Canton Bern, at ca. 17 m a peat bed (Schieferkohle) underlies 2.0 m sandy loam and 0.4 m gravel. Pollen studied by M. Welten but no data available. Coll. 1959 by Hl. de Vries and H. Müller-Beck, Bern.

	38,340 ± 800
GrN-2558. Signau 1	**36,390 B.C.**
	36,700 ± 900
GrN-3242. Signau 1 bis	**34,750 B.C.**

Top 11 cm of seam.

	42,000 ± 1400
GrN-3202. Signau 2	**40,050 B.C.**

14 to 28 cm below top.

	43,000 ± 1000
GrN-2611. Signau 3	**41,050 B.C.**

54 to 60 cm below top.

	50,000 $^{+3500}_{-2000}$
GrN-2654. Signau 4	**48,050 B.C.**

83 to 93 cm below top.

General Comment: all samples were fully pretreated, but as climatic evidence and relative stratigraphic position are lacking no comparison is possible.

Glütschtal series, Switzerland

At two localities in the Glütschtal (46° 43′ N Lat, 7° 36′ E Long) near Lake Thun, Canton Bern, peat beds (Schieferkohle) are exposed between layers of boulder clay. Pollen studied by M. Welten but no data available.

GrN-2559. Glütschtal I, Hurifluh **> 52,000**

Top part of 15-cm-thick pressed peat bed overlain by 18 m of gravel and 8 m till. Considered to belong to Early Würm Interstadial. Coll. 1959 by Hl. de Vries and H. Müller-Beck.

41,000 ± 1300

GrN-3223. Glütschtal II, Wasserfluh **39,050 B.C.**

Peat from 15-cm-thick main seam in middle of ca. 5 m clay deposit with four more thin peaty seams (two above, two below) and covered by ca. 11 m till. Considered definitely younger than Hurifluh seam.
General Comment: both samples fully pretreated but as comparative data are lacking no judgment is possible.

GrN-2546. Mörschwil, Switzerland **> 52,000**

GrN-2635. Mörschwil, bis **> 52,000**

Compressed peat (Schieferkohle) from middle of 1-m bed at 475 m above sealevel near Mörschwil, midway between Lake Constance and St. Gallen (47° 27′ N Lat, 9° 24′ E Long), Canton St. Gallen. Bed in top of lacustrine clay and covered by till. Pollen diagram published by W. Lüdi (1953). Submitter considers interstadial date more likely than interglacial date. Coll. and subm. 1959 by F. Saxer, Nat. History Mus., St. Gallen. *Comment:* result leaves it undecided whether bed dates from Early Würm or Eemian, but precludes Pleniglacial age.

GrN-1477. Drachenloch II, Switzerland **> 53,000**

Charcoal from cave Drachenloch at 2445 m above sealevel near St. Gallen (47° 27′ N Lat, 9° 24′ E Long) Canton St. Gallen. From closed hearth in Bed IV containing "Alpine Palaeolithic" implements. See Bächler (1921, fig. 15, p. 110-112). According to this author date is Riss-Würm interglacial. Later authors, however, advocated Würm-interstadial dating. Coll. 1920 by E. Bächler; subm. 1958 by H. Bächler, St. Gallen and H. Gross.

G. Austria

48,500 ± 2000

GrN-1217. Senftenberg, Austria **46,550 B.C.**

GrN-1771. Senftenberg (chlorite) **> 54,000**

Charcoal from loess section in brickyard at Senftenberg (48° 30′ N Lat, 15° 33′ E Long) 7 km NW of Krems, Lower Austria. Charcoal cluster lay on top of Göttweig soil horizon and was affected by solifluc-

tion connected with onset of cold period (Felgenhauer *et al.,* 1959; Fink, 1962). Different view held by Brandtner (1961) and Gross (1958) who considered charcoal to have been deposited in loess on which Göttweig soil developed and thus to be older than Göttweig horizon. This opinion contested by Fink (1962), who argues that charcoal would have been destroyed during soil formation if it had been older. Coll. 1952 by F. Brandtner and J. Fink; subm. by F. Brandtner, formerly Vienna. *Comment:* GrN-1217 treated with dil. acid and alkali. As contamination by recent rootlets could not be excluded another part of sample was treated more elaborately with sodium chlorite to dissolve any rootlets. Result GrN-1771 indicates some contamination in GrN-1217.

GrN-2906. Wetzleindorf, Austria, (acid only) > 47,000

GrN-2696. Wetzleindorf > 50,000

Charcoal cluster from top of Göttweig soil horizon in brickyard at Wetzleindorf (48° 29′ N Lat, 16° 24′ E Long) 8 km S of Ernstbrunn (Fink, 1962). Coll. 1959 and subm. by J. Fink, Hochschule für Bodenkultur, Vienna. *Comment:* both the portion pretreated with dil. acid only and the fully pretreated portion give infinite date, indicating sample (and therefore the soil horizon) to be older than 50,000 yr.

GrN-3261. Krems-Weinbauschule, Austria, charcoal 46,800 ± 1800 44,850 B.C.

41,400 ± 1800

GrN-3197. Krems-Weinbauschule, humus 39,450 B.C.

Charcoal cluster from loess just above Göttweig soil horizon exposed behind Winery school in Krems, Lower Austria (48° 25′ N Lat, 15° 36′ E Long). Coll. 1961 and subm. by J. Fink, Vienna. *Comment:* alkali-soluble (humus) fraction is considerably younger than insoluble charcoal indicating that some contamination may still be present in latter. 46,800 ± 1800 yr is therefore to be interpreted as minimum. *General Comment:* charcoal dates from Senftenberg, Wetzleindorf and Krems establish that Göttweig soil antedates Pleniglacial Period (Hochwürm) and place it either in Riss/Würm Interglacial or Early Glacial (Frühwürm), or both. Even if one sample were to belong to final stage of lower loess accumulation, possibility that all three do can be disregarded (see General Comment on Göttweig-Paudorf series).

Oberfellabrunn series, Austria

In abandoned brickyard at Oberfellabrunn (48° 34′ N Lat, 16° 00′ E Long) 5.5 km W of Hollabrunn, Lower Austria, a fossil soil complex (Fellabrunner Bodenbildungskomplex = Stillfried A Komplex) is exposed. On basal loess lies a 0.5 to 0.7 m weathering zone stratigraphically equivalent to Göttweig Weathering Zone followed by a 1 to 1.2 m humus zone consisting of two weakly developed, loamy fossil soil horizons. Whole complex is similar to profiles of Stillfried and Dolní Věs-

tonice. In hanging loess (2.8 m) no equivalent of Stillfried B soil (= Paudorf) is present. Hl. de Vries used a sequence of sediment samples taken from cleaned profile to demonstrate possibility of obtaining approximate dates from humus contained in loess sediment (de Vries, 1959; Felgenhauer *et al.,* 1959). Coll. 1958 and subm. by F. Felgenhauer and J. Fink.

16,700 ± 800

GrN-1911. Oberfellabrunn 1, humus 14,750 B.C.

Humus extracted from yellow, slightly layered loess at ca. 1.20 m depth. *Comment:* humus yield 0.034%.

31,800 ± 500

GrN-1901. Oberfellabrunn 2, humus 29,850 B.C.

Humus from yellow loess at ca. 2.3 m depth. *Comment:* humus yield 0.37%.

37,800 ± 700

GrN-1745. Oberfellabrunn 3, humus 35,850 B.C.

Humus from uppermost humic loam layer at ca. 3.0 m depth. *Comment:* humus yield 0.98%.

42,300 ± 800

GrN-1800. Oberfellabrunn 4, humus 40,350 B.C.

Humus from slightly humic layer separating the two fossil soils at ca. 3.5 m depth. *Comment:* humus yield 0.78%.

42,100 ± 800

GrN-1740. Oberfellabrunn 5, humus 40,150 B.C.

Humus from lower humic loam layer at ca. 4.0 m depth. *Comment:* humus yield 0.82%.

General Comment: chemical procedure is described in detail in de Vries (1959) and Felgenhauer *et al.* (1959). De Vries explicitly pointed out possibility of contamination by remaining rootlets—all samples contained rootlets—and infiltrated younger humus. That results are only to be considered as minimum ages was proven when de Vries repeated humus extraction on another portion of sample 3 using slightly different procedure (dissolution of humus in 5% NaOH) also applied to samples from Dolní Věstonice (see below). Fulvic acids which dissolve in dil. acid were also measured. New results were as follows:

43,000 ± 700

GrN-2610. Oberfellabrunn 3 bis, humus 41,050 B.C.

32,900 ± 500

GrN-2116. Oberfellabrunn 3 bis, fulvic acids 30,950 B.C.

GrN-2610 is nearly 1 half-life of C^{14} older than GrN-1745 and proves that carbon used for latter determination contained at least 0.5% recent contaminant, while only 1% recent contaminant would cause true age to be older than 52,000 yr. Young apparent age of fulvic acids also demonstrates presence of younger carbon in sample. It is therefore quite

clear that all these dates on humic substance are to be considered as minimum values only.

Göttweig-Paudorf series, Austria

To clarify age of Göttweig and Paudorf fossil soils, samples from the type sites (48° 21′ N Lat, 15° 37′ E Long) ca. 8 km S of Krems, Lower Austria were investigated (profile in Fink, 1961). 10-kg loess samples were taken from surface of natural exposures in pathway W of Furth and N of Göttweig (locus typicus), in pathway N of Aigen and at Paudorf by J. Fink in 1959. Unexpected results GrN-3092 and GrN-2492 (below) and impossibility of ascertaining whether sample 1/59 and 12/59 had been interchanged, led to collection of new material in 1962. Subm. by J. Fink, Vienna.

GrN-2179. Göttweig-Furth 12/59, humus **27,240 ± 450**
25,290 B.C.

Humus extracted from sample from top part of *Göttweig* soil horizon in path W of Furth. *Comment:* much too young.

GrN-2196. Göttweig-Aigen, 6/59, charcoal **32,140 ± 860**
30,190 B.C.

GrN-2309. Göttweig-Aigen 6/59, humus **27,670 ± 510**
25,720 B.C.

GrN-3205. Göttweig-Aigen 7/59, carbonate **10,000 ± 120**
8050 B.C.

GrN-4556. Göttweig-Aigen 3/62, humus **22,700 ± 250**
20,750 B.C.

Three samples from top part of *Paudorf* soil horizon in wall of pathway N of Aigen. Sample 6/59 contained concentration of charcoal specks separated from 1.5 kg of loess and measured as GrN-2196. Humus extracted from rest of this portion of loess gave result GrN-2309. Carbonate fraction of similar loess sample analyzed to ascertain degree of isotopic exchange with recent carbon, gave result GrN-3208. GrN-4556 is result of humus extract from 2 kg of fresh sample. *Comment:* date of 32,140 yr on charcoal represents a reliable figure for Paudorf fossil soil horizon. Both "humus dates" are younger. Apparent age of 10,000 yr for carbonate fraction of loess shows considerable exchange with recent bicarbonate in soil moisture, as is to be expected on old wall exposure (see also GrN-3204, below).

GrN-3092. Paudorf 1/59, 1st humus extract **43,300 ± 2300**
42,350 B.C.

GrN-2492. Paudorf 1/59, 2nd humus extract **42,300 ± 2500**
40,350 B.C.

Humus extract of sample from top part of *Paudorf* soil horizon at natural exposure at Paudorf. *Comment:* humus extracted with 5% NaOH solution gave result GrN-3092. Subsequent treatment with alkali

yielded enough organic material for second measurement, GrN-2492. Similarity of results suggest age of ca. 43,000 ± 2000 yr for humus which is much older than expected for Paudorf soil; suspicion arose that samples 1/59 and 12/59 had accidentally been interchanged. However, no evidence for this could be found. If sample is indeed correct, explanation for discrepancies between different samples must be sought in nature of material measured. For discussion see *General Comment* below.

GrN-4541. Paudorf 2/62, humus **29,250 ± 500 / 27,300 B.C.**

GrN-3204. Paudorf 2/62, carbonate **10,850 ± 120 / 8900 B.C.**

Humus from 4 kg of sample coll. 1962 from *Paudorf* soil horizon at Paudorf (GrN-4541) and carbonate fraction of soil (GrN-3204).

GrN-3190. Paudorf 2/59, humus **33,800 ± 500 / 31,850 B.C.**

Humus from 4 kg of sample from bottom of *Paudorf* soil horizon at Paudorf.

GrN-3248. Paudorf 4/59, humus **41,500 ± 1800 / 39,550 B.C.**

Humus from 3 kg of sample from top of *Göttweig* soil horizon at Paudorf. Carbon content determined separately as 0.34% of dry weight. *General Comment:* of series only GrN-2196 : 32.140 ± 860 yr, obtained on charcoal can be considered reliable. Because of impossibility of separating later infiltrated humus from original humus, dates obtained on humic substance should be considered minimum. Results GrN-2309, GrN-4541 and GrN-3190 are so close to GrN-2196 that they must be considered highly satisfactory. Procedure for extraction of humus was as follows: 1-kg portion of loess is first treated with hydrochloric acid until all carbonate is expelled. Then sample is washed repeatedly with dil. HCl until no more calcium ions are present. This is intended to dissolve fulvoacids, the more mobile component of humus. After further washing with water until neutral, 5% sodium hydroxide is added and allowed to stand at 60° overnight. Next day solution is separated in centrifuge and dissolved humic substance precipitated by acidifying. After precipitate is washed to pH 4 it is dried and combusted. Usually a 2nd and 3rd alkali extraction is performed on loess but yield is generally small.

All samples were observed to contain minute rootlets which were removed during processing as far as possible. Their presence could, however, be responsible for dates appearing too young.

Regarding interpretation of results consideration must be given to relationship of organic material dated and horizon from which it comes. First it must be stressed that both Paudorf and Göttweig "soils" are only represented by portion of lower (B) horizon of original soil. Actual surface has invariably been destroyed in this region, undoubtedly by

solifluction. Secondly, soil developed in surface layer of loess during period when little deposition was taking place. There is thus hiatus between a soil horizon and overlying loess. A sample from interface can either date recommencement of loess deposition or period of soil formation, or terminal stages of accumulation of bottom loess. In our opinion assumption of Fink (1962) concerning sample from Senftenburg (see above) that charcoal found in top of remnant soil would probably date onset of younger loess accumulation because older charcoal would have been destroyed during long period of soil formation, is most probable assumption to make. Brandtner's (1961) insistence that charcoal was deposited in older loess before soil formation started seems less likely.

This is not necessarily true for humus content. Loess accumulated during stadial periods has an appreciable humus content compared to remnant soil horizons and apparent age obtained from a mixture could actually be higher than age of soil. An appreciable error could only occur if not much more humus is accumulated during lifetime of soil, but in exceptional cases (GrN-3092 ?) an observable error may arise. These considerations, together with fact that humus extracts are always liable to contain younger infiltration, stress unreliability of dates obtained from such material. Probably the most reliable dates on humus thus far obtained are those from Dolní Věstonice (see below). Here contamination was avoided as much as possible by first removing 5 m from old exposure. Secondly humic content of fossil soils is much (10 x) higher than that of intervening loess, and finally, according to Kukla and Klíma (1961) soils are still intact and original surfaces identifiable.

Willendorf series, Austria

Upper Palaeolithic site Willendorf II (48° 21′ N Lat, 15° 25′ E Long) on left bank of Danube ca. 14 km N of Melk, Lower Austria, has repeatedly been excavated since 1908. Nine culture layers are distinguished: Layers 1-4 represent Primitive to Middle Aurignacian, 5-9 show at least two stages of Eastern Gravettian. Following Bayer, Pittioni (1954) places Aurignacian layers in upper part of Göttweig weathering zone and Gravettian layers in "WII" but no younger Paudorf horizon is present. F. Felgenhauer could not locate either fossil soil during his excavation in 1955 and stratigraphic position must be considered uncertain. Famous Venus I of Willendorf came from Layer 9.

GrN-1273. Willendorf II 4 **32,060 ± 250**
30,110 B.C.

Charcoal from Aurignacian Layer 4, excavation 1955. Coll. by F. Felgenhauer 1955; subm. by H. Schwabedissen.

GrN-1287. Willendorf II 1 **30,530 ± 250**
28,580 B.C.

Charcoal from Aurignacian Layer 1, excavation 1908 by J. Bayer and H. Obermayer. Subm. 1957 by F. Brandtner.

General Comment: both samples treated with acid and alkali. Brandtner claims to have found fossil coal in Layer 4. Use of coal has been reported by B. Klima for Ostrave-Petřkovice (Klima, 1956). As sample GrN-1273 was rinsed before treatment it should not have contained enough coal to be serious; 10% fossil contaminant would make result only 800 yr older. Sample GrN-1287 was carefully checked for fossil coal. As GrN-1273 is obtained on freshly collected material and GrN-1287 from old museum collection for which stratigraphic origin cannot be checked, former is considered more reliable. Compare also H246/231: 32,000 ± 3000 for Willendorf II Layer 5 (lower Gravettian). These are only dates available for Aurignacian in the region. Judged from dates obtained, Aurignacian settlement belongs to Paudorf Interstadial or slightly earlier. De Vries (1958) erroneously labelled GrN-1287 as dating Layer 7.

GrN-1327. Aggsbach a Austria **22,670 ± 100 / 20,720 B.C.**

GrN-1354. Aggsbach b (chlorite) **25,760 ± 170 / 23,810 B.C.**

GrN-2513. Aggsbach c (chlorite) **26,800 ± 200 / 24,850 B.C.**

Charcoal hearth-filling from (Eastern) Gravettian settlement at Aggsbach (48° 19′ N Lat, 15° 25′ E Long) on left bank of Danube 10 km N of Melk, Lower Austria. Culture layer occurs in top of 20 to 30 cm loess horizon, influenced by solifluction, under 5 m of loess. Coll. 1957 and subm. by F. Brandtner. *Comment:* sample was rinsed in water and care taken that no rootlets or coal were included. Subsequently it was given normal pretreatment with acid and alkali. As first result GrN-1327 seemed too young, two further portions were treated with chlorite and conc. sulfuric acid to remove undetected rootlets. Oldest date must be considered most reliable. Culture correlated with Layer 5 of Willendorf II and must be somewhat younger than Layer 4 (see above). Approx. same date is obtained for Krems-Wachtberg (see below). GrN-1327 and GrN-1354 already published by de Vries (1958). GrN-1327 is misquoted by Movius (1960) and Brandtner (1961).

GrN-3011. Krems-Wachtberg, Austria **27,400 ± 300 / 25,450 B.C.**

Charcoal from E. Gravettian settlement on the Wachtberg at Krems (48° 25′ N Lat, 15° 36′ E Long) Lower Austria, near Palaeolithic site of Hundssteig in pure loess, 3 to 5 m below surface. Coll. during excavation in 1930 by J. Bayer; subm. 1958 by F. Felgenhauer. *Comment:* culture correlated with Gravettian at Willendorf (Layers 5 to 9, see above) and considered older than settlement at Pavlov (see below). Compares well with Aggsbach date above.

GrN-2523. Stillfried B, Austria **28,200 ± 290 / 26,250 B.C.**

GrN-2533. Stillfried B, (chlorite) **28,340 ± 220 / 26,390 B.C.**

Charcoal from 8-cm thick lens just above Stillfried B soil horizon in loess section at Stillfried (48° 25′ N Lat, 16° 51′ E Long) in March valley ca. 7 km S of Dürnkrut, Lower Austria. Wood determined by B. Frenzel to be *Larix decidua*. Stillfried B soil in eastern dry loess landscape is correlated with Paudorf soil in more humid westerly region around Krems. For details see Fink (1962). Coll. and subm. 1959 by J. Fink. *Comment:* GrN-2523 treated with acid and alkali, but since sample contained rootlets a portion of already pretreated material was digested with chlorite and extracted with conc. sulfuric acid to dissolve any rootlets (GrN-2533). As dates are identical result can be considered reliable. Sample does *not* form part of soil horizon but lies above it and is separated from it by ca. 10 cm of loess. Interstadial proper must therefore be older than 28,340 yr.

GrN-4006. Ströblitz, Austria **31,900 ± 800 / 29,950 B.C.**

GrN-4013. Ströblitz, humus **30,030 ± 800 / 28,080 B.C.**

Slightly pressed log found in building pit at Ströblitz in Vienna (48° 13′ N Lat, 16° 22′ E Long). It lay on junction between 3-cm-thick rustbrown sand covering (Riss) river terrace, and 50-cm-thick "Anmoor" horizon containing pollen of cold flora *(Larix, Juniperus, Pinus)*. Coll. 1962 by O. Klaus; subm. by J. Fink. *Comment:* expected age early glacial: Amersfoort or older. Sample fully pretreated with acid and alkali. As humus extract (GrN-4013) gives practically same date as wood, contamination by recent infiltration can be excluded and result considered very reliable. Radiocarbon date places sample in beginning of Denekamp-Paudorf interstadial (see fig. 1).

H. Czechoslovakia

Dolní Věstonice II series, Czechoslovakia

Detailed description of new excavations at famous site in brickyard at Dolní Věstonice (Unterwisternitz), Site II (48° 53′ N Lat, 16° 40′ E Long) some 35 km S of Brno, is given in monograph by Klima *et al.* (1962). Two main "soil-complexes" can be distinguished: upper one considered equivalent to Stillfried B (=Paudorf, *auctores*) and lower one to Stillfried A (="Göttweig *proparte*," *auctores*). As stated by authors lower series contains Eemian lessivé soil at base, and several steppe-soils on top, one of which also has lessivé below it and is considered to represent an Early Würm interstadial. Stillfried B soil separating upper two loess deposits contains Gravettian remains in its upper portion (sample 9). Samples 1-8 coll. from specially and carefully cleaned surface (Profile 4)

ca. 5 m deep in face of brickyard to avoid presence of recent rootlets. Humus was extracted by de Vries from 1 to 3 kg portions in similar manner as for Oberfellabrunn (see above) except that 5% NaOH was used to dissolve humic substance as the higher concentration proved to give more reliable dates. See also Kukla and Klima (1961). Coll. and subm. 1959 by B. Klima, Brno.

15,350 ± 1000
GrN-2102. Dolní Věstonice 1 13,400 B.C.

Humus from 2500 g of loess at 420 cm depth in uppermost loess (Zone B 3i). *Comment:* humus yield 0.008%. $CaCO_3$ content 9%.

18,400 ± 700
GrN-2093. Dolní Věstonice 2 16,450 B.C.

Humus from 2245 g of loess at 560 cm depth in uppermost loess (Zone B 3e). *Comment:* humus yield 0.02%. $CaCO_3$ content 10%.

28,300 ± 300
GrN-2092. Dolní Věstonice 3 26,350 B.C.

Humus from 2245 g loess at 680 cm depth in culture layer at top of (Paudorf) soil, B 3c. *Comment:* humus yield 0.16%. $CaCO_3$ content 1.5%.

GrN-2105. Dolní Věstonice 4 > 34,000

Humus from 2500 g loess at 925 cm depth in middle loess, B2m. *Comment:* humus yield 0.02%. $CaCO_3$ content 10%.

GrN-2599. Dolní Věstonice 5, humus > 51,800

42,000 ± 800
GrN-2614. Dolní Věstonice 5, fulvic acids 40,050 B.C.

49,900 ± 600
GrN-2152. Dolní Věstonice 5 (enriched) 47,950 B.C.

Humus from soil at 1150 cm depth in uppermost chernozem Schwarzerde) of lower soil complex, B2g. *Comment:* humus yield 0.76%. $CaCO_3$ content 3%. When sample gave infinite date (GrN-2599) de Vries extracted humus from ca. 14 kg of new sample for enrichment. He obtained 120 L of CO_2 and enriched it by a factor of 9.36. Compared with GrN-2599 the finite result GrN-2152 is too young and some recent rootlets or fulvic acid must have been incorporated. Result must be considered minimum.

GrN-2604. Dolní Věstonice 8 > 50,000

Humus from 1000 g soil at 1390 cm depth in lowest chernozem of lower soil complex, B1d. *Comment:* humus yield 0.7%. $CaCO_3$ content 3.7%.

29,000 ± 200
GrN-2598. Dolní Věstonice 9 27,050 B.C.

Charcoal from same pit as other samples, but in Profile 3 ca. 60 m

to SW at 450 cm depth in upper part of "Paudorf" soil. Stratigraphically equivalent to GrN-2092.

General Comment: dates from lower soil complex confirm that it belongs to Early Würm and Eemian and demonstrates that Oberfellabrunn results are too young. Two dates for upper soil (GrN-2092 and GrN-2598) compare well with those from Stillfried and Göttweig-Aigen see *General Comment* on Göttweig-Paudorf series above).

GrN-1286. Dolní Věstonice, Czechoslovakia **25,820 ± 170**
23,870 B.C.

Charcoal from Gravettian settlement in top of "Paudorf" fossil soil at Dolní Věstonice (48° 52′ N Lat, 16° 40′ E Long) ca. 2 km S of site Dolní Věstonice II (de Vries, 1958). Coll. by K. Absalon during excavation in late twenties. Subm. 1956 by H. Schwabedissen. *Comment:* result is much younger than date for fresh charcoal from same horizon at Site II (GrN-2598, above) but comparable to dates for Pavlov (below) where culture is distinctly above soil horizon.

Pavlov series, Czechoslovakia

Eastern Gravettian settlement site at Pavlov (Pollau) (48° 52′ N Lat, 16° 40′ E Long), 500 m S of Dolní Věstonice site where GrN-1286 was collected (see above). Coll. by B. Klima, Brno.

GrN-1272. Pavlov a **26,620 ± 230**
24,670 B.C.

GrN-4812. Pavlov a bis **26,730 ± 250**
24,780 B.C.

Charcoal subm. 1956 by H. Schwabedissen.

GrN-1325. Pavlov b **25,020 ± 150**
23,070 B.C.

Charcoal subm. by F. Brandtner.

General Comment: dates already discussed by de Vries (1958). As de Vries suspected coal in GrN-1272 a further portion of same sample was inspected for coal but none could be detected. This material (GrN-4812) gave same age and date of ca. 26,670 yr must be considered reliable, while GrN-1325 may be too young. If true age of settlement was 25,020 yr Pavlov *a* would have to contain 20% fossil coal to cause the higher age and this is considered impossible. Important fact is that settlement was situated in loess *above* Paudorf fossil soil (Kukla and Klima, 1961) and therefore dates to period *after* soil formation had ceased and loess deposition had started again. Results therefore postdate Paudorf Interstadial and confirm GrN-2598 for Dolní Věstonice, above.

GrN-1482. Brno-Maloměřice, Czechoslovakia **> 48,500**

Charcoal (*Picea* sp.) from excavation on bank of Svitava River at Brno-Maloměřice, Czechoslovakia (49° 12′ N Lat, 16° 40′ E Long), found in washed-down hearth in lower part of slope deposit which carried a

soil indicated by submitters as "Würm I/II." Bed was at base of redeposited loess-loam, placed within same interstadial and on top of another likewise reworked loess-loam which merges into a fluvial sand considered to belong to terrace "Würm I" (Valoch, 1961; Musil, 1962). Coll. 1957 by R. Musil and K. Valoch; subm. 1957 by K. Valoch, Moravské Museum, Brno. *Comment:* date seems to indicate correlation with Early Weichselian deposits of W. Europe, if not earlier.

Pod hradem series, Czechoslovakia

Excavation in cave Pod hradem (Burghöhle) near Brno, Czechoslovakia (49° 12′ N Lat, 16° 40′ E Long). Submitter distinguishes two "interstadials" denoted by "W ½" and "W ⅔" respectively (Valoch, 1961; see also monograph by Musil and others, 1965). Subm. 1958 by K. Valoch.

GrN-848. Pod hradem A — **33,300 ± 1100** / **31,350 B.C.**

GrN-1735. Pod hradem A — **29,400 ± 230** / **27,450 B.C.**

GrN-1724. Pod hradem A, humus — **33,100 ± 530** / **31,150 B.C.**

Charcoal from Trench II, 30 m from entrance at 190 to 200 cm depth in upper part of "W ½" sediments. *Comment:* fully pretreated with acid and alkali. GrN-1735 is measurement on further portion of same charcoal and as it is considerably younger than both other dates sample may not have been homogeneous.

GrN-1751. Pod hradem C, sol. fraction — **28,200 ± 220** / **26,250 B.C.**

Charred bone from same place, 240 cm deep, directly on rock floor. Upper part of "W ½". *Comment:* sifted and treated as for charred bone (see Groningen IV). Elsewhere in cave Aurignacian overlies levels corresponding to samples A and C.

GrN-1743. Pod hradem E — **21,500 ± 100** / **19,550 B.C.**

GrN-1918. Pod hradem E, sol. fraction — **26,830 ± 300** / **24,880 B.C.**

Charcoal or charred bone 13 to 14 m from entrance at "base W ⅔." *Comment:* GrN-1743 treated only with acid; GrN-1918 was treated as for charred bone and may still be somewhat too young.

General Comment: although these dates may be somewhat too young it seems evident that cave deposit placed in "interstadial W ½" has nothing to do with "W ½ interstadial" in loess-sections of region which dates beyond 50,000 yr (GrN-1482, and GrN-2599, above).

I. Poland

Konin series, Poland

Extensive exposures in Wartha valley at Marantów, 5 km N of Konin (52° 14′ 40″ N Lat, 18° 16′ E Long), reveal several peat beds in thick sands below Brandenburg moraine. Pollen-analysis indicates cold climate suggesting post-Eemian age. Younger gyttja and peat occurs on sand and gravel in erosion gully cut into moraine and is therefore Late-glacial in age (Rutkowski, 1960). Coll. and subm. 1959 by E. Rutkowski, Inst. for Geology, Warsaw.

GrN-2566. Konin 2 **> 50,000**

Peat from uppermost peat bed below till at 7.5 to 7.8 m depth. *Comment:* date suggests Early Glacial age or older.

12,020 ± 120

GrN-2024. Konin 5 **10,070 B.C.**

Gyttja from base of Late-glacial gyttja bed at 5.3 to 5.5 m depth. *Comment:* date suggests Bölling age.

GrN-4095. Józefów, Poland **> 37,000**

Peat from 2 m depth at Józefów (ca. 51° 47′ N Lat, 20° 00′ E Long), 35 km E of Lódź. Peat bed overlies "organic deposits" presumably of Eemian age and is unconformably overlain by wind-worn sands and gravels and, on top, bedded silt and sand. Subm. 1963 by G. C. Maarleveld, Ede, Netherlands. *Comment:* result excludes possibility of Paudorf or Late-glacial age.

J. Italy

Gnif Gnaf series, Italy

Wood excavated from right bank of Mussolini channel in Agro Pontino plain at locality Gnif Gnaf (41° 30′ N Lat, 12° 50′ E Long) near town Latina. Coll. and subm. by A. C. Blanc, Rome, Italy (Blanc *et al.*, 1957).

GrN-1353. Gnif Gnaf I **> 55,000**

Sample of *Quercus* from Layers E2 or E3 preceding coldest phase of Early Würm. Subm. 1957.

GrN-1798. Gnif Gnaf II **> 50,000**

48,600 ± 2300

GrN-2501. Gnif Gnaf II, humus fraction **46,650 B.C.**

58,000 ± 500

GrN-2572. Gnif Gnaf II (enriched) **56,050 B.C.**

Log of *Abies* from Layer E1 or E2 of a new digging made in 1958. *Comment:* sample carefully pretreated with acid and alkali. Extremely low C^{14} activity of alkali-soluble fraction (0.24% of modern) (GrN-2501) implies that age of ca. 58,000 yr is quite reliable.

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