HERBS AS JULY TEMPERATURE INDICATORS FOR PARTS OF THE PLENIGLACIAL AND LATE-GLACIAL IN THE NETHERLANDS[1]

E. KOLSTRUP[2]

ABSTRACT

Kolstrup, E. 1979 Herbs as July temperature indicators for parts of the Pleniglacial and Late-Glacial in The Netherlands – Geol. Mijnbouw 58: 377-380.

From the present July temperature demands of plant species also found as fossils in Weichselian Pleniglacial and Late-Glacial deposits in and near The Netherlands a reconstruction of the former minimum mean July temperatures is attempted and compared to a previous record. Analysis of a section near Epe suggests that there may have been a warmer interval around 14.000 years B.P. and the name of 'Epe Interstadial' is provisionally proposed for this interval in The Netherlands.

INTRODUCTION

From The Netherlands and its nearest surroundings a number of pollen diagrams are available from the time between 10,000 years B.P. and approximately 50,000 years B.P., i.e., from the Weichselian Late-Glacial and Pleniglacial.

The pollen diagrams from the Pleniglacial show that the tree pollen content, almost exclusively of *Pinus, Betula* and *Salix,* generally amounts to less than 20%, Cyperaceae, Gramineae and other herbs contributing the remaining part of the pollen. Generally speaking conclusions concerning the former temperatures deduced from pollen diagrams are drawn on the basis of the composition and amount of tree pollen as compared to the contribution of the herbs, but it is possible that shortlived ameliorations of the climate without an immediate migration of trees may have taken place. If information concerning the environment during these periods is required it is therefore necessary to estimate the environmental demands of those herbs and waterplants that did have time to immigrate.

In many diagrams a low percentage of redeposited pollen and spore types is found, some time spans being only represented by one diagram; the interpretation consequently may become somewhat uncertain, because it is not quite certain whether the plants used for the temperature estimates did indeed grow at the site at the time of deposition.

During the 13th Nordiske Geologiske Vintermøde (Copenhagen, 1978) a preliminary outline was given of the temperature demands of some plant species used for the reconstruction of former climates (KOLSTRUP, 1978). In the meantime a further elaboration of these temperature demands has resulted both in a greater precision of some temperature estimates and a re-assessment of some of the minima given at that meeting.

METHOD

The method for the deduction of the minimum mean July temperatures as well as the uncertainties of this method are given in KOLSTRUP (in prep.). Here it need only be mentioned that most plants, both aquatic and terrestrial ones, seem to occur commonly below a certain altitude both in Scandinavia

[1] Manuscript received: 1979-04-26.
Revised manuscript received and accepted: 1979-06-22.

[2] Danmarks Geologiske Undersøgelse, Thoravej 31, COPENHAGEN, Denmark.

and in the Alps and to become scarcer and finally to disappear altogether at higher altitudes (HEGI, 1906-1931, 1935- ; HULTÉN, 1971). Consequently, tentative minimum mean July temperature demands for the individual plant species may be deduced from a comparison of the present highest altitude at which the plants appear in Scandinavia and in the Alps with July temperature maps from these areas.

In the present paper only the July temperature will be dealt with. Additional ecological information concerning the various periods mentioned below can be found in CLEVERINGA ET AL. (1977), KOLSTRUP (in prep.) and KOLSTRUP & WIJMSTRA (1977).

TEMPERATURE ESTIMATES

In figure 1 the plant species are listed in the upper part according to their minimum mean July temperature demands. The lowest temperatures are to the left, the highest to the right. Where more plants seem to have the same minimum demands they are listed alphabetically within the group. In the left hand part of the figure a time table is given together with the Pleniglacial and Late-Glacial Weichselian periods and deposits.

In the figure a dot indicates low percentages or single finds of pollen and in some cases of seeds. A dot with an X across it indicates an abundance of the species. The plant species indicated in the figure represent records of BEHRE (1966: Late-Glacial), BOHNCKE & DEE (in prep.: Late Glacial), CLEVERINGA ET AL. (1977: Late Glacial), VAN DER HAMMEN (1951: Late-Glacial), KOLSTRUP & WIJMSTRA (1977: Pleniglacial), VANDENBERGHE & GULLENTOPS (1977: Pleniglacial) and ZAGWIJN (1974: Pleniglacial).

Additionally, palaeobotanical evidence from three new localities is presented, namely from Epe, Staphorst, and Vijvekapelle (KOLSTRUP, in prep.). Possibly the Epe time represents a short warmer period. As it is uncertain whether it overlaps in time with the Susacá-Raunis Interstadial (VAN DER HAMMEN & VOGEL, 1966; DREIMANIS, 1966), it is provisionally given the local name of Epe Interstadial. Whether the deposits from Staphorst and Vijvekapelle also represent warmer intervals is doubtful.

Each time span is represented by a single line. This means that shorter, cooler phases within a certain time span are not reflected in the temperature curve. This is a drawback of the method as used here, but it is always possible to split up a well-dated period, such as the Allerød or the Late Dryas, into shorter intervals.

In the right hand part of the figure the estimated minimum mean July temperatures are given for the various periods.

A perusal of the various time spans indicated in figure 1 from the bottom to the top shows that during the lower part of the Moershoofd Interstadial Complex several plant species cover the whole temperature range between 7 °C and 13 °C. However, only one specimen with a minimum July temperature of 12-13 °C was found, and as all types have only been found in small amounts, it is concluded that the July temperature was periodically around 13 °C, provided of course that the plant species used as indicators grew in situ in these localities. In the younger part of the Moershoofd Interstadial Complex fewer temperature indicators are found. There is good evidence of a mean of 10 °C, and only one single specimen was found with a higher temperature requirement. Therefore, the more cautious estimate of 10 °C for July has been adopted.

In the lower part of the Hengelo Interstadial a great variety of species is present covering the whole temperature range. Therefore, the minimum mean July temperature was probably around 13 °C, possibly 15 °C at times. In the upper part of the Hengelo Interstadial fewer species are present, but there is a broad spectrum of species with minimum demands lying between 7 and 13 °C. Accordingly the minimum average July temperature was probably about 13 °C.

Indicator plants are poorly represented in the Denekamp Interstadial. The most thermophilous taxon, viz. *Myriophyllum,* has a minimum of about 10 °C, but as it is not abundant, the mean July temperature cannot have much exceeded 10 °C.

Also in the older deposits from Vijvekapelle the number of species was low and the mean July temperature has probably been in the order of 9 to 10 °C.

In the younger deposit from Vijvekapelle there is an abundance of *Selaginella selaginoides.* Taking the present temperature demands of this species into account (MAMAKOWA, 1970; KOLSTRUP, in prep.), the average July temperature may have been at least 7 °C, and probably 8 to 10 °C is a reasonable estimate.

Also the specimens found in the deposit from Staphorst point to a July temperature around 10°C. The great amount of secondary pollen in this locality renders the conclusions somewhat uncertain, however.

From the Epe locality both pollen and seeds have been studied which proved to belong to a fair number of species and the July temperature was probably 12 °C or more. Temperature indicators suggesting a July temperature above 12 °C are present, but the fact that a relatively high percentage of secondary pollen is present renders a higher temperature estimate somewhat uncertain.

Plant species that may be used as temperature indicators are of frequent occurrence during all periods of the Late-Glacial. This abundance is partly due to the fact that several diagrams covering the same time interval are included.

The Bølling time is well represented with species in all temperature groups, and consequently the temperature may have been in the order of 13 °C or more. Also during the Earlier Dryas the temperature may have been high. A single find of *Typha angustifolia* in this zone may even indicate a July temperature of 14 °C or more. During the Allerød the deduced July temperature was about the same as during the Bølling time, and the Late Dryas cannot have been very cold

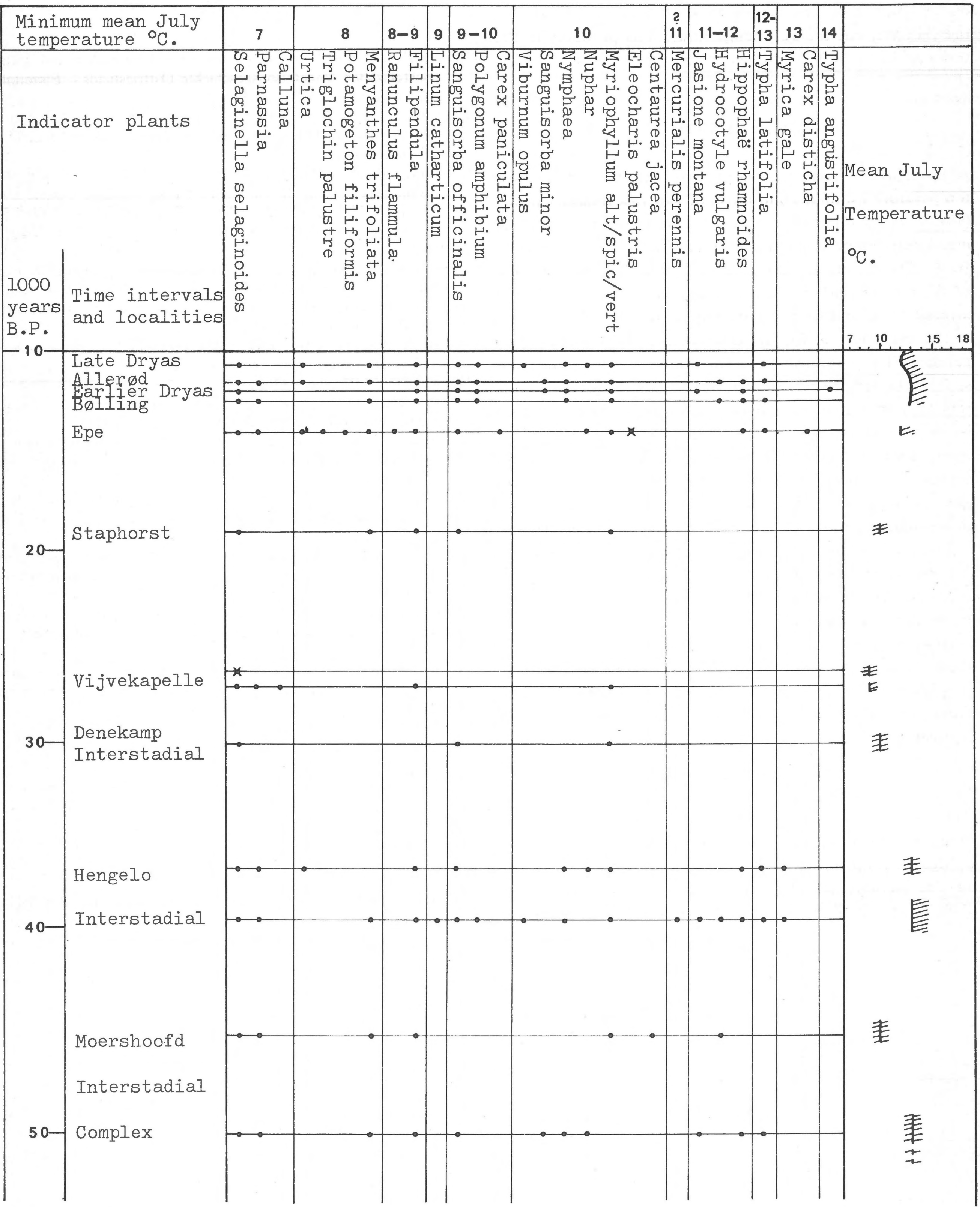

Fig. 1
July temperature indicators found as fossils in Weichselian Pleniglacial and Late-Glacial deposits together with the estimated minimum mean July temperatures for The Netherlands. The hatching suggests the possible range of the estimated temperatures. For additional explanation, see the text.

either. There may have been a small decrease as compared to the Allerød, but the July temperature was probably in the order of 12 to 13 °C, at least during part of the time.

CONCLUSIONS

A comparison between the present minimum mean July temperature estimates and those of VAN DER HAMMEN ET AL. (1967) shows some differences. In the latter estimates the mean July temperature for the Pleniglacial does not exceed 10 °C. The mean July temperature for the Bølling is around 11 °C, for the Earlier Dryas less than 10 °C, for the Allerød around 14 °C and for the Late Dryas about 10 °C.

The main reason for the discrepancies between the two curves is that previously the temperature estimates were based on the tree-line (VAN DER HAMMEN ET AL., 1967) while now they are based on herbs and waterplants. As some of the herbs and waterplants are less dependant on soil development (compare IVERSEN, 1954) and less delayed in their migration than are the trees, the present method is thought to give an improved estimate of the former temperature conditions compared to the method based on the tree-line.

The temperatures indicated in figure 1 are only tentative. It is highly probable that new diagrams will add more specimens to the list and this may conceivably result in higher temperature estimates.

New diagrams may elucidate the question of whether the fossil remains of some of the less well represented thermophilous species recorded till now were redeposited or indicate that the plants actually grew in situ at the time of deposition.

ACKNOWLEDGEMENTS

The author is very thankful to P. Cleveringa (Amsterdam) who critically read the first draft of the manuscript, to A. D. J. Meeuse (Amsterdam) who improved the English text, and to The Netherlands Organisation for the Advancement of Pure Research (Z.W.O.) which financed a part of the investigation.

REFERENCES

Behre, K. E. 1966 Untersuchungen zur spätglazialen und frühpostglazialen Vegetationsgeschichte Ostfrieslands – Eiszeitalter u. Gegenwart 17: 69-84.

Bohncke, S. J. & H. Dee (in prep.) Paleoecological study of an upper Late Glacial and Holocene sequence from 'De Borchert', The Netherlands.

Cleveringa, P., W. de Gans, E. Kolstrup & F. P. Paris 1977 Vegetational and climatic developments during the Late Glacial and the early Holocene and aeolian sedimentation as recorded in the Uteringsveen (Drente, The Netherlands) – Geol. Mijnbouw 56: 234-242.

Dreimanis, A. 1966 The Susacá-Interstadial and the subdivision of the Late-Glacial. A discussion – Geol. Mijnbouw 45: 445-448.

Hegi, G. 1906-1931, 1935- Illustrierte Flora von Mittel-Europa. Bd. I-VII – Lehmann (München).

Hultén, E. 1971 Atlas över växternas udbredning i Norden – Generalstabens litogr. anst. förlag (Stockholm).

Iversen, J. 1954 The Late-Glacial flora of Denmark and its relation to climate and soil. In Studies in vegetational history – Danm. geol. Unders. II Rk. 80: 87-119.

Kolstrup, E. 1978 Urters anvendelse som klimaindikatorer i træfattige palaeovegetationer – Abstr. 13th Nord. Geol. Vinterm. (Copenhagen, 1978) : 81.

—(in prep.) Climate and stratigraphy between 30,000 and 13,000 B.P. in northwestern Europe with special emphasis on The Netherlands.

Kolstrup, E. & T. A. Wijmstra 1977 A palynological investigation of the Moershoofd, Hengelo, and Denekamp Interstadials in The Netherlands – Geol. Mijnbouw 56: 85-102.

Mamakowa, K. 1970 Late-Glacial and early-Holocene vegetation from the territory of Krakow (Poland) – Acta Palaeobot 11: 3-12.

Vandenberghe, J. & F. Gullentops 1977 Contribution to the stratigraphy of the Weichsel Pleniglacial in the Belgian coversand area – Geol. Mijnbouw 56: 123-128.

Van der Hammen, T. 1951 Late-Glacial flora and periglacial phenomena in The Netherlands – Leidse Geol. Meded. 17: 71-183.

Van der Hammen, T., G. C. Maarleveld, J. C. Vogel & W. H. Zagwijn 1967 Stratigraphy, climatic succession and radiocarbon dating of the Last Glacial in The Netherlands – Geol. Mijnbouw 46: 79-95.

Van der Hammen, T. & J. C. Vogel 1966 The Susacá-Interstadial and the subdivision of the Late-Glacial – Geol. Mijnbouw 45: 33-35.

Zagwijn, W. H. 1974 Vegetation, climate and radiocarbon datings in the Late Pleistocene of The Netherlands. Part II: Middle Pleniglacial – Meded. Rijks Geol. Dienst. N.S. 25: 101-110.