AN EARLY POST-GLACIAL POLLEN PROFILE FROM FLÅMSDALEN, A TRIBUTARY VALLEY TO THE SOGNEFJORD, WESTERN NORWAY

By

Ivar Klovning and Ulf Hafsten

(University Botanical Museum, Bergen)

Abstract. Pollen analysis and radiocarbon measurements of nekron-mud from the base of a 5 m deep organic deposit in a pot-hole on Furuberget, a rocky promontory in the lower part of the Flåmsdalen valley, show that this part of the valley was free of ice before 7000 B.C.

Introduction

Flåmsdalen, a 20 km long, much glaciated tributary valley to the Sognefjord, cutting southwards into the peripheral parts of the Hardangervidda plateau, contains a number of erosional features from the time the ice retreated from this valley (H. Holtedahl 1960). Among these is a series of sharply incised, mostly very narrow canyons of different sizes and shapes, often fringed with pot-holes. The canyons form a system, with a major canyon, present in parts of the main valley, forming the river channel of the present river and a series of tributary canyons which are mostly dry at the present time. These tributary canyons, which are supposed to be sub-glacial erosional phenomena, are very numerous on and around Furuberget, a broad and steep, rocky promontory (riegel), nearly 200 m high, that almost closes the Flåmsdalen valley 5 km south of the head of the Aurland fjord (Fig. 1). The fact that the river here, at this typical valley step, has cut a deep canyon, indicates that the valley once was completely closed at this place. The most extensive canyon occurring on Furuberget runs in an arc from southwest to east across the central part of the promontory and contains a series of pot-holes that are, especially in the flat, eastern part of the canyon, completely filled with organic matter (Klovning 1963).

Fig. 1. Looking up the valley from beneath the valley step at Furuberget. Above the canyon shown in the lower central part of the picture, the valley turns to the left behind Furuberget. The level of the highest Post-Glacial marine limit is indicated to the right (MG) and the approximate location of the spot where the pollen samples were taken is marked with an arrow with a P on top. Photo Klovning.

Fieldwork

In an attempt to get information about the time the ice retreated from Flåmsdalen, a short series of samples intended for pollen analysis was procured from one of these pot-holes, viz. the easternmost in the above-mentioned canyon. The bottom of the canyon is very flat here and wet, with bogs and water covering the surface. The pot-hole from which the samples were taken has a diameter of about 4 m and is filled with

a 5 m deep layer of nekron-mud that is covered with a very wet vegetation of *Sphagnum* mosses, *Menyanthes*, and fluviatile sedges. The sampling was carried out by means of a Hiller sampler in December 1962 while the surface was frozen. Only the lowermost 1/2 m of the organic section was preserved. The organic sediment rests on a 0.06 m thick layer of blue clay, containing flakes of phyllite and overlying sand or gravel. The nekron-mud itself contained no minerogenous matter and could thus be analysed after treatment with KOH and acetolysis.

Furuberget seems well suited for a pollen-analytic investigation for the following reasons: 1) it lies well above the highest Late-Glacial marine limit which is here around 135 m, 2) here the ice may have disappeared relatively early, thus making it possible to trace the first vegetation that immigrated to the valley after the last glaciation, 3) the filling-in process was probably able to take place uninterrupted by the river or any other form of outwash and disturbance once the ice tongue covering Furuberget had disappeared, and 4) the central position in the valley, the place without doubt being representative of the pollen deposition from the district. The sampling spot itself, however, cannot be said to be quite ideal from a pollen-analytical point of view, because the north rim of the canyon here is covered with birch trees, the crowns of which form an overhanging canopy that may disturb a normal pollen deposition.

The Pollen Analysis

The results of the analyses are shown in a conventional pollen diagram (Fig. 2). In addition to the depth scale and the stratigraphy column indicated to the left, the diagram contains: 1) an AP or arboreal pollen section, 2) a QM or mixed oak-forest section, on an enlarged scale, where *Corylus* has also been quoted, 3) a TOTAL diagram showing the relation between the amount of trees (black) and anemophilous herbs (hatched), 4) a NAP or non-arboreal pollen section showing the amount of the individual herb pollen categories, in per cent of the AP sum, and 5) an AqP or hydrophyte section, the calculation basis of which is the sum of AP + NAP + AqP. The zone division, completing the diagram in a column of its own, follows Jessen's system (Jessen 1935).

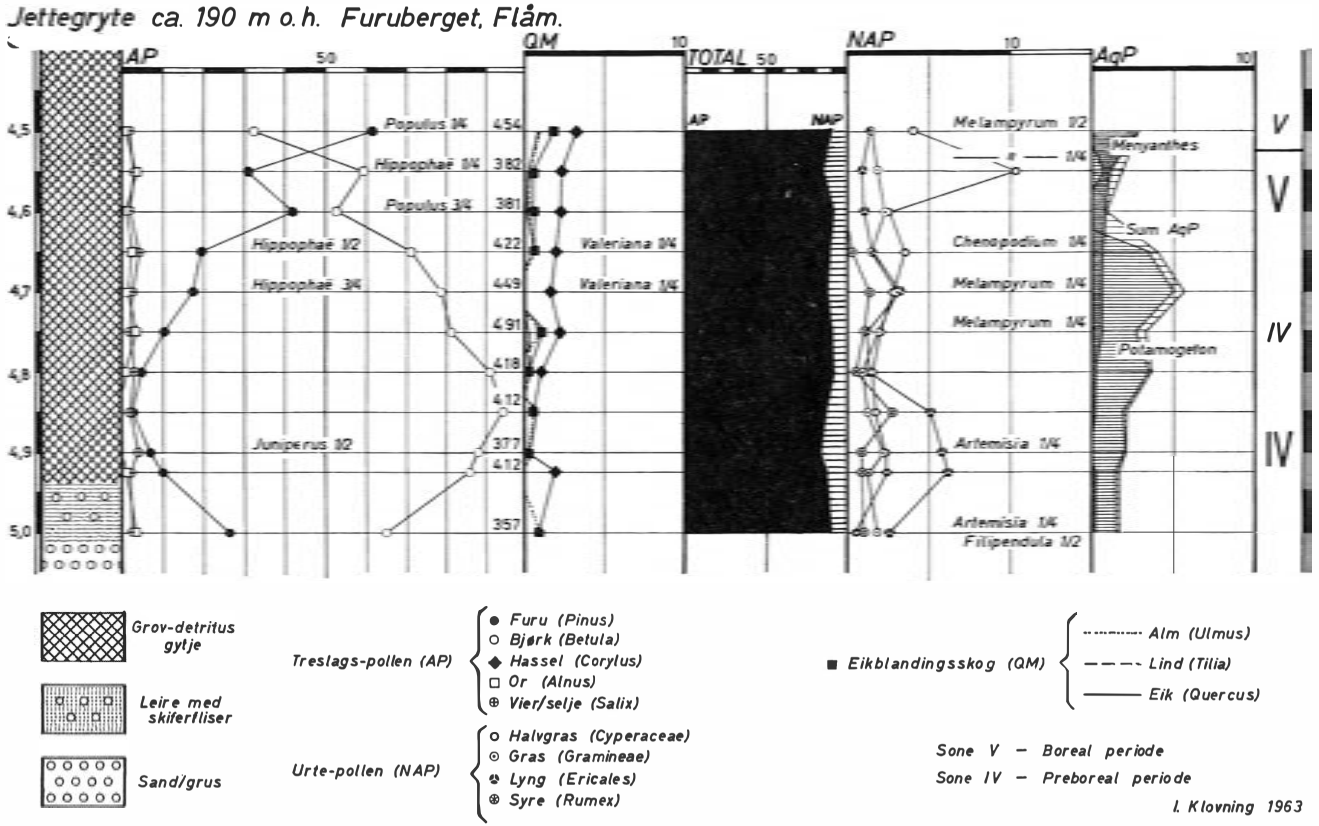

Fig. 2. Pollen diagram of samples from the base of the organic deposits in one of the pot-holes on Furuberget.

The prominent maximum for birch, the abundant occurrence, relatively, of *Salix* and *Hippophaë*, and the very sparse occurrence of alder, hazel, and mixed oak-forest pollen in the lower half of the diagram reflect typical Pre-Boreal conditions. The distinct tendency for a replacement of birch by pine, as well as the increasing importance of hazel and mixed oak-forest pollen in the upper half of the diagram furthermore agree with the vegetational conditions characterizing the transition from the Pre-Boreal to the Boreal period. The diagram presented thus seems to reflect a sequence normal for the early Post-Glacial (s.s) vegetational development in South Norway (HAFSTEN 1960).

Radiocarbon Dating

Since, however, pollen-analytical investigations for comparison are very rare in this part of the country, one cannot exclude completely the possibility that the vegetational development reflected by this short profile refers to a period of the Post-Glacial era other than the Pre-Boreal/Boreal one. Today the valley is completely dominated by birch forest, and a pollen flora like the one represented by the diagram might also be reflected under different climatic conditions than those prevailing during Pre-Boreal and Boreal times. A check of the pollen-analytical dating was therefore highly desirable, and we are very grateful for radiocarbon measurements to the NAVF committee, which approved our application for a C^{14} dating of the base material of the nekron-mud. The samples on which the C^{14} analysis is based were taken by means of Hiller's sampler at the end of September 1963. Sufficient material was secured by 3 separate borings, and the sediment column removed at each boring was 0.10 m thick. The depth down to the blue clay layer at the base of the nekron-mud was here a little greater than at the spot where the pollen samples had been taken, viz. varying from 5.16 to 5.25 m, but the sequence was apparently exactly the same. The radiocarbon measurement was carried out by Mr. R. Nydal, Research Fellow, and his collaborators at the Radiological Dating Laboratory in Trondheim. The result of the measurements, which was available at the beginning of July 1964, was stated in number of years prior to 1950, but is here given in relation to the birth of Christ, viz.

T-412: 7350 $\pm$ 300 B.C.

As the transition between the Pre-Boreal and Boreal period is generally given at 7000–7500 B.C., this result confirms the pollen-analytical dating.

A corresponding early Post-Glacial retreat of the ice in the fjords and valleys cutting into the Hardangervidda plateau is evidenced also by 1) a pollen-analytical investigation on Busnes, Kinsarvik, in the inner part of the Hardangerfjord area (ANUNDSEN 1963), 2) pollen analysis and radiocarbon datings in Valldalen, Röldal (HAFSTEN 1965), and 3) a radiocarbon dating of subfossil shells (*Mya truncata, Saxicava arctica, Pecten islandicus*) from Instevik, Kyrkjebö, in the central part of the Sognefjord area (NYDAL *et al.* 1964).

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