SVERIGES GEOLOGISKA UNDERSÖKNING

SER. C AVHANDLINGAR OCH UPPSATSER N:O 574

ÅRSBOK 54 (1960) N:o 5

AN INTERGLACIAL PEAT AT ALE NEAR LULEÅ, NORTHERN SWEDEN

BY

ERIK FROMM

WITH CONTRIBUTIONS BY R. W. KOLBE

AND HERMAN PERSSON

STOCKHOLM 1960

Sveriges Geologiska Undersöknings senast utkomna publikationer:

Geological survey of Sweden. Recent publications.

Ser. Aa. Geologiska kartblad i skalan 1:50 000 med beskrivningar

Geological maps, scale 1:50 000, with explanations

Priset för karta i Ser. Aa med beskrivning är 10:— kr, för karta enbart 8:— kr.
(Price: map sheet + descriptive text Sw. cr. 10:—, map sheet Sw. cr. 8:—)

N:o 197 *Laholm* av W. Larsson och C. Caldenius { Beskr. under utarbetande. / Expl. in preparation.
» 198 *Halmstad* av W. Larsson och C. Caldenius » » »
» 199 *Uppsala* av P. H. Lundegårdh och G. Lundqvist. With English summaries. 1956
» 200 *Eskilstuna* av P. H. Lundegårdh och G. Lundqvist. English summaries. 1959

Ser. Ad. Agrogeologiska kartblad i skalan 1:20 000 med beskrivningar

Agrogeological maps, scale 1:20 000, with explanations

Priset för karta i Ser. Ad med beskrivning är 8:— kr, för karta enbart 6:— kr.
(Price: map sheet + descriptive text Sw. cr. 8:—, map sheet Sw. cr. 6:—)

N:o 2 *Lund* av G. Ekström. 1953, karta med beskrivning
» 3 *Revinge* » » » t. v. utan beskrivning
» 4 *Löberöd* » » » t. v. » »
» 5 *Örtofta* » » » t. v. » »
» 6 *Kävlinge* » » 1955, t. v. » »
» 7 *Teckomatorp* » » 1955, t. v. » »
» 8 *Trollenäs* » » 1955, t. v. » »
» 9 *Bosjökloster* » » 1956, t. v. » »

} Explanation in preparation

Ser. C. *Årsbok 51 (1957)*

N:o 550 Lundqvist, J., Övre Klarälvsdalens kvartärgeologi. Summary: Quaternary geology of the Upper Klarälven valley, Värmland. Med 3 planscher. 1957 5,00
» 551 Lundqvist, J., Geokronologiska undersökningar i Värmland. Summary: Geochronological researches in Värmland, Western Sweden. Med en plansch. 1957 2,50
» 552 Sund, R. B., Nyare undersökningar inom nordöstra Upplands berggrund. Engl. abstract: New investigations in the Archaean of North-Eastern Uppland. Med en plansch. 1957 3,00
» 553 Lundegårdh, P. H., Göteborgstraktens berggrund. Med en plansch. Summary: Petrology of the Göteborg (Gothenburg) — Kungälv region, Western Sweden. 1958 7,50
» 554 Lundqvist, J., C 14-dateringar av rekurrensytor i Värmland. Summary: C 14-determinations of recurrence surfaces in Vermland, Western Sweden. 1957 2,00
» 555 Åhman, E., Degerberget, Baggen och Kluntarna. Några drag ur Piteområdets berggrundsgeologi. With English abstract. [Some features of the petrology of the Pite region.] 1957. 2,50
» 556 Assarsson, G., Kristallisationserscheinungen und Paragenese in den Systemen der Alkalichloride — Erdalkalichloride — Wasser. With Engl. abstract. 1957 2,00
» 557 Lundqvist, G., C 14-analyser i svensk kvartärgeologi 1955 — 57. With English summary. [C 14-analyses in Swedish Quaternary geology.] 1957 . 2,00

Forts. å omslagets 3:e sida

SVERIGES GEOLOGISKA UNDERSÖKNING

SER. C AVHANDLINGAR OCH UPPSATSER N:O 574

ÅRSBOK 54 (1960) N:o 5

AN INTERGLACIAL PEAT AT ALE NEAR LULEÅ, NORTHERN SWEDEN

BY

ERIK FROMM

WITH CONTRIBUTIONS BY R. W. KOLBE

AND HERMAN PERSSON

STOCKHOLM 1960

Abstract

During a well-digging 20 km W of Luleå a thin peat layer, resting on fine sand, was found below 5 m of till. The radiocarbon age was determined by the Stockholm laboratory (> 24 000 B. P.). The peat consists of *Tomentypnum nitens*, probably an alpine-arctic variety or modification (Herman Persson). The pollen flora is dominated by non-arboreal species and indicates a treeless arctic vegetation. The diatom flora consists of fresh water species, indicating a fen or swamp, not a peat bog or a lake (R. W. Kolbe). The terrestric, probably arctic peat is situated only a few metres above the present level of the Bothnian Bay. It is not quite excluded, that the Ale locality does not represent a real interglacial stage, but an interstadial during an earlier part of the last glaciation.

General description

In April 1957 mr A. Flinkfeldt, schoolteacher in the village of Ale, reported to the Geological Survey of Sweden of a well-digging, in which a thin peat layer was found below several metres of till. The well had then already been covered and was inaccessible, but mr Flinkfeldt had preserved a sample of the peat. The following description of the site and its stratigraphy is founded upon mr Flinkfeldt's very accurate account and upon observations, made by the present author during a visit in July 1957 (cf. Fromm 1958).

The village of Ale is situated at 65° 37′ N Lat, 21° 42′ E Long, in the coastal plain at the Bothnian Bay, about 20 km approximately W of the town of Luleå, upon a very flat moraine ridge, extending in the general direction of the ice flow, from NW to SE. The height above the present level of the Bothnian Bay is only 10—20 m. This ridge is crossed by some smaller moraine ridges in direction SW—NE, representing recessional end moraines of the type, common to this region. At the crests the moraine is generally exposed and slightly wave-washed during the land elevation. The slopes are covered by late-Glacial and post-Glacial clay and silt deposited in the Bothnian Bay. According to investigations of the clay in the Luleå region (Fromm 1949) the deglaciation took place about 7 000 B. C., at the transition between the Yoldia and Ancylus stages of the Baltic. The height of the Baltic (the marine limit) was then about 240 m above the present level. The land elevation continued through the post-Glacial time, and is now 0.9 m per century. Ale was thus covered by the Bothnian Bay up to the last millennia.

The actual well-digging is situated on the north-western slope of a flat moraine elevation, possibly an end moraine ridge of the type mentioned (Fig. 1). The stratigraphy in the well was, according to mr Flinkfeldt, from the surface:

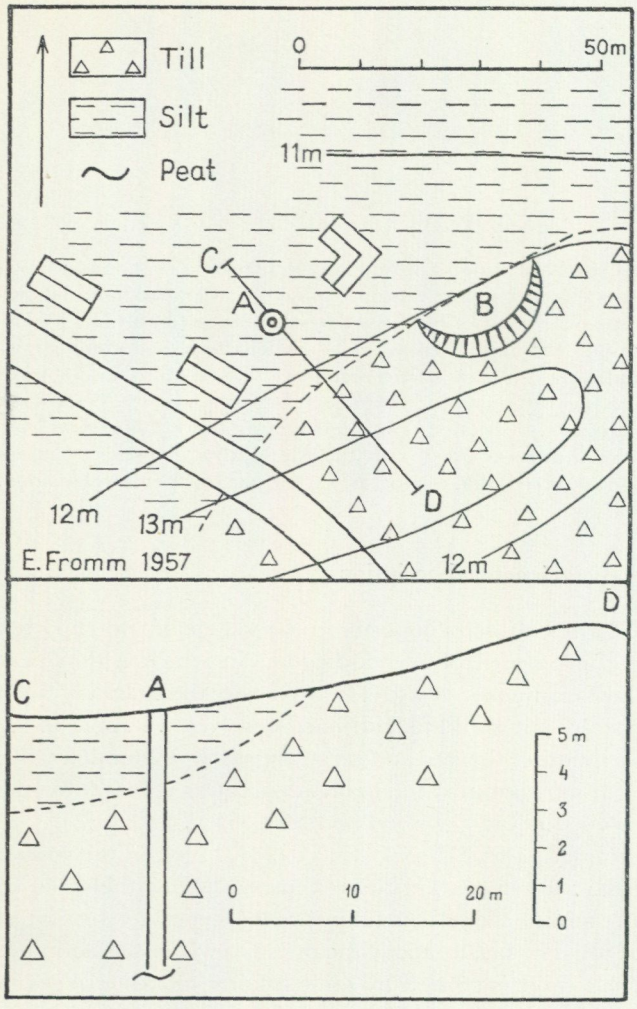

Fig. 1. Sketch map of the locality at Ale and profile. A: well. B: pit in the moraine. C—D: profile. Contours on the map are approximate height above the present sea level (estimated).

a. 2 m silt and clay,
b. 5 m till,
c. A thin layer of tough peat, probably about 1 dm, resting upon fine sand.

In the sand the groundwater was reached and the digging did not proceed any further. The remaining depth to the bedrock may be considerable. About 150 m W of the well the bedrock in a water boring lies 27 m below the surface. The till has a composition within the normal range of the moraine deposits. A sample from the adjacent moraine (Fig. 1, pit B) had a grain size composition according to Table I. The covering silt forms a very gentle slope. The quaternary deposits around the well thus are quite normal, and there seem to be no possibilities for slidings or displacements.

The geological facts thus strongly suggest a true submorainic position of the peat. Even if the submorainic strata may be disturbed by the ice pressure, it

Table I. Ale deposit. Composition of covering till

Grain size mm	Fraction	Weight per cent
20 —6	Gravel, coarse	7
6 —2	» , fine	8
2 —0.6	Sand, coarse	10
0.6 —0.2	» , medium	14
0.2 —0.06	Fine sand	27
0.06 —0.02	Very fine sand	20
0.02 —0.006	Silt, coarse	11
0.006—0.002	» , fine	3
< 0.002	Clay	0.3

is hardly possible to assume any longer transport of a thin layer of peat with the ice. The Ale deposit lies most likely in a primary position. With consideration of the marine limit and the land elevation, the presence of terrestric peat only a few metres above the Baltic would exclude a deposition during a late-Glacial oscillation. As described, the peat is not longer accessible, and only one sample was available. The sample consisted of small pieces of peat with admixture of the underlying fine sand. The sand, also containing small peat particles, was removed by a sieve. The peat was examined for macrofossiles under a binocular microscope, but nothing else than moss was found. Small samples were then taken for moss and pollen investigations. The remaining quantity of peat was just enough for a radiocarbon measurement, and was wholly consumed. Slides for diatom investigations were prepared from the sifted sand fraction. It may at once be emphasized, that none of these microscopic examinations has given any reason to suspect perceivable contaminations during the digging from recent matter or the post-Glacial surface sediments.

Radiocarbon age determination

Through the kind support of professor G. Lundqvist, the age of the peat was determined by the Radioactive Dating Laboratory in Stockholm, with result "more than 24 000 years" (Östlund 1959, St-325), essentially older than the late-Glacial and post-Glacial development of the region. It would, however, be possible to calculate a definite age (about 29 000 years, Östlund, personal communication). This fact cannot be taken as a positive indication of a real age, lower than the maximum limit of the method, the small quantity of the sample prohibiting chemical treatment for removal of younger humus. The position of the peat close to the present groundwater level is favourable for precipitation of humus. Due to the land elevation such a contamination *in situ* must have occurred quite recently (during the last millennium). An admixture of some 3 per cent of recent organic matter would explain the apparent definite age mentioned. When discussing the geological dating of the sample we are thus permitted to allow ages, older than this value, beyond the measuring limit.

Pollen analysis

The sample for pollen analysis was treated by acetolysis and examined by mrs Urve Miller. The results are given below in Table II. The slides were moderately rich in pollen grains. The pollen was partly in a very bad state of preservation, the grains flattened or corroded. All grains therefore could not be determined. The general character of the flora, in particular the proportion between arboreal and non-arboreal species, cannot be affected by this uncertainty in any higher degree, as the not identified pollen clearly represents different types, some of them reasonably already occurring among the identified pollen. The frequencies are expressed in per cent of the total number identified pollen.

Table II. Ale deposit. Pollen flora

	Per cent
Betula[1]	12
cfr Pinus[2]	+
Salix	17
Artemisia	4
Caryophyllaceae	1
Chenopodiaceae	+
Polygonum cfr bistorta	+
Cyperaceae[3]	19
Gramineae	45
	100 %

+ = traces
Total number of identified pollen grains: 321

	Per cent
Polypodiaceae	1
Bryophytes	3
Not determined, mostly corroded or collapsed	29

Rhizopodes, Pediastrum, moss leaves, radicelles of Cyperaceae, fungus hyphae

This flora clearly indicates a treeless, open tundra vegetation. Proofs of this are the preponderance of pollen from non-arboreal vegetation, the relatively high percentage of *Salix* and the occurrence of *Artemisia*.

The pollen spectrum is unlike anything found in this region from late-Glacial or post-Glacial deposits, and represents a quite different phyto-geographical and climatic environment.

---

[1] Always flattened and collapsed. Only a few grains could be identified with certainty, and then as *Betula*, the pores being clearly visible. Some of the remaining more uncertain grains may possibly represent other similar pollen, e. g. *Myrica*. On general grounds *Betula* may be regarded as the most probable type, and all are counted under this heading.

[2] Very corroded. Only one pollen grain could with a certain probability be determined as *Pinus*. More uncertain cases are counted among 'not determined'.

[3] The *Cyperaceae* pollen is not so well preserved as that of *Gramineae*. Only grains with clearly visible pores are counted under this heading. Other, uncertain cases are counted among 'not determined'.

Diatoms

A portion of the sand fraction of the sample was prepared for diatom investigations through boiling with hydrogen peroxide and mounting in Caedax (Bayer, n = 1.55) on slides. A general survey of the rather sparse flora of several small species gave the result according to Table III expressed in per cents of counted diatom frustules. Already this superficial examination indicates a pure fresh-water deposit, without influence from any larger basin of water. Six slides were then submitted to dr R. W. Kolbe at the Paleobotanical Department of the Museum of Natural History in Stockholm for a closer investigation.

Table III. Ale deposit. General character of diatom flora

	Per cent
Cymbella spp	26
Eunotia spp	7
Hantzschia amphioxys	22
Navicula spp, Pinnularia spp	38
Neidium dubium	1
Stauroneis spp	5
Tabellaria fenestrata	1
	100 %

Number of frustules counted: 283

Dr Kolbe's list of species, founded upon an investigations of all the slides, and his comments are given in the Appendix 1.

The diatoms thus indicate a deposition in contact only with fresh water, in a rather eutrophic fen. Noteworth is the complete absence of Baltic diatoms, either brackish-marine species or fresh-water species of the types, common in the Ancylus lake. The Ale submorainic strata must have been deposited clearly above the shore of the Baltic, whatever the hydrographic conditions in the Bothnian Bay may have been. The shoreline thus can be presumed to lie at least not higher than at the present moment.

In this connexion it may be mentioned, that the diatom flora found at Ale gives no support to the theory, that certain marine diatoms in the late-Glacial clay in the Luleå region (Hamberg 1906) are re-deposited from assumed marine interglacial strata (Brander 1943). These marine diatoms are, however, not confined to the Luleå region. They occur in the late-Glacial clays in the whole coastal district of the province of Norrbotten (Fromm 1949 and unpublished), and are more likely a regular feature of the diatom flora of the late-Glacial Yoldia-sea.

The peat moss

No other macrofossiles than mosses were found. Samples were submitted to dr Herman Persson at the Paleobotanical Department of the Museum of Natural History in Stockholm. His result, reported in Appendix 2 is that the

peat consists of the moss *Tomentypnum nitens*, probably an alpine-arctic variety or modification. A very good agreement is thus found between the probable results of the fossil investigations: pollen — a treeless heath or tundra; diatoms — a rather eutrophic fen; bryophytes — an arctic heath, with a certain preference of calcareous soils. The last requirement is not fulfilled by the quaternary deposits at Ale. The bedrock in the region, from which the loose deposits are derived, mainly consists of microcline granite. On a fresh, not yet leached surface, uncovered from ice or from the sea through land elevation, the soil conditions may have been favourable enough.

As a background to the finding of *Tomentypnum nitens* a survey of earlier reports of fossil occurrences of this moss may be of interest, without any claim of exhaustiveness. (In older literature, the moss is found under different combinations of the genus names *Camptothecium* or *Hypnum* and the species names *nitens* or *trichoides*). Dr Persson has pointed out the occurrence of the arctic form together with the mammoth at the Taimyr peninsula (Savič-Ljubitskaja and Abramova 1954). *Tomentypnum* (*Camptothecium*) is characteristic of peat formed in dry, late stages of arctic fens (Gorodkov 1954). Several finds, without distinction between the arctic forms and the main fen-form, are reported from the outer part of the last glaciation and in the periglacial zone in Europe: from *Dryas* deposits in Scania (Nathorst 1877, Holst 1906, 1908) and Denmark (Jessen 1920), from a peat with *Betula nana* from Senftenberg near Dresden, together with other northern mosses, of Dryas or Allerød age (Firbas-Grahmann 1928, Firbas 1949—1952), at two localities, cited by Nathorst (1914), with arctic plants, at Kraków (Žmuda 1914) and at Borna near Leipzig together with mammoth (Weber 1914), and at two of the Irish localities, investigated by Jessen (1949), from the Allerød and Boreal ages respectively.

Tomentypnum is not reported from the earlier known Swedish interglacial localities with mosses. In Denmark three localities from the last interglacial contain *Tomentypnum* (*Camptothecium*) (Jessen and Milthers 1928), arctic clay at Herning, boreal mud at Egtved (cf. Milthers 1925) and atlantic calcareous mud at Hörup.

Fossil *Tomentypnum* thus has its main distribution in arctic and boreal strata, in agreement with the interpretation of the Ale deposit.

Discussion

The geological facts and the fossil content of the Ale deposit give a quite consistent picture: a terrestric fen in probably arctic environment, essentially older than the late-Glacial development of the region, and indicating a low level of the Baltic.

Before discussing the geological position of the Ale peat we may consider the significance of other interglacial deposits in northern Sweden, with radiocarbon datings (Östlund 1957, G. Lundqvist 1957) or else confirmed. The deposits in Jämtland at Vålbacken (Thorslund 1938, 1939) and Pilgrimstad

(Kulling 1945) are in the main arctic or subarctic. The localities along the coastal district of the Bothnian Bay represent more temperate climates, approaching the present one. Bollnäs (Eriksson [Halden] 1912, Halden 1915, 1948) registers the most favourable climate, Härnö (Munthe 1904, 1909, 1946), Långsele (Sundius and Sandegren 1948) and Boliden (Grip 1949, J. Lundqvist 1955) more boreal types. The differences can partly be explained through the geographic positions of the localities. Some of the Härnö fossils, however, indicate a rather cold, boreal or subarctic climate. The pollen flora at all these places was dominated by arboreal pollen.

The arctic — subarctic interglacial localities in Jämtland are situated in such an altitude (above 300 m), that they may be contemporary with relatively high levels of the Baltic. Asklund (1936) even interprets submorainic gravel at Frösön as shore deposits, and discusses a very high interglacial Baltic shore, but also mentions the possibility of icedammed lakes. The localities in the coastal region are all situated below the late-Glacial marine limit. The Bollnäs mud (ca 90 m) was deposited in a bay or lagoon of the contemporary Baltic, perhaps the Eem sea (cf. Brander 1943)[1]. The localities at Långsele (75 m) and Härnö (some metres) are fresh-water deposits, probably also Boliden (210 m). There is an obvious contradiction between the brackish Baltic deposit at Bollnäs and the Långsele mud, the latter being situated at a lower level and representing a rather long time, probably during the first part of an interglacial period, but clearly in a fresh-water basin without any open connection with the Baltic. The Härnö mud indicates an interglacial level of the Baltic not higher than the present one. There is no indication in the interglacial strata at Härnö of a preceding higher sea level.

On general grounds we may assume, that all these localities, recording a boreal — temperate climate in northern Sweden represent a real interglacial stage, not only an interstadial. In all probability they belong to the last interglacial. A preservation of older interglacials within the central part of the glaciations seems too unlikely (cf. G. Lundqvist 1957). It is possible that the Långsele and Härnö deposits indicate a low level of the Baltic at the beginning of the interglacial period, contrary to the post-Glacial development and the parallel with Bollnäs. There may have existed other relations between the crustal movements in Scandinavia and the world-wide eustatic changes of level during the period now concerned, causing a progress of the shore displacement, different from that in late-Glacial and post-Glacial time. It must, however, be admitted, that the known facts are too fragmentary to permit a coherent reconstruction of the interglacial development in central and northern Sweden.

In any case, Ale has a more pronounced cold character than any of the Bollnäs, Härnö, Långsele, or Boliden deposits. Of the localities mentioned the Härnö mud shows the closest affinities (a rather cold climate, low level of the Baltic). A cold stage would occur in the beginning, or at the end of an interglacial period. If we assume a land elevation, resembling that of the late-Glacial time, the Ale region would have been submerged at the beginning of the inter-

[1] See additional note on p. 13.

glacial period. A cold stage near the end of the period would be more likely. As mentioned, the land elevation during the interglacial stage may have differed considerably from post-Glacial conditions. There is no proof, however, and the parallels with the other localities are not conclusive.

Another possibility may not be quite excluded. The cold climate at Ale could be compatible with an interstadial stage during an earlier part of the last glaciation, older than the minimum value of the radiocarbon dating. Such an oscillation must demand a rather long duration to permit an ice retreat into the central parts of the North European glaciation. The Göttweiger interstadial might perhaps be considered as a possible dating.

The Ale locality fits well into the pattern of distribution, shown by the interglacial deposits in and around Scandinavia (Sandegren in Sundius and Sandegren 1948). It lies in the central region of the glaciation in the northern part of a group of localities (mainly those mentioned previously in this section). Other, and mostly far better preserved interglacial deposits occur near the margins of the last glaciation. In the intervening zone there are hardly any interglacial deposits in a primary position.

The Ale peat has not been especially protected from the ice movement. In this area we must then assume a generally rather weak erosional force of the ice (cf. Sandegren op. cit.). The possibility, that a loose, fossilbearing deposit is preserved during an entire glaciation in any case must be rather small. Now about ten such submorainic, dated deposits are known in northern Sweden. We must then conclude, that at many more places resistent and thicker, fossil-free deposits, e. g. till or gravel, are preserved under the till of the last glaciation.

Many of the actual cases of such submorainic deposits (cf. G. Lundqvist 1943) are certainly late-Glacial, formed during oscillations of the ice margin or even subglacially. Other fossil-free submorainic deposits without certain dating may, however, be remnants of stages before the last glaciation. The probability that such unidentified, old deposits exist, grows with every new confirmed find of interglacial deposits.

Appendix 1

Diatomological examination

by

R. W. Kolbe

Ale, interglacial deposit, list of species

Frequency: +++ rather common
++ rather rare
+ rare

Cymbella cuspidata Ehr.	+
» heteropleura et var. minor Cl.	+
» microcephala Grun.	+
» naviculiformis Auersw.	+
» obtusa Greg.	++
» perpusilla A. Cl.	++
» ventricosa Ktz.	+

Didymosphaenia geminata (Lyngb.) M. Schm.	+
Eunotia arcus Ehr.	+
» pectinalis et var. minor (Ktz.) Rabh.	+
» » var. ventralis (Ehr.) Hust.	+
» praerupta Ehr.	+
» » var. inflata Grun.	+
» veneris (Ktz.) O. M.	+
Fragilaria construens var. triundulata (Ehr.) Gr.	+
» virescens Rlfs	+
Gomphonema gracile Ehr.	+
» intricatum Ktz.	+
» lagerheimii A. Cl.	+
Hantzschia amphioxys (Ehr.) Gr.	+++
Navicula dicephala (Ehr.) W. Sm.	+
» exigua (Greg.) O. M.	+
» lagerstedtii Cl. [1]	+
» mutica var. ventricosa (Ktz.) Cl.	+
» paludosa Hust. [2]	++
» pupula var. rectangularis (Greg.) Gr.	+
» radiosa var. tenella (Breb.) Gr.	+
» tuscula (Ehr.) Gr.	+
Neidium bisulcatum (Lagst.) Cl.	+
» dubium (Ehr.) Cl.	+
Pinnularia borealis Ehr.	+
» interrupta W. Sm.	+
» microstauron f. diminuta Gr.	+
» subcapitata et varr. Greg.	++
» sublinearis Gr.	+
» subcapitata var. stauroneiformis V. H.	+
Stauroneis anceps Ehr.	+
» » f. linearis (Ehr.) Cl.	+
» parvula var. capitata Östr.	+
» phoenicentron Ehr.	+
Tetracyclus lacustris Rlfs	+

Comments

The diatom flora of the sample is characterized by:

1. the absence of dystrophic forms
2. » » » plancton forms
3. » » » lacustrine forms
4. the frequency of dwarf individuals

The diatom community of the present material cannot have originated in a peat bog (cf. 1) nor in any water of low pH (a type of waters very common in Scandinavia). Although of the eutrophic type, the original biotope cannot have been a lake or pond (absence of lacustrine forms); it cannot have had a larger volume of water (absence of plancton forms and of *Melosira* species).

It is probable that the biotope was a fen or swamp (but not a peat bog).

[1] Kolbe 1959
[2] Hustedt 1957

Some aerophilous forms and frequent dwarf individuals seem to furnish a further proof of this assumption.

The diatom community gives no indication as to the specific type of climate during which this flora originated. The diatom flora could have lived in a climate which was similar to the present one, but might just as well have been of a colder type. Most species are common eurytherm forms, as far as our knowledge of their ecology goes; the "northern forms" in the list are too few to be characteristic.

Appendix 2

Bryological examination

by

Herman Persson

The moss found at Ale is *Tomentypnum nitens* (Hedw.) Loeske, the only species within its genus. This moss species has a wide distribution in the northern hemisphere with increasing frequency to the north. In the lowlands and especially in the subalpine birch belt, where it has the greatest frequency, it is a typical fen moss, often occurring abundantly. It may be regarded as a not very pronounced subalpine species. It demands a somewhat calcareous environment and has its best development in rich fens. Higher up in the alpine belt and in arctic regions it changes its habitat from fens to heaths, often the alpine *Dryas* heath (Mårtensson 1956). It then puts on rather a different appearance with another type of branching, often another colour and practically without any tomentum, which is very characteristic of the common lowland type. Small differences in the form of the leaves also occur, but are more difficult to define. The differences lie above all in the outer habitus. These forms occur not only in the Scandinavian mountains and in the Arctic but also in the Alps, and have been given several names, most commonly var. *involutum* Limpr. or var. *atrichum* (Kindb.) C. Jens. The former name may be considered having the priority.

It has never been investigated, if these forms are genetically determined, or only modifications of the common fen form, growing in lower altitudes. This question may not be settled without comparisons through experimental cultures. It is certain, however, that in the Arctic regions only the var. *involutum* seems to occur, not the main form of *Tomentypnum nitens*. Thus H. W. Arnell (1917) during the examination of the material from the Vega expedition found that *Tomentypnum nitens* was represented exclusively by the var. *involutum*. The same applies to the material, collected by the Fram expedition in arctic North America. I should like to quote Bryhn (1907 p. 127): "Synes at være almindelig overalt. Exemplarer findes fra alle undersøgte Steder og altid uden filthaaret Stilk, altsaa som Varieteten *insignis* Milde" [Seems to be common everywhere. Specimens are found from all localities investigated and always without tomentum, thus as var. *insignis* (another name for var. *involutum*)]. It is also

interesting to note, that the Russian bryologists L. I. Savič-Ljubitskaja and A. L. Abramova (1954) at their examination of mosses from the mammoth occurrences in the Taimyr peninsula only could find the var. *involutum*, which also was the only form of *Tomentypnum nitens*, now growing in the Taimyr peninsula.

Concerning the Ale moss, it is naturally difficult to distinguish in a fossil material between forms, mainly differing in outer habitus. The Ale moss, however, agrees so closely with var. *involutum*, that with considerable probability it seems to belong to this variety. That would mean, that it has grown under climatic and ecological conditions resembling those of the present alpine region of the Scandinavian mountains and of the Arctic regions.

It seems worth mentioning, that during the examination of the Ale material it very soon was clear to me, that it must consist of *Tomentypnum nitens*, especially on account of the structure of the leaves. I was, however, much surprised that the tomentum, so very characteristic of this species, was practically missing. The type of branching also differed from what I expected. Only by a closer study of the literature I found that these peculiar alpine-arctic forms existed Earlier I had no cause to deal with them, but now it struck me, how well the Ale moss agreed with them.

I have submitted the Ale material to docent O. Mårtensson, Uppsala, who more than any now living bryologist has studied the bryophytes of the Scandinavian mountains. He declares (personal letter): "det ser ju ut att vara en mera kraftig, satt, nordlig art" [it seems to be a more robust, stout, northern type].

Summing up the facts I conclude, that the Ale moss with considerable probability belongs to var. *involutum* Limpr. of *Tomentypnum nitens* (Hedw.) Loeske. That would mean that the moss had grown under climatic conditions, resembling those of the alpine region of the Scandinavian mountains and of the Arctic.

Note added in proof (E. FROMM)

Brander's reconstruction of an interglacial marine transgression in the northern Baltic was partly founded upon comparisons with the intramorainic clays on the Mga river near Leningrad. New polenanalytical and diatomological investigations (Znamenskaja 1959, Čeremisinova 1959) confirm that these strata give an almost complete record of the last (Eemian) interglacial with a marine transgression.

LITERATURE

DGU: Danmarks geologiske undersøgelse
GFF: Geologiska Föreningens i Stockholm Förhandlingar
SGU: Sveriges geologiska undersökning

ARNELL, H. W., 1917: Die Moose des Lena-Tales. — Arkiv för Botanik 15 (5).

ASKLUND, B., 1936: Frösöns submoräna avlagringar. — SGU, C 402.

BRANDER, G., 1943: Neue Beiträge zur Kenntnis der interglazialen Bildungen in Finnland. — Bull. Comm. Géol. Finl., 128.

BRYHN, N., 1907: Bryophyta in itinere polari norvagorum secundo collecta. — Rept. Second Norwegian Arctic Exped. in the "Fram", 1898—1902. Kristiania.

ČEREMISINOVA, E. A., 1959: Палеогеография мгинского моря (на основе данных диатомового анализа) [The paleogeography of the Mga sea from data of diatom analysis]. Doklady Akad. Nauk SSSR, 129: 2.

ERIKSSON [HALDEN], B., 1912: En submorän fossilförande aflagring vid Bollnäs i Hälsingland. — GFF 34.

FIRBAS, F., 1949—52: Waldgeschichte Mitteleuropas. I—II. — Jena.

— und GRAHMANN, R., 1928: Über jungdiluviale und alluviale Torflager in der Grube Marga bei Senftenberg (Niederlausitz). — Abh. Sächs. Akad. der Wissensch. Math.-Phys. Klasse, 40: 4.

FROMM, E., 1949: Datering av den senglaciala utvecklingen i Norrbottens kustland. GFF 71.

— 1958: Ett förmodat interglacialfynd nära Luleå [lecture abst.]. — GFF 80.

GORODKOV, B. N., 1954: Материалы для познания четвертичных ландшафтов Арктики [Contributions to the knowledge of the quaternary terrains of the Arctic]. — Botaničeskij Žurnal, 39: 1.

GRIP, E., 1949: Ett fynd av submoräna, växtförande avlagringar vid Boliden. — GFF 71.

HALDEN, B., 1915: Det interglaciala Bollnäsfyndets stratigrafi. — GFF 37.

— , 1948: Nya data rörande det interglaciala Bollnäsfyndet. In: SUNDIUS and SANDEGREN, Interglacialfyndet vid Långsele. — SGU C 495.

HAMBERG, A., 1906: Öfversikt af Lule älfs geologi. — SGU, C 202.

HOLST, N. O., 1906: De senglaciala lagren vid Toppeladugård. — SGU, C 200.

— , 1908: Efterskörd från de senglaciala lagren vid Toppeladugård. — SGU, C 210.

HUSTEDT, FR., 1957: Die Diatoméenflora des Flussystems der Weser im Gebiet der Hansestadt Bremen. — Abh. Naturwiss. Ver. Bremen 34.

JESSEN, K., 1920: Moseundersøgelser i det nordøstlige Sjælland. — DGU, II R, 34.

— , 1949: Studies in the Late Quaternary Deposits and Flora History of Ireland. — Proc. Roy. Ir. Acad. 52, B 6.

— , and MILTHERS, V., 1928: Interglacial fresh-water deposits in Jutland and Northwest Germany. — DGU, II R, 48.

KOLBE, R. W., 1959: Zur Taxonomie von Navicula Lagerstedtii Cl. — Sv. Bot. Tidskr. 53.

KULLING, O., 1945: Om fynd av mammut vid Pilgrimstad i Jämtland. — SGU, C 473.

LUNDQVIST, G., 1943: Norrlands jordarter. — SGU, C 457.

— , 1957: C^{14}-analyser i svensk kvartärgeologi 1955—57. — SGU, C 557.

LUNDQVIST, J., 1955: Interglacialfyndet vid Boliden. — GFF 77.

MILTHERS, V., 1925: Kortbladet Bække. — DGU, I R, 15.

MUNTHE, H., 1904: Om den submoräna Hernögyttjan och dess ålder. — GFF 26.

— , 1909: Härnögyttjan ännu en gång. — GFF 31.

— , 1910: Preliminary list of plant remains found in the Hernögyttja. — GFF 32.

— , 1946: Nya bidrag till kännedomen om Hernögyttjan. — SGU, C 481.

MÅRTENSSON, O., 1956: Bryophytes of the Torne-träsk area, Northern Swedish Lapland. — K. Vetensk. Akad. Avh. i Naturskyddsär. 15.

NATHORST, A. G., 1877: Nya fyndorter för arktiska växtlämningar i Skåne. — GFF 3.

— , 1914: Neue Erfahrungen von den Vorkommen fossiler Glacialpflanzen und einige darau besonders für Mitteleuropa basierte Schlussfolgerungen. — GFF 36.

SAVIČ-LJUBITSKAJA, L. I. and ABRAMOVA, A. L., 1954: Ископаемые мхи из района раскопок таймырского мамонта [Fossil mosses from the district of the excavations of the Taimyr mammoth]. — Botaničeskij Žurnal. 39: 4.

SUNDIUS, N. and SANDEGREN, R., 1948: Interglacialfyndet vid Långsele. — SGU, C 495.

THORSLUND, P., 1938: Växtfynd i leran vid Vålbackens tegelbruk i Jämtland. — GFF 60.

— , 1939: Kvartärgeologiska iakttagelser inom östra Storsjöbäckenet. — SGU, C 429.

WEBER, C. A., 1914: Die Mammutflora von Borna. — Abh. Naturwiss. Ver. Bremen 23.

ŻMUDA, A. J., 1914: Fossile Flora des Krakauer Diluviums. — Bull. Intern. Acad. Sciences Cracovie.

ZNAMENSKAJA, O. M., 1959: Стратиграфическое положение мгинских морских отложений [The stratigraphic position of the marine deposits in the valley of the Mga river]. Doklady Akad. Nauk SSSR, 129: 2.

ÖSTLUND, H. G., 1957: Stockholm Natural Radiocarbon Measurements I. — Science 126.

— , 1959: Stockholm Natural Radiocarbon Measurements II. — Am. Journ. Science, Radiocarb. Suppl. 1.

KUNGL. BOKTR. STHLM 1960

Årsbok 52 (1958)

N:o 558 STÅLHÖS, G., Rackebymassivet; ett västsvenskt norit-gabbromassiv. Summary: The Rackeby norite-gabbro massif; W. Sweden. 1958 4,00

» 559 LUNDQVIST, J., Studies of the Quaternary history and deposits of Värmland, Sweden. Experiences made while preparing a survey map. 1958 6,00

» 560 HAST, N., The measurement of rock pressure in mines. 1958 15,00

» 561 LUNDQVIST, G., Kvartärgeologisk forskning i Sverige under ett sekel. [A century of investigation in the Quaternary geology in Sweden.] 1958. . . 4,00

» 562 SAHLSTRÖM, K. E. och BÅTH, M., Jordskalv i Sverige 1951 — 1957. Zusammenfassung: Erdbeben in Schweden 1951 — 1957. 1958 1,50

Årsbok 53 (1959)

N:o 563 SANDEGREN, R., Register över Sveriges geologiska undersöknings publikationer 1858—1958. [Index of publications of the Geological survey of Sweden 1858—1958] 1959 10,00

» 564 OFFERBERG, J., Rocks and stratigraphy of the Ledfat area, Västerbotten county, Northern Sweden. 1959. With two plates 10,00

» 565 LUNDQVIST, G., C 14-daterade tallstubbar i fjällen. Summary: C 14-dated pine stumps from the High Mountains of Western Sweden. 1959 3,00

» 566 MÖLLER, H., Från nordostis till lågbaltisk is. En glacialgeologisk studie i sydvästra Skåne. Zusammenfassung: Vom Nordosteis zum Niederbaltischen Eis. Eine glazialgeologische Studie in SW-Schonen. 1959 9,00

» 567 NILSSON, K., Isströmmar och isavsmältning i sydvästra Skånes backlandskap. Zusammenfassung: Eisströme und Eisabschmelzung im Hügelland des südwestlichen Schonens. Mit zwei Tafeln. 1959 6,50

» 569 HJELMQVIST, S., Förekomsten av tungmineral i kaolinen på Ivö. Abstract: Occurrence of heavy minerals in the kaolin of Ivö. 1959 2,00

Årsbok 54 (1960)

N:o 571 BROTZEN, F., On Tylocidaris species (Echinoidea) and the stratigraphy of the Danian of Sweden. — With a bibliography of the Danian and the Paleocene. With three plates. 1959 7,00

» 573 LUNDQVIST, J., Issjöar och isavsmältning i östra Jämtland. Summary: Ice-lakes and Ice Recession in Eastern Jämtland, Central Sweden. 1959 . . . 2,00

» 574 FROMM, E., An Interglacial Peat at Ale near Luleå, Northern Sweden. — With contributions by R. W. Kolbe and Herman Persson. 1960 . . . 2,00

Ser. Ba. Översiktskartor (Survey maps)

N:o 14 Jordartskarta över södra och mellersta Sverige. Efter de geologiska kartbladen sammandragen vid S. G. U. av K. E. SAHLSTRÖM. Skala 1 :400 000 [Quaternary deposits of Southern and Central Sweden]

Mellersta bladet, tryckt 1947 15,00

Södra bladet, tryckt 1948 15,00

Norra bladet, tryckt 1949 15,00

Forts. å omslagets 4:de sida

N:o 15 Jordartskarta över Uppsalatrakten. 1:20000. Av N. G. Hörner † och B. Järnefors. Berggrunden sammanställd av P. H. Lundegårdh. [Quaternary deposits of the Uppsala region.] 1956 8,00
Beskrivning till Jordartskarta över Uppsalatrakten. Av B. Järnefors. Summary: Quaternary deposits in the Uppsala region. 1958 5,00

» 16 Karta över Sveriges berggrund. (Pre-Quaternary rocks of Sweden.) Skala 1:1 milj. Sammanställd av N. H. Magnusson m. fl. 1958. Karta i tre blad. (Map in three sheets; each 15 Sw. cr.) Pris per blad. 15,00
Description to this map in Sw. and Engl. editions in preparation

» 17 Karta över Sveriges jordarter. (Quaternary deposits of Sweden.) Skala 1:1 milj. Sammanställd av G. Lundqvist 1958. Karta i tre blad. (Map in three sheets; each 15 Sw. cr.) Pris per blad. 15,00
Beskrivning till Jordartskarta över Sverige. Av G. Lundqvist. 1958. . . . 5,00
Description to accompany the Map of the Quaternary deposits of Sweden. English edition by G. Lundqvist. 1959 5,00

» 20 Jordartskarta över Götaälvdalen. (Quaternary deposits in the Göta älv valley). Skala 1:20000. Av B. Järnefors 1959. Karta i tre blad. (Map in three sheets; each 11 Sw. cr.) Pris per blad 11,00

Ser. Ca.

N:o 37 Gavelin, S. och Kulling, O., Beskrivning till berggrundskarta över Västerbottens län. [Description to Map of the Pre-Quaternary rocks of the Västerbotten County, N. Sweden.] Karta i skala 1:400000. With English summaries. 1955. Beskrivning med karta 45,00
Endast karta (Map single) 18,00

» 38 Lundqvist, J., Beskrivning till jordartskarta över Värmlands län. (Quaternary deposits of the county of Värmland.) Karta i skala 1:200000. 1958. Beskrivning med karta (Text with map) 65,00
Karta i två blad (Map in two sheets) 30,00

» 41 Ödman, O. H., Beskrivning till berggrundskarta över urberget i Norrbottens län. English summary: Description to map of the Pre-Cambrian rocks of the Norrbotten County, N. Sweden, excl. the Caledonian mountain range. Karta i skala 1:400000. 1957. Beskrivning med karta. (Text with map) 45,00
Karta i två blad (Map in two sheets) 20,00

Meddelanden i stencil.

N:o 4 Stålhös, G., Bidrag till kännedomen om den radioaktiva strålningens fördelning inom den svenska berggrunden. Summary: Contribution to the knowledge of the distribution of the radioactivity in the bedrock of Sweden. 3,00

Pris 2 kronor

Distribueras genom

Generalstabens Litografiska Anstalts Förlag, Vasagatan 16, Stockholm 16

STOCKHOLM 1960. KUNGL. BOKTRYCKERIET P. A. NORSTEDT & SÖNER PRINTED IN SWEDEN