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PALAEOBOTANICAL INVESTIGATIONS AT SERMERMIUT, JAKOBSHAVN, WEST GREENLAND

BY

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WITH 8 FIGURES AND 14 TABLES IN THE TEXT, AND 7 PLATES

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Abstract

Palaeobotanical investigations were undertaken in two transects in a bog at Sermermiut (69°12′ N, 51°08′ W) near Jakobshavn. Pollen diagrams from three profiles were worked out, and a series of macrofossil samples examined. A series of samples from one of the profiles has also been dated by the radiocarbon method.

A comprehensive reference material of recent pollen from Greenland has been examined. Caryophyllaceae was especially the subject of examination, and a key to the determination of their pollen is presented. The recent pollen sedimentation in the area is elucidated by analysis of the content of pollen in a number of moss cushions.

The succession of the plant communities which caused the peat formation is described. The most important feature is the twice occurring change from a dwarf shrub heath to a *Sphagnum* bog. The radiocarbon datings of these events show close agreement with the re-growth of the European raised bogs at about 700–500 B.C. and A.D. 400 resp. (RY III and RY II).

CONTENTS

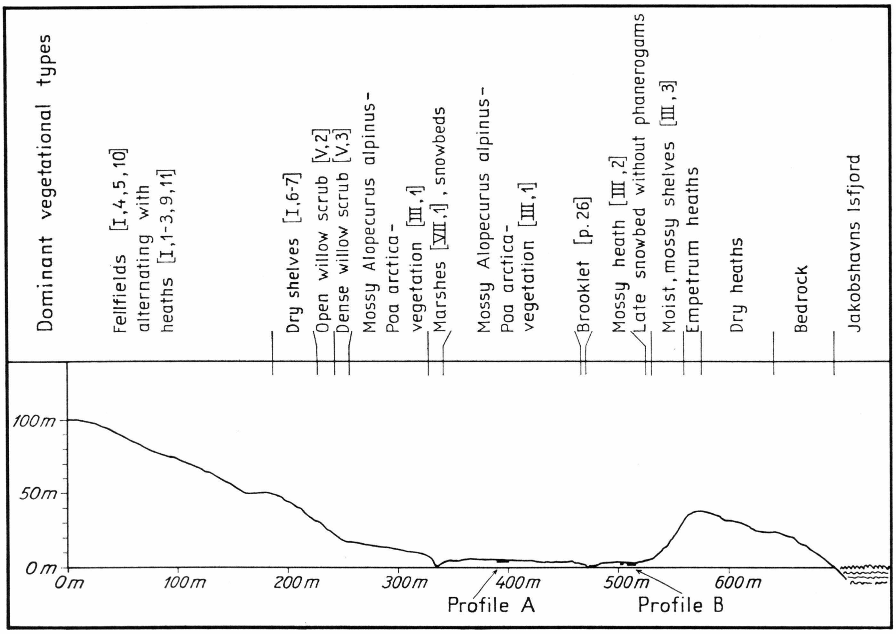

Fig. 1. Transection of the Sermermiut Valley. The orientation is almost N (left) – S (right). The numbers in [ ] refer to the vegetational analyses in FREDSKILD (1961).

INTRODUCTION

The existence of two Paleo-Eskimo cultures prior to the Inugsuk-culture in West Greenland were suggested by J. MELDGAARD in 1952. In order to obtain stratigraphical evidence for this he undertook excavations the following year at Sermermiut, and the results were presented in 1958 (MELDGAARD 1958). Two sections close to the beach furnished the proof: an older culture-layer containing artefacts from the Sarqaq-culture, covered by a thick, completely sterile peat, followed by a younger culture-layer with artefacts from the Dorset-culture, again covered by a sterile peat. In one of the sections, A, a 2 m thick kitchen-midden from the Inugsuk-culture covered the upper sterile peat, while in the other section, B, no traces of culture younger than Dorset were found.

MELDGAARD (1958) gives photographs and drawings of the sections at Sermermiut besides chapters dealing with "Interpretation of the stratigraphy" and "Cultural periods and climatic changes in Disko Bugt".

The National Museum of Denmark continued the excavations in 1955, and SV. JØRGENSEN and J. TROELS-SMITH made detailed investigations of sections and took out series of samples for pollen analysis, macrofossil determinations and radiocarbon datings. TH. MATHIASSEN presented the archeological material in a paper (MATHIASSEN 1958) with

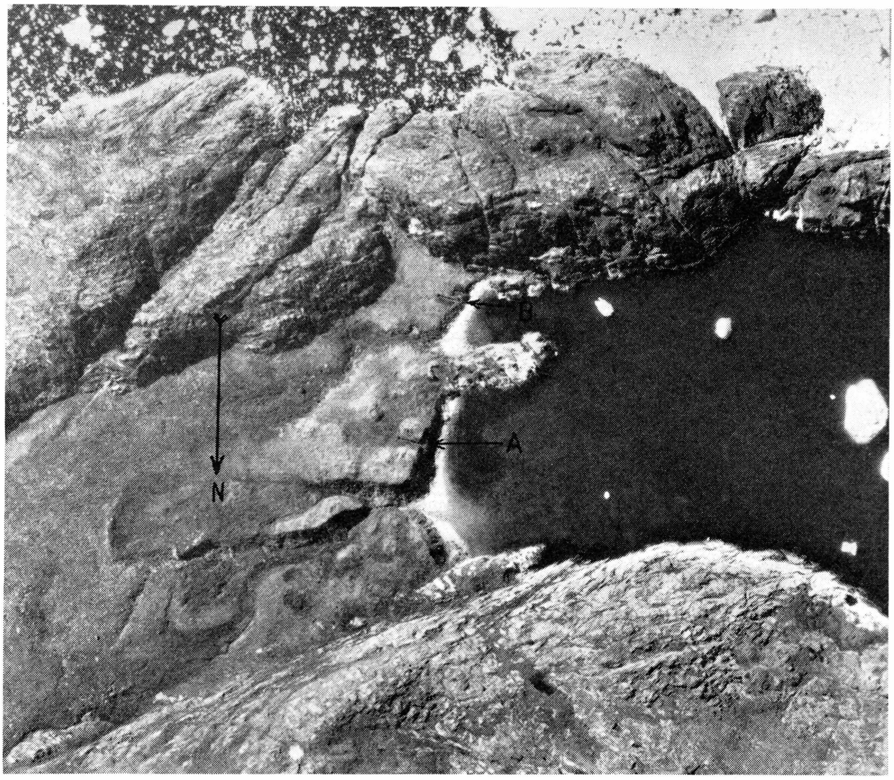

Fig. 2. Air-photo of Sermermiut (1958). Copyright Geodetic Institute, Copenhagen.

photographs and drawings of the sections, together with brief descriptions of the layers.

In 1957 the present author investigated the recent vegetation in the area around Sermermiut and Jakobshavn and collected a herbarium, besides reference material of pollen, seeds, and fruits, with a view to the coming investigation of the subfossil samples.

In Fig. 1 a transect of the valley is outlined, with references to the predominant vegetation types as described in FREDSKILD (1961).

The former settlement Sermermiut (69°12′ N, 51°08′ W) is situated in a valley and is separated from Jakobshavn Isfjord by a 40 m high ridge which ends in a small peninsula (Fig. 2). In the photograph the ruins of Neo-Eskimo houses from the 19th Century are visible as light squares, and the trenches from the excavations in 1953 and 1955 can also be seen.

The average temperatures for Jakobshavn, 3 km northeast of Sermermiut, are: July 7.7° C, February −19.0° C, the year −5.7° C. The mean annual precipitation is 215 mm. The bedrock consists of gneiss.

This paper deals with the results of the palaeobotanical investigations.

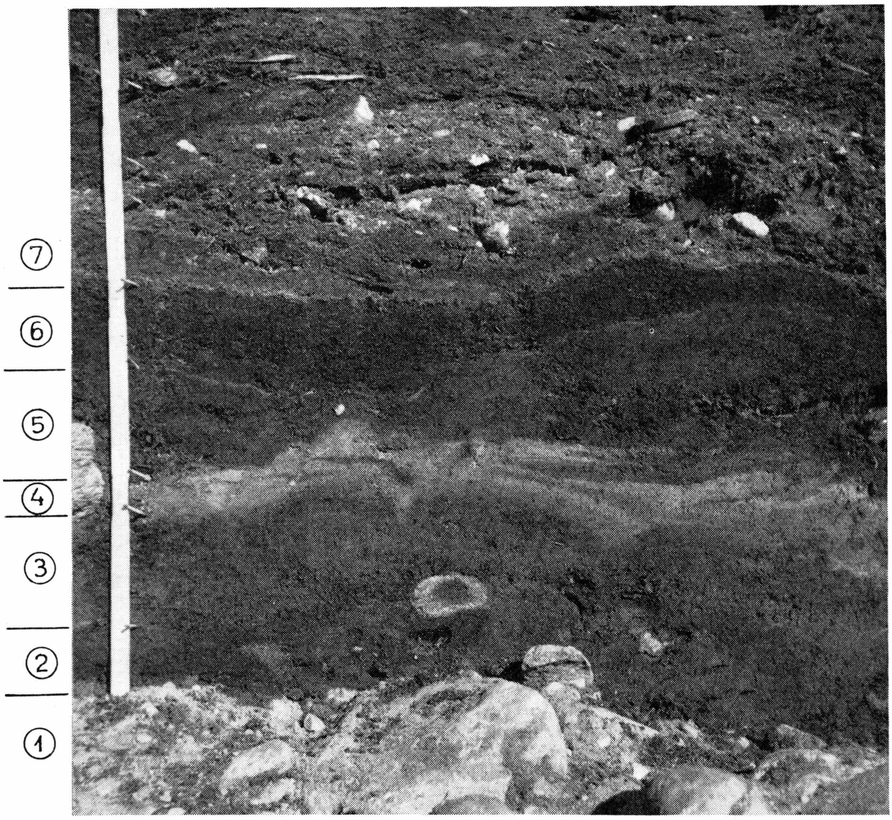

Fig. 3. Section A, Sermermiut. The samples in Profile A I are taken on the right side of the ruler, while Profile A II is just outside the left-hand edge of the photograph, below the stone. J. MELDGAARD phot.

DESCRIPTION OF PROFILES

Profile A

A photograph of the profile is shown in Fig. 3.

Based on the descriptions in MELDGAARD (1958, pp. 12–16), on observations made during the preparation of the pollen slides and washing of the macrofossil samples, and, not least, on the characterization given by SVEND JØRGENSEN in the field of a section only half a meter east of MELDGAARD's profile A (MATHIASSEN 1958, Fig. 5, measured by Sv. JØRGENSEN), the following formula can be given, using the terminology proposed by TROELS-SMITH (1955):

Layer 1: Gg 2, Ga 1, Gs 1 (MELDGAARD's layer A), sand, gravel, pebbles, and stones. (In fact $^1/_2$–$^3/_4$ of the layer are stones bigger than 5 cm).

Layer 2: $Th^3 3^1/_2$, $(Ga+Gs)\,^1/_2$, anthrax+ (layer B), a sandy peat consisting of rootlets and basal parts of herbs; odd pieces of charcoal.

Layer 3: $Th^3 4$, Dl+, Tb^3+ (layer C), a peat consisting of rootlets and basal parts of herbs, besides odd remnants of dwarf shrubs and mosses.

Layer 4: Ga 2, Gs 1, (Ag+As) 1, Sh+, (layer D), sand with clay and gravel, and a touch of humic substances.

Layer 5: The uppermost part of the layer: Th^3 3, Tl^3 1, Ga+. The lowermost part of the layer: Th^3 $2^1/_2$, Tl^3 1, Ga $^1/_2$, anthrax+. (Layer 5 = layer E). A peat much resembling the one in layer 6, but with an increasing amount of sand and charcoal downwards. At the boderline between layer 5 and 6 a very thin sandy layer, cf. Fig. 3.

Layer 6: Th^3 3, Tl^3 1, Tb^3+, Ga + (layer F), a peat consisting of rootlets and basal parts of herbs, some twigs and roots of dwarf shrubs, besides a little moss, and a touch of fine sand.

Layer 7: Stratum confusum (layer G).

Profile B

The section (plates I and II, besides Figs. 2–3 in MATHIASSEN (1958) was measured by Sv. JØRGENSEN, who described the layers in the field. Some of the descriptions have been slightly modified by the author as a consequence of closer investigations of the samples. Layers 14–16 do not occur in the profile proper (Plate VI), but in the section.

1. Stony sand.
   Nig. 2 (when wet), + (when dry), strfc. 0, elas. 0, sicc. 2.
   Color: Greyish brown when wet, greyish yellow when dry.
   Struc.: Heterogeneous, in places sandy and stony, in places clayey.
   Comp.: Ga 2, Gs 1, Ag 1.

2. Culture layer.
   Nig. 3, strfc. +, elas. 0, sicc. 2.
   Color: Greyish black to black.
   Struc.: Heterogeneous, stones and sand coated with humus. Gradually transition to layer 3.
   Comp.: Sh 1, Ga 1, Gs 1, Gg $^1/_2$, (Ag+As) $^1/_2$.

3. Culture layer.
   Nig. 4, strfc. +, elas. 0, sicc. 2.
   Color: Black.
   Struc.: Crumbling, greasy-clayey.
   Comp.: Sh 2, Ga $^1/_2$, Gs $^1/_2$, Tb^1sphagni $^1/_2$, (Ag+As) $^1/_2$, Gg+, anthrax+.

4. Slightly clayey sand.
   Nig. 1, strfc. 0–1, elas. 0, sicc. 2.
   Color: Grey, in places bright or dark brownish.
   Struc.: Slightly heterogeneous.
   Comp.: Ga 2, Sh 1, Ag 1, Gs+, Th^1 (+).

5. Humified peat.
Nig. 3, strfc. 3, elas. 1, sicc. 2.
Color: Dark grey-brown, dries up brighter, more red-brown.
Struc.: Laminar.
Comp: Th^3 4, Ga++, Ag+, Dl+, Dh+.

6. Humified peat.
Nig. 2–3, strfc. 3, elas. 1, sicc. 2.
Color: Grey-brown.
Struc.: Laminar.
Comp.: Th^2 4, Dl+, Dh+, Ag+, Ga (+).

7. Slightly humified peat with twigs.
Nig. 4, strfc 1, elas 2, sicc. 2.
Color: Dark brown-black.
Struc.: Heterogeneous, laminar.
Comp.: Th^1 3, Dl 1, Ag (+), Ga (+).

8. Light brown moss peat.
Nig. 2, strfc 1, elas. 3–4, sicc. (1)–2.
Color: Light yellow-brown.
Struc.: Felted.
Comp.: Tb^1sphagni 3, Th^1 1, Ga (+).

9. Black brown swamp peat.
Nig. 3–4, strfc. 1, elas. 3, sicc. 2.
Color: Black-brown.
Struc.: Felted, lowermost with *Sphagnum*, uppermost with other mosses. Cultural traces in topmost part of the layer, close to the border to layer 10.
Comp.: Th^3 4, Tb^1+, Dl (+).

10. Laminar swamp peat.
Nig. (2)–3, strfc. 3, elas. 2, sicc. 2.
Color: Greyish brown.
Struc.: Laminar. Cultural traces in lowermost part of the layer.
Comp.: Th^2 4, Tb^1+, Dl+.

11. Light brown *Sphagnum* peat.
Nig. 2, strfc. 1, elas. 3–4, sicc. 2.
Color: Light brown.
Struc.: felted; the sample from the profile consisted almost exclusively of *Sphagnum squarrosum*.
Comp.: Tb^1sphagni 4, Ga (+).

12. Laminar swamp peat.
Nig. (2)–3, strfc. 3, elas. 2, sicc. 2.
Color: Greyish-brown.
Struc.: Laminar. The uppermost cm in the profile was almost pure sand.
Comp.: Th^1 4, Dl+.

13. Recent moss peat with *Sphagnum*.
Comp.: Tb^0 3, Tb^0sphagni 1, Th^0+.

14. Sand and gravel.
Nig. 1–2, strfc. ?, elas. 0, sicc. 2.
Color: Brown-yellow.
Comp.: Ga 3, Gs 1, Gg+.

15. Sandy and clayey peat.
Nig. 2, strfc. 2–3, elas. +, sicc. 2.
Color: Grey yellow-brown.
Struc.: Heterogenous, laminar; the layer locally separated in minor layers of alternating peat or mineral particles.
Comp.: Th^1 2, Ag 1, Ga 1.

16. Sandy, laminar swamp peat.
Nig. 2, strfc. 3, elas. 2, sicc. 2.
Color: Grey-yellow.
Struc.: Laminar.
Comp.: Th^2 3, Ga 1, Dl +.

MICROFOSSILS

Comments on the pollen lists

The pollen samples were acetolyzed, stained with alkaline fuchsine, and embedded in glycerine. Like most other arctic samples these samples contained a certain amount of aeolian fine sand and silt, which was removed either by decanting or by treatment with cold hydrofluoric acid for a day. This method was preferred to the common boiling in HF, as experience has shown that the size of the pollen grains is less affected. All slides are permanent mounts, sealed with a paraffin-mastix-mixture, and afterwards covered by shellac. They are stored at the National Museum of Denmark.

The terminology of the flowering plants follows JØRGENSEN, SØRENSEN and WESTERGAARD (1958). In Table I all the spores, etc. found are listed. The pollen is divided into 4 groups in the list: 1) shrubs and dwarf shrubs, 2) anemophilous herbs, 3) entomophilous herbs, and 4) longdistance transported pollen. (Pollen types grouped under 1–3 are found in species growing in this part of Greenland).

After this follows a group containing: "a.i.d." (i.e. pollen found impossible to determine because of a too high degree of destruction), "a. i. p." (indeterminable because of the pollen being excessively folded), and finally "a. i. l." (indeterminable because of the pollen being partly concealed under remains of another plant, being filled up with microscopical pyrite crystals, etc.).

Next in the table follow the spores, and finally a group covering *Botryococcus braunii*, microscopical charcoal, and "D. b." (the degree of destruction. This shows the number of common psilate pollen — in casu *Betula* and Gramineae — with destruction marks on the exine, expressed as percentages of the total number of the same species).

A "+" in the table denotes pollen or spores not observed during the counting of the sample, but during the preparation, or later during the revision of the rarer pollen grains, the position of which is always noted. In the case of some spores the number is followed by an asterisk, which denotes that the spore in question was only counted in one or very few slides. The number actually given is extrapolated from this.

As a rule at least 1000 pollen grains were counted in each sample in the A-diagrams, and at least 2000 in the B-diagram.

Table I.

	A I 1	A I 2	A I 3	A I 4	A I 5	A I 6	A I 7	A II 1	A II 2	A II 3	B 1	B 2	B 3
Shrubs and dwarf-shrubs													
Betula nana L.	17	11	494	72	65	185	812	16	15	47	66	55	32
Salix arctophila-type	..	..	..	..	..	..	..	..	..	..	..	..	..
Salix glauca-type	7	48	29	96	167	521	10	16	47	63	35	26	24
Cassiope sp.	..	..	..	..	..	..	..	..	..	..	..	..	..
Empetrum hermaphroditum (LGE.) HAGERUP	21	32	156	144	280	359	167	11	102	276	5	17	14
Ledum palustre L. ssp. *decumbens* (AIT.) HULT.	..	..	792	..	..	..	..	..	14	11	1	2	5
Pirola-type	..	..	..	..	..	..	..	..	..	..	..	..	..
Vaccinium-type	..	..	..	..	..	..	..	..	..	..	..	..	..
Ericales sp.	..	..	4	2	1	1	1	1	3	..	1	1	1
Anemophilous herbs, represented in the part of Greenland													
Artemisia sp.	..	2	..	1	..	..	..	1	6	3	1	2	3
Cyperaceae sp.	..	1	5	539	140	37	6	3	3	12	2	1	..
Gramineae sp.	2150	1950	292	162	841	60	178	710	966	836	1005	3127	3342
Oxyria digyna (L.) HILL	..	..	..	..	..	..	..	..	..	..	..	1	1
Rumex acetosella L. s.l.	..	..	1	1	3	2	..	..	2	2	..	11	6
Oxyria/Rumex acetosella	..	..	..	..	2	..	..	..	2	1	..	2	..
Entomophilous herbs, represented in the part of Greenland													
Campanula sp.	..	..	..	..	1	..	..	..	1	..	..	..	1
Cruciferae sp.	4	4	..	..	..	..	..	207	5	..	..	9	42
cf. *Dryas* sp.	1	..	..	..	..	..	..	..	..	..	..	..	..
Erigeron-type	..	..	..	..	..	..	..	..	..	..	..	..	..
Koenigia islandica L.	..	..	..	..	..	..	..	..	..	..	..	..	..
Montia fontana L. ssp. *fontana* WALTERS	..	..	..	..	..	..	..	..	..	..	..	..	..
Pedicularis sp.	..	..	..	..	1	..	..	..	..	16	..	..	..
Potentilla sp.	..	..	..	..	..	..	..	..	..	..	..	..	..
Polygonum viviparum L.	..	..	..	8	1	1	..	..	1	1	..	..	..
Ranunculus hyperboreus-type	..	..	..	..	..	..	..	..	..	..	..	..	..
Ranunculus lapponicus L.	..	..	..	..	2	1	..	..	23	45	..	..	..
Ranunculus sp.	..	..	..	..	..	..	..	..	..	..	..	..	..
Sagina sp.	..	..	..	..	..	..	..	..	..	..	..	..	..
Silene acaulis/Minuartia rubel.	..	..	..	..	..	..	..	..	..	..	..	..	
Saxifraga cernua-type	..	..	..	..	..	..	..	..	..	..	..	..	2
Saxifraga foliolosa-type	..	..	..	..	..	..	..	..	..	..	..	..	..
Saxifraga nivalis-type	..	..	..	..	..	..	..	..	..	..	..	..	..
Saxifraga oppositifolia-type	..	..	1	2	8	1	1	84	10	13	2	+	1
Stellaria humifusa ROTTB.	..	..	..	..	..	..	..	..	..	..	10	4	4

B 4	B 5	B 6	B 7	B 8	B 9	B 10	B 11	B 12	B 13	B 14	B 15	B 16	B 17	B 18	B 19	B 20	B 21	B 22
36	21	342	1312	16	18	98	32	216	54	273	109	195	344	264	64	203	119	21
..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	2	..	..	3
14	17	49	26	1707	1698	108	6	30	13	68	24	92	272	93	33	101	75	333
..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1
18	9	511	17	11	139	185	118	1170	782	99	50	90	311	139	1092	62	51	12
7	..	126	3	1	1	16	2	52	10	10	..	6	1	1	1	2	6	6
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..
..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
1	2	..	..	1	2	7	1	7	..	..	2	5	..	..	2	..	3	..
1	..	2	..	..	..	3	..	2	..	4	1	..	..	1	2	1	7	9
..	1	6	..	4	41	324	1168	460	12	20	13	6	10	..	43	1158	955	82
2590	2445	1476	889	313	105	954	648	258	1255	1742	1854	1505	1100	2004	924	416	752	1943
1	..	..	..	..	..	..	..	..	..	1	2	..	..	..	..	..	..	1
3	3	2	..	..	..	9	1	2	..	8	11	9	18	..	16	5	4	1
3	..	..	..	..	..	..	..	..	..	1	3	3	2	..	..	..	..	..
..	..	1	..	..	..	..	..	..	..	..	1	..	..	..	..	2	1	..
79	3	..	..	..	..	..	..	..	..	2	..	..	6	..	..	..	..	4
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	2	1	..	..	..	..	..	..	..
..	..	..	..	..	..	11	6	..	..	..	4	..	..	..	..	5	3	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	1	..	1	..	..	..	..
..	..	..	..	6	..	..	..	..	..	..	..	1	..	..	..	..	..	..
..	..	..	..	..	..	1	..	..	..	1	..	..	..	..	..	5	1	..
..	..	..	..	..	..	266	15	7	..	..	7	..	..	..	42	9	7	..
..	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	2	..	1
..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..
1	..	..	..	..	..	..	..	1	..	1	..	..	1	..	..	..	1	1
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..
..	..	..	..	..	..	1	..	..	..	1	..	..	..	..	..	..	..	..
4	2	1	..	1	..	8	1	7	5	7	4	9	11	8	6	5	6	66
1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

(continued)

Table I

	A I 1	A I 2	A I 3	A I 4	A I 5	A I 6	A I 7	A II 1	A II 2	A II 3	B 1	B 2	B 3
Stellaria longipes/Cerastium alpinum	1	5	5	6	86	1	..	64	3	1	2	5	5
Viscaria alpina (L.) G. DON	..	..	..	..	..	..	..	..	..	..	..	+	..
Viscaria/Silene acaulis	..	..	..	..	..	..	..	+	..	1	..	..	..
Long distance transport													
Alnus sp.	..	1	1	1	1	3	1	..	3	..	..	..	4
Chenopodiaceae sp.	..	..	..	..	..	..	..	..	1	..	..	..	..
Corylus sp.	..	..	..	..	..	..	..	..	..	..	..	..	..
Juniperus sp.	..	..	..	..	..	..	..	..	..	..	..	..	1
Picea sp.	..	..	..	..	..	..	..	..	..	..	..	..	..
Pinus sp.	..	..	..	..	$1^1/_2$	1	..	..	..	$2^1/_2$	..	..	1
Ulmus sp.	..	..	..	..	..	..	..	..	..	..	..	..	1
a. i. d.	..	..	6	14	10	7	1	5	10	8	..	..	..
a. i. p.	..	..	1	2	3	5	..	6	3	2	1	2	1
a. i. l.	..	..	..	..	..	..	..	..	..	..	..	..	..
Σ pollen excl. long distance transport	2200	2053	1786	1049	1611	1181	1176	1124	1216	1338	1132	3265	3484
Spores													
Botrychium sp.	..	..	..	..	..	..	..	..	..	..	..	..	..
Dryopteris-type	..	..	..	..	1	..	..	1	2	..	..	+	..
Equisetum sp.	..	29	9	175*	144*	487*	..	..	..	1	..	..	..
Lycopodium annotium L.	..	1	2	3	1	1	..	1	2	2	2	1	3
Lycopodium selago L.	..	..	..	..	..	..	..	1	..	..	..	..	..
Sphagnum sp.	..	5	5	..	2	7	..	..	..	3	..	..	..
Tilletia sphagni	..	..	..	..	..	..	..	..	..	..	..	..	..
Botryococcus braunii KÜTZ.	..	..	..	..	..	..	..	..	..	..	..	..	..
Charcoal	55	19	29	cc	94*	19*	8	cc	183*	142*	r	c	c
Degree of destruction (D.b.)	0	95	28	29	15	60	0.5	14	8.9	8.5	26	0.1	0.1

Determination of pollen

In the following an account of some of the determinations will be given.

Betulaceae

No attempt has been made to determine the sparse pollen of *Alnus* as to species. The Greenland representative of this genus, *Alnus crispa*, is found only in South-West Greenland south of 66° N, and all the pollen

(continued)

B 4	B 5	B 6	B 7	B 8	B 9	B 10	B 11	B 12	B 13	B 14	B 15	B 16	B 17	B 18	B 19	B 20	B 21	B 22
10	90	3	14	7	1	2	2	34	3	11	2	129	25	19	7	25	8	10
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1	1	2	3	..	..	6	6	2	..	2	2	2	1	..	3	5	3	..
..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	1	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	$3\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	1	..	..	$1\frac{1}{2}$	2	$3\frac{1}{2}$	..	+	..	..	1	..	1	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1	..	..	..	3	9	7	..	..	3	1	..	2	3	2	..	..	5	..
5	2	5	..	3	1	..	..	..	..	1	4	1	2	1	..	..	1	..
..	1	2	..	..	..	..	..	1	1	..	1	2	..	1	..	1	..	..
2775	2596	2527	2261	2073	2015	2006	2001	2247	2139	2254	2093	2057	2106	2534	2234	2006	2005	2494
..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	1	..	+	1	1	2	2	..	37	2	1	3	1	3	1	..	..
..	2	..	..	148	4	20	4	10	..	2	1	..	..	..	1	23	1807*	..
..	..	3	..	..	..	3	2	3	..	3	3	3	3	1	1	2	2	..
..	..	1	..	..	..	..	..	1	1	..	1	..	..	..	..	2	..	..
..	..	..	..	..	9	1356	75425*	10911*	..	44	6	..	..	1	10	517	644	13
..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..
c	65	22*	..	31*	6	328*	89	18*	15	210*	248*	65*	..	..	170*	52*	69	18
0.2	1.3	0.5	46	0.6	3.3	0.5	0.1	0	0	1.0	0.3	0.4	1.5	0.7	0	6.9	3.1	0

is therefore taken to be long distance contamination. *Betula nana* is the only birch in this part of Greenland, *B. glandulosa* is found in South Greenland south of 64° N, and *B. pubescens* south of 62°30′ N. No pollen grains were of a size indicating *B. pubescens* (Eneroth 1951, Bryan 1954), whereas an incidental long distance *B. glandulosa* may be included in *B. nana*.

Campanulaceae

Campanula rotundifolia and *C. uniflora* occur in the area, but their pollen could not be differentiated.

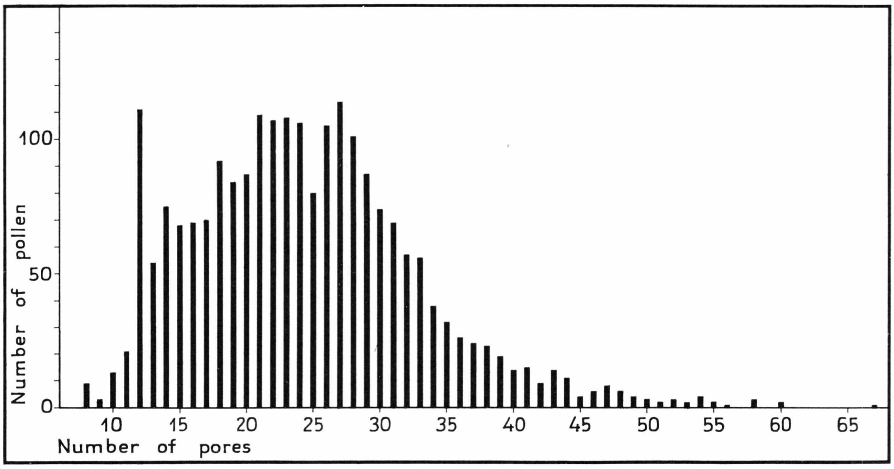

Fig. 4. The number of pores in recent pollen grains of all the investigated species of Caryophyllaceae. This figure is a summation of all the single counts in Plate III.

Caryophyllaceae

The number of pollen grains from this family found in several samples invited an attempt to make determinations as to genera and species. The indigenous flora of Greenland includes 9 genera, represented by 32 species, of which the 6 may be included in *Stellaria longipes* GOLDIE s.l., and the 2 (*Cerastium alpinum* and *C. arcticum*) may be regarded as *C. alpinum* s.l. Pollen of all species except *Cerastium arvense*, found only in one locality in Greenland, has been investigated, making a total of 85 collections, of which 82 originate from Greenland, while one coll. of *Arenaria pseudofrigida* is from Novaja Zemlja, one coll. of *Silene acaulis* from Norway, and the only coll. of *Minuartia rossii* is from Alaska. 2 coll. of *M. rossii* (from Igloolik, N.W.T. and Alaska), 2 coll. of *Stellaria monantha*, and one of *S. calycantha*, all from Greenland, turned out to be without pollen. All indigenous Caryophyllaceae have pollen of the periporate type. It was expected that the pore numbers would be grouped around figures like 8, 12, 16, 18, 24, etc., but apart from a peak at 8, and especially at 12, there was a fairly smooth distribution, as shown in Fig. 4.

In every slide the number of pores has been counted in 25 or more pollen grains, and besides this 50 pollen grains of the species in question, as well as 50 pollen grains of *Corylus* (added to every recent pollen slide as a kind of built-in scale (cf. FÆGRI & IVERSEN 1964)) were measured ($\eth = 1.72\,\mu$, sculpture- and structure measuring with $\eth = 0.80\,\mu$). In a few older slides *Corylus* was not added, and in some older slides the pollen grains were too swollen to be measured. In Plate III the result

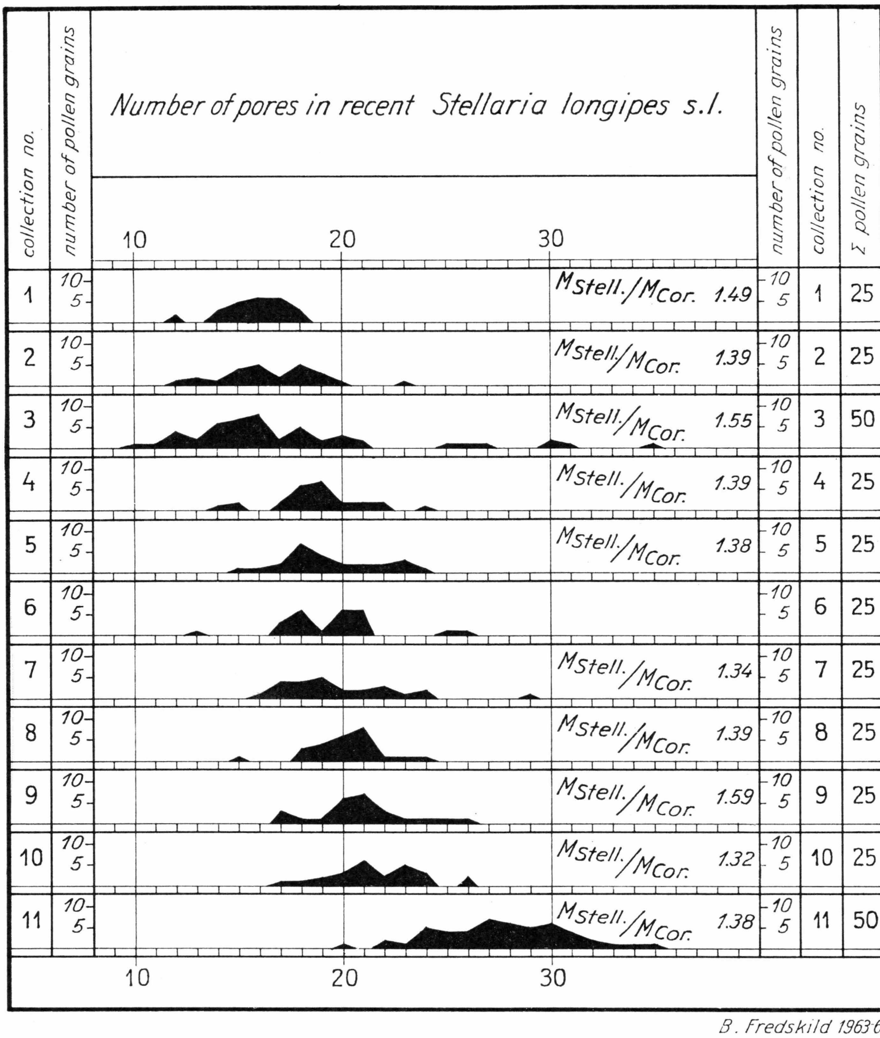

Fig. 5. Number of pores in pollen grains of recent *Stellaria longipes* s. l. The average size of the pollen grains of *Stellaria* in relation to the average size of those of *Corylus* is indicated

of the counting of the number of pores is shown. In all but one case (the rarely flowering *Minuartia rossii*) at least 2 coll. of each species were available. Mostly there were but minor differences from one collection to another of the same species, only within *Stellaria longipes* was the deviation extreme. In all 11 coll. were investigated within this collective species, and the result is given in Fig. 5.

The collections are:

1. *Stellaria monantha.* Godthåb Fjord, Itivnera, leg. B. Fredskild No. 1665, several specimens. 2. *S. monantha.* Sdr. Strømfjord Air-base, C. Vibe 1953. 3. *S. ciliatosepala.*

Danmarkshavn, A. LUNDAGER 1907, one specimen. 4. *S. ciliatosepala.* Jameson Land, ALVIN PEDERSEN No. 37, one specimen. 5. *S. crassipes.* Peary Land, Heilprin Land, B. FREDSKILD No. 2638, several specimens. 6. *S. longipes* s. str. x *S. monantha?*, Egedesminde, GRØNTVED No. 313, one (or two) specimen. 7. *S. longipes* s. str. Tunugdliarfik, Qagssiarssuk, B. FREDSKILD No. 2165. 8. *S. monantha.* Sdr. Strømfjord Air-base, T. W. BÖCHER No. 121. 9. *S. longipes* s. str. Sermermiut, B. FREDSKILD No. 1610. 11. *S. longipes* s. str. Jakobshavn, B. FREDSKILD No. 361, several specimens.

It can be seen that there is no relation to be found between the average pore number and the average size of the pollen grain. (A possible relation between the pore number and the size of a single pollen grain within a single slide has not been investigated).

The size of the pollen grains within Caryophyllaceae can be seen in Plate IV. The average size of 3.720 pollen grains of *Corylus* in glycerol (73 preparations, mainly from the same collection of recent *Corylus*) is 32.27 μ ($\delta = 1.72\,\mu$). As a result of the investigation the following key (see below) is given. Several species can be found in more than one place in the key. A key to some Scandinavian Caryophyllaceae has been presented by CHANDA (1962), and FÆGRI & IVERSEN (1964) has a special key to periporate Caryophyllaceae. MP/MC = the size of the pollen in question in relation to the size of *Corylus*.

Key to the pollen of native Greenlandic Caryophyllaceae

A. Columellae arranged in a reticuloid pattern. Homobrochate, but perforations in tectum of varying size, in the same number as the luminae.

- B. Columellae scattered, few pores (9–21) .... *Minuartia stricta*
- BB. Columellae dense, many pores (20–45)
  - C. Usually 20–30 pores, small grain (MP/MC < 1.0) .... *Viscaria alpina*
  - CC. Usually 25–42 pores, big grain (MP/MC 1.0–1.4)
    - D. Pore 2.0–3.2 μ .... *Melandrium apetalum* ssp. *arcticum*
    - DD. Pore 2.4–6.4 μ .... { *Melandrium affine* / *Melandrium triflorum* }

AA. Columellae not arranged in a reticulum

- E. Columellae dense
  - F. With annulus
    - G. Annulus extremely narrow
      - H. Shape globular, mostly 12–23 pores, spines on tectum very coarse ..... *Minuartia biflora*
      - HH. Shape globular or ± ovoid, many pores

I. Usually 23–38 pores, exine 1.6–2.4 μ, MP/MC ca. 0.9, spines minute .... *Sagina procumbens*

II. Usually 32–67 pores, exine 2.4–3.2 μ, MP/MC ca. 1.2, spines minute .... *Sagina nodosa*

III. Usually 20–40 pores, exine 1.6–2.4 μ, MP/MC 0.8–1.0, spines variable .... *Sagina saginoides*

GG. Annulus distinct, broad

K. Spines distinct, operculum with many small granules, 17–33 pores *Silene acaulis*

KK. Spines distinct or minute, operculum with few, big granulae, 20–32 pores *Honckenya peploides*

(KKK. Spines minute or medium, annulus very broad, 26–45 pores .... *Melandrium triflorum*)

KKKK. Spines minute

10–19 pores .... *Minuartia rossii*

16–29 pores .... *Arenaria pseudofrigida*

18–30 pores .... *Arenaria humifusa*

17–33 pores .... *Minuartia rubella*

20–37 pores .... *Viscaria alpina*

FF. Without annulus

(L. 12–23 pores, shape globular .... *Minuartia biflora*)

LL. 20–60 pores, shape mostly ovoid

M. 20–48 pores, MP/MC 0.8–1.0 ...... *Sagina saginoides*

MM. 24–60 pores, MP/MC > 1.1 .... { *Sagina intermedia* / *Sagina caespitosa* }

EE. Columellae scattered

N. Columellae evenly distributed, 10–17 pores *Minuartia groenlandica*

NN. Columellae unevenly distributed, heterogeneous

O. Shape subpolyedric

P. Annulus narrow, usually 12–18 pores *Cerastium cerastoides*

PP. Annulus broad, usually 15–22 pores *Cerastium regelii*

OO. Shape globular

8–13 pores, pore diameter 4.0–4.8 μ, annulus broad, MP/MC ca. 1.0 .... *Stellaria humifusa*

9–21 pores, pore 3.2–4.8 μ, annulus lacking or very small, spines medium or minute, operculum with numerous small granules, MP/MC 0.9–1.0 .... *Minuartia stricta*

10–17 (24) pores, pore 4.0–5.6 μ, operculum with 5–8 big granules, spines minute, MP/MC 1.0–1.2 .... *Minuartia groenlandica*

10–35 pores, pore 3.2–9.7 μ, MP/MC 1.3–1.6 .... *Stellaria longipes* s.l.

(11–23 pores, pore 4.8–6.4μ, annulus small	*Cerastium cerastoides*)
16–26 pores, pore 4.0–5.6μ, operculum with numerous small granules, MP/MC 1.2–1.3	*Stellaria calycantha*
19–34 pores, pore 4.0–5.6μ, operculum with many big granules, and, in between, with small granules, MP/MC 1.3–1.5 . . .	*Cerastium alpinum*
19–40 pores, pore 4.8–6.4μ, operculum with many big granules, usually with small granules in between, MP/MC ca. 1.6	*Cerastium arcticum*
20–34 pores, pore 4.8–6.4μ, MP/MC ca. 1.4	*Cerastium fontanum* ssp. *scandicum*

In the subfossil samples one pollen grain of a *Sagina* was found (B 14), too badly preserved for a closer determination, whereas the 19 *Stellaria humifusa* in the lowermost 4 samples of profile B were unmistakable. One pollen grain of *Viscaria alpina* (B 2) is fairly reliable, whereas 3 badly preserved ones (A II 1, A II 3, and B 6) are either *Viscaria* or *Silene acaulis* (length of spines intermediate), and one pollen grain (B 20) is either *Viscaria* or *Minuartia rubella*. 587 pollen grains of the *Stellaria longipes – Cerastium alpinum* type were found. When possible the number of pores was counted in the subfossil pollen grains, and in Pl. V the result is given, each sample separately, and underneath, for comparison, are given the curves from Pl. III for the pore number in recent *S. longipes*, *Cerastium alpinum* and *C. arcticum*. 53 pollen grains in A II originate mainly, if not exclusively, from *Stellaria longipes* (cf. No. 11 in Fig. 5, collected 1 km from Sermermiut), though the possibility cannot be excluded that a few may be *Cerastium*. 61 pollen grains in A I, 5 must all be *Stellaria longipes*, as must the 114 in B 16, and most other samples also contain *Stellaria*. *Cerastium* seems, on the other hand, to be represented among the 56 pollen grains in B 5, and the single pollen grain in B 1, as well as several of the pollen grains in B 17, 18, 19, 20, and 22 are most likely *Cerastium* as well.

Chenopodiaceae

2 pollen grains (A II, 2 and B 10) must be attributed to long-distance transport, as this family, represented by *Atriplex*, is in Greenland restricted to the Tasermiut-fjord in the south, and to Godthåb Fjord (IVERSEN 1954, p. 88).

Compositae

2 pollen grains are referred to *Erigeron*-type (including *Erigeron* and *Gnaphalium*). 52 *Artemisia* grains were found. *Artemisia* was not found in the area investigated by the author (map in FREDSKILD 1961, p. 7),

nor was there any collection of it from this vicinity at the Botanical Museum in Copenhagen, but Porsild (1920, p. 152) mentions it as being common on the mainland from Nûgssuaq peninsula southwards, and it is also indicated on the distribution map in Böcher (1951, p. 385). It grows on dry sandy or gravelly slopes, and, apart from the lowermost samples in the profiles, it has probably not been growing on the spot, but the pollen must have been transported here from some distance.

Cruciferae

Far from all Greenlandic species produce pollen of the well-known Cruciferous-type (tricolpate, per-reticulate, polar area small). Yet the following species belong to this type (If nothing else is stated the collections are from Greenland): *Arabis alpina* (2 coll.), *A. arenicola* (2 coll.), *Cardamine bellidifolia* (1 coll.), *Cochlearia groenlandica* (2 coll.), *Draba aurea* (2 coll.), *D. hirta* (2 coll.), *D. nivalis* (1 coll.), and *Halimolobus mollis* (1 coll. with extremely small grains). *Subularia aquatica* is tricolpate, operculate (1 coll.).

Tricolpate or pericolpate are: *Braya nova-angliae* (in the only collection there were as many tricolpate as pericolpate grains), *Braya thorild-wulffii* (one coll. with only tricolpate, another with both types), *Draba arctogena* (one coll. with as many tricolpate as pericolpate), *D. lactea* (one coll. with only tricolpate, another with as many tricolpate as pericolpate).

Pericolpate pollen grains only were met in: *Arabis holboellii* (1 coll.), *Braya linearis* (1 coll.), *B. purpurascens* (2 coll.), *Draba bellii* (1 coll.), *Lesquerella* (1 coll., with extremely large grains, very often more or less stephanocolpate with 6 (5–7) colpes, but then usually with a very short colpe in one or both polar areas; the thickness of the exine is varying, thinning out towards the colpe, but still with the same size of brochi), and *Rorippa islandica* (1 coll. from Greenland with only pericolpate grains, another from Denmark with both types).

The pollen grains of *Eutrema edwardsii* (2 coll. from Greenland, 1 from Canada) deviate from the other Cruciferae pollen. In the two coll. (from Greenland) the grains are without normal apertures. It happens, though, that 2–3 adjoining brochi are torn, this possibly indicating the aperture. In the third coll. (from Canada) the major part of the pollen grain is more or less pericolpate, but transitional types, ranging from this to the almost inaperturate type, are common. The size of brochi varies widely from grain to grain. Finally were 2 coll. of the collective species *Cardamine pratensis* more or less abnormal, the pollen grains varying between (a very few) tricolpate pollen with a "normal" reticulum, to tri- or pericolpate pollen with a very thick exine, built up by the fusing muri without typical columellae, often more or less frustillate and fossulate, gemmate, verrucate or even clavate.

Because of this incomplete reference material and the great variations in the pollen grains, even within the same slide, it has not been possible to determine the subfossil grains. It can however be said that all the pollen found belonged to the "normal" Cruciferous type. The maxima in the lowermost parts of the diagrams do not seem to be caused by *Cochlearia* as one might have been expected of Cruciferae growing together with *Stellaria humifusa* and *Elymus.*

Cyperaceae

Usually the thin-walled Cyperaceae pollen grains were very crumpled, but even in samples with well preserved pollen grains, as for example the upper Cyperaceae maximum in profile B, a closer determination was impossible, as the diagnostic distinguishing characters, given in the special key in FÆGRI & IVERSEN (1964, p. 195) within the *Carex* type (length of lateral lacunae 20–35 per cent of that of the grain in *Carex*, 30–50 per cent in *Eriophorum*) were not applicable to the reference material from Greenland (3 species of *Eriophorum* (4 coll.), 13 *Carex* (14 coll.), one *Scirpus* and one *Eleocharis*). The lateral lacunae in the *Eriophorum* pollen were af the same length as in the *Carex* pollen.

Ericales

(including Empetraceae, Ericaceae and Pirolaceae).

The subfossil pollen grains have been determined to the following species or types: *Empetrum hermaphroditum*, *Cassiope*-type, *Ledum palustre* ssp. *decumbens*, *Vaccinium*-type and *Pirola*-type. Badly conserved grains have been included in Ericales sp.

Empetrum hermaphroditum

The big tetrad with 3–4(–5) colpate single grains and short irregular colpes without costae, and with a thick endexine is fairly well defined. Reference material from Greenland consisted of 5 coll. as well as a slide prepared from subfossil stamens in a bud, found in sample No. B m 3.

Cassiope-type

Small thin-walled, more or less triangular tetrad with very long colpes. Psilate, with costae colpi, but no transversal furrow. This type is represented by *Cassiope tetragona* (2 coll.) and *Harrimanella hypnoides* (2 coll.), both common in the area today.

Ledum palustre ssp. *decumbens*

Medium-sized, regular, rounded-triangular thick-walled tetrad with medium to long colpes. The colpe straight, often open, bordered by heavy costae colpi, and with a short transversal furrow at the transition from one grain to the next (4 coll.). *Ledum groenlandicum*, a more oceanic species occurring in South-West Greenland with its northern limit south of 68° N (Böcher 1952, map p. 34) has similar grains (2 coll.). The grains of *Loiseleuria procumbens* are rather similar, but the tetrad is not triangular, the individual pollen grain being more rounded (1 coll.).

Vaccinium-type

Big tetrad, each grain globular and with long colpe without or with only slight costae colpi. The exine thin, psilate, fossulate. A hint of a transversal furrow just observable. *V. vitis-idaea* ssp. *minus* (1 coll.), *V. uliginosum* ssp. *microphyllum* (1 coll.) and *Oxycoccus quadripetalus* var. *microphyllus* (1 coll.) have pollen grains of this type. *Oxycoccus* does not occur in the area.

Pirola-type

Each grain in the tetrad globular. Colpes of medium length. Endexine thin, ectexine thick, scabrate. The edge of the colpe indistinct and irregular without costae and transversal furrow. *P. grandiflora* (3 coll.), *P. minor* (1 coll.) and *Phyllodoce coerulea* (3 coll.) are of this type. The pollen grains of *Ramischia secunda* are not united in tetrads. *Pirola grandiflora* is the only representative in the area.

Rhododendron lapponicum

Big tetrad with globular grains. The ectexine is thick with very distinct columellae. The colpes short to medium with distinct costae and transversal furrow (2 coll.). No subfossil pollen of this type was recorded.

Andromeda polifolia and *Arctostaphylos uva-ursi* do not occur in the area, and, apart from a single occurrence on Nûgssuaq and two on Disko, nor is *Arctostaphylos alpina* found so far north on the west coast. Reference material from Greenland of the last 3 species was insufficient for an accurate description.

Gramineae

During the working out of the diagrams no distinction was made at all within Gramineae, though it was observed that in some samples the grass pollen were very big.

After finishing the counting of the subfossil samples Greenlandic reference material of 25 species has been investigated. *Elymus mollis* is easily distinguished from the others morphologically because of the regularly scattered punctae, the other genera showing maculae with more or less visible punctae. *Elymus mollis* has, apart from this, very big grains, as shown by the only measured coll. from Greenland:

M_{length} = 55.15 μ (39.7–67.2), $M_{breadth}$ = 49.53 μ (37.9–63.8), M = 52.34 μ, $M_{Corylus}$ = 30.83 μ, $M_{Elymus}/M_{Corylus}$ = 1.80. The other genera found in the area all have pollen of the *Festuca*-type (*Agrostis borealis*, *Alopecurus alpinus*, *Calamagrostis neglecta*, *Hierochloë alpina*, *Phippsia algida*, *Poa alpina*, *P. arctica*, *P. glauca*, *P. pratensis*, *Puccinellia vaginata* and *Trisetum spicatum* have been investigated). The only species with somewhat deviating pollen is *Alopecurus alpinus*, having big grains with maculae, usually with very distinct punctae. The size in 3 coll. are:

	M_{length}	$M_{breadth}$	M	$M_{Corylus}$	$M_{Alopec.}/M_{Cor.}$
1.	50.82 μ (41.1–62.1)	48.41 μ (41.4–58.6)	49.62 μ	34.36 μ	1.44
2.	52.97 μ (37.9–65.5)	50.55 μ (37.9–62.1)	51.86 μ	38.08 μ	1.36
3.	42.86 μ (34.5–57.9)	38.59 μ (32.6–48.3)	40.73 μ	30.53 μ	1.33

100 *Alopecurus* and 100 *Corylus* were measured in each sample (δ = 1.72 μ).

In order to solve the problem of what species were responsible for the distinct graminé maxima in the pollen diagrams, an examination was made of the first 25 Gramineae pollen grains met with in the samples in question with phase contrast equipment with xenon bulb:

Sample No.	*Elymus mollis*	*Alopecurus alpinus*	*Festuca*-type
Profile AI No. 3 ...	0	18	7
— — 2 ...	0	8	17
— — 1 ...	0	1	24
Profile AII No. 5 ...	0	12	13
— — 2 ...	0	6	19
— — 1 ...	1	6	18
Profile B No. 22 ...	0	12	13
— — 15 ...	0	23	2
— — 13 ...	0	14	11
— — 6 ...	1	4	20
— — 5 ...	0	15	10
— — 4 ...	6	10	9
— — 3 ...	22	2	1
— — 2 ...	23	2	0
— — 1 ...	24	1	0

It must be emphasized, however, that while the determination of *Elymus* is fully reliable, the distinction between *Alopecurus alpinus* and the *Festuca*-type is less certain, being mainly based on the size of the often very crumpled pollen grains.

Polygonaceae

While the determination of subfossil pollen of *Koenigia* and *Polygonum viviparum* causes no difficulties, the distinction between *Rumex* *acetosella* and *Oxyria digyna* in badly preserved material can be very difficult. The reference material from Greenland consisted of 7 coll. of *R. acetosella* (incl. *R. tenuifolius*), 8 of *Oxyria* and one of *Rumex acetosa* ssp. *lapponicus*, the latter occurring in the southernmost part of Greenland only. The morphological variation is very great, yet the distinguishing characteristics mentioned in FÆGRI & IVERSEN (1964) as a rule apply (*Oxyria* tricolporate, tectate, psilate, *R. acetosa*-type tricolporate or pericolporate, semitectate, per-reticulate). 7 pollen grains were determined to *Oxyria*, 120 to *R. acetosella* (30 being tricolporate, 20 4-colporate, while in the remainder the number could not be counted). 19 pollen grains were listed as being either *Oxyria* or *R. acetosella*.

Ranunculaceae

In the area this family is represented by *Ranunculus confervoides*, *R. reptans*, *R. hyperboreus*, *R. lapponicus* and *R. pygmaeus*. The subfossil grains all belong to one main type, including the three latter species, which is characterized morphologically by being totally (or practically) without the circular thickenings of the tectum on top of the coarse columellae, and without the light ring. Generally speaking *R. lapponicus* has very coarse and scattered columellae (apart from minute ones in between), each having on top of the tectum a very distinct spine, visible in optical section, whereas in *R. hyperboreus*-type (including *R. pygmaeus*) the coarse columellae are finer and more dense, and the spines are delicate and almost imperceptible. Some few grains were very badly preserved, and are listed as *Ranunculus* sp.

Salicaceae

5 species of *Salix* only are found in Greenland: *S. arctica*, *S. uva-ursi*, *S. herbacea*, *S. glauca*, and *S. arctophila*, of which only the latter three occur within the area. Morphologically there is great variation within the pollen grains, but two types could be distinguished: *Salix herbacea*-type and *S. glauca*-type. It must be emphasized, however, that within reference slides of *S. herbacea* a few pollen grains of *S. glauca*-type can be met with, and vice versa.

Salix herbacea-type

Characterized by FÆGRI & IVERSEN (1964): "sculpturing ± irregular, muri with pronounced knot-like thickenings, columellae indistinct". Besides *S. herbacea* (3 coll. from Greenland) *S. arctophila* (3 coll.) partly belongs to this type, partly to the following.

Salix glauca-type

has regular sculpturing and comprises *S. glauca* (7 coll.), *S. arctica* (1 coll.), and *S. uva-ursi* (1 coll.). The variation within the 7 collections of *S. glauca* is very great. Very often the grains are heterobrochat, and this species should therefore not be used as an example of the homobrochate Salices (Fægri & Iversen l.c.).

Saxifragaceae

The pollen can be arranged in 4 types, partly described in Fægri & Iversen (1964, pp. 176–178, 181). A quite comprehensive reference material, mainly from Greenland, has shown the great variation, even within a single species. While for example *Saxifraga oppositifolia*-type and *S. foliolosa*-type have been found with tricolpate pollen grains only, collections of the two other types with mainly or exclusively tricolpate grains alternate with collections (of the same species) with mainly or exclusively pericolpate grains and with collections containing both types. The same can be said about other distinguishing characteristics.

Saxifraga oppositifolia-type

Tricolpate. Distinctly striate, vallae usually meridional on one or two intercolpi, but transverse on the third. This type is found in *S. oppositifolia* (4 coll. from Greenland), *S. tricuspidata* (3 coll.), *S. aizoon* (4 coll. plus 1 from Spain), *S. aizoides* (3 coll. plus 1 from Switzerland).

Saxifraga cernua-type

Tri- or pericolpate. Scabrate-rugulate-shortly striate, often perfossulate. Tectum with spines ranging in size from almost imperceptible to very coarse. Columellae uniform, coarse, scattered. The colpe membrane covered by granulae of varying size, often as coarse as the very thick tectum, sometimes distinctly operculate, now and then without any clearly marked colpi. This type (in Fægri & Iversen termed *S. hirculus*-type) includes *S. cernua* (2 coll. plus 1 from Iceland), *S. caespitosa* s.l. (4 coll.), *S. rivularis* (3 coll.), *S. hyperborea* (1 coll.), *S. hirculus* (1 coll. from Iceland, 1 from Switzerland), and *S. flagellaris* ssp. *platysepala* (1 coll.).

Saxifraga nivalis-type

Tri- or pericolpate, micro per-reticulate. In some grains the reticulum is almost fused to a psilate tectum, carried by evenly distributed columellae. As a rule the columellae are invisible except in the phase-contrast microscope with xenon bulb. They are arranged in several rows in muri. In some grains the breadth of muri is bigger than the diameter of the lumen. A margo is rarely indicated. The colpe with or without equatorial constriction. This type includes *S. nivalis* (2 coll.) and *S. tenuis* (2 coll.).

Saxifraga foliolosa-type

Tricolpate. Reticulate-micro reticulate, size of lumen up to 1.5 μ, homobrochate. Single, low columellae in lumen. Several rows of columellae in muri. With a usually narrow margo, and equatorial constriction. The pollen of this type often resembles *Salix*. It includes *S. foliolosa* (5 coll.) and *S. stellaris* (1 coll. plus 1 from Sweden and 1 from Norway).

Scrophulariaceae

The delicate grain of *Pedicularis* is usually syncolpate with two furrows fused to a ring. This is the case with *P. lapponicus* (2 coll.), *P. labradorica* (2 coll.), *P. hirsuta* (2 coll.), and *P. lanata* (1 coll.), while *P. flammea* (2 coll.) has three furrows arranged as in a tricolpate grain, but fused at the poles. The 17 pollen grains found (A I No. 5 and A II No. 3) all belonged to the first type.

MACROFOSSILS

In section A some samples were taken in 1953 by J. MELDGAARD. The position is shown in Fig. 3, which is based on the same photograph as Fig. 6 in MELDGAARD (1958). No radiocarbon samples were taken from Section A.

The samples in Profile B intended for macrofossil analysis and radiocarbon dating were taken in 1955 by SVEND JØRGENSEN and J. TROELS-SMITH. After returning to Copenhagen the samples were divided vertically, the one half being dried and the other half stored in containers filled with a preservative (18 parts 60 per cent alcohol, 1 part formalin, and 1 part acetic acid conc.). Unfortunately the samples are not of the same volume, and the content of macrofossils can thus not be compared. It would also have been an advantage if the height of the samples had been less, in which case minor changes in the plant succession would have been reflected as is the case in the pollen diagram.

The macrofossil samples were placed in diluted nitric acid to make the samples fall apart, and were later washed on a fine-meshed sieve (openings 0.4 × 0.4 mm). Seeds, fruits, leaves and other determinable plant fragments, as well as small insects, puparies, etc. were picked away. The results are listed in Table II. It must be emphasized, that the depth of the permafrost table highly influences the preservation of, for example fruits of grasses, and it was not to be expected that one would find grass-fruits in the lowermost samples. All finds are stored at the National Museum.

A small portion of the uppermost 8 samples were taken for moss analysis before washing, and in the samples poor in mosses every piece of moss was collected for a determination undertaken by KJELD HOLMEN in 1960–61.

The results were as follows:

B m 10: *Sphagnum squarrosum*
B m 9: *Aulacomnium palustre*
Calliergon stramineum
Dicranum sp.
Polytrichum juniperinum, presumably var. *strictum*

Table II.

	A I m 1	A I m 2	A I m 3	A I m 4	A I m 5	A II m 1	A II m 2	B m 1	B m 2	B m 3	B m 4	B m 5	B m 6	B m 7	B m 8	B m 9	B m 10
Seeds																	
Betula nana L.	..	..	..	..	53	..	..	..	..	23	..	..	..	1	8	3	..
Empetrum hermaphroditum (Lge.) Hagerup	111	416	110	1397	96	119	562	11	110	521	266	126	22	313	355	94	4
Alopecurus alpinus Sm.	..	..	..	..	38	..	2	..	..	..	..	..	..	14	86	131	12
Poa glauca Vahl coll.	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
Poa sp.	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Gramineae sp.	..	1	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
Potentilla sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..
Caryophyllaceae sp.	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..
Cerastium alpinum L. s.l.	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Cruciferae sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	1	3	1	..
Luzula sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..
Eriphorum angustifolium Honck.	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..
Carex bigelowii Torr. coll.	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..
Carex rariflora (Wbg.) Sm.	..	..	..	..	..	..	..	..	..	..	..	..	6	1	..	..	..
Carex lachenalii Schk.	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..
Carex sp.	..	1	..	..	..	..	17	..	..	..	..	..	4	..	4	..	..
Ranunculus hyperboreus Rottb.	..	..	..	..	..	..	..	..	..	..	..	..	20	3	3	..	11
Ranunculus lapponicus L.	..	..	..	..	..	..	17	..	..	..	..	..	7	..	1	2	..
Montia fontana L. ssp. *fontana* Walters	..	..	..	..	..	..	..	..	...	..	..	..	38	..	..	..	..
Other macrofossils																	
Sphagnum	..	..	..	..	..	..	..	+	+	+	..	..	+	+	+	..	+
Bryophyta	..	..	..	..	+	..	+	..	..	..	..	..	..	+	+	+	..
Charcoal	+	..	2	+	1	+	..	..	15	..	..	..	..	..	+	1	..
Empetrum leaves	..	..	..	+	c	8	..	..	..	+	..	+	..	1	130	22	..
Betula leaves	..	..	..	..	+	..	..	..	..	..	..	..	+	..	..	+	..
Betula scales	..	..	..	..	2	..	..	..	..	..	..	..	..	..	4	2	..
Salix leaves	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..
Vaccinium microphyllum leaves	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..
Cenococcum geophilum Fr., sclerotia	..	..	c	c	..	+	..	..	..	..	..	cc	1	..	2	..	..

B m 8: *Aulacomnium turgidum*
Calliergon trifarium
Calliergon turgescens
Dicranum elongatum
Drepanocladus exannulatus
Meesia uliginosa
Sphagnum squarrosum
B m 7: *Dicranum elongatum*
Sphagnum balticum
B m 6: *Sphagnum squarrosum*
Sphagnum? teres, sporadic
B m 5: *No mosses*
B m 4: *No mosses*
B m 3: One tiny piece of *Sphagnum squarrosum*
B m 2: *Sphagnum squarrosum*
B m 1: One tiny pice of *Sphagnum squarrosum*

In B m 10 *Sphagnum* constituted almost 100 per cent of the sample, in B m 6 about 75 per cent, while the amount of mosses in no other sample exceeded 1 per cent.

Calliergon turgescens, *Meesia uliginosa* and *Polytrichum juniperinum* were not included in the collections brought home by the author in 1957 (FREDSKILD 1961, pp. 13–15). All three species are frequent in the Disko Bugt area (K. HOLMEN, verbal information).

The insects and mites from the profile have been investigated by NIELS HAARLØV (in prep.), and LISE HANSEN has been kind enough to determine the sclerotia of *Cenococcum geophilum* FR.

RECENT POLLEN SEDIMENTATION

As shown by the enormous fluctuations in the curves of the pollen diagrams the spectra are characterized by the local vegetation, and in order to elucidate this problem some recent moss samples were treated in the same way as the subfossil samples had been treated, and were analyzed. Unfortunately the samples had not been taken in the field, but, years later, were taken from the peat-brick-like samples taken for soil analysis, still covered by the green mosses etc., or from special moss- or lichen samples taken for the herbarium. This proceeding is of course unsatisfactory, but these particular analyses seem to give information valuable enough to justify publication. References in [] refer to numbers, pages, or figures in FREDSKILD (1961).

In the small tables on the following pages the figure in the column before the Latin name denotes the degree of cover of the Hult-Sernander scale ($5 = {}^1/_1 - {}^1/_2$, $4 = {}^1/_2 - {}^1/_4$, $3 = {}^1/_4 - {}^1/_8$, $2 = {}^1/_8 - {}^1/_{16}$, $1 < {}^1/_{16}$, + = single). The figure in the column following the Latin name denotes the percentage of the species (genus, family or type) found in the recent moss sample from the square in question.

Table III. Willow scrub completely covering the ground, with just a few straws of *Festuca rubra* s.l. and *Poa arctica* [V, 3] at the foot of the sun-exposed slope of the Sermermiut valley (cf. Fig. 1).

	Betula nana	0.03	1	*Cerastium arcticum*	.
5	*Salix glauca* ....type	99.6	+	*Draba nivalis*	.
1	*Festuca rubra* s.l.	.	1	*Polygonum viviparum*	.
1	*Poa arctica*	.	1	*Stellaria monantha*	.
	.... Gramineae	0.4		Σ pollen	3209
	Cyperaceae	0.03			

Table IV. Willow scrub. Open, low willow scrub on south-exposed shelves [V, 2], cf. Fig. 1.

	Betula nana	5.8	1	*Potentilla tridentata*	
5	*Salix glauca* ... type	21		... *Potentilla*	3.3
	Empetrum hermaphroditum	1.2		*Rumex acetosella*	0.4
	Ericales	3.7	2 +	*Saxifraga tricuspidata* (*incl. in*)	
1	*Poa arctica*			... *S. opposit.*-type	34
1	*Poa glauca*		1	*Stellaria longipes*	
	... Gramineae	25		... *Stell.-Cerast.*-type	2.1
	Cyperaceae	2.1		*Viscaria alpina*	0.4
	Cruciferae	0.8		*Assulina*	0.4
+	*Campanula rotundifolia*			*Ambrosia*	0.4
	... *Campanula*	0.4		Σ pollen	243

Table V. Mossy grass community, [III, 1], entirely uniform, covering the major part of the horizontal, rather well-drained valley bottom with the many Neo-Eskimo ruins, cf. Fig. 1.

	Betula nana	1.8	+	*Draba hirta* ... type	0.1
	Salix glauca-type	2.5		*Rumex acetosella*	0.1
(+)	*Empetrum hermaphroditum*	3.3		*Saxifraga opposit.*-type	0.3
	Ledum decumbens	0.2	1	*Stellaria longipes*	
(+)	*Vaccinium microphyllum*			... *Stell.-Cerast.*-type	1.1
	... *Vaccinium*-type	0.1		*Viscaria alpina*	0.1
	... Ericales	0.6		*Viscaria/Silene acaulis*	0.1
5	*Alopecurus alpinus*			*Equisetum*	0.1
5	*Poa arctica*			Charcoal	c
	... Gramineae	89		*Artemisia*	0.1
	Cyperaceae	0.3		Σ pollen	1137
	Campanula	0.1			

Table VI. Moss-carpet with *Poa arctica* and *Luzula confusa* [III, 3] on small shelves on steep, north facing slope, cf. Fig. 1.

	Betula nana	1.3		*Oxyria digyna*	0.1
	Salix glauca-type	1.8		*Rumex acetosella*	0.1
	Empetrum hermaphroditum	0.7		*Saxifraga opposit.*-type	0.2
	Ledum decumbens	0.1		*Stellaria-Cerast.*-type	0.3
5	*Poa arctica* ... Gramineae	94		*Lycopodium selago*	0.1
	Cyperaceae	0.9		*Sphagnum*	0.1
2	*Luzula confusa* ... Juncaceae	0.1		*Assulina*	14
				Artemisia	0.1
				Σ pollen	1110

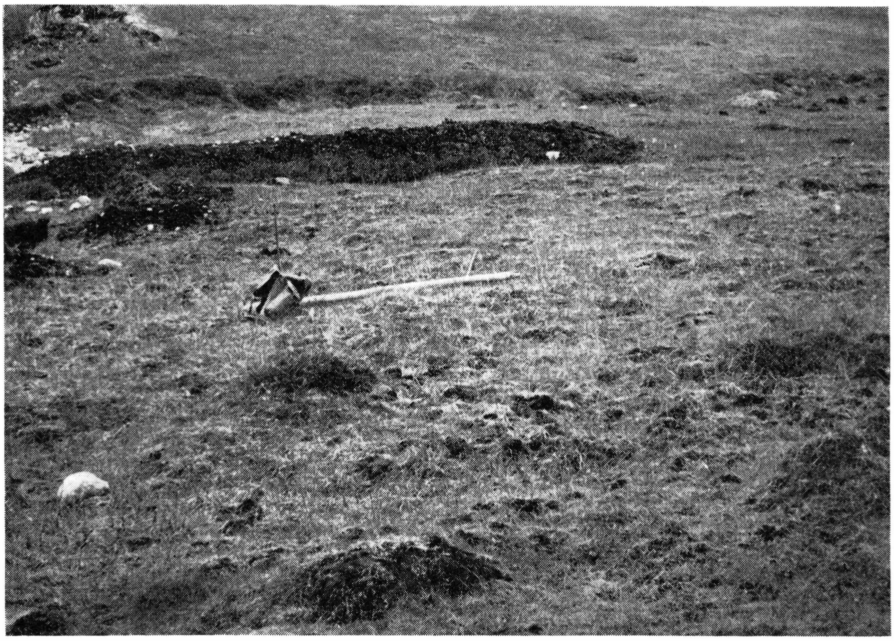

Fig. 6. The present vegetation at Sermermiut B, seen towards the NE with the brooklet in the background. B. F. phot.

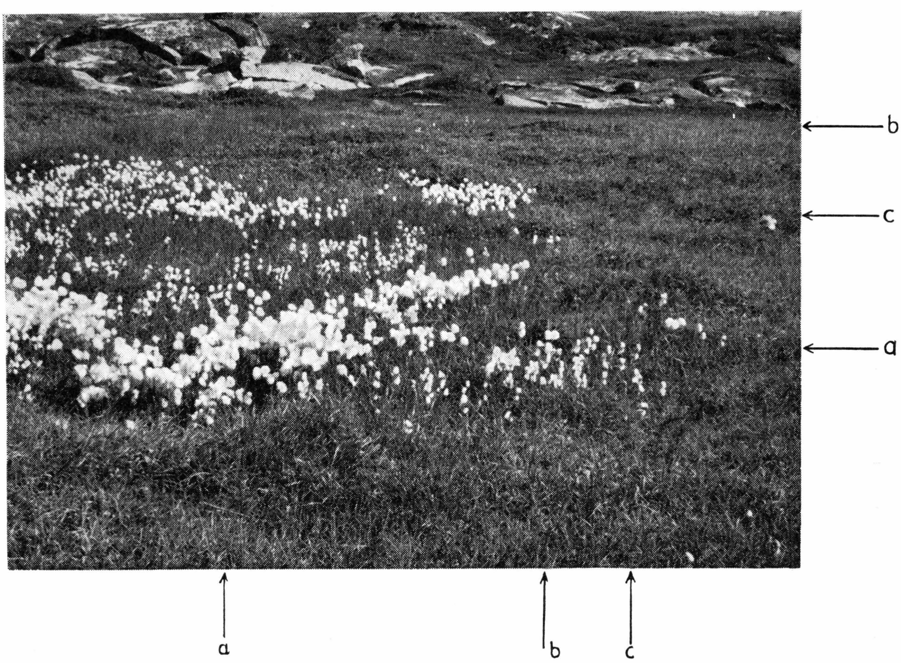

Fig. 7. *Eriophorum scheuchzeri-E. angustifolium* marsh surrounded by moss-rich dward-shrub heaths in the valley between Jakobshavn and Sermermiut. a–a shows the position of the recent pollen sample from the march [VII,2], b–b from the moss-rich dwarf-shrub heath [III,4] and c–c from the moist dwarf-shrub heath [III,5]. B. F. phot.

Table VII. Moss-rich community with Empetrum and grasses [III, 2], covering the southernmost part of the Sermermiut-valley, cf. Fig. 1 and 6.

	Betula nana	1.6	1.5	1	Cyperaceae	0.8	0.4
	Salix glauca-type	5.7	0.8		*Potentilla*	0.3	.
4+	*Empetrum hermaphrod.*	16	34		*Rumex acetosella*	0.1	.
1	*Ledum decumbens*	0.2	0.2		*Saxifraga opp.*-type	0.1	.
1	*Vaccinium microphyll.*				*Stell.-Cerast.*-type	.	0.1
	Ericales	0.3	.	1	*Sphagnum*	.	0.1
1	*Alopecurus alpinus*				*Assulina*	0.2	2.5
2	*Poa arctica*	.	.		Chenopodiceae	.	0.1
	Gramineae	74	62		*Pinus*	0.1	.
					Σ pollen	1086	1100

Table VIII. Moss-rich dwarf-shrub heath [III, 4], just a few metres from a more moist dwarf-shrub heath with i.a. *Ranunculus lapponicus* [III, 5], and from an *Eriophorum*-march [VII, 2], cf. Fig. 7.

3	*Betula nana*	36	35	1	*Carex bigelowii*		
4	*Salix glauca* type	7.6	9.5		Cyperaceae	9.7	10
	Empetrum hermaphrod.	1.7	5.4	1	*Pedicularis hirsuta*	0.3	0.2
	Ledum decumbens	0.3	.	+	*Pedicularis lapp.*		
2	*Pirola grandiflora*			2	*Polygonum viviparum*	.	.
	Pirola-type	28	.	+	*Stell.* cf. *monantha*	.	.
1	*Vaccinium microph.*			1	*Equisetum*	.	.
	Vaccinium-type	2.1	.		*Lycopodium selago*	0.7	.
	Ericales	1.7	3.0		*Sphagnum*	0.3	.
1	*Poa arctica* .. Gramineae	12	37		*Assulina*	13	0.9
					Σ pollen	290	223

Table IX. Moist dwarf-shrub heath [III, 5] cf. the just mentioned heath [III, 4] and Fig. 7.

3	*Betula nana*	33		*Campanula*	0.2
5	*Salix glauca*		1	*Pedicularis hirsuta* type	2.1
2	*Salix arctophila*		1	*Polygonum viviparum*	0.4
	± incl. in *Salix glauca*-type	16		*Potentilla*	0.1
	± incl. in *S. herbacea*-type	0.1	2	*Ranunculus lapponicus*	3.1
	Empetrum hermaphroditum	2.3		*Rumex acetosella*	0.1
	Ledum decumbens	0.1	1	*Stell.* cf. *monantha*	
4	*Vaccinium microphyllum*		2	*Equisetum arvense* type	0.2
	Vaccinium-type	8.7		*Sphagnum*	0.7
	Ericales	0.3		*Assulina*	2.4
1	*Alopecurus alpinus*			*Ambrosia*	0.1
1	*Poa arctica*			*Artemisia*	0.1
	Gramineae	21		*Σ* pollen	1000
3	*Carex bigelowii* ... Cyperaceae	12			

Table X. *Salix arctophila*-marsh [VII, 3], on one side bordered by similar vegetations and bedrock, on the other side by a *Carex saxatilis*-marsh.

	Betula nana	28		*Saxifraga opposit.*-type	0.2
4	*Salix arctophila*....... ± incl.			*Stell.-Cerast.*-type	0.2
	in......... *Salix glauca*-type	12		*Dryopteris*-type	0.2
	Empetrum hermaphroditum ...	7.3		*Equisetum*..................	0.6
	Ledum decumbens	0.7		*Lycopodium annotinum*	0.1
	Ericales....................	1.8		*Lycopodium selago*...........	0.7
1	*Poa arctica* .... Gramineae	22		*Sphagnum*..................	0.1
3+	*Carex bigelowii*..............			*Botryococcus*	0.1
1	*Carex saxatilis*			*Assulina*	106
	.... Cyperaceae	26		*Abies*	0.1
1	*Polygonum viviparum*........			*Alnus*	0.3
	Oxyria digyna	0.2		*Archangelica*-type	0.1
	Rumex acetosella	0.3		*Artemisia*	0.8
	Oxyria/Rumex acetosella	0.0		*Pinus*	0.1
	Saxifraga cernua-type	0.1		Σ pollen	1320

Table XI. Moss-rich dwarf-shrub heath [VII, 7], surrounded by marshes, cf. the two following examples. The first of the two samples consists of fresh mosses, while the second is loose, brownish material underneath the moss-cushions.

4	*Betula nana*	14	7.5	1	*Polygonum viviparum*...	0.2	.
2	*Salix arctophila* ...... ±				*Rumex acetosella*	0.2	.
	incl. in *S. glauca*-type ...	22	5.4		*Saxifraga oppos.*-type...	.	0.2
3	*Empetrum hermaph.*	3.6	10		*Stell.-Cerast.*-type	.	0.1
1	*Ledum decumbens*	1.5	0.7		*Lycopodium annotinum*..	.	0.1
3	*Vaccinium microph.*				*Lycopodium selago*......	0.2	0.7
	.... *Vaccinium*-type	6.4	40	1	*Sphagnum nemoreum* . }	0.2	0.1
	.... Ericales	2.2	0.7	+	*Sphagnum rubellum*... }		
	Gramineae	1.3	1.0		*Assulina*	11	6.3
3	*Carex bigelowii*				Charcoal	0.8	.
+	*Eriophorum angustif.* ...				*Alnus*	0.2	0.2
	.... Cyperaceae	44	33		*Artemisia*	.	0.1
1	*Pedicularis lapp*... type	5.3	0.5		*Plantago lanceolata*.....	0.2	
					Thalictrum	0.2	.
					Σ pollen	535	1013

Table XII. Marsh with dwarf-shrubs [VII, 6]. This vegetation is bordered, on the one side by a *Carex saxatilis-Carex holostoma-Eriophorum angustifolium*-marsh [VII, 4], on the other side by the just mentioned moss-rich dwarf-shrub heath [VII, 7].

1	*Betula nana*	11	2	*Juncus castaneus*	
1	*Salix arctophila*			Cruciferae	0.1
	± incl. in *Salix glauca*-type	4.1		*Erigeron*-type	0.1
	± incl. in *S. herbacea*-type	0.1	1	*Pedicularis flammea*	
1	*Empetrum hermaphroditum*	7.5	1	*Pedicularis hirsuta*	
	Ledum decumbens	0.3		*P. hirsuta*-type	0.2
1	*Vaccinium microphyllum*		1	*Polygonum viviparum*	0.1
	Vaccinium-type	1.7		*Saxifraga opp.*-type	0.1
	Ericales	1.2		*Dryopteris*-type	0.1
	Gramineae	2.4		*Lycopodium selago*	1.2
3	*Carex bigelowii*		+	*Sphagnum platyphyllum* }	0.3
3	*Carex holostoma*		1	*Sphagnum subfulvum* }	
1	*Eriophorum angustifolium*			*Assulina*	1.6
	Cyperaceae	71		*Artemisia*	0.2
				Σ pollen	1000

Table XIII. *Sphagnum-Drepanocladus*-marsh with *Carex saxatilis* [VII, 4], cf. the two preceeding examples.

	Betula nana	12		*Stell.-Cerast*-type	0.1
	Salix glauca-type	7.3		*Rumex acetosella*	0.2
	Empetrum hermaphroditum	3.8		*Saxifraga opp.*-type	0.2
	Ledum decumbens	0.4		*Lycopodium selago*	1.4
	Vaccinium-type	0.3	5	*Sphagnum platyph*...... type	0.6
	Ericales	0.9		*Assulina*	0.2
	Gramineae	1.9		*Alnus*	0.1
3	*Carex saxatilis* ... Cyperaceae	73		*Artemisia*	0.1
				Σ pollen	1055

Table XIV. *Eriophorum*-marsh [VII, 2], shown on Fig. 7.

	Betula nana	22		*Oxyria digyna*	0.1
	Salix glauca-type	9.5		*Potentilla*	0.1
	Empetrum hermaphroditum	3.0		*Rumex acetosella*	0.1
	Ledum decumbens	0.1		*Stell.-Cerast.*-type	0.1
	Ericales	0.5	+	*Equisetum arvense*	
	Gramineae	13		*Assulina*	0.3
1	*Carex bigelowii*			*Botryococcus*	0.1
3	*Eriophorum angustifolium*			*Artemisia*	0.1
5	*Eriophorum scheuchzeri*			Σ pollen	1012
	Cyperaceae	52			

Summary

The result of these investigations can be summarized as follows:

A. Pollen occurring in every sample (though possibly not in the sample from the dense willow scrub).

Betula nana

was found in percentages between 36 and 1, only in the dense willow scrub was the frequency lower. If *Betula* occurs within the square investigated the percentages range between 36 and 7. If it does not grow within the very square it ranges between 28 and 1.3.

Salix

In the dense willow scrub the percentage was 99.6, otherwise, in squares with *Salix*, the amount varied between 22 and 4 per cent, and in squares without *Salix* between 9.5 and 0.8 per cent.

Empetrum hermaphroditum

If occurring in the square the frequencies varied between 34 and 3 per cent, if not, between 8 and 0.7 per cent. The dispersion of *Empetrum* pollen is more effective than in the other Ericales, which do not exceed 4 per cent when not present in the square in question.

Gramineae

As with *Salix* the percentages in pure stands were very high, up to 94 per cent. In any case, if growing in the square at all the percentages exceeded 12 per cent (apart from the willow scrub), if not actually growing on the spot the percentages ranged between 13 and 1.

Cyperaceae

Percentages between 73 and 10 were found if Cyperaceae was growing within the square. If not, the percentages were between 2.1 and 0.3.

B. Pollen not found in every sample.

Pedicularis

P. hirsuta and/or *P. lapponica* grew in the square in five out of the fifteen examples, and in the samples pollen grains were found in frequencies ranging from 5.3–0.2 per cent. Pollen of *Pedicularis* was found in no other samples.

Polygonum viviparum

Pollen was found only in some of the samples from squares with this species as a component (0.4–0.1 per cent), in other samples it was not found.

Rumex acetosella

was found in 9 out of 15 samples (0.4–0.1 per cent), in spite of the fact that it was not growing in any of the squares.

Saxifraga oppositifolia-type

was found in 8 samples (0.3–0.1 per cent) from squares without plants of this group. In one sample 34 per cent were found, *S. tricuspidata* covering 2+ in the square.

Stellaria longipes-Cerastium alpinum-type

From 6 squares without Caryophyllaceae this type obtained percentages between 0.3 and 0.1. In two squares with *S. longipes* s.l. (degree of cover: 1) the pollen frequency of this type was 2.1 resp. 1.1 per cent, while in two other squares with few *Stellaria longipes* s.l. no pollen was found.

Lycopodium selago

was more frequent than *L. annotinum*, the first found in 7 samples (1.4–0.1 per cent), the second in 2 samples (0.1 per cent). None of these species were found in the squares investigated.

Sphagnum

seems to have a small spore production nowadays in the area; they were found in 8 samples in frequencies not exceeding 0.7 per cent, whether growing in the square with a cover of 5, or found only outside the square.

C. Long distance transport.

Artemisia

19 pollen grains were found in 8 of the 15 samples, in percentages from 0.8–0.1, even though the species is not found within the area, which was scoured by the author almost daily for three months. The possibility can however not be excluded that it may grow in the area further to the east of Jakobshavn.

A total of 15333 pollen grains were counted in the recent moss samples. Out of these 17 (0.1 per cent) can not originate from plants growing in the vicinity of Sermermiut: *Abies* 1, *Alnus* 8, *Ambrosia* 2, *Archangelica*-type 1, Chenopodiaceae 1, *Pinus* 2, *Plantago lanceolata* 1, and *Thalictrum* 1.

An attempt to get a standard pollen spectrum for the whole area in a recent gyttja failed, as the sample, a cushion of *Sphagnum platyphyllum* in the deepest part of a temporary pond (FREDSKILD 1961, p. 47 and 60), contained i.a. 2 pollen grains of *Hippuris*, which does not grow in the pond today, thus showing that the clayey gyttja sticking to the *Sphagnum* contained re-bedded pollen.

RADIOCARBON DATINGS

A series of 10 samples from profile B has been dated at the Carbon-14 Dating Laboratory of the Danish National Museum (Tauber 1960 and 1964), and the results are listed in Fig. 8. The date 790 ± 100 B.C. for layer 5 is the average of three measurements on independently prepared samples: 600 ± 120, 720 ± 120 and 1040 ± 120 B.C. In the date list (Tauber 1960) sample K-516 is erroneously referred to layer 3 as given in Mathiassen (1958, Fig. 2); the sample actually dated, however, belongs to layer 5 (in Mathiassen l.c. named layer 6). The date A.D. 40 ± 100 for the uppermost part of layer 9 is the average of two measurements: A.D. 30 ± 120 and A.D. 50 ± 120; and the date A.D. 10 ± 100 for layer 10 is likewise the average of two measurements: 90 ± 120 B.C. and A.D. 100 ± 120. All other dates are based on one measurement each.

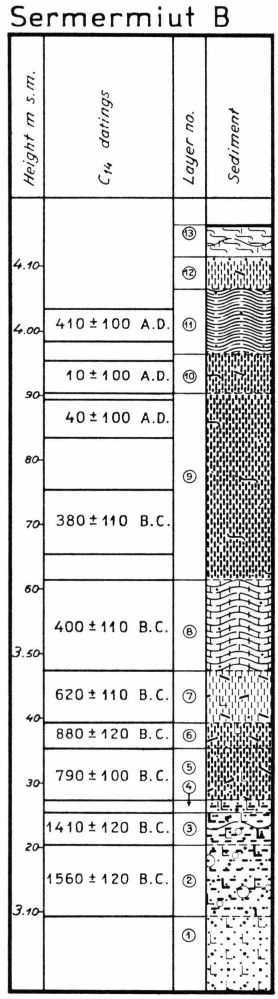

Fig. 8. Radiocarbon datings of Sermermiut B.

The dating of layer 5 gives a *terminus ante quem* for the Sarqaqculture at Sermermiut, as this layer was free of artefacts. A *terminus post quem* cannot be obtained, and an exact dating of the culture at this locality cannot be obtained by the material at hand. The datings of the humous sand constituting the culture layers (2 and 3) are supposed to be a little older than the culture as they are likely to contain humic substances accumulated under the vegetation growing there at the settling time.

The above mentioned dates are in agreement with other datings of a Sarqq-culture in West Greenland: Igdlorssuit 90 km north of Sermermiut: 1620 ± 150 B.C. and 1390 ± 140 B.C. (both samples may contain charcoal from driftwood, TAUBER (1960)), Sarqaq 100 km north of Sermermiut: 810 ± 100 B.C. (average of three measurements on charcoal of *Betula nana*, TAUBER (1960)), Itivnera, head of Godthåb Fjord: 1010 ± 110 B.C. (wood of *Juniperus* from the floor of a ruin, TAUBER (1962)), and Ika, Sukkertoppen district: 1410 ± 120 B.C. (charcoal from driftwood, TAUBER (1966)).

As yet the only dating of West-Greenlandic Dorset-culture is the one from Sermermiut.

The people of the Inugsuk-culture (a stage of the Thule-culture) settled at Sermermiut close to or shortly after A.D. 1000.

INTERPRETATION OF THE PROFILES AND DIAGRAMS

I. The plant succession

In the following an attempt has been made to reconstruct the plant succession which formed the peat. This has been done on the basis of the pollen diagrams, and analysis of the macrofossils and sediment-types. Further the recent pollen sedimentation and the ecology of the present vegetation has been taken into consideration.

The more detailed attention has been given to profile B. A summary of the 10 stages into which pollen diagram B has been divided is given first, followed by a discussion.

Stage 1: An emerged beach covered by beach-vegetation gradually changes into a grass heath. On this lawn the Sarqaq-people settle, but their influence on the vegetation is only slight, chiefly marked by the dominance of *Alopecurus alpinus*.

Stage 2: A grass vegetation still covers the area.

Stage 3: A dwarf-shrub heath, first dominated by *Ledum palustre* ssp. *decumbens* and *Empetrum hermaphroditum*, later by *Betula nana*.

Stage 4: A willow scrub.

Stage 5: A *Sphagnum* bog with Cyperaceae, among others *Carex bigelowii* and *C. rariflora*, with *Montia fontana*, *Ranunculus hyperboreus* and *R. lapponicus*.

Stage 6: An *Empetrum* heath without hydrophilous species.

Stage 7: Another moist community, with the same species as in stage 5 (+ *Koenigia islandica*), but in smaller frequencies.

Stage 8: A grass and dwarf-shrub heath. In this stage the Dorset-people settle.

Stage 9: A moist heath, first dominated by *Empetrum*, later by sedges and the other hydrophilous species.

Stage 10: A heath, dominated by grasses, and with some *Salix*, but without the hydrophilous species.

Profile B

In the pollen diagram B (Plate VI) the following stages can be separated:

Stage 1 includes pollen samples 1–4. The coarse-textured soil, quite recently emerged from the sea, was invaded by a vegetation dominated by *Elymus mollis*, and in the beginning with scattered *Stellaria humifusa*, and later Cruciferae, (though probably not *Cochlearia groenlandica*). The samples No. 2–4 are from the Sarqaq-culture layer; as the Sarqaq eskimoes, settling on a dry, sandy beach must have caused some mix-up in the uppermost centimeters of the surface, the curves must be regarded with some caution. It seems plausible, though, that *Alopecurus alpinus* and other grasses (*Festuca rubra*? *Poa arctica*?) replace *Elymus* simultaneously with the appearance of Crucifers (*Draba hirta*?) and the disappearance of *Stellaria humifusa*. *Saxifraga cernua*, favoured by human activity, may be growing on the spot at this stage.

Of macrofossils only seeds of *Empetrum hermaphroditum* were found (samples B m 1–2).

Stage 2 is represented by sample 5 only. The grasses — *Alopecurus alpinus* and others, though not *Elymus* — still dominate, and the peak of Caryophyllaceae pollen (3.5 per cent) must indicate a local growth of plants from this family. As indicated by the pollen (cf. p. 20) there is evidence of the growth both of *Stellaria longipes* s.l. and of *Cerastium alpinum* s.l. While *Stellaria longipes* never, or only exceptionally, produces seeds, *Cerastium alpinum* fructifies abundantly, but unfortunately no macrofossil sample was taken.

The sand layer, characterized by this pollen sample, has small extension vertically as well as horizontally (cf. Pl. I) and the origin of it is uncertain. It is without traces of culture.

Stage 3 is represented by samples No. 6–7. In sample 6 *Empetrum* and *Ledum palustre* ssp. *decumbens* have marked peaks, and both species must have been growing on the very spot. *Betula nana* (13 per cent) may also have been growing on the spot, or close to it. Grasses still constitute more than half of the spectrum (58 per cent), but whatever other species may have contributed their share, *Alopecurus alpinus* was a minor component. *Poa arctica*, *P. pratensis* s.l., and possibly *Festuca rubra*, are likely as inhabitants of this moist heath. The combination *Ledum palustre* ssp. *decumbens–Empetrum hermaphroditum–Betula nana* is well known from West Greenland (cf. BÖCHER 1954, p. 267, BÖCHER 1963, p. 180, and FREDSKILD 1961, p. 37). It has a wide ecological range, but is frequent on bog-like terrain, even if its optimum seems to be the heath. In the Sermermiut valley today the wide range is illustrated by its growing on sand in fell fields on the dry, sun-exposed slope (cf. Fig. 1

[I, 10]) as well as in the moist, mossy heath covering the area from where this profile originates.

Pollen sample No. 7 has 58 per cent *Betula*, a higher frequency than found in any of the recent pollen samples (max. 36 per cent). The grasses constitute almost the remainder (39 per cent).

The macrofossils in layer 5 (B m 3), from which sample No. 6 originates, consist of great amounts of *Empetrum* seeds together with 23 *Betula* fruits, while in layer 6 (B m 4) only *Empetrum* seeds are preserved. The most probable explanation of this discrepancy is that while pollen samples were taken with a gap of, usually, 2.5 cm between them, the macrofossil samples in the lowermost part of the profile were cut out like a pillar, without space in between. With the undulating boundaries between the layers a sample with a volume of half a litre or more may easily have been contaminated from neighbouring layers. Another explanation of the missing fruits of *Betula* in layer No. 6 may be the higher degree of humification, illustrated by the curve of destruction, which shows an absolute maximum here. The fruits of *Betula nana* are very delicate, in contrast to the seeds of *Empetrum*. The twigs found in the layer were too badly preserved to allow a determination. Two fruits in B m 4 of *Eriophorum augustifolium* must have been carried there by the wind, as the frequency of Cyperaceae is 0.2, 0.0 and 0.2 per cent in samples No. 6, 7 and 8 resp.

This stage, the *Ledum–Empetrum–Betula nana* heath, may have lasted a long period of time, as indicated by the destruction, and, possibly, also by the radiocarbon dating, the age of layer 6 being 880 $\pm$120 B.C., while that of layer 7 is 620$\pm$120 B.C.

Stage 4 is a willow scrub, represented by samples No. 8 and 9. This is also the constituent of layer 7, a slightly humified peat, $^1/_4$ of which is made up of twigs. *Equisetum* sp. was growing on the spot, as was *Polygonum viviparum*. Concerning the other constituents of the dense willow scrub only guesses are left, but grasses in the lower part and *Empetrum* in the higher are likely. The macrofossils include seeds and leaves of *Empetrum* and one indeterminable fruit of a grass.

Stage 5, including samples No. 10–12, represent a hydrophilous community. $^3/_4$ of the sediment is slightly decomposed *Sphagnum squarrosum*, and the pollen slides were as if paved with *Sphagnum* spores. No dwarf shrubs were growing on the spot in the first part of the stage, whereas Gramineae, Cyperaceae, *Montia fontana*, *Ranunculus hyperboreus* and, not least, *R. lapponicus* were growing in the *Sphagnum*. Fruits of *Carex bigelowii* and *C. rariflora* were found (B m 6), besides fruits of *Ranunculus lapponicus*, *R. hyperboreus* and seeds of *Montia*, thus completing the picture of a wet *Sphagnum* bog.

At the end of the stage (sample No. 12) *Montia* and *Ranunculus hyperboreus* disappear, and *R. lapponicus* and the Cyperaceae receed, while *Empetrum* spreads over the area together with *Stellaria longipes* s.l. and *Ledum*, forming a transition to the next stage.

Stage 6 is represented only by sample 13, but the sudden disappearance of all hydrophilous species is the reason why this stage is separated as a stage at all. *Empetrum* and grasses — *Alopecurus alpinus* and others — are the main components in this more mesophilous vegetation.

Stage 7 comprises samples No. 14–15. The vegetation was moist, indicated by pollen and seeds of *Montia*, *Koenigia*, *Ranunculus lapponicus*, *R. hyperboreus*, and *Carex rariflora*, besides *Sphagnum* spores, but the frequencies are much smaller than in stage 5, and grasses, mainly *Alopecurus alpinus*, constituted the major part of the vegetation. *Dicranum elongatum* and *Sphagnum balticum* occur, a combination found by BÖCHER (1963, p. 177, analysis No. 27) at Kangersuneq, 68°50′ N, east of Christianshåb, on a heath rich in mosses and lichens, and with *Empetrum*, *Ledum palustre* ssp. *decumbens* and *Vaccinium uliginosum* ssp. *microphyllum* as the dominant species. Other components in his community are *Betula nana*, *Salix arctophila*, *Carex rariflora*, *Eriophorum angustifolium*, *Pedicularis lapponica*, *Pinguicula vulgaris*, *Ranunculus lapponicus*, *Tofieldia pusilla*, and *Equisetum arvense.* The vegetation of stage 7 was slightly more moist, and presumably hummocky, much resembling the vegetation around the excavations today [III, 2].

Sample B m 7 unfortunately comprises both pollen samples No. 13 and No. 14. The peak of spores of the *Dryopteris* type in No. 14 is peculiar, as none of the Polypodiaceae growing in this area today (*Woodsia glabella*, *W. ilvensis*, *Cystopteris fragilis* and *Dryopteris fragrans*) are likely to have been growing in a community like this. The most probable explanation is that a piece of a fertile leaf from a fern was blown to the spot and thus caused a contamination.

Stage 8 (sample No. 16–18) was a somewhat dryer heath, dominated by grasses, mainly *Alopecurus alpinus*, and with some *Betula*, *Salix glauca*, *Empetrum*, *Stellaria longipes*, and *Polygonum viviparum*, and with a number of mosses (10 species recorded !). Single seeds of Cruciferae, *Luzula*, *Carex*, *Ranunculus hyperboreus*, and *R. lapponicus* were found in B m 8–9, but — apart from Cruciferae — not registered in the pollen spectra. The seeds of *Ranunculus* may be contamination from just above the sample B m 9. This layer contains artefacts of the Dorset culture.

Stage 9 (sample No. 19–21) was a moist heath, initially dominated by *Empetrum*, later by Cyperaceae, and with *Montia*, the two *Ranunculus* species and *Equisetum* growing in a mat of *Sphagnum squarrosum.* Two pollen grains of *Saxifraga foliolosa* in sample No. 20 may indicate growth of this plant in the community, as these two pollen represent the only record of the species in the diagram. This stage very much resembles stage 5.

Stage 10 was the last stage represented in the diagram, and it is illustrated by sample No. 22 only. All the hydrophilous plants have disappeared, and grasses — *Alopecurus alpinus* and others — have spread over the area, possibly accompanied by a few *Salix glauca* and some Cruciferae, and with *Polygonum viviparum.* The peak of pollen of the *Saxifraga oppositifolia*-type is strange. Pollen of this type is found in *S. oppositifolia*, *S. tricuspidata*, *S. aizoon*, and *S. aizoides*, but none of these species are likely to have been growing in this community, and a macroscopical source of contamination (like the *Dryopteris*-peak in No. 14) is most likely. No macrofossil sample was taken, but in the pollen sample a number of *Sphagnum* leaves were found in the sandy peat.

The present vegetation on top of the profile has not been investigated, but the whole area where the excavation took place is covered by a moist, mossy heath [III, 2], dominated by *Empetrum*, and with *Ledum*, *Vaccinium*, *Poa arctica*, and *Alopecurus alpinus.* The moss layer is dominated by *Aulacomnium palustre*, and contains 9 further species, i.a. *Sphagnum squarrosum.* The pollen spectrum of this community is found on p. 34.

Long distance transport

The diagram shows two maxima of long distance transported pollen contemporaneous with the maxima of Cyperaceae, and a third maximum is contemporaneous with the moist period (stage 7) in between. If to the curve is added the pollen and spores of species not likely to have grown in the community in question (*Oxyria*, *Dryopteris*-type, *Rumex acetosella*, *Artemisia*, *Campanula*), the maxima will be even more pronounced. The curves for microscopical charcoal show 4 maxima: in the Sarqaq-layer, in the first and in the second wet period, and in the Dorset-layer, and as no cultural traces from the more than 800 years between the two cultures are recorded, the two maxima in between may be explained either as indications of occasional eskimo camps in the vicinity, or as long distance transported smoke particles (forest fires in Canada), only slightly smaller than pollen grains. Particles essentially smaller than pollen grains are not counted as charcoal, even if they actually are charcoal.

Profile A

The two profiles, A I and A II, are too small and with a too big gap between the pollen samples to give a detailed picture of the succession in this part of the Sermermiut valley, but the main trends can be deduced from them: On a beach with herbs, almost exclusively grasses, the Sarqaq-people settle. After their disappearance only minor changes in the vegetation, for example the greater frequency of *Alopecurus alpinus* at the expence of other grasses, can be registered. Later a moist vegetation spreads. At the end of this stage, or shortly after, the Dorset people settle, and after their disappearance a dwarf-shrub heath spreads over the area. The moist period (stage 9 in profile B), cannot be traced here, presumably a consequence of the building of Inugsuk-houses on this very spot.

The stages mentioned in the following discussion of the profiles A I and A II are stages in these profiles and must not be confused with stages 1–10 in profile B.

Profile A I

Stage 1. Layer No. 1, the emerged sandy beach, is not represented by pollen samples.

Stage 2 includes pollen samples No. 1 and 2. The vegetation was totally dominated by grasses, not *Elymus*, but *Alopecurus* and, even more so, by other species. Some Cruciferae are recorded in both samples. In A I m 1–2 quite a number of *Empetrum* seeds were found. Layer 2 (pollen sample No. 1) is the Sarqaq-layer, a sandy peat with macroscopical, but very little microscopical charcoal.

Stage 3 (sample No. 3) was a dwarf-shrub heath, dominated by *Ledum* and *Betula nana.*

Stage 4 (sample No. 4) is characterized by the maximum in the curve for Cyperaceae, and a change in the sediment from peat to clayey sand. *Polygonum viviparum* and a few *Empetrum* constitute part of the vegetation, but what species of Cyperaceae is responsible for the maximum cannot be said, as the macrofossil sample (A I m 3) gives no hint, but the change in sediment indicates hydrophilous species. In this layer charcoal and artefacts from the Dorset-culture were found.

Stage 5 (sample No. 5) was a moist *Empetrum-Salix glauca* heath rich in grasses, of which *Alopecurus alpinus* formed an important element. *Stellaria longipes* s.l. was common, and *Polygonum viviparum* and *Pedicularis* (*P. lapponica* or *P. hirsuta*, not *P. flammea*, cf. p. 27) also occurred, besides *Ranunculus lapponicus.* Dorset artefacts were found at the bottom of the layer.

Stage 6 (sample No. 6) was a *Salix glauca–Empetrum* heath with very few herbs, but with abundant *Equisetum.* The one pollen grain of *Ranunculus lapponicus* may be accidental, or it may — together with the peak in the *Sphagnum* curve — indicate that the plant community was still somewhat damp, but stage 6 was no doubt drier than stage 5.

Stage 7 (sample No. 7) was a dry *Betula nana* heath with a few specimens of *Empetrum* and some grasses, among which *Alopecurus* was most important, but *Poa glauca* also occurred. Two seeds of *Cerastium alpinum* were found, but no pollen. It must be kept in mind, though, that the macrofossil sample covers a longer period than the pollen sample, vertically 8.5 against app. 1 cm.

Profile A II

Stage 1. As is the case with A I, this stage — the emerged beach — is not illustrated by samples.

Stage 2 (sample No. 1) was a herb community, dominated by grasses (though neither by *Elymus* nor by *Alopecurus*), and with Cruciferae, *Cerastium alpinum* s.l. and a *Saxifraga* (*oppositifolia* or *tricuspidata*?) as frequent species. This is the Sarqaq-layer.

Stage 3 (sample Nos. 2–3) was a moist community, still dominated by grasses, but now with *Alopecurus alpinus* as frequent or dominant species, and with *Ranunculus lapponicus* as an important element. The fruits of Carex (A II m 2) were badly preserved and without utriculi. All 17 fruits were distigmate, and *Carex bigelowii* appears the more likely. *Polygonum viviparum* was growing in the community, in No. 3 accompanied by a *Pedicularis* (not *P. flammea*). This stage is older than the Dorset-layer.

II. Causes of the Plant Succession.

As mentioned above, the first settling in site B had only a slight influence on the vegetation, though it may partly be responsible for the accumulation of humus, which sets in. Some time later the, presumably, driest plant community after the onset of the peat formation (the *Betula nana* heath in the second half of stage 3) covers the area. This vegetation only adds very little to the sediment, as indicated by the small thickness of the layer. This is in agreement with the maximum in the destruction curve and the radiocarbon datings.

What factor may have caused the change from a *Betula nana* heath to a willow scrub are not easy to see, but heavier snowcovering during winter or other slight changes to more humid conditions may be responsible. The willow scrub presumably marks the initial phase of a climatic deterioration. If so, the upper boundary of layer 6 is equivalent to a recurrence surface.

Alterations in moisture conditions must, at any rate, be the cause of the drastic change which sets in in the fifth or sixth Century B.C., when the willow scrub is replaced by a *Sphagnum* bog.

Possible causes may be: 1) a higher precipitation in the form of rain during the summer, 2) a heavier snow-fall during autumn and winter, 3) a raising of the permafrost table, or 4) a lowering of the summer temperature.

ad 2) A bigger snow-fall during autumn and winter, or a change in the prevailing wind directions would cause bigger snow beds close to the ridge between Sermermiut and the fjord. Close to this snow-bed a prolonged period with seeping meltwater during the summer would be the result, and this would change the vegetation. Section A, however, is situated in the middle of the valley, far from the sheltering effect of the ridge, and on higher level. A snow-bed along the ridge can thus not be responsible for the change in vegetation, which is shown in diagrams A I and II (Plate VII).

ad 3–4) The permafrost level in section B is today app. 25 cm, and below corresponding communities the level is usually between 24 and 30 cm. Coarse-textured soils, i.e. soils with poor water-retaining capacity, have a much deeper-lying permafrost table, cf. FREDSKILD (1961). If a peat layer overlaying a well-drained coarse-textured soil is essentially thinner than 20–25 cm, the peat will thaw each summer. At the time when the formation of layer 8 starts, the peat had a thickness (in the compressed state today between 25 and 30 cm) sufficient to prevent the thaw from reaching the underground if only a slight lowering of the temperature occurred. This would greatly influence the drainage of the soil and consequently change the moisture conditions.

The neighbourhood of Jakobshavn Isfjord may influence the local climate. Today the fjord is packed with icebergs, calved from the glacier front 50 km up the fjord, but in some periods, cf. MELDGAARD (1958, p. 24) Dutch vessels could sail into the fjord, while in others the glacier front was less than 20 km away from Sermermiut.

Whatever the details may be, the generally accepted lowering in the temperature at the transition Sub-boreal–Sub-Atlantic must be conclusive. As a) more cloudy and, eventually, more rainy summers caused by prevailing northern and north-western winds instead of eastern winds, b) a heavier snow-fall with delayed melting, and c) a raising of the permafrost table, will affect soil conditions, and thereby the vegetation in the same direction, the main cause (apart from the lowering in the temperature) can not be stated. The insulating effect of a thick moss carpet will strengthen the effect of the other causes, and may alone be responsible for the raising of the permafrost table, but at least one of the three requirements mentioned is necessary for initiating the growth of *Sphagnum*.

It has been suggested that the climatic deterioration in the middle of the first millennium B.C. should be connected with the formation of permanent pack-ice in the Arctic Ocean north of 75°–80° N. (Brooks, 1949; Lamb, 1963). This would agree with the vanishing of the Independence-cultures, which flourished on Peary Land, North Greenland between 2000 and 500 B.C. (Knuth, 1966), and with the sparseness of driftwood on the lower (younger) raised beaches, contrary to the abundance, even at the heads of the long fjords, during the occupation (Knuth, 1954).

After this humid period at Sermermiut there follows a short, somewhat drier period (stage 6), again followed by a humid period, though not as pronounced as in stage 5.

When the Dorset-people settled at Sermermiut around, or shortly after the birth of Christ, the area was covered by a rather dry dwarf-shrub heath. After their disappearance the sedimentation continued unchanged for a time (cf. the section, Plate I). Their refuse, which is in fact very limited in amount, cannot be responsible for the change in vegetation which sets in suddenly (note the sharp border-line between layers No. 10 and 11) around A.D. 400. This is contemporaneous with the next pronounced RY in N.W. Europe, RY II. From Sarqaq, 100 km north of Sermermiut Meldgaard (1958, foot-note p. 22) mentions still another evidence of deterioration in the climate after the Dorset occupation.

On top of layer 12 in profile B rests the present moss-carpet, and though no indication could be found during the excavation, it has been suggested that the Inugsuk-people peeled turf on this site. A complete lack of sedimentation during $1^1/_2$ millennium in the place cannot be accepted. On profile A Meldgaard states (1958, p. 15): "On top of this layer a very pronounced horizon of compressed grasses can be distinguished, a feature that must be explained by the existence of a dryer surface when the accumulation of F was completed". The layer mentioned is layer 6 in Profile A I, a layer formed by a *Betula nana-Empetrum* heath with grasses. This vegetation succeeded the more moisture demanding heath which spread over the area after the end of the Dorset settling. This change must be considered a proof of a climatic amelioration. The pollen sample (No. 7) is unfortunately taken app. 3 cm below the border.

Meldgaard (l.c. p. 23) gives a diagram of "Periods of culture and climate at Sermermiut", which must consequently now be corrected.

PALEOBOTANICAL EVIDENCE OF POST-GLACIAL CLIMATIC CHANGES IN GREENLAND

Besides the evidence deduced by the author from the diagrams from Sermermiut, IVERSEN (1954) has published some pollen diagrams from lakes at different elevations near Kapisigdlit at the head of Godthåb Fjord. The most complete diagram is from "Lake 100 m s.m." which was isolated from the fjord a short while after the ice had receded from the valley. The pollen diagram has been divided into five well defined pollen zones: The first is characterized by Gramineae and Cyperaceae, and with *Empetrum* and other Ericales as the only shrubs. In the second zone *Salix* (*S. glauca*-type) is common, but Gramineae and Cyperaceae are still most frequent. The third zone is marked by the immigration of *Betula nana* and *Juniperus*, and in the fourth — the warm period — they are accompanied by *Alnus crispa*. The fifth zone is marked by the deterioration of the climate, reflected in the recession of the alder scrub and the advance of *Empetrum–Vaccinium* heath. With some hesitation IVERSEN synchronizes zone III roughly with European Atlantic time, zone IV with Sub-boreal, and zone V with Sub-atlantic, yet he correlates the boundary IV–V with RY II (A.D. 400) instead of with RY III (500 B.C.).

Another lake in the same drainage system, "Lake 8 m s.m.", was isolated in the later part of zone III. In the pollen diagram from this lake, presented by IVERSEN (l.c.), one level can be dated accurately, as a Norse farmstead is found on a slope towards the lake. A sudden ample occurrence of microscopical charcoal in the diagram contemporaneous with a decline in the curves of *Alnus* and *Salix* and an incline in the curves of Gramineae and Cyperaceae, indicates the beginning of the occupation phase which starts shortly after A.D. 1000. In 1960 the present author made borings in the same lake, and a sample taken from the lowermost 9 cm of the lake mud has been dated to 2390 ± 120 B.C. (TAUBER 1966). As the transition from marine clay to lake mud is 20 cm below the boundary between zones III and IV this boundary can not be synchronous with the European boundary between the Atlantic and the Sub-boreal (app. 3000 B.C.).

The sediments throughout the cores are fairly uniform, only tending to be slightly coarser towards the top. On the assumption of a uniform sedimentation in the period from the isolation of the lake up to A.D. 1000, a sedimentation rate of 1 cm in app. 25 years can be estimated. This would date the boundary III–IV to app. 2000 B.C., and the boundary IV–V to app. A.D. 400, the latter in accordance with the estimation of IVERSEN. If this holds good, RY III, which in N.W. Europe is the most pronounced of the RY's, is not reflected in the curves of terrestrian plants, but it must be kept in mind that the gap between the pollen samples in zone IV is 20 cm while in zone V it is only 5 cm. At the estimated sedimentation rate 20 cm covers a period of 500 years.

Only one of the curves in the pollen diagram may give a hint of a decline of the temperature within zone IV: the curve for *Myriophyllum alterniflorum*. This plant today covers almost the entire bottom of the lake. Now completely sterile, it began to bloom at the same time as the immigration of *Alnus*, but in the middle of zone IV it almost totally stopped flowering, and this may well reflect a decline of the temperature. The youngest sample containing a considerable amount of *Myriophyllum* pollen can at the estimated sedimentation rate be dated to 850 B.C., while the next sample in the diagram, being without *Myriophyllum* pollen, can be dated to 350 B.C. Flowering is only traced in three of the following 17 samples. The same trend is shown in the diagram from "Lake 100 m s.m.".

It must be mentioned too, that the climatic change around A.D. 1300 (RY I) can be demonstrated in pollen diagrams published by IVERSEN (1934) from the same part of Greenland.

In Iceland the climatic deterioration sets in at 700–500 B.C. (EINARSSON, 1961 and 1963), and quite recently recurrence surfaces have been demonstrated in Nova Scotia (OGDEN, 1960), but they have not so far been dated.

In a paper "Central Canadian palynology, and its relevance to northwestern Europe in the Late Quaternary Period" presented to the "Second International Conference on Palynology. Utrecht." Aug. 1966 H. NICHOLS demonstrated radiocarbon-dated climatic deteriorations in bogs in Keewatin (61° N, 101° W) and North Manitoba (57° N, 101° W), Canada. Pronouneed decreases in peat humification and changes in the pollen spectra occurred around 3100, 2700, 1500 anh 600 B.P., this corresponding with RY IV–I. The paper will be published in "Review of Palaeobotany and Palynology" vol. IV, 1967 (Elsevier, Amsterdam).

Indices of a former more favourable climate in the Jakobshavn area have been mentioned by FREDSKILD (1961), but will be summarized here. In a now temporary pond with *Sparganium angustifolium* as the only phanerogam, *Myriophyllum exalbescens*, *Hippuris vulgaris*, *Potamogeton filiformis* and *Ranunculus confervoides* have formerly grown and produced fruits. Considering the rare fruit production of *Myriophyllum* *exalbescens* in Greenland today, the temperature in the former pond must have been favourable. As mentioned above (p. 38) pollen of *Hippuris* was found in a sample from the bottom of another temporary pond. In a small pool with only a few sterile shoots of *Hippuris*, the species have formerly produced seeds, and *Potamogeton filiformis*, now extinct in the pool, has been fruiting.

At what time this more favourable climate prevailed can not be said; it would therefore be desirable to get a standard pollen diagram from the area. The two lakes in the valley between Jakobshavn and Sermermiut would seem to be suitable for this purpose. Their bottoms are covered by *Potamogeton groenlandicus*, *Ranunculus confervoides*, and mosses, and a layer of gyttja of a certain thickness can be expected. The samples should also be suitable for radiocarbon datings, as the area is within the zone of archaic, acid rocks.

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REFERENCES

Brooks, C. E. P., 1949. Climate through the ages. London.

Bryan, Margaret S., 1954. Interglacial pollen spectra from Greenland. Geol. Survey of Denmark, II. Ser., No. 80.

Böcher, T. W., 1951. Distributions of plants in the circumpolar area in relation to ecological and historical factors. Journ. of Ecology 39, 2.

— 1952. Contributions to the flora and plant geography of West Greenland. M. o. G. 147,9.

— 1954. Oceanic and continental vegetational complexes in Southwest Greenland. M. o. G. 148,1.

— 1963. Phytogeography of Middle West Greenland. M. o. G. 148,3.

Chanda, S., 1962. On the pollen morphology of some Scandinavian Caryophyllaceae. Grana Palynologica 3, 3.

Einarsson, Th., 1961. Pollenanalytische Untersuchungen zur spät- und postglazialen Klimageschichte Islands. Sonderveröffentlichungen des Geol. Inst. der Uniersität Köln, 6.

— 1963. Pollen-analytical studies on the vegetation and climate history of Iceland in late and post-glacial times. In: North Atlantic Biota and their History. Oxford.

Eneroth, O., 1951. Undersökning rörande möjligheterna att i fossilt material urskilja de olika *Betula*-arternas pollen. Geol. Fören. Stockholm Förh. vol. 73.

Fredskild, B., 1961. Floristic and ecological studies near Jakobshavn, West Greenland. M. o. G. 163,4

Fægri, K. and Iversen, Johs., 1964. Textbook of pollen analysis. Copenhagen.

Haarløv, N. (in prep.). Arthropoda (Acarina, Diptera) from Subfossil Layers in West Greenland. M.o.G. 184,3.

Iversen, Johs., 1934. Moorgeologische Untersuchungen auf Grønland. Medd. Dansk Geol. Foren. 8.

— 1954. Origin of the flora of Western Greenland in the light of pollen analysis. Oikos 4, 2, 1952–53.

Jørgensen, C. A., Sørensen, Th., and Westergaard, M., 1958. The flowering plants of Greenland. Biol. Skr. Dan. Vid. Selsk. 9.4.

Knuth, E., 1954. The Paleo-eskimo Culture of Northeast Greenland elucidated by three new sites. American Antiquity 19,4.

— 1966. (in preparation). Ecóle Pratique des Hautes Etúde Sorbonne. Sixième Section. Contributions no. ?, Paris.

Lamb, H. H., 1963. On the nature of certain climatic epochs which differed from the modern (1900–39) normal. In: Arid Zone Research – XX. Changes of Climate. UNESCO. Paris.

Mathiassen, Th., 1958. The Sermermiut Excavations 1955. M. o. G. 161,3.

Meldgaard, J., 1952. A Paleo-eskimo Culture in West Greenland. American Antiquity 17, 3.

— 1958. Sermermiut, and its different Periods of Culture. *In*: Larsen, H. and Meldgaard, J., Paleo-eskimo Cultures in Disko Bugt, West Greenland. M. o. G. 161, 2.

OGDEN, J. G., 1960. Recurrence surfaces and pollen stratigraphy of a postglacial raised bog, Kings County, Nova Scotia. Am. Journ. af Science 258.

PORSILD, M. P., 1920. The flora of Disko Island and the adjacent coast of West Greenland from 66°–71° N.lat. M. o. G. 58,1.

TAUBER, H., 1960 a. Copenhagen natural radiocarbon measurements III. Am. Journ. of Science Radiocarbon Supplement 2.

— 1960 b. Copenhagen radiocarbon dates IV. Am. Journ. of Science Radiocarbon Supplement 2.

— 1962. Copenhagen radiocarbon dates V. Radiocarbon 4.

— 1964. Copenhagen radiocarbon dates VI. Radiocarbon 6.

— 1966. Copenhagen radiocarbon dates VII. Radiocarbon 8.

TROELS-SMITH, J., 1955. Characterization of unconsolidated sediments. Geol. Survey of Denmark, IV, Ser. 3, 10.

Færdig fra trykkeriet den 20. januar 1967.

PLATES

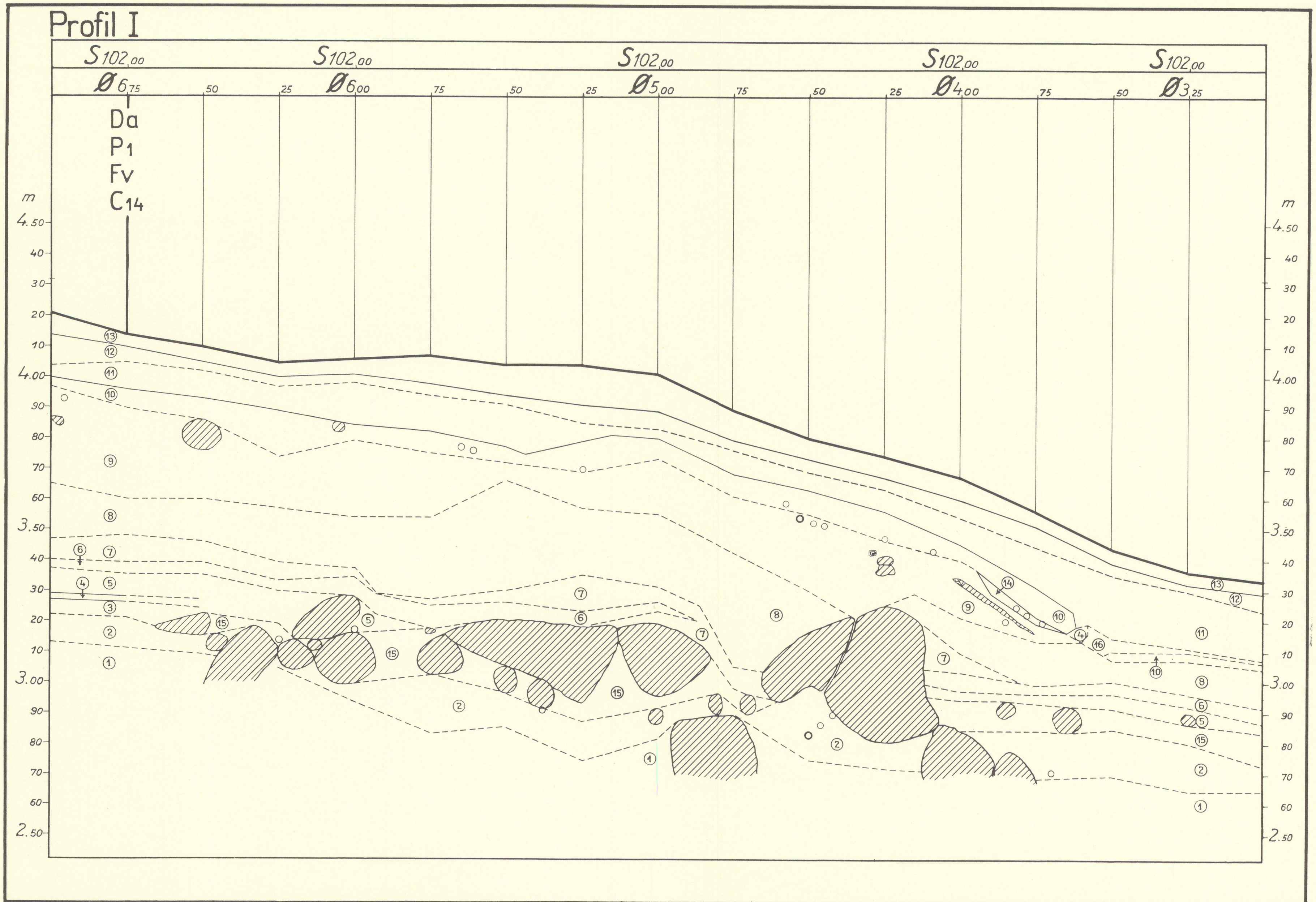
Plate I–VII

Corrections

In sample 5 in the diagram, Plate VI, read 2.5 % charcoal instead of 0 %.

In the headings of Plates VI and VII read shrubs and dwarf-shrubs for scrubs and dwarfscrubs, and hydrophilous for hygrophilous.

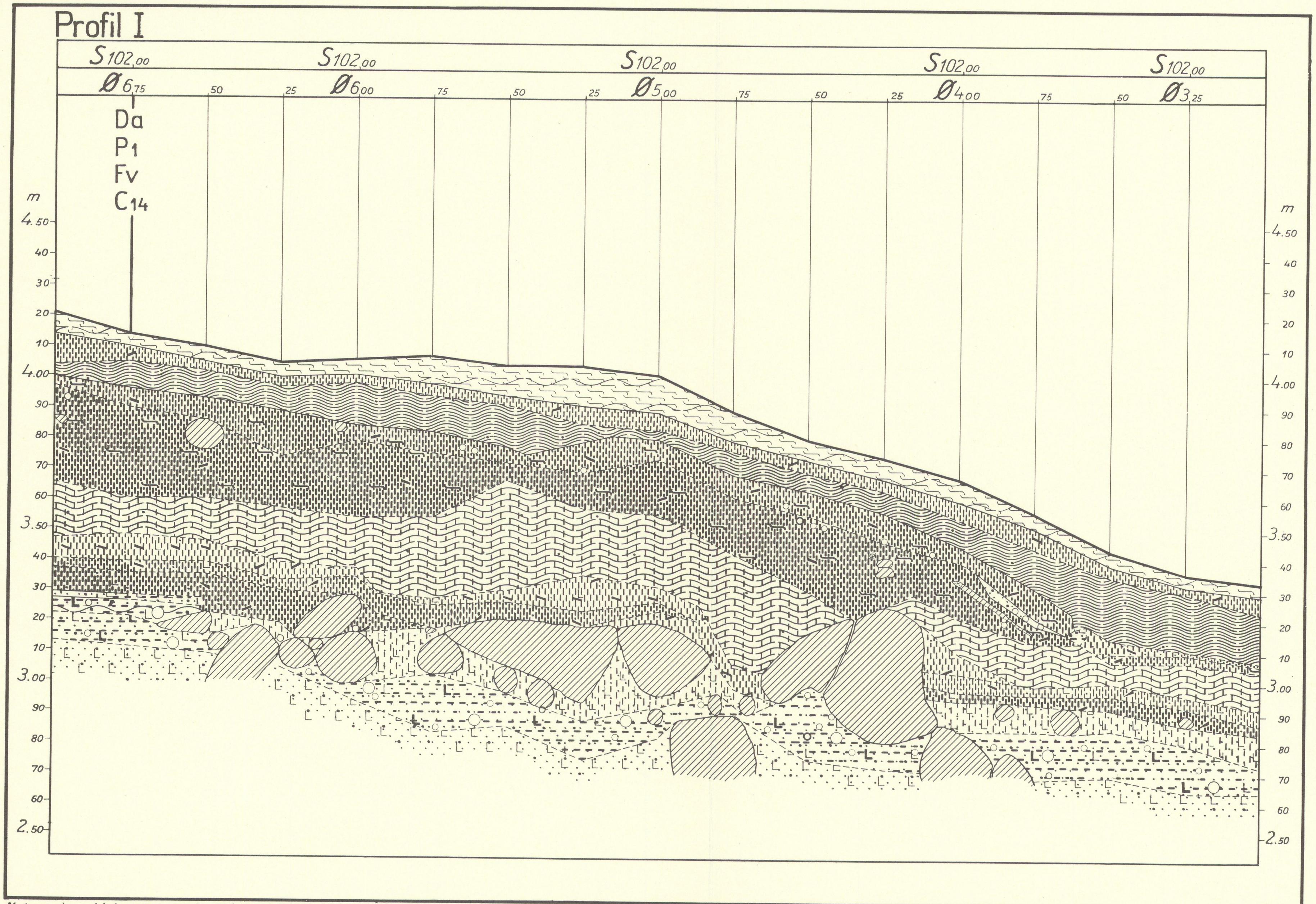
Sermermiut B
Jakobshavn, Grønland.



Metres above high water mark. Chips ○ and tools ● of angmaq or chalcedony.

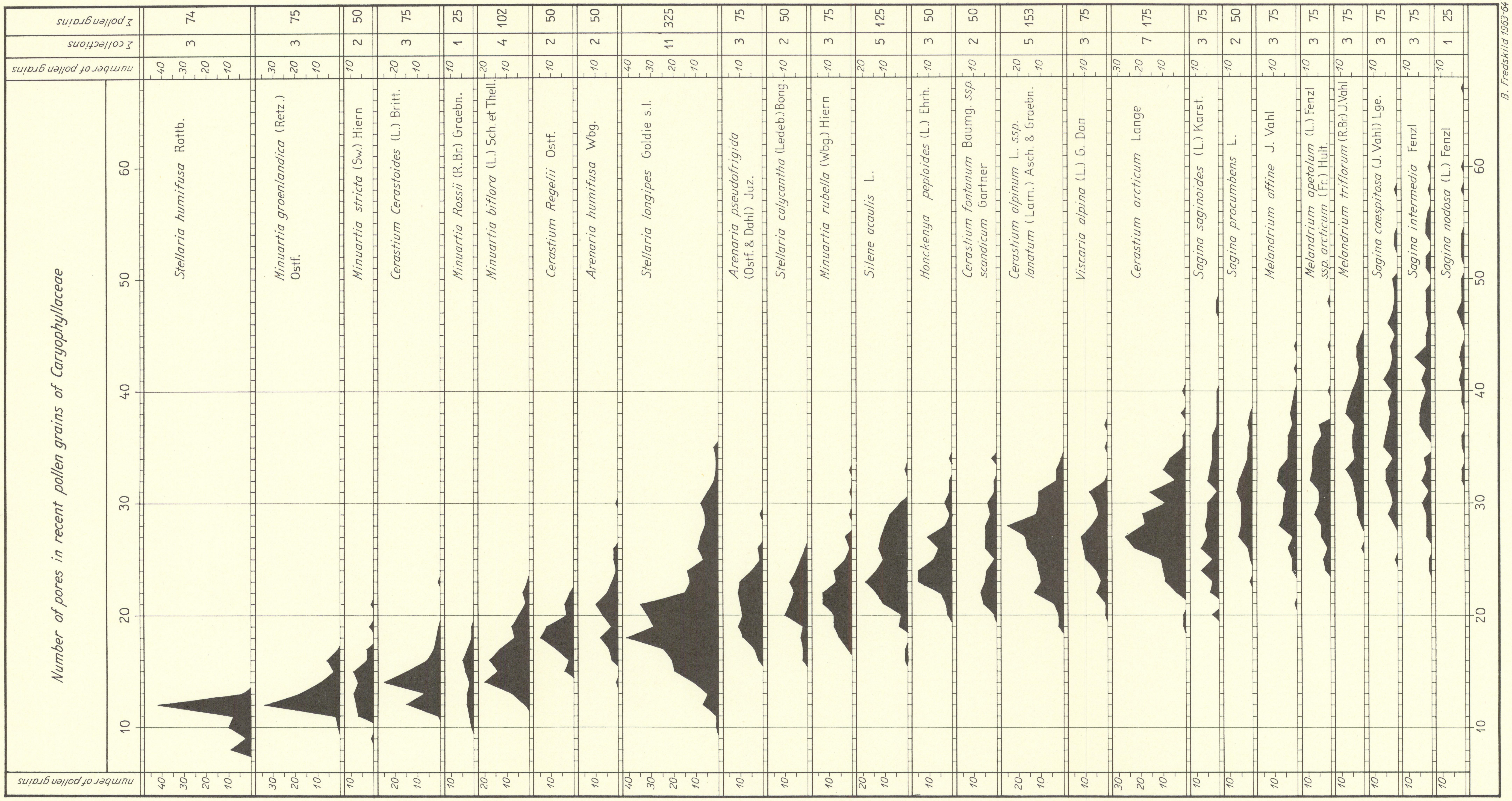
Measured by Svend Jørgensen 1955.

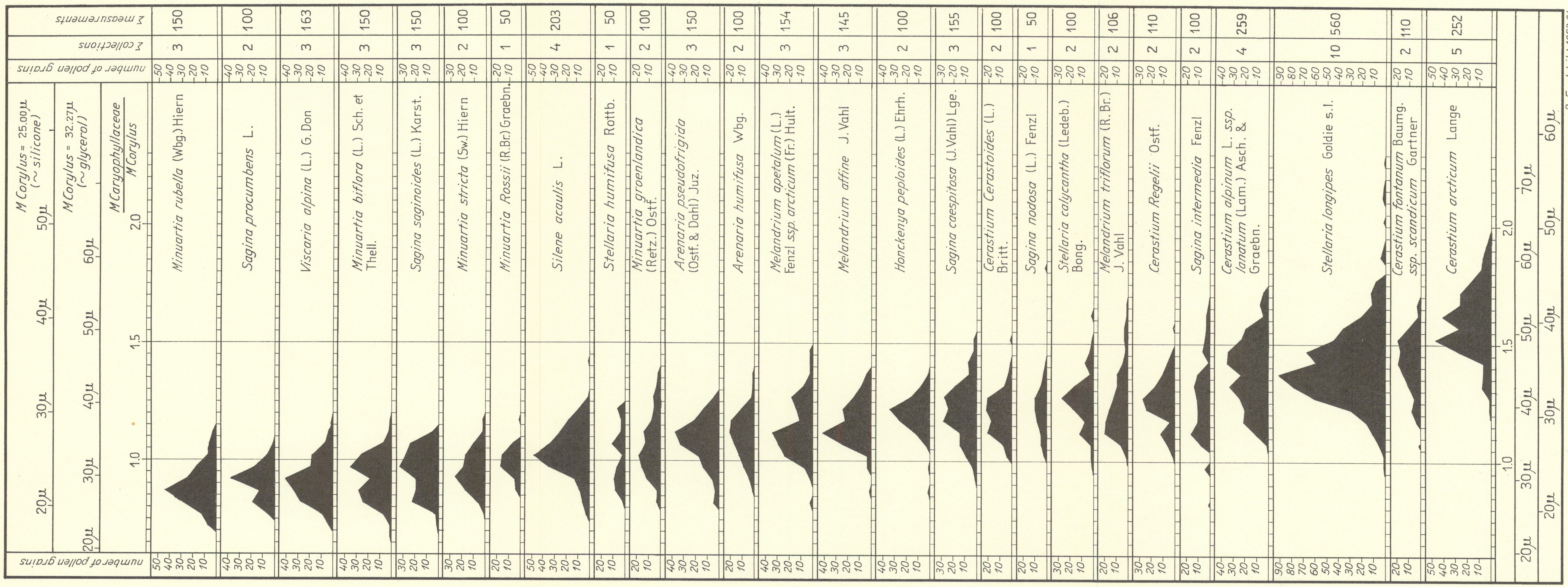
Sermermiut B
Jakobshavn, Grønland.

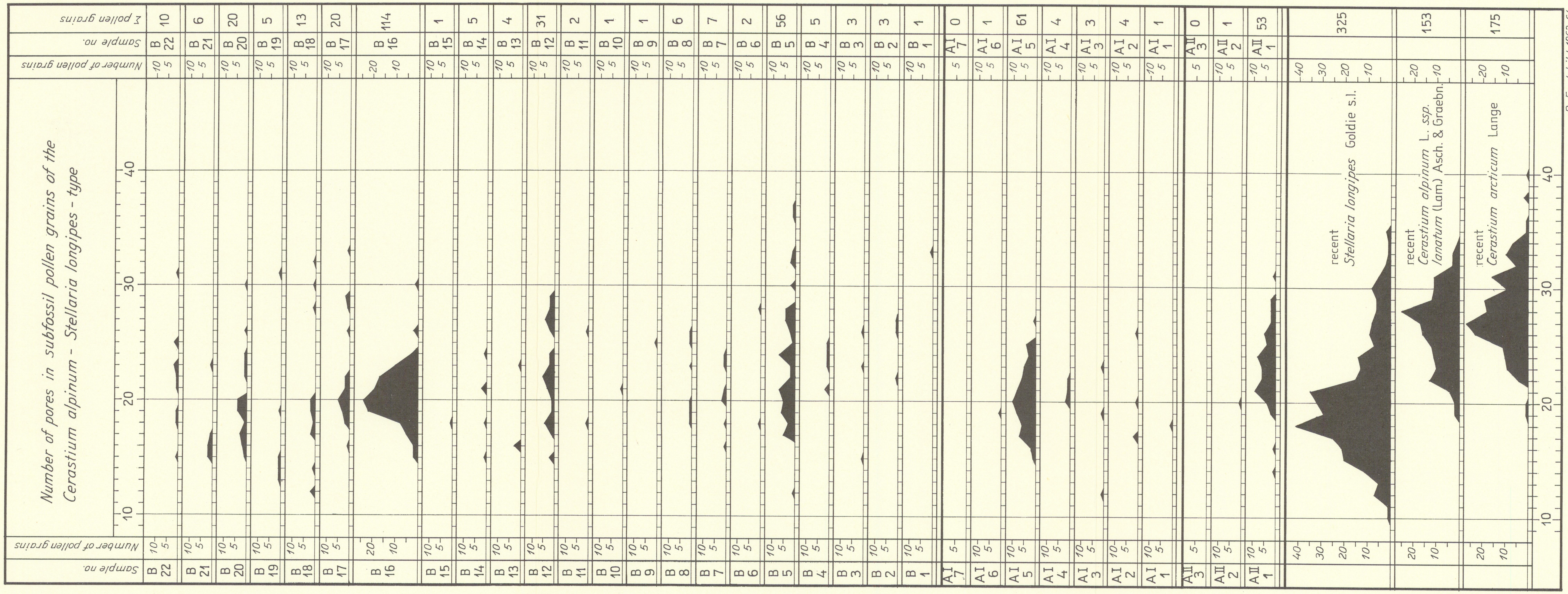


Metres above high water mark. Chips ○ and tools ◯ of angmaq or chalcedony.

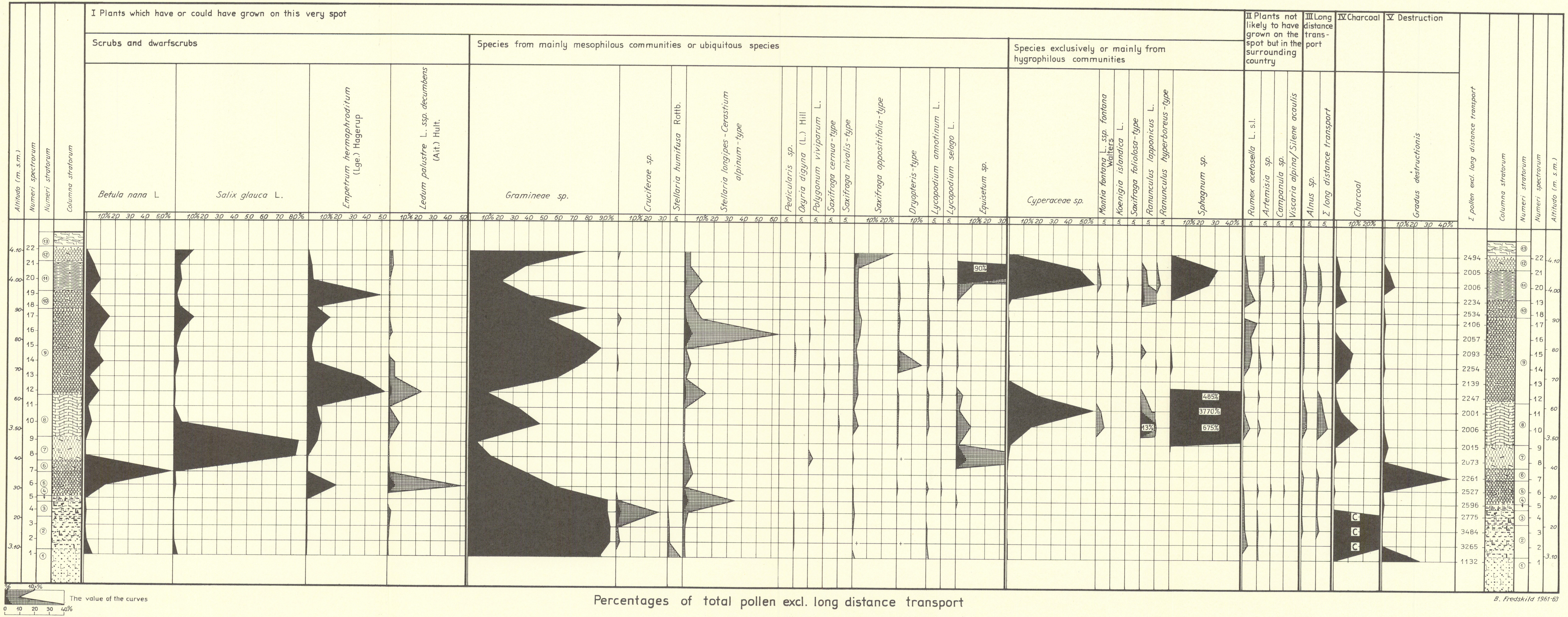
Measured by Svend Jørgensen 1955.


Number of pores in recent pollen grains of Caryophyllaceae
Σ pollen grains
Σ collections
number of pollen grains
Stellaria humifusa Rottb.
Minuartia groenlandica (Retz.) Ostf.
Minuartia stricta (Sw.) Hiern
Cerastium Cerastoides (L.) Britt.
Minuartia Rossii (R.Br.) Graebn.
Minuartia biflora (L.) Sch. et Thell.
Cerastium Regelii Ostf.
Arenaria humifusa Wbg.
Stellaria longipes Goldie s.l.
Arenaria pseudofrigida (Ostf. & Dahl) Juz.
Stellaria calycantha (Ledeb.) Bong.
Minuartia rubella (Wbg.) Hiern
Silene acaulis L.
Honckenya peploides (L.) Ehrh.
Cerastium fontanum Baumg. ssp. scandicum Gartner
Cerastium alpinum L. ssp. lanatum (Lam.) Asch. & Graebn.
Viscaria alpina (L.) G. Don
Cerastium arcticum Lange
Sagina saginoides (L.) Karst.
Sagina procumbens L.
Melandrium affine J. Vahl
Melandrium apetalum (L.) Fenzl ssp. arcticum (Fr.) Hult.
Melandrium triflorum (R.Br.) J.Vahl
Sagina caespitosa (J. Vahl) Lge.
Sagina intermedia Fenzl
Sagina nodosa (L.) Fenzl
B. Fredskild 1963-64


Σ measurements
Σ collections
number of pollen grains
M Corylus = 25.00µ (~ silicone)
M Corylus = 32.27µ (~ glycerol)
M Caryophyllaceae / M Corylus
Minuartia rubella (Wbg.) Hiern 3 150
Sagina procumbens L. 2 100
Viscaria alpina (L.) G. Don 3 163
Minuartia biflora (L.) Sch. et Thell. 3 150
Sagina saginoides (L.) Karst. 3 150
Minuartia stricta (Sw.) Hiern 2 100
Minuartia Rossii (R.Br.) Graebn. 1 50
Silene acaulis L. 4 203
Stellaria humifusa Rottb. 1 50
Minuartia groenlandica (Retz.) Ostf. 2 100
Arenaria pseudofrigida (Ostf. & Dahl) Juz. 3 150
Arenaria humifusa Wbg. 2 100
Melandrium apetalum (L.) Fenzl ssp. arcticum (Fr.) Hult. 3 154
Melandrium affine J. Vahl 3 145
Honckenya peploides (L.) Ehrh. 2 100
Sagina caespitosa (J.Vahl) Lge. 3 155
Cerastium Cerastoides (L.) Britt. 2 100
Sagina nodosa (L.) Fenzl 1 50
Stellaria calycantha (Ledeb.) Bong. 2 100
Melandrium triflorum (R.Br.) J. Vahl 2 106
Cerastium Regelii Ostf. 2 110
Sagina intermedia Fenzl 2 100
Cerastium alpinum L. ssp. lanatum (Lam.) Asch. & Graebn. 4 259
Stellaria longipes Goldie s.l. 10 560
Cerastium fontanum Baumg. ssp. scandicum Gartner 2 110
Cerastium arcticum Lange 5 252
B. Fredskild 1963-64


Number of pores in subfossil pollen grains of the Cerastium alpinum - Stellaria longipes - type
Σ pollen grains
Sample no.
Number of pollen grains
recent Stellaria longipes Goldie s.l.
recent Cerastium alpinum L. ssp. lanatum (Lam.) Asch. & Graebn.
recent Cerastium arcticum Lange
B. Fredskild 1963-64

Sermermiut B
Jakobshavn, Greenland



Percentages of total pollen excl. long distance transport

Sermermiut A
Jakobshavn, Greenland