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ROLF W. FEYLING-HANSEN

SHORELINE DISPLACEMENT  
IN CENTRAL VESTSPITSBERGEN  
AND  
A MARINE SECTION FROM  
THE HOLOCENE OF TALAVERA  
ON BARENTSØYA  
IN SPITSBERGEN

*With a record of the foraminifera*

Reprints from

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- Nos. 13—81. Skrifter om Svalbard og Ishavet.
  - > 82—89. Norges Svalbard- og Ishavsundersøkelser. Skrifter.
  - > 90— . Norsk Polarinstitut Skrifter.

In addition a special series is published: NORWEGIAN—BRITISH—SWEDISH ANTARCTIC EXPEDITION, 1949—52. SCIENTIFIC RESULTS. This series will comprise six volumes, four of which are now completed.

Topographic and hydrographic surveys make an important part of the work done by Norsk Polarinstitut. A list of the published maps and charts is found on the back of SKRIFTER.

A complete list of publications (including maps and charts) is obtainable on request.

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**ÅRBØKER**

- Årbok 1960. 1962. Kr. 15,00.
- Årbok 1961. 1962. Kr. 24,00.
- Årbok 1962. 1963. Kr. 28,00.
- Årbok 1963. 1965. Kr. 35,00.

## SHORELINE DISPLACEMENT IN CENTRAL SPITSBERGEN

BY ROLF W. FEYLING-HANSEN (OSLO)

In the year of 1955 a late Quaternary stratigraphical sequence was established for the area around the Billefjord in central Spitsbergen (FEYLING-HANSEN: "Stratigraphy of the marine late Pleistocene of Billefjorden, Vestspitsbergen" — Norsk Polarinst. Skr. Nr. 107). It was done on the basis of shoreline studies and investigation of fossil shells of marine molluscs and barnacles in the deposits.

The *Billefjord* is a 32 km long fjord which branches off from the *Isfjord* towards northnortheast in the island of Vestspitsbergen. The most characteristic features of shore topography along the east coast of the fjord are large, so-called cusped forelands. They are more or less triangular in shape and are prograded in a northnortheast direction by addition of successive beach ridges. This is caused by dominant longshore beach drifting to the north produced by the great fetch of southwesterly winds.

When these processes act during periods of constant position of the shoreline, the result will be horizontal beach plains. But in the *Billefjord* the same processes have been operative during a period of emergence or, more correct, during a period of negative shift of the shoreline. Therefore, the resulting beach plains are not horizontal, but slope in the direction in which the forelands prograde, the older beach ridges being more elevated than the younger ones. The gradient of the slope depends on the rate of emergence and the rate of progradation. Every new beach ridge had to form at a lower level than its predecessor and every new lamina in the growing sequence was deposited at a lower sea level than the previous lamina. Thus the beach ridges, which occupy the surface of the sloping beach plains, record the vertical as well as the horizontal movements of the shoreline.

Collecting fossils from these sediments one is, provided the fossils have remained in situ, able to associate every collected specimen with its corresponding sea level, that is: with the position of the shoreline synchronous with the time at which the specimen was imbedded in the sediment. — There exist several factors tending to confuse the indications provided by the fossils. Fossil shells may be brought from their original place and redeposited by streams, waves, currents, or even by solifluction and glacial advance. Such factors were considered in every specific case, and allochthonous material, as far as possible, let out of consideration.

Shorelines of marine origin were found up to 90 m above present-day sea level in the Billefjord, up to 96 m in the Sassenfjord on the south side of the Isfjord. Marine shells were found in the deposits up to 84.5 m above present sea level.

The time interval in which the shoreline shifted from 90 m to 60 m above present-day sea level was called the *Late Glacial Cold Period*. Only two species of marine

molluscs were found in the deposits between 84.5 m and 60 m, *Saxicava arctica* (= *Hiatella arctica*) and *Mya truncata*. Fossils are extremely rare in the Billefjord area at these levels.

The time during which the shoreline moved from 60 m to 40 m above present-day sea level was called the *Post Glacial Temperate Period*. 14 new species occurred in the deposits of this period, and this fossil fauna suggests that the Temperate Period had marine-climatic conditions similar to those prevailing in the area to-day. The fauna of the terraces between 60 m and 40 m is usually dominated by *Mya truncata*, hence they were called *Mya terraces*.

The time during which the shoreline moved from 40 m to 3 m above present-day sea level was called the *Post Glacial Warm Period*. 39 new species immigrated to the inner Isfjord area during this period, among them 7 which now seem to be extinct in Spitsbergen waters: *Heteranomia squamula*, *Volsella modiola*, *Arctica islandica* (= *Cyprina islandica*), *Zirfaea crispata*, *Emarginula fissura*, *Littorina littorea* and *Omalogyra atomus*. The climatical conditions in the area during this period were decidedly better than those prevailing there to-day, they were probably similar to those prevailing at present along the coasts of Finnmark and Iceland. — The fossil fauna of the littoral deposits between 40 m and 6 m above present sea level was found to be characterized by dominant occurrence of *Astarte borealis*. Terraces within this height interval, therefore, were termed *Astarte terraces*. They were further divided into *Upper Astarte terraces*, from 40 m to 17 m a. s. l., and *Lower Astarte terraces*, from 17 m to 6 m a. s. l. Between 6m and 3 m a. s. l. there occur littoral features which were termed *Mytilus terraces*, because *Mytilus edulis* dominates the fauna in most of them.

Finally, the time during which the shoreline moved from 3 m above sea level to its present position was called the *Sub-Recent Period*. At these levels the Warm-interval indicators have disappeared from the fossil fauna.

These results are now ten years old. Three-and-a-half years ago Dr. RAPP of the University of Uppsala, urged that some of the shell samples of my collections from central Spitsbergen be dated by radiological methods. Five samples were placed at his disposal, and he submitted them for dating to the Radiocarbon dating laboratory of the University of Uppsala, where the datings were carried out by Dr. INGRID OLSSON (FEYLING-HANSSEN and OLSSON: "Five radiocarbon datings of post glacial shorelines in central Spitsbergen." — *Norsh Geogr. Tidsskr.*, vol. 17, 1960.) Later I have submitted more shell samples from the same area for dating by INGRID OLSSON, one of these has now been dated, and is listed, together with the others, below. All the datings here presented are corrected to the new international standard (NBS oxalic acid), and given before 1950.

Three of the samples were from *Mya terraces* of the Temperate interval, taken 56.0 m above sea level, 50.7 m a.s.l., and 42.0 m a. s. l. After washing with acid every sample was run twice, once the outer layers and once the inner parts. The outer layers were run as a check in order to detect possible contaminations, these values are called "a"-values. The results from the inner parts should be considered as the best approximation to the real ages, they are called "b"-values:

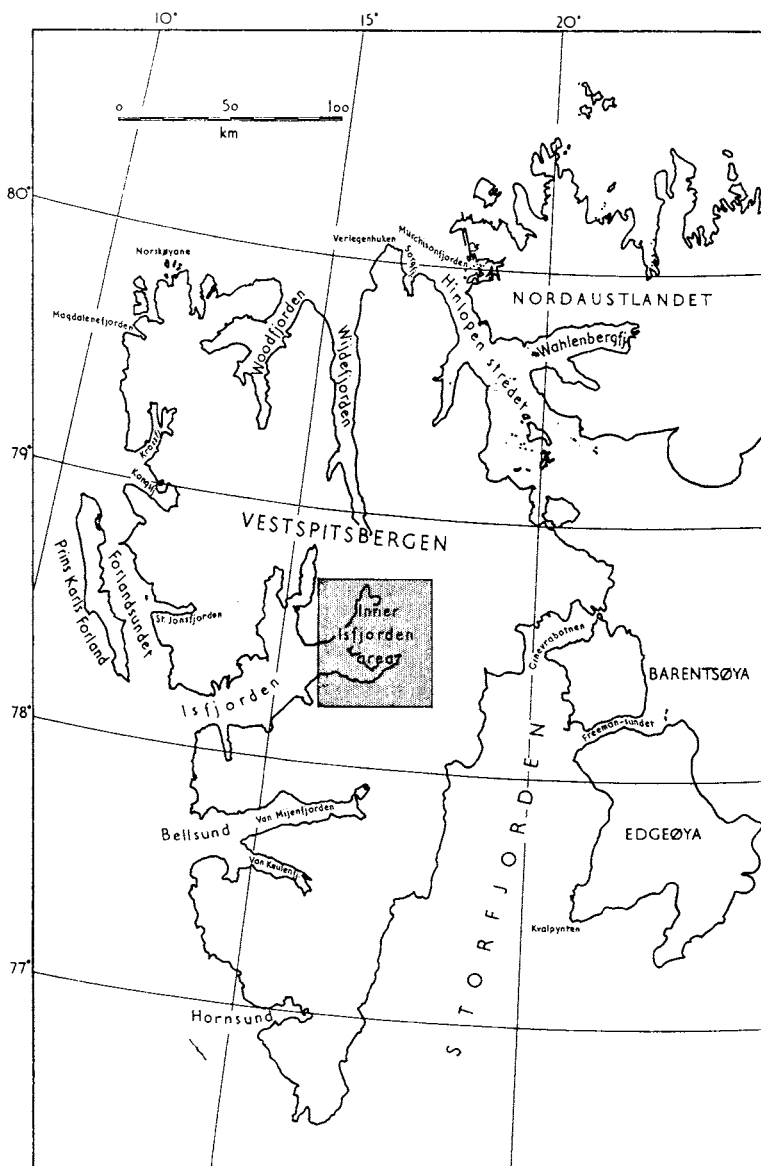


Fig. 1.

These results are inserted in the diagram of figure 2. Time is plotted along the abscissa in thousands of years from right to left, zero indicating AD 1950. Heights are plotted along the ordinate in metres above present-day sea level. The b-values of the dates are indicated with rings, the short horizontal lines indicate the range of deviation of a- and b-values together.

56.0 m a. s. l.	}	(U-132) b: 9965	+	160	years before 1950
		(U-131) a: 10585	+	330	” ” ”
50.7 m a. s. l.	}	(U-128) b: 10105	+	150	” ” ”
		(U-127) a: 9975	+	150	” ” ”
42.0 m a. s. l.	}	(U-124) b: 9435	+	200	” ” ”
		(U-123) a: 9705	+	180	” ” ”

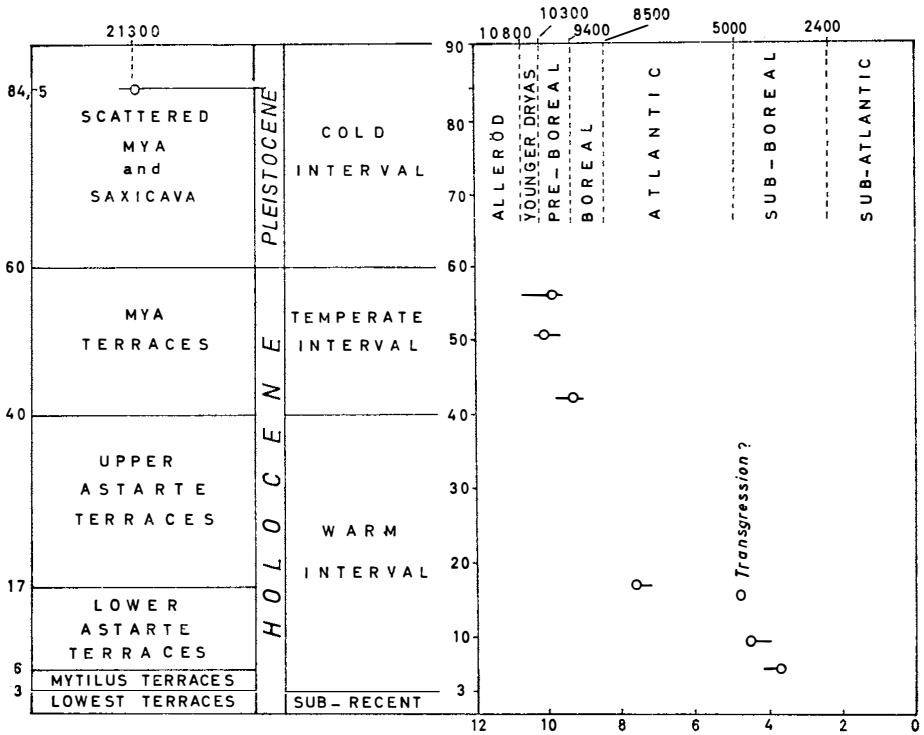


Fig. 2.

Two of the samples were from *Astarte* terraces of the Warm interval, taken 17.0 m a. s. l. and 9.7 m a. s. l.:

17.0 m a. s. l.	{	(U-130) b: 7720 $\pm$ 110 years before 1950
		(U-129) a: 7535 $\pm$ 170 " " "
9.7 m a. s. l.	{	(U-203) b: 4500 $\pm$ 90 " " "
		(U-204) a: 4160 $\pm$ 170 " " "

One of the samples was from a *Mytilus* terrace of the Warm interval, taken 5.8 m a. s. l.:

5.8 m a. s. l.	{	(U-126) b: 3935 $\pm$ 100 years before 1950
		(U-125) a: 4110 $\pm$ 160 " " "

On the left side in the diagram the stratigraphical sequence of central Spitsbergen has been added, and in the upper part the stratigraphical units of BLYTT-SERNANDER. The ages of the zone borders in the Blytt-Sernander system are based upon recent radiocarbon dates.

From this combination it appears that the Temperate interval of central Spitsbergen is probably synchronous with BLYTT-SERNANDER's Pre-Boreal time. Furthermore, the Warm interval of central Spitsbergen is probably identical with the Post Glacial Warm interval in Europe, comprising Boreal, Atlantic and Sub-Boreal time. A rapid negative shift of the shoreline seems to have taken place during Pre-Boreal time.

1960 INGRID OLSSON and I collected shell material from the highest occurrence of fossils in the Billefjord, 84.5 m above sea level at Ekholmvikta. Only small fragments of *Mya truncata* and *Saxicava arctica* were found. This sample has now been dated by INGRID OLSSON:

84.5 m a. s. l.	{	(U-189) b: 21300 $\pm$ 500 years before 1950
		(U-190) a: 18100 $\pm$ 500 " " "

Due to contamination, 21300 years is considered a minimum age for the sample.

At Skansbukta on the west side of Billefjorden there occurred a thin peat layer buried in marine gravel, probably indicating a transgression (Cp. FEYLING-HANSEN: "A marine section from the Holocene of Talavera, Barents öya in Spitsbergen" —). A sample from this peat has been dated by INGRID OLSSON:

Peat, 16.2 m a. s. l. (U-185): 4800  $\pm$  120 years before 1950.

If a transgression, it seems probably to have taken place simultaneously with the late Atlantic — early Sub-Boreal transgression known from many other localities, e. g. in northern Europe.

A MARINE SECTION FROM THE HOLOCENE OF TALAVERA  
ON BARENTSÖYA IN SPITZBERGEN  
WITH A RECORD OF THE FORAMINIFERA

BY ROLF W. FEYLING-HANSEN (OSLO)

The German Expedition to Southeast Spitsbergen, 1959–1960, under the leadership of Professor Dr. JULIUS BÜDEL, among many other activities studied an unconsolidated marine deposit located on the eastern part of the Talavera foreland, a coastal plain at the southwest corner of Barentsöya (Barents Island) in Spitsbergen. The morphology of this foreland was described by BÜDEL in the year of 1960.

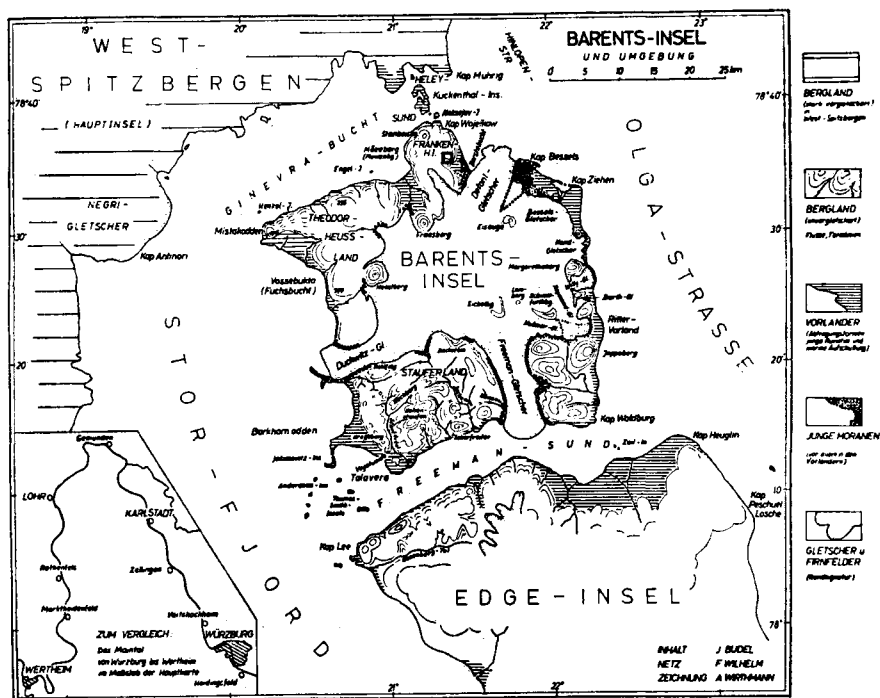


Fig. 1. The location of the section is marked with a filled circle. Maps from Büdel, 1960.

On the east side of the brook Staufersbekken (fig. 1) marine deposits form a terrace, the surface of which rises gently inland. At the brook, approximately 300 m from the shore, the terrace surface is situated 15 m above sea level. At this place a section



was worked out from the surface down almost unto the underlying bedrock, which was there situated 5.7 m below the surface. The bedrock consists of ice-smoothed and striated diabase.

Samples of fossil shells of marine molluscs and cirripeds, and fragments thereof, were collected at 11 different horizontal zones in this section, and in addition a number of sediment samples were taken throughout the section.

This collection was generously handed over to me by Professor BÜDEL, and the present study is a report on my study of the material.

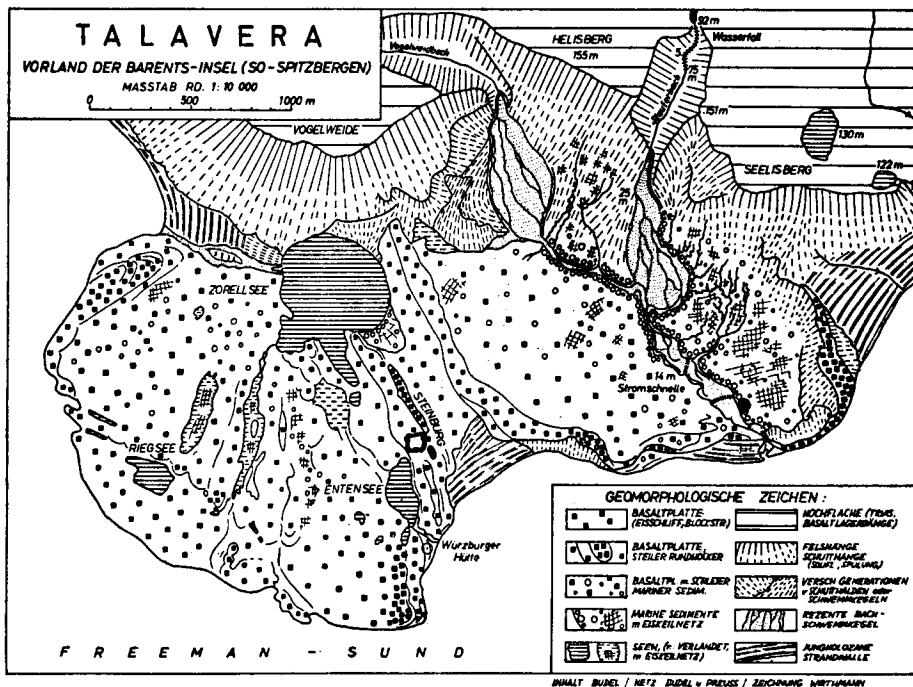


Fig. 2. The location of the section is marked with a filled circle. Maps from Büdel, 1960.

SEDIMENT

The deposit is build up of irregularly alternating coarser and finer strata, apparently in horizontal position. The bulk of the material in the upper part of the section consists of sand, to a greater or lesser degree containing pebbles. In the lower half of the section the sediment is silty or even clayey. The top of the permafrost was situated, 42 cm below the surface (August 20, 1960).

In figure 3 a schematic illustration of the section is presented. Some of the sediment samples were treated mechanically, and their grain size distribution analysed. The median diameter (the 50% point of the cumulative curve, the size of the middle particle), in millimetres, plotted to the left of the section, confirms the broad charac-

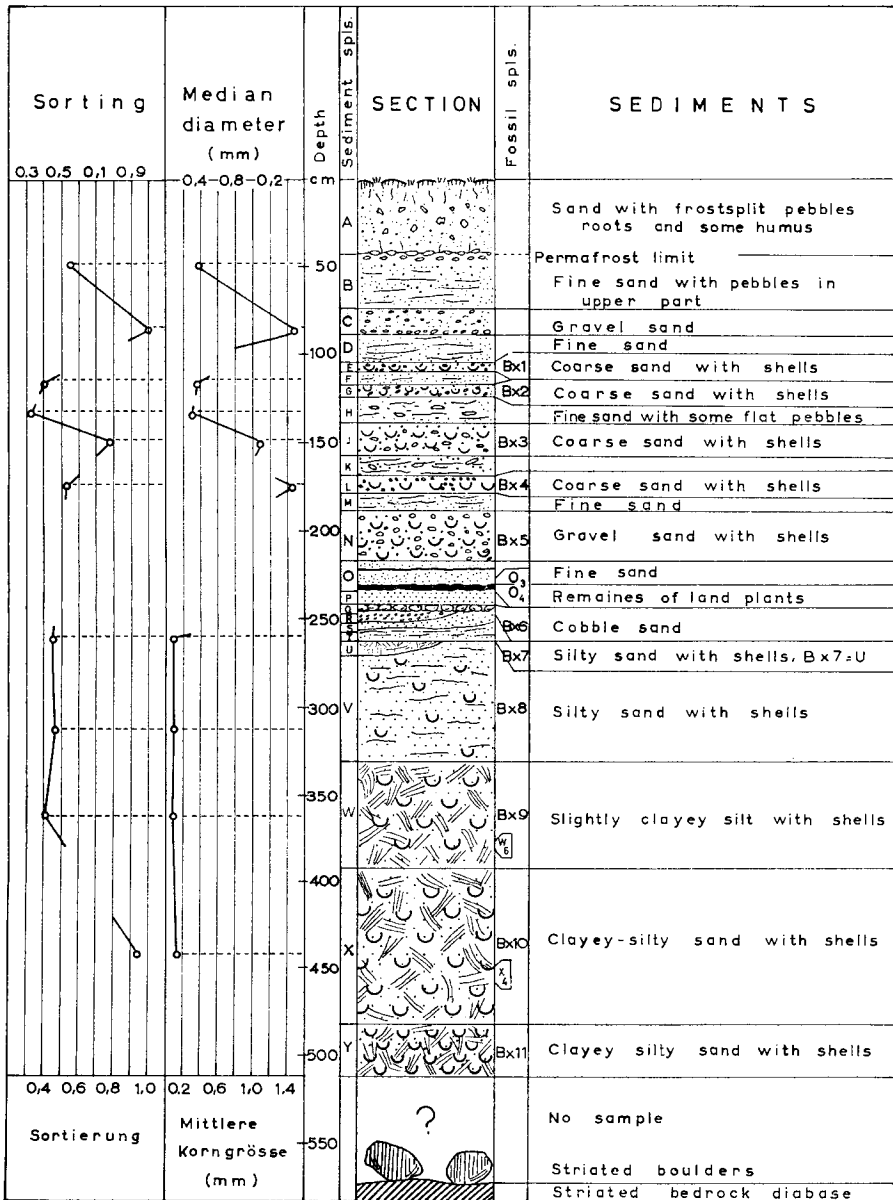


Fig. 3. The marine section from Talavera.

teristics given above. The coefficient of sorting,  $S_0$ , has been calculated as the logarithm of the ratio between the quartiles,  $S_0 = \log \frac{Q_{75}}{Q_{25}}$ . All mechanically analysed samples were well sorted.

The sand was dark, the major part of it originating from diabase and black slate. Many pebbles and granules were black, flat slate particles with well rounded margins. They were usually horizontally oriented. The stones of the gravelly strata seldom exceeded 2 cm in length or diameter.

However, 243 cm below the surface there was a 7–8 cm thick layer of cobble sand almost exclusively consisting of fist-sized, and even larger, particles. Below this stratum a finer gravel, maximum thickness 7 cm, occurred. The particles had an average diameter of 1 cm, and were stained red with iron oxide. Below this there was a 10 cm thick layer of yellow sand, and further downwards silty sand and clayey silt dominated the section. Sampling was stopped 60 cm above the bedrock. The basal layers, not represented in the investigated material, contained erratic boulders (oral communication from Dr. BÜDEL).

Above the layer with cobble sand there was a 10 cm thick layer of rust-brown sand, and above this a 2–4 cm thick bluish black silty-sandy humus with roots and leaves and other particles, of land plants, almost a peat formation, occurred. Mosses (not Sphagnum) were frequent, ericacean leaves and fragments of woody plants occurred. The sample has not been subjected to pollen analyses; this would probably be of some interest.

This peat stratum lies 2.33 m below the surface and 12.6 m above present-day sea level.

#### MARINE MEGA-FOSSILS

Shells and shell fragments of marine molluscs and barnacles were collected at 11 zones within the section of Talavera. The highest of these zones from which shells were collected, lay 103 to 108 cm below the surface, the lowest 481 to 511 cm below the surface. The deposit thus contained marine fossils above the previously mentioned layer with plant remains as well as below it.

The fossil fauna was poor, 13 different species of mollusca, 2 cirripedia and 1 species of *Lithothamnion* being present.

In calculating the frequency of the different species of pelecypods only whole valves and umbonal fragments were counted, and their number divided by two, of gastropods whole shells and summits of broken shells were counted. Clods of *Lithothamnion* were not counted, their presence was only indicated. The number of balanid specimens were calculated from the kind and number of compartments present.

*Sample Bx 1*, 103–108 cm below the surface, fine gravel, contained:

<i>Astarte elliptica</i>	. . . . .	1 specimen
<i>Saxicava arctica</i>	. . . . .	6 specimens
<i>Mya truncata</i>	. . . . .	3 specimens
<i>Balanus crenatus</i>	. . . . .	4 specimens

The sample contained 100 shell fragments, but only umbonal fragments were counted. The specimens of *Saxicava arctica* were small.

*Sample Bx 2*, 116—123 cm below the surface, coarse sand, contained:

<i>Astarte borealis</i>	. . . . .	1 specimen
<i>Astarte elliptica</i>	. . . . .	1 specimen
<i>Macoma calcarea</i>	. . . . .	1 specimen
<i>Saxicava arctica</i>	. . . . .	4 specimens
<i>Mya truncata</i>	. . . . .	1 specimen
<i>Balanus crenatus</i>	. . . . .	2 specimens

*A. elliptica* and one specimen of *S. arctica* were represented by whole shells, the rest by quite small fragments. *A. borealis* and *A. elliptica* of normal size. Two echinid spines occurred.

*Sample Bx 3*, 138—156 cm below the surface, sand with flat stones 2 cm in diameter, contained:

<i>Astarte borealis</i>	. . . . .	1 specimen
<i>Saxicava arctica</i>	. . . . .	22 specimens
<i>Mya truncata</i>	. . . . .	3 specimens
<i>Balanus crenatus</i>	. . . . .	2 specimens

Many unbroken valves occurred in this sample, several shells of *S. arctica* were relatively large and elongated (*pholadis*-form).

*Sample Bx 4*, 168—178 cm below the surface, sand with flat stones 1.5 cm in diameter, contained:

<i>Macoma calcarea</i>	. . . . .	1 specimen
<i>Saxicava arctica</i>	. . . . .	21 specimens
<i>Mya truncata</i>	. . . . .	7 specimens
<i>Balanus balanus</i>	. . . . .	1 specimen
<i>Balanus crenatus</i>	. . . . .	1 specimen

Some quite large and elongated shells of *S. arctica* occurred, and two shells of *M. truncata*.

*Sample Bx 5*, 188—218 cm below the surface, gravel with approximately  $\frac{1}{5}$  of the pebbles 2 cm in diameter, the rest on an average 1 cm, contained:

<i>Astarte borealis</i>	. . . . .	3 specimens
<i>Astarte elliptica</i>	. . . . .	1 specimen
<i>Macoma calcarea</i>	. . . . .	1 specimen
<i>Saxicava arctica</i>	. . . . .	23 specimens
<i>Mya truncata</i>	. . . . .	11 specimens
<i>Balanus balanus</i>	. . . . .	1 specimen
<i>Balanus crenatus</i>	. . . . .	1 specimen

Most of the valves were unbroken, the shells of *A. borealis* had the periostracum partly preserved. Many shells of *S. arctica* were small and many *M. truncata* thin-shelled.

*Sample Bx 6*, 243–250 cm below the surface, coarse gravel with fist-sized, and even larger, stones, contained:

<i>Astarte borealis</i>	. . . . .	2 specimens
<i>Saxicava arctica</i>	. . . . .	20 specimens
<i>Mya truncata</i>	. . . . .	16 specimens
<i>Balanus balanus</i>	. . . . .	1 specimen
<i>Balanus crenatus</i>	. . . . .	1 specimen

Many unbroken valves. *A. borealis* had partly preserved periostracum. The shells of *S. arctica* were on the whole quite small, *M. truncata* was mostly thin-shelled.

*Sample Bx 7*, 262–269 cm below the surface, silty sand, contained:

<i>Astarte borealis</i>	. . . . .	27 specimens
<i>Serripes groenlandicus</i>	. . . . .	1 specimen
<i>Saxicava arctica</i>	. . . . .	1 specimen
<i>Mya truncata</i>	. . . . .	3 specimens
<i>Balanus balanus</i>	. . . . .	1 specimen

The shells of *A. borealis* were large, with dark, almost black, periostracum. Many specimens had united valves.

*Sample Bx 8*, 269–330 cm below the surface, dark-brown sandy silt, contained:

<i>Nuculana pernula</i>	. . . . .	1 specimen
<i>Astarte borealis</i>	. . . . .	30 specimens
<i>Astarte montagui</i>	. . . . .	2 specimens
<i>Serripes groenlandicus</i>	. . . . .	1 specimen
<i>Saxicava arctica</i>	. . . . .	1 specimen
<i>Mya truncata</i>	. . . . .	5 specimens
<i>Cylichna alba</i>	. . . . .	1 specimen
<i>Cingula castanea</i>	. . . . .	1 specimen

The shells of *A. borealis* were large, with dark periostracum, one specimen had united valves. Some echinid epines occurred in the sample.

*Sample Bx 9*, 330–390 cm below the surface, brown silty to slightly clayey sand, contained:

<i>Astarte borealis</i>	. . . . .	1 specimen
<i>Astarte elliptica</i>	. . . . .	1 specimen
<i>Clinocardium ciliatum</i>	. . . . .	1 specimen
<i>Serripes groenlandicus</i>	. . . . .	1 specimen
<i>Macoma calcarea</i>	. . . . .	2 specimens
<i>Saxicava arctica</i>	. . . . .	22 specimens
<i>Mya truncata</i>	. . . . .	12 specimens
<i>Balanus balanus</i>	. . . . .	1 specimen
<i>Balanus crenatus</i>	. . . . .	1 specimen

Some of the *Saxicava* shells were quite large.

*Sample Bx 10*, 390–480 cm below the surface, silty-clayey sand with an apparently weathered zone in the upper part. This unit of the section was quite rich in fossil specimens, but only a few different species occurred in the sample:

<i>Astarte borealis</i>	. . . . .	2 specimens
<i>Astarte elliptica</i>	. . . . .	2 specimens
<i>Saxicava arctica</i>	. . . . .	22 specimens
<i>Mya truncata</i>	. . . . .	23 specimens
<i>Balanus balanus</i>	. . . . .	2 specimens

Three clods of *Lithothamnion* sp. were present, and a complete specimen of *B. balanus* was attached to one of them. Many specimens of *M. truncata* and *S. arctica* had their valves united. Some shells were overgrown with bryozoans.

*Sample Bx 11*, 480–511 cm below the surface, silty-clayey sand, rich in fossils. The sample contained:

<i>Heteranomia squamula</i>	. . . . .	1 specimen
<i>Astarte elliptica</i>	. . . . .	2 specimens
<i>Saxicava arctica</i>	. . . . .	7 specimens
<i>Mya truncata</i>	. . . . .	14 specimens
<i>Omalogyra atomus</i>	. . . . .	1 specimen
<i>Balanus balanus</i>	. . . . .	2 specimens
<i>Balanus crenatus</i>	. . . . .	1 specimen

Echinid spines and four clods of *Lithothamnion* were present. Many specimens of *M. truncata* and *S. arctica* had their valves united. Of *B. balanus* six compartments, belonging to two species were found. Nearly all shell material was overgrown with bryozoans. The megafossils of these samples are plotted together in figure 4.

#### THE AGE OF THE DEPOSIT

All fossils found in the investigated section belong to species still living today. Therefore it should be quite an easy task, as far as the ecology of these species is known, to draw paleoecological conclusions from the fossils present. Before doing so, however, it must be considered to what extent the fossils found represent species which lived on the spot, belonged to the biotope of the corresponding time, or to what extent some of them, or all, may have been brought in from a foreign environment by some transporting agency. Serious possibilities exist of fossils having been redeposited by streams, waves, currents, or even by solifluction and glacial advance.

Solifluction and glacial advance as confusing factors may be excluded in the present case as the sediment seems to occur in undisturbed strata. In such strata fossils may be considered to have remained in situ if the size and weight of the biogenic particles, size of fossil specimens and fragments thereof, are of an order of magnitude different from that of the particles of the minerogenic matrix. This is certainly the



case with the lower part of the Talavera section, where the biogenic particles are enormously large and heavy compared with the particles of the clayey-silty sand. In good agreement with this is also the frequent occurrence of fossil pelecypods with united valves and wellpreserved periostracum in those parts of the deposit. In the upper part of the section there are undoubtedly strata in which biogenic and minerogenic particles are of approximately equal size, an instance which would, in many cases, prove that one and the same agency brought them together. Such indication of possible redeposition exists especially with the two uppermost samples, Bx 1 and 2, in which the minerogenic component was relatively coarse and the shells were represented mostly by quite small fragments. Other samples from the upper part of the deposit, however, contain mostly unbroken valves.

On the whole, there are reasons to believe that the major part of the fossil shells of the investigated section are *in situ*.

The composition of the fossil faunas of the Talavera section is quite uniform. Except the two samples, Bx 7 and Bx 8, the faunas are dominated by *Saxicava arctica* or *Mya truncata* or by both of them. There is no pronounced difference in faunal composition between samples taken above the layer with remnants of land plants, and samples taken below it.

Most of the species are eurythermal forms which do not indicate anything particular about *water temperature* at the time when these sediments were deposited. They are boreo-arctic forms which today would be able to live in Spitsbergen waters as well as along the whole Norwegian coast. An exception is *Heteranomia squamula*, which has never been taken alive in Spitsbergen waters. It lives along the Norwegian coast, the Murman coast, in the White Sea, the Barents Sea and in the southern part of the Kara Sea (FEYLING-HANSSSEN 1955 a, p. 127). One valve of this species occurred in the lowest sample, Bx 11, of the Talavera Section. It indicates marine-climatic conditions more favourable than those prevailing in the area today, and is regarded as an important guide fossil to deposits from the Post Glacial Warm interval in Spitsbergen (FEYLING-HANSSSEN 1955 a).

This indication is to some degree supported by the presence of fossil shells of *Astarte borealis*.

In central Spitsbergen, i. e., in Billefjorden, Sassenfjorden and at Kapp Wijk in Dicksonfjorden, the first appearance of *Astarte borealis* in late Pleistocene deposits coincides with the beginning of the *Post Glacial Warm interval* (FEYLING-HANSSSEN 1955 a, b). Due to its high frequency, very often it dominates the fossil faunas, this species is a very useful guide fossil for shallow-water deposits of that age, especially for the upper limit of Warm interval deposits.

This does, of course, not necessarily apply to the region of Barentsöya. Most probably the ecological conditions on the east coast of Vestspitsbergen are somewhat different from those of the inner Isfjorden area. Furthermore the Late Pleistocene — Holocene shoreline displacement as well as the stratigraphy of corresponding deposits in the Storfjorden area are almost unknown. Shorelines and marine deposits in Barentsöya may have been raised to heights quite different to those of corresponding formations in central Spitsbergen.



On the other hand *Astarte borealis* from undisturbed Holocene deposits has nowhere in Spitsbergen, or Svalbard as a whole, been recorded at heights greater than the upper limit of Post Glacial Warm interval formations. This limit seems in central Spitsbergen to be situated at 40 m above present-day sea level.

Thus, from these two indications, the presence of *Heteranomia squamula* and the, partly rich, occurrence of *Astarte borealis*, it is believed that *the fossiliferous sediments of the Talavera section are of Holocene age, deposited during some part of the Post Glacial Warm interval*. This conclusion is supported by radiocarbon dating of organic material from the peat stratum. The dating was carried out by INGRID OLSSON at the Uppsala radiocarbon laboratory in 1961 and gave a result of 6000  $\pm$  400 years before present.

#### MICROFOSSILS

Samples Bx 7 and Bx 8, partly also Bx 6, below the peat stratum, and Bx 5 above this stratum differ from the other samples by their relatively large content of *Astarte borealis*. Sample Bx 8 contained 30 valves of this species, Bx 7 contained 27. In sample Bx 6 there were 4 and in Bx 5, 5. To see if this larger content of *A. borealis* probably registered a change in water temperature, the Foraminifera in sample Bx 8 were separated and analyzed and then compared with the foraminiferal content of sample Bx 11, which contained no *A. borealis* at all. The clayey silt which adhered to or filled the shells of these two samples were used for foraminiferal analyses. The foraminifera have proved to be valuable temperature indicators, but are also influenced by depth. If any change in temperature took place with the change in *Astarte* frequency, it would presumably have been reflected in the composition of the foraminiferal fauna.

However, as seen from the analyses here presented, the composition of the foraminifera fauna was almost equal in the two samples. As a check the foraminiferal content of two more samples, X<sub>4</sub> and W<sub>6</sub>, situated between Bx 8 and Bx 11 in the section, were investigated, with the same result. The four analyses are plotted together in figure 5, where the species are arranged according to the system of POKORNÝ (1958).

The four micropaleontologically investigated samples were all rich in foraminifera. Sample Bx 11, the lowest one, contained 39 different species, 565 specimens were counted, this accounting for approximately  $\frac{1}{15}$  of the sample. Sample X<sub>4</sub>, 460 cm below the surface, contained 34 different species, 483 specimens were counted. Sample W<sub>6</sub>, 380 cm below the surface, contained 32 different species, 405 specimens counted, and sample Bx 8, which contained 30 valves of *Astarte borealis*, yielded 34 different species of foraminifera, 567 specimens were counted. On an average, a sediment sample of 150 g weight contained 7500 specimens of foraminifera, 50 per gramme sample. A total of 57 different species were observed in the four investigated samples.

Already the relatively high frequency of both species and specimens in these fossil microfaunas points towards quite favourable environmental conditions. For the pur-

TALAVERA SECTION		FORAMINIFERA			
Sample number		B x 8	W 6	X 4	B x 11
Depth below the terrace surface in centimetres		269-330	375-385	355-385	480-511
ALVEOLOPHRAGMIUM CRASSIMARGO	.				
ALVEOLOPHRAGMIUM JEFFREYSI	.	.			
RECURVIDES TURBINATUS					.
SPIROPECTAMMINA BIFORMIS					.
TROCHAMMINA NANA	.				
TROCHAMMINELLA ATLANTICA				.	
QUINQUELOCULINA AGGLUTINATA	.	.			.
QUINQUELOCULINA ARCTICA	.	.			.
QUINQUELOCULINA SEMINULUM	.	.			x
PATEORIS HAUERINOIDES					x
TRILOCULINA OBLONGA					.
TRILOCULINA TRIHEDRA	.				.
MILIOLINELLA CHUKCHIENSIS					.
DENTALINA FROBISHERENSIS			.		
LENTICULINA (ASTACOLUS) CREPIDULA	.				
LAGENA LAEVIS	.				
LAGENA SEMILINEATA				.	
GUTTULINA DAWSONI	.	.			
GUTTULINA CF. LACTEA	.			.	.
SIGMOMORPHINA AFF. UNDULOSA				.	.
PSEUDOPOLYMORPHINA NOVANGLIAE	.	.			
GLOBULINA GLACIALIS	.	.	.	.	.
LARYNGOSIGMA HYALASCIDIA				.	.
LARYNGOSIGMA WILLIAMSONI					.
ESOSYRINX CURTA		.			.
BULIMINELLA AURICULA					.
VIRGULINA LOEBLICI				.	
OOLINA BOREALIS	.	.	.	.	.
OOLINA CAUDIGERA	.	.	.	.	x
OOLINA MELO	.	x	.	.	x
OOLINA SCALARIFORME - SULCATA				.	
OOLINA SQUAMOSO - SULCATA		.			
FISSURINA MARGINATA	x	.	x	x	x
ANGULOGERINA FLUENS	.	.	.	.	.
BOLIVINA PSEUDOPUNCTATA	.	.	x	x	x
CASSIDULINA CRASSA	o	x	●	o	
ISLANDIELLA NORCROSSI		.			
ISLANDIELLA TERETIS	x	.	.	.	.
NONIONELLA AURICULA				.	
NONIONELLA IRIDEA				.	
NONION LABRADORICUM	●	●	●	●	
ASTRONONION GALLOWAYI	●	●	■	●	
PATELLINA CORRUGATA			.	x	
CIBICIDES BERTHELOTI	.	.	.	.	.
EPONIDES PATAGONICA				.	
BUCCELLA FRIGIDA	x	x	x	x	x
BUCCELLA INUSITATA	●	.	.	.	.
TRICHOHYALUS BARTLETTI				.	
CIBICIDES LOBATULUS	o	■	●	■	
GLOBIGERINA BULLOIDES	.		.	.	.
PROTELPIDIUM ORBICULARE	x	x	x	x	x
ELPHIDIUM BARTLETTI	x	o	x	x	x
ELPHIDIUM FRIGIDUM	.	.	.	.	.
ELPHIDIUM INCERTUM CLAVATUM	●	x	x	x	x
ELPHIDIUM INCERTUM INCERTUM	x	.	.	.	.
ELPHIDIUM SUBARCTICUM	●	●	o	o	
ELPHIDIELLA ARCTICA	x	.	.	.	.

Fig. 5 The Foraminifera of 4 samples from the section. A point indicate less than 1%, an x 1.1–5.0%, an open ring 5.1–10.0%, a filled ring 10.1–20.0%, a filled square 20.1–40.0%.

## Talavera, Barents Island.

Sample Bx 8.

Foraminifera	Frequency	Percentage
<i>Alveolophragmium crassimargo</i>	2	0.4
<i>Trochammina nana</i>	1	0.2
<i>Quinqueloculina agglutinata</i>	1	0.2
<i>Quinqueloculina seminulum</i>	1	0.2
<i>Quinqueloculina arctica</i>	1	0.2
<i>Triloculina trihedra</i>	1	0.2
<i>Lenticulina (Astacolus) crepidula</i>	1	0.2
<i>Lagena laevis</i>	1	0.2
<i>Oolina caudigera</i>	1	0.2
<i>Oolina melo</i>	2	0.4
<i>Oolina borealis</i>	4	0.7
<i>Fissurina marginata</i>	6	1.1
<i>Guttulina dawsoni</i>	2	0.4
<i>Guttulina cf. lactea</i>	3	0.5
<i>Pseudopolymorphina novangliae</i>	5	0.9
<i>Globulina glacialis</i>	1	0.2
<i>Angulogerina fluens</i>	4	0.7
<i>Bolivina pseudopunctata</i>	1	0.2
<i>Nonion labradoricum</i>	58	10.1
<i>Astrononion gallowayi</i>	85	15.0
<i>Elphidium bartletti</i>	13	2.3
<i>Elphidium frigidum</i>	2	0.4
<i>Elphidium incertum clavatum</i>	77	13.6
<i>Elphidium incertum incertum</i>	13	2.3
<i>Elphidium subarcticum</i>	85	15.0
<i>Elphidiella arctica</i>	8	1.4
<i>Protelphidium orbiculare</i>	15	2.6
<i>Cibicides lobatulus</i>	45	7.9
<i>Cibicides bertheloti</i>	1	0.2
<i>Buccella frigida</i>	8	1.4
<i>Buccella tenerrima</i>	63	11.1
<i>Cassidulina crassa</i>	47	8.3
<i>Islandiella teretis</i>	7	1.2
<i>Globigerina bulloides</i>	1	0.2
	566	100.1

pose of comparison I refer some figures for 12 Arctic bottom samples, assumed to be of Recent age, 8 from Spitsbergen and 4 from Northeast Greenland, which I collected, at depths varying between 7 and 30 m, in 1950 and 1951. A sample from Wijdefjorden, 8 m depth, in Spitsbergen contained 33 different species of foraminifera and one from Myggbukta, 10 m depth, Northeast Greenland, yielded 24 different species. The number of different species in the other 10 samples varied between

## Talavera, Barents Island.

## Sample Bx 11.

Foraminifera	Frequency	Percentage
<i>Recurvoides turbinatus</i>	2	0.4
<i>Spiroplectammina biformis</i>	1	0.2
<i>Quinqueloculina agglutinata</i>	2	0.4
<i>Quinqueloculina seminulum</i>	8	1.4
<i>Quinqueloculina arctica</i>	2	0.4
<i>Pateoris hauerinoides</i>	10	1.8
<i>Triloculina trihedra</i>	4	0.7
<i>Triloculina oblonga</i>	1	0.2
<i>Miliolinella chukchiensis</i>	1	0.2
<i>Oolina caudigera</i>	10	1.8
<i>Oolina melo</i>	6	1.1
<i>Oolina borealis</i>	4	0.7
<i>Fissurina marginata</i>	7	1.2
<i>Laryngosigma hyalascidia</i>	4	0.7
<i>Laryngosigma williamsoni</i>	3	0.5
<i>Sigmomorphina aff. undulosa</i>	4	0.7
<i>Esosyrinx curta</i>	2	0.4
<i>Guttulina cf. lactea</i>	1	0.2
<i>Pseudopolymorphina novangliae</i>	1	0.2
<i>Globulina glacialis</i>	5	0.9
<i>Buliminella auricula</i>	4	0.7
<i>Bolivina pseudopunctata</i>	6	1.1
<i>Nonion labradoricum</i>	83	14.7
<i>Astrononion gallowayi</i>	110	19.4
<i>Elphidium bartletti</i>	11	1.9
<i>Elphidium incertum clavatum</i>	9	1.6
<i>Elphidium incertum incertum</i>	1	0.2
<i>Elphidium subarcticum</i>	54	9.6
<i>Elphidiella arctica</i>	4	0.7
<i>Protelphidium orbiculare</i>	9	1.6
<i>Cibicides lobatulus</i>	130	23.0
<i>Cibicides bertheloti</i>	1	0.2
<i>Buccella frigida</i>	13	2.3
<i>Buccella tenerrima</i>	4	0.7
<i>Patellina corrugata</i>	8	1.4
<i>Cassidulina crassa</i>	32	5.7
<i>Islandiella teretis</i>	5	0.9
<i>Trichohyalus bartletti</i>	1	0.2
<i>Globigerina bulloides</i>	1	0.2
	564	100.2

7 and 16. As a total of the 12 samples 53 different species were observed. In the faunas of most of these samples there was a pronounced dominance of two species, viz., *Elphidium incertum clavatum* CUSHMAN and *Cassidulina crassa* D'ORBIGNY, these two species usually accounting for more than 80 per cent of the fauna. This frequency distribution is quite characteristic for Arctic faunas from shallow water and is commonly found also with fossil foraminiferal faunas from glacial clays of Late Pleistocene age in Norway (FEYLING-HANSEN 1954, 1957).

The samples from the Talavera section, as illustrated in diagram 2, do not show such dominances. *Elphidium i. clavatum* is moderately represented, and so is *Cassidulina crassa*.

We shall here not enter upon a detailed discussion of the fossil foraminifera from Talavera. The quite rich representation of specimens belonging to the genus *Elphidium* indicate shallow water. But a change in the microfaunal composition, according to the change in the *Astarte* frequency, was not found with the foraminifera. As the foraminifera are usually more sensitive to variation in water temperature than to changes in depth, the relatively constant composition of the foraminiferal fauna through the four investigated samples, suggests that the fluctuation in the *Astarte* frequency is not caused by variation in water temperature.

#### SHORELINE DISPLACEMENT

*Astarte borealis*, at least in Arctic environment, is usually found in shallow water, down to 45 m. (Cp. i. a. THORSON 1933, 1934). As already mentioned, it is very frequent in littoral deposits from the Post Glacial Warm interval of Spitsbergen. *A. borealis* did not disappear from Spitsbergen waters with the climatic deterioration at the close of that interval, but is one of the most common species there also today. The Recent shores of the country are usually crowded with shells of this species.

The richer occurrence of *Astarte borealis* especially in sample Bx 8 and Bx 7, is probably a registration of shallower water towards the peat layer of the section. The peat layer itself, with its remains of land plants, would then indicate that during the Holocene land rise the sediments of the locality had at a certain time emerged from the sea and turned into dry land which was able to carry the vegetation, the traces of which are now found in the peat layer. The presence of marine shells in the sediments of the section above this layer would, reasoning along the same line, prove that the sea again transgressed the locality.

It is, certainly, possible that the layer with humus and plant remains is allochthonous. It might simply have been carried to sea by a stream, then brought to the locality by waves and currents, and finally, in one way or another, incorporated in the sediment. If so, it should be possible to find marine fossils with the silty fine sand of this stratum.

In order to investigate this, sample O<sub>4</sub> from the plantbearing layer was treated for foraminifera analysis, megafossils were absent. The sample was then thoroughly investigated under the binocular microscope, with meagre result, however: three specimens of foraminifera were found in the whole 200 g. sample, viz., 1 *Astro-*

*nonion gallowayi*, 1 *Elphidium incertum incertum* and 1 *Cibicides lobatulus*. Compared with the other micropaleontologically investigated samples, which on an average contained 50 specimens per gramme, this is practically nothing. As a counter-check sample O<sub>3</sub>, the fine sand resting upon the plantbearing layer, was micropaleontologically investigated — with the result here presented.

Talavera, Barents Island.		Sample O <sub>3</sub>
Foraminifera	Frequency	Percentage
<i>Pateoris hauerinoides</i>	3	1.3
<i>Triloculina oblonga</i>	1	0.4
<i>Miliolinella chukchiensis</i>	1	0.4
<i>Oolina caudigera</i>	1	0.4
<i>Oolina melo</i>	2	0.9
<i>Fissurina marginata</i>	3	1.3
<i>Pseudopolymorphina novangliae</i>	2	0.9
<i>Bolivina pseudopunctata</i>	1	0.4
<i>Nonion labradoricum</i>	15	6.6
<i>Astrononion gallowayi</i>	66	28.9
<i>Elphidium bartletti</i>	5	2.2
<i>Elphidium i. clavatum</i>	2	0.9
<i>Elphidium i. incertum</i>	13	5.7
<i>Elphidium subarcticum</i>	47	20.6
<i>Elphidiella arctica</i>	2	0.9
<i>Protelphidium orbiculare</i>	6	2.6
<i>Cibicides lobatulus</i>	24	10.5
<i>Buccella frigida</i>	6	2.6
<i>Buccella tenerrima</i>	3	1.3
<i>Cassidulina crassa</i>	25	11.0
	228	99.9

228 specimens of foraminifera, accounting for  $\frac{4}{5}$  of the treated sample, were picked out. The sample weighed approximately 150 g and was coarser than the minerogenic fraction of sample O<sub>4</sub>. Even though we should expect less foraminifera in sample O<sub>4</sub> than e. g. in sample X<sub>4</sub>, because of the finer texture of the latter, we should, for a similar reason, expect more foraminifera in O<sub>4</sub> than in O<sub>3</sub>. As the exact reverse appears to be the case, this would seem to strengthen the assumption of autochthonous character of the plantbearing layer.

In 1950 I found in a section of a raised marine formation at the northeast side of Skansbukta, Billefjorden, a 3 cm thick lamina of humus and roots 1,5 m below the surface of the formation. Also at this locality the sediments were shell-bearing below as well as above the humus bearing layer. As the surface of that formation was quite strongly sloping, the presence of the humus layer was explained by soil flow (FEYLING-HANSSSEN 1955 a, pp. 109–111). A similar explanation is not easily

applied to the Talavera section because the surface of the deposits there are very flat and even.

Sample Bx 6, containing shells from the layer of very coarse gravel 10 cm below the humus-bearing stratum, was richer in *Saxicava arctica* and *Mya truncata* than in *Astarte borealis*. On the other hand *Saxicava arctica* was represented mostly by small and somewhat irregular forms, forms which were commonly associated with quite coarse sediments in the Holocene of central Spitsbergen (FEYLING-HANSSSEN 1955 a, p. 148). *Mya truncata* was in this sample, in a similar way, represented mostly by thin-shelled specimens, which in central Spitsbergen were frequent in younger and coarser deposits.

Similar conditions, though less pronounced, occurred with sample Bx 5, probably indicating shallow water and quite coarse-grained sediment at the early stage of the transgression in the locality. On the other hand, in sample Bx 4 as well as in Bx 3 there occurred large and long *Saxicava* shells of the *pholadis* form, probably indicating a somewhat greater depth and finer-grained sediment. And finally, in sample Bx 1 the *Saxicava* shells were again small and the *Mya* fragments thin, probably suggesting utmost littoral conditions.

From these considerations I assume that *the section of Talavera reveals evidence of a marine transgression which took place within the Post Glacial Warm interval*. As noted above, the plant-bearing layer was radiometrically dated at 6000 years  $\pm$  400 years before present. It should here be remembered that there is certainly the possibility of a smaller or greater hiatus existing between the emergence of the locality and the immigration of land plants to it.

The sediments of the Talavera section seem to have been deposited in shallow water. Compared with shallow-water deposits, e. g., at Anservika or in Skansbukta (FEYLING-HANSSSEN 1955, p. 61, 112) in central Spitsbergen, they are, however, relatively fine-grained. The reason is probably the sheltered character of the locality where the section at Talavera was worked out. It is facing the narrow Freeman sundet (Freeman Sound), but is protected against direct wave attack, even from the sound, by a ridge of diabase extending in an eastwesterly direction. Similar ridges occur at many different places on the Talavera foreland. They act, or acted, as breakwaters. This is beautifully illustrated along the Stauffer Brook, at our section: Between Freeman-sundet and the diabase ridge mentioned above the surface of the raised marine deposits is patterned with parallel beach ridges, whereas the terrace surface on the leeward side of the breakwater seems to be devoid of beach ridges. It should also be remembered that during a greater part of the year drift ice along the eastern coasts of Spitsbergen calm the waves which would otherwise unobstructed be generated by easterly and northeasterly winds.

#### THE SAMPLE FROM SKANSBUKTA

The main movement of the shoreline in Spitsbergen during the Holocene epoch has been a negative shift from a Holocene marine limit down to Recent sea level

(Cp. FEYLING-HANSSSEN 1955, JAHN 1959, BIRKENMAIER 1960). This shift took place at a variable rate, sometimes faster, sometimes slower. Radiocarbon datings, carried out on material from central Spitsbergen and from Nordaustlandet (Northeast Land) by INGRID OLSSON of the Radiocarbon dating laboratory of the University of Uppsala, inform us about two different parts in the main trend of this negative shift, an early, most probably Pre-Boreal, with a very rapid shoreline displacement, and a later with a slow displacement (FEYLING-HANSSSEN and OLSSON, 1960). This main trend is in good accordance with the trend of Post Glacial land recovery registered at many localities in Fennoscandia, not to mention other areas. It is also well known that evidence of standstills and positive shifts of the shoreline have been pointed out in many Fennoscandian localities. A conspicuous transgression took place in Boreal and early Atlantic time, another at the transition between Atlantic and Sub-Boreal time.

In Billefjorden, central Spitsbergen, the trend of the recovery is in a way illustrated in the sloping ridged beach plains, the ridges representing successive stages in the position of the shoreline. But this illustration is not reliable because the gradient of the slope depends both on the rate of the progradation, i. e., on the amount of material supplied by longshore drifting, and the rate of the land rise. Nevertheless, the formations of ponds and lakelets in larger swales of the ridged surfaces may have been supported by retardations or slight positive shifts of the shoreline.

I furthermore found (FEYLING-HANSSSEN, 1955 p. 48) that there was usually a break between the beach plains of the Post Glacial Temperate and those of the Post Glacial Warm interval. A simultaneous sudden change occurred in the fossil fauna at the border between the Temperate and the Warm interval. I wrote (1955) that this might be explained as resulting from a positive movement of the shoreline, interrupting its general negative shift, but that the occurrence of a transgression had not been proved by any certain finding.

After having found the traces of a transgression at Talavera, I felt it wise to reconsider the occurrence of the 3 cm thick lamina of humus with roots in the previously mentioned section in Skansbukta, Billefjorden (FEYLING-HANSSSEN 1955, p. 113), which was explained by soil flow. The terrace surface was there situated 17.7 m above sea level and the humus layer 1.5 m below this surface (1955, fig. 52). Below the humus-bearing layer there was a bed with coarse gravel, and between these two strata a 5 cm thick sandy transition. Above the humus there was also sand which became coarser upwards. Marine shells occurred above as well as below the humus layer.

Apart from the sediments being coarser in this section than in the Talavera section, similarities certainly exist. A sample of the humus layer from Skansbukta was submitted for dating to the C<sup>14</sup> laboratory of Uppsala, where the dating was carried out by INGRID OLSSON, and the result was: 4800 years  $\pm$  120 years before present.

If this sample represents emerged land, this land was again drowned by a transgression which seems to have taken place simultaneously with the late Atlantic-early Sub-Boreal transgression traced e. g. in northern Europe. The Talavera transgression may belong to a very early part of this transgression or to a late part of



the Boreal-early Atlantic transgression — or to another positive shift of the shoreline.

However, attempts at correlation must wait until more finds are made and more datings carried out. Then we shall also have a more detailed picture of the Holocene shoreline displacement in Spitsbergen.

#### FAUNAL REFERENCE LIST

The original references to the species found in this study are arranged alphabetically. The photographs of foraminifera for the plates were taken by O. BRYNILDSDRUD, University of Oslo.

##### *Foraminifera*

- Angulogerina fluens* TODD 1947, Plate 2, figures 12, 13  
in Cushman and Todd, Contr. Cushman Lab. Foram. Res., vol. 23, pt. 3, p. 67, pl. 16, figs. 6, 7.
- Astrononion gallowayi* LOEBLICH and TAPPAN 1953  
Smithsonian Miscell. Coll., vol. 121, No. 7, p. 90, pl. 17, figs. 4–7.
- Bolivina pseudopunctata* HÖGLUND 1947  
Zool. Bidrag från Uppsala, vol. 26, p. 273, pl. 24, fig. 5; pl. 32, figs. 23, 24; text figs. 280, 281, 287.
- Buccella frigida* (CUSHMAN) 1922  
*Pulvinulina frigida* CUSHMAN, 1922, Contr. Canadian Biol. No. 9 (1921), p. 12 (144). — *Buccella frigida* (CUSHMAN) ANDERSEN, 1952, Journ. Washington Acad. Sci., vol. 42, No. 5, p. 144, figs. 4a–c, 5, 6a–c.
- Buccella tenerrima* (BANDY, 1950), Plate 3, figures 3–5  
Journ. Pal., vol. 24, No. 3, p. 278, pl. 42, fig. 3.
- Buliminella auricula* (HERON-ALLEN and EARLAND 1932), Plate 2, figures 1–4  
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- Cassidulina crassa* D'ORBIGNY 1839, Plate 2, figure 14  
Voyage l'Amér. Mérid., p. 56, pl. 7, figs. 18–20.
- Islandiella norcrossi* (CUSHMAN, 1933)  
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- Islandiella teretis* (TAPPAN, 1951), Plate 2, figures 15, 16  
*Cassidulina laevigata* D'ORBIGNY, BRADY, 1884 (not D'ORBIGNY, 1826), Rep. Voy. Challenger, vol. 9 (Zoology), p. 428, pl. 54, figs. 1–3. — *Cassidulina teretis* TAPPAN, 1951, Contr. Cushman Found. Foram. Res., vol. 2, pt. 1, p. 7, pl. 1, figs. 30a–c.
- Cibicides bertheloti* (D'ORBIGNY 1839)  
*Rosalina bertheloti* D'ORBIGNY, 1839, in Barker, Webb and Berthelot, Hist. Nat. Iles Canaries, vol. 2, pt. 2, p. 135, pl. 1, figs. 28–30.

*Cibicides lobatulus* (WALKER and JACOB) 1798

*Nautilus lobatulus* WALKER and JACOB, 1798, in G. Adams: Essays on the Microscope. F. KANMACHERS (2nd) Edition (London), p. 642, pl. 14, fig. 36 — *Cibicides lobatula* (WALKER and JACOB), CUSHMAN, 1931, U.S. Nat. Mus. Bull., 104, pt. 8, p. 118, pl. 21, figs. 3a—c.

*Alveolophragmium crassimargo* (NORMAN 1892)

*Haplophragmium crassimargo* NORMAN, 1892, Museum Normanum, pt. 8, p. 17. — *Haplophragmoides major* CUSHMAN, 1920, U.S. Nat. Mus. Bull., 104, pt. 2, p. 39, pl. 8, fig. 6. — *Labrospira crassimargo* (NORMAN), HÖGLUND, 1947, Zool. Bidrag från Uppsala, vol. 26, p. 141, pl. 11, fig. 1, text figs. 121, 125.

*Alveolophragmium jeffreysi* (WILLIAMSON 1858)

*Nonionina jeffreysi* WILLIAMSON, 1858, Recent Foraminifera of Great Britain, p. 34, figs. 72, 73. — *Alveolophragmium jeffreysi* (WILLIAMSON), LOEBLICH and TAPPAN, 1953, Smithsonian Miscell. Coll., vol. 121, No. 7, p. 31, pl. 3, figs. 4—7.

*Dentalina frobisherensis* LOEBLICH and TAPPAN 1953, Plate 1, figure 5

Smithsonian Miscell. Coll., vol. 121, No. 7, p. 55, pl. 10, figs. 1—9.

*Elphidiella arctica* (PARKER and JONES 1864), Plate 3, figure 13

*Polystomella arctica* PARKER and JONES, 1864, in H. B. Brady, Trans. Linn. Soc. London, Zool., vol. 24, p. 471, pl. 48, fig. 18. — *Elphidiella arctica* (PARKER and JONES), CUSHMAN, 1939, U.S. Geol. Surv. Prof. Pap. 191, p. 65, pl. 18, figs. 11—14.

*Elphidium bartletti* CUSHMAN 1933, Plate 3, figure 8, 9

Smithsonian Miscell. Coll., vol. 89, No. 9, p. 4, pl. 1, fig. 9.

*Elphidium frigidum* CUSHMAN 1933

Smithsonian Miscell. Coll., vol. 89, No. 9, p. 5, pl. 1, fig. 8.

*Elphidium incertum clavatum* CUSHMAN 1930, Plate 3, figure 10

*Elphidium incertum* (WILLIAMSON) var. *clavatum* CUSHMAN, U.S. Nat. Mus. Bull. 104, pt. 7, p. 20, pl. 7, fig. 10. — *Elphidium clavatum* CUSHMAN, LOEBLICH and TAPPAN, 1953, Smithsonian Miscell. Coll., vol. 121, No. 7, p. 98, pl. 19, figs. 8—10.

*Elphidium incertum incertum* (WILLIAMSON 1858)

*Polystomella umbilicata* var. *incerta* WILLIAMSON, 1858, Recent Foraminifera of Great Britain, p. 44, pl. 3, fig. 82a. — *Elphidium incertum incertum* (WILLIAMSON), FEYLING-HANSEN, 1954, Norsk Geol. Tidsskr., vol. 33, No. 1—2, p. 141, pl. 2, fig. 10.

*Elphidium subarcticum* CUSHMAN 1944, Plate 3, figures 11, 12

Cushman Lab. Foram. Res. Spec. Publ. 12, p. 27, pl. 3, figs. 34, 35.

*Eponides patagonica* (D'ORBIGNY 1839), Plate 3, figures 1, 2

*Rotalina patagonica* D'ORBIGNY, 1839, Voyage dans l'Amérique Méridionale, pt. 5. Foraminifères, p. 36, pl. 2, figs. 6—8. — *Eponides patagonica* (D'ORBIGNY), CUSHMAN, 1927, Bull. Scripps Inst. Oceanography, La Jolla, California, vol. 1, p. 162, pl. 5, figs. 1, 2.

- Esosyrinx curta* (CUSHMAN and OZAWA 1930), Plate 1, figures 15, 16  
*Pseudopolymorphina curta* CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, art. 6, p. 105, pl. 27, figs. 3a, b. — *Esosyrinx curta* (CUSHMAN and OZAWA), LOEBLICH and TAPPAN, 1953, Smithsonian Miscell. Coll., vol. 121, No. 7, p. 85, pl. 15, figs. 1–5.
- Fissurina marginata* (WALKER and BOYS 1784), Plate 2, figure 11  
*Serpula (Lagena) marginata* WALKER and BOYS, 1784, in Walker, Testacea minuta rariora, etc. (London), p. 2, pl. 1, fig. 7.
- Globigerina bulloides* D'ORBIGNY 1826  
 Ann. Sci. Nat., vol. 7, p. 277, No. 1; Modèles No. 76, and young, No. 17.
- Globulina glacialis* CUSHMAN and OZAWA 1930, Plate 1, figures 11, 12  
 Proc. U.S. Nat. Mus., vol. 77, Art. 6, p. 71, pl. 15, figs. 6, 7.
- Guttulina dawsoni* CUSHMAN and OZAWA 1930, Plate 1, figure 7  
 Proc. U.S. Nat. Mus., vol. 77, Art. 6, p. 47, pl. 12, figs. 1, 2.
- Guttulina cf. lactea* (WALKER and JACOB 1798), Plate 1, figure 8  
*Serpula lactea* WALKER and JACOB, 1798, in G. ADAMS, Essays on the Microscope. F. KANMACHERS (2nd) edition, p. 634, pl. 14, fig. 4. — *Guttulina lactea* (WALKER and JACOB), OZAWA, 1929, Contr. Cushman Lab. Foram. Res., vol. 5, p. 36, pl. 6, figs. 6–10.
- Lagena laevis* (MONTAGU 1803)  
*Vermiculum laeve* MONTAGU, 1803, Testacea Britannica, p. 524. — *Lagena sulcata* WALKER and JACOB var. *laevis* (MONTAGU), PARKER and JONES, 1865, Philos. Trans. Roy. Soc. London, vol. 155, p. 349, pl. 13, fig. 22 (called *Lagena laevis* on plate description).
- Lagena semilineata* WRIGHT 1886  
 Proc. Belfast Nat. Field Club, n.s., vol. 1, app. 9, p. 320, 26, fig. 7.
- Laryngosigma hyalascidia* LOEBLICH and TAPPAN 1953, Plate 1, figure 13  
 Smithsonian Miscell. Coll., vol. 121, No. 7, p. 83, 15, figs. 6–8.
- Laryngosigma williamsoni* (TERQUEM 1878), Plate 1, figure 14  
*Polymorphina williamsoni* TERQUEM, 1878, Mém. Soc. Géol. France, ser. 3, vol. 1, p. 37. — *Sigmomorphina williamsoni* (TERQUEM), CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, Art. 6, p. 138, pl. 38, figs. 3, 4.
- Miliolinella chukchiensis* LOEBLICH and TAPPAN 1953, Plate 1, figure 4  
 Smithsonian Miscell. Coll., vol. 121, No. 7, p. 47, pl. 6, fig. 7.
- Lenticulina (Astacolus) crepidula* (FICHTEL and MOLL 1803), Plate 1, figure 6  
*Nautilus crepidula* FICHTEL and MOLL, 1803, Test. Micr., p. 107, pl. 19, figs. g–i. — *Cristellaria crepidula* (FICHTEL and MOLL), BRADY, 1884, Rep. Voy. Challenger, vol. 9 (Zoology), p. 542, pl. 67, figs. 20a, b. — *Astacolus crepidulus* FICHTEL and MOLL), BARKER, 1960, Soc. Econ. Paleontologists and Mineralogists, Spec. Publ. No. 9, p. 142, pl. 67, figs. 20a, b.
- Nonionella auricula* HERON-ALLEN and EARLAND 1930, Plate 2, figures 17–19  
 Royal Micr. Soc. Jour., vol. 50, p. 192, pl. 5, figs. 68–70.
- Nonionella iridea* HERON-ALLEN and EARLAND 1932  
 Discovery Reports, vol. 4, p. 438, pl. 16, figs. 14–16.

- Nonion labradoricum* (DAWSON 1860), Plate 2, figures 20, 21  
*Nonionina labradorica* DAWSON, 1860, Canadian Naturalist, vol. 5, p. 191, fig. 4. — *Nonion labradoricum* (DAWSON), CUSHMAN, 1939, U.S. Geol. Surv. Prof. Pap. 191, p. 23, pl. 6, figs. 13–16.
- Oolina caudigera* (WIESNER 1931), Plate 2, figures 8–10  
*Lagena* (*Entosolenia*) *globosa* (MONTAGU) var. *caudigera* WIESNER, 1931, Deutsche Südpolar-Exped., 1901–1903, vol. 20 (Zoology, vol. 12), p. 119, pl. 18, fig. 214. — *Oolina caudigera* (WIESNER), LOEBLICH, and TAPPAN, 1953, Smithsonian Miscell. Coll., vol. 121, No. 7, p. 67, pl. 13, figs. 1–3.
- Oolina borealis* LOEBLICH and TAPPAN 1954, Plate 2, figures 5, 6  
*Entosolenia costata* WILLIAMSON, 1858, (not *Oolina costata* EGGER 1857), Recent Foraminifera of Great Britain, p. 9, pl. 1, fig. 18. — *Oolina costata* (WILLIAMSON), F. PARKER, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 409, pl. 4, figs. 20, 21. *Oolina borealis* LOEBLICH and TAPPAN, new name, 1954. Jour. Washington Acad. Sci., vol. 44, No. 12.
- Oolina melo* D'ORBIGNY 1839, Plate 2, figure 7  
 Voyage dans l'Amérique méridionale, Foraminifères, vol. 5, pt. 5, p. 20, pl. 5, fig. 9.
- Oolina scalariforme-sulcata* (WIESNER 1931)  
*Lagena* (*Entosolenia*) *scalariforme-sulcata* WIESNER, 1931, Deutsche Südpolar-Exped., 1901–1903, vol. 20 (Zoology, vol. 12), p. 120, pl. 18, fig. 219. — *Oolina scalariforme-sulcata* (WIESNER), LOEBLICH and TAPPAN, 1953, Smithsonian Miscell. Coll., vol. 121, No. 7, p. 72, pl. 13, fig. 7.
- Oolina squamoso-sulcata* (HERON-ALLEN and EARLAND 1922)  
*Lagena squamoso-sulcata* HERON-ALLEN and EARLAND, 1922, British Antarctic Exped., 1910, Nat. Hist. Rep., Zool., vol. 6. No. 2, p. 151, pl. 5, figs. 15, 19. — *Oolina squamoso-sulcata* (HERON-ALLEN and EARLAND), LOEBLICH and TAPPAN 1953, Smithsonian Miscell. Coll., vol. 121, No. 7, p. 74, pl. 12, figs. 6, 7.
- Pateoris hauerinoides* (RHUMBLER 1936), Plate 1, figure 3  
*Quinqueloculina subrotunda* (MONTAGU) forma *hauerinoides* RHUMBLER, 1936, Foram. der Kieler Bucht, Teil 2 — Ammodisculinidae bis Textulinidae, vol. 1, No. 1, pp. 206, 217, 226, text figs. 167 (p. 205), 208–212 (p. 225). — *Pateoris hauerinoides* (RHUMBLER), LOEBLICH and TAPPAN, 1953, Smithsonian Miscell. Coll., vol. 121, No. 7, p. 42, pl. 6, figs. 8–12; text figs. 1A, B.
- Patellina corrugata* WILLIAMSON 1858  
 Recent Foraminifera of Great Britain, p. 46, pl. 3, figs. 86–89.
- Protelphidium orbiculare* (BRADY 1881), Plate 3, figure 14  
*Nonionina orbicularis* BRADY, 1881, Annals and Mag. Nat. Hist., ser. 5, vol. 8, p. 415, pl. 21, fig. 5. — *Elphidium orbiculare* (BRADY), LOEBLICH and TAPPAN, 1953, Smithsonian Miscell. Coll., vol. 121, No. 7, p. 102, pl. 19, figs. 1–4. — *Protelphidium orbiculare* (BRADY), TODD and LOW, 1961, Contr. Cushman Found. Foram. Res., vol. 12, pt. 1, p. 20, pl. 2, fig. 11.
- Pseudopolymorphina novangliae* (CUSHMAN 1923)  
*Polymorphina lactea* (WALKER and JACOB) var. *novangliae* CUSHMAN, 1923,

- U.S. Nat. Mus. Bull. 104, pt. 4, p. 146, pl. 39, figs. 6—8. — *Pseudopolymorphina novangliae* (CUSHMANN), PARKER, 1952, Mus. Comp. Zool. Bull., vol. 106, No. 10, p. 455, pl. 3, figs. 11, 12.
- Quinqueloculina agglutinata* CUSHMAN 1917  
U.S. Nat. Mus. Bull. 71, pt. 6, p. 43, pl. 9, fig. 2.
- Quinqueloculina arctica* CUSHMAN 1933, Plate 1, figure 1  
Smithsonian Miscell. Coll., vol. 89, No. 9, p. 2, pl. 1, figs. 3a—c.
- Quinqueloculina seminulum* (LINNÉ 1767), Plate 1, figure 2  
*Serpula seminulum* LINNÉ, 1767, Systema Natura, ed. 12, p. 1264. — *Quinqueloculina seminulum* (LINNÉ), D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 303. — CUSHMAN, 1929, U.S. Nat. Mus. Bull. 104, pt. 6, p. 24, pl. 2, figs. 1, 2.
- Recurvoides turbinatus* (BRADY 1881)  
*Haplophragmium turbinatum* BRADY, 1881, Quart. Journ. Micr. Soc., n.s., vol. 21, p. 50; Rep. Voy. Challenger, vol. 9 (Zoology), p. 312, figs. 9a—c. — *Recurvoides turbinatus* (BRADY), F. PARKER, 1952, Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 402, pl. 2, figs. 23, 24.
- Sigmomorphina* aff. *undulosa* (TERQUEM 1878), Plate 1, figures 9, 10  
*Polymorphina undulosa* TERQUEM, Mém. Soc. Géol. France, sér. 3, vol. 1, 1878, p. 41, pl. 3 (8), figs. 35a, b. — *Sigmomorphina undulosa* (TERQUEM), CUSHMAN and OZAWA, 1930, Proc. U.S. Nat. Mus., vol. 77, p. 131, pl. 34, figs. 4, 5.
- Trichohyalys bartletti* (CUSHMAN 1933), Plate 3, figures 6, 7  
*Discorbis bartletti* CUSHMAN, 1933, Smithsonian Miscell. Coll., 89, No. 9, p. 6, pl. 2, figs. 3—6. — *Trichohyalus bartletti* (CUSHMAN), LOEBLICH and TAPPAN, 1953, Smithsonian Miscell. Coll., vol. 121, No. 7, p. 117, pl. 23, figs. 1—7.
- Triloculina oblonga* (MONTAGU 1803)  
*Vermiculum oblongum* MONTAGU, 1803, Testacea Britannica, p. 522, pl. 14, fig. 9. — *Triloculina oblonga* (MONTAGU), D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 300, No. 16, Modèles No. 95.
- Triloculina trihedra* LOEBLICH and TAPPAN 1953  
Smithsonian Miscell. Coll., vol. 121, No. 7, p. 45, pl. 4, fig. 10.
- Trochammina nana* (BRADY)  
*Haplophragmium nana* BRADY, 1881, Quart. Journ. Micr. Soc., vol. 21, p. 50. — *Trochammina nana* (BRADY), CUSHMAN, 1920, U.S. Nat. Mus. Bull. 104, pt. 2, p. 80, pl. 17, fig. 1.
- Trochamminella atlantica* F. PARKER 1952  
Bull. Mus. Comp. Zool., vol. 106, No. 9, p. 409, pl. 4, figs. 17—19.
- Virgulina loeblichii* FEYLING-HANSSSEN 1954  
Norsk Geol. Tidsskr., vol. 33, pt. 3—4, p. 191, pl. 1, figs. 11—13.

#### *Pelecypoda*

- Astarte borealis* (CHEMNITZ 1784)  
*Venus borealis* CHEMNITZ, 1784, Neues syst. Conchylien-Cabinet, vol. 7, p. 26, pl. 39, fig. 412. — *Astarte borealis* (CHEMNITZ), PHILIPPI, 1845, Abbild. und Beschreib. neuer oder wenig gekannter Conchylien, p. 58, pl. 1, fig. 11.

*Astarte elliptica* (BROWN 1827)

*Crassina elliptica* BROWN, 1827, Illustr. of the conchology of Great Britain and Ireland, pl. 18, fig. 3. — *Astarte elliptica* DAUTZENBERG and FISCHER, 1912, Rés. Camp. Sci. Albert I de Monaco, vol. 37, p. 418, pl. 11, figs. 12–14.

*Astarte montagui* (DILLWYN 1817)

*Venus montagui* DILLWYN, 1817, A descript. catalogue of recent shells according to the Linnean method, p. 167. — *Astarte montagui* (DILLWYN), MÖRCH, 1868, Faunula molluscorum Islandiae, Vid. Medd. naturh. Foren. Kjöbenhavn, p. 223. — FEYLING-HANSEN, 1955, Norsk Polarinst. Skr. No. 107, p. 137, pl. 21, figs. 3–12.

*Clinocardium ciliatum* (FABRICIUS 1780)

*Cardium ciliatum* FABRICIUS, 1780, Fauna Groenlandica, p. 410. — *Clinocardium ciliatum* (FABRICIUS), FEYLING-HANSEN, 1955, Norsk Polarinst. Skr. No. 107, p. 141, pl. 22, fig. 3.

*Heteranomia squamula* (LINNÉ 1767)

*Anomia squamula* LINNÉ, 1767, Systema naturae editio 12 reformata tom. I. Pars II. Classis VI. Vermes, p. 1151. — *Heteranomia squamula* (LINNÉ), WINCKWORTH, 1932, Journ. Conch., vol. 19 (London), p. 240.

*Nuculana pernula* (MÜLLER 1779)

*Arca pernula* MÜLLER, 1779, Beschäft. Berliner Ges. Naturf. Freunde, vol. 4, p. 55. — *Leda pernula* (MÜLLER), JENSEN and SPÄRCK, 1934, Danmarks Fauna. Blöddyr II, Saltvandmuslinger, p. 28, fig. 14. — *Nuculana pernula* (MÜLLER), T. SOOT-RYEN, 1958, Norsk Polarinst. Skr. No. 113, p. 8.

*Macoma calcarea* (CHEMNITZ 1782)

*Tellina calcarea* CHEMNITZ, 1782, Neues system. Conchylien-Cabinet, vol. 6, p. 140, pl. fig. 136. — *Macoma calcarea* (CHEMNITZ), FEYLING-HANSEN, 1955, Norsk Polarinst. Skr. No. 107, p. 145, pl. 23, figs. 8–13.

*Mya truncata* LINNÉ 1758

LINNÉ, 1758, Systema naturae. Regnum animale. Editio 10, p. 670. — FEYLING-HANSEN, 1955, Norsk Polarinst. Skr. No. 107, p. 148, pl. 25.

*Saxicava arctica* (LINNÉ 1767)

*Mya arctica* LINNÉ, 1767, Systema naturae, Ed. 12, p. 1113. — *Hiatella arctica* (LINNÉ), LAMARCK, 1819, Hist. nat. animaux sans vert., vol. 6, p. 30. — *Saxicava arctica* (LINNÉ), DAUTZENBERG and FISCHER, 1912, Rés. Camp. Sci. Albert I de Monaco, vol. 37, p. 504. — FEYLING-HANSEN, 1955, Norsk Polarinst. Skr. No. 107, p. 146, pl. 23, figs. 4–7, pl. 24, figs. 1–5.

*Serripes groenlandicus* (CHEMNITZ 1782)

*Cardium groenlandicum* CHEMNITZ, 1782, Neues syst. Conchylien-Cabinet, vol. 6, p. 202, pl. 19, fig. 198. — *Serripes groenlandicus* (CHEMNITZ), FEYLING-HANSEN, 1955, Norsk Polarinst. Skr. No. 107, p. 142, pl. 22, figs. 4, 5.

## Gastropoda

*Cingula castanea* (MÖLLER 1842)

*Rissoa castanea* MÖLLER, 1842, Index molluscorum Groenlandiae, p. 9. —

*Cingula castanea* (MÖLLER), G. O. SARS, 1878, Mollusca regionis arcticae Norvegiæ. Universitetsprogram förste halvår 1878 (Christiania), p. 174, pl. 10, figs. 1a–b.

*Cylichna alba* (BROWN 1827)

*Volvaria alba* BROWN, 1827, Ill. of the conchology of Great Britain and Ireland (London), pl. 38, figs. 43, 44.

*Omalogyra atomus* (PHILIPPI 1841)

*Truncatella atomus* PHILIPPI, 1841, Zool. Bemerk., Arch. Naturgesch., vol. 7, pt. 1, p. 54, pl. 5, fig. 4. — *Omalogyra atomus* (PHILIPPI), FEYLING-HANSEN, 1955, Norsk Polarinst. Skr. No. 107, p. 161, pl. 26, figs. 11, 12.

#### *Cirripedia*

*Balanus balanus* (LINNÉ 1758)

*Lepas balanus* LINNÉ, 1758; 1767, Systema naturae, Ed. 12, p. 1107. — *Balanus balanus* (LINNÉ), BROCH, 1924, Skr. Vidensk. Selsk. Kristiania. I. No. 17, p. 73, pl. 1, figs. 1, 2; pl. 2, figs. 1, 2.

*Balanus crenatus* BRUGUIÈRE 1789

Encyclopédie méthodique. Hist. nat. des vers., vol. 1 (Paris). — BROCH, 1924, Skr. Vidensk. Selsk. Kristiania. I. No. 17, p. 78, pl. 1, figs. 3–6; pl. 2, fig. 14.

#### *Lithothamnia*

*Lithothamnion* cf. *glaciale* KJELLMAN 1883

*Lithothamnion* species, FEYLING-HANSEN, 1955, Norsk Polarinst. Skr. Nr. 107, p. 174, pl. 17, figs. 11–15.

### ZUSAMMENFASSUNG

#### *Ein Holozän-Aufschluß von der Talavera*

Die deutsche Expedition nach Südost-Spitzbergen 1959/60 unter Leitung von Professor BÜDEL in Würzburg hat, unter vielen anderen Gegenwartsbildungen, auch die frischen marinen Sedimente untersucht, die durch die junge Landhebung über den Meeresspiegel gelangt sind. So wurde am Stauerbach auf dem Talavera-Vorland der Barents-Insel ein solches Sedimentprofil durch einen Suchgraben im Detail aufgenommen. Die Lokalität ist in Figur 1 angegeben, sie liegt an der Ostseite des Stauerbaches etwa 300 m von der Küste entfernt. Die Ablagerungen bilden da eine ausgedehnte Ebene, den sogenannten Pfeilplan, dessen Oberfläche am Aufschluß 15 m über dem Meeresspiegel liegt. Der gletschergeschliffene Felssockel, bestreut durch einen Moränenschleier mit erratischen Blöcken, liegt 5,7 m unter der Terrassenoberfläche.

In diesem Profil wurden Schalen und Fragmente mariner *Mollusken* und *Cirripeden* in 11 verschiedenen horizontalen Zonen gesammelt. Zusätzlich wurden auch Sedimentproben lückenlos durch fast das ganze Profil entnommen. Diese Sammlung wurde mir, generöser Weise, in die Hände gelegt. Einige von den Sedimentproben waren leider auf dem Transport durcheinander gekommen, die große Mehrzahl der

Sedimentproben und alle Fossilienproben waren jedoch unversehrt nach dem aufgenommenen Profil zusammenfügbar.

Die Gesamtmächtigkeit des Profils (Fig. 2) ist 570 cm, von den untersten 60 cm wurden aber keine Proben entnommen. Die Ablagerung besteht größtenteils aus horizontalgeschichteten gröberen und feineren Sanden in unregelmäßigem Wechsel. In der oberen Hälfte des Profils führen die Sandlagen „Plattelschotter“ und Gerölle verschiedener Größe. In der unteren Hälfte ist schluffiger, stellenweise sogar toniger Feinsand vorherrschend. Einige Sedimentproben wurden mechanischen Analysen unterworfen. Die Werte für mittlere Korngröße und Sortierungsgrad sind links im Diagramm eingetragen. Alle untersuchten Proben sind gut sortiert. Der Sand ist im allgemeinen dunkel, die Plattelschotter bestehen meistens aus schwarzem Schiefer, die Gerölle oft aus dunklem, fast schwarzem Diabas.

243 cm unter der Oberfläche ist eine 7–8 cm dicke Zone von über faustgroßem, kantengerundetem Grobschotter (Q). Am Unterrand der Grobschotter kommt rostbraune, schwach eingeregelter Plattelschotter (R) vor, darunter ockergelber, heller, scharfer Feinsand (S) und weiter darunter sepiabrauner, heller, leicht schluffiger Feinsand.

Oberhalb der Grobschotterzone folgt eine 10 cm dicke hell- bis rostbraune Sandlage mit kleinen Schlufflinsen und darüber eine 2–4 cm dicke schwarzblaue schluff- und humushaltige Feinsandzone mit Wurzelfäden, Blättern und anderen Überresten von Landpflanzen, eine Art Torfhorizont. Moose (nicht Sphagnum) kamen häufig vor, dazu Fragmente von holzartigen Pflanzen. Die Blätter gehören zu *Ericacéen*. Eine Pollenanalyse wurde nicht durchgeführt. Dieser Torfhorizont liegt 2,33 m unter der Terrassenoberfläche und 12,6 m über dem jetzigen Meeresniveau. Die Frostbodengrenze lag am 18. August 42 cm tief.

Die Benennungen Bx (Fig. 2) deuten die Zonen an, aus denen fossile *Mollusken* und *Cirripedien* gesammelt wurden. Die Megafossilien-Fauna war arm: 13 verschiedene Arten von Mollusken, 2 Cirripedien und 1 Kalkalge waren da. Figur 3 zeigt in Diagrammform die Verteilung der verschiedenen Arten durch die 11 Proben Bx 1 bis Bx 11. Die Symbole geben die Häufigkeit an. Ein Quadrat bedeutet 21 oder mehr Exemplare, ein Ring 6–20, ein X 3–5 und ein Punkt 1–2. Nur ganze Muschelschalen und Umbofragmente gebrochener Schalen (mit 2 dividiert) wurden gerechnet. Es gibt also im Profil marine Fossilien oberhalb wie auch unterhalb der genannten Torfzone.

Alle die gefundenen Arten leben auch heute. Was von der Ökologie dieser Arten bekannt ist, d. h. insoweit man die Bedürfnisse dieser Arten zu ihrer physikalischen Umgebung kennt, wäre es relativ einfach, Rückschlüsse auf die ehemaligen Verhältnisse in der Lokalität zu machen. Bevor man solche Rückschlüsse auf marinklimatische Verhältnisse während der Sedimentation der Ablagerungen von der Talavera versucht, muß aber berücksichtigt werden, in welchem Grade die Fossilien an ihren ursprünglichen Stellen geblieben sind, oder wie weit sie von irgendeinem transportierenden Agens nach dem Tode hierhergeführt wurden. Wie steht es also mit dem Problem der Redeposition (Umlagerung)?

Die Schalen könnten beispielsweise von einem Gletschervorstoß in furchtbarste



Vermischung geraten sein, oder sie könnten durch Solifluktionsvorgänge von ursprünglich höheren Niveaus ins niedrigere verfrachtet worden sein. Erodierende Flüsse, die ältere Ablagerungen abtragen, befördern natürlich biogene Partikel mit den minerogenen talwärts und sedimentieren sie aufs neue unter Mitwirkung von Wellenschlag und Küstenströmen.

Gletschervorstöße und Solifluktion haben sicher keine direkte Einwirkung auf die Sedimente ausgeübt. Das zeigt die unzerstörte Schichtung.

Im allgemeinen können die Fossilien solcher Schichten als in situ-Fossilien angesehen werden, wenn ein beträchtlicher Größenunterschied zwischen minerogenen und biogenen Partikeln im Sediment besteht. So stellt es sich unzweifelhaft mit der unteren Hälfte des Profils: die biogenen Partikel, z. B. die *Astarte*-Schalen, sind ungeheuer groß im Vergleich mit den kleinen Feinsandpartikeln, geschweige denn den Tonpartikeln. In guter Übereinstimmung hiermit ist das häufige Vorkommen von Exemplaren mit noch zusammenhängenden Schalenklappen und gut erhaltenem Periostracum. — In der oberen Hälfte des Profils gibt es aber Schichten, in denen minerogene und biogene Partikel von ungefähr gleicher Größenordnung sind, wo man sich also vorstellen könnte: ein und dasselbe Agens habe Minerogenes und Biogenes zusammengebracht. Die Verhältnisse bei den Proben Bx 1 und Bx 2 könnten in dieser Weise gedeutet werden; da waren auch die meisten Schalen gebrochen. In den anderen Proben vom oberen Teil des Profils kamen am meisten unzerbrochene Schalen vor. Im ganzen genommen bekommt man den Eindruck: die Mehrzahl der Fossilien des Profils liegt in situ.

Die Zusammensetzung dieser fossilen Faunen von der Talavera ist recht einheitlich. Außer den zwei *Astarte*-reichen Proben sind die Faunen durch Dominanz von *Saxicava arctica* und *Mya truncata* charakterisiert. Man findet keine bedeutenden Unterschiede zwischen den Megafossilengemeinschaften von Proben unterhalb und Proben oberhalb des Torfhorizonts. Die meisten der vorhandenen Arten sind eurytherme Formen, die nichts besonderes über die Wassertemperatur andeuten. Sie sind boreo-arktische Formen, die in Spitzbergen, wie auch an der ganzen norwegischen Küste entlang leben können. Eine Ausnahme ist *Heteranomia squamula*, die niemals in Spitzbergen lebend gefunden wurde. Ihre heutige Nordgrenze ist etwas südlicher gelegen. Eine Schale von dieser Art kommt in der *tiefsten* Probe vor und sollte also etwas günstigere marinklimatische Verhältnisse andeuten als die jetzigen.

Eine solche Annahme wird durch das Vorkommen von *Astarte borealis* unterstützt. Das erste Auftreten dieser Art in holozänen Ablagerungen Zentral-Spitzbergens trifft mit dem Beginn der postglazialen Wärmezeit zusammen. Dies kann natürlich nicht ohne weiteres für die Gegend der Barents-Insel geltend gemacht werden. Die ökologischen Verhältnisse sind hier wahrscheinlich etwas verschieden von denen in Zentral-Spitzbergen. Die spätquartäre Stratigraphie und die Landhebungsvorgänge sind noch wenig bekannt.

Andererseits wurde *Astarte borealis* in ungestörten Ablagerungen Spitzbergens überhaupt niemals in größerer Höhe als 40 m über dem jetzigen Meeressniveau gefunden, d. h. niemals höher als die obere Grenze der Wärmezeitablagerungen in Zentral-Spitzbergen.

Auf Grund dieser zwei Indikationen: des Vorkommens von *Heteranomia squamula* und des stellenweise reichen Vorkommens von *Astarte borealis* nehme ich an, daß die fossilienführenden Sedimente des Talaveraprofils von holozänem Alter sind, und weiter, daß sie während eines Abschnittes der postglazialen Wärmezeit abgelagert wurden. Diese Schlußfolgerung wird durch eine Radiocarbonatierung des Torfhorizontes, ausgeführt von Dr. INGRID OLSSON in Uppsala, unterstützt. Das Alter dieses Horizontes ergab sich zu  $6000 \pm 400$  Jahren vor der Gegenwart.

Um zu untersuchen, ob der relativ größere Gehalt von *Astarte borealis* in den Proben Bx 7 und Bx 8 möglicherweise eine Änderung in der Wassertemperatur anzeige, wurden Foraminifer-Analysen herangezogen. Die *Foraminiferen* haben sich nämlich als gute Temperaturindikatoren erwiesen, sie sind weniger von der Wassertiefe abhängig. Wenn also die Änderung in der *Astarte*-Frequenz von einer Temperaturänderung verursacht wäre, hätte man erwarten sollen, daß das in der Zusammensetzung der Foraminiferenfauna deutlich zutage komme.

Eine *Astarte borealis*-reiche Probe und eine *Astarte borealis*-leere wurden mikropaläontologisch untersucht und miteinander verglichen. Die zwei Analysen ergaben, daß die Zusammensetzung der zwei Foraminiferenfaunen ungefähr gleich waren. Als Kontrolle wurden noch zwei Proben mikropaläontologisch untersucht — mit demselben Resultat. Die vier Analysen sind in Abbildung 4 zusammengestellt. Die Foraminiferenanalysen deuten darauf hin, daß die Fluktion der *Astarte*frequenz nicht von einer Temperaturänderung verursacht wurde.

Es ist aber bekannt, daß *Astarte borealis* mindestens in arktischen Gewässern eine typische Flachwasserform repräsentiert. Zum Beispiel sind die gegenwärtigen Strände Spitzbergens reichlich mit Schalen dieser Spezies bestreut.

Die größere *Astarte*-Frequenz gegen die Torfzone im Profil könnte deshalb eine Grundannäherung andeuten, ein Seichterwerden, das mit der Torfzone in einer Verlandung kulminierte. Das Vorkommen müßte dann als Beweis für eine nachfolgende Transgression gelten können.

Es ist natürlich möglich, daß diese Torfzone nicht autochtones, sondern allochtones Material repräsentiert. Irgendein Bach könnte es zur See verfrachtet haben, Wellen und Ströme transportierten es an unsere Stelle, wo es in irgendeiner Weise im Sediment eingebaut wurde. In diesem Fall hätte man das Vorkommen von marinen Fossilien in dem schluffhaltigen Feinsand der Torfzone vermuten können.

Megafossilien waren nicht da. Von Mikrofossilien fand ich nach sorgfältigem Suchen der ganzen Probe (etwa 200 g), drei einzelne Foraminiferenexemplare. Als eine Überprüfung wurde die Probe von dem darüberliegenden Feinsand mikropaläontologisch analysiert. Diese Probe (etwa 150 g) ergab 285 Foraminiferenexemplare, obzwar auch diese letzte Probe gröber war als die des Torfhorizontes. Diesen Umstand bekräftigt die Annahme, daß die Torfzone des Talavera-Profiles von autochtonem Charakter ist.

Ich glaube deshalb, in diesem Sedimentprofil eine Transgression nachgewiesen zu haben. Durch die früher erwähnte Radiocarbonatierung des entscheidenden Torfhorizontes ist auch das Alter — approximaler Weise — bekannt, nämlich  $6000 \pm 400$  Jahre vor der Jetztzeit.

Die Sedimente des Talaveraprofils sind im seichten Wasser abgesetzt. Doch sind sie feinkörniger als viele Flachwassersedimente Zentral-Spitzbergens. Das ist in der vor Wind und Wellen gut gedeckten Lage der Talavera-Lokalität begründet. Südlich des schmalen Freeman-Sundes liegt die große Edge-Insel, die Südspitze des Talaveravorlandes schützt gegen den Wellenschlag des Storfjordes, und im Osten liegt während des größten Teiles des Jahres das Treibeis als riesenhafter Wellendämpfer. Außerdem funktionieren die vielen steilen Rundhöcker auf dem Talaveravorland ehemals, bei höherem Meeresniveau, als effektive Wellenbrecher.

Die Hauptbewegung der Strandlinie auf Spitzbergen während der holozänen Epoche ist eine negative Verschiebung gewesen, von der marinen Grenze des Holozäns bis zum jetzigen Meeresniveau. Diese Verschiebung ist mit wechselnder Geschwindigkeit geschehen. Radiocarbonatierungen einiger Schalenproben aus Zentral-Spitzbergen und Nordostland, ebenso von INGRID OLSSON in Uppsala ausgeführt, zeigen zwei Phasen in der Bewegung: eine frühe mit rapider Bewegung und eine spätere mit langsamer Bewegung. Die frühe Phase trat hauptsächlich in prä-borealer Zeit ein. Dies steht in guter Übereinstimmung mit sonstigen holozänen Strandverschiebungen, wie sie beispielsweise in Nord-Europa nachgewiesen sind. Es ist auch wohlbekannt aus diesen anderen Gebieten, daß Stagnationen, sogar positive Oscillationen, in der allgemeinen negativen Verschiebung der Strandlinie stattfanden. — 1955 schrieb ich, daß einige Züge in der allgemeinen Ausgestaltung der Holozänablagerungen Zentral-Spitzbergens, so auch Züge des Faunenwechsels, Oscillationsvorgänge in der Strandverschiebung andeuten, daß aber damals keine konkrete Transgressionsspuren entdeckt waren.

Nachdem eine Transgression am Talavera-Profil nachgewiesen war, erinnerte ich mich an ein ähnliches Profil in der Skansbucht des Billefjordes in Zentral-Spitzbergen. Da wurde auch eine dünne Torfzone in einem marinen Aufschluß gefunden. Die Torfzone lag 1,5 m unter der Terrassenoberfläche, die da 17,7 m über dem Meeresniveau lag. Dieses Vorkommen wurde damals als ein Solifluktionsergebnis angesehen.

Neulich habe ich die torfartige Probe von der Skansbucht hervorgefunden und in Uppsala datieren lassen. Die Probe war  $4800 \pm 120$  Jahre alt.

Wenn man eine Parallelisierung versuchen würde, hätte man hier die von anderswo gut bekannte Transgression am Übergang Atlanticum-Subboreal repräsentiert. Die Talavera-Transgression scheint also älter zu sein.

Für die Erläuterung der späteren Phase der Strandverschiebung Spitzbergens müssen wir mit Spannung und Hoffnung weiteren Funden und Datierungen entgegensehen.

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PLATE 1-3

Plate 1

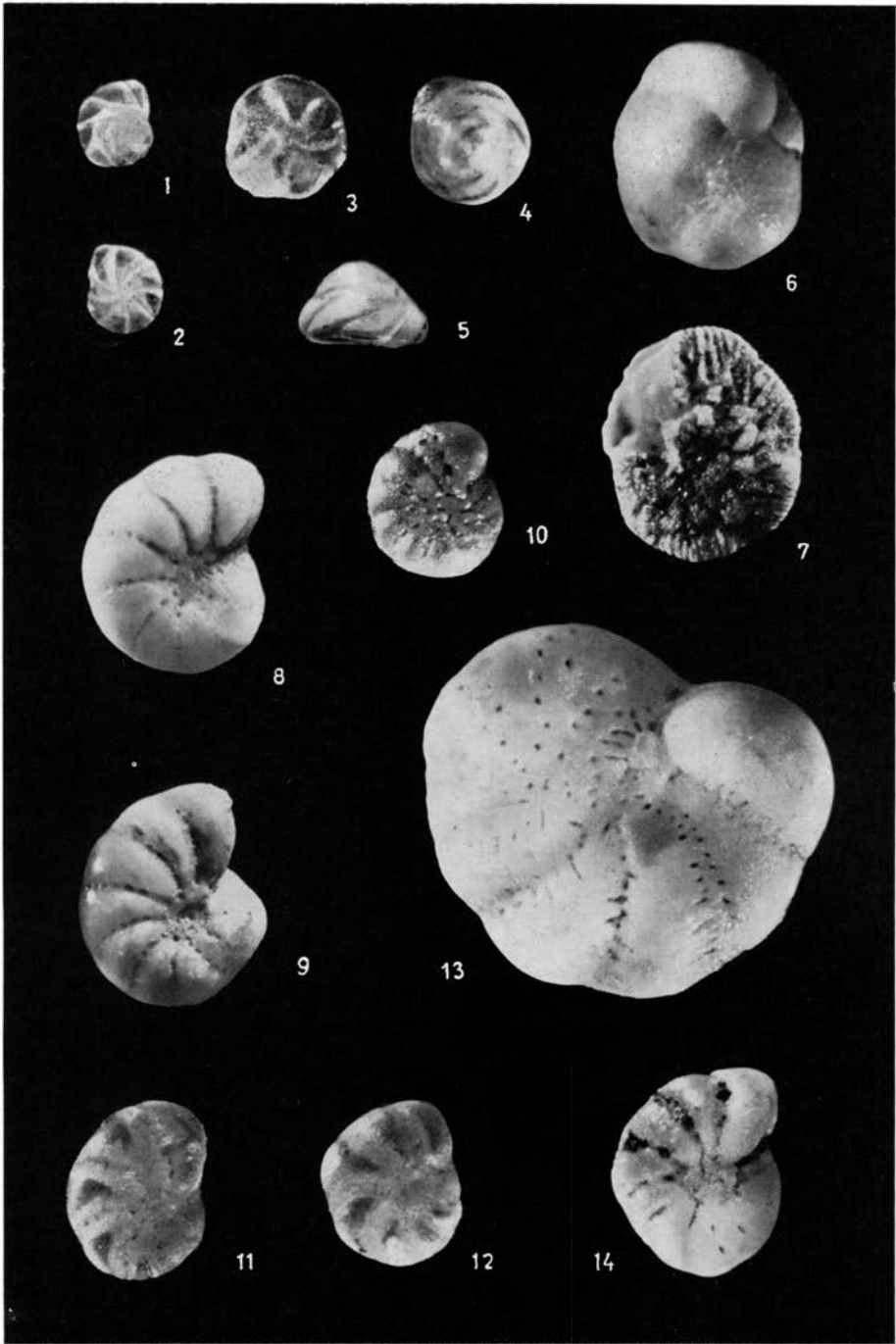
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