DET KONGELIGE INDUSTRI-, HÅNDVERK-
OG SKIPSFARTSDEPARTEMENT

NORSK POLARINSTITUTT
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SKRIFTER

Nr. 94

QUATERNARY FOSSILS

FROM THE SASSEN-AREA IN ISFJORDEN, WEST-SPITSBERGEN

(The Marine Mollusc Fauna)

BY

ROLF W. FEYLING-HANSSEN AND FINN A. JØRSTAD

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Nr. 1. HOEL, A., *The Norwegian Svalbard Expeditions 1906—1926.* 1929. Kr. 10,00.
„ 2. RAVN, J. P. J., *On the Mollusca of the Tertiary of Spitsbergen.* 1922. Kr. 1,60.
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„ 5. LYNGE, B., *Lichens from Spitsbergen.* 1924. Kr. 2,50.
„ 6. HOEL, A., *The Coal Deposits and Coal Mining of Svalbard.* 1925. Kr. 10,00. [Out of print.]
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Nos. 1—11: Vol. I. From Nr. 12 the papers are only numbered consecutively.

Nr. 12. STENSIÖ, E. A:SON, *The Downtonian and Devonian Vertebrates of Spitsbergen.* Part I. *Cephalaspidae.* A. Text, and B. Plates. 1927. Kr. 60,00.
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„ 19. FREBOLD, H., *Das Festungsprofil auf Spitzbergen. Jura und Kreide.* II. *Die Stratigraphie.* 1928. Kr. 3,00.
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„ 23. HEINTZ, A., *Die Downtonischen und Devonischen Vertebraten von Spitzbergen.* III. *Acanthaspida. — Nachtrag.* 1929. Kr. 3,00.
„ 24. HERITSCH, F., *Eine Caninia aus dem Karbon des De Geer-Berges.* 1929. Kr. 3,50.
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„ 30. ORVIN, A. K., *Beiträge zur Kenntnis des Oberdevons Ost-Grönlands.* HEINTZ, A., *Oberdevonische Fischreste aus Ost-Grönland.* 1930. Kr. 4,00.
„ 31. FREBOLD, H., *Verbr. und Ausb. des Mesozoikums in Spitzbergen.* 1930. Kr. 17,00.
„ 32. ABS, O., *Über Epidemien von unspezifischen Katarrhen der Luftwege auf Svalbard.* 1930. Kr. 2,00.
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„ 36. SMEDAL, G., *Acquisition of Sovereignty over Polar Areas.* 1931. Kr. 10,00.

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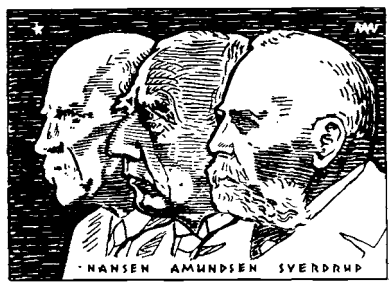

OSLO
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A. W. BRØGGERS BOKTRYKKERI A/S

Contents.

Introduction.

The Quaternary fossils listed in this paper originate from raised beaches in the Sassen area in Isfjorden, West Spitsbergen. The fossils were collected during our partisipation in Norsk Polarinstitutt's expedition to Svalbard in the summer of 1948. As for us, it was an exploratory trip to get acquainted with conditions concerning the Quaternary geology of Spitsbergen. Our main task was to look for faunal demarkations between raised marine deposits in the region, *i. e.* to see if there is a possibility of basing correlations of raised beaches on the fossil faunas associated with them.

We have tried to collect fossils systematically and we have measured the altitudes of fossil-bearing localities. We thus had to concentrate our work on a limited region, and the conclusions which we have drawn from our investigations probably only apply to this region. Further observations from a wider area are needed before more extended conclusions can be drawn.

This paper must be regarded as a preliminary one; it is a report on our observations. The collected material was worked out during our one month's stay at the Tromsø Museum after our return to Norway. The manuscript has been written partly in Tromsø, partly in Uppsala.

We are greatly indepted to the director of the Tromsø Museum, T. Soot-Ryen, for advice and courtesy. We wish also to express our thanks to him for specific identification of some of our gastropods. Further we wish to express our thanks to docent Dr. Ivar Hessland (Uppsala) for valuable criticism. We are greatly indepted to the director of Norsk Polarinstitutt, Professor H. U. Sverdrup, and to Dr. A. K. Orvin, who provided economic aid for our work.

Uppsala Universitets Paleontologiska Institution, in March 1949.

Rolf W. Feyling-Hanssen.

Tromsø Museum, in March 1949.

Finn A. Jørstad.

General Remarks.

On the so-called Mytilus period of Spitsbergen.

In the literature dealing with the Quaternary geology of Spitsbergen, discussions have been carried out on the post-glacial climatic changes (Högbom 1911 and 1913 ,Hoel 1910 and 1914, Knipowitsch 1903, Elton and Baden-Powell 1931, Baden-Powell 1939, Balchin 1941 and others). Numerous scientific expeditions to Spitsbergen and Svalbard in general, have brought back fossils of a Quaternary marine fauna from raised beaches. Knipowitsch (1903) gives a list of Quaternary fossils known up to that year. This list contains moreover, species still living in the Spitsbergen area, but three of them, are now extinct there, viz.: *Mytilus edulis, Cyprina islandica* and *Littorina littorea*. Knipowitsch (1903) also gives the finding-places of most of the fossils collected. It seems as if the species mentioned above, among which *Mytilus edulis* is the most frequent, originate from localities from just above sea-level up to about 25 m above sea-level.

The finds of these more boreal marine molluscs, indicating a milder climate than that prevailing in the area today, caused the establishment of the so-called *Mytilus* period on Spitsbergen. Certain elements of the flora were more favoured (Andersson 1910) and the marine life of Svalbard was richer in this period than it is today. Since *Mytilus edulis* had not been found until then at greater altitudes than 25 m above sea-level, Högbom (1911) conciders the *Mytilus* period to have been a late portion of post-glacial time. First he states that 25 m makes 30 per cent of the whole late-Quaternary land-upheaval, and second that only the "high-arctic" species *Mya truncata* and *Saxicava arctica* are met with at greater altitudes.

Later on, this *Mytilus* period has been widely extended, because more boreal species have been found, and because the boreal assemblage, especially *Mytilus edulis,* has been found at greater altitudes.

To the species mentioned above, Lamplugh (1911) added *Anomia squamula* L. and *Onoba aculeus* Gould from Cora Island in Ekmanfjord. Dautzenberg and Fischer (1912) added *Volsella (Modiola) modiolus* (L.), which was found in raised beaches in Advent Bay in 1906 by the Prince of Monaco. *Mya truncata* L. was recorded from localities up to

65 m above present sea-level (Högbom 1911). Kulling (1936) reports that *Mytilus edulis,* together with *Astarte borealis* and *Mya truncata,* was found by the 1923 Oxford Expedition in Wahlenbergfjord, Hinlopenstredet, at an altitude of 55 m. In a broken-up shell bank from 14 to 21 m above sea-level in Lomfjord, Hinlopenstredet, Kulling found "large quantities of *Mya truncata, Macoma calcarea* and *Astarte borealis,* and — more sparingly — *Astarte montagui, Pecten (Chlamys) islandicus, Saxicava rugosa,* and also *Cyprina islandica*" (l. c. p. 4). Elton and Baden-Powell (1931) record *Cyprina islandica* from 3 to 6 m above sea-level at Advent Bay, and in Billefjorden they have collected this species from 30 to 45 m above sea-level.

Thus the *Mytilus* period must be extended at least up to 55 m above present sea-level.

In 1911 Hoel found *Mytilus edulis* 70 m above sea-level at Dickson Bay (reported by Frebold 1935). Balchin (1941), who also gives a list of Quaternary fossils collected in raised beaches in Billefjord, reports *Mytilus edulis* from at least the same altitude, as far as can be seen from his list and maps.

But the *Mytilus* period still exists in literature. From the first time this term has been used in papers dealing with the Quaternary geology of Svalbard, the *Mytilus* period has been established on s c a t t e r e d finds of, in the first instance, *Mytilus edulis* in raised beaches. Scattered finds, however, constitute too weak a basis on which to build up the post-glacial history of this region.

No one knows exactly what is meant by this *Mytilus* period, or how to limit it, — unless it should be that the *Mytilus* period embrazes the whole sequence of Quaternary fossil-bearing horizons in this region.

It seems that the best thing to do, is to put aside this *Mytilus* period for the time being, at least until more detailed observations on the fossil fauna are at hand.

Morphology.

Last summer we made an attempt to collect Quaternary fossils systematically from raised morphological features in the Sassen area, the innermost parts of Isfjorden, West Spitsbergen. Going round from south, east, to north, the localities dealt with are Ledalen, Vindodden, Kapp Belvedère (east of Blomedalen), Sveltihel, the dominating shingle ridges and terraces briefly called Sassen, Kapp Schoultz, Von Post Glacier (the morains south of the glacier's front), Kapp Murdoch, Bjonahamna, Gipsvika (eastern and western part), Gipshuk, Gåsodden, Anservika and Gåsøyane (Anser Islands). The localities are marked on the map.

The raised morphological features in the region are, to a great extent, worked out and mapped in detail by W. G. V. Balchin in his

treatise on "The Raised Features of Billefjord and Sassenfjord West Spitsbergen" (1941). Balchin finds that the coast falls into four broad divisions: The raised shingle complexes, raised platforms, raised wave-cut features, scree cone and fan coast. The first group Balchin describes as follows (l. c. p. 367): "The raised shingle complexes make an assemblage of features which can be described as magnificent, and shingle beaches in perfect preservation are raised in places over 300 feet above sea-level. Three main groups may be distinguished: Billefjord, Gips Bay and Bjona Haven. — A relative change of level has taken place during the formation, and marine processes have worked at successively lower levels. Shingle ridges have been built up on the rising front. But during periodic stillstands, longshore drift and consequent erosion appear to have been dominant, and cliffs were cut in the old raised shingle ridges. With continued elevation the cliffs have been raised above wave action and mark past shorelines; the coast now resembles a series of steps rising landwards to a height, in places, of 250 feet."

About the second group Balchin writes: "Raised platforms. — These are best developed at the junction of Sassenfjord and Billefjord, where the Gåsøyane (Anser Islands) are undoubtedly fragments of a raised platform of marine erosion. — The coastal plain of the adjacent mainland from Anser Bay to Gips Bay is similarly a plain of marine denudation emerging directly from the sea. The platform rises gently inland reaching in three-quarters of a mile a height of 308 feet at the base of Mount Jean: Here there are fragments of an old cliff."

The third group, raised wave-cut features, Balchin has given a somewhat diffuse explanation. One cannot from his work definity see what is meant by this group. Balchin writes that these features occur near Bruse Hut in Sassen and near Cape Schoultz on the east side of the Tempelfjord. We have traced similar complexes at Kapp Murdoch and also just east of Bjonahamna, and we would like to give these particular features another name and another explanation. Undoubtedly these formations represent successions of raised delta plains. They are always found to be associated with river outlets.

The explanation of the last group, scree cone and fan coasts, is already given in the name. "The coast is either precipitious — or built up of scree cones which descend steeply to the sea." (l. c. p. 372.)

Although we do not agree with all what Balchin has worked out on this subject, the reader is referred to Balchin's paper on the raised features in the region dealt with. His maps especially may be of great value.

Occurrence of fossils.

The fossils collected are, to a great extent, associated with the raised features as a whole, shingle ridges, cliffs and beaches; that means those distinguished destructional features giving evidence of a relative change of level. By treating the material statistically we have meant to make an approach towards correlating the different terraces on the basis of their fossil faunas.

Special conditions have to be considered. Balchin (1941, l. c. p.373) expresses this as follows: "In making such collections various factors tend to diminish the accuracy. The more delicate fauna naturally breaks up under the conditions of deposition, whilst frost action renders collecting on the upper exposed surfaces difficult, comminution having proceeded at a rapid rate. The possibility of modern shells being transported by birds, and fauna being carried downwards by stream action must also be borne in mind." — To these factors must be added the solifluction as one more reason for fossils being carried downwards. As to the frost action, mentioned by Balchin, this does not really make collecting difficult. Large quantities of shells may be found on the surface, and they seem to be quite unaffected by frost action. In localities where the ground contains mud or clay, the fossils are actually frozen up to the surface, and may easily be picked up. This appearance is always, to some degree, associated with so-called structural grounds. Of course, this factor too is responsible for fossils being moved from the point where they were first deposited.

The localities from where collection are to be made, must be chosen with consideration for these conditions.

The fossils listed on the following pages may be divided into two main groups: those collected in sand-gravel-shingle material, and those taken in clay-silt material. The first group, and most of the shells collected fall into this, contains fossils originating from near the top and from the surface of ridges and terraces. Such fossil-bearing localities are found to be those least affected by the factors mentioned above. This is due to the relative coarse sediments, unconsolidated gravel and shingle, which are found here. The porosity of the material prevents solifluction and the forming of structural ground. This makes it possible, with a high degree of accuracy, to associate the fossils with the ridges and terraces in which they are found.

The faunal assemblages which appear from such localities are composed of animals sedimentated in shallow water, or simply washed ashore at the time when the feature spoken of was situated at sea-level. Under such conditions of depositing the fauna will nearly always have a somewhat mixed composition. Undoubtedly the greater part of the shells here belong to species inhabiting the littoral zone or even the

tidewater zone. But some of them may in some way or other have drifted in from greater depths. However, this can only have taken place to a small extent.

A far more serious difficulty of relating the fauna to one particular terrace, is that of the redepositing of minerogenic and biogenic material from ridges and terraces situated at greater heights. By wave action and erosion in terraces just raised, sediments from these may be carried downwards and deposited anew on what, by further lowering of the shoreline, will appear as the next terrace in the sequence. In fact, the upper terraces have produced a great part of the material of which those beneath are built up. The fossil faunas mixed up in this way may probably cause some confusion in correlating the different beaches. Regarding for instance the modern shore, shells of *Mytilus edulis* are now and then met with. It is almost certain that *Mytilus edulis* does not live in the Isfjord today (Knipowitsch 1902 and 1903, Odhner 1915, and Heintz 1926). The shells of this mussel in the modern shore are washed down from overlying older sediments. However, by calculating the fauna in the recent shores, *Mytilus edulis* always makes a very small per cent of the whole faunistic assemblage (except at Gåsøyane), although it may be dominant in the next overlying terrace from which it originates. When dredging in shallow water on mud-and gravel-plains just outside the coast, we never obtained this species. It thus seems as if the faunas are less mixed up in the outermost parts of the terraces. To offset the difficulties as far as possible, most of the collections are made from such localities. By treating statistically the material from numerous localities, one may hope that possibly occuring anomalies are smoothed out.

The second group of fossils contains those collected in solifluction slopes, and those from collections made elsewhere in mud and clay sediments. Collecting in solifluction slopes, one cannot definitely tell from where the fossils originate. In most cases, however, they can be traced to an upper limit. Regarding fossils collected in mud and clay material near the basis of raised terrace cliffs, one may assume that they belong to a relative deep-water facie. The fossils here appear to be to some extent *in situ,* as many of the pelecypods are found with united valves. In view of the few localities in which we have collected fossils in such deposits, we have not tried to correlate the faunas thus obtained with those mentioned in the first group.

In the second group, fossils collected in morainic material are also included. Only one typical locality of this kind has been visited by us — the morains of Von Post Glacier in Tempelfjord. One must presume that the faunas here are mixed up on a greater scale, according to the amount of destruction of older deposits by the fluctuating glacier. Fossils collected in the moraines of this locality are not considered by correlating the raised beaches.

Methods.

The heights of fossil deposits are measured with tacheometer. Heights were initially referred to local high-water mark. This mark will, as known, at different times be found at different levels. In connection with tidal observations carried out at the camp, we have as far as possible tried to get a mean high-water mark as basis for measurements. The same tidal observations have enabled us to make a correction to approximate mean sea-level, as the topographers do it. Thus all the heights given refer to mean sea-level.

As the main task of our investigations last summer was to find out if there is a possibility of basing a correlation between raised beaches on Spitsbergen on the fossil faunas, *i. e.* if any definite faunal demarkations between deposits could be pointed at, we have worked out our material statistically. The tedious methods used by analysing shell beds (Antevs 1928, Hessland 1943), have not been convenient. Typical shell beds are not met with in this region (perhaps *Mytilus* beds may be spoken of). We have in each locality picked up a number of fossils great enough to give an imagination of the faunal composition. (Microfossils, *i. a.* foraminifera, which have been observed in our samples, are not considered in this paper.) In the following faunal lists the frequency of different species are indicated by number of specimens. Of the gastropodes whole shells and summits of broken shells are counted and of the pelecypods valves and umbonal fragments, whose number is divided by two. Of the balanids the carinas or rostras are counted. Chitonids and echinids are not calculated. By a section through a *Mytilus* terrace at Sveltihel, the biogenic material has been weighed. The short time at hand for working out the material has prohibited valve measurements and calculating of indexes, although this would have been of some interest. The genus *Astarte* Sowerby has been rather roughly treated. As the taxonomy of this genus seems to be somewhat confused at the moment, we have only separated Jensen's (1912) four species: *Astarte borealis* (Chemnitz), *Astarte elliptica* (Brown), *Astarte crenata,* (Gray) and *Astarte montagui* (Dillwyn). We have not considered subspecies and a varieties.

Special Part.

Localities and fossil faunas.

V i n d o d d e n. Vindodden represents the delta built up by Blomedalselva (Flower-valley-river). West of the river outlet two terraces may be distinguished. The lower and smaller rises gently inland from 2.6 m to 3.6 m above sea-level. *Mytilus edulis* L. occurs here. Due to the vegetation no fossils were collected.

The second terrace, the front of which is situated 22 m from the coast, rises from 7 m to 14.7 m above sea-level 242 m inland. The assemblage collected here was:

7 m. Vindodden, west of the river outlet.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	22.5	95.7
Mytilus edulis L.	0.5	2.1
Chlamys islandica (Müller)	0.5	2.1
	23.5	99.9

East of the river outlet fossils were collected in a distinct shingle terrace, the surface of which rises from 19.6 m to 21.5 m. Fossils were collected on and in the outer part of this terrace:

19.6 m. Vindodden, terrace east of the river outlet.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	59.5	97.5
Mya truncata L.	1.0	1.6
Mytilus edulis L.	0.5	0.8
	61.0	99.9

Above this terrace lies a smaller one, at an altitude of 24.4 m. No fossils were found here. A shell of a small *Buccinum* sp. was picked up from the surface. This must have been transported by bird. Further up, the material consists of shingle, gravel and boulder clay, representing reminisences of a terminal moraine in Blomedalen. More or less horizontal lines can be figured out here too, but they are all indistinct. No fossils were found.

In the east side of the valley, outside the features mentioned above, two characteristic shorelines were measured. The highest has an altitude

Fig. 1. Vindodden and Blomedalen (Flower valley), Kapp Belvedère to the left and Ledalen to the right.

of 63 m, the lower of 58 m above sea-level. The lower is developed as a terrace. The surface material at both levels is unconsolidated shingle. No fossils were found, but below these lines, at a height of 33.2 m, fragments of *Mya truncata* L. occurred.

Kapp Belvedère, east of Vindodden. Due to wave action on the rocks, the coast here is precipitous, the height of the rock wall averaging from 3 to about 4 m. The rock plain, rising gently inland, is covered with sediments consisting of shingle, gravel and sand with a thickness from 1 to 1.5 m. A terrace is developed with ridge patterns and wave-cut markings on the surface, rising inland from 5.3 to about 13 m above sea-level. Above this height most of the evidence of ridging is destroyed by solifluction. The intensity of solifluction increases upwards. The uppermost horizontal line on the side of Mont Belvedère was measured, the altitude being 96.2 m above sea-level. This line is probably due to wave action. It is cutting the pre-Quaternary strata of the mountain which dip to the east. But destructions have taken place to a high degree, so that nothing definite can be said about the upper marine limit.

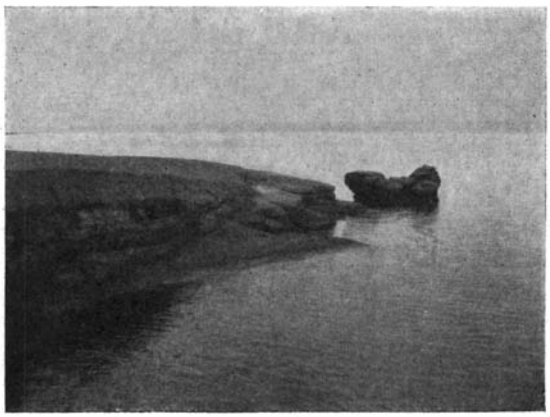


Fig. 2. Kapp Belvedère.

Fossils were collected at different heights in this locality:

5.3 m. Kapp Belvedère, terrace, shingle, sand and silt.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	194 0	93.5
Mytilus edulis L.	4.5	2.2
Mya truncata L.	3.0	1.5
Saxicava arctica (L)	1.5	0.7
Astarte montagui (Dillwyn)	0.5	0.2
Cyprina islandica (L.)	0.5	0.2
Chlamys islandica (Müller)	0.5	0.2
Buccinum glaciale L.	3.0	1.5
	207.5	100.0

Astarte borealis (Chemnitz) is represented by 388 valves and umbonal fragments. To this comes a quantity of shell fragments without umbo, not counted. Most of the valves are unbroken. The greater part of them have periostracum and ligament quite or partly preserved. Some specimens were found with united valves. Most of the valves have eroded beaks. *Cyprina islandica* (L.) is represented by 1 umbonal fragment.

13 m. Kapp Belvedère. Shingle, gravel and silt.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	126.0	92.7
Mya truncata L.	6.5	4.8
Saxicava arctica (L.)	2.0	1.5
Mytilus edulis L.	0.5	0.4
Serripes groenlandicus (Chemnitz)...	0.5	0.4
Cyprina islandica (L.)	0.5	0.4
	136.0	100.2

Astarte borealis (Chemnitz) is represented by 252 valves and umbonal fragments. A little more than a hundred shell fragments without umbo were also present. Most of the shells have a worn appearance, and do not show periostracum or ligament.

Cyprina islandica (L.) is represented by 4 shell fragments without umbo. Three of the fragments belong to the same valve.

The highest place where fossils were found in this locality is at an altitude of 57.3 m above sea-level. 1 valve and 29 small shell fragments were picked up. Accordingly, the assemblage here is:

Mya truncata L. 2 specimens.
Saxicava arctica (L.) 1 specimens.

On the outermost and western part of the terrace described above, where *Astarte borealis* is dominating, there is a small ridge ascending to a small shingle plain just below the terrace surface inside. Here we worked out a vertical section from the rock 3.05 m above sea-level, on which the deposits are resting, to the surface of the shingle plain 3.80 m above sea-level. At every 15 cm 2 dm^3 of the gravel were taken, and the fossils contained in the quantity were picked out. The result is tabulated below. The samples are numbered I to V from base to surface:

Species	I	II	III	IV	V
Mytilus edulis	2.0	5.0	5.0	6.0	2.0
Astarte borealis	7.0	6.5	4.0	5.0	6.0
Astarte montagui	-	0.5	-	-	0.5
Mya truncata	0.5	0.5	0.5	1.0	0.5
Saxicava arctica	-	-	-	1.5	1.0
Margarites groenlandica....	-	1.0	-	-	-
Balanus sp.	0.5	-	-	-	-
Lithothamnion sp.	-	-	-	×	-
	10.0	13.5	9.5	13.5	10.0

The minerogenic material in the lower part of the section is fine sand with pebbles. Here some specimens were found with united valves. The material is growing coarse upwards and turning into shingle because the finer material is washed out. All valves of *Astarte borealis* have eroded beaks. Periostracum and ligament are preserved in the specimens form the lower part of the section.

Between Kapp Belvedère and Sveltihel. The raised features here are magnificently developed, wave-cut cliffs and terraces rising stepwise inland. The cliffs are worked out in the rocks, and the plains are covered with generally coarse, unconsolidated sediments. A tacheometric line of levels was run perpendicular to the coast:

Fig. 3. Mytilus-terrace at Sveltihel.

6.0 m above sea-level, lowest terrace, *Astarte borealis*.
7.4 » — — terrace containing *Astarte borealis*.
9.2 » — — little terrace.
11.8 » — — little terrace.
14.1 » — — little terrace.
31.5 » — — prominent terrace, no fossils found.
49.4 » — — prominent terrace, *Mya truncata*.
58.8 » — — solifluction slope, *Mya truncata*.

Fossils were very rare; collections were not made from these localities.

Sveltihel, Sassenfjord. The abrational front against the sea is worked out in shingle- and gravel plains and underlying solid rock. Due to erosion and wave action the topography gives a cut-up appearance. Shingle platforms and raised beaches were measured at the following heights:

2.3 m above sea-level, lowest shingle platform.
3.6 » — — extended shingle platform.
3.6 » — — shingle plain east of the above mentioned.
7.0 » — — separated rock platform with gravel and sand.
7.0 » — — rock platform with sand and vegetation.
20.9 » — — terrace.
27.2 » — — terrace.
43.2 » — — terrace.
62.2 » — — terrace.
70.5 » — — little terrace.
85.7 » — — highest line on the mountainside.

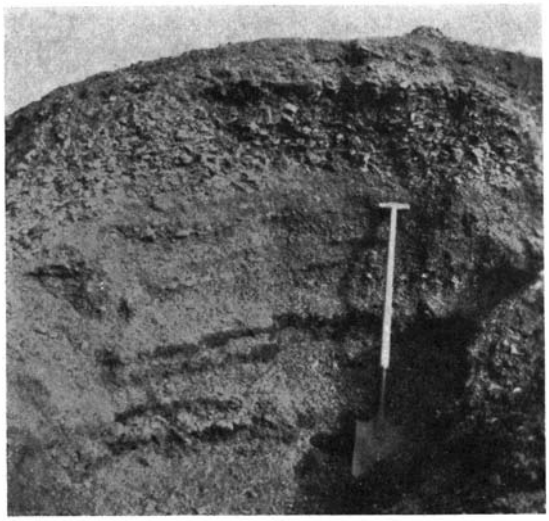


Fig. 4. Section in the Mytilus-terrace at Sveltihel.

Fossils were collected in the lower features:

2.3 m. Sveltihel, shingle platform with sand and gravel.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	77.0	40.3
Saxicave arctica (L.)	57.0	29.8
Mya truncata L.	23.5	13.3
Astarte montagui (Dillwyn)	16.0	8.4
Mytilus edulis L.	4.0	2.1
Astarte elliptica (Brown)	3 5	1.8
Chlamys islandica (Müller)	0.5	0.3
Macoma calcarea (Chemnitz)	0.5	0.3
Buccinum glaciale L.	2.0	1.1
Buccinum sp.	2.0	1.1
Buccinum undatum L.	1.0	0.5
Bela sp.	1.0	0.5
Lunatia pallida (Brod. & Sow.)	1.0	0.5
Tonicella marmorea (Fabricius)	plates	-
Balanus balanus (L.) Da Costa	1.0	0.5
Lithothamnion sp. (not rare)	-	-
	191.0	100.2

The *Mytilus*-shells and probably some of those of *Astarte borealis* may have been washed down from the 3.6 m terrace to the west.

Astarte borealis (Chemnitz): 154 valves and umbonal fragments, and also fragments without umbo. Very few of the shells show traces of periostracum. 1 specimen was found with united valves.

In the 3.6 m shingle plain west of the lower terrace mentioned above, a section was worked out in the sediments from the surface to the underlying rock. At every 15 cm 2 dm^3 of the material was taken. The fossils

included in each sample are counted and weighed. The result is tabulated, the samples being numbered from I to X from surface to bedrock. The minerogenic material in each sample has been separated in fractions according to coarseness, thus: < 0.5 mm, 0.5—2 mm, 2—10 mm and > 10 mm.

Table I A gives the result of the mechanical analysis of the minerogenic material. In each sample 200 grams of the material have been treated. The result is figured by simple curves showing the frequency variations of the four fractions.

It will be seen that the curve indicating the coarsest fraction, > 10 mm, corresponds fairly well to that of the total biogenic fraction in table I B. This curve is calculated in per cent of the total weight of the biogenic material, 1144.8 g. Further it is seen that the *Mytilus*-curve, also calculated from weight, follows almost exactly the total-curve. *Mytilus edulis* represents the coarsest particles in the biogenic fraction, and its curve corresponds very well with that of the coarsest particles in the minerogenic fraction, A. The interpretation of this feature may be that the deposition of minerogenic and biogenic material in this section are the result of a common factor. This terrace may be looked upon as a typical shore-building. The fossils met with in the section are most probably simply washed ashore and sorted according to coarseness together with the minerogenic material. In the lowest samples, IX and X, conditions seem to have been somewhat otherwise. Many of the specimens here are found with the valves united and with well preserved periostracum, thus giving the appearance of being *in situ*. These two samples are also richest in species.

In table I C curves showing the frequency of *Saxicava arctica* and *Mytilus edulis* are drawn. These curves are calculated from number of specimens, per mille of the total number 288. The interesting thing here is that the *Saxicava*-curve is closely corresponding to the *Lithothamnion*-curve in B. *Lithothamnion* is rather richly represented in the section (total 500.3 g), and the valves of *Saxicava arctica* most commonly occur with irregular forms, generally of small size. Examining unbroken *Lithothamnion*-clods in the recent shore, it becomes evident that small and irregular formed specimens of *Saxicava* are closely connected with *Lithothamnion*. The clods of Lithothamnion may contain numerous specimen of *Saxicava* completely embedded and overgrown in *Lithothamnion*. These specimens of *Saxicava* found in the clods, are always deformed and of small size. The fossil *Lithothamnion* are generally broken into small pieces, thus revealing the *Saxicava*-specimens contained in the former clods. As a general rule it may be stated that the occurrence of *Lithothamnion* always seems to be associated with the occurrence of small and irregular formed specimens of *Saxicava arctica*. In the section dealt with, the *pholadis*-form of *Saxicava arctica* is rarely

Sveltihel. Sassenfjord. Mytilus-terrace 3.60 m above sea-level.

Species	I		II		III		IV	
	sp.	g.	sp.	g.	sp.	g.	sp.	g.
Mytilus edulis	0.5	3.6	8.5	31.9	9.5	43.9	34.0	165.9
Chlamys islandica	-	-	-	-	0.5	0.1	-	-
Astarte elliptica	1.0	0.3	-	-	-	-	0.5	0.6
Astarte borealis	2.5	6.2	4.5	9.9	2.0	1.8	2.0	5.8
Astarte montagui	2.0	0.1	1.0	0.8	2.5	1.0	4.0	1.2
Axinopsis orbiculata	-	-	-	-	-	-	-	-
Macoma calcarea	-	-	-	-	-	-	-	-
Macoma torelli	-	-	-	-	-	-	-	-
Clinocardium ciliatum	-	-	-	-	-	-	-	-
Serripes groenlandicus	-	-	-	-	-	-	0.5	1.1
Mya truncata	3.0	4.1	1.5	1.7	1.0	1.9	3.0	3.3
Saxicava arctica	4.0	3.4	3.5	5.3	4.5	7.2	7.0	6.0
Puncturella noachina	-	-	-	-	-	-	1.0	-
Margarites groenlandica	-	-	-	-	-	-	-	-
Lepeta coeca	-	-	-	-	-	-	-	-
Lunatia pallida	-	-	-	-	-	-	-	-
Littorina saxatilis	-	-	1.0	0.1	-	-	-	-
Buccinum glaciale	-	-	-	-	-	-	3.0	9.6
Buccinum sp.	-	-	-	-	1.0	0.8	1.0	0.1
Trophon clathratus	-	-	-	-	1.0	0.3	-	-
Tonicella marmorea	1	pl.	-	-	-	-	-	-
Strongylocentrotus sp.	-	-	-	-	-	-	spines	
Balanus balanus	-		1.0	0.1	0.5	0.1	-	-
Balanus sp.	-	-	-	-	-	-	-	-
Lithothamnion sp.	-	4.1	-	23.1	-	40.8	-	41.8
	13.0	21.8	21.0	72.9	22.5	97.9	56.0	235.4

met with in layers where *Lithothamnion* is most frequent. The same phenomena has been noted from many other localities visited.

In sample IV, one valve of *Mytilus edulis* with pearl was found. In V one specimen of *Astarte borealis* was found with united valves. The shells of *Saxicava arctica* were very small and with irregular forms. In VI, *Saxicava arctica* occurs in small and irregular specimens. In sample VII, one specimen of *Astarte montagui* with the valves united was found. In VIII, some of the *Saxicava*-shells were of the *pholadis*-form. One specimen of *Astarte borealis* was found with united valves. In IX, many specimens of *Saxicava* and *Astarte* with united valves were found. The specimens of *Astarte* have well preserved periostracum. Two juvenile specimens of *Mya truncata* were also found. In sample X, specimens with united valves and well preserved periostracum were numerous. One adult individual of *Mya truncata* was found with its sipho preserved. Foraminifera were also present.

If the fossils included in this section are treated as a whole, the composition of the faunal assemblage in this terrace will be:

V		VI		VII		VIII		IX		X			
sp.	g.	sp.	g.	sp.	g.	sp.	g.	sp.	g.	sp.	g.	sp.	g.
3.5	18.9	2.5	8.4	4.5	14.5	9.5	50.1	15.0	97.8	5.0	29.5	92.5	464.5
0.5	0.2	-	-	-	-	-	-	-	-	-	-	1.0	0.3
-	-	0.5	0.2	-	-	-	-	-	-	-	-	2.0	1.1
3.5	5.4	2.5	2.5	2.5	5.1	3.0	7.7	3.0	11.4	3.5	3.9	29.0	59.7
2.5	0.6	6.5	0.9	5.0	0.5	0.5	-	3.0	2.6	2.0	0.8	29.0	8.5
-	-	-	-	-	-	-	-	-	-	0.5	-	0.5	0.0
-	-	-	-	-	-	-	-	0.5	0.1	0.5	0.1	1.0	0.2
-	-	-	-	-	-	-	-	-	-	0.5	0.1	0.5	0.1
-	-	-	-	-	-	0.5	-	-	-	-	-	0.5	0.0
0.5	0.1	-	-	-	-	-	-	0.5	-	1.0	0.2	2.5	1.4
5.5	2.4	4.0	3.7	4.0	1.4	2.5	5.5	2.5	2.6	4.5	7.5	31.5	34.1
9.0	4.3	11.5	5.9	9.5	3.0	4.5	4.9	13.0	16.0	7.5	5.3	74.0	61.3
-	-	1.0	-	-	-	-	-	-	-	-	-	2.0	0.0
-	-	-	-	-	-	-	-	1.0	-	-	-	1.0	0.0
-	-	-	-	-	-	-	-	1.0	0.1	-	-	1.0	0.1
1.0	0.1	-	-	-	-	-	-	1.0	0.1	-	-	2.0	0.2
-	-	-	-	-	-	-	-	2.0	0.1	1.0	0.1	4.0	0.3
-	-	-	-	-	-	-	-	-	-	-	-	3.0	9.6
-	-	-	-	1.0	0.2	-	-	-	-	1	operc.	3.0	1.1
-	-	1.0	0.1	-	-	-	-	1.0	0.2	-	-	3.0	0.6
-	-	3	pl.	1	pl.	-	-	-	-	-	-	-	-
-	-	-	-	spines		spines &	pl.	spines		spines		-	-
0.5	0.1	-	-	-	-	1.0	0.9	1.0	-	-	-	4.0	1.2
-	-	-	-	0.5	0.1	0.5	0.1	-	-	-	-	1.0	0.2
-	62.9	-	47.2	-	47.8	-	33.1	-	130.1	-	69.4	-	500.3
26.5	95.0	29.5	68.9	27.0	72.6	22.0	102.3	44.5	261.1	26.0	116.9	288.0	1144.8

3.6 m. Sveltihel.

Species	Specimens	Per cent
Mytilus edulis L.	92.5	32.1
Saxicava arctica (L.)	74.0	25.7
Mya truncata L.	31.5	10.9
Astarte borealis (Chemnitz)	29.0	10.1
Astarte montagui (Dillwyn)	29.0	10.1
Serripes groenlandicus (Chemnitz)	2.5	0.9
Astarte elliptica (Brown)	2.0	0.7
Chlamys islandica (Müller)	1.0	0.4
Macoma calcarea (Chemnitz)	1.0	0.4
Macoma torelli (Steenstr.) Jensen	0.5	0.2
Axinopsis orbiculata G. O. Sars	0.5	0.2
Clinocardium ciliatum (O. Fabricius)	0.5	0.2
Littorina saxatilis (Olivi)	4.0	1.4
Buccinum glaciale L.	3.0	1.0
Buccinum sp.	3.0	1.0
Trophon clathratus (L)	3.0	1.0
Puncturella noachina (L.)	2.0	0.7
Lunatia pallida (Brod. et Sow.)	2.0	0.7
Margarites groenlandica (Chemnitz)	1.0	0.4
Lepeta coeca (Müller)	1.0	0.4
Tonicella marmorea (O. Fabricius)	plates	-
Balanus balanus (L.) Da Costa	4.0	1.4
Balanus sp.	1.0	0.4
Strongylocentrotus droebachiensis (Müller)	spines	-
Lithothamnion sp. (500.3 g)	-	-
	288.0	100.3

Table I.

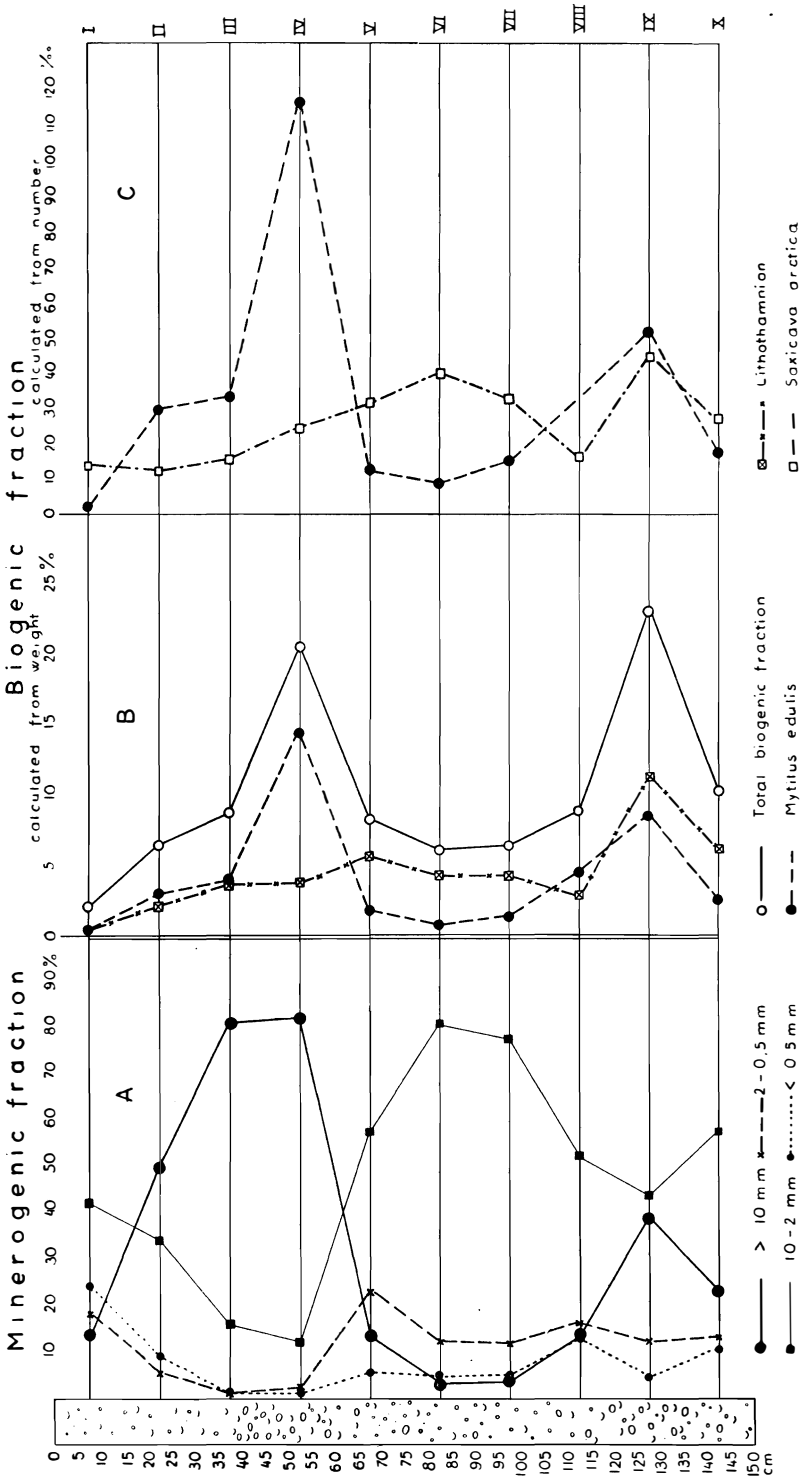


TABLE I

Fossils were also collected in the sediments of one of the 7 m — platforms:

7.0 m. Sveltihel, separated platform, sand and gravel.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	141.0	51.7
Saxicava arctica (L.)	47.0	17.2
Astarte montagui (Dillwyn)	41.5	15.2
Astarte elliptica (Brown)	21.5	7.9
Mya truncata L.	8.5	3.1
Crenella decussata (Montagu)	2.5	0.9
Chlamys islandica (Müller)	2.0	0.7
Macoma calcarea (Chemnitz)	1.0	0.4
Leda pernula (Müller)	0.5	0.2
Lepeta coeca (Müller)	2.0	0 7
Puncturella noachina (L.)	2.0	0.7
Littorina saxatilis (Olivi)	1.0	0.4
Buccinum sp.	2.0	0.7
Tonicella marmorea (Fabricius)	4 plates	-
Balanus balanus (L.) Da Costa	0.5	0.2
Strongylocentrotus	spines	-
	273.0	100.0

Lithothamnion was frequently met with here. *Spirorbis sp.* and foraminiferas were also present.

S a s s e n. Some of the collections from the magnificent complex of raised features in this locality will be dealt with later in this paper, because they probably represent a relative deepwater-facie of the fossil assemblages. From the upper parts of the terraces and on their surfaces we have collected fossils at the following heights:

20.5 m above sea-level, large terrace.
26.5 » — — terrace.
29.1 » — — shingle ridge.
32.5 » — — terrace.

The faunal compositions are as follows:

20.5 m. Sassen, terrace, gravel with sand:

Mya truncata L.	8.5	specimens
Saxicava arctica (L.)	2.5	»
Macoma calcarea (Chemnitz)	1.5	»
Astarte montagui (Dillwyn)	1.5	»
Chlamys islandica (Müller)	0.5	»
Littorina sp.	1.0	»

Fig. 5. The complex of raised delta-plains at Sassen.

The shells in this collections are too few for further calculating.

26.5 m. Sassen, terrace, gravel with some sand.

Species	Specimens	Per cent
Mya truncata L.	91.0	94.8
Saxicava arctica (L.)	3.0	3.1
Macoma calcarea (Chemnitz)	1.5	1.6
Mytilus edulis L.	0.5	0.5
	96.0	100.0

From a shingle ridge above this locality, altitude 29.1 m, were collected:

Mya truncata L. ..... 6.5 specimens
Mytilus edulis L. ..... 1.5 »
Saxicava arctica (L.) ..... 1.0 »
Chlamys islandica (Müller) ..... 0.5 »

On the terrace at altitude 32.5 m a locality richer in fossils was found. Collection was made not from the outer part of this terrace, but from just outside the basis of the cliff of the over-lying terrace:

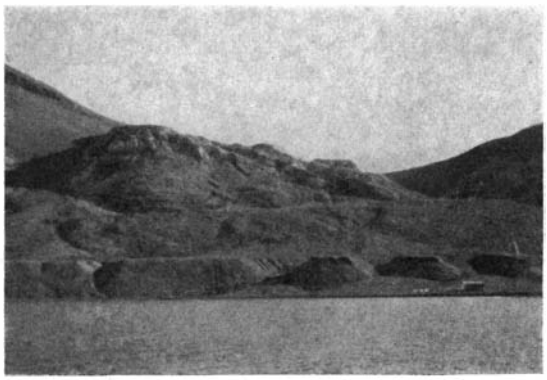


Fig. 6. Kapp Schoultz.

32.5 m. Sassen, terrace, gravel with sand.

Species	Specimens	Per cent
Mya truncata L.	101.0	82 1
Saxicava arctica (L.)	12.5	10.2
Macoma calcarea (Chemnitz)	5 5	4.5
Lepeta coeca (Müller)	3.0	2.4
Balanus balanus (L.) Da Costa	1.0	0.8
	123.0	100.0

From a small platform about 10 m above sea-level were picked up:

Astarte borealis (Chemnitz) ..... 0.5 specimens
Mya truncata L. ..... 0.5 »
Saxicava arctica (L.) ..... 0.5 »

From a shoreline in the hill-side south of the main complex of raised features in this locality, 16.3 m above sea-level, were found fragments of:

Mya truncata L.
Littorina littorea (L.)
Balanus balanoides (L.) Bruguière.

Above this shoreline is another one, at a height of 24.4 m above sea-level. Here were collected:

Mytilus edulis L. ..... 2.0 specimens
Mya truncata L. ..... 1.0 »
Saxicava arctica (L.) ..... 0.5 »
Macoma calcarea (Chemnitz) ..... 0.5 »

K a p p S c h o u l t z. In this locality magnificent terraces are found at different heights The highest of them is partly destroyed by solifluction. The fossils collected on the surface and in the upper parts of the terraces are listed below. Collections made from clay sediments in this locality will be dealt with later in this paper.

Fig. 7. Raised shorelines at Kapp Schoultz.

13.8 m. Kapp Schoultz, terrace, gravel and sand.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	32.0	73.3
Astarte montagui (Dillwyn)	5.0	11.1
Saxicava arctica (L.)	2.5	5.6
Mytilus edulis L.	2.0	4.4
Mya truncata L, ...	1.5	3.3
Chlamys islandica (Müller)	1.0	2.2
	45.0	99.9

East of the huts on Kapp Schoultz there is a well preserved terrace, the abrational cliff of which ascends steeply from sea level to an altitude of 28.8 m. From the surface of this terrace and from the upper part of its cliff, the following species were found:

Saxicava arctica (L.) ..... 2.0 specimens
Mytilus edulis L. ..... 1.0 »
Chlamys islandica (Müller) ..... 1.0 »
Mya truncata L. ..... 0.5 »
Trophon clathratus (L.) ..... 1.0 »
Tonicella marmorea (O. Fabricius) ..... 2 plates
Strongylocentrotus droebachiensis (Müll.) ... spines & plates

By digging in the same cliff somewhat lower, at a height of about 20 m above sea-level, a collection was made:

Mya truncata L. ..... 10.5 specimens
Saxicava arctica (L.) ..... 10.5 »
Volsella modiolus (L.) ..... 2.0 »

Fig. 8. Tempelfjord with Von Post Glacier, Bjonapynten to the left, Kapp Schoultz to the right.

Mytilus edulis L.	1.5	specimens
Chlamys islandica (Müller)	0.5	»
Astarte borealis (Chemnitz)	0.5	»
Macoma calcarea (Chemnitz)	0.5	»
Tonicella marmorea (O. Fabricius)	6	plates
Balanus balanus (L.) Da Costa	4	specimens

Echinide plates and spines.

Von Post Glacier. On the south side of the glacier front a lateral moraine remains, protruding about 2 km westward along the fjord side. There is a hunters' hut just at the end of this moraine. A little lagoon has been formed inside the modern stormridge east of the hut. The moraine is cut through by erosional furrows. Most of these were dry when we visited the locality (August the 24th).

Collections were made from the morainic material and from the bottom of the largest erosional furrow. The fossils thus obtained, will be dealt with later in this paper.

Proceeding from the scree cones just inside the little lagoon, there is a marine terrace. The height of this terrace (at the outermost part of its surface) is 19.7 m above sea-level. The minerogenic material is composed of gravel and sand. Fossils were collected from its surface and from the upper part of its erosional cliff:

19.7 m. Von Post Glacier, terrace, gravel and sand.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	14.5	50.9
Astarte montagui (Dillwyn)	4.5	15.8
Chlamys islandica (Müller)	3.0	10.5
Mya truncata L.	1.5	5.3
Mytilus edulis L.	1.0	3.5
Saxicava arctica (L.)	0.5	1.8
Cyprina islandica (L.)	0.5	1.8
Littorina littorea L.	1.0	3.5
Trophon clathratus (L.)	2.0	7.0
	28.5	100.1

K a p p M u r d o c h. To this locality, on the north side of Tempelfjord, we have only paid a short visit. Snow made work difficult. Fossils were collected from a terrace 7 m above sea-level, east of the delta built up by the Murdoch river. The terrace deposits are resting on a rock platform. Where the rock surface is exposed, it shows glacial striae with main direction NE—SW. The lower part of the terrace is composed of moraine material containing boulders Upwards the material is turning into bedded sand and gravel. The fossils collected are:

7 m. Kapp Murdoch, terrace.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	86.0	69.1
Saxicava arctica (L.)	14.0	11.2
Mytilus edulis L.	14.0	11.2
Astarte montagui (Dillwyn)	3.5	2.8
Astarte elliptica (Brown)	3 5	2.8
Mya truncata L.	2 0	1.6
Chlamys islandica (Müller)	1.5	1.2
	124.5	99.9

Lithothamnion sp. were also present.

B j o n a h a m n a. The raised features of this locality are mapped by Balchin (1941). Along the shingle cliff running NNW from Bjonapynten, bordering the Bjona Foreland to the east, *Mytilus edulis* and *Astarte borealis* are most frequently met with. The cliff is about 12 m high at Bjonapynten, coming down to 3 or 4 in the port. In a solifluction slope west of the hut belonging to the Scottish Spitsbergen Syndicate were found, about 6.5 m above sea-level:

Fig. 9. Raised shorelines at Bjonapynten.

Mya truncata L.	3.5	specimens
Astarte borealis (Chemnitz)	1.0	»
Saxicava arctica (L.)	0.5	»

In marine deposits north of the hut at an altitude of about 36 m, the following species were found:

Saxicava arctica (L.)	some fragments
Mya truncata L.	some fragments, one with umbo
Chlamys islandica (Müller)	1 fragment
Balanus balanus (L.) Da Costa	1 fragment

G i p s v i k a. Concerning the raised features in this locality, the reader is again refered to the maps given by Balchin (1941). (Balchin has on his map used the name Gips Hook for the little peninsula which in this paper is called Gåsodden. We have used the name Gipshuk for the localities in the neighbourhood of the hunters' hut just east of Gipsvika, east of the 45 m-peninsula.)

At the inner part of Gipsvika, to the north, two terraces were measured. The lower terrace, the cliff of which is situated 137 m from the coast, rises inland from 7.3 m above sea-level to 19.8 above sea-level at the range of 380 m from the coast. Above and inside this terrace is another one, 28.3 m above sea-level. The minerogenic material in both is composed of sand, gravel and shingle. Fossils were collected from the cliff and surface of the lower terrace:

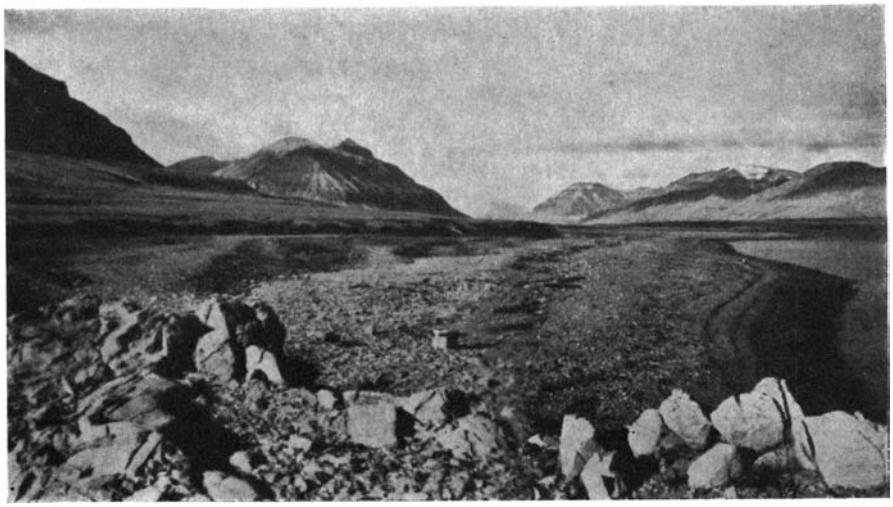


Fig. 10. Eastern part of Gipsvika.

7.3 m. Gipsvika, eastern part, terrace.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	82.0	48.8
Astarte montagui (Dillwyn)	56.0	33.3
Mytilus edulis L.	21.5	12.8
Saxicava arctica (L.)	2.5	1.5
Mya truncata L.	2.5	1.5
Astarte crenata (Gray)	0.5	0.3
Chlamys islandica (Müller)	0.5	0.3
Macoma calcarea (Chemnitz)	0.5	0.3
Serripes groenlandicus (Chemnitz)	0.5	0.3
Thracia septentrionalis Jeffreys	0.5	0.3
Puncturella noachina (L.)	1.0	0.6
Lithothamnion sp.	-	-
	168.0	100.0

At about the middle of the northern coast of Gipsvika there is an anticlinal flexure in the rock, and just west of this a 3.9 m-terrace is developed, with shingle patterns on its surface. The faunal assemblage in this terrace is:

3.9 m. Gipsvika, terrace, sand and shingle.

Species	Specimens	Per cent
Mytilus edulis L.	40.0	82.5
Astarte borealis (Chemnitz)	2.5	5.2
Mya truncata L.	1.5	3.1
Saxicava arctica (L.)	1.0	2.1
Chlamys islandica (Müller)	0.5	1.0
Buccinum glaciale L.	2.0	4.1
Buccinum groenlandicum (Chemnitz)	1.0	2.1
Lithothamnion sp.	-	-
	48.5	100.1

Above this terrace is another one rising gently inland from 9.7 m above sea-level to 10.5 m above sea-level. Fossils were sparsely represented. Fragments and umbonal fragments of the following species were found:

Mytilus edulis L.	12.0	specimens
Astarte borealis (Chemnitz)	4.0	»
Mya truncata L.	0.5	»
Saxicava arctica (L.)	0.5	»
Chlamys islandica (Müller)	0.5	»
Lithothamnion sp.		

From a solifluction slope west of this locality the following species were collected, altitude 32.8 m:

Mya truncata L.	3.5	specimens
Astarte crenata (Gray)	0.5	»
Macoma calcarea (Chemnitz)	0.5	»
Mytilus edulis L.	0.5	»

From a little terrace 25.8 m above sea-level, at the western part of Gipsvika, we picked up:

Mya truncata L.	10	small fragments
Mytilus edulis L.	4	» »
Strongylocentrotus?	1	plate

Above this terrace, at a height of 30.5 above sea-level, were found:

Saxicava arctica (L.)	3.0	specimens
Mya truncata L.	2.5	»
Mytilus edulis L.	1.0	»
Balanus balanus (L.) Da Costa	2.0	»
Strongylocentrotus	2	plates

West of the solifluction slopes marked on Balchin's map, there is a well developed terrace at a height of 45 m above sea-level. The minerogenic material is composed of bedded sand and gravel in the upper part of the deposits, turning into morainic material further down. A rich fossil fauna occurs in the bedded layers. The following collection was made:

45 m. Gipsvika, terrace, sand and gravel.

Species	Specimens	Per cent
Saxicava arctica (L.)	183.5	42.2
Mya truncata L.	181.0	41.7
Macoma calcarea (Chemnitz)	12.0	2.8
Chlamys islandica (Müller)	0.5	0.1
Mytilus edulis L.	0.5	0.1
Littorina saxatilis (Olivi)	7.0	1.6
Lepeta coeca (Müller)	3.0	0.7
Lacuna vincta (Montagu)	2.0	0.5
Buccinum undatum L.	2.0	0.5
Lunatia pallida (Brod. et Sow.)	1.0	0.2
Trophon truncatus (Strøm) ?	1.0	0.2
Balanus balanus (L.) Da Costa	41.0	9.4
Strongylocentrotus ?	-	-
	434.5	100.0

Saxicava arctica (L.), 186 unbroken valves and 181 umbonal fragments. Most of the shells belong to specimens of the *pholadis*-form. The shells are rather thick. Shells of more irregular form are also represented; some with high posterior end.

Mya truncata L., 93 valves and 269 umbonal fragments counted. Most of them thick-shelled.

Lunatia pallida (Brod. et Sow.)?, 40 juvenile individuals of this species were found among sand inside a specimen of *Littorina saxatilis*. The identification is somewhat uncertain.

Balanus (Eubalanus) balanus (L.) Da Costa, 38 carina, 41 rostra, 16 opercula, 165 other plates and 34 plate fragments. The plates belong to large specimens.

This terrace rises inland to a height of 56.5 m above sea-level. Heavy whale vertebra were found in its surface. From the same locality 14 fragments of *Mya truncata* were picked up.

North of the 45 m peninsula, west of Gipsvika, there is a shore-line at an altitude of 60 m. From this were collected:

Mya truncata L. ..... 7 small fragments
Saxicava arctica (L.) ..... 1 small fragment

This is the highest place where we found marine fossils in this locality.

Above this we measured a rock platform with gravel and shingle, altitude 80,1 m above sea-level. This may be of marine origin. No fossils were found.

Anservika. Collection was made from a terrace composed of sand and gravel, altitude 10 m above sea-level.

10 m. Anservika, terrace, sand and gravel.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	52.5	50.7
Mytilus edulis L.	36.0	34.8
Mya truncata L.	4.5	4.4
Saxicava arctica (L.)	3.0	2.9
Astarte montagui (Dillwyn]	3.0	2.9
Astarte elliptica (Brown)	1.5	1.5
Macoma calcarea (Chemnitz)	1.0	1.0
Cyprina islandica (L.)	0.5	0.5
Chlamys islandica (Müller)	0.5	0.5
Balanus balanus (L.) Da Costa	1.0	1.0
Lithothamnion	-	-
	103.5	100.2

Gåsøyane. Collection was made from a 7 m-terrace on the north side of the sound between the two main islands of the group. The fossils listed below originate from the upper part of the terrace cliff.

7 m. Gåsøyane, terrace, sand and gravel.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	52.0	69.3
Mytilus edulis L.	9 0	12.0
Mya truncata L.	4.5	6.0
Astarte montagui (Dillwyn)	2.5	3.3
Saxicava arctica (L.)	2.0	2.7
Chlamys islandica (Müller)	0.5	0.7
Littorina sp.	1.0	1.3
Buccinum sp.	1 0	1.3
Tonicella marmorea (Fabricius)	0.5	0.7
Balanus balanus (L.) Da Costa	2.0	2.7
Strongylocentrotus ?	-	-
Lithothamnion	-	-
	75.0	100.0

Fossils were also collected near the basis of the cliff:

2 m. Gåsøyane, in the cliff of the 7 m-terrace.

Species	Specimens	Per cent
Saxicava arctica (L.)	15.0	15.0
Mytilus edulis L.	6.5	6.5
Astarte borealis (Chemnitz)	6.0	6.0
Mya truncata L.	5.0	5.0
Crenella decussata (Montagu)	3.5	3.5
Turtonia minutum (Fabricius)	1.0	1.0
Astarte montagui (Dillwyn)	0.5	0.5
Macoma calcarea (Chemnitz)	0.5	0.5
Cingula aculea (Gould)	28.0	28.0
Lepeta coeca (Müller)	15.0	15.0
Margarites helicina (Phipps)	6.0	6.0
Moelleria costulata (Müller)	4.0	4.0
Puncturella noachina (L.)	2.0	2.0
Cingula castanea (Müller)	2.0	2.0
Natica clausa Brod. et Sow.	1.0	1.0
Littorina saxatilis (Olivi)	1.0	1.0
Tonicella marmorea (Fabricius)	-	-
Balanus balanus (L.) Da Costa	3.0	3.0
Strongylocentrotus	-	-
Spirorbis	-	-
Lithothamnion	-	-
	100.0	100.0

Remarks on the Local Development of the Faunas.

Before making any conclusions from the faunal assemblages listed on the previous pages, the local development of the faunas should be considered. It is evident that different physical conditions will support different developments of the faunal assemblages. The fossils hitherto dealt with, must be regarded as representing a shallow-water facie, a great part of them possibly being washed ashore at the different sea-levels. One may therefore hope to get an idea of local development by taking into consideration the faunas on the modern shores. Thus we have made collections from the present shore beneath those localities where fossils were collected. As mentioned before, som of the shells found on the modern shores represent fossils carried down from older deposits. All shells of *Mytilus edulis* may be regarded a fossils washed down from higher levels. We have not tried to separate potential fossils in making collections from the present shores. The shells carried down from older deposits generally make a very small per cent of the whole assemblage. The lists of species collected on the present shores are given on the three following pages.

Vindodden, west, present shore, fine sand.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	21.5	22.99
Saxicava arctica (L.)	17.0	18.18
Serripes groenlandicus (Chemnitz) ..	12.0	12 83
Mya trunacta L.	11.5	12.30
Liocyma fluctuosa (Gould)	9.5	10.16
Macoma calcarea (Chemnitz)	3.0	3 21
Mytilus edulis L.	1.5	1.60
Pandora glacialis Leach	1.0	1.07
Chlamys islandica (Müller)	0 5	0 53
Buccinum glaciale L.	4.0	4.28
Lunatia pallida (Brod. et. Sow)	4.0	4.28
Natica clausa Brod. et Sow.	3.0	3 21
Neptunea despecta (L.)	2.0	2.14
Buccinum tenue Gray ?	1.0	1.07
Sipho islandicus (Chemnitz)	1.0	1 07
Admete viridula (Fabricius)	1 0	1.07
	93.5	99.99

Vindodden, east, present shore, fine sand and gravel.

Species	Specimens	Per cent
Saxicava arctica (L.)	37.5	26.41
Astarte borealis (Chemnitz)	26.0	18.31
Macoma calcarea (Chemnitz)	24 5	17.25
Serripes groenlandicus (Chemnitz)...	22.0	15.49
Liocyma fluctuosa (Gould)	10.0	7 04
Mya truncata L.	8.5	5.98
Astarte montagui (Dillwyn)	4.0	0.82
Thracia myopsis (Beck)	2.0	1.41
Modiolaria discors substriata (Gray)	1.0	0.70
Mya pseudoarenaria Schlesch	0.5	0.35
Sipho islandicus (Chemnitz)	2.0	1.41
Natica clausa Brod. et Sow.	2.0	1.41
Lunatia pallida (Brod, et Sow.)	1.0	0.70
Buccinum groenlandicus (Chemnitz) .	1.0	0 70
	142.0	99.98

Sveltihel, present stormridge, gravel.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	33 5	45.89
Serripes groenlandicus (Chemnitz) ..	21.0	28.77
Saxicava arctica (L.)	7.0	9.59
Mya truncata L.	4.5	6.16
Mytilus edulis L.	3 0	4.11
Buccinum glaciale L.	2.0	2.74
Buccinum ovum Midd.	1.0	1.37
Buccinum sp, ...	1.0	1.37
	73.0	100.0

Kapp Schoultz, present shore, gravel and fine sand.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	16.0	44.45
Chlamys islandica (Müller)	5.0	13.89
Mya truncata L.	1.5	4.17
Saxicava arctica (L.)	1.0	2.78
Astarte montagui (Dillwyn)	0.5	1.39
Buccinum glaciale L.	4.0	11.11
Buccinum undatum L.	3.0	8.33
Margarites groenlandica (Chemnitz)	2.0	5.56
Littorina saxatilis (Olivi)	1.0	2.78
Lunatia pallida (Brod. et Sow.)	1.0	2.78
Lacuna vincta (Montagu)	1.0	2.78
	36.0	100.2

Gipsvika, inner part, present shore, gravel and sand.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	82.0	56.36
Astarte montagui (Dillwyn)	17.0	11.68
Mytilus edulis L.	16.5	11.34
Mya truncata L.	11.0	7.56
Saxicava arctica (L.)	5.5	3.78
Serripes groenlandicus (Chemnitz) ..	4.0	2.75
Astarte elliptica (Brown)	1.5	1.03
Chlamys islandica (Müller)	1.0	0.69
Liocyma fluctuosa (Gould)	0.5	0.34
Modiolaria discors laevigata (Gray) .	0.5	0.34
Buccinum glaciale L.	2.0	1.37
Margarites helicina (Phipps)	2.0	1.37
Natica clausa Brod. et Sow.	1.0	0.69
Lacuna vincta (Montagu)	1.0	0.69
Tonicella marmorea (Fabricius)	-	-
Lithothamnion	-	-
	145.5	99.99

Gipsvika, outer part, present shore, sand.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	37.5	40.76
Saxicava arctica (L.)	14.0	15.22
Astarte montagui (Dillwyn)	9.5	10.33
Macoma calcarea (Chemnitz)	6.5	7.07
Liocyma fluctuosa (Gould)	4.5	4.89
Mya truncata L.	4.0	4.35
Astarte elliptica (Brown)	1.0	1.09
Serripes groenlandicus (Chemnitz) ..	1.0	1.09
Astarte crenata (Gray)	0.5	0.54
Chlamys islandica (Müller)	0.5	0.54
Lepeta coeca (Müller)	2.0	2.17
Buccinum sp.	3.0	3.26
Lacuna vincta (Montagu)	2.0	2.17
Tonicella marmorea (Fabricius)	-	-
Balanus balanoides (L.) Bruguière ..	5.0	5.43
Balanus balanus (L.) Da Costa	1.0	1.09
Lithothamnion sp.	-	-
	92.0	100.0

Gåsøyane, present shore, sand gravel and pebbles.

Species	Specimens	Per cent
Mytilus edulis L.	11.5	23.96
Saxicava arctica (L.)	9.5	19.79
Astarte borealis (Chemnitz)	1.5	3.13
Astarte montagui (Dillwyn)	1.5	3.13
Astarte elliptica (Brown)	0.5	1.04
Modiolaria discors laevigata (Gray)	0.5	1.04
Buccinum undatum L.	4.0	8.33
Littorina saxatilis (Olivi)	3.0	6.25
Margarites groenlandica (Chemnitz)	1.0	2.08
Margarites helicina (Phipps)	2.0	4.17
Lepeta coeca (Müller)	2.0	4.17
Amauropsis islandica (Gmelin)	1.0	2.08
Buccinum glaciale L.	1.0	2.08
Tonicella marmorea (Fabricius)	2.0	4.17
Balanus balanus (L.) Da Costa	4.0	8.33
Balanus balanoides (L.) Bruguière	3.0	6.25
Strongylocentrotus	-	-
	48.0	100.0

Gåsodden, present shore, gravel.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	38.5	63.11
Astarte montagui (Dillwyn)	8.5	13.93
Astarte elliptica (Brown)	3.0	4.92
Mya truncata L.	1.5	2.46
Mya pseudoarenaria Schlesch	1.5	2.46
Saxicava arctica (L.)	1.0	1.64
Crenella decussata (Montagu)	1.0	1.64
Lepeta coeca (Müller)	3.0	4.92
Buccinum glaciale L.	1.0	1.64
Natica clausa Brod. et Sow.	1.0	1.64
Margarites olivacea (Brown)	1.0	1.64
Strongylocentrotus droebachiensis (Müller)	-	-
	61.0	100.0

Anservika, west, present shore, gravel.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	45.5	36.25
Astarte montagui (Dillwyn)	44.0	35.06
Astarte elliptica (Brown)	10.0	7.97
Mya truncata L.	9.5	7.57
Saxicava arctica (L.)	5.0	3.98
Serripes groenlandicus (Chemnitz)	1.5	1.19
Mya pseudoarenaria Schlesch	1.0	0.80
Pandora glacialis Leach	1.0	0.80
Crenella decussata (Montagu)	1.0	0.80
Macoma calcarea (Chemnitz)	0.5	0.40
Chlamys islandica (Müller)	0.5	0.40
Buccinum glaciale L.	3.0	2.39
Buccinum undatum L.	1.0	0.80
Trophon clathratus (L.)	2.0	1.59
Lithothamnion	-	-
	125.5	100.0

The differences in the composition of these faunal assemblages are rather great. As characterizing factors, the abundant occurrence of *Astarte borealis* and *Saxicava arctica* in most localities may be mentioned and also the general occurrence of *Serripes groenlandicus*, which is seldom met with in raised deposits. Valves of *Clinocardium ciliatum* (Fabricius) are frequently met with. They are nearly always transported by bird.

Terrace measurements.

The measurements of terraces and raised beaches have been made in the first instance to determine the height of fossil-bearing localities. Additionally, heights of some terraces, from which no collections have been made, have been measured.

Since fossils have been collected mostly from the outer parts of the terraces, most of the heights given relate to these parts of the terraces, very often the outer edge of the terrace plain. The upper terminations of these plains (they are generally rising inland) have been determined only in a few cases; this, partly because the upper limit may be difficult to figure out — due to solifluction of above-lying material.

Probably due to more or less advanced abration, the heights of the outer parts of contemporaneous terraces may be somewhat different. This may to some extent be associated with differences in exposition of the localities. Next, if the terrace gravel is resting on bedrock above sea-level, this may cause greater resistance against abration. The amount of sediment supply under the formation of the terrac may also account for the height of its outer part today.

A somewhat confusing fact about the terraces is that the sequence is not the same in all localities. A great terrace plain at inner (eastern) Gipsvika rises inland from 7.3 m to 19.8 m above sea-level without any interruption, and in Sassen, south, a delta-plain rises from 7.9 m to 22.3 m above sea-level. On the other hand, between Kapp Belvedère and Sveltihel the following sequence of terraces has been measured: 6 m, 7.4 m, 9.2 m, 11.8 m, and 14.1 m. In the western part of Gipsvika there is a terrace plain rising from 9.7 m to 10.5 m above sea-level. In Anservika a well developed terrace plain at altitude 10 m was measured, and in Sassen there is also a terrace at a height of 10 m bove sea-level. Within the same division the most distinguished terrace at Vindodden (west) rises from 7 m to 14.7 m, and at Kapp Belvedère from 5.3 m to 13 m — without any 10 m-terrace.

Probably some more or less local conditions may account for these phenomena (cfr. Peach 1916).

The most prominent features among the raised beaches of the Sassen-area are the 7 m-terraces. 10 terraces of about this height have been measured in 9 different localities: Vindodden, west 7 m (rising to 17.7 m); between Kapp Belvedère and Sveltihel 7.4 m; Sveltihel, two terraces within a short distance from each other, both 7 m; Sassen, north

6.8 m; Sassen, south, 7.9 m (rising to 22.3 m); Kapp Schoultz 8.3 m (upper termination); Kapp Murdoch 7 m; Gipsvika, east, 7.3 m (rising to 19.8 m); Gåsøyane, about 7 m. To these must be added the 5.3 m-terrace (outer edge) at Kapp Belvedère (rising to about 13 m).

Collections have been made from four of these terraces, but fossils have been observed in all of them; in the 7 m-terrace, Sassen, north, only one valve was noticed, viz. *Astarte borealis*.

About 3 to 5 m above sea-level there is another horizon with distinct terraces in different localities: Vindodden, west, 2.6 m (rising to 3.6 m); Sassen, north, 3 m; Sassen, south 3.2 m (rising to 5.2 m); Gipsvika, west, two terraces 3.9 m and 3.2 m. To these terraces may be added the small 3.8 m-terrace at Kapp Belvedère, which may be regarded as representing the inner (upper) remains of a terrace proceeding from this level. From this horizon fossils have been collected in two localities, Sveltihel and Gipsvika.

The reason for the exceptional high inner termination of the terrace at Sassen, south (5.2 m), is that this terrace represents a typical delta plain, the upper part of which is fluvial and not marine.

At an altitude of about 10 m, terraces have been met with in three localities: Sassen, north, 10 m; Gipsvika, west, 9.7 m (rising to 10.5 m); Anservika, 10 m. To these may be added the small 9.2 m terrace midway between Kapp Belvedère and Sveltihel, and also a 10.5 m-level at Kapp Schoultz (inner termination). Fossils have been found in these terraces, except at Sassen, south, and in the two last mentioned. A real collection from this horizon was made only in Anservika.

A well defined horizon is met with at about 20 m above sea-level. Terraces at this level were found in five localities: Vindodden, east, 19.6 m (rising to 21.5 m); Sveltihel, 20.9 m; Sassen, north, 20.5 m; Von Post Glacier, 19.7 m; Gipsvika, 19.8 (upper termination of the 7.3 m terrace). To these must be added a 20 m-terrace at Bjonahamna (aneroid measurement), and the upper termination, 22.3 m, of the 7.9 m-terrace at Sassen, south. The upper part of this terrace in Sassen represents the fluvial facie of a delta plain. This may account for the great height measured here. Collections from the 20 m-level were made at Vindodden, east, and at Von Post Glacier. Fossils were also found in the 20.5 m-terrace, Sassen.

Above this level it is more difficult to point out well defined horizons. Excellent terraces may be found but not at the same altitude in many different localities.

At 24.4 m above the sea-level two small terraces or beaches have been measured, viz. Vindodden, east, cut into morainic deposits, where no fossils were found, and Sassen, shoreline with gravel in the hill side south of the main complex of raised features in this locality, where fossils were sparsely represented.

In Sassen, south, a terrace plain was measured, rising from 25.7 m to 29.5 m. Further, within these limits were measured: a 27.2 m-terrace at Sveltihel; a 26.5 m-terrace at Sassen, north; a shingle ridge above this at 29.1 m; a small 25.8 m-terrace at Gipsvika, west; a great 28.3 m-terrace at Gipsvika, east; and a magnificent terrace at altitude 28.8 m at Kapp Schoultz. 27.5 m may be regarded as an average for these levels.

Between Kapp Belvedère and Sveltihel a prominent terrace at a height of 31.5 m was measured. An aneroid measurement of a terrace at Bjonahamna gave 32 m. In the Sassen-complex three terraces at about this level were measured. 34.2 m (northern part of the complex), 32.5 m (middle part), and 32.7 m (rising to 32.9 m) in the southern part of the complex. Fossils were collected only from the 32.5 m-terrace at Sassen.

In the southern part of the Sassen-complex there is a terrace rising from 35.5 m to 36.9 m above sea-level. In Bjonahamna some fragments of shells were found in marine deposits at a height of 36 m above sea-level (aneroid measurement).

The upper termination of the great shingle plain at Bjonahamna was determined at 40 m above sea-level.

In the Sassen-complex (southern part) there is a prominent terrace rising from 43.1 m to 47.0 m above sea-level. This is also a typical delta-terrace or delta-plain. In the northern part of the complex there is a terrace at 45.7 m above sea-level. At Sveltihel one of the terraces measured is situated at a height of 43.2 m, and one of the most prominent terraces at Gipsvika is found at altitude 45 m. This great terrace rises gently inland to a height of 56.5 m above sea-level. Numerous fossils were collected from this locality.

Two terraces at about 50 m have been measured, the one in the southern part of the Sassen-complex, 49.8 m above sea-level (rising to 50.1 m), the other between Kapp Belvedère and Sveltihel, 49.4 m. *Mya truncata* was found in the last one.

In the Sassen-complex there is a terrace situated at a height of 55.6 m.

Above this terrace and in the same locality, there is another one rising from 58.6 m to 61.7 m. Levels of probably the same age are found in: Blomedalen (Vindodden), east side of the valley, 58 m, shoreline; Bjonahamna, 58 m (aneroid measurement); Gipsvika (western part), 60 m, shoreline.

Above this shoreline in the eastern side of Blomedalen (Flower-valley), there is another one at altitude 63 m. At Sveltihel a terrace is situated at a height of 62.2 m above sea-level. In the norhern part of the Sassen-complex a terrace is found at a height of 62.5 m, and in the southern part of the same complex there is a terrace rising from 63.1 m to 65.5 m above sea-level. This is the highest plain of marine origin found in this locality.

In the northern part of the Sassen-complex, according to our measurements, the highest marine terrace is found at altitude 67.3 m. Morainic material is dominating above this level in this locality. Aneroid measurement of a terrace at Bjonahamna gave 65 m.

Above these levels very few measurements are at hand. At Sveltihel a small terrace is situated 70.5 m above sea-level. The highest terrace at Bjonahamna was found 70 m above sea-level (aneroid measurement). In the western part of Gipsvika the highest feature probably of marine origin (rock plain covered with gravel and shingel) is situated 80 m above sea-level. The highest line in the mountain side at Sveltihel was found to be situated 85.7 m above sea-level, while at Kapp Belvedère a similar line is found 96.2 m above sea-level.

In two localities a terrace below the 3—5 m-level has been found: at Sveltihel there is a well developed shingle plain 2.3 m above sea-level, and at Gipsvika (about the middle part) there is a terrace, with ridge patterns on its surface, rising from 1.2 m to 1.9 m above sea-level. It may be noted that the recent barrier beach mounts to greater height than the terrace surface inside. (The height of the barrier beach at Sveltihel is 2.9 m; at Gipsvika 1.7 m. The difference is most probably due to the degrees of exposure of the two localities.) We have only found terraces in distinct development at this low level in the two above-mentioned localities.

In addition to the terrace measurements dealt with, some accessory or subordinate levels between 10 and 20 m may be mentioned. The previously mentioned, small 11.8 m-terrace between Kapp Belvedère and Sveltihel corresponds fairly well with the outer part of the great shingle plain at Bjonapynten, 12 m above sea-level. The 14.1 m-terrace between Kapp Belvedère and Sveltihel may be connected with the prominent 13.8 m-terrace at Kapp Schoultz. Further there is an aneroid measurement of a terrace at Bjonahamna 15 m above sea-level, and in the northern part of the Sassen-complex there is a terrace situated 16.3 m above sea-level.

Uncertainities may be attached to some of our measurements on account of the basis chosen — the local highwater mark is subjected to fluctuations which it is difficult to make corrections for. The accuracy, however, is sufficiently great to reveal some main levels in the sequence of raised beaches in the Sassen-area.

The following levels or zones may be regarded as prominent and regional within the area:

From	2.6	to	5.2 m	average:	3.6 m
»	5.3	»	8.3 »	»	7.0 »
»	9.2	»	10.5 »	»	10.0 »
»	19.6	»	22.3 »	»	20.5 »
»	25.7	»	29.5 »	»	27.6 »
»	31.5	»	32.9 »	»	32.3 »

From	43.1	to	47.0 m	average	45.0 m
»	58.0	»	61.7 »	»	59.3 »
»	62.2	»	65.5 »	»	63.5 »

Terraces and raised beaches in the Sassen-area are usually met with at about those heights indicated by the average values given in the right column.

Less prominent or subordinate levels may be found at about:

2	m	above	sea-level
14	»	—	—
24	»	—	—
36	»	—	—
50	»	—	—
70	»	—	—

It would be unsafe on the basis of our measurements from a limited area to enter upon the problem of tilted shorelines. This should not be done before numerous measurements from a much wider area are at hand.

On the other hand it may be of some interest to compare our levels in the Sassen-area with those found by A. M'Ewen Peach (1916) in other parts of West-Spitsbergen. Peach introduced the terms:

1. The 25-foot Beach, (about 7.5 m).
2. The Saxicava Beach, (from 50 to 70 feet (15 to 21 m).
3. The 150-foot Beach, (about 45 m).
4. The 240-foot level, less prominent (about 72 m).

It will be seen that 1 corresponds fairly well with the 7 m-terraces in the Sassen-area. The upper limit of 2. may be associated with our 20.5 m-level. The 150-foot Beach (3.) is the same as the 45 m-level in the Sassen-area, and 4. may probably be connected with our less prominent 70 m-level.

Peach has traced the 25-foot beach in several localities on Prins Karls Forland. In West-Spitsbergen he reports this level from Recherche Bay (Bellsund), Calypso Bay to Kapp Lyell, Kings Bay (Deer Sound), Engelskbukta, St. Jonsfjorden (Osborn Inlet), and in Isfjorden he has mentioned the 25-foot beach from the north-east side of Advent Bay, and a fragment of a beach at this level is also mentioned from Bjonahamna. Peach reports fossils at this level only from Richard Lagoon (Prins Karls Forland) (*Mya* mentioned), and from Recherche Bay (*Mytilus edulis*).

The *Saxicava* Beach is reported from about the same localities. Fossils mentioned within this level are: *Astarte arctica (= A. borealis)*, *Mya truncata* and *Saxicava arctica.*

The 150-foot Beach is also reported from about the same localities. Peach did not find any fossils at this level.

From some of the localities investigated by him, Peach reports beaches higher than 150 feet above sea-lvel, *i. a.* two terraces on the west side of Advent Bay, 260 and 400 feet (about 78 and 120 m) above sea-level.

If Peach has traced really contemporaneous beaches over this wide area, and since his levels seem to correspond fairly well with those in the Sassen-area, these facts contradict the assumptions of warped shore-lines in West-Spitsbergen, suggested *i. a.* by Balchin (1941) and Wordie (1921 p. 42—43). On the other hand these observations may support the idea of eustatic changes of sea-level, suggested *.i a.* by Horn and Orvin (1918 p. 49). It may here be added that Werenskiold (1924 p. 10) north of Stormbukta, Sydkapplandet, measured an 8 m high cliff with a plain (450 m broad) rising inland to 20 m above sea-level.

It seems, however, as stated by Baden-Powell (1939 l. c. p. 346) that "the surest way to prove whether the changes of level have been eustatic or isostatic (or a combination of both), is by correlation by faunal methods where possible, as almost anything can be proved by a consideration of heights alone". Peach (1916) has touched upon this task in introducing the term *Saxicava* Beach. His fossil collections, however, are far from sufficiently great. There seems to be little reason, if any, for using the term *Saxicava* beach only because *Saxicava* is found among the species occurring at this level.

In the following we will see how some zones in the sequence of raised beaches in the Sassen-area may be characterised by the fossil fauna contained.

Some fossil horizons within the sequence of raised beaches (littoral sediments).

Entering upon the problem of faunal demarcations in the sequence of raised beaches, it should once more be stated that the conclusions reached here are most probably limited to the Sassen-area, or at least to inner fjord regions. Our investigations have been made at the inner-mast parts of the 100 km long Isfjord; conditions may be found to be different, for instance, on the west coast of West-Spitsbergen.

It will be seen from the faunal lists concerning the terraces, that it would be very difficult to base a characterisation of the different levels on the occurrence alone, of certain species. The o c c u r r e n c e alone, of, for instance, *Mytilus edulis* at different levels does not characterize any of these levels (the modern shore and perhaps the 2 m-level are characterized by the absence of this species), but the f r e q u e n c y of *Mytilus edulis,* the per cent it makes of the different assemblages, clearly

distinguishes the 3.6 m-level. Thus we have based the identification of certain fossil horizons on the frequency, the dominance, of those species most commonly met with within the sequence of raised beaches in the Sassen-area. These species are: *Mytilus edulis, Astarte borealis, Mya truncata* and *Saxicava arctica.* These species (except *A. borealis*) have been found at all levels within the sequence dealt with, but their frequency at different levels varies in such a way that it is possible to distinguish certain fossil horizons on this basis.

In Table II per cent-frequency curves are drawn for the four more numerous species mentioned above. The values for each level are calculated as means of the per cents of each of the four species at that level, all localities within the area being considered.

The *Mytilus*-horizon. — It will be seen that *Mytilus edulis* shows a prominent maximum (mean: 57.3 per cent) at the average 3.6 m-level. Collections have been made from two terraces belonging to this level, viz. Sveltihel (3.6 m) and Gipsvika (3.9 m). In both localities *Mytilus edulis* dominated the faunal assemblage. At Sveltihel a vertical section in the terrace material was worked out. The per cent of *Mytilus* thus revealed was 32.1. If the sampling had been somewhat more extensive and taken only from the upper part of this terrace, in accordance with the method used at other localities, the per cent of *Mytilus* would have been greater (cfr. Table I). The faunal list concerning the 3.9 m-terrace at Gipsvika, probably gives a more correct imagination of the faunal composition in littoral sediments at this level. The per cent of *Mytilus edulis* here was 82.5. On the other hand, local conditions may, to some extent, account for the difference in development of the faunal assemblages in the two localities.

As mentioned in the previous chapter, terraces belonging to the 3.6 m-level are found in several localities. Fossils of *Mytilus edulis* were noted in all of them, but collections were made only from the two mentioned above. It may seem to be somewhat unsafe to regard the dominance of *Mytilus* at the 3.6 m-level as regional within the Sassen-area only from its dominance in two localities. In the first place, however, these two localities are situated at a considerable distance from each other (about 13 km across the Sassenfjord), and secondly, additional observation (see following chapter) have revealed further evidence of the dominance of *Mytilus edulis* at about 3,6 m above sea-level.

Above this level *Mytilus edulis* is still present among the fossils found, but decreasing in frequency with increasing heights. Within the sequence of more prominent terraces *Mytilus,* as a matter of fact, is present in all of them. In the 32.5 m-terrace at Sassen, no specimen of this species was found, but in Gipsvika it was found at 30.5 m (1 specimen), and at 32.8 m (0.5 specimen). At the 7 m-level *Mytilus* obtains about 7 per cent (average of the collections made at this level). At the

20.5 m-level the average percentage of *Mytilus* is about 2. The per cent of *Mytilus* in the collection from the 26.5 m-terrace at Sassen is 0.5, and in the 45 m-terrace at Gipsvika 0.1 per cent. One valve was found in this locality. This is the highest level at which we have found *Mytilus edulis* in the Sassen-area.

In the 10 m-terrace at Anservika 36 specimens of *Mytilus* were picked up besides 52.5 specimens of *Astarte borealis*. This makes the highest per cent of *Mytilus* (34.8) at a level about the 3.6 m-horizon.

Beneath the 3.6 m-level, *Mytilus edulis* is present in the 2.3 m-terrace at Sveltihel. As mentioned earlier, the shells of this species here have probably been washed down from the 3.6 m-terrace to the west. The reason for this assumption is that *Mytilus*-shells were found only just beneath the cliff of the 3.6 m-terrace. Similar conditions concerning the occurrence of *Mytilus* were observed at the lowest terrace in Gipsvika, which probably corresponds to the above mentioned.

Even in the modern shore *Mytilus edulis* is met with. At Gåsøyane shells of this species are rather abundant on the shore. This may be explained by the special morphological development in this locality. This, in connection with the exposed situation (*Mytilus*-shells in the recent shore are most frequently met with on the west sides of the islands), may have facilitated the downwashing and accumulation of the *Mytilus*-shells in the modern shore. Elsewhere along the shores in the Sassen-area, *Mytilus* is only now and then met with.

It thus seems as if *Mytilus edulis* did not live in the Sassen-area at the time associated with the 2 m-level, and, most probably, it does not live in the area today. None of the investigators who have dealt with the mollusc fauna of Isfjorden (cfr. Odhner 1915), have ever taken this species alive there. We newer got it by our dredgings within the Sassen-area (summer 1948). Heintz (1926) reports a find of fresh *Mytilus*-specimens attached to *Ascophyllum nodosum,* in the modern shore at Red Bay. Heintz, however, reaches the conclusion that these specimens have drifted in from a remote southern locality (p. 76).

Above the 2 m-level *Mytilus edulis* is present at all levels at which prominent raised beaches are found within the area. It is sparingly met with in the upper terraces (from 45 m above sea-level), becomes more common at 20.5 m, is rather numerous at 10 m (Anservika), is generally common at 7 m, and shows a pronounced maximum at the average altitude of 3.6 m above sea-level. This horizon (3.6 m above sea-level in the Sassen-area), in which *Mytilus edulis* absolutely dominates the faunal assemblages, and where this species may constitute real shell beds, we will refer to as the *Mytilus*-horizon.

As mentioned previously in this paper, *Mytilus edulis* has been reported as a Quarternary fossil from numerous localities in Svalbard ever since 1864, when Blomstrand found it in a 10—20 feet section on

the east side of Advent Bay. Since then it has been found from just above present sea-level up to 55 m (Wahlenbergfjord, 1923, Oxford Expedition), and even 70 m above sea-level (Dickson Bay, found by Hoel, reported by Frebold, 1935). Horizons, however, in which the occurrence of *Mytilus* dominates, have not previously been reported from Svalbard, as far as can be seen. This may be due to less systematic research, or it may be that real *Mytilus*-terraces occur only in the Sassen-area, which, however, is less conceivable. Indeed, Knipowitsch (1902 III, p. 433) states that fossil shells of *Mytilus edulis* in Svalbard, are met with just above sea-level.

It may be of some interest in this connection to mention that Noe-Nygaard (1932), who collected marine fossils from raised beaches in East-Greenland, found *Mytilus edulis* from 2 m to 57 m above sea-level (Cape Elisabeth, Ella Island in King Oscar Fjord). From his locality I, Röhss Fjord (innermost part of Kempes Fjord), he reports (p. 7): "at the 3 meter-level there was a rather cohesive bed consisting almost entirely of *Mytilus*-fragments (big specimens), in a good state of preservation." The highest marine limit found in the area investigated by Noe-Nygaard is 216 m (Vega Sound). The highest line of probable marine origin measured by us in the Sassen-area is situated about 96 m above sea-level. It thus seems to be unsafe to suggest a correlation of the 3 m-level in East Greenland with the 3.6 m-level in the Sassen-area.

On the other hand it should be born in mind that Hoel reports abrational terraces at Kingsbay—Crossbay at a height of 200—250 m above sea-level (cfr. Werenskiold 1924 pp. 7—11, where also more of these higher shorelines are reported). To this may be added that Grønlie (1924 p. 99) states that *Mytilus edulis* in Novaya Zemlya does not occur above 10 m above sea-level, and he suggests that the immigration of this species to Novaya Zemlya has taken place in late post-glacial time.

The lower *Astarte*-horizon. — Turning again to the faunal lists concerning the terraces, and to Table II, it will be seen that the per cent-frequency curve of *Astarte borealis* has a rather intresting appearance. This species is abundant in the recent shore, forming 36.2 per cent (average of 9 localities). In the 2.3 m-terrace at Sveltihel it forms 40.3 per cent of the assemblage. In the *Mytilus*-horizon the per cent of *Astarte borealis* is pressed down to an average of 7.6. Then, in the 5.3 m-terrace at Kapp Belvedère, there is a sudden rise of the frequency of this species to 93.5 per cent. From this height and up to the 20.5 m-level *A. borealis* is absolutely dominating the assemblages. It is evident from the faunal lists concerning the 5.3-m-terrace, the 7 m-terraces, the 10 m-terrace, the 13.5 m-terraces and the terraces about 20.5 m above sea-level, that the shells of *A. borealis* are very abundant.

The high per cent of this species is not caused only by decreasing numbers of other species at these levels.

Astarte montagui generally occurs together with *A. borealis,* far less abundant, while *A. elliptica* is more frequently met with in clayey sediments. We have only found *A. crenata* twice as a fossil, viz. one valve in the 7.3 m-terrace at Gipsvika, and one valve in a solifluction slope west of this terrace, at 32.8 m above sea-level. As known, *A. crenata* generally lives at somewhat greater depths than *A. borealis.* The same can be said about *A. elliptica,* and this may to some extent account for the scarceness of these species in littoral sediments (cfr. Antevs, 1928; Spärck, 1933; Thorson, 1933 and 1934).

The most conspicuous level within the vertical division in which *A. borealis* dominates, is, no doubt, the 7 m-level (cfr. previous chapter). Collections have been made from five of the terraces belonging to this level. The percentages of *A. borealis* in these assenblages are:

Vindodden, west	7 m	95.7	per cent
Sveltihel	7 »	51.7	—
Kapp Murdoch	7 »	69.1	—
Gipsvika, eastern part ...	7.3 »	48.8	—
Gåsøyane	7 »	69.3	—

To these may be added the 5.3 m-terrace at Kapp Belvedère where *A. borealis* makes 93.5 per cent. The dominance of *A. borealis* at the 7 m-level is remarkable. Only in one of the localities investigated is the per cent of this species below (*i. e.* at Gipsvika). The percentages of *A. borealis* in the modern shore at the localities just mentioned are:

Vindodden, west	23.0	per cent
Sveltihel	45.9	—
Gipsvika, eastern part	56.4	—
Gåsøyane	3.1	—

(Collections from modern shore at Kapp Belvedère and Kapp Murdoch are lacking.) The variations in the percentages of *A. borealis* in the modern shore are great, and do not show any conformity to those at the 7 m-level. Only in one of these collections from the modern shore, does the per cent of *A. borealis* exceed 50, *i. e.* at Gipsvika. (At the present shore, Gåsodden, the per cent of *A. borealis* was 63.1.) In 7 of the 9 collections from modern shore, *A. borealis* is dominating. This dominance, however, is less pronounced than at the 7 m-level. In 6 of the faunal lists concerning modern shore *Serripes groenlandicus* is ranking rather high (lacking in 3 localities), while *Mytilus edulis* moreover is absent. In 5 of the collections from the 7 m-level *M. edulis* is ranking high (as number 2 in 3 of the localities, and as number 3 in 2 of them; absent at Sveltihel), while *Serripes groenlandicus* has been

found only in one of the 7 m-terraces, viz. eastern part of Gipsvika, making 0.3 per cent of the assemblage there.

The faunal assemblage revealed by the collection from the 2.3 m-terrace at Sveltihel shows close similarities to those from recent shore. *Astarte borealis* dominates with 40.3 per cent, next comes *Saxicava arctica,* 29.8 per cent. *Serripes groenlandicus* was not found, while this species in the present shore just outside the terrace makes 28.8 per cent of the assemblage, and *Saxicava arctica* only 9.6 per cent.

As a whole, it may be stated that the faunal composition in the *Mytilus*-horizon (3.6 m above sea-level) is strikingly different from those in the modern shore. The faunal compositions at the 7 m-level in some ways show similarities to those in the modern shore (and that of the 2.3 m-terrace), but in other ways differ distinctly from these, as pointed out above. First and foremost the difference is shown by the pronounced and never failing dominance of *Astarte borealis* at the 7 m-level in the Sassen-area. Wherever, in the area, 7 m-terraces are met with, one may anticipate the dominance of *Astarte borealis* in the fossil fauna included.

This level (average 7 m above sea-level) at which *Astarte borealis* is absolutely dominating, we will refer to as the lower *Astarte*-horizon.

As mentioned in the previous chapter, Peach (1916) has traced his 25-foot beach over a wide area, principally on the west coast of West-Spitsbergen. Probably this beach corresponds to the 7 m-level in the Sassen-area. Peach, however, does not mention any dominance of *Astarte borealis* at this level; in fact he does not report *A. borealis* at all as a fossil from the 25-foot beach. One may therefore suspect conditions on the west coast (at least concerning the 7 m-level) to be different to those in the Sassen-area.

On the journey to our summer station, we had the opportunity to pay a short visit to the wireless station at Kapp Linné at the debouch of Isfjorden. According to a rough aneroid measurement of the large terrace plain here, the height of this was found to be about 7—8 m. Fossils were abundant in the terrace material (gravel, in the upper parts turned into shingle by frost action). In the diary on that date the following is noted:

Mytilus edulis very frequent.
Saxicava arctica frequent.
Balanus balanus frequent.
Mya truncata more seldom.

As seen, *Astarte borealis* is not mentioned. This, of course, does not exclude its presence in the locality, as the observations were made in a hurry. A dominance, however, of *A. borealis* in the 7 m-terrace at

Kapp Linné is impossible. In the recent shore beneath the terrace, the following species were picked up:

Astarte borealis
Astarte crenata
Saxicava arctica
Balanus balanus
Mya truncata,

all of them washed ashore.

From the observations concerning the 7 m-terrace at Kapp Linné, one may suggest, either that animal ecological conditions on the west coast are quite different from those in the inner part of Isfjorden, or that this 7 m-terrace does not correspond to the 7 m-level in the Sassen area.

The upper *Astarte*-horizon. — As already pointed out, *Astarte borealis* dominates the faunal assemblages in the sequence of raised beaches (we are here dealing only with littoral sediments) from an average height of 7 m above sea-level to an average height of 20.5 m above sea-level. This division may be called the *Astarte*-division.

The most conspicuous horizon within this division is the lower *Astarte*-horizon, at an average height of 7 m above sea-level. From the 10 m-level collection on a greater scale has been made only from one locality, viz. Anservika. In this locality (10 m above sea-level), as mentioned previously, shells of *Mytilus edulis* were rather numerous, this species making 34.8 per cent of the faunal assemblage (*A. borealis,* 50.7 per cent). It would be interesting to know if this high percentage of *M. edulis* is a regional characteristic of the 10 m-level within the Sassen-area, or if conditions at Anservika represent only a local phenomenon. Little can be said about this from the evidence of one collection. From the terrace at Gipsvika, rising inland from 9.7 m to 10.5 m above sea-level, sparsely represented specimens were picked up. Among these were 12 specimens of *M. edulis* besides 4 of *A. borealis.* This may probably point towards a general come-back of *Mytilus* at the 10 m-level. The scarceness of fossils in the last locality prohibits certain suggestions.

At the subordinate 14 m-level fossils have been collected from two localities, viz. Kapp Belvedère (13 m) and Kapp Schoultz (13.8 m). In both, *Astarte borealis* clearly dominates.

From the upper part of the *Astarte*-division fossils have been collected in two localities, viz. Vindodden (east of the river outlet, 19.6 m) and at Von Post Glacier (19.7 m). From the 19.6 m-terrace, Vindodden, 119 valves and umbonal fragments of *Astarte borealis* were found, making 97.5 per cent of the community. From the 19.7 m-terrace, Von

Post Glacier, 29 valves and umbonal fragments of this species were picked up, making 50.9 per cent.

The most interesting observation concerning the occurrence of *Astarte borealis* in the sequence of raised terraces, is the abrupt disappearance of this species above the average 20.5 m-level. In a solifluction slope at altitude 21 m Kapp Belvedère, two broken valves of *A. borealis* were found. Elsewhere in the Sassen-area we have never found this species in raised terraces (littoral sediments) at altitudes greater than 19.7 m (Von Post Glacier). From being richly represented in the modern shore, fairly well represented at 3.6 m, being absolutely dominant from 5.3 to 19.7 m, *Astarte borealis* is suddenly absent in the terraces lying above. If this is a fact, and not only due to lack of accuracy in our observations, it should add great interest to further investigations on the ecology of *Astarte borealis.*

In moraine material, red clay, at Von Post Glacier we found *A. borealis* at a height of about 30 m above sea-level. These deposits may have been pushed up from a lower level.

Knipowitsch (1902 II, p. 434—435) reports *Astarte borealis* as a fossil from 15 localities, most of them in the Storfjord-area, one in Billefjorden. In none of these localities, except one, has *Astarte borealis* been found at greater altitudes than 10 m. In one locality, Negri Glacier (Ginevreabotnen), *A. borealis* was found in moraine deposits from 25 to 100 m above sea-level. Sandford (1929) reports finds of many specimens of *A. borealis* at a height of about 180 feet (about 55 m) buried in about 30 feet of clay just north of the Oxford Peninsula in Wahlenberg Bay, North East Land. They were found "with the valves united, and with some of the epidermis still preserved, though the ligament was gone" (l. c. p. 546). Rare valves of *Mytilus edulis* are also reported from this locality, and *Mya truncata* was also found. The minerogenic material, from which this collection has been made, consists of morainic boulder clay. Elton and Baden-Powell (1931 p. 396) report several valves of *A. borealis* from "Upper Raised Beaches" in Billefjorden "at an estimated height of between 100 and 150 feet (30 to 45 m)" (l. c. p. 391). On page 393 the same authors report that from Gyldénøyane (Wahlenbergfjorden, Hinlopenstredet), *Chlamys islandica, Astarte borealis, Astarte elliptica, Mya truncata* and *Saxicava arctica,* were picked up (by the 1923 Oxford Expedition) from 5 to 22 m above sea-level. Elton and Baden-Powell (1931 p. 393) report further the following fossils from 8 to 22 m above sea-level at Duym Point, Hinlopenstredet: *Chlamys islandica, Astarte borealis, Mya truncata, Saxicava* and *Balanus balanus.* In all other localities described by these authors, *Astarte borealis* has been found at lower altitudes. As previously mentioned, Kulling (1936 p. 4) reports, among other species, *A. borealis* from "a broken-up shell bank from 14 to 21 m above sea-level" (l. c. p. 4). Baden-Powell

(1939) has described raised beach fossils from 14 localities in Spitsbergen. *A. borealis* is reported from 6 of these, and in two of these six localities this species has been found above 20 m. One of these two collections, however, is that made by Sandford (1929 p. 547) at the head of Wahlenbergfjorden, which has already been considered. The other is from a raised beach at Petunia Bay (Billefjorden) at a height of 90 feet (27 m) above sea-level.

From these observation it seems as if fossil specimens of *Astarte borealis* may be found in Spitsbergen above the 20.5 m-level too, even in the Sassen-area (cf. the 21 m solifluction slope, Kapp Belvedère). But it is evident, at least concerning the Sassen-area, that the occurrence of *A. borealis* above the 20.5 m-level can only be very rare.

The average 20.5 m-level, at which *Astarte borealis* still dominates the fauna, represents a distinct upper termination of the *Astarte*-division. This level, at an average height of 20.5 m above sea-level, we will refer to as the upper *Astarte*-horizon.

Turning to East Greenland, Noe-Nygaard (1932) reports *Astarte borealis* as a fossil from the following heights in the King Oscar Fjord district: Maria Island, 25 m Cape Oswald, Ella Island, 5 m; bay south of Cape Elisabeth, Ella Island, 13 m (blueish-grey marine clay); Midway between King Oscar Fjord and the bend of Vega Sound, 11 m (clay slope); Central part of Vega Sound, A, 16 m, B, 9—10 m, D, 2—3 m, E, 5 m; Delta south of Cape Simpson, 20 m (as far as can be seen).

About the 25 m Maria Island locality, Noe-Nygaard observes (l. c. p. 8): "Continuous semi-circular raised beaches can be traced from sea-level up to 25 metres' altitude. As to the lowermost beds the material consists mainly of pebbles, while the main constituents of the uppermost 5 metres are sand and gravel." From this upper part the fossils were collected. Thus *Astarte borealis* in this locality may have been found somewhere between 20 and 25 m above sea-level. Above this level the most commonly occurring species are *Mya truncata* and *Saxicava arctica*. This may point towards some resemblance between the King Osar Fjord district in East Greenland and the Sassen-area.

It may be mentioned here that G. Bárðarson (1921 p. 373) from the Breiðifjördur district, West Iceland, reports *Astarte borealis* as a fossil from 2 to 17 m above sea-level. From Novaya Zemlya, on the other hand, Grønlie (1924) reports *A. borealis* from 0 to 163 m above sea-level.

The *Mya*-division. — On account of the few localities above the 20.5 m-level, from which greater collection have been made, it is difficult and rather unsafe to point out certain fossil horizons at these levels. As a whole, however, it seems as if *Mya truncata* becomes the dominant species in littoral sediments just above the 20.5 m-level. (In the 20.5 m-terrase, Sassen, 8.5 specimens of *Mya* were found, thus being

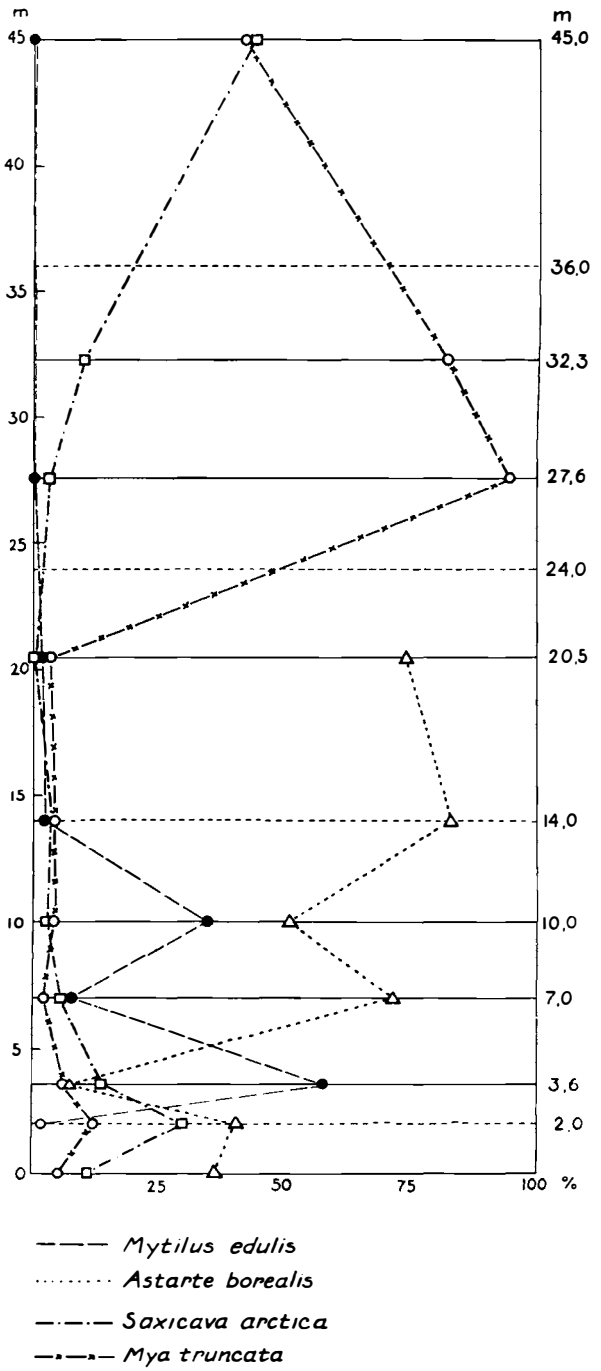
the dominant species in this locality. This collection, however, is too small for comparison with the others from the 20.5 m- level.) In the 26.5 m-terrace at Sassen *Mya truncata* makes 94.8 per cent of the assemblage, and of the collection from the 32.5 m-terrace, Sassen, this species makes 82.1 per cent. In other localities, where fossils are sparsely represented, *Mya truncata* is still the species most frequently met with above the 20.5 m-level.

Perhaps the average 27.6 m and 32.3 m-levels may be called *Mya*-terraces, or the terraces being situated from just above 20.5 m to just beneath 45 m above sea-level may be referred to as the *Mya*-division.

The *Saxicava-Mya*-horizon. — In the 45 m-terrace at Gipsvika, very rich in fossils, *Saxicava arctica* forms 42.2 per cent (367 valves and umbonal fragments) and *Mya truncata* 41.7 per cent (362 valves and umbonal fragments). In a solifluction slope at Kapp Schoultz fossils were traced from about 20 m to 44.6 m above sea-level. Of the collection made here *Mya truncata forms* 67.2 per cent and *Saxicava* arctica 22.7 per cent. The fossils found here may probably originate from a destructed 45 m-terrace.

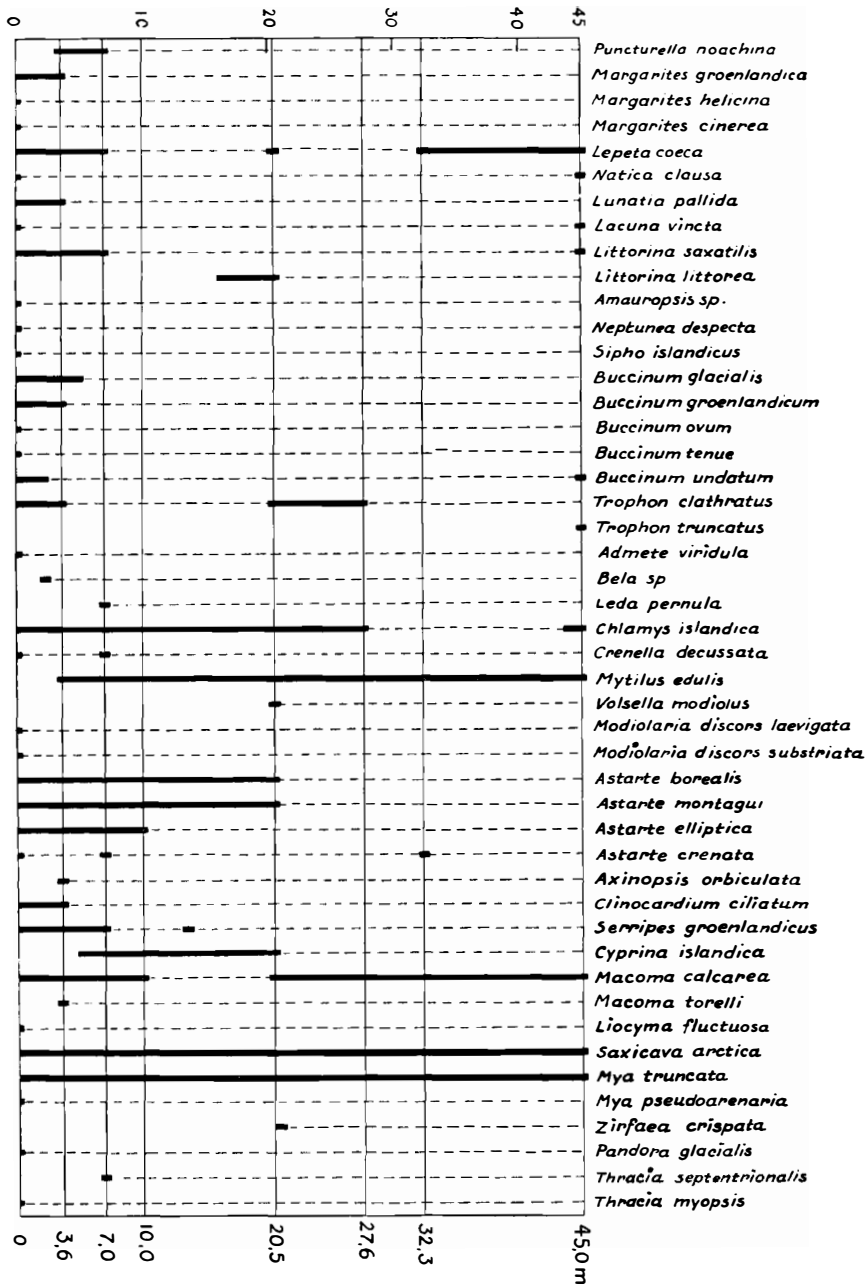
These attempts on characterization of the terraces above the 20.5 m-level must be regarded only as suggestions. The collections and observations at hand are too few for identifications of certain horizons at these levels. It seems, however, as if the dominance of *Mya* and *Saxicava* is a general characteristic concerning the upper raised beaches all over Spitsbergen. This also seems to be the fact in East Greenland (Noe-Nygaard 1932). Above the 20.5 m-level in the Sassen-area the shells of *Mya* and *Saxicava* generally become large and thick.

Table II.



Per cent frequency-curves for the four dominant species in the raised beaches. The average percentage of the occurrences in the localities at each level.

Table III.



Vertical distribution of species in the raised beaches (littoral sediments).

Summary of fossil horizons.

According to what is pointed out on the previous pages, the main fossil horizons in the Sassen-area are:

The *Mytilus*-horizon, average height 3.6 m.
The lower *Astarte*-horizon, average height 7.0 m.
The upper *Astarte*-horizon, average height 20.5 m.
The *Saxicava-Mya*-horizon, height 45.0 m.
The *Astarte*-division from about 7 to 20.5 m.
The *Mya*-division from just above 20.5 m to just below 45 m.

To these horizons may be added the subordinate 2 m-level. Generally *Saxicava arctica* forms a small percentage of the faunal assemblages from the lower terraces (up to 20.5 m). At the 2 m-level, however, this species seems to be abundantly represented. Moreover *Saxicava arctica* at this level occurs in small forms, very often irregularly shaped. This may be associated with the very rich occurrence of *Lithothamnion* at this level. The 2 m-level may be referred to as the semi-recent shore.

Additional observations.

1. Ancient drift wood.

As noted by all who have travelled in Spitsbergen waters, drift wood washed ashore along the coasts is very commonly met with.[1] In the Sassen-area drift wood is richly represented along the shore in most of the localities visited by us. Generally the drift wood accumulates on and just behind the modern stormridge. The drift wood consists of pitprops, logs, large trunks etc. It is very seldom that pieces of drift wood, which do not, in some way or other, bear evidence of human activity, are found in the modern shore.

At the coastal plain between Gipsvika and Anservika there seems to be a zonation in the situation of drift wood. In the neighbourhood of the hunter's hut west of Gipsvika, the locality called Gipshuk, at least three zones of drift wood can be figured out.

The first one runs along the recent stormridge. The wood material in this zone has a fresh, yellowish appearance. Above and inside this zone there is a second one. The drift wood in this has a more greyish colour. This greyish colour, however, seems to be the only difference between the wood material in these two zones. The drift wood in this second zone shows, moreover, the same traces of human activity as that in the modern shore, *e. g.* carrying nails and bolts, marked by axes and saws etc.

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[1] As to the origin of the Spitsbergen drift wood, se Agardh, 1870. Cf. also Ingvarson 1910.

Above this second zone follows a third. This zone is much broader than the other two, and it includes only old or ancient drift wood, consisting of trunks, often large and often with root. They are moreover somewhat rotten and often overgrown with vegetation. None of the logs and trunks in this zone seem in any way to have been handled by man.

We made some measurements concerning the drift wood zones in the Gipshuk locality. The recent drift wood zone extends from about the high-water ridge (0.5 m above sea-level) to somewhat inside the stormridge (1.7 m above sea-level. The breadth of this zone was 12 m.

The semi-recent drift wood zone [1] extends from about 2.2 m above sea-level to about 3 m above sea-level. The breadth of this zone is 10—15 m.

The ancient drift wood zone extends from 3.8 m to about 5 m above sea-level. The breadth of this zone is about 25 m. — Between the ancient and semi-recent zone there is some over-lapping. Between the recent and semi-recent zone there is little or no over-lapping.

Fossils were collected within these three zones. By this we hoped to be able to connect the drift wood zones with some of the terrace levels. The minerogenic material in the zones is constituted of sand, pebbles and boulders. The marine fossils in the ancient zone were heavily crushed.

Recent drift wood zone, Gipshuk, 0.5 to 1.7 m:

Saxicava arctica	16	specimens
Astarte borealis	8	—
Modiolaria discors substriata	4	—
Mytilus edulis	1	—
Chlamys islandica	1	—
Astarte elliptica	1	—
Mya truncata	1	—
Puncturella noachina	1	—
Tonicella marmorea	1	—
Balanus balanus	1	—
Strongylocentrus	(spines and plates)	
Lithothamnion	(10 clods)	

Semi-recent drift wood zone, Gipshuk, 2.2 to 3 m:

Saxicava arctica	52	specimens
Astarte montagui	12	—
Modiolaria discors laevigata	8	—

[1] The term "semi-recent" is only preliminary. We do not know much about the genesis of this zone; it is not at all sure that it represents an older zone.

Astarte borealis	7 specimens
Astarte elliptica	7 —
Mya truncata	7 —
Modiolaria discors substriata	2 —
Mutilus edulis	2 —
Macoma calcarea	1 —
Buccinum glaciale	2 —
Buccinum sp.	1 —
Lepeta coeca	1 —
Tonicella marmorea	(4 plates)
Balanus balanoides	2 specimens
Balanus balanus	1 —
Balanus crenatus	1 —
Strongylocentrus	(spines and plates)
Lithothamnion	(ca. 100 clods)

Ancient drift wood zone, Gipshuk, 3.8 to 5 m:

Mytilus edulis	15 specimens
Mya truncata	3 —
Saxicava arctica	2 —
Astarte montagui	1 —
Astarte elliptica	1 —
Macoma calcarea	1 —
Balanus balanus	1 —
Strongylocentrotus?	(spines)

From the collection little can be said about the socalled semi-recent drift wood zone. Probably it may be connected with the previously mentioned 2 m-terraces. Nothing definite, however, can be assured from its fauna.

The ancient drift wood zone, on the other hand, fits fairly well with the *Mytilus*-horizon. The height is somewhat greater than that of the *Mytilus*-horizon. The reason for this, however, may be that this drift wood zone represents no terrace, but a beach. This, in connection with the exposed situation of the locality, accounts for the greater height found here.

The ancient drift wood zone is met with at different localities within the Sassen-area. Thus we have traced it at Vindodden, Kapp Schoultz, Gipsvika and Anservika. In all these localties the ancient drift wood is associated with rich occurrences of *Mytilus*-fragments — and valves.

2. Whale vertebra.

In the Gipshuk locality whale bones are commonly met with. Many of them are entirely hidden by vegetation, but may be detected as irregularities in the ground and revealed by digging. We tried to count the whale bones found within a 200 m broad zone running perpendicular to the coast and also perpendicular to the above-mentioned drift wood zones. The result of this counting was:

Recent drift wood zone	0	whale bones
Semirecent drift wood zone	0	—
Ancient drift wood zone	13	—
Broad zone above	27	—

These numbers do not say very much, because we do not know how many animals they refer to. It is evident, however, that whale vertebrae are more commonly met with in raised beaches than in modern shore. Further it seems as if the maximum frequency of whale vertebra is associated with the lower levels in the sequence of raised beaches. We have found whale bones at a height of 56 m above sea-level (Gipsvika). They seem, however, to be more common at heights from about 3 to about 10 m above sea-level. Further investigations on this line may reveal valuable facts, which may probably enable a rough dating of the *Mytilus*-horizon.

Fossils from Clay Deposits.

Fossil Localities in Moraine.

As mentioned earlier, we have collected fossils in moraine deposits only in one limited area, viz. on the south side of Von Post Glacier in the innermost part of the Tempelfjord. In this locality a well marked lateral moraine extends about 2 km from the present glacier front along the mountain side and ends in a nose. Between the moraine and the mountain side there is an old, now dry glacier-river bed, which ends in a lagoon. This river bed extends eastwards and reaches the present lateral glacier-river, which falls into the fjord after having cut through the moraine, about 0.5 km outside the glacier front. This lateral moraine can be traced further upwards along the glacier, but it is here partly destroyed by the present river. Most probably this lateral moraine is connected to a synchronous terminal moraine across the fjord. Some soundings taken along the coast here, speak in favour of this view. Straight off the nose of the lateral moraine, north of it, the depth was found to be 15 m; inside and east of it, it amounted to 31 m, and a bit further out (west of the nose) the depth was 52 m.

The minerogenic material of this moraine consists, for the greater part, of red-coloured clay and silt, intermixed with sand and pebbles. Boulders were rare. The material is strongly consolidated. This, together with the present or semi-present erosion by the glacier water and the melting of probable sub- or intermorainic ice, has given the area a very rough morphology. Fossils were seen scattered throughout this area, but seemed to dominate towards the south, that is in the most lateral parts of the moraine. In the old glacier-riverbeds fossils, which have been washed out of the moraine, were rather common.

On the shore at the inner part of the lagoon mentioned, only a few feet above sea-level, the following outwashed fossils were found:

Astarte borealis (Chemnitz)	1.5	specimens
Mya truncata L.	1.0	—
Mytilus edulis L.	1.0	—
Chlamys islandica (Müller)	0.5	—
Saxicava arctica (L.)	0.5	—
Clinocardium ciliatum (Fabricius) ...	0.5	—
Cyprina islandica (L.)	0.5	—

Further up in the old riverbed 185.5 specimens were picked up from clay material, 4.1 m above sea-level:

4.1 m. Von Post Glacier, clay, river bed in moraine.

Species	Specimens	Per cent
Saxicava arctica (L.)	80.0	43.1
Astarte borealis (Chemnitz)	23.0	12.4
Astarte elliptica (Brown)	21.0	11.3
Astarte montagui (Dillwyn)	20.0	10.8
Mya truncata L.	14.0	7.6
Mytilus edulis L.	4.0	2.2
Chlamys islandica (Müller)	3.5	1.9
Macoma calcarea (Chemnitz)	1.5	0.8
Bathyarca glacialis (Gray)	1.0	0.5
Clinocardium ciliatum (Fabricius) ...	0.5	0.3
Yoldiella frigida (Torell)	0.5	0.3
Crenella decussata (Montagu)	0.5	0.3
Serripes groenlandicus (Chemnitz) ..	0.5	0.3
Thracia myopsis (Beck) Möller	0.5	0.3
Margarites groenlandica (Chemnitz) .	5.0	2.7
Puncturella noachina (L.)	3.0	1.6
Bela sp.	2.0	1.1
Lepeta coeca (Müller)	1.0	0.5
Lunatia pallida (Brod. et Sow.)	1.0	0.5
Natica clausa Brod. et Sow.	1.0	0.5
Buccinum glaciale L.	1.0	0.5
Sipho togatus (Mørch)	1.0	0.5
Tonicella marmorea (Fabricius)	-	-
Strongylocentrotus droebachiensis (Müller)	-	-
Lithothamnion	-	-
	185.5	100.0

The fossils of this locality have been washed out of the moraine. Fragments were rather common. The first impression of the faunal assemblage was the dominance of *Saxicava arctica,* the *Astarte*-species, and *Lithothamnion.* This is confirmed by the list above (except for *Lithothamnion).* As a whole, the species are, for the greater part, the same as those which were common in the terraces. Some of them, however, we have not found in the terraces, as for example *Bathyarca glacialis, Yoldiella frigida,* and *Thracia myopsis.* The two first mentioned species have, as far as can be seen, not previously been reported as fossils from Svalbard. These species, not commonly met with in the terraces, may originally have been deposited at greater depths than those common for the terrace deposits. The fossil fauna, given above, thus may be regarded as a mixture of at least two primal assemblages. The fossils from the other localities in this area point in the same direction:

6 m. Von Post Glacier, dry river bed in the moraine.

Species	Specimens	Per cent
Astarte borealis (Chemnitz)	17.5	38.9
Saxicava arctica (L.)	16.0	35.6
Astarte elliptica (Brown)	4.0	8.9
Astarte montagui (Dillwyn)	3.5	7.8
Mya truncata L.	2.0	4.4
Clinocardium ciliatum (Fabricius) ...	1.0	2.2
Mytilus edulis L.	0.5	1.1
Chlamys islandica (Müller)	0.5	1.1
Lithothamnion	-	-
	45.0	100.0

This locality is situated in the same river bed as the preceeding one, but a bit further upwards. The fossils from the two last mentionad localities were picked up from the surface. It will be understood that the underlying material was not really morainic, but rather fluvial or glacifluvial.

On the nose of the moraine at a height of about 6 m above sea-level, the following species were picked out of the surface where they stuck firmly to the consolidated clay- silt material:

Saxicava arctica (L.)	3.0	specimens
Astarte borealis (Chemnitz)	1.0	—
Astarte montagui (Dillwyn)	0.5	—
Mya truncata L.	0.5	—
Bathyarca glacialis (Gray)	0.5	—
Leda pernula Müller	0.5	—
Thracia devexa G. O. Sars	0.5	—
Sipho togatus (Mørch)	1.0	—
Neptunea despecta L. var.	1.0	—

Of these species, *Bathyarca glacialis* and *Thracia devexa* have not been found in the terraces and *Leda pernula* only once. As far as we can see, *Thracia devexa* has not previously been reported as a fossil from Svalbard. For the variaty of *Neptunea despecta* see under Systematic part.

In the more elevated part of the moraine, about 1.5 km east of the nose, fossils were collected from a locality situated at an estimated height of 30 m above sea-level. The material consisted of clay and silt, with some sand and pebbles, fairly consolidated. The fossils were picked and dug out of a narrow edge, which had come into existence by the erosion:

30 m. Von Post Glacier, moraine, red clay-silt.

Species	Specimens	Per cent
Astarte elliptica (Brown)	67 5	31.6
Astarte montagui (Dillwyn)	66.0	30.9
Astarte borealis (Chemnitz)	14.0	6.6
Saxicava arctica (L.)	13.5	6.3
Mya truncata L.	4.0	1.9
Bathyarca glacialis (Gray)	3.0	1.4
Macoma calcarea (Chemnitz)	2 0	0.9
Mytilus edulis L.	2.0	0.9
Leda pernula (Müller)	1.0	0.5
Yoldiella frigida (Torell)	0.5	0.2
Liocyma fluctuosa (Gould)	0.5	0.2
Clinocardium ciliatum (Fabricius)	0.5	0.2
Lepeta coeca (Müller)	15.0	7.0
Lunatia pallida (Brod. et Sow.)	5.0	2.3
Sipho togatus (Mörch)	2.0	0.9
Trophon clathratus grandis Mörch	2.0	0.9
Pyrulofusus deformis Reeve	1.0	0.5
Sipho islandicus (Chemnitz)	1.0	0.5
Buccinum glaciale L.	1.0	0.5
Admete viridula (Fabricius)	1.0	0.5
Bela sp.	3.0	1.4
Siphonodentalium vitreum Sars	5.0	2.3
Tonicella marmorea (Fabricius)	-	-
Rhynchonella psittacea (Gmelin)	1.0	0.5
Balanus balanus (L.) Da Costa	2.0	0.9
Strongylocentrotus	-	-
Lithothamnion	-	-
	213.5	100.0

Astarte elliptica (Brown): 114 unbroken valves and 21 umbonal fragments. Periostracum usually preserved; most of the valves have eroded umbos.

Astarte montagui (Dillwyn): 115 unbroken valves and 17 umbonal fragments. Of the entire valves, 101 had eroded umbo.

Astarte borealis (Chemnitz): 23 whole valves and 5 umbonal fragments. Maximum size: L = 39 mm, H = 34 mm.

Saxicava arctica (L.): Most of the valves are thin; some deformed and thick.

Bathyarca glacialis (Gray): 4 whole and 2 defect valves. All the six valves are of different shape, so probably they representant 6 specimens. The largest valve measured: L = 18 mm, H = 16 mm. It was very thick and probably deformed.

Lepeta coeca (Müller): 7 whole and 8 defect valves. Maximum size: 13.5 mm diameter.

The finds of *Siphonodentalium vitreum* and *Rhynchonella psittacea* are the only ones we made during our field investigations. The first mentioned has, as far as we can see, not previously been found as a Quaternary fossil on Svalbard.

As it will be seen from the list of fossils found in this locality, it seems as if they represent different faunal assemblages, *i. e.* this actual assemblage seems to consist of different facies, *e. g.* a littoral and a more deepwater facie. An earlier readvancement of Von Post Glacier, which mixed up both minerogenic material and organisms, may account for this. Probably this readvancement has taken place in a period later than that in which the 20 m-terraces in the Sassen-area were formed.

Lamplugh (1911, p. 237—238) writes: "The absence of shells or other marine detritus showed that in this case (the moraine of Von Post Glacier) we had to deal with the land-spoil of the glacier and not with redistributed marine deposits." According to our observations this is not the fact.

Solifluction Slopes, Structural Fields and Silt-clay Deposits.

L e d a l e n. Ledalen is the first little valley west of Vindodden. We have collected fossils at three localities here, on the west side of the river.

Just up from the river, at a height of 32 m above sea-level (aneroid measurement), fossils were found in very coarse material, consisting of sand, pebbles and boulders, intermixed with silt. The fossils, which were picked up from the surface, had probably been frozen up. The two following species were found:

Mya truncata L.	62	specimens
Saxicava arctica (L.)	20	—

About 10 m lower only *Saxicava* was found. The largest specimen here measured 50.3 mm in length.

About half a kilometer west of the river outlet a locality was found near the shore, approximately 4 m above sea-level. The material consisted for the greater part of clay and silt, in some parts with sand and scattered pebbles. Stratification was visible. The following species were found:

4 m. Ledalen, west of the river outlet, clay-silt.

Species	Specimens	Per cent
Mya truncata L.	141.0	50.5
Macoma calcarea (Chemnitz)	66 5	23.8
Liocyma fluctuosa (Gould)	23 5	8.4
Astarte borealis (Chemnitz)	15 5	5.6
Saxicava arctica (L.)	6.5	2.3
Serripes groenlandicus (Chemnitz)	4.5	1.6
Thracia myopsis (Beck)	3.5	1.3
Mya pseudoarenaria Schlesch	3.0	1.1
Mytilus edulis L.	3 0	1 1
Chlamys islandica (Müller)	1 5	0.5
Clinocardium ciliatum (Fabricius)	1.5	0.5
Nucula tenuis (Montagu)	1.0	0.4
Thracia septentrionalis Jeffreys	1.0	0 4
Astarte montagui (Dillwyn)	0.5	0.2
Axinopsis orbiculata G. O. Sars	0.5	0.2
Cyprina islandica (L.)	0.5	0.2
Heteranomia squamula (L.)	0.5	0.2
Bela sp.	2.0	0.7
Natica clausa Brod. et Sow.	1.0	0.4
Lacuna vincta (Montagu)	1.0	0.4
Balanus balanus (L.) Da Costa	1.0	0.4
	279.0	100.2

Mya truncata L.: 110 unbroken valves and 172 umbonal fragments. Specimens with united valves occurred. Periostracum most often partly preserved. The specimens were usually regular and rather thin.

Macoma calcarea (Chemnitz): 99 valves and 34 umbonal fragments. They were in the same condition as *Mya truncata*. Some of the valves were dark blue inside. 20 per cent of the specimens were perforated by Naticids(?).

Liocyma fluctuosa (Gould): 38 valves and 9 umbonal fragments.

Serripes groenlandicus (Chemnitz): 3 valves and 6 umbonal fragments. The shells are throughout somewhat thicker than those found on the modern shore.

Thracia septentrionalis Jeffreys: The measurements of the two valves are: 1) length 23.8 mm, height 17.9 mm; 2) length 20.5 mm, height 15.0 mm. We have only once found this species in the terraces, viz. Gipsvika. As far as we can see, it has not previously been reported as a Quaternary fossil from Svalbard.

The faunal list from this locality includes four species not found in the terraces: *Thracia myopsis* (Beck), *Mya pseudoarenaria* Schlesch, *Nucula tenuis* (Montagu), and *Heteranomia squamula* (L.).

About half a kilometer west of the locality just described, we have collected fossils in solifluction material, consisting of clay, sand, pebbles and angular blocks. The material is resting on bedrock, and is partly sliding down the abration cliff. The height above sea-level varied from

0 m to 6 m. All the specimens in this locality are large and well developed. The following species were found:

0—6 m. Ledalen, west of the river outlet, clay-stones.

Species	Specimens	Per cent
Mya truncata L.	91 5	45.2
Macoma calcarea (Chemnitz	80.5	39.8
Cyprina islandica (L.)	10.0	4.9
Saxicava arctica (L.)	4.5	2.2
Serripes groenlandicus (Chemnitz)	2.5	1.2
Chlamys islandica (Müller)	1.0	0.5
Mytilus edulis L.	0.5	0.3
Lepeta coeca (Müller)	1.0	0.5
Lacuna vincta (Montagu)	1.0	0.5
Balanus balanus (L.) Da Costa	10.0	4.5
	202.5	99.6

Cyprina islandica (L.): The largest valve measured 83 mm in height and 106 mm in length. Besides this we found fragments belonging to even larger specimens.

Serripes groenlandicus (Chemnitz): The fragments (no unbroken valve was found) of this species seem to belong to specimens more thick-shelled than those living in the area today.

Balanus balanus (L.) Da Costa: 41 fragments of which 4 carina and 10 rostra, all belonging to large specimens.

K a p p B e l v e d è r e. Fossils were collected from a solifluction slope 21 m above sea-level (above the terraces described earlier in this paper). The material consisted of clay, silt, sand, and gravel. No unbroken shells were found in this locality. Most probably this slope represents a destroyed terrace; this seems to be confirmed by the fauna revealed:

Mya truncata L.	23.5	specimens
Saxicava arctica (L.)	2.0	—
Astarte borealis (Chemnitz)	1.0	—
Mytilus edulis L.	0.5	—
Zirfaea crispata (L.)	0.5	—
Macoma calcarea (Chemnitz)	0.5	—
Buccinum sp.	1.0	—

Zirfaea crispata (L.): 1 umbonal fragment of a left valve with apophyse. This fragment represents the only find we made of this species during our field work. As far as can be seen, this species has not previously been reported as a Quaternary fossil from Svalbard. *Zirfaea crispata* has been found as a fossil in Greenland; first discovered

in 1902 by M. C. Engell (1904, 1905) at Orpigsok, southeastern part of Disco Bay, lat. 68° 37′ N, (described also by Ad. S. Jensen 1905); later found in the same locality by Jensen and Harder (1910) in black gravel up to about 10 m above sea-level. The recent northern limit for distribution of this species is, according to Jensen and Spärck (1934), Murmansk, Finnmark and Iceland. Considering its total distribution, *Zirfaea crispata* must be regarded as a boreal species, as *e. g. Cyprina islandica* (cfr. Jensen 1942). *Zirfaea crispata* is never taken alive in Spitsbergen waters.

From a solifluction slope 29 m above sea-level were collected:

Mya truncata L.	7.0	specimens
Saxicava arctica (L.)	0.5	—
Mytilus edulis L.	0.5	—

The fragments here were very small. Among the shell fragments there are two which probably belong to *Astarte* and one perhaps belongs to *Cyprina islandica*. The fragments, however, are too small for certain identification.

S a s s e n. About half a kilometer south of the headquarters of the hunter Nöis, we have collected fossils in an erosional cliff. The material consisted of pebbles and sand in the upper parts, and this was resting upon deposists of clay mixed with sand. The height of the upper limit of the clay material was 28.8 m above sea-level. The following fossils were found in this material:

28.8 m. Sassen, north; clay mixed with sand.

Species	Specimens	Per cent
Mya truncata L.	64.0	53.3
Macoma calcarea (Chemnitz)	50.0	41.7
Saxicava arctica (L.)	6.0	5.0
	120.0	100.0

Mya truncata L.: 123 unbroken valves and 5 defect; most of them very thick.

Macoma calcarea (Chemnitz): 71 valves and 26 umbonal fragments. Both thin and thick shells.

Saxicava arctica (L.): 10 unbroken valves and 2 defect. Largest valve: length 49.5 mm, smallest 36.0 mm. Largest index (L:H) 59.52, smallest 44.44.

We have collected fossils at three places in stripes of soil flow. The material in the stripes consisted of clay and sand, whereas the

interspace between the stripes was covered with vegetation. At all three localities the fossils were picked up from the surface:

7 m. Sassen, stripes of flow earth, clay and sand.

Species	Specimens	Per cent
Astarte elliptica (Brown)	53.0	24.2
Mya truncata L.	41.0	18.7
Saxicava arctica (L).	36.5	16.7
Astarte montagui (Dillwyn)	32.0	14.6
Astarte borealis (Chemnitz)	29.5	13.5
Macoma calcarea (Chemnitz)	19 5	8.9
Mytilus edulis L.	3.5	1.6
Chlamys islandica (Müller)	2 0	0.9
Clinocardium ciliatum (Fabricius) ...	0.5	0.2
Serripes groenlandicus (Chemnitz) ..	0.5	0 2
Trophon clathratus (L.)	1.0	0.5
Tonicella marmorea (Fabricius)	-	-
	219.0	100.0

4.6 m. Sassen, stripes of flow earth, clay and sand.

Species	Specimens	Per cent
Saxicava arctica (L.)	50.0	53.5
Macoma calcarea (Chemnitz)	7.5	8.0
Mya truncata L.	6.0	6.4
Astarte montagui (Dillwyn)	3.5	3.7
Heteranomia squamula (L.)	3.5	3.7
Mytilus edulis L.	2.0	2.1
Astarte borealis (Chemnitz)	2.0	2.1
Chlamys islandica (Müller)	1.5	1.6
Astarte elliptica (Brown)	1.0	1.1
Clinocardium ciliatum (Fabricius) ...	0.5	0 5
Lepeta coeca (Müller)	10.0	10.7
Puncturella noachina (L.)	3.0	3.2
Trophon clathratus (L.)	1.0	1.1
Margarites helicina (Phipps)	1.0	1.1
Balanus balanus (L) Da Costa)	1.0	1.1
	93.5	99.9

Great masses of *Lithothamnion* were found in this locality. *Strongylocentrotus* was also represented.

The third collection was made at the same elevation as the above-listed and half a kilometer to the south:

4.6 m. Sassen, stripes of flow earth, clay and sand.

Species	Specimens	Per cent
Saxicava arctica (L.)	90.0	47.9
Astarte elliptica (Brown)	36.0	19.2
Astarte montagui (Dillwyn)	21.5	11.4
Mya truncata L.	8 5	4.5
Astarte borealis (Chemnitz)	5.5	2.9
Mytilus edulis L.	3.5	1.9
Chlamys islandica (Müller)	2.0	1.1
Macoma calcarea (Chemnitz)	2.0	1.1
Trophon clathratus (L.)	6.0	3.2
Puncturella noachin (L.)	5.0	2.7
Lepeta coeca (Müller)	2.0	1.1
Margarites helicina (Phipps)	2.0	1.1
Lacuna vincta (Montagu)	1 0	0.5
Littorina saxatilis (Olivi)	1.0	0.5
Sipho sp.	1.0	0.5
Tonicella marmorea (Fabricius)	-	-
Balanus balanus (L.) Da Costa	1.0	0.5
Lithothamnion (dominating)	-	-
	188.0	100 1

In the area between the three localities just described and the westward running river, there are some old elevated lagoons. In the inner parts of these some fossils were found. At a height of 4 m, where the material consisted of pebbles, the following species were collected:

Mya truncata L.	3.5	specimens
Saxicava arctica (L.)	2.0	—
Chlamys islandica (Müller)	1.0	—
Macoma calcarea (Chemnitz)	0.5	—
Astarte montagui (Dillwyn)	0.5	—

At a height of 0.5 m above sea-level, near the shore of the Sassen river, the following fossils were found in mud material:

Mytilus edulis L.	3.5	specimens
Liocyma fluctuosa (Gould)	0.5	—
Astarte elliptica (Brown)	0.5	—
Buccinum sp.	1.0	—

K a p p S c h o u l t z. As described in the chapter on the terraces, we have collected fossils on the surface and in the upper parts of a gravel terrace situated at a height of 13.8 m above sea-level at Kapp Schoultz. In the lower parts of the cliff of this terrace, the material is composed of clay and silt, coarser material being rare. As it will be seen from the following list, the composition of the fauna here is quite

different from that in the upper part of the terrace. The fossils are generally very well preserved, and specimens with the valves united were not at all rare. The following species were found:

4 m. Kapp Schoultz, clay-silt, at the base of the 13.8 m-cliff.

Species	Specimens	Per cent
Mya truncata L.	54.0	34.3
Macoma calcarea (Chemnitz)	48.0	30.5
Astarte montagui (Dillwyn)	28.5	18.1
Astarte borealis (Chemnitz)	15.5	9.9
Saxicava arctica (L.)	4.0	2.5
Astarte elliptica (Brown)	3.5	2.2
Chlamys islandica (Müller)	0.5	0.3
Axinopsis orbiculata G. O. Sars	0.5	0.3
Littorina saxatilis (Olivi)	2.0	1.3
Margarites groenlandicus (Chemnitz)	1.0	0.6
Tonicella marmorea (Fabricius)	-	-
Strongylocentrutus ?	-	-
Lithothamnion	-	-
	157.5	100.0

Mya truncata L.: 48 unbroken valves and 60 umbonal fragments, besides other fragments. Nearly all valves have preserved grey-brown periostracum. The united valves were usually filled with clay, and in some of them remnants of the sipho was found.

Macoma calcarea (Chemnitz): 65 valves and 31 umbonal fragments. Periostracum and ligament often well preserved.

The above-lying terrace (or terraces) is destroyed by solifluction, especially in the neighbourhood of the huts on Kapp Schoultz. Fossils were traced from about 20 m above sea-level up to an altitude of 44.6 m. As the solifluction slope here is rather steep, one may assume that the fossils occurring here, originate from the upper part of the slope. Collections were made from the slope on each side of the river here. The assemblage may be associated with the 45 m-level:

20 m to 44.6 m. Kapp Schoultz, solifluction slope.

Species	Specimens	Per cent
Mya truncata L.	93.0	67.2
Saxicava arctica (L.)	31.5	22.7
Chlamys islandica (Müller)	6.5	4.7
Macoma calcarea (Chemnitz)	4.5	3.3
Lepeta coeca (Müller)	1.0	0.7
Balanus balanus (L.) Da Costa	2.0	1.4
	138.5	100.0

Mya truncata L.: 4 valves and 182 umbonal fragments. Some of them belong to thick-shelled specimens.

Saxicava arctica (L.): 27 valves and 36 umbonal fragments; shells large and very thick.

Gipsvika. West of the 7.3 m-terrace at the inner part of Gipsvika there is a rivulet. This has eroded the marine sediments, which for the greater part consists of sand and pebbles, and in one place exposed the underlying brown clay mixed with sand. Fossils were found in this deposit. The height above sea-level of the clay sediments was 40 m (aneroid measurement). The following species were found:

Mya truncata L.	23.5	specimens
Macoma calcarea (Chemnitz)	9.0	—
Strongylocentrotus?	—	—
Lithothamnion	—	—

The specimens of *Mya truncata* were throughout rather thick, whereas the valves of *Macoma calcarea* were fairly thin.

Systematic Part.

Remarks on the species found.

In the following a systematic survey will be given of those mollusc species which we have found as Quarternary fossils in the Sassen-area. At the end of this part all mollusc species found as Quaternary fossils on Spitsbergen (also those not found by us) are listed.

Nucula tenuis (Montagu 1808).

Arca tenuis Montagu 1808. — This species we have only found once, viz. one specimen in clay-sand deposits at a height of about 4 m in Ledalen. All fossils in this locality are probably, as mentioned earlier, primarly sedimentated at a higher level. — This species is first recorded by Knipowitsch (1902) from the east coast.

Leda pernula (Müller 1779).

Arca pernula Müller 1779. — We have found this species three times: one valve in the 7 m-terrace at Sveltihel, one valve at a height of 6 m in the moraine deposits of Von Post Glacier, and two valves about 30 m above sea-level in the same moraine. — It is first recorded by Knipowitsch (1902) from the east coast (var. *expansa* (Reeve)).

Yoldiella frigida (Torell 1859).

Yoldia frigida Torell 1859. Syn. *Portlandia frigida* (Torell 1859). — Only found in the moraine deposits of Von Post Glacier: one valve in a river bed, altitude 4.1 m, and one valve at a height of about 30 m in red clay. As far as we can see, this species has not earlier been reported as a fossil from Svalbard.

Bathyarca glacialis (Gray 1824).

Arca glacialis Gray 1824. — This species too we have only found in the moraine deposits of Von Post Glacier, viz. one specimen in the river bed 4.1 m above sea-level, one valve at a height of 6 m, and three specimens at a height of about 30 m, the two last localities in red clay. Judging from the literature concerned, this species has not previously been reported as a fossil from Svalbard.

Heteranomia squamula (Linné 1767).

Anomia squamula Linné 1767. — Found twice by us, viz. one valve in Ledalen and 3.5 specimens frozen up in stripes of soil flow in Sassen, 4.6 m above sea-level. This species is first recorded by Lamplugh (1911) (as *Anomia ephippium* L.) from Cora Island in the Ekmanfjord, one of the northern tributaries to the Isfjord.

Chlamys islandica (Müller 1776).

Ostrea islandica Müller 1776. Syn. *Pecten islandicus* (Müller 1776). This species is rather common, though it never occurred in great quantities in the different localities visited by us (not above 5 per cent). We have found it in all sorts of material and in all types of localities investigated, from just above sea-level up to 45 m. It seems, however, to be most common below 20 m. This species is first recorded by Heer (1770) from Advent Bay.

Crenella decussata (Montagu 1808).

Mytilus decussatus Montagu 1808. — Found in three localities by us, viz. 3.5 specimens in the middle part of a terrace cliff at Gåsøyane (Anser Island) 2 m above sea-level, one valve in the river bed at the moraine of Von Post Glacier, altitude 4.1 m, and 2.5 specimens in the 7 m-terrace at Sveltihel. The first record is by Lamplugh (1911) from Cora Island in Ekmanfjord.

Mytilus edulis Linné 1758.

Rather common, especially in shingle terraces, up to 45 m, but really dominating only between 3 and 5 m above sea-level. In a collection from a 3.9 m-terrace at Gipsvika this species makes 82 per cent of the assemblage. *Mytilus edulis* is first reported by Blomstrand (1864) from

a 10—20 feet high section on the east side of Advent Bay. Chydenius (1865) reports this species form North Spitsbergen, a 25 feet high section (clay and gravel) at the coast on the western side of Treurenberg Bay, a single shell found (leg. Von Yhlen). Frebold (1935) reports that Hoel has found this species at an altitude of 70 m in Dickson Bay. This is probably the highest elevation at which *Mytilus edulis* has been found.

Volsella modiolus (Linné 1758).

Mytilus modiolus Linné 1758. Syn. *Modiola modiolus* (Linné 1758). — We have only found this species once, viz. four umbonal fragments 20 m above sea-level in the cliff of a terrace at Kapp Schoultz. It has apparently only been found once earlier, reported by Dautzenberg et Fischer (1912) from Advent Bay, where it was found by the Prince of Monaco in 1906.

Modiolaria discors laevigata (Gray 1824).

Modiola laevigata Gray 1824. — Only found very sparsely at two localities, viz. one valve in Anservika, 1.4 m above sea-level, and two specimens at Gipshuk at a height of about 2 m. This species is reported by Knipowitsch (1902) from Edgeøya (Stans Foreland), probably at an altitude of 2.3 m. Nordmann (1912) reports it too.

Modiolaria discors substriata (Gray 1824).

Modiola laevigata v. *substriata* Gray 1824. — This species we have found once in the inner part of Gipsvika about 2 m above sea-level. It is, however, not certain that this specimen represents a fossil. *Modiolaria discors substriata* is reported by Knipowitsch (1902) from Edgeøya. Apparently it has not been found as a fossil on West Spitsbergen.

Astarte borealis (Chemnitz 1788).

Venus borealis Chemnitz 1788. — This species has been found in terraces up to an altitude of 21 m, in the moraine of Von Post Glacier at a height of 30 m. In littoral sediments it is dominating the fossil fauna in the so-called *Astarte*-division from an average height of 7 m to 20.5 m above sea-level, where it constitutes from 50 to 97 per cent of the assemblages. We have avoided trying to separate the different varieties of this species, in this report. It is first reported by Woodward (1860) from the east coast, and later found by numerous investigators in different parts of Spitsbergen.

Astarte montagui (Dillwyn 1817).

Venus montagui Dillwyn 1817. — The vertical distribution of this species is about the same as that of *A. borealis*. It is, however, far from being as common as *A. borealis,* and forms seldom more than 10 per cent of the assemblage in the localities investigated by us. It is reported by *Knipowitsch* (1902) from the west and east coast.

Astarte elliptica (Brown 1827).

Crassina elliptica Brown 1827. — This species is found to be rare in littoral sediments. In clay material at a height of 30 m above sea-level in the moraine of Von Post Glacier, *A. elliptica* was the dominating one of 12 species. Woodward (1860) reports it from the east coast.

Astarte crenata (Gray 1824).

Nicania crenata Gray (1824). — We have found this species twice, viz. one valve in a 7 m-terrace at Gipsvika, and one valve in a solifluction slope 33 m above sea-level in the same locality. As far as we can see, this species has not previously been reported as a fossil from Svalbard.

Axinopsis orbiculata G. O. Sars 1878.

We have found this species only in the lowest horizons, viz. one valve in a *Mytilus*-terrace at Sveltihel, 3.6 m above sea-level, one valve in sand-clay deposits west of the river outlet in Ledalen, and one valve at an altitude of 4 m at Kapp Schoultz in material consisting of clay and mud. It is reported by Knipowitsch (1902) from Edgeøya, and by Nordmann (1912) from Cora Island, Ekmanfjord.

Turtonia minuta (Fabricius 1780).

Venus minuta Fabr. 1780. Syn. *Cyamium minutum* Fabr. 1780. Only found once, viz. two valves in a terrace cliff 2 m above sea-level at Gåsøyane (Anser Islands). This species is reported by Elton and Baden-Powell (1931) from Wijdefjord on the north coast. It is apparently not found as a fossil on the west coast.

Clinocardium ciliatum (Fabricius 1780).

Cardium ciliatum Fabr. 1780. — One valve of this species was found in a terrace, viz. at Sveltihel, 3.6 m above sea-level. Five other finds were made in more or less clayey material, up to a height of 7 m

in marine deposits, and at an elevation of 30 m in the moraine of Von Post Glacier. At all these localities only a few specimens were found. It is reported by Knipowitsch (1902) from Edgeøya and the east coast.

Serripes groenlandicus (Chemnitz 1782).

Cardium groenlandicum Chemnitz 1782. — Found rather rarely in the terraces up to 13.5 m. In the other types of fossiliferous localities it is rare too, and in these not found at an altitude higher than 7 m. The specimens from the collection west of the river outlet in Ledalen show larger and thicker shells than are usually found among recent specimens. This species is recorded by Heer (1870) from Advent Bay, and by Knipowitsch (1902) from the east coast.

Cyprina islandica (Linné 1767).

Venus islandica Linné 1767. — Fragments found in four terraces up to about 19 m above sea-level. West of the river outlet in Ledalen this species was richly represented; the valves were very large and thick. First recorded by Heer (1870) from Advent Bay.

Macoma calcarea (Chemnitz 1782).

Tellina calcarea Chemnitz 1782. — This species has been found in most of the terraces investigated, up to a height of 45 m, though rather scarce. In clay-silt deposits it is far more common. *Macoma calcarea* has been found on the west, north and east coasts of Spitsbergen. First reported by Nordenskjöld (1867) from Bellsund (leg. Robert).

Macoma torelli (Steenstrup) Jensen.

Only found once, viz. in a *Mytilus*-terrace 3.6 m above sea-level at Sveltihel. As far as we can see, it has not earlier been reported as a fossil from Svalbard. Odhner (1915) has no record of this species in his treatise on the modern mollusc fauna of the Isfjord, but Jensen and Spärck (1934) report it as occurring at Spitsbergen.

Liocyma fluctuosa (Gould 1841).

Venus fluctuosa Gould 1841. — We have never found this species in the terraces, though it is rather common on the modern shore in some localities. West of the river outlet in Ledalen, 4 m above sea-level, 23.5 specimens of this species were found, making 8.5 per cent of the faunal assemblage. One valve was found in the moraine of Von Post Glacier, altitude 30 m. — It is reported by Knipowitsch (1902) from the east coast and from Edgeøya. Not earlier reported from the western regions.

Saxicava arctica (Linné 1766).

Mya arctica Linné 1766. — (Here included *S. rugosa* Lamarck and *S. pholadis* Linné). Very common in the terraces. At levels below 3.5 m it forms 10 to 30 per cent of the assemblages and at altitudes between 30 and 45 m it forms 10 to 40 per cent. In the interval from about 5 to 30 m it hardly amounts to 10 per cent. At Gipsvika we have found fragments of *S. arctica* on an ancient beach 60 m above sea-level. — First reported by Nordenskjöld (1867) from Advent Bay.

Mya truncata Linné 1758.

This species is very common in the terraces, but it seems to be dominating only above 20 m, where it forms 42 to 95 per cent of the faunal assemblages. We have found it in shorelines up to 60 m above sea-level. In clay-silt deposits this species usually dominates the fauna also at lower levels. It is very variable in size and shape. The whole serie from forma *ovata* Jensen to var. *uddevallensis* Hancock is represented. In littoral sediments the larger and thicker shells seem to be associated with the higher levels. — First reported by Torell (1859) from the west coast, by Woodward (1860) from the east coast, and by Sandford (1929) from the north.

Mya pseudoarenaria Schlesch 1931.

Mya truncata var. *ovata* Jensen 1900. — We have never found this species in the terraces, and only once elsewhere, viz. in clay deposits west of the river outlet in Ledalen, 4 m above sea-level, six separate valves were found. Probably one must regard Heer (1870) as the first one to mention this species from Svalbard. He has, however described it as a form of *M. truncata;* "f. parte postica anticeam fere superante, subproducta, rotendata" (det. Loven, p. 92). It is, however, admirable that Heer and Loven regarded it as a form of *M. truncata* and not as *M. arenaria,* as done by many previous and some modern authors who have dealt with arctic molluscs. Knipowitsch (1902) reports it from the east coast and from Edgeøya. Elton and Baden-Powell (1931) report the find of *M. arenaria* as a fossil from Billefjord (Klaas Billen Bay) and from Wijdefjord. As it seems as if these two authors are not aware of the existence of the var. *ovata* Jensen, and as *M. arenaria* is never reported from Svalbard, neither as living nor as a fossil (though Elton and Baden-Powell report it as apparently living: "two individuals in the Klaas Billen dredgings, one of which was empty", (1931 l. c. p. 388)), we prefer to regard these specimens (reported by Elton and Baden-Powell) as belonging to the species *M. truncata ovata* Jensen, or in the new taxonomy: *M. pseudoarenaria* Schlesch.

Zirfaea crispata (Linné 1758).

Pholas crispata Linné 1758. One umbonal fragment with apophyse was found at an altitude of 21 m at Kapp Belvedère (cfr. p. 64). This species has, as far as we can see, never been found in Svalbard, neither as a fossil nor alive.

Thracia septentrionalis Jeffreys 1872.

This species was found twice, viz. one valve in the 7.3 m-terrace in Gipsvika and two valves in clay material west of the river outlet in Ledalen. It has not previously been reported as a fossil from Svalbard.

Thracia myopsis (Beck) Møller 1842.

Syn. *Thracia truncata* Packard 1867. — This is the most common of the *Thracia*-species we have found, though it was only found three times, viz. one valve in a semirecent shoreline in Anservika, at a height of 1.5 m, one valve in the river bed of Von Post moraine, altitude 4 m, and 3.5 specimens in clay deposits west of the river outlet in Ledalen, altitude 4 m. It is reported by Knipowitsch (1902) from Edgeøya, and by Elton and Baden-Powell (1931) from Wijdefjord.

Thracia devexa G. O. Sars 1878.

Of this species we have found one valve at a height of 6 m in the moraine deposits (red clay) of Von Post Glacier. As far as can be seen, it has not previously been reported as a fossil from Svalbard.

Siphonodentalium vitreum M. Sars 1835.

Five specimens were found at a height of 30 m above sea-level in the moraine of Von Post Glacier. Not previously reported as a fossil from Svalbard.

Puncturella noachina (Linné 1771).

Patella noachina Linné 1771. — This species is not common. We have found it twice in the terraces, up to 7 m above sea-level. In clay deposits we have not found it above 4.5 m. It is previously reported by Knipowitsch (1902) from Edgeøya, and from the west coast by Lamplugh (1911).

Moelleria costulata (Møller 1842).

Margarita(?) costulata Møller 1842. — Only found once, viz. 4 specimens at a height of 2 m in the cliff of the 7 m-terrace at Gåsøyane. It is reported by Knipowitsch (1902) from the east coast and from Edgeøya, and by Lamplugh (1911) from the west coast.

Margarites groenlandica (Chemnitz 1781).

Trochus groenlandicus Chemnitz 1781. Syn. *Margarita* sp. Found twice in the terraces up to 3.7 m above sea-level, and in two clay localities, not above 4.1 m. First reported by Knipowitsch (1902) from the east coast, from the west coast by Lamplugh (1911), and from the north coast by Elton and Baden-Powell (1931).

Margarites helicina (Phipps 1774).

Turbo helicina Phipps 1774. Syn. *Margarita* sp. — Never found in upper parts of terraces. 16 specimens found at a height of 2 m in the cliff of the 7 m-terrace at Gåsøyane. Elsewhere three specimens were found in a solifluction slope south of the main complex of raised features in Sassen, altitude 4.6 m. This species is reported by Knipowitsch (1902) from Edgeøya, and by Lamplugh (1911) from Cora Island in Ekmanfjord.

Lepeta coeca (Müller 1776).

Patella coeca Müller 1776. — This species is rather common, both in the terraces and in other localities. In the terraces we have found it up to 45 m above sea-level. 15 specimens were found in the cliff of the 7 m-terrace at Gåsøyane (altitude 2 m), and it was also rather richly represented at a height of 30 m in the moraine of Von Post Glacier. Reported by Knipowitsch (1902) from Edgeøya (only one specimen), by Lamplugh (1911) from Isfjorden, and by Elton and Baden-Powell from the north coast (1931).

Natica clausa Broderip et Sowerby 1829.

Syn. *Natica affinis* (Gmelin 1790?). — Not found in the terraces, but at three other localities, one specimen at each, up to an altitude of 4.1 m above sea-level. Reported by Knipowitsch (1902) from the east coast, Edgeøya, Barentsøya and from Billefjorden.

Lunatia pallida (Broderip et Sowerby 1829).

Natica pallida Brod. et Sow. 1829. Syn. *Lunatia groenlandica* Beck 1842. — Found twice in the terraces, up to 3.7 m above sea-level. One specimen was found at a height of 4.1 m in the river bed in the moraine of Von Post Glacier, and 5 specimens in red clay at an altitude of 30 m in the same locality. — Reported by Knipowitsch (1902) from the east coast and from Edgeøya.

Lacuna vincta (Montagu 1803).

Turto vincta Montagu 1803. — Found once in a terrace, viz. in the outer part of Gipsvika at a height of 45 m above sea-level. One specimen was found in Sassen (4.1 m above sea-level), and one specimen west of the river outlet in Ledalen. As far as we can see, this species has not previously been reported as a fossil from Svalbard.

Littorina saxatilis (Olivi 1792).

Turbo saxatilis Olivi 1792. Syn. *Littorina rudis* (Maton 1797). — This species was found three times in the terraces, at the highest locality 7 specimens were found (45 m above sea-level). It is reported by Knipowitsch (1903) from Bohemanneset in Isfjorden. It is further reported by Elton and Baden-Powell (1931) from Billefjorden. These authors write, however, that "*L. saxatilis* is now extinct as living animal in Spitsbergen waters" (l. c. p. 403). This is not the case. We have found living specimens in Isfjorden from Kapp Linné in the west to Gipshuk in the east, (cfr. also Odhner 1915).

Littorina littorea (Linné 1758).

Turbo littorea Linné 1758. — Found twice, viz. in the terrace 19 m above sea-level at Von Post Glacier, and in an ancient shoreline 16.3 m above sea-level in Sassen. — Reported by Heer (1870) from Advent Bay.

Cingula castanea (Møller 1842).

Rissoa castanea Møller 1842. — Two specimens were found in the cliff of the 7 m-terrace at Gåsøyane 2 m above sea-level. — Reported by Lamplugh (1911) from Cora Island in Ekmanfjord.

Cingula aculea (Gould 1841).

Rissoa aculea Gould 1841. — Found once, at the same locality as the other species of this genus; 28 specimens were found. — Reported by Lamplugh (1911) from the same locality as the foregoing species (as *Onoba aculeus* Gould).

Neptunea despecta (Linné 1758).

Murex despectus Linné 1758. — In the moraine of Von Post Glacier at a height of 6 m above sea-level, a fragment (last whorl with umbilicus) belonging to this species was found. This fragment, however, represents not the typical form, but probably a form of the var. *carinata* Lamarck. It has a great resemblance to one of the transition forms of Brøgger, between *Neptunea despecta* L. var. *carinata* Lam. and *N. denselirata* Brøgger (Brøgger 1900—01, tab. IV, Fig. 5). (Cfr. also Knipowitsch 1902 p. 368—69). — As far as can be seen, neither the typical form nor any variaties have previously been reported as a fossil from Svalbard.

Sipho islandicus (Chemnitz 1780).

Fusus islandicus Chemnitz 1780. Syn. *Colus islandicus* (Chemnitz 1780). — One specimens was found at an altitude of 30 m above sea-level in the moraine deposits of Von Post Glacier. It is not previously reported as a fossil from Svalbard.

Sipho togatus (Mørch 1869).

Fusus ebur var. *togata* Mørch 1869. — Only found in the moraine of Von Post Glacier; one specimen at a height of 4.1 m in the river bed, one specimen in red clay at an altitude of 6 m, and two specimens in red clay 30 m above sea-level. This species has not previously been reported as a fossil from Svalbard.

Pyrulofusus deformis (Reeve 1847).

Fusus deformis Reeve 1847. — Of this species we have found one fragmentary specimen at a height of 30 m in the moraine of Von Post Glacier. Aditionally, two fragments were found about 1 m above the high-water line at the inner part of Gipsvika. We cannot say for certain if these two fragments represent fossils.—This species has only once been reported as a fossil fom Svalbad, Cöster (1925) and it seems to be very rare in the modern fauna too (cfr. Knipowitsch 1901 p. 462, and 1902 p. 371, Dautzenberg et Fischer 1912 p. 67, and Odhner 1915 p. 200).

Buccinum glaciale Linné 1761.

This species is rather common in the terraces up to 5.3 m. Above this height we have not found it. In clay deposits it was only found below 4.1 m, except for one specimen found 30 m above sea-level in the moraine of Von Post Glacier. — Reported by Knipowitsch in the year 1902 from the east coast and by Woodward (1860) from the west coast. From the north coast it is reported by Sandford (1929).

Buccinum groenlandicum Chemnitz 1788.

One specimen was found in a terrace at a height of 3.7 m at the inner part of Gipsvika. About 1 m above the highwater line in the same locality 26 specimens were found, these are, however, probably not fossils. — Reported by Knipowitsch (1902) from the east and west coast.

Buccinum tenue Gray 1839.

One specimen probably belonging to this species was found in the inner part of Gipsvika at the same low locality where *B. groenlandicum* and *Pyrulofusus deformis* were found. Whether it is a fossil or not, is uncertain. — Reported by Knipowitsch (1902) from the east coast and by Lamplugh (1911) from the west coast.

Buccinum undatum Linné 1758.

Found twice in the terraces, viz. one specimen at Sveltihel, 2.3 m above sea-level, and two specimens in the 45 m-terrace at Gipsvika. As far as we can see, it has not previously been reported as a fossil from Svalbard.

Trophon clathratus (Linné 1767).

Murex clathratus Linné 1767. — This species has only been found twice in terraces, viz. three specimens at Sveltihel, 3.6 m above sea-level, and two specimens in the 19 m-terrace at Von Post Glacier. In clay deposits it is not quite so rare. In the moraine of Von Post Glacier we have found this species 30 m above sea-level, (probably the form *grandis* Mørch). — Reported by Knipowitsch from the east coast (1902) and from the west coast (1903).

Trophon truncatus (Strøm 1767).

Buccinum truncatus Strøm 1767. — One specimen was found in the 45 m-terrace at Gipsvika. — Elton and Baden-Powell (1931) have, in their tabular list of molluscs, listed *Boreotrophon truncatum* (syn. for *Trophon truncatus*) from Billefjorden (p. 404), but in the text (p. 403) they have written *T. clathratus,* so we do not know which species they found.

Admete viridula (Fabricius 1780).

Tritonium viridulum Fabricius 1780. — One specimen of this species was found at an altitude of 30 m in the moraine of Von Post Glacier. — Reported by Knipowitsch (1902) from Edgeøya. Not previously reported from the western region.

Tonicella marmorea (Fabricius 1780).

Chiton marmoreus Fabricius 1780. — Fragments of this species are rather common at lower levels. In terraces it has been found up to 28.8 m above sea-level (Kapp Schoultz). The highest elevation at which it has been found is 30 m, in the moraine of Von Post Glacier. — Reported by Knipowitsch from the east coast (1902) and from the west coast (1903).

Explanation to the Tabular list.

In the following tabular enumeration, we have tried to set up all mollusc species known as Quaternary fossils from Svalbard. In respect of the regional distribution, we have only separated the west, east, and north coasts of West-Spitsbergen. Barentsøya and Edgeøya are placed under the east coast, Isfjorden under the west. (Our own finds are marked with a cross in the first column.) In the other columns the years of the first report of the species are given. In the list of literature one may see which author was the first to mention the different species. If our find is the first known, the year 1948 is placed in the west coast column.

Some remarks on the list are needed and in the following, the numbers correspond to the species numbers in the list.

2. From the east coast Knipowitsch has reported it as var. *expansa* (Reewe).

4. Knipowitsch has used the name *L. pernula* var. *minuta* Müller, and writes (1902 l. c. p. 451): "Diese Form ist auf dem Strande gefunden worden, est ist fraglich ob wir es hier mit rezenten oder fossilen Exemplar zu tun haben."

13. Reported by Dautzenberg et Fischer in 1912, but found in the year 1906.

19. By Elton and Baden-Powell mentioned as var. *striata.*

33. Torell (1859 p. 81) has mentioned *Mya uddevallensis.*

34. From the west and north coast Elton and Baden-Powell report *Mya arenaria.* As mentioned previously we consider these specimens as *M. pseudoarenaria.*

44. var. *grandis* (Mørch).

45. Knipowitsch (1902) reports from the east coast both forma *typica* and var. *umbilicalis* (Brod. et Sow.).

71. Knipowitsch (1902) reports from the east coast the var. *scalariformis* (Beck).

73. Knipowitsch (1902) reports var. *grandis* (Mørch) from the east coast and west coast.

76. From the east coast var. *laevis* Lech.

77. et var. *spitzbergensis* Friele.

80. Reported by Knipowitsch as war. *semiplicata* G. O. Sars.

83. Knipowitsch (1902) reports var. *violacea* (Migh.) et var. *laevior* G. O. Sars. Nordmann (1912) writes *Bela violacea* (Migh.).

84. et var. *corticata* Beck.

As it will be seen from the list, the total number of mollusc species known as Quaternary fossils from Svalbard amounts to 84. 65 of these species are known from the western regions. In the year 1903, according to Knipowitsch, the total number of known species was 62 (with variaties), and 20 of these from the west. In the Sassen-area, the district of our investigations, we have found 56 species. 13 of these species are new for the Quaternary fauna of Svalbard, and 20 new for the western regions of West-Spitsbergen.

No.	Tabular enumeration of all Mollusc species found as Quaternary fossils on Svalbard	Found by the authors	West coast of West-Spitsbergen	East coast of West-Spitsbergen with Barents Island and Edge Island	North coast of West-Spitsbergen
1	*Tonicella marmorea* (Fabricius 1780)	×	1903	1902	-
2	*Nucula tenuis* (Montagu 1808)	×	1912	1902	-
3	*Leda pernula* (Müller 1779)	×	1911	1902	-
4	*Leda minuta* (Müller 1779)	-	-	1902	-
5	*Portlandia arctica* (Gray 1824)	-	1911	-	-
6	*Yoldiella frigida* (Torell 1859)	×	1948	-	-
7	*Yoldiella lenticula* (Müller 1824)	-	-	1902	-
8	*Bathyarca glacialis* (Gray 1824)	×	1948	-	-
9	*Heteranomia squamula* (Linne 1767)	×	1911	-	-
10	*Chlamys islandica* (Müller 1776)	×	1870	1902	1931
11	*Crenella decussata* (Montagu 1808)	×	1911	-	-
12	*Mytilus edulis* Linne 1758	×	1864	1902	1865
13	*Volsella modiolus* (Linne 1758)	×	1912a	-	-
14	*Modiolaria discors laevigata* (Gray 1824).	×	1912	1902	-
15	*Modiolaria discors substriata* (Gray 1824).	×	1948	1902	-
16	*Modiolaria corrugata* (Stimpson 1851) ...	-	-	1902	-
17	*Modiolaria nigra* (Gray 1824)	-	-	1902	-
18	*Astarte borealis* (Chemnitz 1788)	×	1870	1860	1929
19	*Astarte montagui* (Dillwyn 1817)	×	1902	1902	1931
20	*Astarte elliptica* (Brown 1827)	×	1903	1860	1931
21	*Astarte crenata* (Gray 1824)	×	1948	-	-
22	*Axinopsis orbiculata* G. O. Sars 1878	×	1912	1902	-
23	*Thyasira flexuosa* (Montagu 1870)	-	1912	1902	1931?
24	*Turtonia minuta* (Fabricius 1870)	×	1948	-	1931
25	*Montacuta maltzani* Verkrüzen 1875	-	-	1902	-
26	*Clinocardium ciliatum* (Fabricius 1780) ...	×	1911	1902	-
27	*Serripes groenlandicus* (Chemnitz 1782) ..	×	1870	1902	-
28	*Cyprina islandica* (Linne 1767)	×	1870	-	1936
29	*Macoma calcarea* (Chemnitz 1782)	×	1867	1902	1929
30	*Macoma torelli* (Steenstrup) Jensen	×	1948	-	-
31	*Liocyma fluctuosa* (Gould 1841)	×	1948	1902	-
32	*Saxicava arctica* (Linne 1776)	×	1867	1902	1929
33	*Mya truncata* Linne 1758	×	1859	1860	1929
34	*Mya pseudoarenaria* Schlesch 1931	×	1870	1902	1931
35	*Zirfaea crispata* (Linne 1758)	×	1948	-	-
36	*Thracia septentrionalis* Jeffreys 1872	×	1948	-	-
37	*Thracia myopsis* (Beck) Müller 1842	×	1948	1902	1931
38	*Thracia devexa* G. O. Sars 1878	×	1948	-	-
39	*Siphonodentalium vitreum* M. Sars 1835 ..	×	1948	-	-
40	*Puncturella noachina* (Linne 1771)	×	1911	1902	-
41	*Scissurel a crispata* Fleming 1829	-	1912	-	-
42	*Moelleria costulata* (Müller 1842)	×	1911	1902	-
43	*Margarites cinerea* (Couthouy 1839)	-	-	1902	-
44	*Margarites groenlandica* (Chemnitz 1781) .	×	1911	1902	1931
45	*Margarites helicina* (Phipps 1774)	×	1911	1902	-
46	*Acmaea rubella* (Fabricius 1780)	-	1911	1902	-
47	*Lepeta coeca* (Müller 1776)	×	1911	1902	1931
48	*Natica clausa* Brod. et Sow. 1829	×	1902	1902	-
49	*Lunatia pallida* (Brod. et Sow. 1829)	×	1948	1902	-
50	*Amauropsis islandica* (Gmelin 1783)	-	-	1902	-
51	*Velutina laevigata* (Linne 1767)	-	1912	-	-
52	*Lacuna pallida* (Donovan 1800)	-	-	1902	-
53	*Lacuna vincta* (Montagu 1803)	×	1948	-	-
54	*Littorina saxatilis* (Olivi 1792)	×	1903	-	-
55	*Littorina littorea* (Linne 1758)	×	1870	-	1870

No.	Tabular enumeration of all Mollusc species found as Quaternary fossils on Svalbard	Found by the authors	West coast of West-Spitsbergen	East coast of West-Spitsbergen with Barents Island and Edge Island	North coast of West-Spitsbergen
56	*Cingula castanea* (Müller 1842)	×	1911	-	-
57	*Cingula aculea* (Gould 1841)	×	1911	-	-
58	*Trichotropis borealis* Brod. et Sow. 1829	-	-	1902	-
59	*Neptunea despecta* (Linne 1758)	·	1948	-	-
60	*Neptunea fornicata* Gray 1839	-	-	1902	-
61	*Sipho islandicus* (Chemnitz 1780)	×	1948	-	-
62	*Sipho kroeyeri* (Müller 1842)	-	1912	1902	1929
63	*Sipho togatus* (Mörch 1869)	×	1948	-	-
64	*Pyrulofusus deformis* (Reeve 1847)	×	1925	-	-
65	*Buccinum ciliatum* (Fabribius 1780)	-	1902?	1902	-
66	*Buccinum glaciale* Linne 1761	×	1860	1902	1929
67	*Buccinum terrae-novae* Beck 1869	-	-	1902	-
68	*Buccinum groenlandicum* Chemnitz 1788	×	1902	1902	-
69	*Buccinum ovum* Midd	×	1948	1902	-
70	*Buccinum tenue* Gray 1839	×	1948	1902	-
71	*Buccinum undatum* Linne 1758	×	1948	-	-
72	*Trophon clathratus* (Linne 1767)	×	1903	1902	-
73	*Trophon truncatus* (Strøm 1767)	×	1931	-	-
74	*Columbella rosacea* (Gould 1840)	-	1930a	-	-
75	*Admeta viridula* (Fabricius 1780)	×	1948	1902	-
76	*Bela rugulata* (Müller) Troschel 1866	-	-	1902	-
77	*Bela exarata* (Müller 1842)	-	-	1902	-
78	*Bela impressa* Beck	-	-	1902	-
79	*Bela pyramidalis* (Strøm 1788)	-	-	1902	-
80	*Bela gigantea* (Mörch 1869)	-	-	1902	-
81	*Bela simplex* (Midd)	-	-	1902	-
82	*Bela woodina* (Müller)	-	-	1902	-
83	*Bela bicarinata* (Couthoy 1838)	-	1911	1902	-
84	*Cylichna alba* (Brown 1827)	-	-	1902	-

Literature.

Agardh, I. G. 1870 a. Om den Spetsbergska Drift-vedens ursprung. Övers. Kongl. Vet.-Akad. Forh. B. 26, No. 2. Stockholm 1870.

Andersson, G. 1910. Die jetzige und fossile Quartärflora Spitzbergens als Zeugniss von Klimaänderungen. Die Veränderungen des Klimas seit dem Maximum der letzten Eiszet. 11. Internat. Geologenkongress. Stockholm 1910.

Antevs 1928. Shell beds on the Skagerack. Geolog. För. Förh. B. 50. Stockholm 1928.

Baden-Powell, D. F. W. 1939. On further Collections of Quaternary Fossils from Spitsbergen. The Geolog. Mag. Vol. LXXVI, No. 7. London 1939.

Balchin, W. G. V. 1941. The raised Features of Billefjord and Sassenfjord, West-Spitsbergen. — The Geogr. Journ. Vol. XCVII, No. 6. London 1941.

Barðarson, Gudmundur G. 1921. Fossile Skalafleiringer ved Breidifjordur i Vest-Island. Geol. För. Förh. Bd. 43. Stockholm 1921.

Blomstrand, C. W. 1864. Geognostiska iakttagelser under en resa till Spetsbergen år 1861. Kongl. Svenska Vetenskaps-Akademiens Handlinger, Ny följd. Bd. 4, No 6. Stockholm 1864

Chydenius, K. 1865. Svenska expedisjonen till Spetsbergen år 1861 under ledning af Otto Torell, p. 141—142. Stockholm 1865.

Cöster, Fredrik 1925. Results of the Swedish Expedition to Spitzbergen in 1924, I. Quaternary Geology of the Region around the Kjellström Valley. — Geografiska Annaler. B. VII. Stockholm 1925.

Dautzenberg, Ph. et Fischer, H. 1912 a. Moll. provenant des camp de l'Hirondelle et de la Princesse Alice dans les Mers du Nord. Rés. Camp. Sci. Albert I de Monaco. Fasc. XXXVII. Monaco 1912.

De Geer, G. 1912. Excursion A 1, Spitzbergen. — Extrait du compte Rendu du XI:e Congrès Géologique Internationale. Stockholm 1912.

Elton, C. S. and Baden-Powell, D. F. W. 1931. On a Collection of Raised Beach Fossils from Spitsbergen. — The Geolog. Mag. Vol. 68. London 1931.

Engell, M. C. 1904. Undersøkelser og opmaalinger ved Jakobshavn isfjord og i Orpigsuit sommeren 1902. Meddelelser om Grønland. H. 26. Kjøbenhavn 1904.

— 1905. Eine nachtertiäre Wärmeperiode in Grönland. Petermans Mitteilungen 1905. H. 4.

Frebold, H. 1935. Geologie von Spitzbergen, der Bäreninsel, des König Karl- und Franz-Joseph-Landes. Berlin 1935.

Glen, A. R. 1934. The Oxford University Expedition to Spitsbergen, 1933. Geogr. Journ. Vol. 84. London 1934.

Grønlie, O. T. 1924. Contributions to the Quaternary Geology of Novaya Zemlya. — Rept. Sci. Results Norw. Exp. to Novaya Zemlya 1921. Norske Videnskapsakad. Nr. 21, Kristiania 1924.

Heer, Oswald 1870. Die miocene Flora und Fauna Spitzbergens. Mit einem Anhang über die diluvialen Ablagerungen Spitzbergens. Kongl. Sv. Vetenskaps.-Akad. Handl. B. 8, No. 7. Stockholm 1870.

Heintz, A. 1926. Blåskjell på Spitsbergen. — Norsk Geolog. Tidsskr. Vol. 9. No. 1. Oslo 1926.

Hessland, I. 1943. Marine Schalenablagerungen Nord-Bohusläns. — Bull. of Geolog. Instit. of Uppsala. Vol. XXXI. Uppsala 1943.

Hoel, A. 1910. Geologiske iakttagelser på Spitsbergenekspedisjonene 1906 og 1907. — Norsk Geolog. Tidsskr. B. 1. Kristiania 1910.

— 1914. Exploration du Nord-Quest du Spitzberg, entreprise sous les auspieces de S. A. S. le Prince de Monaco par la Mission Isachsen. Resultats des campagnes scientifiquees accomplies sur son yacht. Fasc. XLII Troisieme partie par A. Hoel. Monaco 1914.

Horn, G. and Orvin, A. K. 1928. Geology of Bear Island. Norges Svalbard- og Ishavs-Undersøkelser No. 15. Oslo 1928.

Högbom, B. 1911. Bidrag til Isfjordsområdets kvartärgeologi. Geolog. För. Förh. B. 33. Stockholm 1911.

— 1913. Om Spetsbergens Mytilustid. — Geolog. Förh. B. 35. Stockholm 1913.

Ingvarson, Fredrik 1910. Die Treibhölzer auf dem Ellesmere-Land. Rep. of the Sec. Norw. Arctic Exp. in the "Fram" 1898—1902. No. 24. Kristiania 1910.

Jensen, Ad. S. 1900. Studier over nordiske Mollusker. I Mya. — Vidensk. Medd. Naturhist. Foren. København 1900.

— 1909. On the Mollusca of East-Greenland. I. Lamellibranchiata. With an introduction on Greenlands fossil Mollusc-Fauna from the Quaternatry time. Medd. om Grønland, Bd. 29. København 1909.

— 1912 a. Results of the Ingolf Expedition. Lamellibranchiata. København 1912.

Jensen, Ad. S. 1942. Two new West Greenland Localities for Deposits from the Ice Age and the Post-Glacial warm Period. — Det Kgl. Danske Vid. Selsk. Biolog. Medd. B. XVII, No. 4. København 1942.

Jensen, Ad. S. and Harder, P. 1910. Post-Glacial changes of climate in Arctic Regions as revealed by investigations on marine deposits. Die Veränderungen des Klimas —. 11. Internat. Geologenkongress Stockholm 1910.

Jensen, Ad. S. og Spärck, R. 1934. Bløddyr II. Saltvandsmuslinger. Danmarks Fauna. København 1934.

Knipowitsch, N. 1902, 1903. Zoologische Ergebnisse der russischen Expeditionen nach Spitsbergen. Mollusca und Brachiopoda. II und III Annuaire du Musee Zoologique de l'Acad. Imp. d. Sc. St. Petersbourg. T. VII. 1902 und 1903.

Kulling, O. and Ahlmann, H. W. 1936. Observations on Raised Beaches and their Faunas. Surface Markings. Scientific Results of the Swedish-Norwegian Arctic Expedition in the Summer 1931. — Geogr. Annaler, B. XVIII. Stockholm 1936.

Lamplugh, G. W. 1911. On the Shelly Moraine of the Sefstrøm Glacier and other Spitsbergen phenomna illustrative of British Glacial Conditions. — Proceed. Yorkshire Geolog. Soc. New Ser. Vol. XVII. 1909—11. Leeds 1911.

Laursen, Dan. 1944. Contributions to the Quaternary geology of northern west Greenland especially the raised Marine Deposits. — De danske Nûgssuaq ekspeditioner 1938 og 1939. — Mus. de Min. et de Geolog. de l'Univer. de Copenhague. Com. Geolog. no. 23. København 1944.

Nansen, Fridtjov 1902. The Oceanography of the North Polar Basin. The Norwegian North Polar Expedition 1893—1896. Scientific Results, Vol. III, No. 3, p. 420. Oslo 1902.

Noe-Nygaard, A. 1932. Remarkh on Mytilus edulis L. in raised beaches in East-Greenland. Meddelelser om Grønland. Bd. 95. No. 2. København 1932.

Nordenskjöld, A. E. 1867. Sketch of the Geology of Spitsbergen. Stockholm 1867.

Nordmann, V. 1912. *Anomia squamala* L. som Kvartærfossil på Spitsbergen. Medd. fra Dansk Geolog. For. B. 4. København 1912.

Odhner, N. Hj. 1915. Zoologische Ergebnisse der Schwedischen Expedition nach Spitzbergen 1908. Teil II. Die Molluskenfauna des Eisfjordes. Kungl. Svenska Vetensk. Akad. Handl. B. 54. No. 1. Stockholm 1915.

Orvin, Anders K. 1934. Geology of the Kings Bay Region, Spitsbergen. — Norges Svalbard- og Ishavsundersøkelser. Skrifter nr. 57. Oslo 1934.

Peach, Aungus M'Ewen 1916. The Preglacial Platforms and Raised Beaches of Prince Charles Foreland. — Transactions of the Edinburgh. Geolog. Soc. Vol. X. Edinburgh 1916.

Sandford, K. S. 1929. The glacial conditions and Quaternary history of North-East Land. — The Geogr. Journal. Vol. 74. London 1929.

Schlesch, H. 1931 a. Studien über Mya-Arten. — Arch. für Molluskenkunde. Jahrg. LXIII, H. 4—5. Frankfurt a/M 1931.

Spärck, R. 1933. Contributions to the animal ecology of the Franz Joseph Fjord and adjacent East-Greenland waters. I—II. Medd. Om Grønland, Bd. 100, No. 1. København 1933.

Thorson, G. 1933. Investigations on shallow water animal communities in the Franz Joseph Fjord (East Greenland) and adjacent waters. Medd. om Grønland. B. 100. Nr. 2. København 1933.

— 1934. Contributions to the animal ecology of the Scoresby Sound fjord complex (East-Greenland) Hydrography by H. Ussing. Medd. om Grønland, Bd. 100, No. 3. København 1934.

Torell, O. 1859. Bidrag till Spitsbergens Molluskfauna. Stockholm 1859.
Vogt, Th. 1933. Late-Quaternary Oscillations of level in Southeast-Greenland. Skrifter om Svalbard og Ishavet No. 60. Oslo 1933.
Werenskiold, W. 1924. Høie strandlinjer på Spitsbergen. Norsk Geolog. Tidsskr. Bd. VII. Kristiania 1924.
Woodward, S. P. 1860 in Appendix to Lamont, James: Notes about Spitzbergen in 1859. — Quart. Journ. Geolog. Soc. London. Vol. 16. London 1860.
Wordie, J. M. 1921. Present-day conditions in Spitsbergen. The Geogr. Journ. 58. London 1921.

Printed February 1950.

Nr. 37. FREBOLD, H., *Fazielle Verh. des Mesozoikums im Eisfjordgebiet Spitzb.* 1931. Kr.8,75
„ 38. LYNGE, B., *Lichens from Franz Josef Land.* 1931. Kr. 3,00.
„ 39. HANSSEN, O. and J. LID, *Flowering Plants of Franz Josef Land.* 1932. Kr. 3.50.
„ 40. KIÆR, J. † and A. HEINTZ, *The Downtonian and Devonian Vertebrates of Spitsbergen.* V. Suborder *Cyathaspida.* 1935. Kr. 25,00.
„ 41. LYNGE, B. and P. F. SCHOLANDER, *Lichens from N. E. Greenland.* 1932. Kr. 9.50.
„ 42. HEINTZ, A., *Beitr. zur Kenntnis d. devonischen Fischfauna O.-Grönlands.* 1931. Kr.4.00.
„ 43—46. BJØRLYKKE, B., *Some Vascular Plants from South East Greenland. Collected on the "Heimen" Expedition in 1931. Preliminary Report.* LID, J., *Vascular Plants.* LYNGE, B., *Lichens.* OMANG, S. O. F., *Beiträge zur Hieraciumflora.* 1932. Kr. 4.00.
„ 47. LYNGE, B., *A Revision of the Genus Rhizocarpon in Greenland.* 1932. Kr. 2.00.
„ 48. VAAGE, J., *Vascular Plants from Eirik Raude's Land.* 1932 Kr. 7,00.
„ 49. SCHAANNING, H. THO. L., 1. *A Contribution to the Bird Fauna of East-Greenland.* 2. *A Contribution to the Bird Fauna of Jan Mayen. — Zool. Res. Norw. Sc. Exp. to East-Greenland. I.* 1933. Kr. 3,00.
„ 50. JELSTRUP, H. S., *Détermination astronomique de Mygg-Bukta au Groenland Oriental,* 1932. Kr. 3,75.
„ 51. BIRKELAND, B. J. et GEORG SCHOU, *Le climat de l'Eirik-Raudes-Land.* 1932. Kr. 2,00.
„ 52. KIÆR, J. †, *The Downtonian and Devonian Vertebr. of Spitsb.* IV. Suborder *Cyathaspida.* 1932. Kr. 5,50.
„ 53. 1. MALAISE, R., *Eine neue Blattwespe.* 2. A. ROMAN, *Schlupfwespen.* 3. O. RINGDAHL, *Tachiniden und Musciden.* 4. M. GOETGHEBUER, *Chironomides du Groenland oriental, du Svalbard et de la Terre de François Joseph. — Zool. Res. Norw. Sc. Exp. to East-Greenland. II.* 1933. Kr. 4,00.
„ 54. VARTDAL, H., *Bibliographie des ouvrages norvégiens relatifs au Grœnland (Y compris les ouvrages islandais antérieurs à l'an 1814).* 1935. Kr. 12,00.
„ 55. OMANG, S. O. F., *Übersicht über die Hieraciumflora Ost-Grönlands.* 1933. Kr. 2,50.
„ 56. DEVOLD, J. and P. F. SCHOLANDER, *Flowering Plants and Ferns of Southeast Greenland.* 1933. Kr. 20,00.
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„ 58. JELSTRUP, H. S., *Détermination astronomique à Sabine-Øya.* 1933. Kr. 2,50.
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„ 62. SCHOLANDER, P. F., *Vascular Plants from Northern Svalbard.* 1934. Kr. 15,00.
„ 63. RICHTER, S., *A Contr. to the Archæology of North-East Greenland.* 1934. Kr. 25,00.
„ 64. SOLLE, G., *Die devonischen Ostracoden Spitzbergens.* 1935. Kr. 5,50.
„ 65. 1. FRIESE, H., *Apiden.* 2. LINDBERG, H., *Hemiptera.* 3. LINNANIEMI, W. M., *Collembolen. Zool. Res. Norw. Sc. Exp. to East-Greenland. IV.* 1935. Kr. 2,50.
„ 66. 1. NORDENSTAM, Å., *The Isopoda.* 2. SCHELLENBERG, A., *Die Amphipoden.* 3. SIVERTSEN, E., *Crustacea Decapoda, Auphausidacea, and Mysidacea. Zool. Res. Norw. Sc. Exp. to East-Greenland. V.* 1935. Kr. 5,00.
„ 67. JAKHELLN, A., *Oceanographic Investigations in East Greenland Waters in the Summers of 1930—1932.* 1936. Kr. 7,00.
„ 68. FREBOLD, H. und E. STOLL, *Das Festungsprofil auf Spitzbergen.* III. *Stratigraphie und Fauna des Jura und der Unterkreide.* 1937. Kr. 5,50.
„ 69. FREBOLD, HANS, *Das Festungsprofil auf Spitzbergen.* IV. *Die Brachiopoden- und Lamellibranchiatenfauna des Oberkarbons und Unterperms.* 1937. Kr. 10,00.
„ 70. DAHL, EILIF, LYNGE, B., and P. F. SCHOLANDER, *Lichens from Southeast Greenland.* 1937. Kr. 4,50.
„ 71. 1. KNABEN, NILS, *Makrolepidopteren aus Nordostgrönland.* 2. BARCA, EMIL, *Mikrolepidopteren aus Nordostgrönland. Zool. Res. Norw. Sc. Exp. to East-Greenland. VI.* 1937. Kr. 3,50.
„ 72. HEINTZ, A., *Die Downtonischen und Devonischen Vertebraten von Spitzbergen. VI. Lunaspis-Arten aus dem Devon Spitzbergens.* 1937. Kr. 2,00.
„ 73. *Report on the Activities of Norges Svalbard- og Ishavs-undersøkelser 1927—1936.* 1937. Kr. 10,00.
„ 74. HØYGAARD, ARNE, *Some Investigations into the Physiology and Nosology of Eskimos from Angmagssalik in Greenland.* 1937. Kr. 1,50.
„ 75. DAHL, EILIF, *On the Vascular Plants of Eastern Svalbard.* 1937. Kr. 3,50.
„ 76. LYNGE, B., *Lichens from Jan Mayen.* 1939. Kr. 4,50.
„ 77. FREBOLD, HANS, *Das Festungsprofil auf Spitzbergen. V. Stratigraphie und Invertebratenfauna der älteren Eotrias.* 1939. Kr. 5,00.

Nr. 78. ORVIN, ANDERS K., *Outline of the Geological History of Spitsbergen.* 1940. Kr. 7.00.
„ 79. LYNGE, B., *Et bidrag til Spitsbergens lavflora.* 1940. Kr. 1,50.
„ 80. *The Place-Names of Svalbard.* 1942. Kr. 50,00.
„ 81. LYNGE, B., *Lichens from North East Greenland.* 1940. Kr. 14,00.

From No. 82 the title of these publications has been changed from *Skrifter om Svalbard og Ishavet* to *Norges Svalbard- og Ishavs-undersøkelser. Skrifter.*

„ 82. NILSSON, TAGE, *The Downtonian and Devonian Vertebrates of Spitsbergen. VII. Order Antiarchi.* 1941. Kr. 11.50.
„ 83. HØEG, OVE ARBO, *The Downt. and Devonian Flora of Spitsbergen.* 1942. Kr. 33.00.
„ 84. FREBOLD, HANS, *Über die Productiden des Brachiopodenkalkes.* 1942. Kr. 6,00.
„ 85. FØYN, SVEN and ANATOL HEINTZ, *The Downtonian and Devonian Vertebrates of Spitsbergen. VIII.* 1943. Kr. 5,00.
„ 86. *The Survey of Bjørnøya (Bear Island) 1922—1931.* Kr. 9,00.
„ 87. HADAČ, EMIL, *Die Gefäßpflanzen des „Sassengebietes" Vestspitsbergen.* Kr. 6.00.
„ 88. *Report on the Activities of Norges Svalbard- og Ishavs-undersøkelser 1936—1944.* Kr. 6,50.
„ 89. ORVIN, ANDERS K., *Bibliography of Literature about the Geology, Physical Geography, Useful Minerals, and Mining of Svalbard.* Kr. 12,00.
„ 90. HENIE, HANS, *Astronomical Observations on Hopen.* Kr. 3.00.
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„ 94. FEYLING-HANSSEN, ROLF W. and JØRSTAD, FINN A., *Quaternary Fossils.* Kr. 8,25.

MAPS AND CHARTS

The following topographical maps and charts have been published separately:

Maps:

Bjørnøya. 1:25 000. 1925. New edition 1944. Kr. 3,00.
Bjørnøya. 1:10 000. [In six sheets.] 1925. Kr. 30,00.
Adventfjorden—Braganzavågen. 1:100 000. 1941. Kr. 2.00.
Svalbard. 1:2 000 000. 1937. New edition 1944. Kr. 1,00.
Topografisk kart over Svalbard. Blad C 13. Sørkapp. 1:100 000. 1947. Kr. 3,00.
Topografisk kart over Svalbard. Blad B 10. Van Mijenfjorden 1:100 000. 1948. Kr. 3,00.
Austgrønland. Eirik Raudes Land frå Sofiasund til Youngsund. 1:200 000. 1932. Kr. 2,00.

Preliminary topographical maps [1:50 000] covering claims to land in Svalbard may be obtained separately.

Charts:

No. 501. Bjørnøya. 1:40 000. 1932. Kr. 4,00.
„ 502. Bjørnøyfarvatnet. 1:350 000. 1937. Kr. 4,00.
„ 503. Frå Bellsund til Forlandsrevet med Isfjorden. 1:200 000. 1932. Kr. 5,00.
„ 504. Frå Sørkapp til Bellsund. 1:200 000. 1938. Kr. 5,00.
„ 505. Norge—Svalbard, nordre blad. 1:750000. 1933. Kr. 4,00.
„ 506. Norge—Svalbard, søre blad. 1:750 000. 1933. Kr. 4,00.
„ 507. Nordsvalbard. 1:600000. 1934. Kr. 4,00.
„ 508. Kongsfjorden og Krossfjorden. 1:100 000. 1934. Kr. 4,00.
„ 509. Frå Storfjordrenna til Forlandsrevet med Isfjorden. 1:350 000. 1946. Kr. 4,00.
„ 510. Frå Kapp Linné med Isfjorden til Sorgfjorden. 1:350 000. 1946. Kr. 4,00.
„ 511. Austgrønland, frå Liverpoolkysten til Store Koldeweyøya. 1:600000. 1937. Kr. 4,00.

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