THE LUNDERGÅRD CLAY OF VENDSYSSEL, DENMARK, AND ITS FORAMINIFERA

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KNUDSEN, K. L.: The Lundergård Clay of Vendsyssel, Denmark, and its foraminifera. *Bull. geol. Soc. Denmark,* vol. 22, pp. 155–192. Copenhagen, November, 12th 1973.

Samples from five short borings in Lundergård mose, Vendsyssel, have been analyzed for their foraminifera content. The marine Quaternary deposits of borings I, II and III consist mainly of clay, here called the Lundergård Clay. It contains a characteristic foraminifera fauna with *Elphidium excavatum,* forma *clavata* and *Cassidulina crassa* as the dominant species and *Quinqueloculina stalkeri* and *Elphidium ustulatum* as characteristic species. The fauna is arctic and belongs to an interstadial rather than an interglacial environment. The fauna is compared with assemblages from other marine Quaternary deposits from Vendsyssel and from adjacent areas, and the age of the Lundergård Clay is discussed. It may represent either a hitherto unknown facies of the Older *Yoldia* Clay of Vendsyssel, which is supposed to be of Weichselian interstadial age, or it may be older and correlatable with the Holderness Basement Till of Saale interstadial age.

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Lundergård mose (mose = moor), which covers an area of about 10 km², is situated in the western part of Vendsyssel (fig. 1). It is surrounded by glacigenic deposits to the north and east, and by aeolian sands to the south and west. The flat moor area and the glacigenic highland are partly separated by a chalk ridge extending NNW-SSE (fig. 2).

Marine Quaternary deposits at Lundergård were first described by Jessen in 1899, and referred by him to the Older *Yoldia* Clay of Vendsyssel. The purpose of the present study has been to investigate the content of foraminifera in these deposits, and on the basis of the assemblages to attempt an ecological and stratigraphical interpretation. Foraminifera assemblages from other marine Quaternary deposits of Vendsyssel have been described and discussed by Feyling-Hanssen et al. (1971).

The material for the investigation was provided by 5 short borings in Lundergård mose. The borings were carried out with a 54 mm piston sampler equipped with a motor tripod with drop hammer and hydraulic rod puller.

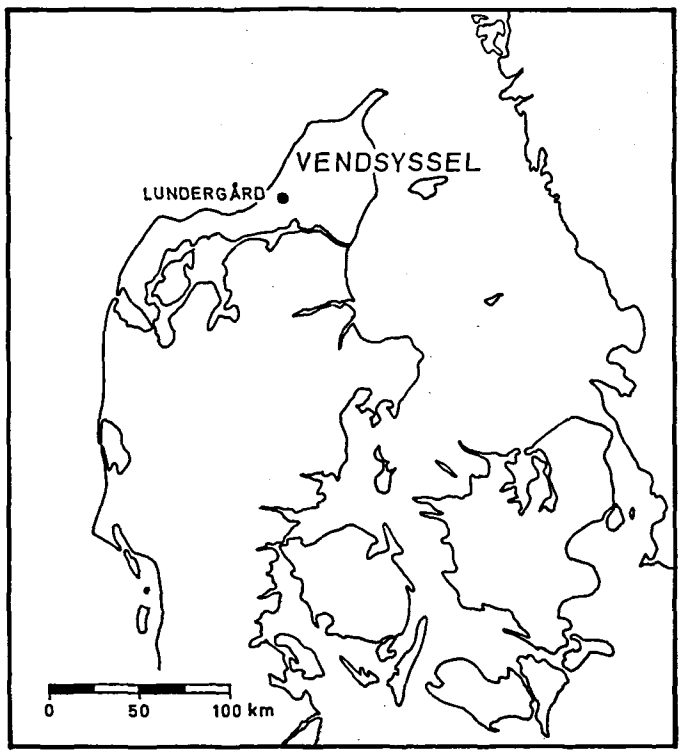

Fig. 1. Location of Lundergård, Vendsyssel, Denmark.

Almost continuous sampling was obtained with a series of cores in 40 cm or 80 cm long tubes. Occasionally there was a lack of material in the sediment sequence between the cores, and usually the layers within the tubes turned out to be slightly compressed. In the diagrams (figs. 5, 6 and 7) the bottom of each core is marked at the correct level, and the core is added on the top of this regardless of any possible compression.

For the foraminifera analysis samples of about 5 cm length (100–200 g dry weight), and with a distance between them of 0.2–1.0 m were treated in the laboratory following the procedure described by Hilterman (1958) and Feyling-Hanssen (1958 and 1964) except that most samples were disintegrated by boiling with liquid detergent instead of treatment with hydrogen peroxide (H_2O_2). The latter treatment may cause surface corrosion of the foraminiferal tests. The samples were washed through two sieves having mesh diameters of 0.1 and 1.0 mm, and foraminifera in the size fraction 0.1–1.0 mm were concentrated by the heavy liquid carbon tetrachloride (CCl_4). It was attempted to count at least 300 specimens of foraminifera from each sample. In poor samples the entire content was counted, and in rich ones the total

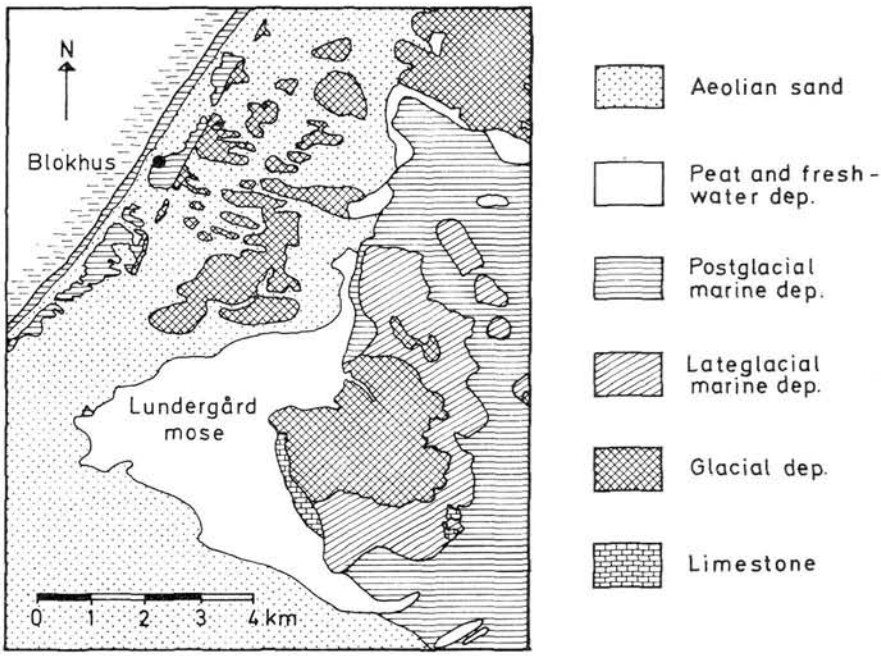

Fig. 2. Geological map of the Lundergård area (After Jessen, 1899).

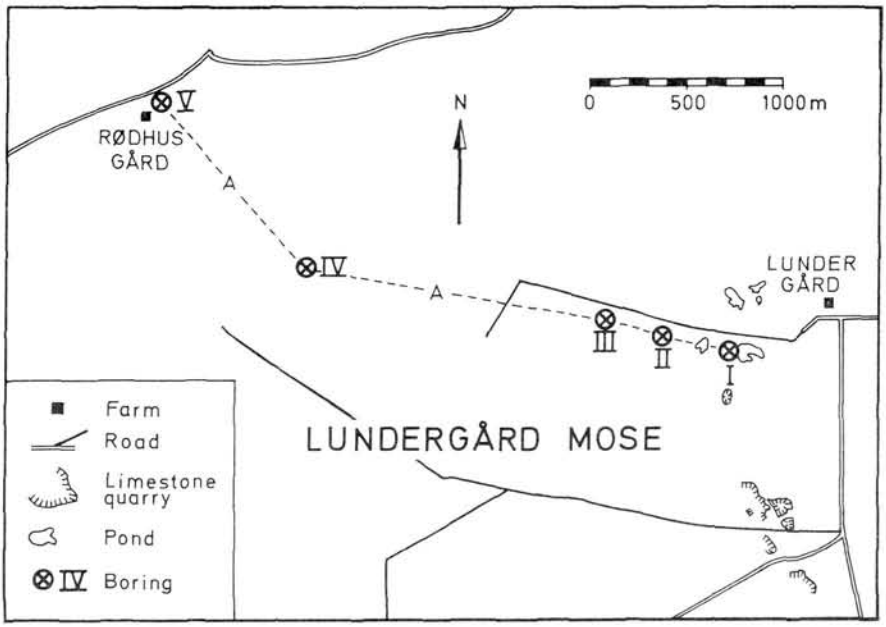

Fig. 3. Location of the five borings in Lundergård mose.

populations were estimated by extrapolation (Phleger, 1960). Results of these quantitative analyses are entered into range charts in which the frequency of selected taxa of foraminifera are illustrated by symbols (fig. 4).

The present assemblages from Lundergård represent thanatocoenoses which might have accumulated over a period of time, consisting partly of allochthonous, partly of autochthonous material. Some of the tests may even have been destroyed by transport or after sedimentation. Thus, as pointed out by Murray (1968), such a palaeothanatocoenosis will most probably

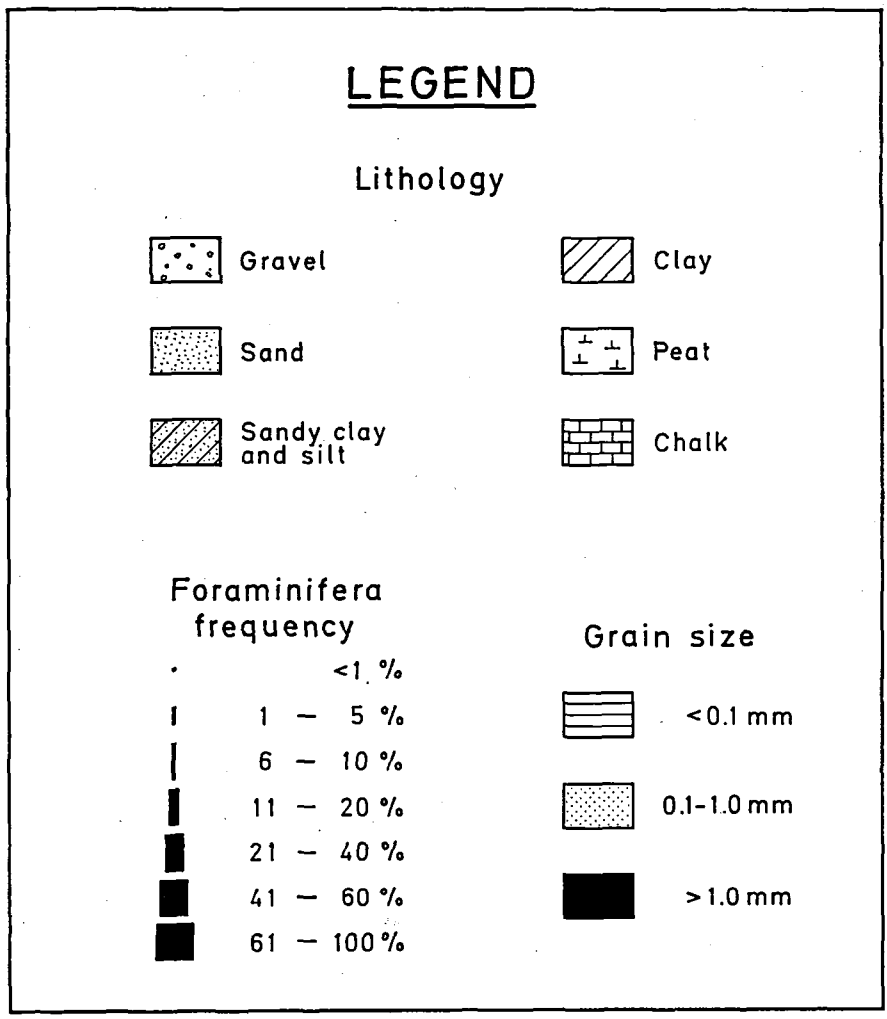

Fig. 4. Symbols used in the range charts.

differ from the assemblage originally inhabiting the biotope. Walton's (1964) faunal diversity, which he defined as the number of ranked species in a counted assemblage, whose cumulative percentage accounts for 95 % of the total fauna, is therefore used as an aid in interpreting the environment of the present deposits. This measure omits the sporadic occurrences of species, whereas e.g. the diversity fields, which Murray used on recent faunas (Murray, 1968, 1969, 1970) attach greater importance to the total number of species.

Faunal diversity according to Walton (1964), number of species per sample, number of specimens per 100 g sediment are shown in the diagrams.

The Borings

The localities of the borings in Lundergård mose are indicated on the map, fig. 3. Foraminifera assemblages are described for the borings I, II and III in the eastern part of Lundergård mose and for boring V, which is situated at its western margin. Some of the borings penetrated the Quaternary deposits and reached the surface of the White Chalk below.

Boring I

Boring I (fig. 3) is 9.6 m deep, and 24 samples were analysed from the interval between 1.4 m below and 6.9 m above sea-level. The bore site is 8 m above sea-level. The deepest sample, which is from the chalk, contains foraminifera from the Maastrichtian and is not discussed further.

Lithology and grain size distribution for the samples 2–24 are shown in fig. 5. The lowermost part of the Quaternary sequence in boring I consists of silt and clayey silt, followed by olive-grey clay. A more sandy interval between 1.0 m and 2.3 m above sea-level is composed of coarse sand in the middle part grading into finer sand and silt in the lower and upper parts. The uppermost part of the boring mainly consists of olive-grey clay with a few thin layers of silt and sand and scattered pebbles (diameter up to 0.5 cm).

The percentage distribution of 26 selected taxa of foraminifera is shown in the range chart, fig. 5. *Elphidium excavatum,* forma *clavata* and *Cassidulina crassa* are the dominant species in most of the samples with a percentage of 50–80 % and 10–15 % respectively. The accessory species *Quinqueloculina stalkeri, Bulimina marginata, Bolivina* cf. *robusta, Elphidium albiumbilicatum, E. asklundi, E. incertum, E. ustulatum* and *Protelphidium orbiculare* are found in nearly all the samples, and *Virgulina loeblichi, Cassidulina laevigata, Islandiella norcrossi, I. teretis, Buccella frigida, Nonion labradoricum* and *Elphidium magellanicum* occur in a number of samples.

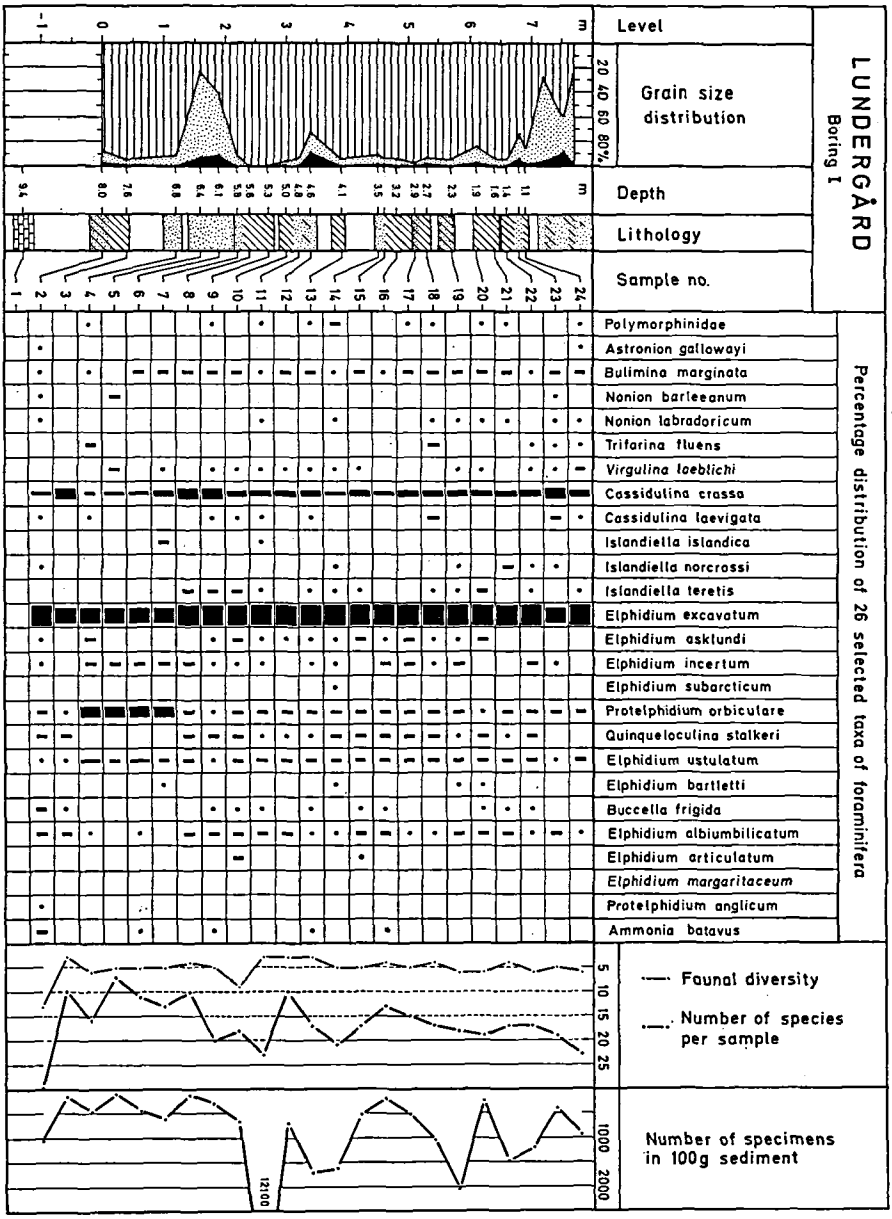

Fig. 5. Range chart for boring I, Lundergård.

Quinqueloculina stalkeri and *Elphidium ustulatum* seem to be the most characteristic accessory species. *Q. stalkeri* accounts for up to 2 % of the total fauna, and *E. ustulatum* usually accounts for up to 3 %, with a maximum of 9 %. The number of specimens is normally between 300 and 1500 per 100 g sediment and the number of species varies from 7 to 30. The faunal diversity usually ranges between 3 and 6 with a maximum of 13.

The assemblages from the Quaternary sequence of boring I belong in an arctic environment, but the lowermost sample (no. 2) contains a boreal element, viz. *Ammonia batavus* accounting for 2 % of the fauna, and in lesser number *Virgulina fusiformis, Nonion barleeanum, Elphidium gerthi* and *Protelphidium anglicum.* Some specimens of *Elphidium excavatum* belong to forma *selseyensis,* which usually occurs in boreal waters (Feyling-Hanssen, 1972).

Elphidium excavatum and *Protelphidium orbiculare* are the dominant species in the sandy part of boring I (samples 4–7). *P. orbiculare* accounts for 24–35 % of the fauna, *Cassidulina crassa* only for 4–11 %. The percentage of *Elphidium ustulatum* is 3–9, but *Quinqueloculina stalkeri* is not present in these samples. *Elphidium incertum* is more frequent than in the clayey part of the boring.

Borings II and III

Boring II is situated about 350 m, and boring III about 700 m, west of boring I. The exact positions are indicated on the map, fig. 3. Boring II is 9.2 m and boring III is 7.4 m deep, and the ground surface at the bore sites lies 8 m above sea level.

The sediment of these two borings consists of hard olive-grey clay, with a few thin layers of silt and sand and scattered pebbles; the upper and lower part of the borings are more sandy. The sand sequence of boring I is not found in boring III. It may be present in boring II where it has not been possible to obtain cores in the interval from 0.4 m below to 3.2 m above sea level. It is sometimes rather difficult to obtain good cores in sandy deposits with the present boring equipment.

Lithology, grain size distribution and percentage distribution of 26 selected taxa of foraminifera in borings II and III are shown in fig. 6. The assemblages are equivalent to those recorded from the clayey parts of boring I. *Elphidium excavatum,* forma *clavata* is the dominant species (60–80 %), *Cassidulina crassa* is second in number (10–25 %), and the most characteristic of the accessory species are *Elphidium ustulatum* (max. 3 %) and *Quinqueloculina stalkeri* (max. 4 %).

The boreal element of the fauna described from the lower part of boring I is not seen in boring III, but the lowermost samples from boring II con-

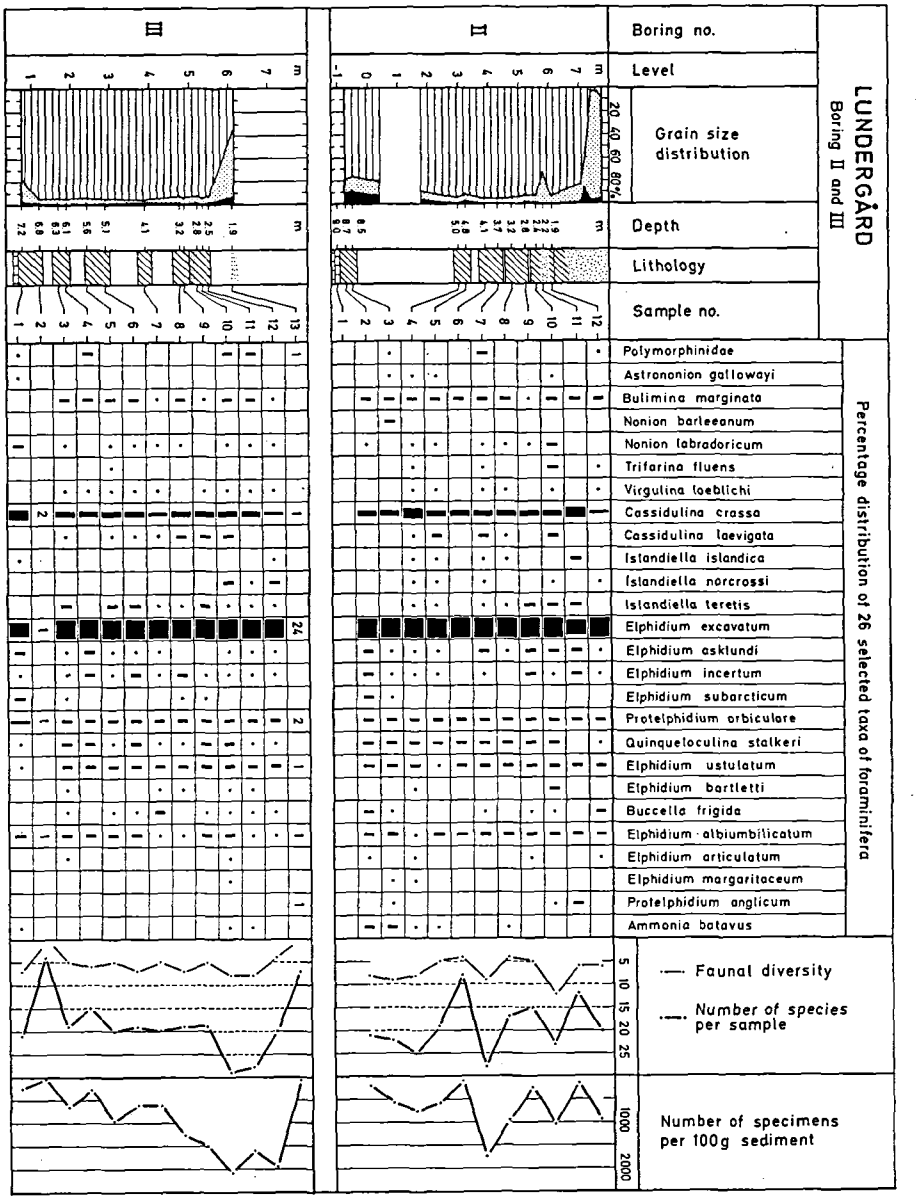

Fig. 6. Range chart for borings II and III, Lundergård.

tains scattered specimens of the boreal species *Ammonia batavus, Virgulina fusiformis, Nonion barleeanum, Elphidium gerthi, E. articulatum, E. margaritaceum* and *Protelphidium anglicum.*

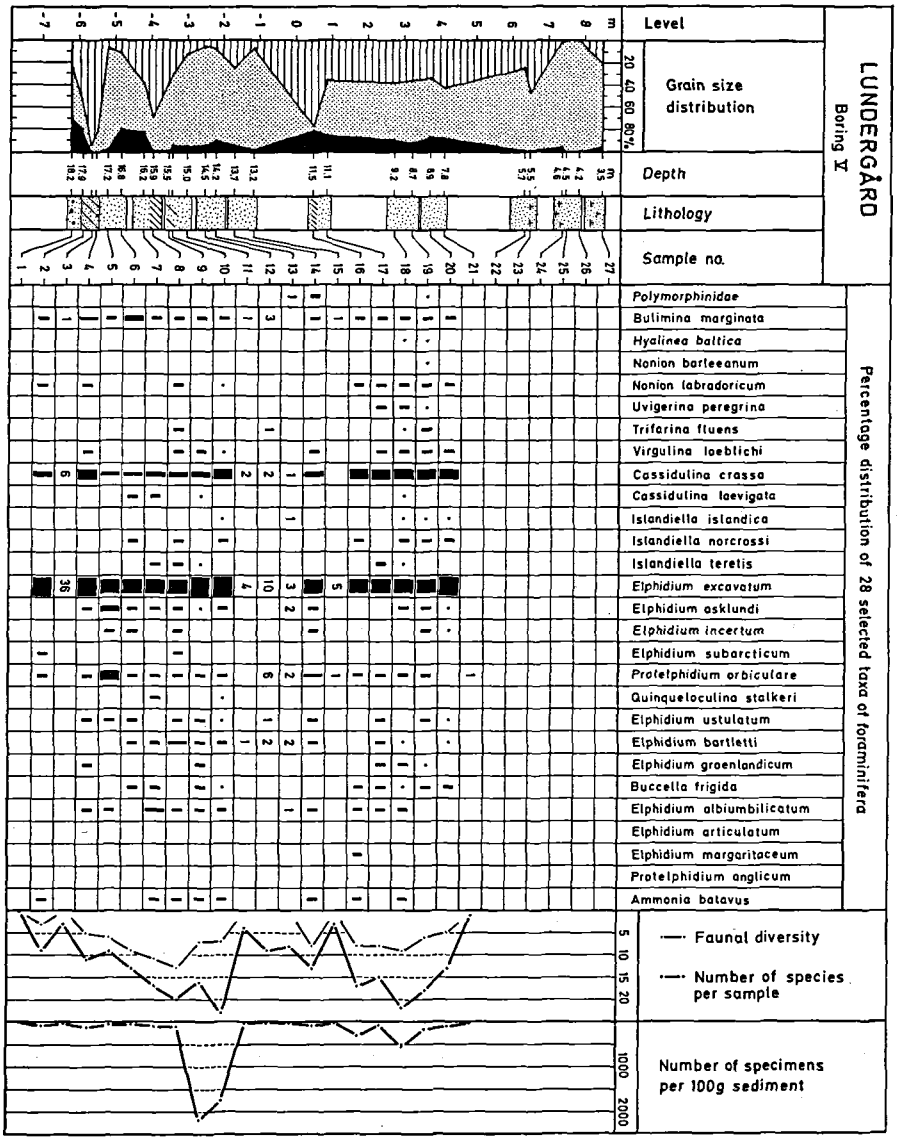

Fig. 7. Range chart for boring V, Lundergård.

Boring V

The 18.3 m deep boring V is located at the western margin of Lundergård mose, 12 m above sea level (fig. 3). The boring did not reach the chalk but in a neighbouring well the chalk surface occurs at 18 m depth, and it is therefore supposed, that practically the whole Quaternary sequence at this locality is represented in boring V.

The lithology and grain size distribution are shown in fig. 7. The sediment from the lower 12.5 m of boring V is mainly coarse sand with scattered pebbles and a few intercalations of fine sand, silt and clay; the lowermost 20 cm is composed of very coarse sand and gravel with some larger stones (diameter 3–5 cm). The upper 5.5 m of the boring consists of alternating layers of well-sorted sand and peat without marine fossils.

The distribution of 33 selected taxa of foraminifera from the lower part of boring V is shown in fig. 7. *Elphidium excavatum,* forma *clavata* and *Cassidulina crassa* are the dominant species, and the most common accessory species are *Protelphidium orbiculare, Bulimina marginata, Elphidium albiumbilicatum, E. asklundi* and *E. bartletti. Elphidium ustulatum,* which is one of the characteristic species in the assemblages of borings I, II and III, is represented also in most of the fossiliferous samples of boring V, but only a few specimens of *Quinqueloculina stalkeri* are found in this boring.

The number of species, the faunal diversity and the number of specimens are shown to the right of fig. 7. The number of specimens is on the whole very low, less than 300 per 100 g sediment, and therefore the percentage indications are rather uncertain for boring V.

Lundergård Clay

Description and ecology

In the borings I, II and III at Lundergård, an olive-grey marine clay with a few intercalation of sand and silt layers is found. This deposit overlies Maastrichtian chalk, and its greatest thickness is 7.1 m in boring I. The marine clay contains a characteristic foraminifera assemblage, and it is here called Lundergård Clay. Its type locality is Lundergård with boring I as type profile.

The dominant species in Lundergård Clay is *Elphidium excavatum,* forma *clavata,* which accounts for about 50–80 % of the total fauna. *Cassidulina crassa* is second in number with a percentage of between 10 and 25 %. The most frequent accessory species are, in systematic succession, *Quinqueloculina stalkeri, Bulimina marginata, Bolivina* cf. *robusta, Elphidium albiumbilicatum, E. asklundi, E. incertum, E. ustulatum* and *Protelphidium orbiculare,* and the most characteristic species in the Lundergård Clay are *Quinqueloculina stalkeri* and *Elphidium ustulatum,* each accounting for up to 2–3 % of the total fauna. The faunal diversity ranges from 3 to 13, usually between 4 and 8, and the number of specimens varies between 300 and 1500, with a maximum of 12,100 per 100 g sediment. An assemblage from Lundergård Clay is shown in plate 9, fig. 1.

The high frequency of *Elphidium excavatum*, forma *clavata* and *Cassidulina crassa* in Lundergård Clay indicates arctic environment, but a few of the accessory species are more frequent in recent boreal waters, e.g., *Bulimina marginata* and *Bolivina* cf. *robusta.* The presence of species such as *Nonion labradoricum, Bulimina marginata* and *Bolivina* cf. *robusta* together with a rather high frequency of *Cassidulina crassa* indicates a water depth of more than 20 m. *Quinqueloculina stalkeri* is a common species in recent arctic faunas (Loeblich & Tappan, 1953; Todd & Low, 1967; Gupta, 1971). *Elphidium ustulatum* is not recorded in recent faunas.

The lowermost sample from the Lundergård Clay of boring I and the two deepest samples of boring II contain more boreal species in the fauna, as specimens of *Ammonia batavus, Protelphidium anglicum, Virgulina fusiformis, Nonion barleeanum, Elphidium gerthi, E. articulatum* and *E. margaritaceum* occur scattered in these samples. In addition some specimens of *Elphidium excavatum* belong to forma *selseyensis* which usually occurs in boreal waters. A corresponding boreal element is not found in the faunas of boring III.

Elphidium excavatum, forma *clavata* is still the dominant species in the sandy sequence of boring I, where it accounts for 48–58 % of the fauna. *Protelphidium orbiculare* is second in number with 24–35 % of the total fauna, whereas *Cassidulina crassa* only accounts for 4–11 %. A few specimens of *Bulimina marginata* and *Bolivina* cf. *robusta* occur, but *Nonion labradoricum* is not present in these samples. The characteristic accessory species *Elphidium ustulatum* accounts for 3–9 % of the fauna, but *Quinqueloculina stalkeri* is not found in the sandy sequence. A high frequency of the shallow-water species *Protelphidium orbiculare* together with a rather low frequency of the more marine species *Cassidulina crassa* and the absence of *Nonion labradoricum* indicate a water depth of less than 20 m. This shallow-water facies of the Lundergård Clay is not found in boring III, but may be present in boring II, where it was not possible to obtain a continuous series of cores (p. 161).

Samples have also been collected from two old brickworks east and west of boring I (the old pits, fig. 3). This clay contains small fragments of molluscs and foraminifera assemblages equivalent to those described from the Lundergård Clay. One of these surface samples from the clay pit between borings I and II contains the following assemblage:

Lundergård, surface sample. Coll. K. L. Knudsen, 1970.

Species	Frequency	Percentage
Elphidium excavatum	295	75
Cassidulina crassa	44	11
Protelphidium orbiculare	10	3
Elphidium ustulatum	9	2
Bulimina marginata	6	2
Nonion labradoricum	5	1
Quinqueloculina stalkeri	4	1
Bolivina cf. *robusta*	4	1
Fissurina laevigata	3	1
Cassidulina laevigata	3	1
Virgulina loeblichi	2	1
Guttulina lactea	1	< 1
Fissurina marginata	1	< 1
Islandiella islandica	1	< 1
Islandiella teretis	1	< 1
Buccella frigida	1	< 1
Elphidium albiumbilicatum	1	< 1
Elphidium bartletti	1	< 1
Elphidium magellanicum	1	< 1
Ammonia batavus	1	< 1
Total	394	

The sample weighed 100 g and the count represent 1/5 of the assemblage. The number of species is 20 and the faunal diversity 7.

A few smaller borings were carried out in the vicinity of borings I, II and III to determine the extent of the Lundergård Clay. About 350 m east of boring I only unfossiliferous sand was found and some borings about 300 m north of boring I contained almost unfossiliferous sand and gravel. An old gravel pit (fig. 3) situated north of boring I, according to information from local people, contained sand down to a depth of 30 m. The chalk outcrops 200 m south of boring I, and in a canal 100 m south of boring II a vertical contact is seen between chalk to the south and Lundergård Clay to the north. These two deposits are covered by a 1 m thick deposit of horizontally stratified sand, sandy peat and peat. The Lundergård Clay is found in boring III, but was not present in boring IV, about 1500 m farther to the west.

The extension of the Lundergård Clay thus seems to be rather limited in the area. It may be regarded as a westerly extension of the glacigenic highland which occurs east of Lundergård mose.

The lower part of boring IV (figs. 3 and 8) contains a poor arctic fauna.

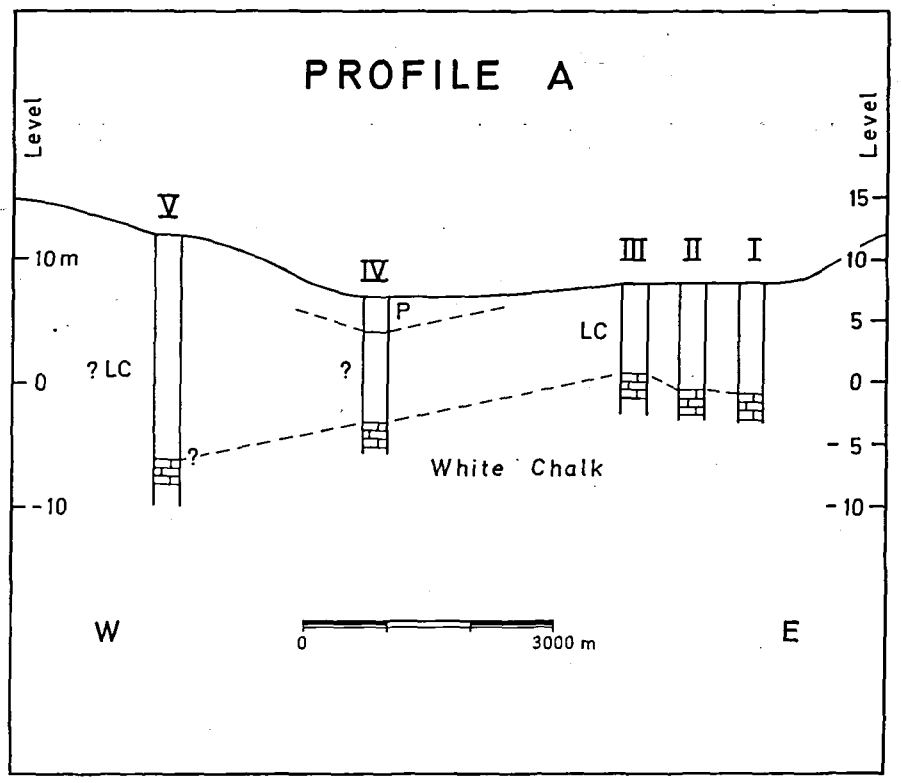

Fig. 8. Profile through the five borings at Lundergård.
LC = Lundergård Clay, P = Postglacial deposits.

The two species *Quinqueloculina stalkeri* and *Elphidium ustulatum,* characteristic of the Lundergård Clay are not found.

The deposits of boring V, farther to the west, contain rather poor arctic assemblages, often characterized by large, robust forms (Pl. 9, fig. 2). *Elphidium ustulatum* occurs in most of the fossiliferous samples from that boring, whereas only a few specimens of *Quinqueloculina stalkeri* are found. The deposits may be regarded as a sandy facies of Lundergård Clay equivalent to the sand sequence of boring I. The fauna is arctic, but contains a boreal element. The accessory species *Bulimina marginata* and *Nonion labradoricum* would normally not indicate very shallow water, unlike the presence of the shallow-water species *Protelphidium orbiculare, Elphidium albiumbilicatum, E. bartletti* and *Buccella frigida.* However, the percentage indications for assemblages from these deposits are rather uncertain because of the low number of specimens per sample.

Correlation

In order to attempt an age determination of the Lundergård Clay comparisons with faunas from different units of other Quaternary deposits in Vendsyssel and from adjacent areas has been made.

The clay deposit at Lundergård was described by Jessen in 1899 (p. 30) and referred by him to the Older *Yoldia* Clay. Jessen did not mention this deposit later, and it seems that it became deleted from his list of Older *Yoldia* Clay occurrences. Thus, in 1918 and 1936 he states that the Older *Yoldia* Clay is restricted to the northern and eastern part of Vendsyssel, and that it is not found in situ (1936) in the southwestern part. The Older *Yoldia* Clay was not found in the Ålborg and the Nibe area (Jessen, 1905, p. 75), and as the Lateglacial Younger *Yoldia* Clay occurs at several places south of Lundergård Mose (Jessen, 1905, p. 99) 2–3 m above sea-level, it might seem possible that Jessen also included the marine clay at Lundergård in the Younger *Yoldia* Clay, even though it is not mentioned.

If Jessen really meant to change his opinion about the age of the clay at Lundergård, and refer it to the Younger *Yoldia* Clay, it would seem natural for him to mention this. Another possibility is that Jessen became uncertain about the stratigraphic position of the clay, probably because of the rather long distance to other localities with Older *Yoldia* Clay, and therefore omitted to mention the locality of Lundergård.

Many of the foraminifera species are the same as described from Lateglacial *Zirfaea* layers and Younger *Yoldia* Clay, from interstadial Older *Yoldia* Clay of Vendsyssel (Andersen, 1971; Jørgensen, 1971; Knudsen, 1971) and interstadial Sandnes Clay of Jæren (Feyling-Hanssen, 1971). However, a corresponding distribution of species is not found in any of these deposits. *Elphidium ustulatum* is not known from Lateglacial deposits, but a single specimen was found in zone F of the Older *Yoldia* Clay at Hirtshals (Andersen, 1971), and three specimens occurred in the Sandnes Clay (Feyling-Hanssen, 1971). Only very few specimens of *Quinqueloculina stalkeri* are found in Lateglacial deposits and Older *Yoldia* Clay of Vendsyssel and in Sandnes Clay of Jæren.

An examination of foraminifera left by the late Dr. Nørvang from the Skærumhede sequence shows that *E. ustulatum* is not present in the *Portlandia arctica* Zone, or in the *Abra nitida* Zone, the *Turritella terebra* Zone or the lower cold zone (Feyling-Hanssen et al., 1971, p. 293). A single specimen of a form very close to *Quinqueloculina stalkeri* occurs in a sample from the *Turritella terebra* Zone. The material is, however, rather inadequate and probably not representative for the faunas as small specimens of foraminifera seem to be underrepresented.

The assemblages of Lundergård Clay indicate a colder climate than the

faunas from Eemian deposits at Stensigmose (Konradi, in press), in Schleswig-Holstein (Lafrenz, 1963) and in the Netherlands (van Voorthuysen, 1957). Mangerud (1970) described a deposit from Fjøsanger near Bergen, which on the basis of pollen was referred to Eemian. An analysis of the foraminifera fauna in these deposits (carried out by Feyling-Hanssen) seems to indicate a rather cold climate. The fauna seems close to the Sandnes Clay (Feyling-Hanssen, pers. communication) and may thus be of Weichselian Interstadial age. *Quinqueloculina stalkeri* and *Elphidium ustulatum* are not present in the assemblage from Fjøsanger.

Buch (1955) described the foraminifera from marine Quaternary deposits in a boring at Inder Bjergum, SW Jutland. These deposits are supposed to be of Holsteinian age. The sequence consists of a lower zone with foraminifera indicating arctic environment, and an upper one indicating milder climate. For camparison A. Buch kindly handed over a sample from each of these zones. The sample from the lower cold zone contains the following foraminifera:

Inder Bjergum, bor. 2, no. 22, 62.23 m below sea-level

Species	Frequency	Percentage
Elphidium excavatum	330	76
Cassidulina crassa	59	14
Protelphidium orbiculare	19	4
Elphidium albiumbilicatum	9	2
Ammonia batavus	5	1
Quinqueloculina stalkeri	2	< 1
Elphidium subarcticum	2	< 1
Polymorphinidae	1	< 1
Bulimina fossa	1	< 1
Islandiella islandica	1	< 1
Epistominella vitrea	1	< 1
Asterigerina gürichi gürichi	1	< 1
Cibicides lobatulus	1	< 1
Elphidium bartletti	1	< 1
Elphidium magellanicum	1	< 1
Indeterminate species	1	< 1
Total	435	

The whole sample (50 g) was analysed. The number of species is 15 and the faunal diversity 5. This fauna shows that the environment was much like that prevailing during deposition of the Lundergård Clay. Many of the

species are the same and their distribution is very similar. Two specimens of *Quinqueloculina stalkeri* are found in the sample from Inder Bjergum, but *Elphidium ustulatum* is not present. *Q. stalkeri* is also present in some samples from the clay of Esbjerg brickworks which is supposed to be of Holsteinian age; in a single sample it even accounts for 10 % of the total fauna. *Elphidium ustulatum* is, however, not found in these samples.

A sample from the upper zone of the marine Holsteinian deposits at Inder Bjergum contains the following assemblage:

Inder Bjergum, bor. 2, no. 14, 31.48 m below sea-level

Species	Frequency	Percentage
Elphidium excavatum	371	92
Ammonia batavus	26	6
Bulimina marginata	4	1
Bulimina sp.	2	< 1
Elphidium magellanicum	1	< 1
Total	404	

The sample weight 35 g and 1/4 of its foraminiferal content was counted. The number of species is 5 and the faunal diversity 2. A number of specimens of *Elphidium excavatum* belongs to forma *selseyensis*. The low faunal diversity indicates extreme ecological conditions, but the fauna shows a higher temperature than indicated by the assemblages of the Lundergård Clay, and the two species *Quinqueloculina stalkeri* and *Elphidium ustulatum* are not present.

Foraminifera assemblages from *Tellina* Clay in the Coast Cliff of Røgle, Funen, which is also supposed to be of Holsteinian age, indicate a milder climate than the faunas from Lundergård Clay, and *Quinqueloculina stalkeri* and *Elphidium ustulatum* do not occur in the examined samples from this deposit.

For comparison, Prof. B. Funnell kindly sent two samples from Inner Silver Pit in the western part of the North Sea. Foraminifera and pollen from this deposit, described by Fisher et al. (1969), are supposed to be of Holsteinian age. One sixth of a sample weighing 11 g contained an assemblage as follows:

Inner Silver Pit, sample no. 16.

Species	Frequency	Percentage
Elphidium excavatum	184	45
Bulimina marginata	117	28
Cassidulina laevigata	72	17
Epistominella takayanagii	10	2
Nonion barleeanum	7	2
Cassidulina crassa	5	1
Ammonia batavus	4	1
Quinqueloculina stalkeri	2	< 1
Lagena distoma	2	< 1
Fissurina laevigata	2	< 1
Bolivina albatrossi	2	< 1
Sigmoilopsis schlumbergeri	1	< 1
Lagena laevis	1	< 1
Lagena striata, f. *typica*	1	< 1
Oolina hexagona	1	< 1
Virgulina fusiformis	1	< 1
Bolivina alata	1	< 1
Total	413	

This assemblage indicates deeper water and higher temperature than the faunas of Lundergård Clay. A few specimens of *Quinqueloculina stalkeri* occur, but *Elphidium ustulatum* is absent. Sample no. 13 from Inner Silver Pit indicates shallower water and lower temperature than sample no. 16. It contains the following foraminifera:

Inner Silver Pit, sample no. 13.

Species	Frequency	Percentage
Quinqueloculina stalkeri	179	84
Cassidulina crassa	21	10
Elphidium excavatum	7	3
Elphidium magellanicum	3	1
Islandiella islandica	1	< 1
Epistominella sp.	1	< 1
Indeterminate species	2	1
Total	214	

The whole sample (15 g) was analysed. This fauna cannot be correlated with any assemblage from the Lundergård Clay. *Quinqueloculina stalkeri* is much more frequent, and *Elphidium ustulatum* not present at all in the fauna. It seems as if *Quinqueloculina stalkeri* is a common species in the

Holsteinian, whereas *Elphidium ustulatum* is not found in these deposits in Northwest Europe.

Feyling-Hanssen (1971) published an analysis of the foraminifera fauna in a sample from Holderness Basement Till, Yorkshire. The age of that deposit is discussed by Catt and Penny (1966), and considered to be of Saale Interstadial age. One fifth of a 100 g sample contained the following assemblage (after Feyling-Hanssen, 1971, p. 103):

Holderness Basement Till. Coll. J. A. Catt.

Species	Frequency	Percentage
Elphidium excavatum	175	44
Cassidulina crassa	53	13
Protelphidium orbiculare	53	13
Elphidium albiumbilicatum	17	4
Quinqueculina stalkeri	11	3
Elphidium asklundi	10	3
Elphidium subarcticum	10	3
Elphidium ustulatum	9	2
Elphidium groenlandicum	7	2
Bulimina marginata (forma *gibba*)	7	2
Buccella frigida	6	2
Trifarina fluens	4	1
Islandiella islandica	4	1
Protelphidium anglicum	4	1
Buccella tenerrima	3	1
Polymorphinidae	3	1
Oolina acuticosta	2	1
Oolina melo	2	1
Virgulina loeblichi	2	1
Astrononion gallowayi	2	1
Cibicides lobatulus	2	1
Globigerina ssp.	2	1
Quinqueloculina seminulum	1	< 1
Pyrgo williamsoni	1	< 1
Lagena striata	1	< 1
Oolina caudigera	1	< 1
Oolina lineata	1	< 1
Oolina squamosa	1	< 1
Fissurina danica	1	< 1
Fissurina laevigata	1	< 1
Fissurina marginata	1	< 1
Trifarina angulosa	1	< 1
Nonion barleeanum	1	< 1
Nonionella auricula	1	< 1
Elphidiella arctica	1	< 1
Total	401	

This fauna is very close to those described from the Lundergård Clay. *Quinqueloculina stalkeri* accounts for 3 % and *Elphidium ustulatum* for 2 % of the total fauna, and most of the other accessory species correspond to those from the Lundergård Clay. It is remarkable that the species *Bolivina* cf. *robusta, Nonion labradoricum, Islandiella teretis* and *Islandiella norcrossi,* which occur in a number of samples from Lundergård Clay, are not present in the sample from Holderness, and that the faunal diversity is higher in the Holderness Basement Till. *Elphidium asklundi* is present in the Holderness sample as well as in the Lundergård Clay. This species is one of the characteristic ones in Middle Weichselian Older *Yoldia* Clay in Vendsyssel and in the Sandnes Clay of Norway, but seems to have a greater stratigraphical range. Thus, it occurs also in the samples from Esbjerg brickworks, considered Holsteinian of age (Cf. Feyling-Hanssen et al., 1971).

In three short borings from the North Sea, about half way between Aberdeen and SW Norway, van Voorthuysen and Toering (Toering, pers. communication) found foraminifera faunas very much like those from Lundergård Clay. There are no quantitative analyses yet, but it has been possible to examine the faunas, and the distribution of species seems very close to the assemblages of Lundergård Clay. The faunas are arctic with more or less boreal species. *Elphidium excavatum,* forma *clavata* and *Cassidulina crassa* are dominant, and *Elphidium ustulatum* and *Quinqueloculina stalkeri* are characterizing accessory species in many of the samples. Otherwise *Bulimina marginata, Protelphidium orbiculare, Cassidulina laevigata* and *Hyalinea baltica* are common accessory species in the material. A higher frequency of *Bulimina marginata, Cassidulina laevigata* and *Hyalinea baltica* in the North Sea samples indicates a greater water depth than during deposition of the Lundergård Clay.

The foraminifera assemblages of the Lundergård Clay show that this deposit does not belong in the oldest Quaternary. *Elphidiella hannai,* which is a characteristic and common species in Amstelian and Icenian (van Voorthuysen, 1949) is not present in the fauna. *Nonion labradoricum* occurs in a number of samples from the Lundergård Clay; this species is found neither in the oldest Quaternary of NW Europe, nor in the Holsteinian of Inner Silver Pit. A few specimens occur in the Holsteinian of Esbjerg (Madsen, 1895) and in the Eemian (*Turritella terebra* Zone) of the Skærumhede sequence in Vendsyssel. The species is, however, common in younger deposits of Vendsyssel and Jæren (Feyling-Hanssen et al., 1971).

Elphidium ustulatum is found in deposits from Miocene to Quaternary, including the Weichselian. The species was originally described from deposits of Miocene or Pliocene age in Alaska (Todd, 1957). It is common in deposits from Baffin Island dated at more than 50,000 BP (Feyling-Hanssen, 1967), and it was also found in a sample dated at 40,000 BP (Feyling-Hans-

sen, pers. communication). It was recorded (as *Elphidium* sp. 2) from the Pliocene of the Netherlands (van Voorthuysen, 1958), and a few scattered specimens occur in older Quaternary deposits of the North Sea (Toering, pers. communication). In the marine Quaternary of Siberia Gudina (1966 and 1969) found *Elphidium ustulatum* (recorded as *Protelphidium lenticulare*) in deposits from Elsterian (the Tiltim-complex, Q_{1-2}), Holsteinian (the Ob-complex, Q_{1-2}), Saalian (the Salemal-complex, Q_2) and from Eemian (the Kazan-complex).

On the basis of the comparisons given above it is still difficult to arrive at a safe conclusion about the age of the Lundergård Clay. The ecological indication of its fauna is too cold for an interglacial and, on the other hand, as a boreal element is present, probably too mild for a full glacial stadial. The clay could have been deposited at the end or at the beginning of a glacial age, or it may belong in an interstadial.

The possibility that the Lundergård Clay might represent a facies of the Younger *Yoldia* Clay of Vendsyssel seems unlikely: The Lundergård Clay is usually rich in fossil foraminifera, whereas the Younger *Yoldia* Clay is nearly unfossiliferous in the southwestern part of Vendsyssel (Jessen, 1899, 1918 and 1936; Knudsen, 1971). Furthermore, the frequency distribution of foraminifera species in Lundergård Clay is characteristic, and differs much more from that of ordinary Younger *Yoldia* Clay faunas than from that of Older *Yoldia* Clay faunas (cf. Feyling-Hanssen et al., 1971).

Boulders with diameter up to more than 50 cm occur above the Lundergård Clay, i.e., in the basal layer of the Postglacial deposits. These blocks were probably transported to the area directly by glaciers, and in this case the underlying clay must be older than the latest glaciation, i.e., older than the Younger *Yoldia* Clay. There is, however, also the possibility that the boulders represent ice-rafted blocks and in that case they may have been brought into the area during the Lateglacial recession of glaciers and dropped on to the clay during its formation. In this case the Lundergård Clay could be of Lateglacial age (Younger *Yoldia* Clay) and the concentration of blocks upon the clay could be due to later erosion of the clay. Usually the Younger *Yoldia* Clay of Vendsyssel does not contain boulders, either in the clay itself or on top of it. Such boulders are, however, found above clay deposits considered Lateglacial of age in the southern part of Læsø (Jessen, 1897; Michelsen, 1967).

As already mentioned (p. 166), the Lundergård Clay is situated in close connection to the glacigenic highland to the east. The borings just north of the Lundergård Clay contains only nearly unfossiliferous sand, and the marine deposits in the lower part of boring IV, to the west, contains poor arctic faunas, which cannot be correlated with the Lundergård Clay assemblages. In southern direction the Lundergård Clay is limited by vertical con-

tact to the White Chalk. This could indicate young tectonic movements, and in that case perhaps glaciotectonic movements.

Van Voorthuysen's and Toering's faunas from deposits in the North Sea and the fauna from Holderness Basement Till in Yorkshire are the only faunas which are very similar to the Lundergård Clay assemblages. The stratigraphic position of the North Sea faunas is not known, but the Holderness Basement Till is considered to be of Saale Interstadial age (Catt & Penny, 1966).

The Lundergård Clay may either represent a hitherto unknown facies of the Older *Yoldia* Clay in Vendsyssel, which is supposed to be of Weichselian Interstadial age (Feyling-Hanssen et al., 1971), or it may be older, and in that case possibly correlatable with the Holderness Basement Till. The deposits from the North Sea mentioned above, the Holderness Basement Till, and the Lundergård Clay may prove to be scattered remains from one basin of Saale Interstadial age.

Systematics

The foraminifera are arranged in accordance with the classification used in Feyling-Hanssen et al., 1971. The first mention is listed for each of the species; only when taxonomic problems make it necessary a few more recent references are added. The presentation of each species is followed by short remarks on the occurrence in Lundergård Clay. Some of the species are illustrated by photographs and scanning electron micrographs.

Most of the species in the Lundergård Clay are the same as recorded from late Quaternary deposits of Vendsyssel and Jæren (Feyling-Hanssen et al., 1971), and for more comprehensive synonymy lists, pictures and remarks on the fossil and Recent distribution, the reader is referred to the systematic part of that paper (Knudsen, 1971).

Miliolidea Ehrenberg, 1839

Miliolidae Ehrenberg, 1839

Quinqueloculina d'Orbigny, 1826

Quinqueloculina agglutinata Cushman

1917 *Quinqueloculina agglutinata* Cushman: *U.S. natl. Mus., Bull.* 71, (6), p. 43, pl. 9, fig. 2.

A single specimen of this species was found in a surface sample of Lundergård Clay east of boring I.

Quinqueloculina seminulum (Linné)

1758 *Serpula seminulum* Linné: Systema naturae. Ed. 10. *Lipsiae* 1, p. 786, pl. 2, fig. 1.
1929 *Quinqueloculina seminulum* (Linnaeus) – Cushmann: *U.S. natl. Mus., Bull.* 104 (6), p. 24, pl. 2, figs. 1, 2.

One specimen of this species was found in the Lundergård Clay of boring I.

Quinqueloculina stalkeri Loeblich and Tappan
Pl. 1, figs. 1–3; pl. 6, figs. 1–4

1953 *Quinqueloculina stalkeri* Loeblich and Tappan: *Smithsonian misc. Coll.* 121 (7), p. 40, pl. 5, figs. 5–9.

Q. stalkeri is a chararcteristic species of the Lundergård Clay, usually accounting for 2 % of the total fauna, with a maximum of 3 %. Only a few specimens occurred in boring V.

Triloculina d'Orbigny, 1826
Triloculina trihedra Loeblich and Tappan

1953 *Triloculina trihedra* Loeblich and Tappan: *Smithsonian misc. Coll.* 121 (7), p. 45, pl. 4, fig. 10.

A single specimen was found in a surface sample of Lundergård Clay west of boring I.

Nodosariidea Ehrenberg, 1839
Nodosariidae Ehrenberg, 1839

Dentalina d'Orbigny, 1839
Dentalina baggi Galloway and Wissler
Pl. 1, fig. 4

1927 *Dentalina baggi* Galloway and Wissler: *J. Paleont.* 1, p. 49, pl. 8, figs. 14, 15.

One specimen of this species was found in boring V, Lundergård.

Marginulina d'Orbigny, 1826
Marginulina glabra d'Orbigny

1826 *Marginulina glabra* d'Orbigny: *Ann. Sci. nat. Paris,* (1) 7, p. 259, Modèles no. 55.
1967 *Marginulina glabra* d'Orbigny – Todd and Low: *U.S. geol. Survey, Prof. Paper* 573-A, p. 22, pl. 3, figs. 8, 9.

A single specimen was found in a surface sample of Lundergård Clay west of boring I.

Lagena Walker and Boys, 1784
Lagena feildeniana Brady
Pl. 1, fig. 5

1878 *Lagena feildeniana* Brady: *Ann. Mag. nat. Hist. London* 5 (1), p. 434, pl. 20, fig. 4.
1913 *Lagena feildeniana* Brady – Cushman: *U.S. natl. Mus. Bull.* 71 (3), p. 29, pl. 15, figs. 1, 2.

A few specimens of *L. feildeniana* occurred in the Lundergård Clay of borings I, II and III.

Lagena laevis (Montagu)
Pl. 1, fig. 6

1803 *Vermiculum laevae* Montagu: *Testacea Britannica.* J. S. Hollis (Romsey, England) 2, p. 524.
1964 *Lagena laevis* (Montagu) – Feyling-Hanssen: *Norges geol. Unders.* 225, p. 289, pl. 11, figs. 13–15.
One specimen was found in boring V, Lundergård.

Lagena semilineata Wright

1886 *Lagena semilineata* Wright: *Belfast Nat. Field Club, Proc., n.s.* 1, p. 320, pl. 26, fig. 7.
1971 *Lagena semilineata* Wright – Knudsen, *in* Feyling-Hanssen et al., p. 209, pl. 4, fig. 3; pl. 16, fig. 2.
A single specimen of this species was found in the Lundergård Clay of boring III.

Lagena striata (d'Orbigny), forma *substriata* Williamson
Pl. 1. fig. 7

1848 *Lagena substriata* Williamson: *Ann. Mag. nat. Hist. London* 2 (1), p. 15, pl. 2, fig. 12.
1964 *Lagena striata* (d'Orbigny), forma *substriata* Williamson – Feyling-Hanssen: *Norges geol. Unders.* 225, p. 294, pl. 12, fig. 6.
One specimen of this form was found in Lundergård Clay, boring I.

Lagena striata (d'Orbigny), forma *typica*
Pl. 1, fig. 8

1839 *Oolina striata* d'Orbigny: *Voyage dans l'Amérique Méridionale – Foraminifères.* 5 (5). (Atlas 9, 1847). Paris, p. 21, pl. 5, fig. 12.
1964 *Lagena striata* (d'Orbigny), forma *typica* – Feyling-Hanssen: *Norges geol. Unders.* 225, p. 293, pl. 12, figs. 4, 5.
A few specimens occurred in Lundergård Clay of borings I and II.

Polymorphinidae d'Orbigny

Guttulina d'Orbigny, 1826
Guttulina austriaca d'Orbigny
Pl. 1, fig. 9

1846 *Guttulina austriaca* d'Orbigny: Foraminifères fossiles du Bassin Tertiaire de Vienne. *Gide et Comp., Paris,* p. 223, pl. 12, figs. 23–25.
1930 *Guttulina austriaca* d'Orbigny – Cushman and Ozawa: *U.S. natl. Mus., Proc.* 77 (6), p. 29, pl. 4, figs. 3–5.
G. austriaca occurs in some of the samples from Lundergård Clay, but always accounts for less than 1 % of the total fauna. Only a single specimen was found in boring V.

Guttulina glacialis (Cushman and Ozawa)

1930 *Globulina glacialis* Cushman and Ozawa: *U.S. natl. Mus., Proc.* 77 (6), p. 71, pl. 15, figs. 6, 7.

One specimen of *G. glacialis* was found in Lundergård Clay, boring II.

Guttulina lactea (Walker and Jacob)
Pl. 1, figs. 10, 11

1798 *Serpula lactea* Walker and Jakob: *In* Adams, G.: *Essays on the Microscope.* Kanmacher. Ed. 2, London, p. 634, pl. 14, fig. 4.

1930 *Guttulina lactea* (Walker and Jakob) – Cushman and Ozawa: *U.S. natl. Mus., Proc.* 77 (6), p. 43, pl. 10, figs. 1–4.

This species occurs in some samples from Lundergård Clay, but always accounts for less than 1 % of the total fauna. A few specimens were found in boring V, Lundergård.

Guttulina problema (d'Orbigny)
Pl. 1, fig. 12

1826 *Polymorphina problema* d'Orbigny: *Ann. Sci. nat. Paris,* (1) 7, p. 266, no. 61.

1971 *Guttulina problema* (d'Orbigny) – Knudsen, *in* Feyling-Hanssen et al., p. 215, pl. 5, figs. 1, 2.

A few specimens of this species were found in the Lundergård Clay, borings III and V.

Globulina d'Orbigny, 1826
Globulina inaequalis Reuss
Pl. 1, figs. 13, 14

1850 *Globulina inaequalis* Reuss: *K. Akad. Wiss. Wien, math.-naturwiss. Cl., Denkschr.* 1, p. 377, pl. 48, fig. 9.

1964 *Globulina inaequalis* Reuss – Feyling-Hanssen: *Norges geol. Unders.* 225, p. 298, pl. 12, fig. 17; pl. 13, figs. 1, 2; text figs. 42–44.

One specimen of *G. inaequalis* was found in Lundergård Clay, boring III.

Sigmoidella Cushman and Ozawa, 1928
Sigmoidella pacifica Cushman and Ozawa
Pl. 1, figs. 15, 16

1928 *Sigmoidella (Sigmoidina) pacifica* Cushman and Ozawa: *Cushman Lab. Foram. Res., Contr.* 4 (1), p. 19, pl. 2, fig. 13.

A single specimen occurred in Lundergård Clay, boring II.

Glandulinidae Reuss, 1850

Glandulina d'Orbigny, 1826
Glandulina laevigata d'Orbigny
Pl. 2, fig. 1

1826 *Nodosaria (Glandulina) laevigata* d'Orbigny: *Ann. Sci. nat. Paris,* (1) 7, p. 252, pl. 10, figs. 1–3.

1953 *Glandulina laevigata* d'Orbigny – Loeblich and Tappan: *Smithsonian misc. Coll.* 121, (7), p. 81, pl. 16, figs. 2–5.

A few specimens of *G. laevigata* occurred in Lundergård Clay, borings I and V.

Oolina d'Orbigny, 1839
Oolina acuticosta (Reuss)
Pl. 2, fig. 2

1862 *Lagena acuticosta* Reuss: *K. Akad. Wiss. Wien* 44 (1), p. 305, pl. 1, fig. 4.
1971 *Oolina acuticosta* (Reuss) – Knudsen, *in* Feyling-Hanssen et al., p. 222, pl. 6, fig. 1; pl. 17, fig. 1.

A few specimens were found in Lundergård Clay, borings I, II, III and V.

Oolina borealis Loeblich and Tappan

1954 *Oolina borealis* Loeblich and Tappan: *J. Washington Acad. Sci.* 44 (12), p. 384.
1971 *Oolina borealis* Loeblich and Tappan – Knudsen, *in* Feyling-Hanssen et al., p. 223, pl. 6, fig. 2; pl. 17, figs. 2–4.

A single specimen of *O. borealis* was found in Lundergård Clay, boring I.

Oolina caudigera (Wiesner)
Pl. 2, fig. 3

1931 *Lagena (Entosolenia) globosa* (Montagu) var. *caudigera* Wiesner: *Deutsche Südpolar-Exped. 1901–03.* 20, Zool. (12), p. 119, pl. 18, fig. 214.
1971 *Oolina caudigera* (Wiesner) – Knudsen, *in* Feyling-Hanssen et al., p. 224, pl. 6, fig. 3.

Single specimens of this species occurred in the Lundergård Clay of borings I, III and V.

Oolina hexagona (Williamson)

1848 *Entosolenia squamosa* (Montagu), var. *hexagona* Williamson: *Ann. Mag. nat. Hist. London* 2 (1), p. 20, pl. 2, fig. 23.
1953 *Oolina hexagona* (Williamson) – Loeblich and Tappan: *Smithsonian misc. Coll.* 121 (7), p. 69, pl. 14, figs. 1, 2.

A few specimens of *O. hexagona* were found in the Lundergård Clay.

Oolina melo d'Orbigny
Pl. 2, fig. 4

1839 *Oolina melo* d'Orbigny: *Voyage dans l'Amérique Méridionale – Foraminifères.* 5 (5). (Atlas 9, 1847). Paris, p. 20, pl. 5, fig. 9.
1971 *Oolina melo* d'Orbigny – Knudsen, *in* Feyling-Hanssen et al., p. 226, pl. 6, fig. 5; pl. 17, fig. 9.

Single specimens occurred in Lundergård Clay, borings I and V.

Fissurina Reuss, 1850
Fissurina annectens (Buchner)

1940 *Lagena annectens* Buchner: *Novo Acta Leopoldina, N.F.* 9, p. 482, pl. 15, figs. 279–293.

Only a few specimens of this species were found in the Lundergård Clay.

Fissurina crustosa, forma *devia* (Buchner)
Pl. 2, fig. 5

1940 *Lagena crustosa*, var. *devia* Buchner: *Novo Acta Leopoldina, N. F.* 9, p. 518, pl. 22, figs. 469–472.

A single specimen was found in Lundergård Clay, boring III.

Fissurina danica (Madsen)
Pl. 2, figs. 6, 7

1895 *Lagena danica* Madsen: *Meddr dansk geol. Foren.* 2, p. 196, pl. 1, fig. 4.

1971 *Fissurina danica* (Madsen) – Knudsen, *in* Feyling-Hanssen et al., p. 228, pl. 6, figs. 6, 7; pl. 18, fig. 3.

This species occurs in some samples from the Lundergård Clay, but always accounts for less than 1 % of the total fauna.

Fissurina laevigata Reuss
Pl. 2, fig. 8

1850 *Fissurina laevigata* Reuss: *K. Akad. Wiss. Wien, math. naturwiss. Cl., Denkschr.* 1, p. 366, pl. 46, fig. 1.

1964 *Fissurina laevigata* Reuss – Feyling-Hanssen, *Norges geol. Unders.* 225, p. 314, pl. 15, figs. 17, 18.

F. laevigata occurs in nearly half of the samples from Lundergård Clay, but usually accounts for less than 1 % of the total fauna. Only a few specimens were found in boring V.

Fissurina lucida (Williamson)
Pl. 2, fig. 9

1848 *Entosolenia marginata* (Montagu), var. *lucida* Williamson: *Ann. Mag. nat. Hist., London* 2 (1), p. 17, pl. 2, fig. 17.

1967 *Fissurina lucida* (Williamson) – Todd and Low: *U.S. geol. Survey, Prof. Paper* 573-A p. 28, pl. 3, fig. 31.

A few specimens were found in the Lundergård Clay of boring I.

Fissurina marginata (Montagu)

1803 *Vermiculum marginatum* Montagu: *Testacea Britannica.* J. S. Hollis (Romsey, England) 2, p. 524.

1953 *Fissurina marginata* (Montagu) – Loeblich and Tappan: *Smithsonian misc. Coll.* 121 (7), p. 77, pl. 14, figs. 6–9.

A few specimens of *F. marginata* occur scattered in the Lundergård Clay.

Parafissurina Parr, 1947
Parafissurina lateralis (Cushman), forma *carinata* (Buchner)

1940 *Lagena lateralis* Cushman, forma *carinata* Buchner: *Novo Acta Leopoldina, N. F.* 9, p. 521, pl. 23, figs. 497–500.

Only a few specimens were found in the Lundergård Clay of borings I and II.

Parafissurina lateralis (Cushman), forma *simplex* (Buchner)

1940 *Lagena lateralis* Cushman, forma *simplex* Buchner: *Novo Acta Leopoldina, N. F.* 9, p. 520, pl. 23, figs. 487–492.

One specimen was found in the Lundergård Clay of boring III.

Buliminidea Jones, 1875

Buliminidae Jones, 1875

Buliminella Cushman, 1911

Buliminella elegantissima (d'Orbigny)

1839 *Bulimina elegantissima* d'Orbigny: *Voyage dans l'Amerique Méridionale – Foraminifères.* 5 (5). (Atlas 9, 1847). Paris, p. 51, pl. 7, figs. 13, 14.

1947 *Buliminella elegantissima* (d'Orbigny) – Höglund: *Zool. Bidr. Uppsala* 26, p. 215, pl. 18, fig. 1; text figs. 196, 197.

B. elegantissima was found in a few samples from Lundergård Clay, but it was rare.

Bulimina d'Orbigny, 1826

Bulimina fossa Cushman and Parker

1938 *Bulimina fossa* Cushman and Parker: *Cushman Lab. Foram. Res., Contr.* 14, p. 56, pl. 9, fig. 10.

1971 *Bulimina fossa* Cushman and Parker – Knudsen, *in* Feyling-Hanssen et al., p. 235, pl. 6, fig. 16; pl. 18, fig. 7.

Only a single specimen of this species was found in the Lundergård Clay of boring III.

Bulimina marginata d'Orbigny

Pl. 2, figs. 10, 11

1826 *Bulimina marginata* d'Orbigny: *Ann. Sci. nat. Paris,* (1) 7, p. 269, pl. 12, figs. 10–12.

1947 *Bulimina marginata* d'Orbigny – Höglund: *Zool. Bidr. Uppsala* 26, p. 227, pl. 20, figs. 1, 2; pl. 22, fig. 1; text figs. 205–218.

1971 *Bulimina marginata* d'Orbigny – Knudsen, *in* Feyling-Hanssen et al., p. 235, pl. 6, figs. 17–20.

B. marginata occurs in more than 90 % of the samples from Lundergård Clay. It usually accounts for up to 2 % of the total fauna; only in boring V it was more frequent in some of the samples.

Virgulina d'Orbigny, 1826

Virgulina fusiformis (Williamson)

1858 *Bulimina pupoides,* var. *fusiformis* Williamson: On the Recent Foram. of Great Britain. *Roy. Soc. Publs.,* p. 63, pl. 5, figs. 129, 130.

1947 *"Bulimina" fusiformis* Williamson – Höglund: *Zool. Bidr. Uppsala* 26, p. 232, pl. 20, fig. 3; text figs. 219–233.

V. fusiformis occurs in some samples from the Lundergård Clay, but never accounts for more than 1 % of the total fauna. It was not found in boring V.

Virgulina loeblichi Feyling-Hanssen

Pl. 2, fig. 12

1954 *Virgulina loeblichi* Feyling-Hanssen: *Norsk geol. Tidsskr.* 33, p. 191, pl. 1, figs. 14–18, text fig. 3.

1971 *Virgulina loeblichi* Feyling-Hanssen – Knudsen, *in* Feyling-Hanssen et al., p. 238, pl. 7, figs. 1–5.

V. loeblichi occurs in more than half of the samples from Lundergård Clay, but usually accounts for less than 1 % of the total fauna.

Virgulina schreibersiana Czjzek

1848 *Virgulina schreibersiana* Czjzek: *Haidinger's nat. wiss. Abh.* 2, p. 147, pl. 13, figs. 18–21.

1964 *Virgulina schreibersiana* Czjzek – Feyling-Hanssen: *Norges geol. Unders.* 225, p. 309, pl. 14, figs. 19–21.

Single specimens were found scattered in the Lundergård Clay.

Uvigerinidae Cushman 1913

Uvigerina d'Orbigny, 1826

Uvigerina peregrina Cushman

1923 *Uvigerina peregrina Cushman: U.S. natl. Mus., Bull.* 104 (4), p. 166, pl. 42, fig. 7–10.

This species occurred only in a few samples from boring V, Lundergård.

Trifarina Cushman, 1923

Trifarina angulosa (Williamson)

Pl. 2, fig. 13

1858 *Uvigerina angulosa* Williamson: On the Recent Foram. of Great Britain. *Roy. Soc. Publs.*, p. 67, pl. 5, fig. 140.

1947 *Angulogerina angulosa* (Williamson) – Höglund: *Zool. Bidr. Uppsala* 26, p. 283, pl. 23, fig. 8; text figs. 305–308.

Only a few specimens of this species were found in the Lundergård Clay.

Trifarina fluens (Todd)

Pl. 2, fig. 14

1947 *Angulogerina fluens* Todd, *in* Cushman and Todd: *Cushman Lab. Foram. Res., Contr.* 23 (3), p. 67, pl. 16, figs. 6, 7.

This species occurs in some samples from Lundergård Clay, but usually accounts for less than 1 % of the total fauna.

Bolivinitidae Cushman, 1927

Bolivina d'Orbigny, 1839

Bolivina alata (Seguenza)

Pl. 2, fig. 15

1862 *Vulvulina alata* Seguenza: *Eco Peloritano, Giornale Sci., Lette and Arti,* (2) 5 (9), p. 115, pl. 2, figs. 5, 5a.

1967 *Bolivina alata* Seguenza – Todd and Low: *U.S. geol. Survey, Prof. Paper* 573-A, p. 26, pl. 4, figs. 6, 7.

A single specimen of *B. alata* was found in the Lundergård Clay, boring II.

Bolivina pseudoplicata Heron-Allen and Earland

1930 *Bolivina pseudoplicata* Heron-Allen and Earland: *J. roy. micr. Soc. London,* (3) 50, p. 81, pl. 3, figs. 36–40.

Single specimens of this species occur scattered in the Lundergård Clay.

Bolivina cf. *robusta* Brady

Pl. 2, fig. 16; pl. 6, figs. 5–7

?1884 *Bolivina robusta* Brady: *Rep. sci. Results Explor. Voy. Challenger 1873–76, Zool.* 9, p. 421, pl. 53, figs. 7–9.

1947 *Bolivina* cf. *robusta* Brady – Höglund: *Zool. Bidr. Uppsala* 26, p. 270, pl. 24, figs. 8, 9; pl. 32, figs. 16–18; text-fig. 287.

B. cf. *robusta* occurs in most of the samples from Lundergård Clay. It usually accounts for up to 1 %, with a maximum of 5 % of the total fauna. This species was only found in a few samples from boring V.

Cassidulinidae d'Orbigny, 1839

Cassidulina d'Orbigny, 1826

Cassidulina crassa d'Orbigny

Pl. 2, fig. 17

1839 *Cassidulina crassa* d'Orbigny: *Voyage dans l'Amérique Méridionale – Foraminifères.* 5 (5). (Atlas 9, 1847). Paris, p. 56, pl. 7, figs. 18–20.

1958 *Cassidulina crassa* d'Orbigny – Nørvang: *Vidensk. Meddr. dansk naturh. Foren.* 120, p. 36, pl. 8, figs. 20–23; pl. 9, figs. 24, 25.

C. crassa is one of the dominant species in Lundergård Clay. It usually accounts for 10–30 % of the total fauna.

Cassidulina laevigata d'Orbigny

Pl. 2, fig. 18

1826 *Cassidulina laevigata* d'Orbigny: *Ann. Sci. nat. Paris,* (1) 7, p. 282, pl. 15, figs. 4, 5.

1958 *Cassidulina laevigata* d'Orbigny – Nørvang: *Vidensk. Meddr dansk naturh. Foren.* 120, p. 38, pl. 9, figs. 27–31.

C. laevigata occurs in many of the samples from Lundergård Clay, but usually accounts for less than 1 % of the total fauna. It was less common in boring V than in the other borings.

Islandiella Nørvang, 1958

Islandiella islandica (Nørvang)

Pl. 2, figs. 19, 20

1945 *Cassidulina islandica* Nørvang: *The zoology of Iceland, Foram.* Munksgaard (Copenhagen and Reykjavik) 2 (2), p. 42, fig. 7.

This species occurs in some of the samples from Lundergård Clay, but usually accounts for less than 1 % of the total fauna.

Islandiella norcrossi (Cushman)
Pl. 3, figs. 1, 2

1933 *Cassidulina norcrossi* Cushman: *Smithsonian misc. Coll.* 89 (9), p. 7, pl. 2, fig. 7.
1971 *Islandiella norcrossi* (Cushman) – Knudsen, *in* Feyling-Hanssen et al., p. 248, pl. 8, figs. 1, 2.

I. norcrossi occurs in about one third of the samples from Lundergård Clay, but usually accounts for less than 1 % of the total fauna, with a maximum of 4 % in a sample from boring V.

Islandiella teretis (Tappan)
Pl. 3, figs. 3, 4

1951 *Cassidulina teretis* Tappan: *Cushman Found. Foram. Res., Contr.* 2 (1), p. 7, pl. 1, fig. 30.
1971 *Islandiella teretis* (Tappan) – Knudsen, *in* Feyling-Hanssen et al., p. 249, pl. 8, figs. 3–6; pl. 18, fig. 13.

I. teretis occurs in most of the samples from Lundergård Clay, but usually accounts for less than 1 % of the total fauna. It was less common in boring V than in the other borings.

Spirillinidea Reuss, 1862

Spirillinidae Reuss, 1862

Patellina Williamson, 1858
Patellina corrugata Williamson

1858 *Patellina corrugata* Williamson: On the Recent Foram. of Great Britain. *Roy. Soc. Publs.*, p. 46, pl. 3, figs. 86–89.
1969 *Patellina corrugata* Williamson – Vilks: *Micropalaeontology* 15 (1), p. 50, pl. 3, fig. 11.

Only a single specimen of this species was found in the Lundergård Clay, boring I.

Discorbidea Ehrenberg, 1838

Discorbidae Cushman, 1927

Buccella Andersen, 1952
Buccella frigida (Cushman)
Pl. 3, figs. 5, 6

1922 *Pulvinulina frigida* Cushman: *Contr. to Canadian Biology*, 1921, p. 12 (144).

B. frigida occurs in about half of the samples from Lundergård Clay. Usually it accounts for up to 1 % of the total fauna, with a maximum of 3 % in a sample from boring V.

Buccella tenerrima (Bandy)

1950 *Rotalia tenerrima* Bandy: *J. Paleont.*, 24, p. 278, pl. 42, fig. 3.

Only a few specimens of this species were found in the Lundergård Clay.

Rosalina d'Orbigny, 1826
Rosalina globularis d'Orbigny

1826 *Rosalina globularis* d'Orbigny: *Ann. Sci. nat. Paris,* (1) 7, p. 271, pl. 13, figs. 1, 2.
1931 *Discorbis globularis* (d'Orbigny) – Cushman: *U.S. natl. Mus., Bull.* 104, (8), p. 22, pl. 4, fig. 9.
Only a single specimen was found in Lundergård Clay, boring II.

Epistominella Husezima and Marukasi, 1944
Epistominella takayanagii Iwasa

1955 *Epistominella takayanagii* Iwasa: *J. geol. Soc. Japan,* 61 (712), p. 16, 17, text fig. 4.
This species occurs in some of the samples from Lundergård Clay, but it usually accounts for less than 1 % of the total fauna. Only a few specimens were found in boring V.

Asterigerinidae d'Orbigny, 1839

Eoeponidella Wickenden, 1949
Eoeponidella laesoeensis Michelsen

1967 *Eoeponidella laesoeensis* Michelsen: *Meddr dansk geol. Foren.* 17, p. 230, pl. 3, figs. 5–8; text figs. 3–7.
A few specimens of this species occurred in surface samples from the Lundergård Clay.

Anomalinidae Cushman, 1927

Hyalinea Hofker, 1951
Hyalinea baltica (Schroeter)
Pl. 3, fig. 7

1783 *Nautilus balthicus* Schroeter: *Einleitung in die Conchylienkenntniss nach Linné.* Gebauer (Halle) 1, p. 20, pl. 1, fig. 2.
1971 *Hyalinea baltica* (Schroeter) – Knudsen, *in* Feyling-Hanssen et al., p. 259, pl. 9, figs. 7, 8.
Only a few specimens of *H. baltica* were found in boring V.

Siphoninidae Cushman, 1928

Siphonina Reuss, 1850
Siphonina prima Plummer

1926 *Siphonina prima* Plummer: *Texas Univ., Bull.* 2644, p. 148, pl. 12, figs. 4a–c.
Only one specimen of this species was found in a surface sample of Lundergård Clay.

Orbitoididea Schwager, 1876

Planorbulinidae Schwager, 1877

Cibicides Montfort, 1808

Cibicides lobatulus (Walker and Jacob)

Pl. 3, figs. 8, 9

1798 *Nautilus lobatulus* Walker and Jacob: *In* Adams, G.: *Essays on the Microscope.* Kanmarcher. Ed. 2, London, p. 642, pl. 14, fig. 36.

1961 *Cibicides lobatulus* (Walker and Jacob) – Nyholm: *Zool. Bidr. Uppsala* 33, p. 157–196, pl. 1–5; text figs. 1–21.

C. lobatulus occurs in many samples from the Lundergård Clay, but usually accounts for less than 1 % of the total fauna.

Cibicides pseudoungerianus (Cushman)

1922 *Truncatulina pseudoungerianus* Cushman: *U.S. geol. Surv., Prof. Paper* 129-E, p. 97, pl. 20, fig. 9.

Only single specimens of this species were found in the Lundergård Clay, borings I and V.

Nonionidea Subbotina, 1959

Nonionidae Schultze, 1854

Nonion Montfort, 1808

Nonion barleeanum (Williamson)

Pl. 3, fig. 10

1858 *Nonionina barleeanum* Williamson: On the Recent Foram. of Great Britain. *Roy. Soc. Publs.*, p. 32, pl. 3, figs. 68, 69.

1971 *Nonion barleeanum* (Williamson) – Knudsen, *in* Feyling-Hanssen et al., p. 261, pl. 9, figs. 15–18.

Scattered specimens of *N. barleeanum* occur in the Lundergård Clay.

Nonion labradoricum (Dawson)

Pl. 3, figs. 11, 12

1860 *Nonionina labradorica* Dawson: *Canadian Nat.* 5, p. 191, fig. 4.

1939 *Nonion labradoricum* (Dawson) – Cushman: *U.S. geol. Survey, Prof. Paper* 191, p. 23, pl. 6, figs. 13–16.

N. labradoricum occurs in about half of the samples from Lundergård Clay. It normally accounts for less than 1 % of the total fauna, with a maximum of 3 % in a sample from boring V.

Nonion depressulus (Walker and Jacob)

1798 *Nautilus depressulus* Walker and Jacob: *In* Adams, G.: *Essays on the Microscope.* Kanmacher, Ed. 2, London, p. 641, fig. 33.

1957 *Nonion umbilicatulus* (Walker and Jacob) – van Voorthuysen: *Med. geol. Sticht., N. Ser.* 11, p. 29, pl. 23, fig. 4.
1971 *Nonion umbilicatulum* (Walker and Jacob) – Knudsen, *in* Feyling-Hanssen et al., p. 263, pl. 10, figs. 3, 4; pl. 19, figs. 2, 3.

A few specimens of this species were found in boring V, Lundergård.

Nonionella Cushman, 1926
Nonionella turgida (Williamson)

1858 *Rotalina turgida* Williamson: On the Recent Foram. of Great Britain. *Roy. Soc. Publs.*, p. 50, pl. 4, figs. 95–97.
1939 *Nonionella turgida* (Williamson) – Cushman: *U.S. geol. Survey, Prof. Paper* 191, p. 32, pl. 9, figs. 2, 3.

Only a single specimen was found in Lundergård Clay, boring II.

Astrononion Cushman and Edwards, 1937
Astrononion gallowayi Loeblich and Tappan

1953 *Astrononion gallowayi* Loeblich and Tappan: *Smithsonian misc. Coll.* 121 (7), p. 90, pl. 17, figs. 4–7.

Only scattered specimens of this species occurred in the Lundergård Clay.

Pullenia Parker and Jones, 1862
Pullenia bulloides (d'Orbigny)

1826 *Nonionina bulloides* d'Orbigny: *Ann. Sci. nat. Paris,* (1) 7, p. 293, no. 2.
1964 *Pullenia bulloides* (d'Orbigny) – Feyling-Hanssen: *Norges geol. Unders.* 225, p. 333, pl. 18, figs. 1, 2.

This species occurs in some samples from Lundergård Clay, but usually accounts for less than 1 % of the total fauna. Only a single specimen was found in boring V.

Pullenia osloensis Feyling-Hanssen

1954 *Pullenia osloensis* Feyling-Hanssen: *Norsk geol. Tidsskr.* 33, p. 194, pl. 1, figs. 33–35.

Only a single specimen was found in the Lundergård Clay, boring I.

Pullenia subcarinata (d'Orbigny)

1839 *Nonionina subcarinata* d'Orbigny: *Voyage dans l'Amérique Méridionale – Foraminifères.* 5 (15). (Atlas 9, 1847). Paris, p. 28, pl. 5, figs. 23, 24.
1964 *Pullenia subcarinata* (d'Orbigny) – Feyling-Hanssen: *Norges geol. Unders.* 225, p. 334, pl. 18, figs. 7, 8.

Only a few specimens occur in the Lundergård Clay.

Elphidiidae Galloway, 1933

Elphidium Montfort, 1808
Elphidium albiumbilicatum (Weiss)

Pl. 4, figs. 1–3; pl. 8, fig. 1

1954 *Nonion pauciloculum* Cushman, subsp. *albiumbilicatum* Weiss: *U.S. geol. Survey, Prof. Paper* 254-G, p. 157, pl. 32, figs. 1, 2.

1971 *Elphidium albiumbilicatum* (Weiss) – Knudsen, *in* Feyling-Hanssen et al., p. 268, pl. 10, figs. 15–19; pl. 19, figs. 4–8.

E. albiumbilicatum occurs in nearly all the samples from Lundergård Clay. It usually accounts for up to 2 % of the total fauna, but was more frequent in a few samples from boring V.

Elphidium articulatum (d'Orbigny)

Pl. 3, fig. 13

1839 *Polystomella articulata* d'Orbigny: *Voyage dans l'Amérique Méridionale – Foraminifères.* 5 (5). (Atlas 9, 1847). Paris, p. 30, pl. 3. figs. 9, 10.

1939 *Elphidium excavatum* (Terquem) – Cushman: *U.S. geol. Survey, Prof. Paper* 191, p. 58, pl. 16, figs. 10–12 (not figs. 7–9).

1968 *Cribrononion articulatum* (d'Orbigny) – Lutze: *Meyniana* 18, p. 27, pl. 1, figs. 1, 2.

1971 *Elphidium umbilicatulum* (Williamson) – Knudsen, *in* Feyling-Hanssen et al., p. 281, pl. 13, figs. 8–11; pl. 23, figs. 1–4.

E. articulatum was found in some samples from the Lundergård Clay, but never accounted for more than 1 % of the total fauna. It was not found in boring V.

Elphidium asklundi Brotzen

Pl. 4, figs. 4–6; pl. 7, figs. 1–4

1943 *Elphidium asklundi* Brotzen, *in* Hessland: *Bull. geol. Inst. Uppsala* 31, p. 267, fig. 109–1.

1971 *Elphidium asklundi* Brotzen – Knudsen, *in* Feyling-Hanssen et al., p. 270, pl. 10, figs. 20, 21; pl. 11, figs. 1–5.

E. asklundi occurs in most of the samples from Lundergård Clay. It usually accounts for up to 1 % of the total fauna, but was more frequent in some samples from boring V.

Elphidium bartletti Cushman

Pl. 5, figs. 1, 2; pl. 8, figs. 2, 3

1933 *Elphidium bartletti* Cushman: *Smithsonian misc. Coll.* 89 (9), p. 4, pl. 1, fig. 9.

This species was found in many samples from Lundergård Clay, but usually accounted for less than 1 % of the total fauna. It was rather frequent in boring V, with a maximum of 6 % of the fauna in one of the samples.

Elphidium excavatum (Terquem)

Pl. 5, fig. 4

1875 *Polystomella excavata* Terquem: *Essai sur le Classement des Animaux qui vivent sur la Plage et dans les environs de Dunkerque.* Paris, p. 25, pl. 2, fig. 2.

1965 *Cribrononion excavatum* (Terquem) – Lutze: *Meyniana* 15, p. 96, pl. 15, figs. 39–41.

1971 *Elphidium clavatum* Cushman – Knudsen, *in* Feyling-Hanssen et al., p. 273, pl. 11, figs. 10–13; pl. 20, figs. 5–8.

E. excavatum is the dominant species in Lundergård Clay, usually accounting for 50–80 % of the total fauna. Most frequently it occurs as forma *clavata*, which is the typical arctic form of the species (Feyling-Hanssen, 1972), but some specimens of the boreal forma *selseyensis* are also present.

Elphidium gerthi van Voorthuysen

1957 *Elphidium gerthi* van Voorthuysen: *Med. geol. Sticht., N. Ser.* 11, p. 32, pl. 23, fig. 12.

A few specimens of *E. gerthi* were found in the Lundergård Clay of borings I, II and V.

Elphidium groenlandicum Cushman
Pl. 4, fig. 7

1933 *Elphidium groenlandicum* Cushman: *Smithsonian misc. Coll.* 89 (9), p. 4, pl. 1, fig. 10.

Only a few specimens of this species were found in the Lundergård Clay.

Elphidium incertum (Williamson)

1858 *Polystomella umbilicatula,* var. *incerta* Williamson: On the Recent Foram. of Great Britain. *Roy, Soc. Publs.,* p. 44, pl. 3, fig. 82a.

1971 *Elphidium incertum* (Williamson) – Knudsen, *in* Feyling-Hanssen et al., p. 277, pl. 12, figs. 11, 12; pl. 21, figs. 8, 9.

E. incertum occurs in most of the samples from Lundergård Clay. Usually it accounted for less than 1 %, with a maximum of 5 % of the total fauna.

Elphidium magellanicum Heron-Allen and Earland

1932 *Elphidium magellanicum* Heron-Allen and Earland: *Discovery Rep., Cambridge* 4, p. 440, pl. 16, figs. 26–28.

This species was found in nearly half of the samples from Lundergård Clay, but usually accounted for less than 1 % of the total fauna.

Elphidium margaritaceum Cushman

1930 *Elphidium advenum* (Cushman), var. *margaritaceum* Cushman: *U.S. natl. Mus., Proc.* 77 (6), p. 25, pl. 10, fig. 3.

Only a few specimens of this species were found in the Lundergård Clay.

Elphidium subarcticum Cushman
Pl. 5, fig. 3; pl. 8, figs. 4, 5

1944 *Elphidium subarcticum* Cushman: *Cushman Lab. Foram. Res., Spec. Publ.* 12, p. 27, pl. 3, figs. 34, 35.

A few specimens of *E. subarcticum* were found in the Lundergård Clay. It never accounted for more than 1 % of the total fauna.

Elphidium ustulatum Todd
Pl. 5, figs. 5–7; pl. 7, figs. 5–7

1957 *Elphidium ustulatum* Todd: *U.S. geol. Surv., Prof. Paper.* 294-F, p. 230, pl. 28, fig. 16.

1971 *Elphidium ustulatum* Todd – Knudsen, *in* Feyling-Hanssen et al., p. 283, pl. 13, figs. 12, 13; pl. 23, figs. 5–7.

E. ustulatum is a characteristic species of the Lundergård Clay. It usually accounts for up to 3 % of the total fauna, with a maximum of 9 % in a sample from the lower part of boring I.

Protelphidium Haynes, 1956
Protelphidium anglicum Murray

1965 *Protelphidium anglicum* Murray: *Cushman Found. Foram. Res., Contr.* 16, p. 149, 150, pl. 25, figs. 1–5; pl. 26, figs. 1–6.

A few specimens occur in the Lundergård Clay of borings I, II and III.

Protelphidium orbiculare (Brady)
Pl. 5, figs. 8, 9; pl. 8, figs. 6, 7

1881 *Nonionina orbicularis* Brady: *Quart. J. micr. Sci.* 21, p. 415, pl. 21, fig. 5.
1939 *Nonion orbiculare* (Brady) – Cushman: *U.S. geol. Survey, Prof. Paper* 191, p. 23, pl. 6, figs. 17–19.

P. orbiculare occurred in nearly all samples from the Lundergård Clay. It usually accounted for up to 3 % of the total fauna, but in a few samples from the lower part of boring I it accounted for 24–35 %.

Rotaliidea Ehrenberg, 1839

Rotaliidae Ehrenberg, 1839

Ammonia Brünnick, 1772
Ammonia batavus (Hofker)
Pl. 5, figs. 10, 11

1951 *Streblus batavus* Hofker: *Siboga Exped., Monogr.* 4b (3), p. 492, 501, fig. 340.

This species was found in about one fourth of the samples from Lundergård Clay, but usually accounted for less than 1 % of the total fauna.

Acknowledgements. I am indebted to Dr. Rolf W. Feyling-Hanssen, Micropalaeontological Department in Århus, for valuable discussion and helpful suggestions during the present work. The borings were carried out by our laboratory workers Mr. S. Aa. Meldgaard and Mr. K. Geer assisted by students. Mrs. L. Ø. Mogensen typed the manuscript, Mrs. J. Gissel Nielsen prepared the drawings, Mr. F. Nyhuus Kristoffersen of the Geological Survey of Denmark prepared the scanning electron micrographs, Mr. S. Aa. Meldgaard the photographs for the plates, and Dr. J. R. Wilson corrected the English manuscript. I wish to offer my sincere thanks to all these helpers and also to Professor B. M. Funnell, University of East Anglia, Mr. A. Buch, Geological Survey of Denmark, and Miss Toering, Geological Survey of Haarlem for providing comparative material. Statens Naturvidenskabelige Forskningsråd kindly provided financial support.

Dansk sammendrag

Der er foretaget en kvantitativ analyse af fossile foraminiferfaunaer i marine kvartære aflejringer i Lundergård mose, Vendsyssel. Prøver fra tre boringer i den østlige del af området indeholder en karakteristisk arktisk foraminiferfauna, og disse aflejringer er her kaldt Lundergård Ler. *Elphidium excavatum*, forma *clavata* og *Cassidulina crassa* er dominerende, mens *Quinqueloculina stalkeri* og *Elphidium ustulatum* er de karakteriserende arter i aflejringen. Faunaen er sammenlignet med kendte foraminiferfaunaer

fra andre kvartære aflejringer i Vendsyssel og fra tilgrænsende områder. Faunaen i Lundergård Ler viser, at dette ikke tilhører de ældste kvartære aflejringer. Den indicerer ikke interglaciale forhold, men hører snarere hjemme i en interstadial tid. Lundergård Leret kan enten tilhøre en hidtil ukendt facies af Ældre *Yoldia* ler i Vendsyssel, som menes at være af Weichselian interstadial alder, eller det kan være ældre, og således måske korreleres med Holderness Basement Till i Yorkshire, som henregnes til en interstadial i Saale.

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Plate 1

Miliolidae, Nodosariidae, Polymorphinidae

Figs. 1–3. *Quinqueloculina stalkeri* Loeblich and Tappan 176
1: Specimen from boring II, no. 5; ×75.
2–3: Specimen from boring I, spl. no. 15; ×75.

Fig. 4. *Dentalina baggi* Galloway and Wissler 176
Specimen from boring V, spl. no. 7; ×60.

Fig. 5. *Lagena feildeniana* Brady 176
Specimen from boring I, spl. no. 24; ×100.

Fig. 6. *Lagena laevis* (Montagu) 177
Specimen from boring V, spl. no. 7; ×75.

Fig. 7. *Lagena striata* (d'Orbigny), forma *substriata* Williamson 177
Specimen from boring I, spl. no. 9; ×100.

Fig. 8. *Lagena striata* (d'Orbigny), forma *typica* 177
Specimen from boring II, spl. no. 10; ×100.

Fig. 9. *Guttulina austriaca* d'Orbigny 177
Specimen from boring II, spl. no. 7; ×75.

Figs. 10–11. *Guttulina lactea* (Walker & Jacob) 178
Specimen from a surface sample of Lundergård Clay; ×75.

Fig. 12. *Guttulina problema* (d'Orbigny) 178
Specimen from boring III, spl. no. 10; ×75.

Figs. 13–14. *Globulina inaequalis* Reuss 178
Specimen from boring III, spl. no. 5; ×75.

Figs. 15–16. *Sigmoidella pacifica* Cushman & Ozawa 178
Specimen from boring II, spl. no. 12; ×75.

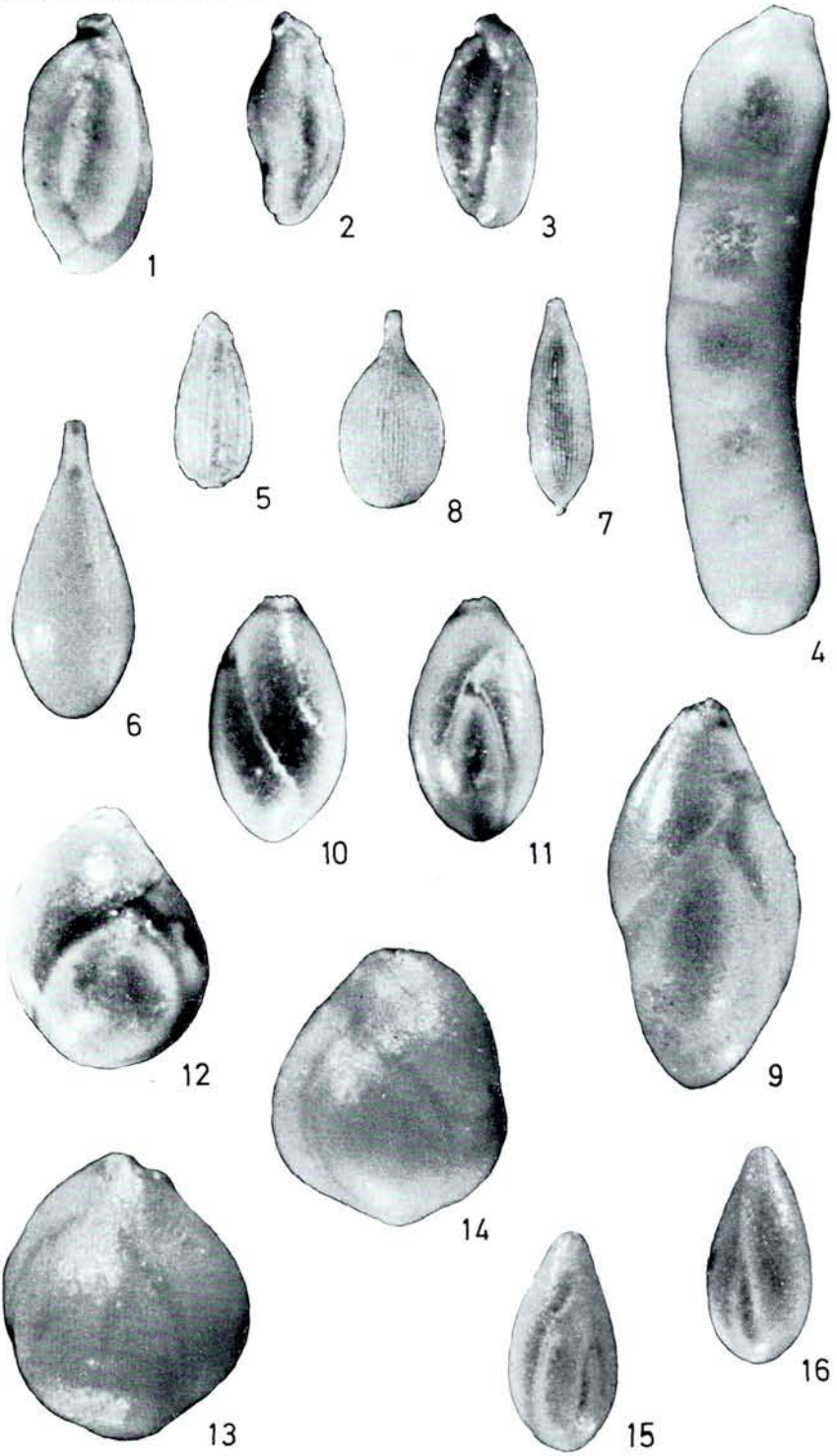
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Plate 2

Glandulinidae, Buliminidae, Uvigerinidae, Bolivinitidae, Cassidulinidae

Fig.1. *Glandulina laevigata* d'Orbigny 178
Specimen from boring I, spl. no. 11; ×75.
Fig. 2. *Oolina acuticosta* (Reuss) 179
Specimen from boring I, spl. no. 11; ×100.
Fig. 3. *Oolina caudigera* (Wiesner) 179
Specimen from boring III, spl. no. 10; ×100.
Fig. 4. *Oolina melo* d'Orbigny 179
Specimen from boring V, spl. no. 9; ×75.
Fig. 5. *Fissurina crustosa* (Buchner), forma *devia* Buchner 179
Specimen from boring III, spl. no. 6; ×100.
Figs. 6–7. *Fissurina danica* (Madsen) 180
Specimen from boring III, spl. no. 4; ×100.
Fig. 8. *Fissurina laevigata* Reuss 180
Specimen from boring V, spl. no. 10; ×75.
Fig. 9. *Fissurina lucida* (Williamson) 180
Specimen from boring I, spl. no. 10; ×75.
Figs. 10–11. *Bulimina marginata* (d'Orbigny) 181
10: Specimen from boring II, spl. no. 4; ×75.
11: Specimen from boring III, spl. no. 5; ×75.
Fig. 12. *Virgulina loeblichi* Feyling-Hanssen 181
Specimen from boring III, spl. no. 9; ×75.
Fig. 13. *Trifarina angulosa* (Williamson) 182
Specimen from boring II, spl. no. 10; ×75.
Fig. 14. *Trifarina fluens* (Todd) 182
Specimen from boring II, spl. no. 10; ×75.
Fig. 15. *Bolivina alata* (Seguenza) 182
Specimen from boring II, spl. no. 2; ×75.
Fig. 16. *Bolivina* cf. *robusta* Brady 183
Specimen from boring II, spl. no. 4; ×75.
Fig. 17. *Cassidulina crassa* d'Orbigny 183
Specimen from boring II, spl. no. 4; ×75.
Fig. 18. *Cassidulina laevigata* d'Orbigny 183
Specimen from boring I, spl. no. 2; ×75.
Figs. 19–20. *Islandiella islandica* (Nørvang) 183
Specimen from boring III, spl. no. 1; ×75.

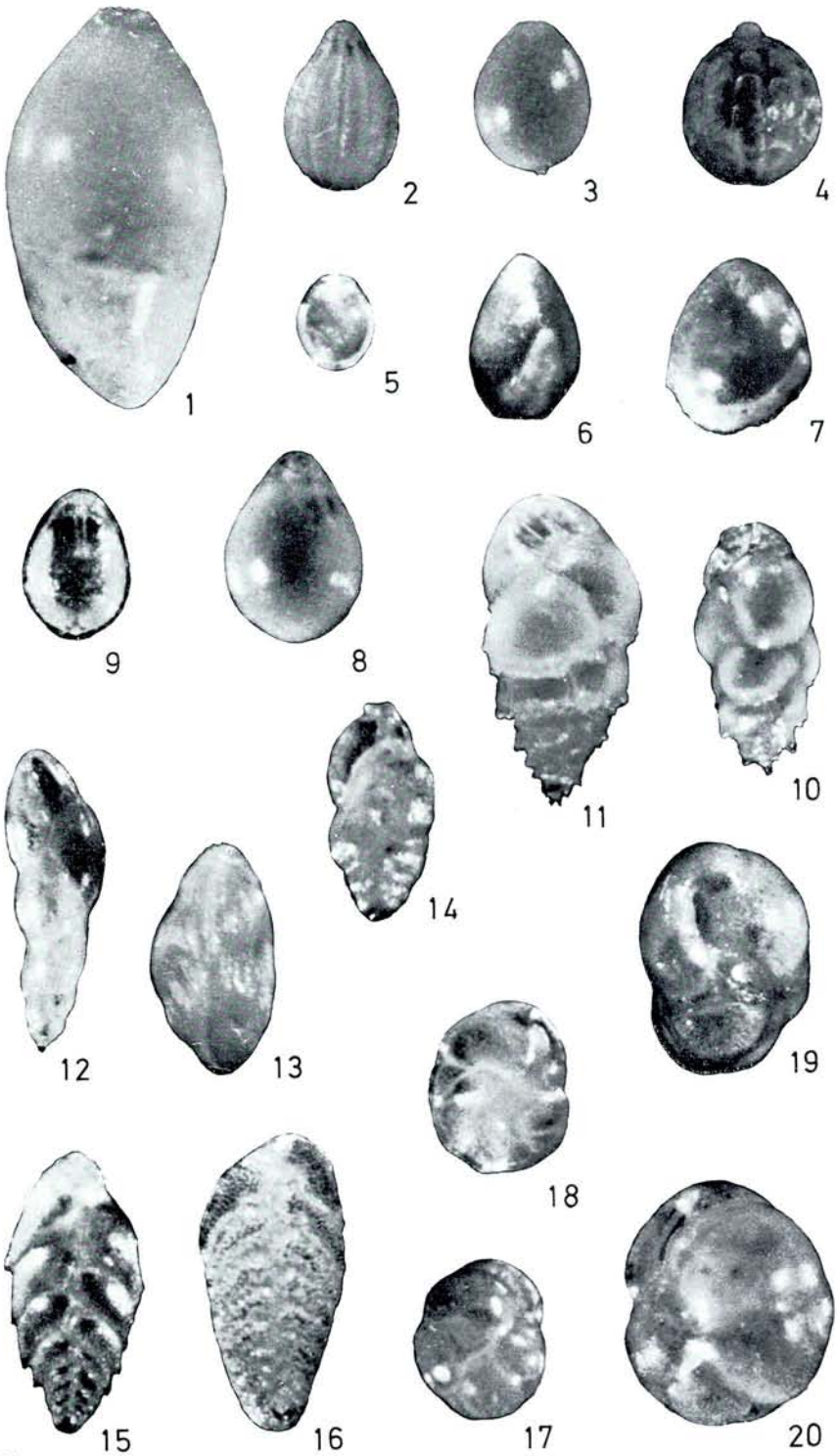
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Plate 3

Cassidulinidae, Discorbidae, Anomalinidae, Planorbulinidae, Nonionidae, Elphidiidae

Figs. 1–2. *Islandiella norcrossi* (Cushman) 184
Opposite sides of specimen from boring II, spl. no. 4; ×75.

Figs.3–4. *Islandiella teretis* (Tappan) 184
Opposite sides of specimen from boring III, spl. no. 3; ×75.

Figs. 5–6. *Buccella frigida* (Cushman) 184
Umbilical and spiral view of specimen from boring I, spl. no. 2; ×75.

Fig. 7. *Hyalinea baltica* (Schroeter) 185
Specimen from boring V, spl. no. 18; ×75.

Figs. 8–9. *Cibicides lobatulus* (Walker & Jacob) 186
Umbilical and spiral view of specimen from boring I, spl. no. 6; ×75.

Fig. 10. *Nonion barleeanum* (Williamson) 186
Specimen from boring IV, spl. no. 10; ×75.

Figs. 11–12. *Nonion labradoricum* (Dawson) 186
Side and edge view of specimen from boring V, spl. no. 8; ×75.

Fig. 13. *Elphidium articulatum* (d'Orbigny) 188
Specimen from boring III, spl. no. 3; ×75.

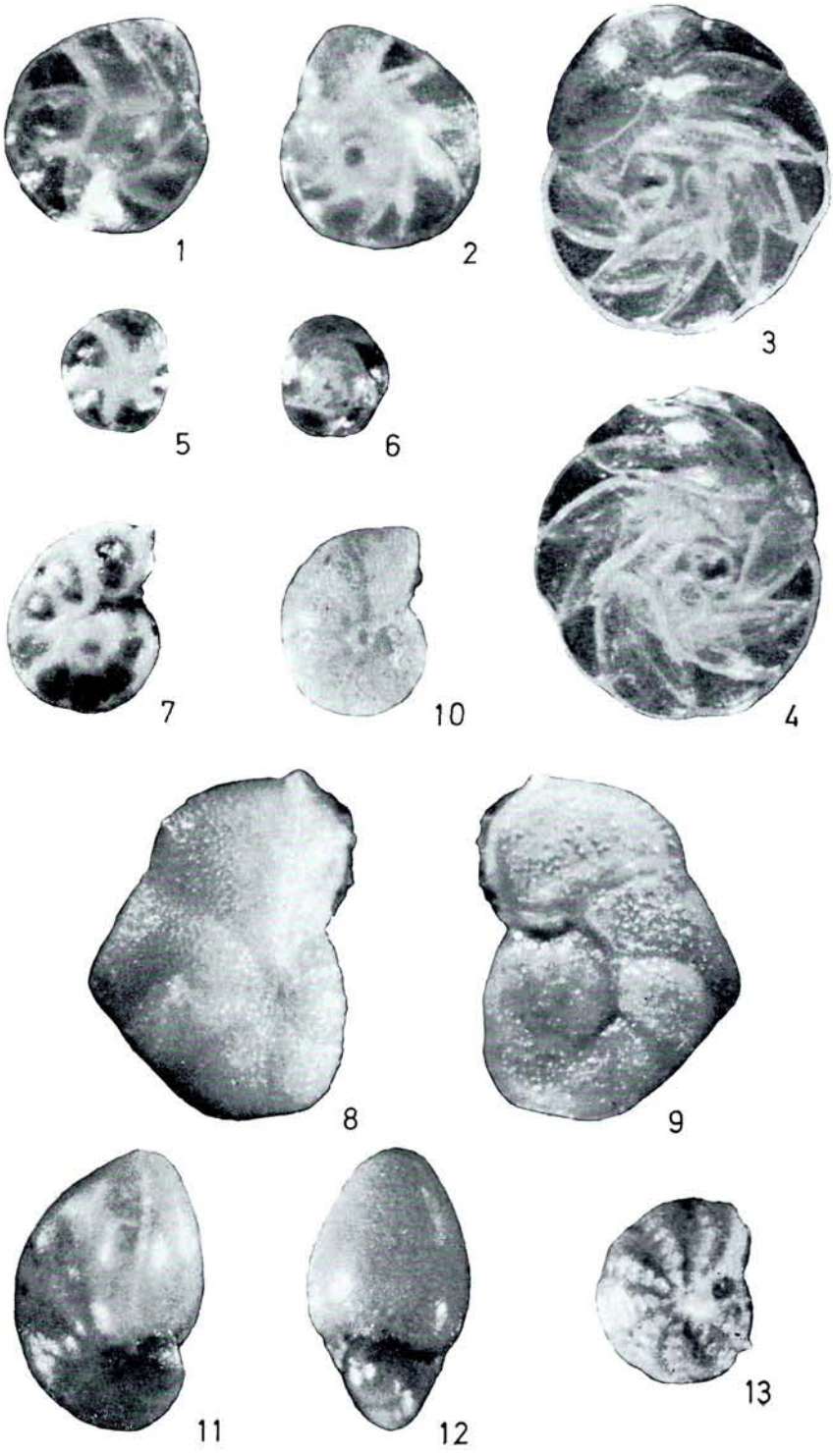
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Plate 4

Elphidiidae

Figs. 1–3. *Elphidium albiumbilicatum* (Weiss) 187
1: Specimen from a surface sample of Lundergård Clay, ×100.
2–3: Edge and side view of specimen from boring III, spl. no. 8; ×75.

Figs. 4–6. *Elphidium asklundi* Brotzen 188
4–5: Side and edge view of specimen from a surface sample of Lundergård Clay; ×75.
6: Specimen from boring V, spl. no. 5; ×75.

Fig. 7. *Elphidium groenlandicum* Cushman 189
Specimen from boring V, spl. no. 7; ×75.

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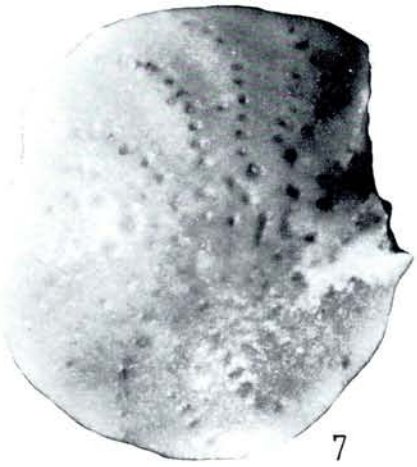

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Plate 5

Elphidiidae, Rotaliidae

Figs. 1–2. *Elphidium bartletti* Cushman 188
Edge and side view of specimen from boring V, spl. no. 7; ×75.

Fig. 3. *Elphidium subarcticum* Cushman 189
Specimen from boring III, spl. no. 8; ×75.

Fig. 4. *Elphidium excavatum* (Terquem), forma *clavata* Cushman 188
Specimen from boring II, spl. no. 4; ×75.

Figs. 5–7. *Elphidium ustulatum* Todd 189
5: Specimen from boring II, spl. no. 3; ×75.
6–7: Side and edge view of specimen from boring I, spl. no. 17; ×75.

Figs. 8–9. *Protelphidium orbiculare* (Brady) 190
Side and edge view of specimen from boring III, spl. no. 7; ×75.

Figs. 10–11. *Ammonia batavus* (Hofker) 190
Umbilical and spiral view of specimen from boring I, spl. no. 2; ×75.

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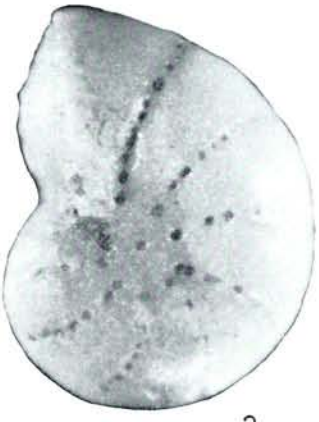

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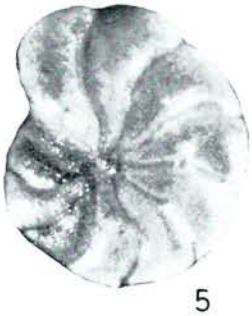

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Plate 6

Miliolidae, Bolivinitidae

Figs. 1–4. *Quinqueloculina stalkeri* Loeblich & Tappan 176
1: Specimen from boring I, spl. no. 19; ×160.
2: Detail of the aperture of the same specimen; ×830.
3: Specimen from boring II, spl. no. 5; ×105.
4: Detail of the wall of the same specimen; ×670.

Figs. 5–7. *Bolivina* cf. *robusta* Brady 183
5: Specimen from boring II, spl. no. 4; ×80.
6: Aperture of the same specimen; ×270.
7: Detail of the wall of specimen from boring I, spl. no. 15; ×250.

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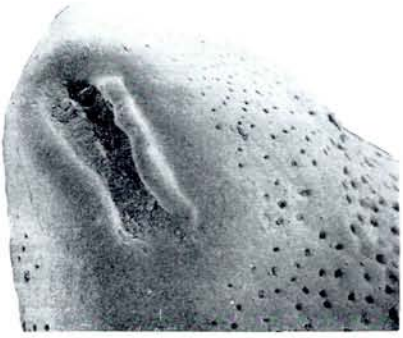

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Plate 7

Elphidiidae

Figs. 1–4. *Elphidium asklundi* Brotzen 188
1–2: Side and edge view of specimen from boring I, spl. no. 14; ×55.
3: Detail of the central area; ×170.
4: Detail of the aperture of the same specimen; ×230.

Figs. 5–7. *Elphidium ustulatum* Todd 189
5–6: Edge and side view of specimen from boring III, spl. no. 11; ×90.
7: Last suture of specimen from boring I, spl. no. 17; ×230.

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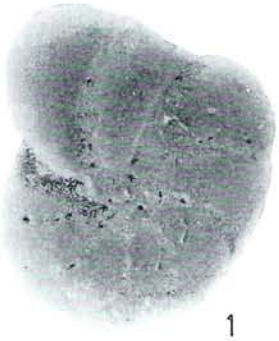

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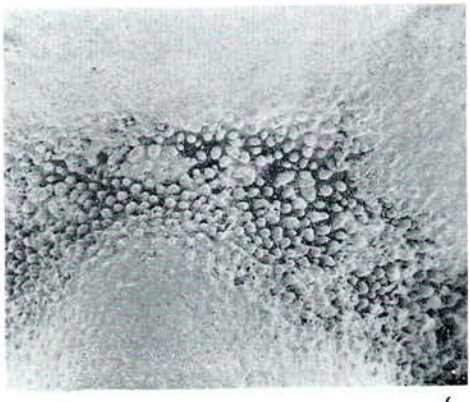

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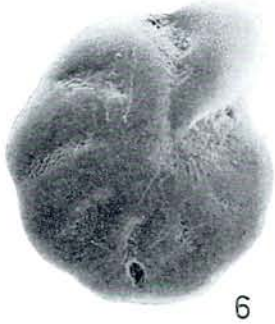

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Plate 8

Elphidiidae

Fig. 1. *Elphidium albiumbilicatum* (Weiss) 187
Specimen from boring III, spl. no. 8; ×85.

Figs. 2–3. *Elphidium bartletti* Cushman 188
2: Side view of specimen from boring I, spl. no. 11; ×85.
3: Detail of suture of the same specimen; ×560.

Figs. 4–5: *Elphidium subarcticum* Cushman 189
4: Side view of specimen from boring III, spl. no. 8; ×80.
5: Detail of suture of the same specimen; ×270.

Figs. 6–7. *Protelphidium orbiculare* (Brady) 190
6: Side view of specimen from boring II, spl. no. 4; ×85.
7: Central area of specimen from boring I, spl. no. 14; ×230.

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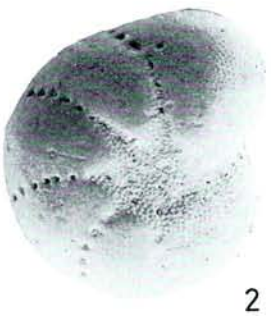

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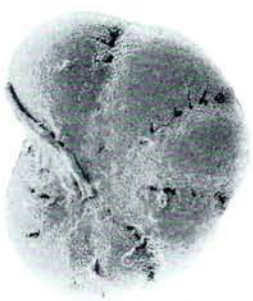

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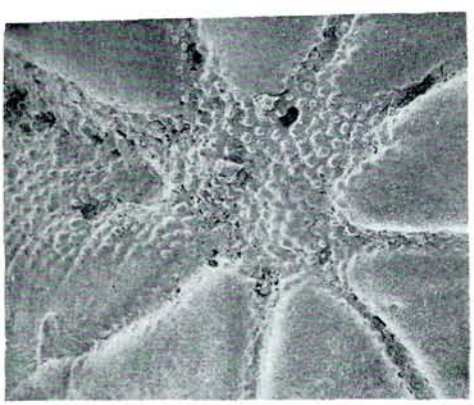

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Plate 9

Fig. 1. Foraminiferal assemblage from the Lundergård Clay of boring III, spl. no. 7; ×35.

Fig. 2. Foraminiferal assemblage from boring V, spl. no. 7; ×35.

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