AGGLUTINATED FORAMINIFERAL STRATIGRAPHY OF MIDDLE JURASSIC TO BASAL CRETACEOUS SHALES, CENTRAL SPITSBERGEN

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ABSTRACT. Foraminiferal distribution data have been used for stratigraphic zonation of a c. 230 m thick sedimentary series comprising the Agardhfjellet and basal Rurikfjellet formations (Callovian to Ryazanian) in central Spitsbergen. The dominant lithologies are organic-rich shales, but siltstones and silty shales with intermediate and low organic content also occur.

The faunas consist almost exclusively of agglutinated taxa, with significant amounts of calcareous forms restricted to a single (Ryazanian) horizon. Altogether, 44 agglutinated and 10 calcareous (Lagenid) species are recorded. The faunal succession is subdivided into eight zones. Age assignments of these are based on regional correlations of foraminiferal occurrences, and macrofaunal associations.

The proposed foraminiferal zones include: (1) *Trochammina rostovzevi* Zone - Callovian; (2) *Recurvoides disputabilis* Zone - Oxfordian; (3) *Haplophragmoides canuiformis* Zone - Lower and Upper Kimmeridgian; (4) *Trochammina rosacea* Zone - uppermost Kimmeridgian and Lower Volgian; (5) *Ammodiscus zaspelovae* Zone - Middle Volgian; (6) *Trochammina* aff. *abrupta* Zone - Middle and Upper Volgian; (7) *Recurvoides obskiensis* Zone - Upper Volgian and lowermost Ryazanian; (8) *Gaudryina* aff. *milleri* Zone - Ryazanian.

Spitsbergen and other areas of the Boreal Realm (western Siberia, the northern North Sea, Sverdrup Basin and western Canada) show an increased development of agglutinated assemblages in Middle Jurassic to Early Cretaceous time. Regionally reduced availability of calcium carbonate associated with locally stagnant conditions are considered critical for this development.

1. Introduction

During the last decade, interest in the Mesozoic geology of Svalbard has increased considerably, both with regard to the main western island Spitsbergen and the smaller eastern islands (Fig. 1). Intensified investigations (including stratigraphy, sedimentology and structural geology) of particularly the Jurassic and Cretaceous of central Spitsbergen (Dypvik et al. in prep., A and B) demonstrate the need for a zonal framework based on microfossils. The present study is intended as a contribution toward this objective.

C. Hemleben et al. (eds.),
Paleoecology, Biostratigraphy, Paleoceanography and Taxonomy of Agglutinated Foraminifera, 969–1015.

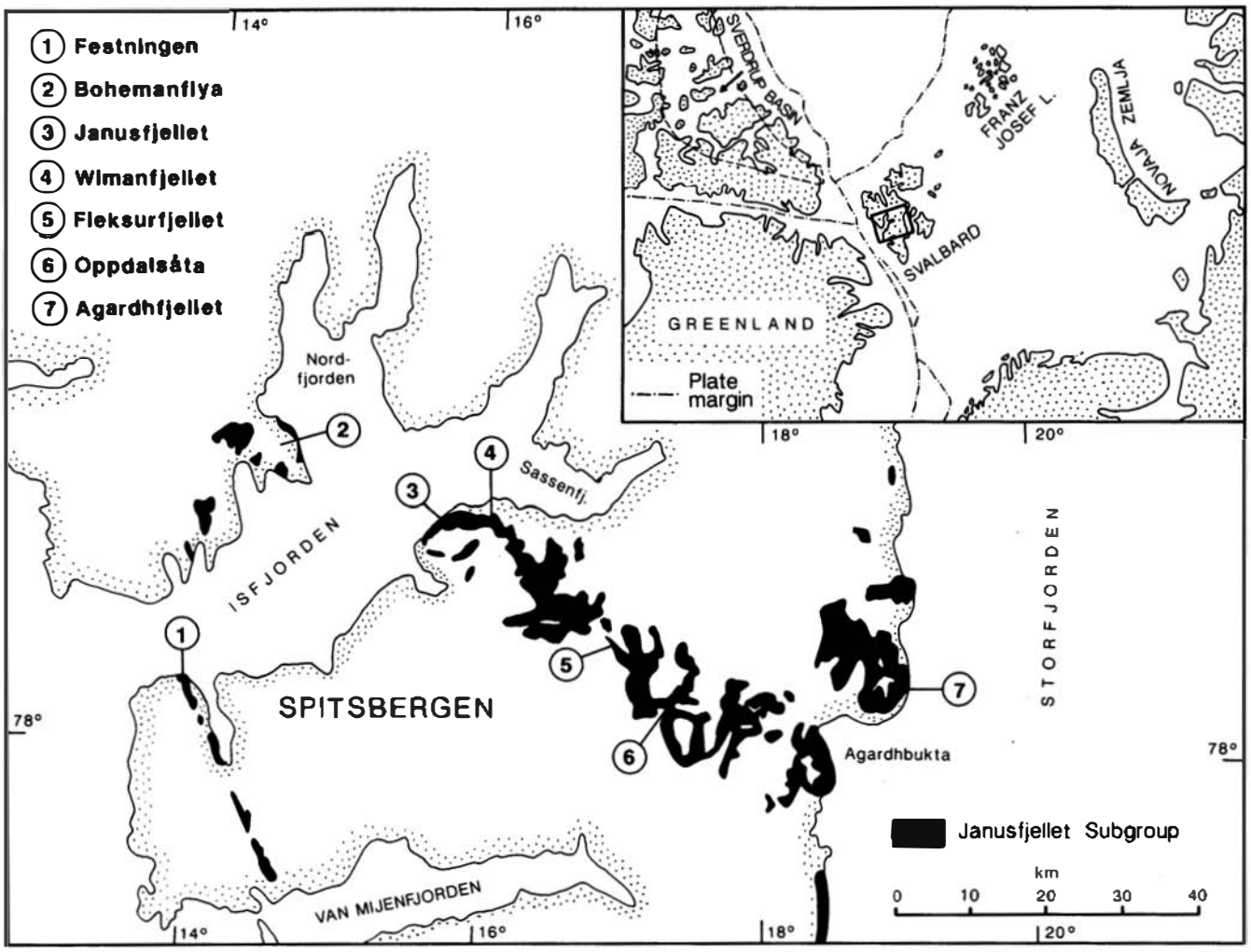

Figure 1. Map of central Spitsbergen showing outcrops of the Janusfjellet Subgroup and localities discussed in text. Insert map - Mesozoic position of Svalbard near Sverdrup Basin and north Greenland (area covered by main map boxed).

This study covers the lower and middle parts of the Janusfjellet Subgroup (Figs. I and 2). More precisely, it deals with the Agardhfjellet Formation and the most basal part of the Rurikfjellet Formation. The study area, referred to as central Spitsbergen, covers the region from Sassenfjorden to Agardhbukta. Here, the Janusfjellet Subgroup is exposed along a NW-SE trending belt coinciding with the NE flank of the Spitsbergen Trough.

Three densely sampled sections located on Janusfjellet, Wimanfjellet and Agardhfjellet form the main basis of the study. The lower 27 m of the Janusfjellet section is located in Konusdalen, 1.3 km from the rest of the section which is located on the northern slope of Janusfjellet. Supplementary samples and observations from additional localities in central Spitsbergen are also included in the paper.

2. Previous work

Investigations of the foraminifera of the Janusfjellet Subgroup began only recently. The first published information consisted of short notes on species occurrences, presented by Klubov (1965) from Wilhelmøya and by Pchelina (1967) from Agardhbukta. An outline description

of the foraminiferal distribution in the Agardhfjellet section was presented by Løfaldli and Thusu (1976).

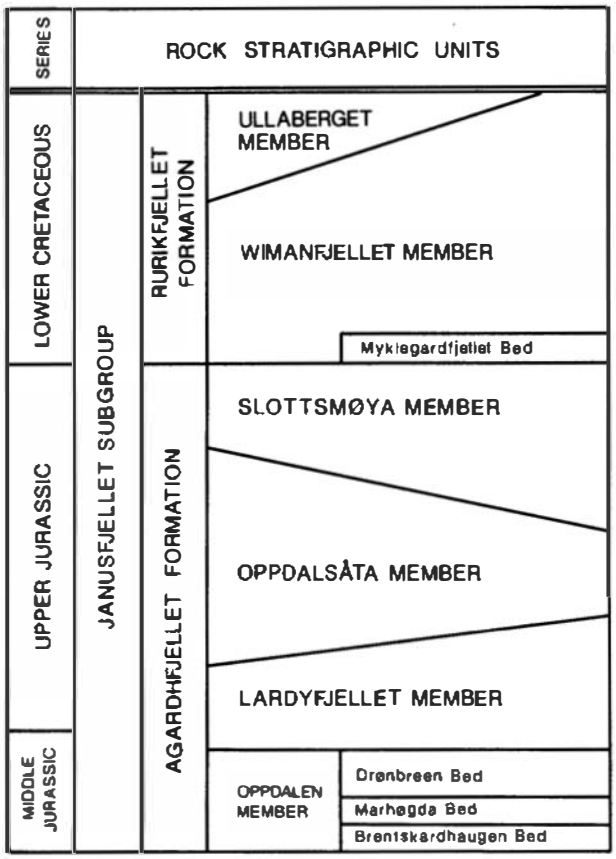

Figure 2. *Stratigraphic scheme of the Middle Jurassic to Lower Cretaceous Janusfjellet Subgroup in central Spitsbergen.*

Papers published subsequently provide more detailed and specialized information. The Jurassic foraminiferal distribution in Kong Karls Land was discussed by Løfaldli and Nagy (1980) with reference to the Hårfagrehaugen section. The regional distribution pattern of foraminifera in the Janusfjellet Subgroup was discussed preliminarily by Nagy and Løfaldli (1981). This was followed by a paper by Løfaldli and Nagy (1983) recording the foraminiferal stratigraphy of the Keilhaufjellet section in southern Spitsbergen. Changing depositional conditions up through the Janusfjellet Subgroup were addressed by Nagy et al. (1988) on the basis of major faunal parameters (species diversity and frequency of genera) combined with lithological features (mainly the organic carbon content). The material for that study was obtained from the Agardhfjellet and Fleksurfjellet sections in central Spitsbergen.

3. Lithostratigraphy and facies

The Janusfjellet Subgroup is a 400 to 600 m thick shale series with subordinate siltstones and sandstones, deposited in various shelf environments. It consists of two formations: The Agardhfjellet (Callovian to Ryazanian) and the Rurikfjellet (Valanginian and Hauterivian).

The subdivision and nomenclature of the subgroup have recently been revised by Dypvik et al. (in prep., A) and their stratigraphical scheme is applied here (Fig. 2).

3.1. THE AGARDHFJELLET FORMATION

This unit has a remarkably uniform thickness in the studied area: 228 m at Wimanfjellet, 226 m at Oppdalsåta and 228 m at Agardhfjellet. Grey to black shales dominate throughout, with subordinate amounts of siltstone and occasionally sandstone. Organic-rich black shales are characteristic of the lower part of the formation, and they also occur locally at higher horizons. There is an overall trend of increasing grain size towards the N and NW. Four members are recognized within the formation and are now briefly described (in ascending order).

3.2. THE OPPDALEN MEMBER

This unit is essentially a fining upwards sequence reflecting a transition from littoral to deeper shelf conditions which developed during the Upper Bathonian - Lower Callovian transgression. It starts with the Brentskardhaugen Bed, a conglomerate typified by its high content of phosphatic pebbles associated with clasts of chert and rock fragments in a sandy matrix. The bed was formed by reworking of the underlying Wilhelmøya Formation, apparently during a Middle Jurassic regression phase and the successive transgression commencing in uppermost Bathonian (Bäckström and Nagy 1985). Directly on top of the conglomerate follows the sandy, oolitic and glauconitic Marhøgda Bed in a fining upwards succession. This in turn is overlain by the Drønbreen Bed, consisting of clay-rich fine sand and silt with a low organic content, grading upwards into grey and black (often papery) shales.

3.3. THE LARDYFJELLET MEMBER

This member is clearly dominated by paper shales which are black, finely laminated and devoid of visible bioturbation. In addition, dark grey shales with increased silt content are present. The paper shales, at least, represent deposition in oxygen deficient environments characterized by a copious supply of organic matter. Thin carbonate - cemented silty beds occur interbedded with the shales. Dolomitic concretions and concretionary beds are observed throughout the unit.

3.4. THE OPPDALSåTA MEMBER:

This interval is characterized by increased content of silt and very fine sand in comparison with the beds above and below. These coarser constituents are concentrated in the upper parts of coarsening upwards sequences, which are best developed in the central part of the study area. The silt- and sand-rich beds are much more heavily bioturbated than the intervening shales. In the Janusfjellet section the member is 125 m thick and contains 3-4 major coarsening upwards sequences. The thickness of the member decreases towards S and SE to only 50 m at Oppdalsåta and Agardhfjellet. The coarsest-grained lithologies are seen at Oppdalsåta where 4-5 coarsening upwards sequences are observed. These sequences are

interpreted as sand ridges deposited in mid-shelf conditions (Dypvik et al. in prep., B).

3.5. THE SLOTTSMOYA MEMBER

The typical lithology of this member is a dark grey, somewhat silty shale containing lens-shaped concretions of sideritic carbonate. The dark grey shales are laterally replaced, wholly or in part, by black paper shales the relative amount of which increases eastwards. In the upper part of the member several minor coarsening upwards sequences are observed at Oppdalsåta. The topmost part of the sequences are commonly rich in bivalve shells and contain the ammonite genus *Dorsoplanites*.

3.6. THE MYKLEGARDFJELLET BED

This is an important marker horizon of plastic clay, up to 2 m thick, easily observable at the boundary between the Agardhfjellet and Rurikfjellet formations. It consists of various subunits of white, yellow to greenish clays, each up to several decimeters thick. The distinct variations in colour are partly due to differential weathering and to the presence of dispersed minerals such as glauconite. The origin of the clays has not been identified, although several interpretations such as altered bentonites, weathering products of carbonate and weathered dolerite, have been put forward. Dypvik et al. (in prep., B) propose a sedimentary marine origin as the clays contain glauconite, foraminifera and belemnites. In the Janusfjellet section numerous intercalations of plastic clay occur in a 12 m thick soft interval including equivalents of the Myklegardfjellet Bed.

4. Material and methods

4.1. STATE OF PRESERVATION AND LABORATORY TREATMENT

The faunas occurring in the studied deposits consist almost exclusively of agglutinated species. Calcareous forms in significant amounts are restricted to a basal horizon of the Rurikfjellet Formation at Agardhfjellet. Outside this horizon only a few calcareous specimens are found scattered in the Agardhfjellet Formation. The agglutinated specimens are usually compressed or more irregularly deformed by compaction. In the agglutinating group, specimens of *Recurvoides* are most commonly well preserved, indicating that this genus is particularly resistant to diagenetic crushing. The calcareous species at the base of the Rurikfjellet Formation occur as body fossils, in a good state of preservation. The few calcareous specimens which occur in the Agardhfjellet Formation are usually poorly preserved internal molds.

The majority of samples treated in this study originate from the well indurated shales forming the main body of the Agardhfjellet Formation. A smaller number of samples consisted of friable siltstones and fine-grained sandstones from the basal part of the Agardhfjellet Formation, and of soft shales and plastic clays from the transition interval between the Agardhfjellet and Rurikfjellet formations. The rock samples were disintegrated in accordance with the so-called kerosene method described by Nagy et al. (1988). A large number of shale samples required several repetitions of this procedure. The paper shales were

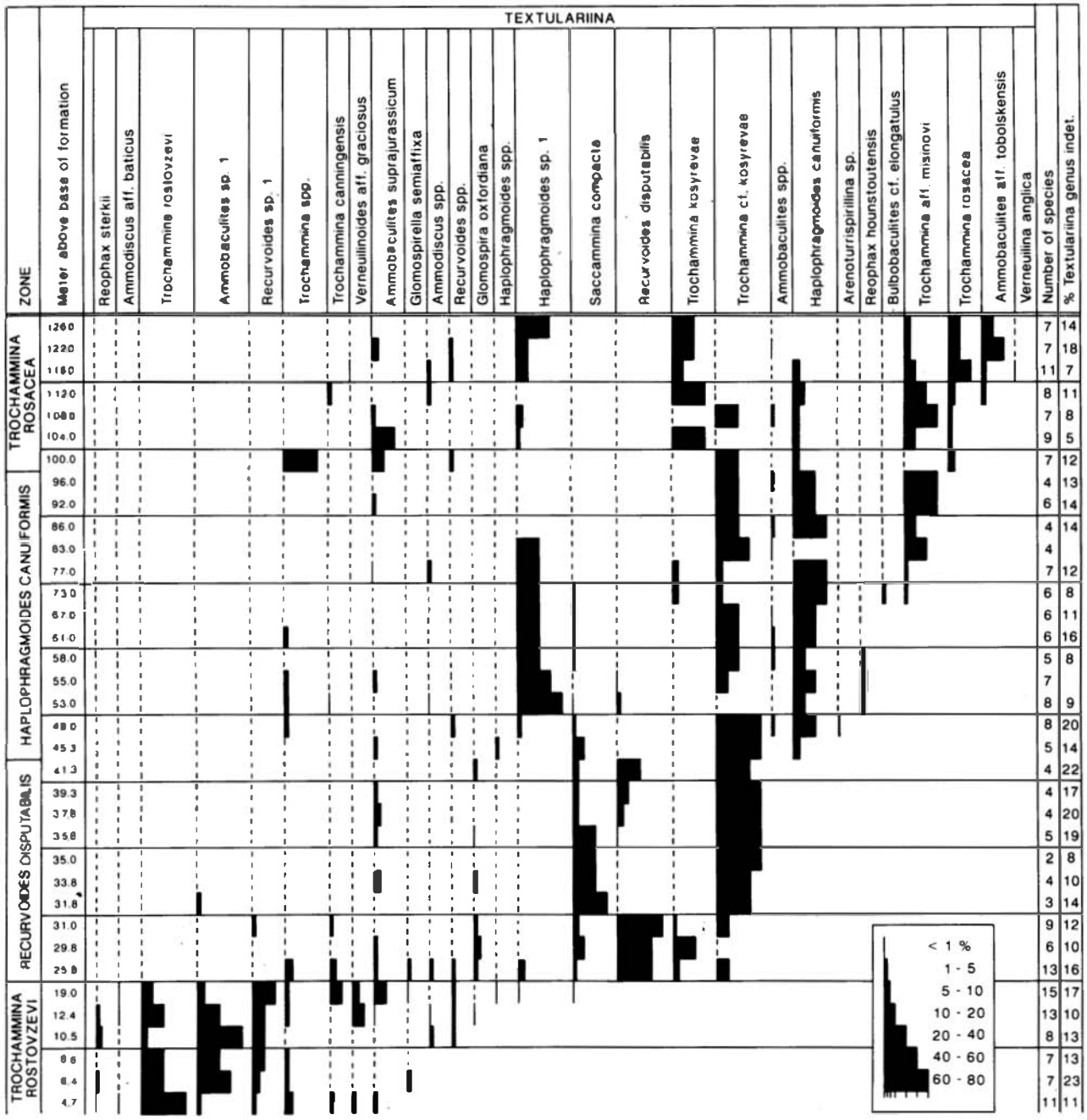

Figure 3. *Stratigraphic distribution of foraminifera in the Janusfjellet section from base to 126 m of the Agardhfjellet Formation. Comprises the faunal succession from the Trochammina rostovzevi Zone to the lower part of the Trochammina rosacea Zone.*

particularly resistant, and required up to four treatments by the kerosene method combined with hydrogen peroxide in order to achieve a sufficient disintegration.

4.2. FAUNAL ANALYSIS AND PRESERVATION

The common use of open nomenclature in this study has two main reasons: the comparatively poor state of preservation of foraminifera in the analysed succession, and the relative paucity

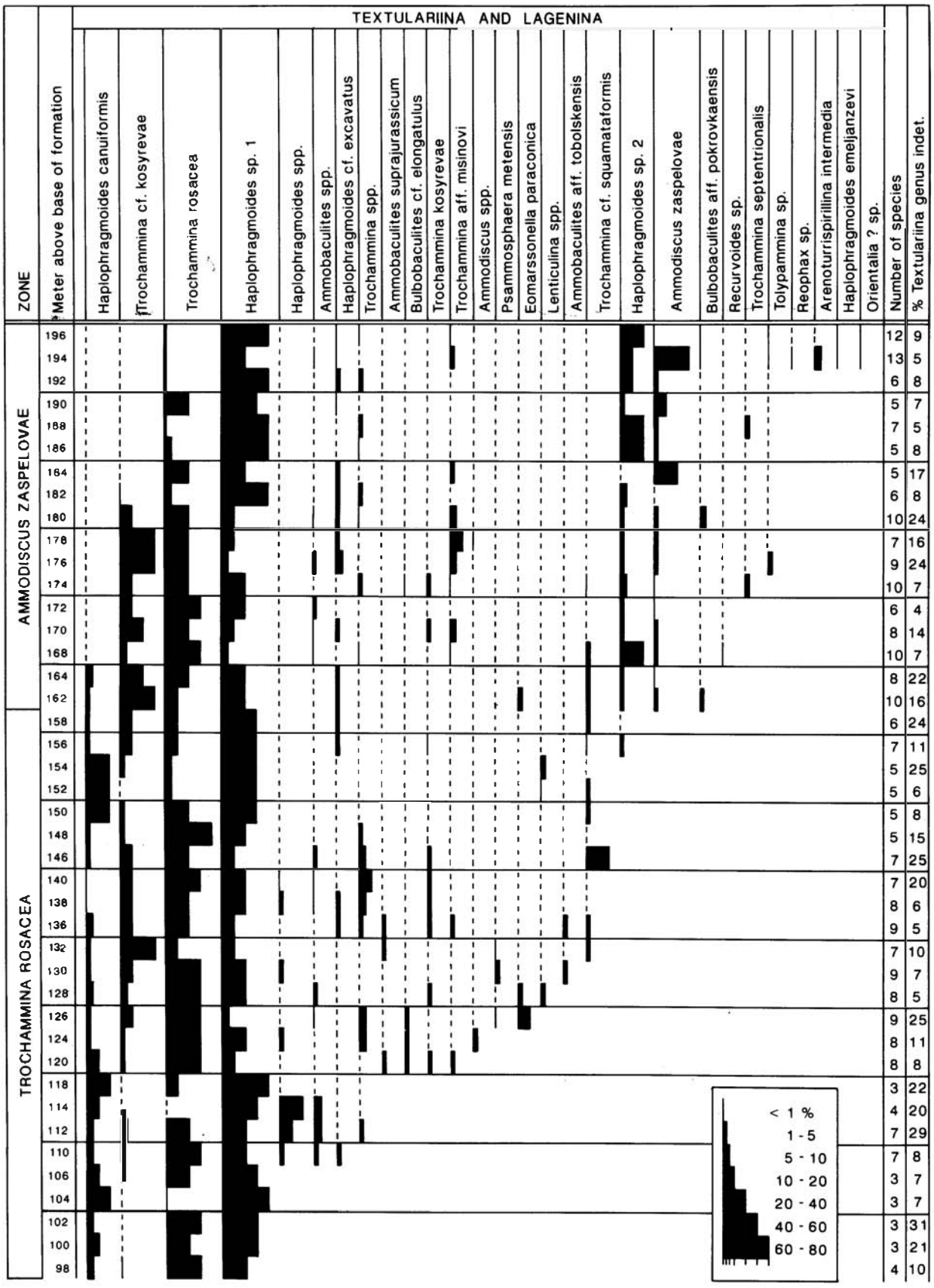

Figure 4. *Stratigraphic distribution of foraminifera in the Agardhfjellet section from 98 to 196 m of the Agardhfjellet Formation. The interval comprises the Trochammina rosacea and Ammodiscus zaspelovae zones.*

of papers dealing with the taxonomy of Jurassic and Cretaceous foraminifera in the Arctic realm. "Textulariina genus indet." is used for agglutinated specimens not identifiable to generic level. Un-numbered "sp." or "spp." are employed for forms identified to the generic level but not sufficiently preserved for closer specific definition. The abbreviation "sp." followed by a number denotes forms which are well defined at the species level, but not more closely identified.

In the range charts (Figs. 3-5) the percentage of Textulariina genus indet. is calculated from the total number of counted specimens. On the other hand, the percentages of taxa distinguished at the specific or generic level are based on the number of counted specimens minus Textulariina genus indet. The number of species is given for a sample size of 300 specimens. The illustrations reproduced in Plate 1 to 6 are reflected light photographs.

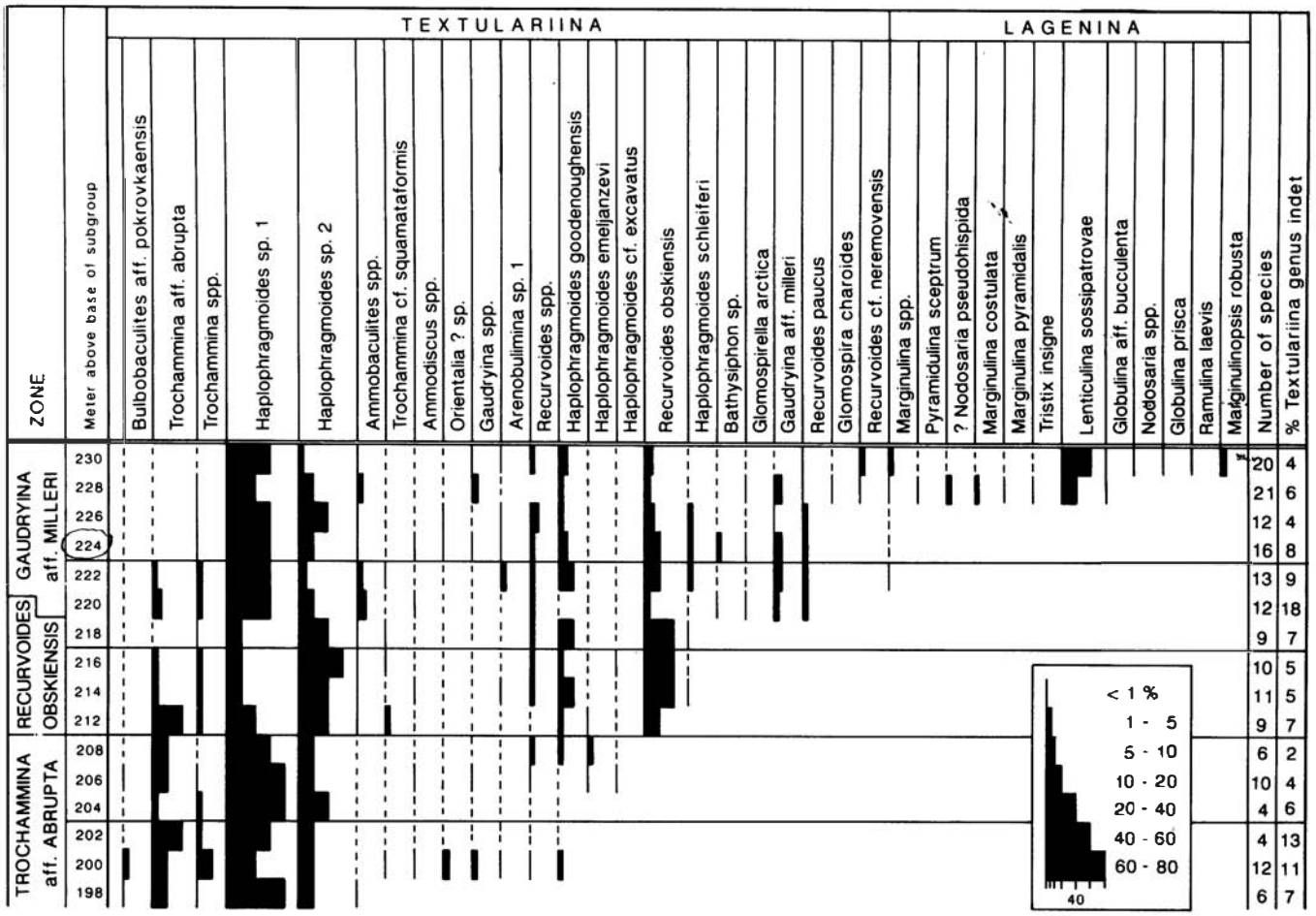

Figure 5. Stratigraphic distribution of foraminifera in the Agardhfjellet section from 198 to 230 m of the Janusfjellet Subgroup. The interval comprises the Trochammina aff. abrupta, Recurvoides obskiensis and Gaudryina aff. milleri zones.

5. Foraminiferal Zonation

The sedimentary succession from the base of the Agardhfjellet Formation to the base of the Rurikfjellet Formation contains an essentially well developed foraminiferal record which is subdivided into eight biostratigraphical zones. The base of each zone is defined by the first

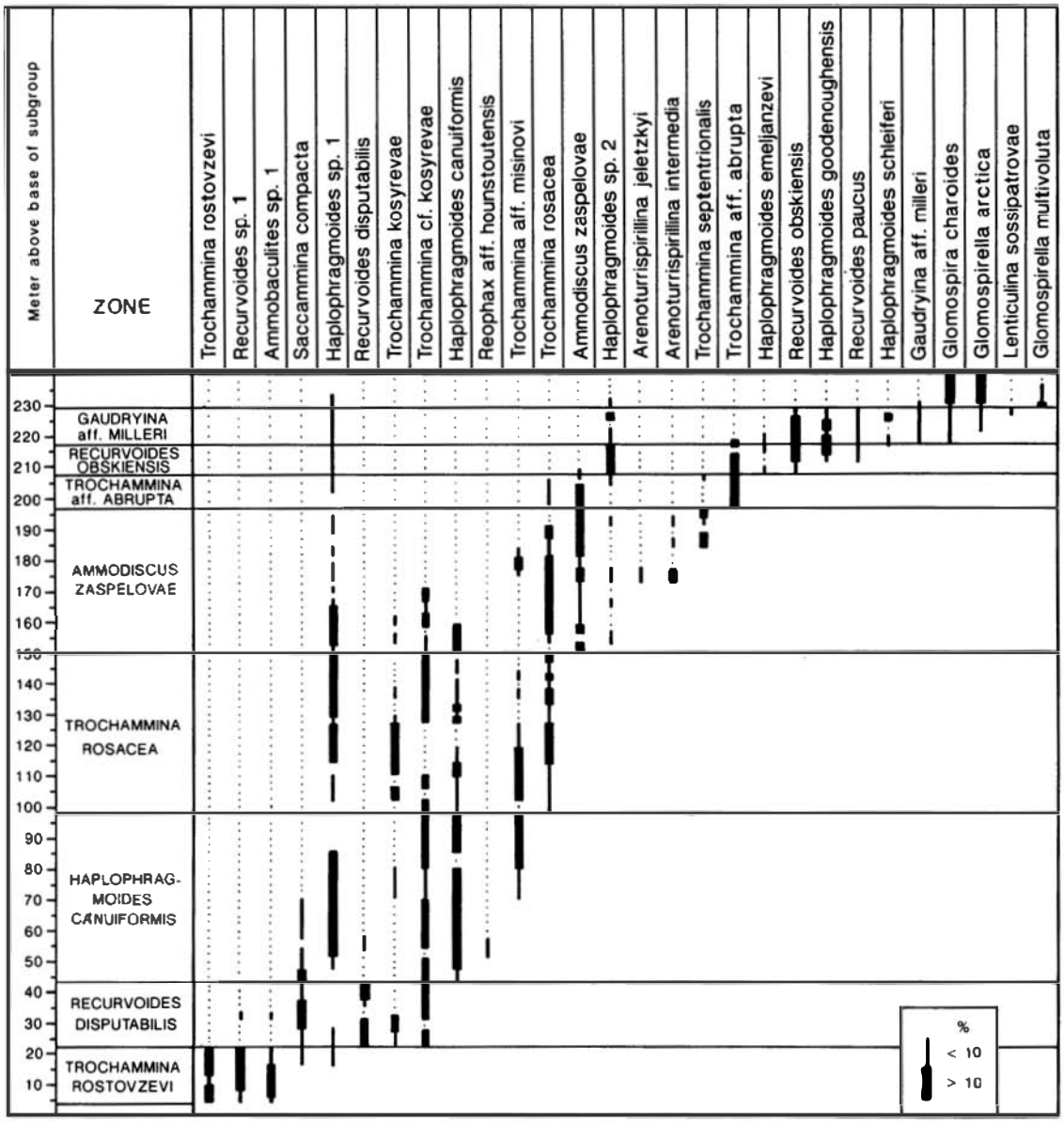

Figure 6. *Distribution of common and stratigraphically significant foraminiferal species in the Janusfjellet section.*

occurrence of its nominate species, while its top is placed at the first occurrence of the species designating the overlying zone. When selecting these zonal markers special emphasis was laid on distinct morphologies still recognizable after considerable diagenetic deformation. Examples of the species composition of each zone are presented in the detailed range charts, Figs. 3 to 5.

In the following list the stratotypes of the proposed zones are given by locality, and position above the base of the Janusfjellet Subgroup: *Trochammina rostovzevi* Zone - Janusfjellet, 4.7 to 19.0 m; *Recurvoides disputabilis* Zone - Janusfjellet, 25.8 to 41.3 m; *Haplophragmoides canuiformis* Zone - Janusfjellet, 45.3 to 96.0; *Trochammina rosacea* Zone - Agardhfjellet, 98.0 to 158.0 m; *Ammodiscus zaspelovae* Zone - Agardhfjellet, 162.0 to 196.0 m; *Trochammina* aff. *abrupta* Zone - Agardhfjellet, 198.0 to 208 m; *Recurvoides obskiensis* Zone - Agardhfjellet 212.0 to 216.0 m; *Gaudryina* aff. *milleri* Zone

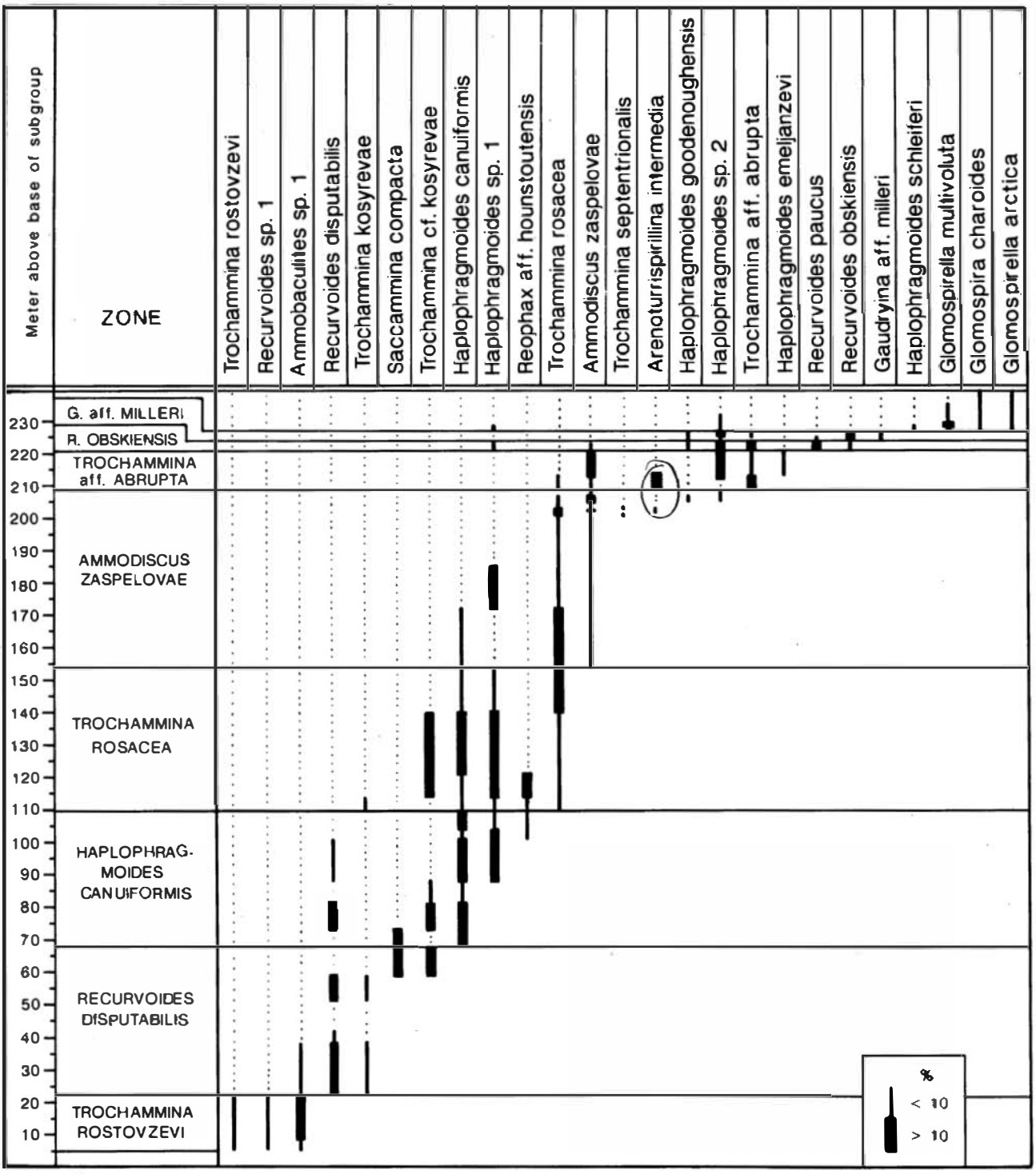

Figure 7. Distribution of common and stratigraphically significant foraminiferal species in the Oppdalsåta section.

- Agardhfjellet, 220.0 to 230.0 m.

The regional applicability of the zonation together with local variations are demonstrated in the three simplified range charts, Figs. 6 to 8. Zonal correlations within the study area are based on the foraminiferal species, while the age assignments are achieved by a combination of foraminiferal and mollusc occurrences.

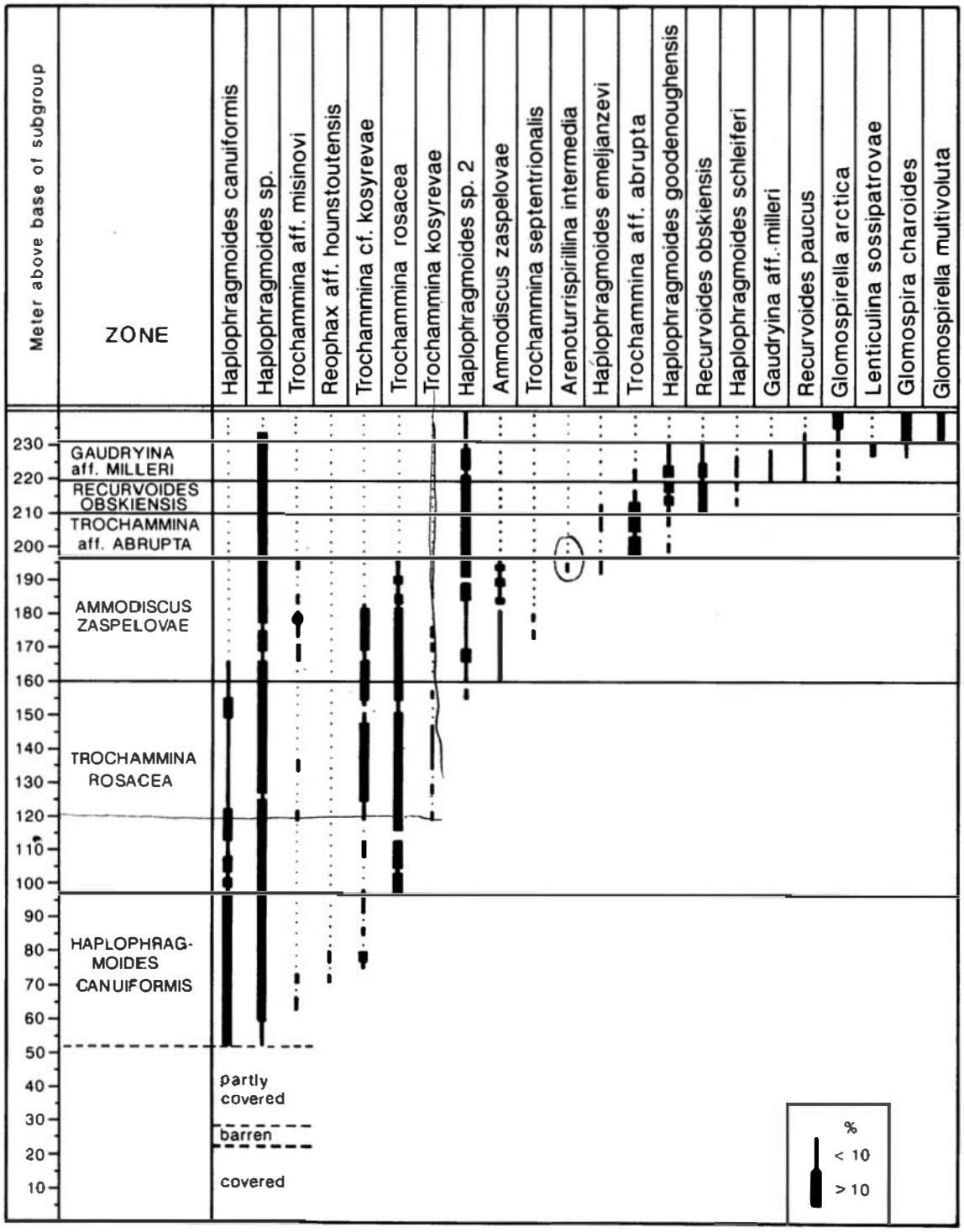

Figure 8. Distribution of common and stratigraphically significant foraminiferal species in the Agardhfjellet section.

5.1. *TROCHAMMINA ROSTOVZEVI* ZONE

The dominant constituent of the zone is *Trochammina rostovzevi* together with *Ammobaculites* sp. 1 and *Recurvoides* sp. 1 (Fig. 3). The number of species varies from 7 to 15 and is high compared to the main part of the Agardhfjellet Formation. The zone occupies a c. 20 m thick interval representing the bulk of the lower, fining upwards portion of the Agardhfjellet

Formation comprising the Drønbreen Bed and the lower strata of the Lardyfjellet Member (Fig. 9). This zone is recognized at Janusfjellet, Fleksurfjellet and Oppdalsåta. In the Agardhfjellet section it is covered with scree.

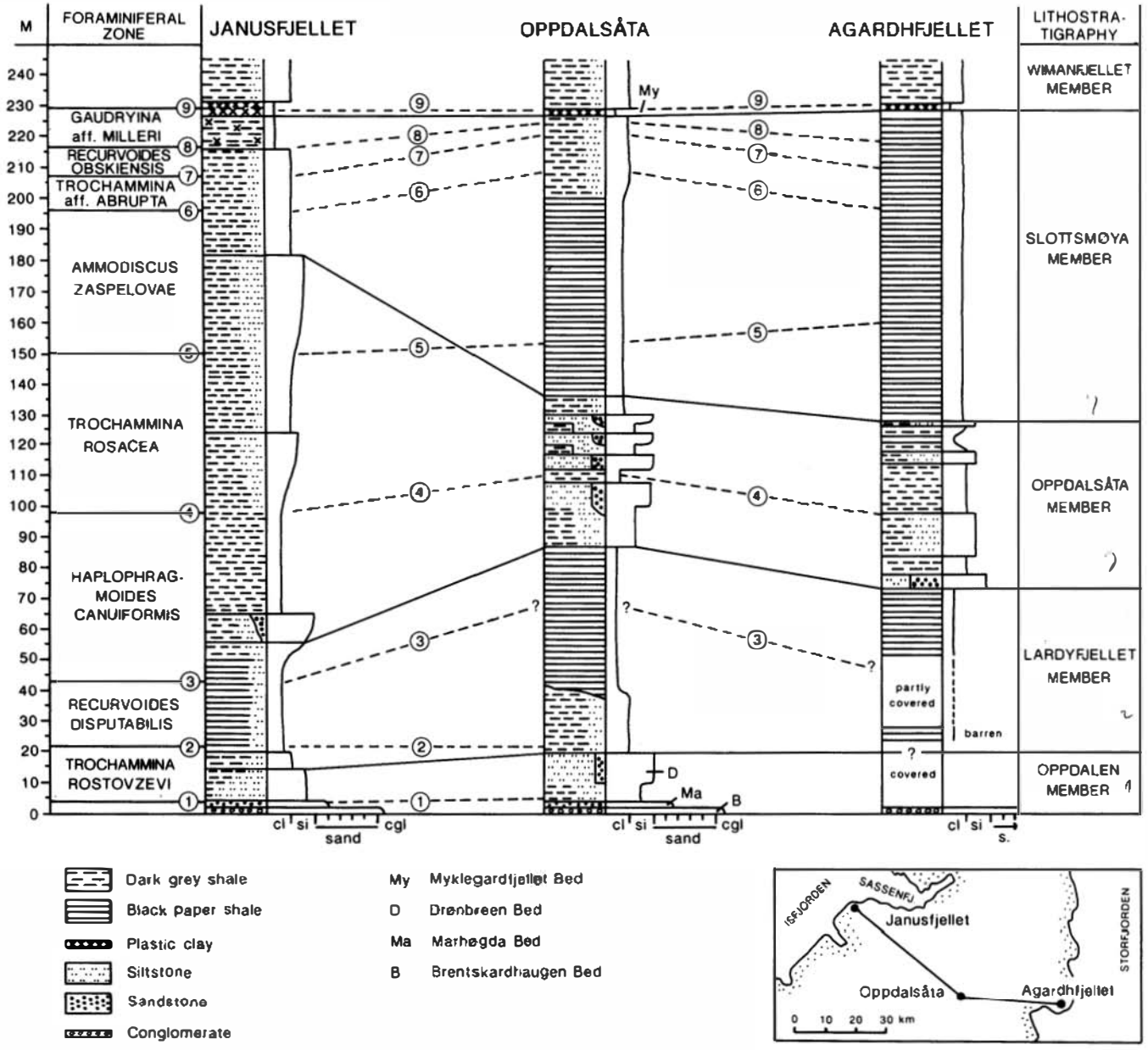

Figure 9. *Correlation of lithologic units and foraminiferal zones of the Janusfjellet, Oppdalsåta and Agardhfjellet sections.*

The basal part of the zone is referred to the lowermost Callovian, because these beds contain *Arcticoceras kochi* Spath and *Arcticoceras* cf. *ishmae* (Keyserling) in Spitsbergen (Erschova 1983), and *A.* cf. *kochi* Spath in Kong Karls Land (Løfaldli and Nagy 1980). The presence of *Kepplerites tychonis* Ravn 5 m above the base of the formation in the Wimanfjellet section indicates that this horizon belongs to the Lower Callovian (*K. tychonis* Zone).

In western Siberia the stratigraphic range of *Trochammina rostovzevi* spans the whole Callovian stage (Dain 1972). However, a Bathonian aspect is imparted to the Spitsbergen zone by the presence of *Ammodiscus* cf. *graniferus* Khabarova, *Ammobaculites* cf. *lapidosus* Gerke and Sharovskaya and *Rhyiadella* aff. *sibirica* (Mjatliuk) at Fleksurfjellet, and *Ammodiscus* aff. *baticus* Dain at Janusfjellet.

5.2. *RECURVOIDES DISPUTABILIS* ZONE

In the Janusfjellet and Oppdalsåta sections the dominant species in the lower part of this zone is *Recurvoides disputabilis*. In the middle of the zone, where the organic-rich black shales dominate, *R. disputabilis* is absent. However, it becomes common again in the upper part of the zone. A typical component of the sparse paper shale fauna is *Saccammina compacta*, which is easily recognizable because of its large size. The presence of this zone at Fleksurfjellet is demonstrated by common occurrence of *R. disputabilis*. In the Agardhfjellet section the interval correlative with this zone is mainly scree covered.

A salient feature of the *R. disputabilis* Zone at Janusfjellet is the high abundance of small specimens belonging to the genus *Trochammina*. In the lower part of the zone these specimens are designated as *T. kosyrevae*, while in higher beds the large number of diagenetically flattened tests are referred to *T.* cf. *kosyrevae*.

The *Recurvoides disputabilis* Zone occurs in the Lardyfjellet Member, which consists mainly of paper shales. The most organic-rich intervals of the member are barren, or show extremely low faunal diversities with species numbers from 2 to 5. The thin segment of paper shale exposed in the lower part of the Agardhfjellet section has an organic carbon content of 12% and is barren of foraminifera. A similarly barren interval is also present in the Oppdalen section.

In western Siberia the stratigraphical range of *R. disputabilis* begins in the Lower Oxfordian, although related forms appear already in the Upper Callovian in eastern parts of the region (Dain 1972). The species continues into the Lower Kimmeridgian, where it is represented by the subspecies *R. disputabilis plana* Dain.

In the Oppdalsåta section ammonites are found at three horizons within this zone. The findings were identified and dated by P.F. Rawson (pers. comm. 1988) as follows: 29 m (above base of formation), *Cardioceras?* sp., possibly Lower Oxfordian; 43 m, *Amoeboceras (Amoebites?)* sp., probably Lower Kimmeridgian; 53 m, *Amoeboceras (Euprionoceras) sokolovi* (Bodylevski), Upper Kimmeridgian.

The top of the *R. disputabilis* Zone is defined by the first appearence of *Haplophragmoides canuiformis*, which in the Oppdalsåta section takes place at 68 m (above base of formation). This first occurrence is located 15 m higher than the above mentioned Upper Kimmeridgian ammonite dating, and 23 m higher than the first occurrence of *H. canuiformis* in the Janusfjellet section. It seems probable that the absence of *H. canuiformis* from comparable low horizons of the Oppdalsåta section reflects conditions which were paleoecologically or preservationally adverse for the species.

5.3. *HAPLOPHRAGMOIDES CANUIFORMIS* ZONE

The most abundant species of the zone is *Haplophragmoides canuiformis*, followed by *Haplophragmoides* sp. 1 and *Trochammina* cf. *kosyreva*. The species diversity increases

slightly relative to the underlying zone.

The lower part of the *H. canuiformis* Zone occurs in the organic-rich paper shales forming the upper part of the Lardyfjellet Member, while its upper part is developed in silty shales, siltstones and fine-grained sandy beds of the Oppdalsåta Member. As mentioned earlier, the base of the zone in the Oppdalsåta section is located 23 m higher stratigraphically than in the Janusfjellet section, owing to the late appearance of identifiable *H. canuiformis* at Oppdalsåta.

H. canuiformis was originally described from Lower Kimmeridgian deposits of western Siberia (Dain 1972). In the Oppdalsåta section the lower part of the range of this species is dated to Upper Kimmeridgian by means of the following three ammonite occurrences (P.F. Rawson, pers. comm. 1988): 75 m, *Xenostephanus?* sp.; 86 m, *Xenostephanus* cf. *ranbyensis* (Arkell and Callomon); 87 m, *Xenostephanus* sp. and *Amoeboceras (Amoebites)* cf. *kitchini* (Salfeld).

The distribution of the large, coarsely agglutinated *Reophax* aff. *hounstoutensis* is associated with intervals showing increased grain size. The species is observed at the following localities and levels: Janusfjellet section from 53 to 55 m, just at the base of the first coarsening upward sequence of the Oppdalsåta Member; Oppdalsåta section from 102 to 122 m, in the middle of the Oppdalsåta Member; Agardhfjellet section from 72 to 78 m, just below the base and within the lower part of the Oppdalsåta Member; Wimanfjellet from 80 to 118 m; Fleksurfjellet from 63 to 77 m.

5.4. TROCHAMMINA ROSACEA ZONE

The quantitatively most important taxa of the zone are *Haplophragmoides* sp. 1, *Trochammina rosacea* and *Trochammina kosyrevae* together with *Haplophragmoides canuiformis* and the group designated *T.* cf. *kosyrevae*. A robust marker species in the middle of the zone is *Ammobaculites* aff. *tobolskensis*, occurring in the 112–126 m interval of the Janusfjellet section and the 130–136 m interval of the Agardhfjellet section. The small but distinct species *Eomarssonella paraconica* is observed in the Agardhfjellet section at 126 and 128 m, but it occurs again also at the base of the *Ammodiscus zaspelovae* Zone at 162 m.

In the Janusfjellet section the *Trochammina rosacea* Zone occupies the middle part of the thick, silty shale dominated interval which is correlated with the Oppdalsåta Member. From this locality the zone can be followed southeastwards, across Wimanfjellet, Fleksurf-jellet and Oppdalsåta to Agardhfjellet. At the latter two localities it is developed in the upper half of the Oppdalsåta Member and the lower part of the finer-grained Slottsmøya Member.

In western Siberia *Trochammina rosacea* is widespread in Middle and Upper Volgian deposits (Sharovskaya 1968, Dain 1972). Its range in Spitsbergen extends downwards into the Upper Kimmeridgian. From Myklegardfjellet (close to the Agardhfjellet section) three mollusc faunules are recorded by Birkenmajer et al. (1982): at 113 m a belemnite faunule suggests an Upper Kimmeridgian age; at c. 126 m bivalve occurrences are considered as Upper Kimmeridgian or Lower Volgian; at 135 m a probable Lower Volgian age is proposed for a faunule consisting mainly of bivalves.

5.5. *AMMODISCUS ZASPELOVAE* ZONE

The base of the zone is defined by the first occurrence of *Ammodiscus zaspelovae*. In the

Agardhfjellet section its stratigraphic range terminates at the top of this zone, which is defined by the appearance of *Trochammina* aff. *abrupta*. At Janusfjellet and Oppdalsåta the range of *A. zaspelovae* extends higher, into the base of the *Recurvoides obskiensis* Zone. Dominant species of the *A. zaspelovae* Zone include *Trochammina rosacea* and the long ranging *Haplophragmoides* sp.1. Characteristic constituents of the zone are *Haplophragmoides* sp.2, *Trochammina septentrionalis* and *Arenoturrispirillina intermedia*, although these also occur at higher horizons. The range of *Haplophragmoides canuiformis* terminates in this zone.

At Janusfjellet the *A. zaspelovae* Zone extends through the upper part of the Oppdalsåta Member and the lower beds of the Slottsmøya Member. Farther to the southeast, at Oppdalsåta and Agardhfjellet, it occupies the middle part of the Slottsmøya Member, owing to reduction in thickness of the Oppdalsåta Member in this direction (Fig. 9). The zone is also recognized at Festningen, Wimanfjellet and Fleksurfjellet.

Within the study area the faunal events marking zonal boundaries seem essentially unaffected by lithological changes from section to section. This is demonstrated by the boundaries between the four upper zones of the Agardhfjellet Formation, which cut through slightly different lithologies from section to section. These lithologies are dark grey silty shales in the Janusfjellet and Oppdalsåta sections, and black paper shales in the Agardhfjellet section (Fig. 9). Another example is the base of the *A. zaspelovae* Zone, which has an almost uniform elevation above the base of the formation: 150 m at Janusfjellet, 156 m at Oppdalsåta and 160 m at Agardhfjellet. Between Janusfjellet and Oppdalsåta this boundary cuts the strongly diachronous upper contact of the Oppdalsåta Member.

The *A. zaspelovae* Zone is assigned to the Middle Volgian, a correlation indicated both by its foraminiferal and macrofossil content. In western Siberia the *A. zaspelovae* Zone has a wide regional distribution in Middle Volgian strata (Dain 1972). In Spitsbergen the two morphologically distinct and stratigraphically important species, *Trochammina septentrionalis* and *Haplophragmoides schleiferi*, first appear in the middle and upper part of this zone, while in the Soviet Arctic they occur in Middle, or more commonly, Upper Volgian deposits. At Oppdalsåta the upper part of the *A. zaspelovae* Zone (approximately 198 m above base of formation) contains numerous specimens of *Dorsoplanites* sp. indicating a Middle Volgian age (P.F. Rawson, pers. comm.). At Myklegardfjellet *Pectinites (?Virgatosphinctes)* sp. occurring at 193 m suggests a Lower or lower Middle Volgian age (Birkenmajer et al. 1982).

5.6. *TROCHAMMINA* aff. *ABRUPTA* ZONE

The base and top of the zone are defined by the first occurrences of *Trochammina* aff. *abrupta* and *Recurvoides obskiensis*, respectively. Common species throughout the zone are *T.* aff. *abrupta*, and more locally *Ammodiscus zaspelovae*, *Haplophragmoides* sp. 1 and *Haplophragmoides* sp. 2. This zone is developed in a 12 to 14 m thick interval of the Slottsmøya Member, and is recognized at Janusfjellet, Wimanfjellet, Fleksurfjellet, Oppdalsåta and Agardhfjellet.

The zone contains typical Middle and Upper Volgian faunal elements such as *Haplophragmoides emeljanzevi* and *Trochammina septentrionalis*. The stratigraphical range of *Haplophragmoides goodenoughensis* begins around the base of this zone and extends beyond the top of the analyzed succession. The species was originally described from the Barremian of the Mackenzie District, Canada (Chamney 1969), and later recorded from the upper

Volgian of the Sverdrup Basin (Wall 1983). In the Oppdalsåta section the presence of *Dorsoplanites maximus* Spath just above the base of the *T.* aff. *abrupta* Zone (211 m above base of formation) indicates a Middle Volgian age (P.F. Rawson, pers. comm. 1988).

5.7. *RECURVOIDES OBSKIENSIS* ZONE

Common faunal elements in this zone are *Recurvoides obskiensis*, *Haplophragmoides goodenoughensis* and *Haplophragmoides* sp. 2, while *Trochammina* aff. *abrupta* is still frequent. Other stratigraphically significant species include *Haplophragmoides schleiferi*, *H. emeljanzevi* and *Recurvoides paucus*. The zone is developed in the upper part of the Slottsmøya Member.

The *R. obskiensis* Zone contains both Volgian and Ryazanian faunal components recorded from western and central Siberia, suggesting an age near the transition between the two stages: The nominate species *R. obskiensis* is recorded from uppermost Volgian to Hauterivian deposits by Romanova (in Glazunova et al. 1960) and Saks (1972), while Dain (1972) tabulated *R.* ex gr. *obskiensis* from Middle and Upper Volgian strata. *Haplophragmoides emeljanzevi* is essentially a Middle and Upper Volgian species as it appears in the stratigraphic treatments by Basov (1968), Sharovskaya (1968), Dain (1972) and Saks (1972). *Haplophragmoides schleiferi* is reported from Volgian and Ryazanian sediments by Sharovskaya (1968) and Saks (1972). The small but distinct *Recurvoides paucus* is depicted from Ryazanian and Hauterivian beds by Dubrovskaya (1962) and Bulynnikova (1967).

5.8. *GAUDRYINA* aff. *MILLERI* ZONE

The faunal signals marking the base and top of the zone are the first appearances of *Gaudryina* aff. *milleri* and *Glomospirella multivoluta*, respectively. Species occurring frequently in the zone are *Recurvoides obskiensis*, *Haplophragmoides* sp. 2 and, more locally, *Haplophragmoides goodenoughensis* and *Haplophragmoides* sp. 1.

The *Glomospira*- and *Glomospirella*-dominated fauna typical for the lower part of the Rurikfjellet Formation begins to develop in this zone, with the sporadic occurrence of *Glomospira charoides* and *Glomospirella arctica*. A striking feature of the zone is the high frequency of calcareous foraminifera in a thin horizon of the Agardhfjellet section. The calcareous component there reaches 25% and is dominated by *Lenticulina sossipatrovae*. This species is also represented in the Janusfjellet section by a few specimens. The zone includes the plastic clays of the Myklegardfjellet Bed which is 50 cm thick at Oppdalsåta and 50-100 cm at Myklegardfjellet (Birkenmajer et al. 1982). At Janusfjellet the zone occupies a 12 m thick interval containing several horizons of plastic clay.

The fauna of this zone shows a marked affinity with Siberian faunas of Ryazanian age and is referred to this stage. The stratigraphically most significant species of the zone, and their occurences in Siberia (on the basis of Bulynnikova 1967, Sharovskaya 1968, Saks 1972 and Dain 1972) are: *Recurvoides obskiensis*, uppermost Volgian to Lower Hauterivian; *Recurvoides paucus*, Berriasian to Lower Hauterivian; *Haplophragmoides schleiferi*, Volgian to Ryazanian; *Lenticulina sossipatrovae*, Ryazanian to Lower Valanginian, rare in Volgian.

The faunule developed immediately above the *Gaudryina* aff. *milleri* Zone is typified by the presence of large specimens of *Glomospirella multivoluta*. This species ocurs in Valanginian deposits in the western Siberian lowland, according to Romanova (in Glazunova

et al. 1960).

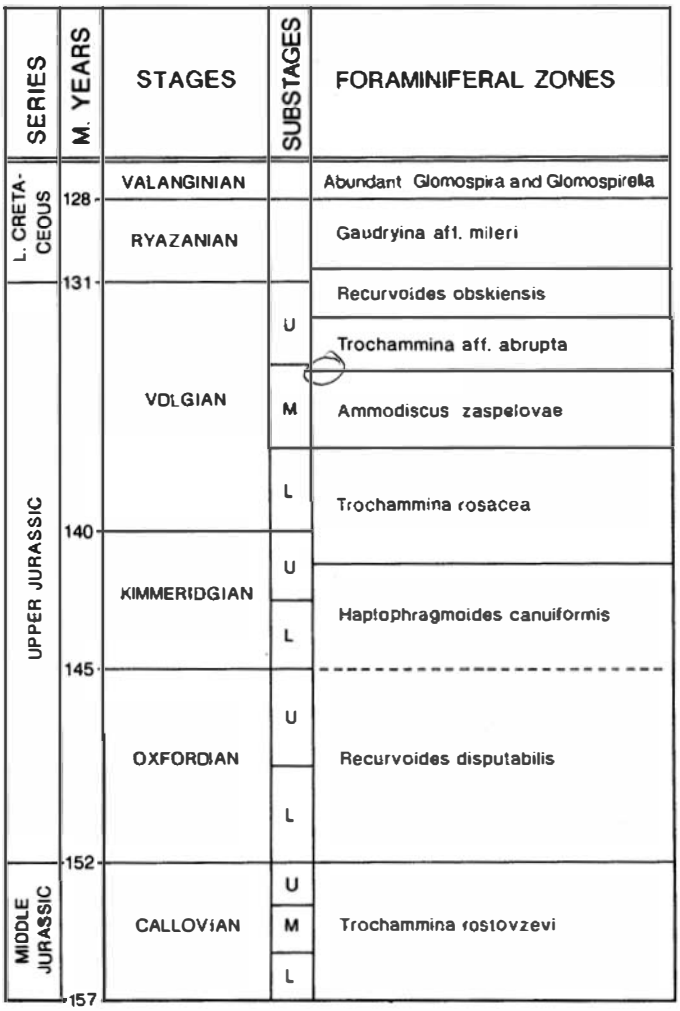

Figure 10. Age relationships of the eight foraminiferal zones recognized in the Callovian to Ryazanian succession of central Spitsbergen.

6. Faunal Comparison with Other Regions

Foraminiferal faunas displaying obvious similarities with the Spitsbergen assemblages have been described from the Middle Jurassic to basal Cretaceous interval of several northern areas (Figs. 11 and 12). Important information concerning faunal composition in these areas is recorded by the following authors: Sverdrup Basin - Souaya (1976), Wall (1983); western Siberia - Dain (1972); northwestern Europe - Barnard et al. (1981), Gordon (1967), Morris and Coleman (1989), Norling (1972); western Canada - Brooke and Braun (1981); Arctic Slope of Alaska - Tappan (1955). Further details about the regional distribution of species are given in the taxonomical part of the present paper.

At the species level the Spitsbergen assemblages show closest affinities with western Siberia and the Sverdrup Basin. The similarities with northwestern Europe are less, and they are weaker still with western Canada and the Arctic Slope of Alaska. In western Siberia 39% of the Spitsbergen species are represented by identical taxa, and 28% have closely related counterparts. In the Sverdrup Basin 28% the Spitsbergen species are represented by identical taxa, and 44% have close relatives. In the other areas the following proportions of the Spitsbergen species are present: northwestern Europe - 22%, western Canada - 11%, Arctic Slope of Alaska - 8%.

As mentioned above, significant amounts of calcareous foraminifera are found at just

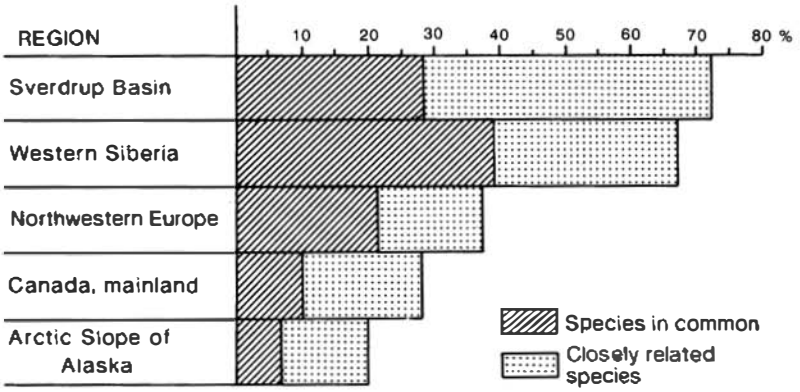

Figure 11. Percentage of Spitsbergen foraminiferal taxa occuring in five other regions.

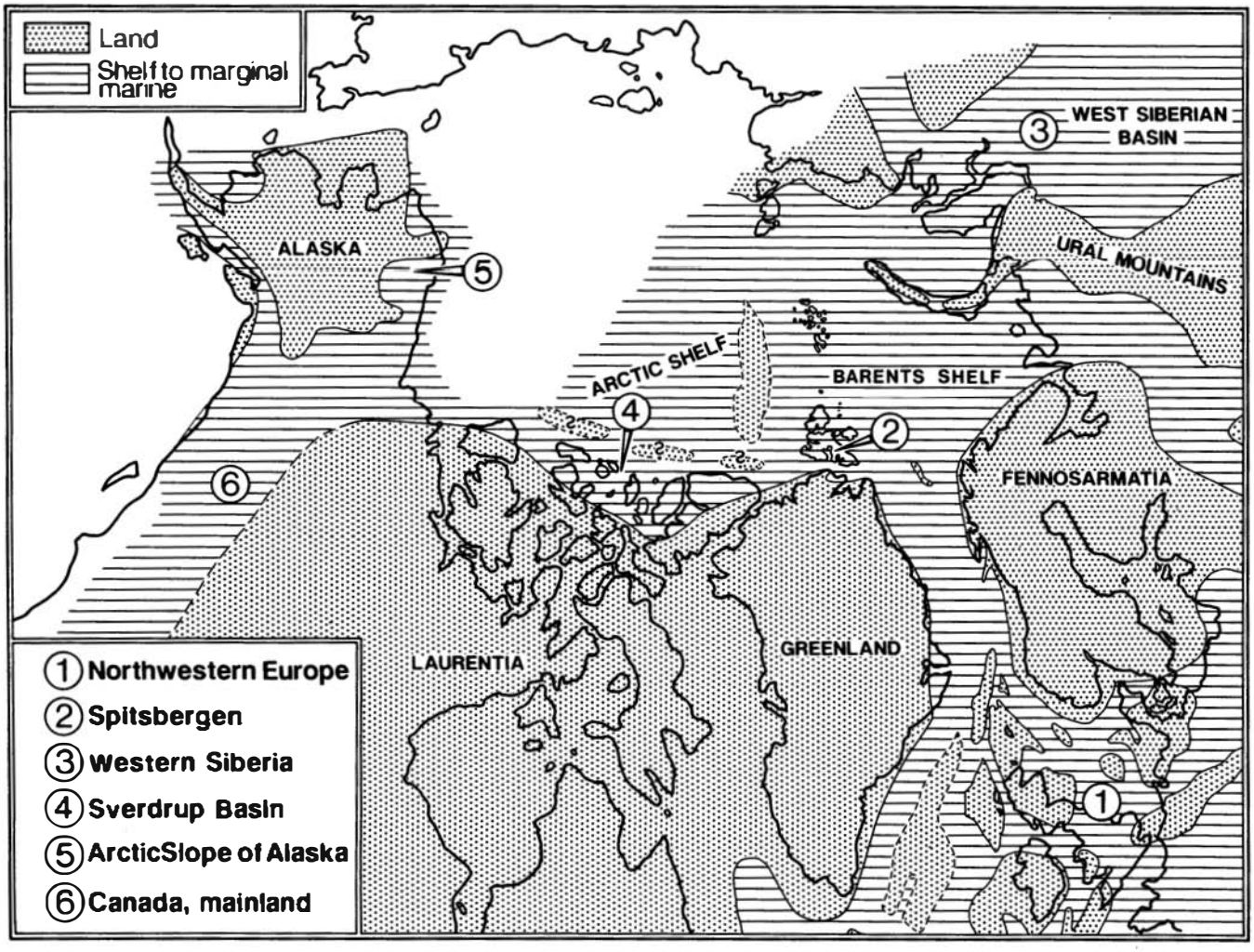

Figure 12. Paleogeographic map for the Upper Jurassic showing position of areas containing foraminiferal faunas which are compared with those from central Spitsbergen. (Paleogeography based on Imlay (1984) and Ziegler (1988)).

one horizon, of Ryazanian age, within the studied Spitsbergen succession. Faunal similarities with normal marine shelf facies of northwestern Europe are almost entirely restricted to the calcareous faunal component developed at this horizon. The agglutinated assemblage found

in the grey to black shales forming the Middle and Upper Jurassic succession of Spitsbergen are, however, closely similar to contemporary faunas of the northern North Sea Basin. These North Sea faunas are predominantly agglutinated and occur in grey to dark grey shales deposited under partly restricted marine conditions.

A striking feature common to many assemblages of the Middle Jurassic to Lower Cretaceous of Northern areas is that they contain a large proportion, or consist exclusively of agglutinated taxa. In addition to Spitsbergen, assemblages of this type are recorded from western Siberia, the northern North Sea Basin, the Sverdrup Basin and western Canada.

It seems highly probable that a significant portion of these similarities can be explained by the affiliation of the mentioned areas to the same major, northern paleogeographical province (Fig. 12), the Boreal Realm. Within this realm, distance appears to have been of little importance for development of faunal affinites, as shown by the fact that in Jurassic time Spitsbergen was located much closer to the Sverdrup Basin than to western Siberia, yet its foraminiferal assemblages are almost equally similar to the faunas of both these areas. The distance from Spitsbergen to western Siberia, northwestern Europe and the Arctic Slope of Alaska was almost equal, yet there are great differences in the species composition of their faunas (Fig. 11). It seems reasonable therefore to assume that similarity between local environments was an important factor responsible for the faunal affinities observed at the species level.

In contrast, the potential for development of agglutinated assemblages appears to have been a regional feature typifying the Boreal Realm. Reduced availability of dissolved calcium carbonate appears to have been a critical regional factor leading to increased tendency to develop agglutinated assemblages in this province. Increased influx of organic matter producing low pH was probably of particular importance in this connection. In certain areas, high organic sedimentation resulted in reduced oxygen levels, acting as an additional factor with restricting influence on the fauna. Such conditions are reflected by organic-rich black shales which are common features of the region (e.g. the Kimmeridge Clay Formation of the North Sea Basin, the Lardyfjellet Member in Spitsbergen and the Ringnes Formation of the Sverdrup Basin).

7. Conclusions

The Agardhfjellet Formation and the basal beds of the Rurikfjellet Formation (Callovian to Ryazanian) in central Spitsbergen contain a varied foraminiferal succession consisting almost exclusively of agglutinated taxa. Calcareous species are found in significant amounts only at the base of the Rurikfjellet Formation at Agardhfjellet. The faunas are strongly affected by diagenetic deformation, which is the main reason for the extensive use of open nomenclature. The proportion of preliminary identifications can, however, be considerably reduced by future detailed taxonomic work based on the well-preserved specimens, although these are rather rare.

This study demonstrates the applicability of agglutinated foraminifera for stratigraphical zonation in formations where other microfossils are sparse or very poorly preserved. The following eight foraminiferal zones are proposed: (1) *Trochammina rostovzevi* Zone - Callovian, recognized in the basal fining upwards portion of the Agardhfjellet Formation; (2) *Recurvoides disputabilis* Zone - Oxfordian, includes much of the paper shales of the

Lardyfjellet Member; (3) *Haplophragmoides canuiformis* Zone - Lower and partly Upper Kimmeridgian, occurs in the upper Lardyfjellet and lower Oppdalsåta members; (4) *Trochammina rosacea* Zone - uppermost Kimmeridgian and Lower Volgian, occupies the middle of the Oppdalsåta Member in the northwest and the upper Oppdalsåta and lower Slottsmøya members in the southeast; (5) *Ammodiscus zaspelovae* Zone - Middle Volgian, occurs in the upper Oppdalsåta and lower Slottsmøya members in the northwest and the middle Slottsmøya Member in the southeast; (6) *Trochammina* aff. *abrupta* Zone - Middle and Upper Volgian, occurs in the Slottsmøya Member; (7) *Recurvoides obskiensis* Zone - Upper Volgian and lowermost Ryazanian, found in the upper part of the Slottsmøya Member; (8) *Gaudryina* aff. *milleri* Zone - Ryazanian, includes the Myklegardfjellet Bed at the base of the Rurikfjellet Formation.

Each zone is defined as the interval extending from the first occurrence of its nominate species to the first appearance of the nominate species of the overlying zone. The greatest detail in zonation is achieved near the Jurassic-Cretaceous boundary owing to increased faunal diversities and better preservation compared to the organically richer shales below.

The zonal markers have an essentially similar spacing in the sedimentary columns of the three sections analyzed in detail, producing an almost parallel course of the zonal boundaries from section to section. An exception is the basal marker of the *Haplophragmoides canuiformis* Zone. The nearly parallel pattern suggests quite homogeneous sedimentation rates regionally. In this context it is important to note that the rather modest lithological variations between sections have not significantly changed the relative positions of the zonal markers.

A salient feature of several northern areas is the occurrence of partly or entirely agglutinated assemblages in the Middle Jurassic to Lower Cretaceous interval. In addition to Spitsbergen such assemblages are recorded from western Siberia, the northern North Sea Basin, the Sverdrup Basin and western Canada. These areas belong to the same major paleogeographical province, the Boreal Realm, where reduced availability of dissolved calcium carbonate seems to have been a critical factor leading to development of agglutinated assemblages. In this connection dysaerobic to anaerobic conditions were also of importance in parts of the realm.

On the species level, the Spitsbergen faunas show close similarities with western Siberia, the northern North Sea Basin and the Sverdrup Basin.

8. Taxonomy

In the samples studied, 54 foraminiferal species are recognized, 44 of which belong to the suborder Textulariina and 10 to Lagenina. The open nomenclature "cf.", "aff." or numbered "sp." is used for 17 of these species. Un-numbered "sp." and "spp." recorded in the range charts are omitted from the following descriptions. The genera are arranged in accordance with the classification proposed by Loeblich and Tappan (1988).

The aim of the present study has been to provide a zonal framework, and the extent of taxonomical treatment is modified to this purpose. Consequently, the taxonomic presentation of species in this chapter is limited to one to three pertinent references, short morphological remarks and information concerning stratigraphic distribution. More detailed taxonomic treatment of the Spitsbergen faunas will be forthcoming in future publications.

Psammosphaera metensis (Terquem)
Plate 1, figure 1
Annulina metensis Terquem 1862, p. 433, pl. 5, figs. 6a-b.
Psammosphaera ? metensis (Terquem).-- Løfaldli and Nagy 1980, p. 75, pl. 1, fig. 13.
In central Spitsbergen only a single specimen of *P. metensis* was found, in the *Trochammina rosacea* Zone at Agardhfjellet. The species has been reported previously from Lower and Middle Jurassic deposits in Western Europe and Spitsbergen (Brouwer 1969, Løfaldli and Nagy 1980).

Saccammina compacta Gerke
Plate 1, figures 2-3
Saccammina compacta Gerke.-- Sharovskaya 1968, fig. in stratigraphical table.-- Lutova 1981, pl. 1, fig. 1; pl. 8, fig. 1.-- Basov et al. 1989, p. 65, fig. 2, 2.
The Spitsbergen specimens referred to *S. compacta* have a subcircular outline and fine-grained wall. All tests are diagenetically compressed. The species was recorded earlier from Bathonian and Callovian deposits in Siberia by Sharovskaya (1968) and Lutova (1981). In Spitsbergen, *S. compacta* is found mainly in the *Recurvoides disputabilis* and *Haplophragmoides canuiformis* zones at Janusfjellet and Oppdalsåta.

Ammodiscus aff. *baticus* Dain
Plate 1, figure 8
Aff. *Ammodiscus baticus* Dain 1948, p. 67, pl. 1, figs. 5-6.-- Khabarova 1959, p. 474, pl. 1, fig. 1.
Because of insufficient preservation it is difficult to decide whether these specimens belong to *A. baticus* or not. Where parts of the original wall surface are visible the tests show a very fine-grained texture. Large grains obscuring the test surface are assumed to have been attached secondarily during diagenesis. Radial striae typical for *A. baticus* are scarcely visible in the present specimens. In Spitsbergen, this form is recorded from the *Trochammina rostovzevi* Zone at Janusfjellet.

Ammodiscus zaspelovae Kosyreva
Plate 1, figures 4-7
Ammodiscus zaspelovae Kosyreva.-- Sharovskaya 1968, fig. in stratigraphical table.-- Kosyreva in Dain 1972, p. 37, pl. 3, figs. 1-6.
The specimens from Spitsbergen are mostly compressed, but correspond in shape and fine-grained wall texture to the type material illustrated by Kosyreva (in Dain 1972). Some of the Spitsbergen individuals show more or less densely spaced constrictions, but smooth tests are also common.

A. zaspelovae has been recorded from Volgian strata of western and central Siberia (Sharovskaya 1968, Dain 1972). In Spitsbergen, the species is found mostly in the *Ammodiscus zaspelovae* Zone at Janusfjellet, Wimanfjellet, Fleksurfjellet, Agardhfjellet, Oppdalsåta and Festningen.

Arenoturrispirillina intermedia Chamney
Plate 1, figures 9-10
Arenoturrispirillina intermedia Chamney 1971, p. 105, pl. 18 A-B, figs. 3-5.
This species differs from *A. jeletzkyi* in having larger dimensions and higher conical coiling. *A. intermedia* was originally described from Kimmeridgian and Portlandian strata of the Mackenzie district and Arctic Archipelago of Canada (Chamney 1971). In central Spitsbergen, it is found in the *Ammodiscus zaspelovae* Zone of the Agardhfjellet, Janusfjellet and Oppdalsåta sections. It occurs also in the *Trochammina* aff. *abrupta* Zone at Oppdalsåta.

Arenoturrispirillina jeletzkyi Chamney
Plate 1, figures 11-16
Arenoturrispirillina jeletzkyi Chamney 1971, p. 106, pl. 18 A-B, figs. 6-9.

This species differs from *A. intermedia* in having a smaller test and lower conical coiling. *A. jeletzkyi* was first described from Oxfordian and Kimmeridgian sediments of the Sverdrup Basin and Canadian mainland (Chamney 1971). In the Sverdrup Basin the species was recorded subsequently from the Upper Jurassic (Balkwill et al. 1977) and, more precisely, from the Upper Volgian (Wall 1983). In central Spitsbergen it occurs in the *Ammodiscus zaspelovae* Zone at Janusfjellet and *Trochammina rosacea* Zone at Wimanfjellet.

Glomospira charoides (Jones and Parker)
Plate 1, figures 17-19
Trochammina squamata var. *charoides* Jones and Parker 1860, p. 304.
Glomospira subarctica Chamney 1969, p. 16, pl. 2, figs. 7-9.-- Wall 1983, pl. 5, fig. 12.
Test subspherical, consisting of a proloculus and a streptospirally wound tubular nonseptate second chamber. The elevated spire results in the nearly globular shape.
Because of their close similarity to *G. charoides*, the specimens described as *G.* subarctica by Chamney (1969) from the Barremian of the district of Mackenzie (Canada) are referred to this species. In central Spitsbergen *G. charoides* occurs sporadically in the *Gaudryina* aff. *milleri* Zone of the Agardhfjellet and Janusfjellet sections. However, it is much more common in the beds overlying this zone.

Glomospira oxfordiana Sharovskaya
Plate 1, figure 23
Glomospira (?) *oxfordiana* Sharovskaya 1966, p. 48, pl. 1, figs. 1-3.
Glomospira oxfordiana Sharovskaya.-- Lutova 1981, p. 14, pl. 1, figs. 3-5; pl. 8, fig. 2.
This is a small, irregularly wound species known from the upper Callovian and Oxfordian of central and western Siberia (Sharovskaya 1966, Lutova 1981). In our samples *G. oxfordiana* occurs in the *Trochammina rostovzevi* and *Recurvoides disputabilis* zones of the Janusfjellet section, and the *R. disputabilis* Zone at Oppdalsåta.

Glomospirella arctica Chamney
Plate 1, figures 20-22
Glomospirella arctica Chamney 1969, p. 18, pl. 2, figs. 13-14; pl. 3, figs. 1-4.
Test subelliptical with the proloculus followed by a long, tubular, undivided second chamber. The last part of the second chamber is wound like a ring around the earlier whorls.

Chamney (1969) described this species from the Barremian of Mackenzie, Canada. In central Spitsbergen it is sporadic in the *Gaudryina* aff. *milleri* Zone of the Agardhfjellet and Janusfjellet sections, but occurs more commonly in the overlying strata.

Glomospirella multivoluta (Romanova)
Plate 1, figures 25-26
Glomospira multivoluta Romanova in Glazunova et al. 1960, p. 50, pl. 2, figs. 3-4.
This is a large species varying in shape from essentially planispiral tests to streptospiral tests having planispiral last whorl. The very fine-grained wall and the densely spaced, more or less distinct radial striae are characteristic.

The species was recorded earlier from the Berriasian - Valanginian of western Siberia (Romanova in Glazunova et al. 1960). In central Spitsbergen it is found in the *Glomospira-* and *Glomospirella*-rich beds just above the *Gaudryina* aff. *milleri* Zone at Janusfjellet, Oppdalsåta and Agardhfjellet.

Glomospirella semiaffixa Sharovskaya
Plate 1, figure 24
Glomospirella semiaffixa Sharovskaya 1966, p. 54, pl. 2, figs. 7-9.-- Sharovskaya 1968, fig. in stratigraphical table.-- Lutova 1981, pl. 1, fig. 6.
This small and very fine-grained species consists of two planispiral outer whorls and a streptospiral inner portion. In our material *G. semiaffixa* occurs in the *Trochammina rostovzevi* and *Recurvoides disputabilis* zones of the Janusfjellet section.

Reophax aff. ***hounstoutensis*** Lloyd
Plate 2, figures 1-3
Aff. *Reophax hounstoutensis* Lloyd 1959, p. 308, pl. 54, figs. 7 a-b; text figs. 5 d-e.
In general shape and coarse wall texture the Spitsbergen species is similar to *R. hounstoutensis* described by Lloyd (1959) from the Kimmeridgian of England. The main differences between the two species are the well defined aperture and low neck of the Spitsbergen form. The latter occurs in the *Haplophragmoides canuiformis* Zone at Janusfjellet, Agardhfjellet, and Fleksurfjellet, and at the transition between the *H. canuiformis* and *T. rosacea* zones at Oppdalsåta and Wimanfjellet.

Reophax sterkii Haeusler
Plate 1, figures 27-28
Reophax sterkii Haeusler 1890, p. 29, pl. 3, fig. 23.-- Oesterle 1968, p. 720, fig. 14 d, fig. 15 f-i.-- Lloyd 1959, p. 307, pl. 54, figs. 6 a-b.
The tests consist usually of three chambers increasing rapidly in size during growth along a slightly sinuous axis. The last chamber is pyriform. The wall is extremely coarse-grained and has small amounts of cement. The species occurs in the *Trochammina rostovzevi* Zone of the Janusfjellet section.

Haplophragmoides canuiformis Dain
Plate 2, figures 1-2
Haplophragmoides (?) *canuiformis* Dain 1972, p. 48, pl. 8, figs. 2-3.
The tests recovered are more or less evolute with an open umbilicus, numerous chambers and a relatively thick last whorl, and thus are closely similar to the individuals illustrated by Dain (1972). Transitional specimens occur between this species and *Haplophragmoides* sp. 1.

Haplophragmoides (?) *canuiformis* was originally described from the Lower Kimmeridgian of western Siberia. In central Spitsbergen this species is common in the *Haplophragmoides canuiformis* and *Trochammina rosacea* zones of the Janusfjellet, Agardhfjellet and Oppdalsåta sections. It occurs only sporadically in the *Ammodiscus zaspelovae* Zone.

Haplophragmoides emeljanzevi Schleifer
Plate 2, figures 8-10
Haplophragmoides (?) *emeljanzevi* Schleifer in Sharovskaya 1966, p. 58, pl. 3, figs. 1-5. -- Sharovskaya 1968, fig. in stratigraphical table.
Haplophragmoides emeljanzevi Schleifer.-- Basov 1968, p. 113, pl. 20, fig. 2 a-b.
These large, flattened, more or less evolute specimens with 12-14 globular chambers in the last whorl display essentially the same morphology as the individuals illustrated from various Siberian localities in the papers listed above.

H. emeljanzevi has been reported earlier from the Volgian of western and central Siberia (Basov 1968, Sharovskaya 1968, Saks 1972). In central Spitsbergen, *H. emeljanzevi* is recorded from the *Gaudryina* aff. *milleri* and *Recurvoides obskiensis* zones of the Janusfjellet section. In the Agardhfjellet and Oppdalsåta sections it is found in the *Trochammina* aff. *abrupta* Zone.

Haplophragmoides cf. ***excavatus*** Cushman and Waters
Plate 2, figures 6-7
Cf. *Haplophragmoides excavatus* Cushman and Waters 1927, p. 82, pl. 10, fig. 3.
Our individuals show considerable variation in size, but most of them are smaller, thinner, and posses fewer chambers than Cushman and Waters figured specimens. In central Spitsbergen, *H.* cf. *excavatus* is found throughout the Agardhfjellet section, except in the *Gaudryina* aff. *milleri* Zone.

Haplophragmoides goodenoughensis Chamney
Plate 3, figures 1-2

Haplophragmoides goodenoughensis Chamney 1969, p. 23, pl. 4, figs. 5-6.-- Souaya 1976, p. 267, pl. 2, fig. 6.-- Wall 1983, pl. 4, figs. 34-35.
The specimens in the present study are smaller and have finer-grained tests than the individuals described by Chamney (1969) from the Barremian of Canada. A fine-grained variant closely similar to the present specimens is figured from the Upper Volgian of the Sverdrup Basin by Wall (1983).

In central Spitsbergen, *H. goodenoughensis* is a common species in the *Gaudryina* aff. *milleri*, *Recurvoides obskiensis* and *Trochammina* aff. *abrupta* zones at Agardhfjellet. It has approximately the same distribution in the other two main sections.

Haplophragmoides schleiferi Sharovskaya
Plate 2, figures 11-13
Haplophragmoides (?) *schleiferi* Sharovskaya 1966, p. 61, pl. 4, figs. 1-7. -- Sharovskaya 1968, figs. in stratigraphical table.
Haplophragmoides schleiferi Sharovskaya.-- Løfaldli and Nagy 1983, p. 100, pl. 1, figs. 8-9.
This is a large, evolute species with even periphery and numerous short chambers. It differs from *Haplophragmoides canuiformis* by its widely open umbilibus, smaller chamber height and width, and finer wall texture.

H. schleiferi was previously recorded from the Volgian and Berriasian of Siberia (Sharovskaya 1966, 1968; Saks 1972) and from the Volgian of southern Spitsbergen (Løfaldli and Nagy 1983). In central Spitsbergen, *H. schleiferi* is found in the *Gaudryina* aff. *milleri* Zone at Janusfjellet, Agardhfjellet and Oppdalsåta. It also occurs in the *Recurvoides obskiensis* Zone at Agardhfjellet.

Haplophragmoides sp. 1
Plate 2, figures 14-17
Haplophragmoides canui Cushman.-- Tappan 1955, p. 42, pl. 9, figs. 11-15.-- Løfaldli and Nagy 1983, p. 100, pl. 1, figs. 1-2.
Test planispiral, involute and biumbilicate, moderately thick though often compressed due to compaction; periphery rounded; 9-12 chambers in the final whorl, increasing gradually in size as added; sutures straight, slightly depressed, sometimes obscure; wall finely arenaceous; aperture an elongate slit at base of final chamber, commonly obscured by the poor preservation.

According to Cushman's (1930) description, the adult stage of *Haplophragmoides canui* has an aperture in the middle of the apertural face. In the Spitsbergen material, we have not been able to find individuals posessing such an aperture, and we suppose that the Spitsbergen specimens belong to a different species. We believe that Tappan's (1955) *H. canui* from Alaska is conspecific with the specimens from Spitsbergen. The aperture of the Alaskan individuals also has a basal position but is obscured due to poor preservation.

Haplophragmoides sp. 1 is a very common species in the sediments of central Spitsbergen. It occurs in all the microfossil zones of the Janusfjellet and Agardhfjellet sections, but has a less even distribution in the Oppdalsåta section.

Haplophragmoides sp.2
Plate 3, figures 3-6
This species is characterized by an open umbilicus, great whorl thickness and numerous (commonly 12) chambers in the final whorl. It is similar to *H. canuiformis* and *H. infracalloviensis* Dain 1948, but differs from these species in having greater whorl thickness. In central Spitsbergen *Haplophragmoides* sp. 2 is a common constituent of the zones above the *Trochammina rosacea* Zone at Janusfjellet, Oppdalsåta and Agardhfjellet.

Ammobaculites suprajurassicum (Schwager)
Plate 3, figures 7-8
Haplophragmium suprajurassicum Schwager 1865, p. 92, pl. 2, fig. 1.

Ammobaculites suprajurassicum (Schwager).-- Lutze 1960, p. 442, pl. 26, figs. 10-12; p l . 27, figs. 4-5.-- Løfaldli and Nagy 1980, p. 78, pl. 2, figs. 12-13; pl. 3, figs. 3-4.
The Spitsbergen specimens are somewhat compressed, their sutures are depressed and their final chamber is rounded and has a quite large, centrally placed aperture; as stated in the original description of the species.

A. suprajurassicum has been reported previously from Upper Jurassic sediments in Western Europe (Schwager 1865, Lutze 1960) and Spitsbergen (Løfaldli and Nagy 1980). In the present samples the species is relatively common in the *Trochammina rosacea* Zone at Janusfjellet and Agardhfjellet.

Ammobaculites aff. ***tobolskensis*** Levina
Plate 3, figures 9-10
Aff. *Ammobaculites tobolskensis* Levina in Dain 1972, p. 61, pl. 15, figs. 3-7.
The Spitsbergen specimens are similar in general shape to *A. tobolskensis,* which was originally described from the Lower Oxfordian of Western Siberia. Although the Spitsbergen specimens are diagenetically deformed, their cross section appears more rounded than that of the Siberian species. *A.* aff. *tobolskensis* is found in the *Trochammina rosacea* Zone at Janusfjellet and Agardhfjellet.

Ammobaculites sp. 1
Plate 3, figures 11-12
This is a coarse-grained species with sutures partially obscured by its rough wall texture. In many specimens only the planispiral part of the test is developed. The species resembles *Ammobaculites borealis* Gerke by its large planispiral part, and *Ammobaculites multiformis* Dain by its coarse-grained wall and variable shape. *Ammobaculites* sp. 1 is abundant in the *Trochammina rostovzevi* Zone, and less common in the *Recurvoides disputabilis* Zone at Janusfjellet and Oppdalsåta.

Recurvoides disputabilis Dain
Plate 4, figures 1-4
Recurvoides disputabilis Dain 1972, p. 55, pl. 10, figs. 6-7; pl. 11, figs. 1-4; pl. 19, fig. 1.-- Løfaldli and Nagy 1980, p. 77, pl. 2, figs. 10-11.
The present specimens are characterized by a relatively flattened test with typically streptospiral inner whorls, a more or less planispiral outer whorl, and a commonly subcircular periphery outline. These forms look much like *R. obskienis,* but have considerably smaller dimensions, fewer chambers and mostly subcircular, instead of elliptical outline.

The species has been recorded from the Oxfordian of western Siberia (Dain 1972), and from the Oxfordian-Kimmeridgian of the Sverdrup Basin (Balkwill et al. 1977). Løfaldli and Nagy (1980) reported *R. disputabilis* from Oxfordian strata of eastern Svalbard. In central Spitsbergen, the species is a common constituent of the *Recurvoides disputabilis* and lower *Haplophragmoides canuiformis* zones at Janusfjellet, Fleksurfjellet and Oppdalsåta.

Recurvoides cf. ***neremovensis*** Bulynnikova
Cf. *Recurvoides neremovensis* Bulynnikova 1967, p. 63, pl. 10. figs. 1-4; pl. 11, figs. 1-7.
The Spitsbergen specimens seem to be similar to the individuals drawn by Bulynnikova (1967), who recorded this species from Hauterivian - Valanginian deposits in western Siberia. In Spitsbergen *R.* cf. *neremovensis* is found in the *Gaudryina* aff. *milleri* Zone of the Agardhfjellet section.

Recurvoides obskiensis Romanova
Plate 3, figures 13-16
Recurvoides obskiensis Romanova in Glazunova et al. 1960, p.55, pl. 44, figs. 1-8. -- Putrja 1967, p. 53, pl. 7, figs. 5-6. -- Souaya 1976, p. 268, pl. 2, figs. 3, 5.
This is a rather large species with elliptical outline, nearly rectangular chamber shape and numerous chambers (12 to 14) in the final whorl. During diagenetic compression the species

obtains a characteristic surface pattern consisting of ridges corresponding to septa, and depressions marking chamber cavities.

R. obskiensis has earlier been recorded from the uppermost Volgian to the Hauterivian of western and central Siberia (Romanova in Glazunova et al. 1960, Saks 1972), from the Volgian and Berriasian of southern Spitsbergen (Løfaldli and Nagy 1983) and from the Berriasian - Valanginian of the Sverdrup Basin (Souaya 1976). In central Spitsbergen *R. obskiensis* is a common species of the *Recurvoides obskiensis* and *Gaudryina* aff. *milleri* zones at Janusfjellet, Oppdalsåta and Agardhfjellet.

Recurvoides paucus Dubrovskaja
Plate 4, figures 5-7
Recurvoides paucus Dubrovskaja 1962, p. 70, pl. 1, figs. 7a,b,v.-- Bulynnikova 1967, p. 59, pl. 8, figs. 7-11.
R. paucus has previously been recorded from Berriasian to Hauterivian deposits in western Siberia (Bulynnikova 1967). In central Spitsbergen the species is found with in the *Gaudryina* aff. *milleri* and *Recurvoides obskiensis* zones at Janusfjellet, Oppdalsåta and Agardhfjellet.

Recurvoides sp. 1
Plate 4, figure 8
This species has a subcircular peripheral outline and a rounded whorl section. The whorls have a more symmetrical arrangement than is usual in *Recurvoides*, and thus resemble superficially the genus *Haplophragmoides*. The coarse wall texture is a distinguishing feature of the species. It is common in the *Trochammina rostovzevi* Zone at Janusfjellet and Oppdalsåta.

Bulbobaculites cf. ***elongatulus*** (Dain)
Plate 4, figures 9-10
Cf. *Haplophragmium elongatulum* Dain 1972, p. 69, pl. 18, figs. 8-10.
The Spitsbergen specimens differ from those figured by Dain in having a more oval cross section, which may be due to compression. Dain illustrates individuals with subcircular to broadly oval cross section.

In central Spitsbergen *B.* cf. *elongatulus* is recorded from the *Trochammina rosacea* and *Ammodiscus zaspelovae* zones of the Agardhfjellet section. It is also found in the *Haplophragmoides canuiformis* Zone of the Janusfjellet section.

Bulbobaculites aff. ***pokrovkaensis*** Kosyreva
Plate 4, figures 11-12
Aff. *Haplophragmium pokrovkaensis* Kosyreva in Dain 1972, p.68, pl. 18, figs. 1-7. -- Løfaldli and Nagy 1983, p. 101, pl. 1, fig. 6.
The Spitsbergen specimens are small, have few chambers and a moderately rough surface. They are similar in general shape to *H. prokrovkaensis* originally described from western Siberia, but differ in having a pyriform, instead of subglobular final chamber. *B.* aff. *pokrovkaensis* occurs in the *Trochammina* aff. *abrupta* and *Ammodiscus zaspelovae* zones of the Agardhfjellet section.

Trochammina aff. *abrupta* Geroch
Plate 4, figures 23-27
Aff. *Trochammina abrupta* Geroch 1966, p. 451, pl. 14, figs. 13-17.
T. abrupta was originally described from Berriasian - Aptian strata of the Polish Carpathians. It differs from the Spitsbergen species by its less conical umbilical side and flat, instead of concave spiral side. The Spitsbergen species corresponds in general shape to a specimen figured by Wall (1983) as *T.* cf. *rosacea* from the Berriasian - Valanginian of the Sverdrup Basin.

In the analyzed sections this form occurs mainly in the *Trochammina* aff. *abrupta* Zone, but is found also in the *Recurvoides obskiensis* and *Gaudryina* aff. *milleri* zones at

Janusfjellet, Oppdalsåta and Agardhfjellet.

Trochammina canningensis Tappan
Plate 4, figures 13-16
Trochammina canningensis Tappan 1955, p. 49, pl. 14, figs. 15-19.
Test small, subglobular, trochoid; 5 to 7 chambers visible on the dorsal side, only the last 3 to 5 chambers of the final whorl visible on the ventral side where they reach to the umbilicus; chambers globular and inflated, increasing rapidly in size as added; sutures distinct, slightly depressed; wall finely arenaceous.

In central Spitsbergen this species occurs most commonly in the *Trochammina rostovzevi* and *Recurvoides disputabilis* zones at Janusfjellet and Fleksurfjellet. It is also found in the *Haplophragmoides canuiformis* and *Trochammina rosacea* zones at Janusfjellet.

Trochammina kosyrevae Levina
Plate 4, figures 17-20
Trochammina kosyrevae Levina in Dain 1972, p. 83, pl. 22, figs. 5-9; pl. 29, fig. 4.
These low trochoid specimens with flat or slightly convex spiral side, convex-concave umbilical side and 6-7 chambers in the final whorl, are similar to the individuals figured by Levina (in Dain 1972).

T. kosyrevae has been reported from Oxfordian strata in western Siberia (Dain 1972) and from Oxfordian-Kimmeridgian sediments of the Sverdrup Basin (Balkwill et al. 1977). In central Spitsbergen the total range of the species extends from the *Recurvoides disputabilis* to the *Ammodiscus zaspelovae* Zone.

Trochammina cf. ***kosyrevae*** Levina
Plate 4, figures 21-22
This is an extensive group including small, diagenetically compressed specimens of *Trochammina*. Their specific affiliation is not addressed here due to insufficient preservation, although many of them reveal close similarities to *T. kosyrevae* in peripheral outline. In the Janusfjellet section *T.* cf. *kosyrevae* occurs from the *Recurvoides disputabilis* to the *Ammodiscus zaspelovae* Zone; in the Oppdalsåta and Agardhfjellet sections its range is shorter.

Trochammina aff. ***misinovi*** Levina
Plate 5, figures 1-2
Aff. *Trochammina misinovi* Levina in Dain 1972, p. 93, pl. 27, figs. 1-4, 6; pl. 29, fig. 13.
These large, flattened tests have lobate periphery, rounded chamber outline and commonly 8 chambers in the final whorl. Among the individuals figured by Levina (in Dain 1972), the Spitsbergen specimens are most similar to pl. 27, figs. 3 and 4.

T. misinovi was originally recorded from Upper Volgian deposits of western Siberia. In central Spitsbergen, *T.* aff. *misinovi* is a common form. In the Janusfjellet section it occurs from the *Haplophragmoides canuiformis* to the *Ammodiscus zaspelovae* Zone, and its distribution is almost the same in the Agardhfjellet section. Not observed in the Oppdalsåta section.

Trochammina rosacea Zaspelova
Plate 5, figures 3-6
Trochammina rosacea Zaspelova 1948, p. 202, pl. 2, figs. 1 a-b.-- Sharovskaya 1961, p. 33, pl. 2, figs. 4 a-c; pl. 3, figs. 1 a-b, 2-4.-- Dain 1972, pl. 28, fig. 7.
The present specimens have usually been flattened diagenetically. They are characterized by having a lobate periphery, commonly 8 chambers in the final whorl, septal sutures straight ventrally but curving backwards on the dorsal side, and a narrow but marked umbilicus.

T. rosacea was earlier reported from the Volgian of western and central Siberia (Sharovskaya 1968, Dain 1972, Saks 1972). In central Spitsbergen it is common in the *Trochammina rosacea* and *Ammodiscus zaspelovae* zones of the Janusfjellet, Agardhfjellet and Oppdalsåta sections. It occurs sporadically in the *Trochammina* aff. *abrupta* Zone.

Trochammina rostovzevi Levina
Plate 5, figures 7-8
Trochammina rostovzevi Levina in Dain 1972, p. 82, pl. 22, figs. 1-3; pl. 29, fig. 1.
These moderately trochoid specimens have a conical spiral side and concave umbilical area, broadly rounded thick periphery, and often five chambers in the final whorl. The Spitsbergen specimens are commonly smaller than the Siberian forms.

Earlier records of *T. rostovzevi* are from Callovian - Oxfordian deposits of western Siberia (Dain 1972) and the Sverdrup Basin (Balkwill et al. 1977). In Spitsbergen it is common in the *Trochammina rostovzevi* Zone at Janusfjellet, Fleksurfjellet and Oppdalsåta.

Trochammina septentrionalis Sharovskaya
Plate 5, figures 9-12
Trochammina septentrionalis Sharovskaya 1961, pl. 3, figs. 5-6, 7 a-b, 8 a-c. -- Dain 1972, pl. 27, fig. 5.
All specimens are more or less diagenetically compressed but they show the characteristic features of *T. septentrionalis:* open umbilical area, numerous narrow chambers (up to 11 in the final whorl), strongly oblique sutures and crenulate periphery.

The species is recorded from Lower Volgian deposits in Siberia (Sharovskaya 1968, Dain 1972). In central Spitsbergen it occurs mainly in the *Ammodiscus zaspelovae* Zone at Janusfjellet, Wimanfjellet, Fleksurfjellet, Oppdalsåta and Agardhfjellet.

Trochammina cf. *squamataformis* Kaptarenko-Chernousova
Plate 5, figures 13-14
Cf. *Trochammina squamataformis* Kaptarenko-Chernousova 1959, p. 51, pl. 8, figs. 1-2. -- Løfaldli and Nagy 1980, p. 79, pl. 4, figs. 5-6.
To this group are referred flattened, medium sized specimens of *Trochammina* showing lobulate periphery and few (4-6) chambers in the final volution. These resemble the specimens recorded as *T.* cf. *squamataformis* by Løfaldli and Nagy (1980) from Kongsøya, eastern Svalbard. In central Spitsbergen, this form occurs in the *Trochammina rosacea* and *Ammodiscus zaspelovae* zones at Agardhfjellet.

Eomarssonella paraconica Levina
Plate 5, figures 15-19
Eomarssonella paraconica Levina in Dain 1972, p. 102, pl. 32, figs. 1-11.
The species is of medium size, conical in shape, usually rapidly expanding, and dully pointed at the apex. The spiral is formed by 5-6 whorls, the first two of which are four-chambered, while the succeeding chambers are triserially arranged.

In western Siberia, *E. paraconica* is a characteristic species of Oxfordian deposits (Dain 1972). In Spitsbergen it occurs in the *Trochammina rosacea* and basal *Ammodiscus zaspelovae* zones of the Agardhfjellet section.

Verneuilinoides aff. *graciosus* Kosyreva
Plate 5, figure 20
Aff. *Verneuilinoides graciosus* Kosyreva in Dain 1972, p. 98, pl. 30, figs. 2-4.
Specimens included here are similar in general shape to *V. graciosus* from the Lower Kimmeridgian of western Siberia, but larger. With a few exceptions, the Spitsbergen specimens are diagenetically distorted. The species occurs in the *Trochammina rostovzevi* and *Trochammina rosacea* zones at Janusfjellet.

Gaudryina aff. *milleri* Tappan
Plate 6, figures 1-4
Aff. *Gaudryina milleri* Tappan 1955, p. 48, pl. 8, figs. 7-8. -- Wall 1983, pl. 4, figs. 18-19; pl. 5, fig. 15.
The specimens included here have narrower tests than *Gaudryina milleri.* They constitute an important part of the *Gaudryina* aff. *milleri* Zone at Janusfjellet, Oppdalsåta and

Agardhf jellet.

Verneuilina anglica Cushman
Plate 6, figures 5-8
Verneuilina anglica Cushman 1936, p. 1, pl. 1, fig. 1. -- Wall 1983, pl. 4, figs. 9-10.
Diagnostic features of the Spitsbergen specimens are triangular cross section, somewhat concave sides and slightly inflated chambers. The specimens correspond closely to the original description of *V. anglica* from the Kimmeridge Clay of England. In central Spitsbergen *V. anglica* occurs in the *Trochammina rosacea* Zone at Janusf jellet and Wimanf jellet.

Arenobulimina sp. 1
Plate 6, figure 9
The specimens included here are characterized by subglobular chambers in a moderately high, trochospiral arrangement. They are closely similar to *Arenobulimina* cf. *torula* recorded by Souaya (1976) and *Arenobulimina* sp. 2 figured by Wall (1983), both from the Sverdrup Basin. In the Spitsbergen material, this species is recorded from the *Gaudryina* aff. *milleri*, *Recurvoides obskiensis* and *Trochammina* aff. *abrupta* zones of the Agardhf jellet section.

? *Nodosaria pseudohispida* Gerke
? *Nodosaria pseudohispida* Gerke in Basov 1968, p. 117, pl. 20, figs. 3-5.
Only a few hispid chambers are found in the present samples. These are similar to the drawings published by Basov (1968) from Callovian to Berriasian deposits in Siberia. The species occurs in the *Gaudryina* aff. *milleri* Zone of the Agardhf jellet section.

Pyramidulina sceptrum (Reuss)
Plate 6, figure 10
Nodosaria sceptrum Reuss 1863, p. 37, pl. 2, fig. 3 a-b. -- Bartenstein et al. 1957, p. 35, pl. 7, fig. 150. -- Bartenstein and Bolli 1973, p. 404, pl. 6, fig. 35.
P. sceptrum was recorded earlier from Berriasian to Albian sediments in Western and Eastern Europe (Reuss 1863, Fletcher 1973, Neagu 1965). It has also been reported from Lower Cretaceous strata in Trinidad (Bartenstein et al. 1957), Venezuela (Guillaume et al. 1972), the northwestern part of the Pacific Ocean (Luterbacher 1975) and northern Siberia (Saks 1972). In Spitsbergen one specimen is found in the *Gaudryina* aff. *milleri* Zone at Agardhf jellet.

Tristix insigne (Reuss)
Plate 6, figure 11
Rhabdogonium insigne Reuss 1863, p. 56, pl. 5, fig. 2. -- Sherlock 1914, p. 258, pl. 18, fig. 21.
Tristix insigne (Reuss). -- Bartenstein and Brand 1951, p. 314, pl. 10, figs. 262-263.
This species has a range from Berriasian to Albian in boreal parts of Europe (Sztejn 1957, Fletcher 1973). In the Spitsbergen material a single specimen, consisting of proloculus and three chambers, occurs in the *Gaudryina* aff. *milleri* Zone of the Agardhf jellet section.

Lenticulina sossipatrovae Gerke and Ivanova
Plate 6, figure 12-16
Lenticulina sossipatrovae Gerke and Ivanova in Saks 1972, p. 259, pl. 44, figs. 1-10.
Test subcircular to oval in outline, last chamber with a projecting angle pointed at the aperture; chambers triangularily semilunar, relatively narrow, 8-10 in number in the last whorl; peripheral margin strongly compressed; septal surface narrow and helmet-shaped.

L. sossipatrovae has been recorded from Upper Volgian to Valanginian deposits in western and central Siberia (Sharovskaya 1968, Saks 1972). In central Spitsbergen this species is met with in the *Gaudryina* aff. *milleri* Zone of the Agardhf jellet and Janusf jellet sections.

Marginulinopsis robusta (Reuss)
Plate 6, figure 19

Cristellaria (Marginulina) robusta Reuss 1863, p. 63, pl. 6, figs. 5-6.
Marginulina robusta Reuss. -- Dam 1948, p. 185, pl. 32, fig. 6.
Lenticulina (Marginulinopsis) robusta (Reuss). -- Bartenstein and Brand 1951, p. 289, pl. 6, figs. 142-143.
The Spitsbergen specimens typically have 9 distinct costae which continue to the apertural neck. *M. robusta* is widely recorded from Berriasian to Albian strata of western Europe (e.g. Michael 1967, Fletcher 1973). Dailey (1973) reported the species from Lower Cretaceous sediments in California. In Spitsbergen it occurs in the *Gaudryina* aff. *milleri* Zone at Agardhfjellet.

Marginulina costulata (Chapman)
Plate 6, figures 17-18
Cristellaria costulata Chapman 1894, p. 649, pl. 9, fig. 10.
Lenticulina (Marginulina) aff. *costulata* (Chapman). -- Magniez-Jannin 1975, p. 124, pl.10, figs. 36-41; text-fig. 56.
Marginulina aff. *striatocostata* Reuss. -- Fursenko and Polenova 1950, p. 50, pl. 4, figs. 7-10.
The Spitsbergen specimens show fine and densely spaced costae, and have compressed initial coils which are characteristic of this species. *M.* aff. *striatocostata*, described by Fursenko and Polenova (1950) from the Russian Platform, is closely similar to our specimens and is referred to *M. costulata.*

This form has been recorded previously from the Volgian (Fursenko and Polenova 1950) to the Albian (Magniez-Jannin 1975). In Spitsbergen it occurs in the *Gaudryina* aff. *milleri* Zone at Agardhfjellet.

Marginulina pyramidalis (Koch)
Plate 6, figure 20
Nodosaria pyramidalis Koch 1851, p. 173, pl. 24, fig. 8.
Marginulina pyramidalis (Koch). -- Bartenstein and Brand 1951, p. 307, pl. 9, figs. 221-223. -- Basov 1967, p. 61, pl. 3, figs. 1-3.
Only a few specimens have been found in the Spitsbergen material. These correspond to the individuals presented by Basov (1967), both with regard to the number of costae and the pointed proximal end.

The species ranges from Valanginian to Albian in boreal parts of Europe (Sztejn 1957), but has also been registered in Early Cretaceous deposits in Trinidad (Bartenstein et al. 1957). However, in northern Siberia it was recorded from Upper Volgian and Berriasian strata (Basov 1967). In Spitsbergen it occurs in the *Gaudryina* aff. *milleri* Zone at Agardhfjellet.

Globulina aff. ***bucculenta*** (Berthelin)
Plate 6, figures 21-22
Aff. *Polymorphina bucculenta* Berthelin 1880, p. 58, pl. 4, figs. 16-17.
Aff. *Globulina* aff. *bucculenta* (Berthelin). -- Magniez-Jannin 1975, p. 228, pl. 15, figs. 22-23, text-fig. 119.
The few specimens observed in our material have well-marked sutures, flush with the test surface. The species occurs in the *Gaudryina* aff. *milleri* Zone of the Agardhfjellet section.

Globulina prisca Reuss
Globulina prisca Reuss 1863, p. 79, pl. 9, fig. 8. -- Bartenstein and Brand 1951, p. 320, pl. 10, fig. 286. -- Bartenstein et al. 1966, p. 158, pl. 3, figs. 286-292, 308.
The Spitsbergen specimens have elongate, oval tests, with somewhat flattened sides, and chambers arranged in a spiral. Three chambers are visible externally.

G. prisca occurs in the Boreal Realm of Europe and North America from the Berriasian to the Cenomanian (Bartenstein et al. 1966, Neagu 1972, Fletcher 1973). Tappan (1962) recorded *G. prisca* from Albian strata in northern Alaska. In central Spitsbergen this species occurs in the *Gaudryina* aff. *milleri* Zone of the Agardhfjellet section.

Ramulina laevis Jones
Plate 6, figure 23
Ramulina laevis Jones in Wright 1875, p. 881, pl. 3, fig. 19. -- Bartenstein and Brand 1951, p. 323, pl. 11, figs. 309-312. -- Magniez-Jannin 1975, p. 234, text-fig. 125.
The single specimen found in our samples possesses two short eccentrically placed necks, and numerous irregular protuberances on the test surface.

R. laevis has previously been recorded mainly from Valanginian to Albian strata (Bartenstein and Brand 1951, Bartenstein et al. 1966). In central Spitsbergen it occurs in the *Gaudryina* aff. *milleri* Zone of the Agardhfjellet section.

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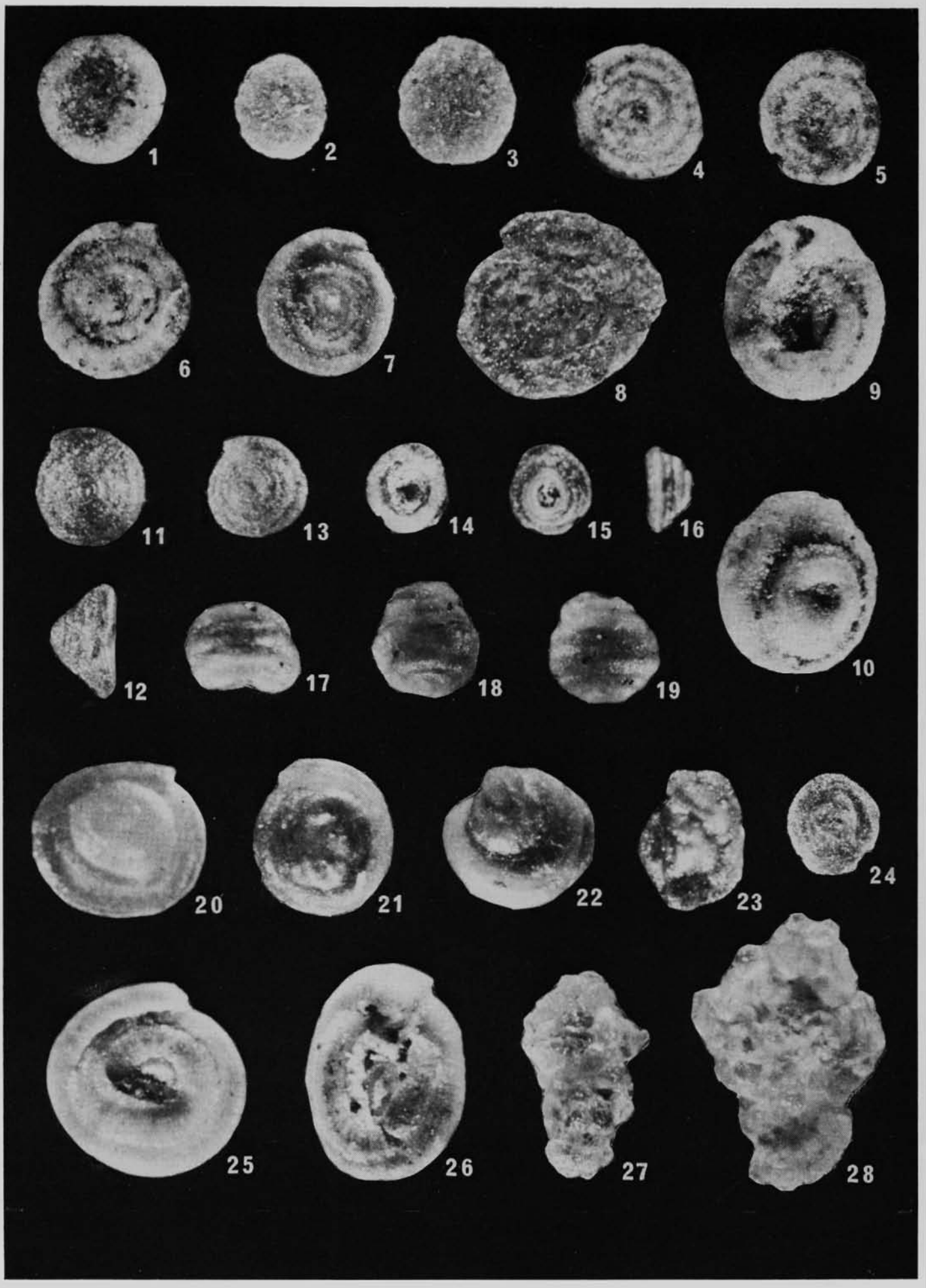
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Plate 1. Sample positions are given in meters above base of Janusfjellet Subgroup.
1. *Psammosphaera metensis* (Terquem) Agardhfjellet section, 130 m, x40. **2-3.** *Saccammina compacta* Gerke, Janusfjellet section, 33.8 m, x48. **4-7.** *Ammodiscus zaspelovae* Kosyrevae, **4.** Agardhfjellet section, 194 m, x50. **5-6.** two specimens from Agardhfjellet section, 194 m, x40. **7.** Janusfjellet section, 192 m, x58 **8.** *Ammodiscus* aff. *baticus* Dain, Janusfjellet section 19 m, x48. **9-10.** *Arenoturrispirillina intermedia* Chamney, Umbilical and spiral views of same specimen, Agardhfjellet section, 194 m, x50. **11-16.** *Arenoturrispirillina jeletzkyi* Chamney, **11-12.** spiral and peripheral views of same specimen, Janusfjellet section, 173.5, x48. **13.** spiral view, Janusfjellet section, 173.5 m, x48. **14-16.** umbilical, spiral and perpheral views of same specimen, Wimanfjellet, 143 m, x40. **17-19.** *Glomospira charoides* (Jones and Parker), Three specimens from Agardhfjellet section. **17-18.** 239 m, x90. **19.** 235 m, x90. **20-22.** *Glomospirella arctica* Chamney, **20.** Janusfjellet section, 237.5 m, x80. **21-22.** two specimens from Agardhfjellet section, 239 m, x90. **23.** *Glomospira oxfordiana* Sharavoskaya, Janusfjellet section, 25.8 m, x90. **24.** *Glomospirella semiaffixa* Sharovskaya, Janusfjellet section, 19 m, x75. **25-26.** *Glomospirella multivoluta* (Romanova), Two specimens from Agardhfjellet section, 239 m, x90. **27-28.** *Reophax sterkii* Haeusler, Two specimens from Janusfjellet section, 12.4 m, x48.

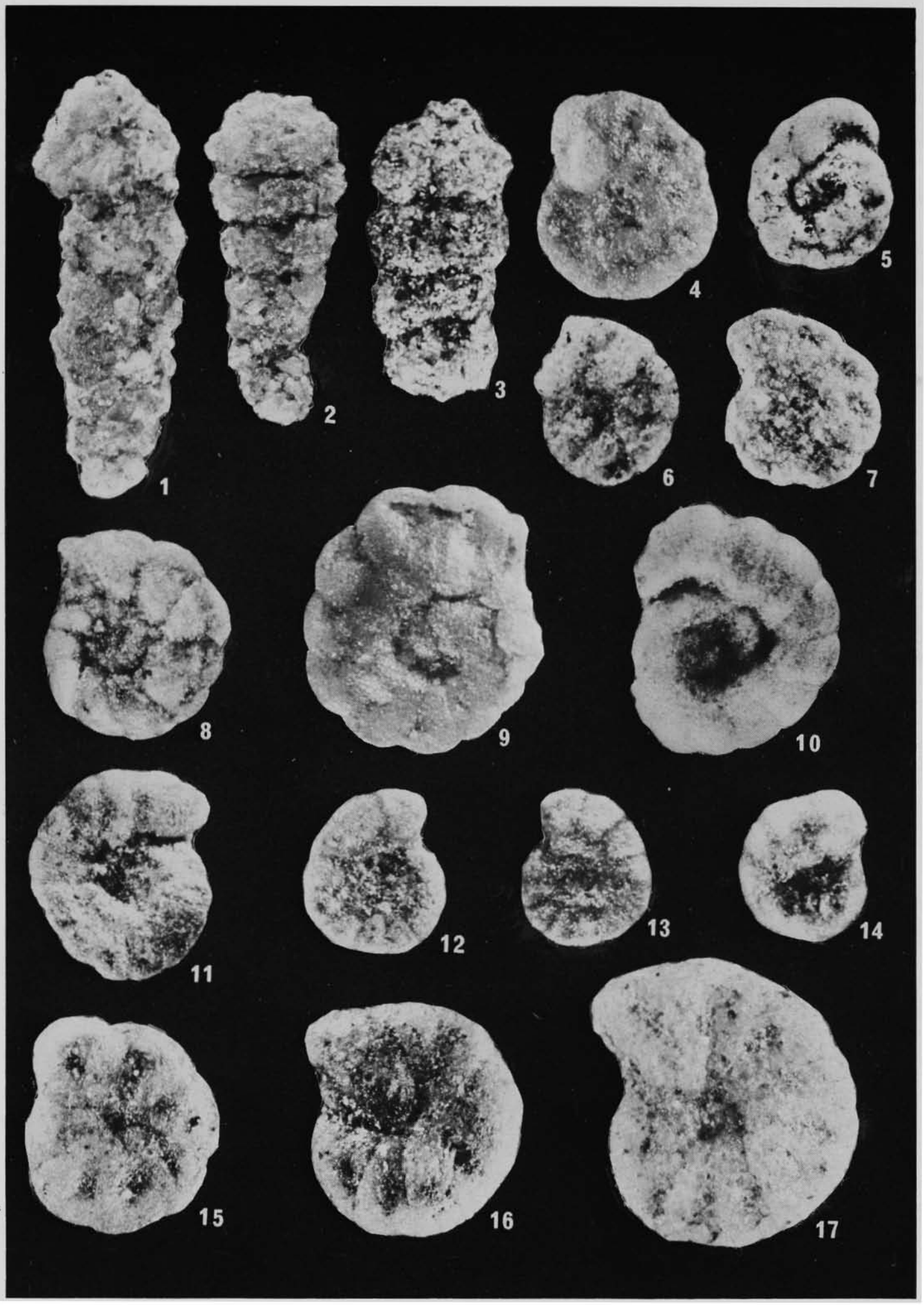
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Plate 2. Sample positions are given in meters above base of Janusfjellet Subgroup.
1-3. *Reophax* aff. *hounstoutensis* Lloyd, **1-2.** two specimens from Wimanfjellet, 96 m, x32. **3.** specimen showing low but distinct neck, Agardhfjellet section, 78 m, x40. **4-5.** *Haplophragmoides canuiformis* Dain, **4.** Janusfjellet section, 79 m, x48. **5.** Agardhfjellet section, 98 m, x40. **6-7.** *Haplophragmoides* cf. *excavatus* Cushman and Waters, Two specimens from Agardhfjellet section. **6.** 138 m, x50. **7.** 194 m, x50. **8-10.** *Haplophragmoides emeljanzevi* Schleifer, Three sepcimens from Agardhfjellet section, 194 m, x40. **11-13.** *Haplophragmoides schleiferi* Sharovskaya, **11.** Agardhfjellet section, 224 m, x50. **12-13.** Two specimens from Agardhfjellet section, 222 m, x40. **14-17.** *Haplophragmoides* sp. 1, Janusfjellet section. 14, 222 m, x40. **15.** 156 m, x40. **16.** 138 m, x40. **17.** 156 m, x48.

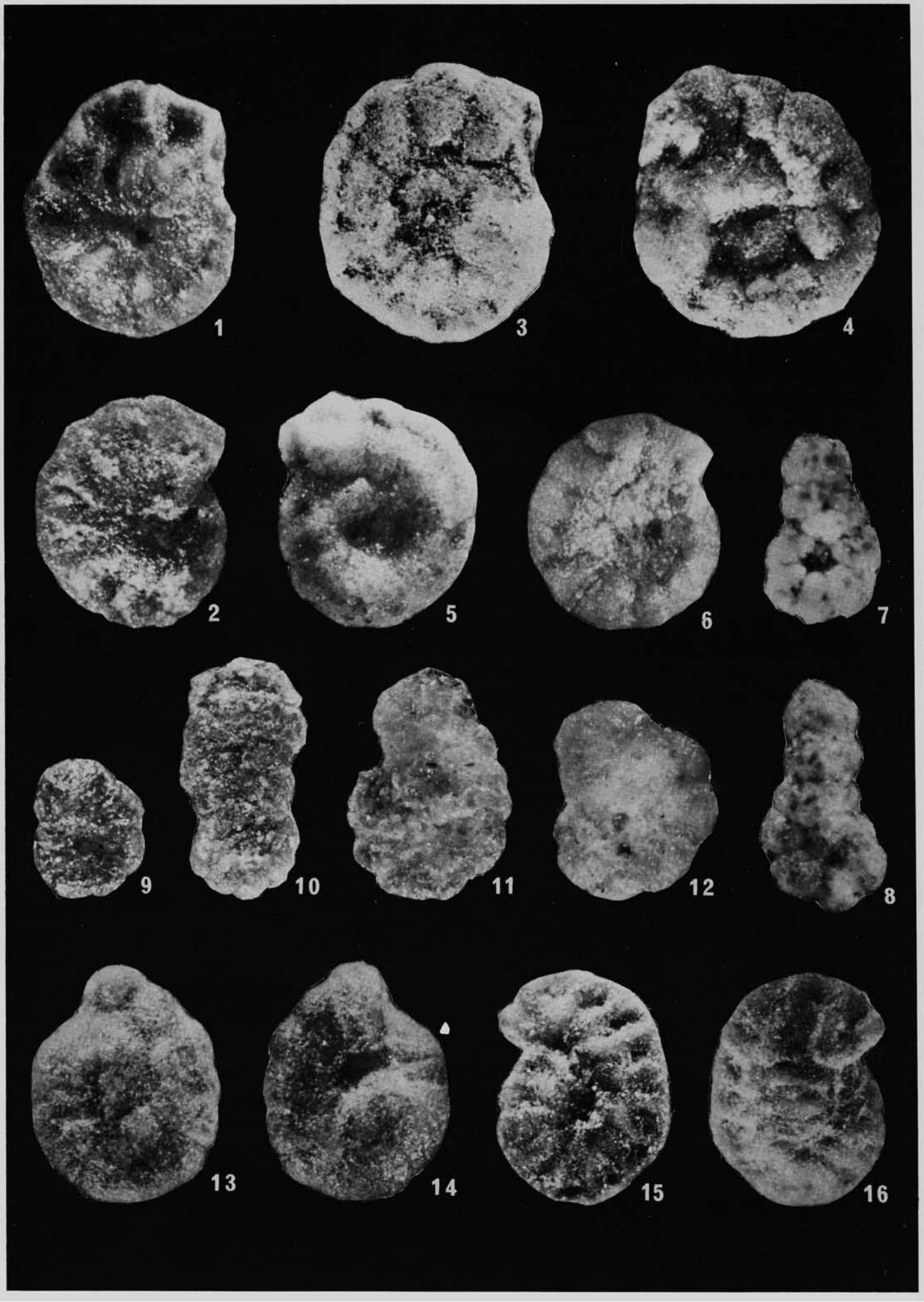
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Plate 3. Sample positions are given in meters above base of Janusf jellet Subgroup.
1-2. *Haplophragmoides goodenoughensis* Chamney, Janusf jellet section. **1.** 216.95 m, x48. **2.** 216.5 m, x48. **3-6.** *Haplophragmoides* sp. 2, **3.** Agardhf jellet section, 150 m, x40. **4.** Agardhf jellet section, 174 m, x48. **5.** Agardhf jellet section, 196 m, x48. **6.** Janusf jellet section, 214.8 m, x48. **7-8.** *Ammobaculites suprajurassicum* Schwager, Two specimens from Agardhf jellet section, 120 m, x90. **9-10.** *Ammobaculites* aff. *tobolskensis* Levina,
9. Janusf jellet section, 122 m, x48. **10.** Wimanf jellet, 96 m, x32. **11-12.** *Ammobaculites* sp. 1, Two species from Janusf jellet section, 10.5 m, x48. **13-16.** *Recurvoides obskiensis* Romanova, Two specimens from Agardhf jellet section. **13-14.** spiral and umbilical views of same specimen, 222 m, x40. **15-16.** umbilical and spiral views of same specimen, 222 m, x50.

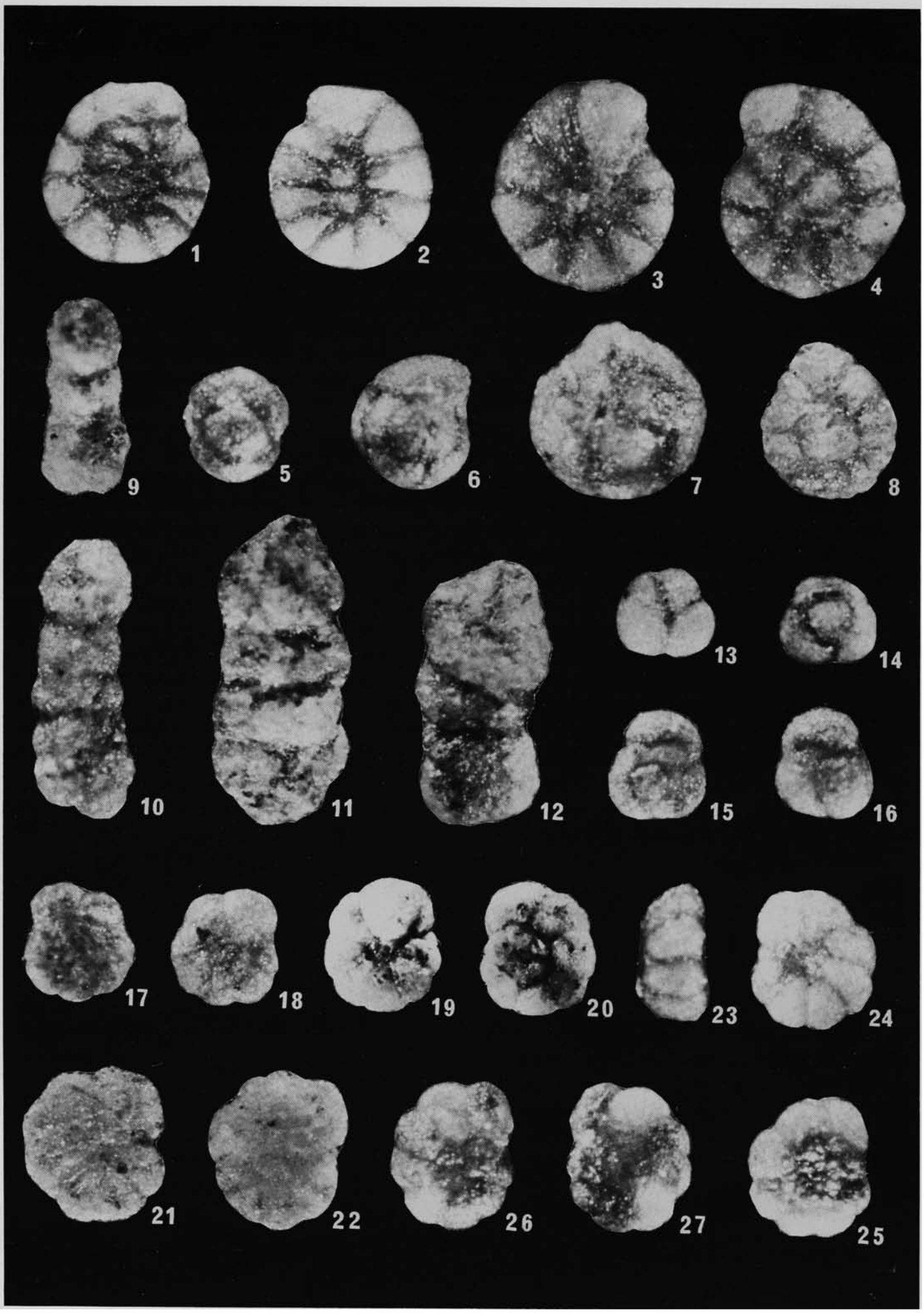
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Plate 4. Sample positions are given in meters above base of Janusfjellet Subgroup.
1-4. *Recurvoides disputabilis* Bulynnikova, Two specimens from Fleksurfjellet section, 29.5 m, x64. **1-2.** spiral and umbilical views of same specimen. **3-4.** umbilical and spiral views of same specimen. **5-7.** *Recurvoides paucus* Dubrovskaya, **5.** Janusfjellet section, 220.5 m, x90. **6.** Agardhfjellet section, 224 m, x90. **7.** Agardhfjellet section, 222 m, x90. **8.** *Recurvoides* sp. 1, Janusfjellet section, 12.4 m, x64. **9-10.** *Bulbobaculites* cf. *elongatulus* Saidova, **9.** Agardhfjellet section, 222 m, x90. **10.** Janusfjellet section, 73 m, x90. **11-12.** *Bulbobaculites* aff. *pokrovkaensis* Kosyreva, Two specimens from Agardhfjellet section, 194 m, x90. **13-16.** *Trochammina canningensis* Tappan, **13-14.** Fleksurfjellet section, 33 m, lateral and spiral views of same specimen, x90. **15-16.** Janusfjellet section, 19 m, spiral and umbilical views of same specimen, x90. **17-20.** *Trochammina kosyrevae* Levina, **17-18.** Janusfjellet section, 112 m, spiral and umbilical views of same specimen, x90. **19-20.** Agardhfjellet section, 174 m, spiral and umbilical views of same specimen, x80. **21-22.** *Trochammina* cf. *kosyrevae* Levina, Two specimens from Janusfjellet section, 58 m, x75. **23-27.** *Trochammina* aff. *abrupta* Geroch, Janusfjellet section, 201 m, x90. **23.** peripheral view. **24-25.** umbilical and spiral views of same specimen. **26-27.** umbilical and spiral views of same specimen.

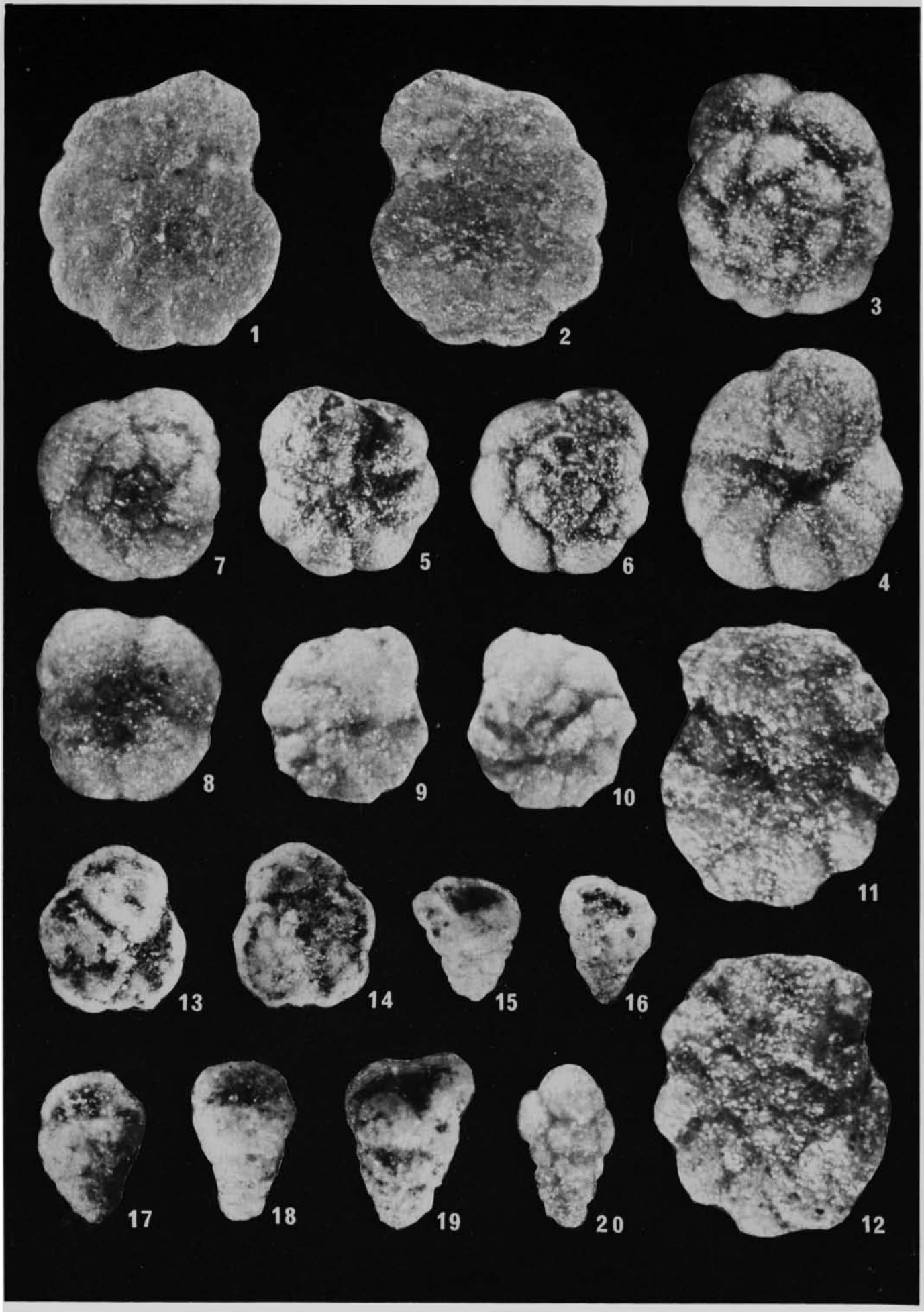
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Plate 5. Sample positions are given in meters above base of Janusf jellet Subgroup.
1-2. *Trochammina* aff. *misinovi* Levina, Janusf jellet section, 136.5 m, spiral and umbilical views of same specimen, x64. **3-6.** *Trochammina rosacea* Zaspelovae, Two specimens from Janusf jellet section, 173.5 m, x60. **3-4.** spiral and umbilical views of same specimen. **5-6.** umbilical and spiral views of same specimen. **7-8.** *Trochammina rostovzevi* Levina, Fleksurf jellet section, 13 m, spiral and umbilical views of same specimen, x60. **9-12.** *Trochammina septentrionalis* Sharovskaya, **9-10.** Janusf jellet section, 167.5 m, umbilical and spiral views of same specimen, x60. **11-12.** Janusf jellet section, 185 m, umbilical and spiral views of same specimen, x60. **13-14.** *Trochammina* cf. *squamataformis* Kaptarenko-Chernousova, Agardhf jellet section, 168 m, umbilical and spiral views of same specimen, x50. **15-19.** *Eomarssonella paraconica* Levina, Five specimens from Agardhf jellet section, 126 m, x90. **20.** *Verneuilinoides* aff. *graciosus* Kosyreva, Janusf jellet section, 19 m, x90.


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Plate 6. Sample positions are given in meters above base of Janusfjellet Subgroup.
1-4. *Gaudryina* aff. *milleri* Tappan, **1.** Janusfjellet section, 220.5 m, x64. **2.** Janusfjellet section, 218.7 m, x64. **3-4.** two specimen from Agardhfjellet section, 222 m, x60. **5-8.** *Verneuilina anglica* Cushman, **5.** Wimanfjellet, 115 m, x80. **6-8.** Three specimens from Janusfjellet section, 152 m, x90. **9.** *Arenobulimina* sp. 1, Agardhfjellet section, 194 m, x64. **10.** *Pyramidulina sceptrum* (Reuss), Agardhfjellet section, 228 m, x80. **11.** *Tristix insigne* (Reuss), Agardhfjellet section, 228 m, x40. **12-16.** *Lenticulina sossipatrovae* Gerke and Ivanova, Five sepcimens from Agardhfjellet section, 230 m, x40. **17-18.** *Marginulina costulata* (Chapman), Two specimens from Agardhfjellet section, 228 m, x40. **19.** *Marginulinopsis robusta* (Reuss), Agardhfjellet section, 230 m, x80. **20.** *Marginulina pyramidalis* (Koch), Agardhfjellet section, 228 m, x80. **21-22.** *Globulina* aff. *bucculenta* (Berthelin), Two specimens from Agardhfjellet section, 228 m, x80. **23.** *Ramulina laevis* Jones, Agardhfjellet section, 230 m, x80.