Upper Palaeozoic fusulinid assemblages, Wandel Sea Basin, North Greenland

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Eight fusulinid assemblages are recognized in the Mallemuk Mountain Group of North Greenland. They are of late Moscovian (*Wedekindellina* assemblage), late Kasimovian (*Rauserites* ex. gr. *simplex* assemblage), early–middle Gzhelian (*Rauserites* ex. gr. *rossicus* assemblage), late Gzhelian – ?early Asselian (*Schellwienia arctica* assemblage), early Asselian (*Sphaeroschwagerina* aff. *S. vulgaris* assemblage), middle–late Asselian (*Schwagerina* ex. gr. *nathorsti* assemblage), latest Asselian – earliest Sakmarian (*Schwagerina* aff. *S. moelleri* – *S.* ex. gr. *exuberata* assemblage) and late Sakmarian (*Schwagerina plicatissima* assemblage) ages. These assemblages show close similarities to faunas described elsewhere in the present Arctic region, i.e. Arctic Russia, Southwest Barents shelf, Svalbard and Arctic Canada.

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Biostratigraphical information from most Upper Palaeozoic deposits of the Wandel Sea Basin in North Greenland is limited (Fig. 1). The zonation of Stemmerik & Håkansson (1989) is based mainly on biostratigraphic work of Dunbar *et al.* (1962) and Petryk (1977), with some additional fusulinid datings by J. E. Whittaker (*in* Stemmerik & Håkansson, 1989). Additional stratigraphical information has been provided by Nilsson *et al.* (1991) based on a few fusulinid bearing samples from Peary Land, Prinsesse Ingeborg Halvø and Amdrup Land (Fig. 2). Five fusulinid faunas of late Moscovian, Gzhelian, middle–late Asselian, late Asselian – ?early Sakmarian and late Sakmarian ages were reported.

No documentation of fusulinid faunas has been published from this region, apart from one paper dealing with fusulinids from Holm Land and Amdrup Land (Ross & Dunbar, 1962). This paper documents the fusulinid faunas presented by Nilsson *et al.* (1991) and discusses their biostratigraphical relevance to the adjacent areas of Spitsbergen, Bjørnøya and Barents Sea (Finnmark Platform) (Fig. 1). In addition, it includes re-examination of the fusulinid material described by Ross & Dunbar (1962) from Holm Land and Amdrup Land (the *Pseudoschwagerina* zone of Dunbar *et al.*, 1962) and Petryk's (1977) material from eastern Peary Land.

Geological framework

During the Late Palaeozoic North Greenland, together with the Barents Shelf region, formed part of a sedimentary basin which connected westwards to the Sverdrup Basin of Arctic Canada and eastwards to the Timan–Pechora Basin of Arctic Russia. Sediments of the Mallemuk Mountain Group are exposed in Peary Land in central North Greenland and in Holm Land, Amdrup Land and Prinsesse Ingeborg Halvø in eastern North Greenland (Fig. 2). They comprise more than 1100 m of shelf carbonates and siliciclastics with subordinate evaporites (Stemmerik & Håkansson, 1989; Fig. 2). Deposition probably occurred in small, isolated fault-blocks separated from the stable Greenland craton by major fault zones during the Moscovian and on a more widespread shelf during late Carboniferous – early Permian times (Håkansson & Stemmerik, 1984; Stemmerik & Håkansson, 1991; Stemmerik & Worsley, 1989).

The Mallemuk Mountain Group comprises three formations: the Kap Jungersen Formation, the Foldedal Formation and the Kim Fjelde Formation. Early Moscovian shelf deposits of the Kap Jungersen Formation are present in the southern Holm Land and southern Amdrup Land blocks (Fig. 2). The base of this formation is, however, diachronous as the formation onlaps an irregular mid-Carboniferous relief. Late Moscovian to Gzhelian shelf deposits of the Kap Jungersen and Foldedal Formations were far more widespread covering Holm Land, southern Amdrup Land, most of Peary Land and possibly also Prinsesse Ingeborg Halvø (Stemmerik & Håkansson, 1991). During the late Carboniferous the mixed siliciclastic and carbonate deposits were succeeded by rather uniform deposition of shallow water carbonates of the Kim Fjelde Formation (Fig. 2). A continuous carbonate platform was gradually developed along the entire length

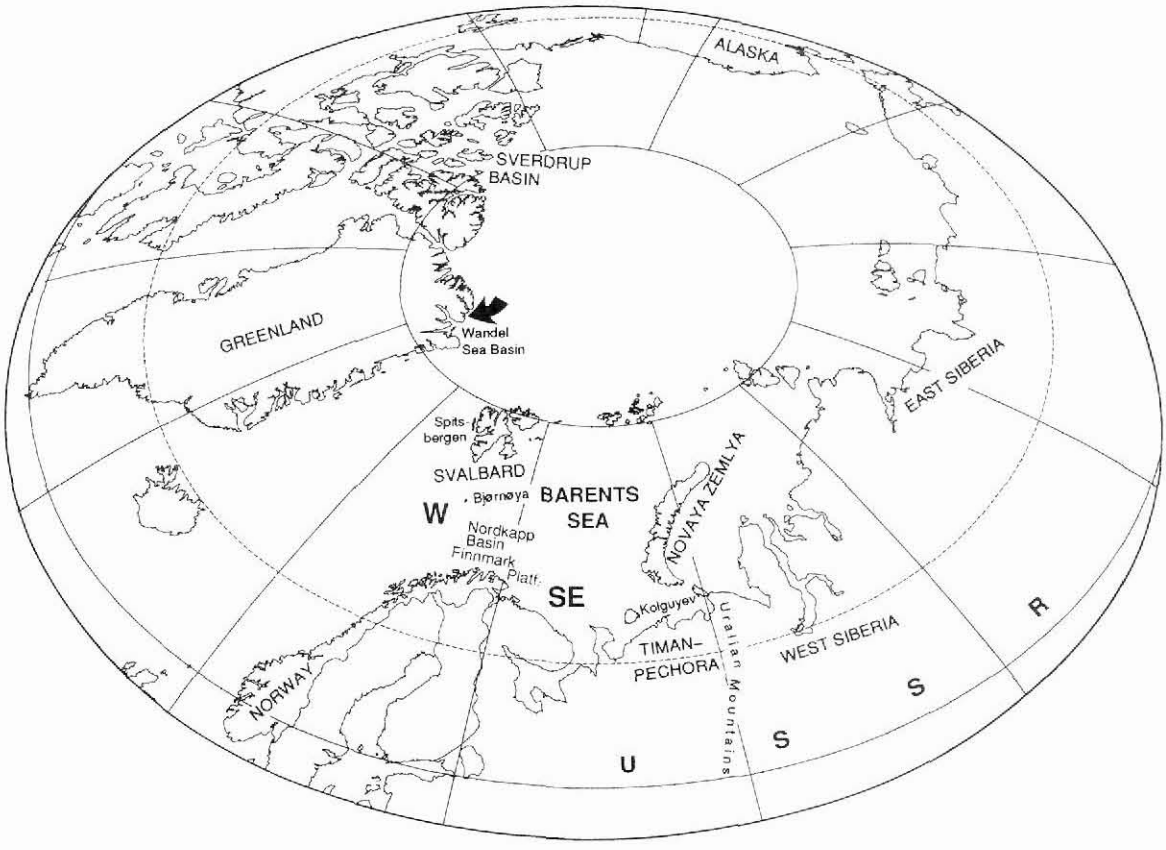


Fig. 1. Locality map in north polar projection showing North Greenland (Wandel Sea Basin), Svalbard (including Bjørnøya), W and SE Barents Sea (Finnmark Platform) and Timan–Pechora Basin of North Russia.

of the Wandel Sea Basin (Stemmerik & Håkansson, 1989). Shallowing conditions took place during the Early Permian mainly in Amdrup Land while the depositional basin apparently became gradually deeper during the same time in Peary Land and Prinsesse Ingeborg Halvø (Stemmerik & Håkansson, 1991).

Fusulinid assemblages

Fusulinid bearing samples from several sections of North Greenland have been investigated and eight local assemblages have been recognized (Fig. 3). The faunas have been compared with faunas in stratotype areas of the Russian Platform and Urals and to faunas elsewhere in the Arctic region (Fig. 4).

Wedekindellina assemblage (late Moscovian)

Sample GGU 221386 from the Kim Fjelde Formation in southern Amdrup Land (Fig. 2) comprises *Wedekindellina dutkevichi* Rauser-Chernousova & Belyaev, *Taitzehoella librovitchi* (Dutkevich), *Beedeina paradistenta* (Safonova) and *Fusulinella* cf. *F. bocki* Möller (Nilsson *et al.*, 1991; Fig. 3). This fauna closely resembles the fauna of the upper Moscovian *Wedekindellina* zone of Dunbar *et al.* (1962) from Holm Land and Amdrup Land, and thus suggests an age older than previously proposed for the lower part of the Kim Fjelde Formation in this area (cf. Stemmerik & Håkansson, 1989).

One sample (GGU 221337) collected in northern Amdrup Land contains poorly preserved specimens of the genus *Fusulinella* (Nilsson *et al.*, 1991; Fig. 3). This indicates a Middle Carboniferous, possible late Moscovian age for these sediments which previously were believed to be of Early Permian age (cf. Stemmerik & Håkansson, 1989).

Rauserites ex. gr. *simplex* assemblage (late Kasimovian)

Fusulinids of Late Carboniferous age ('*Triticites*' spp. and *Pseudofusulinella* spp.) have previously been re-

ported from eastern Peary Land (Petryk, 1977; Stemmerik & Håkansson, 1989). Re-examination of Petryk's collections from the Foldedal Formation shows that the '*Triticites*' fauna in the lower part of the section are more primitive than those from the upper part. The assemblage of '*Triticites*' spp. in the samples 171, 172, 175 and 182 (see Petryk, 1977) are here assigned to *Rauserites* ex. gr. *simplex* (Schellwien), and the *Pseudofusulinella* spp. belongs to the *Pseudofusulinella usvae* group (Fig. 3).

Pseudofusulinella usvae (Duktevich) is long-ranging, occurring in Upper Carboniferous strata as well as in Lower Permian beds. *Rauserites simplex* (Schellwien), however, has a more restricted stratigraphic occurrence. It is present in upper Kasimovian to lower Gzhelian strata

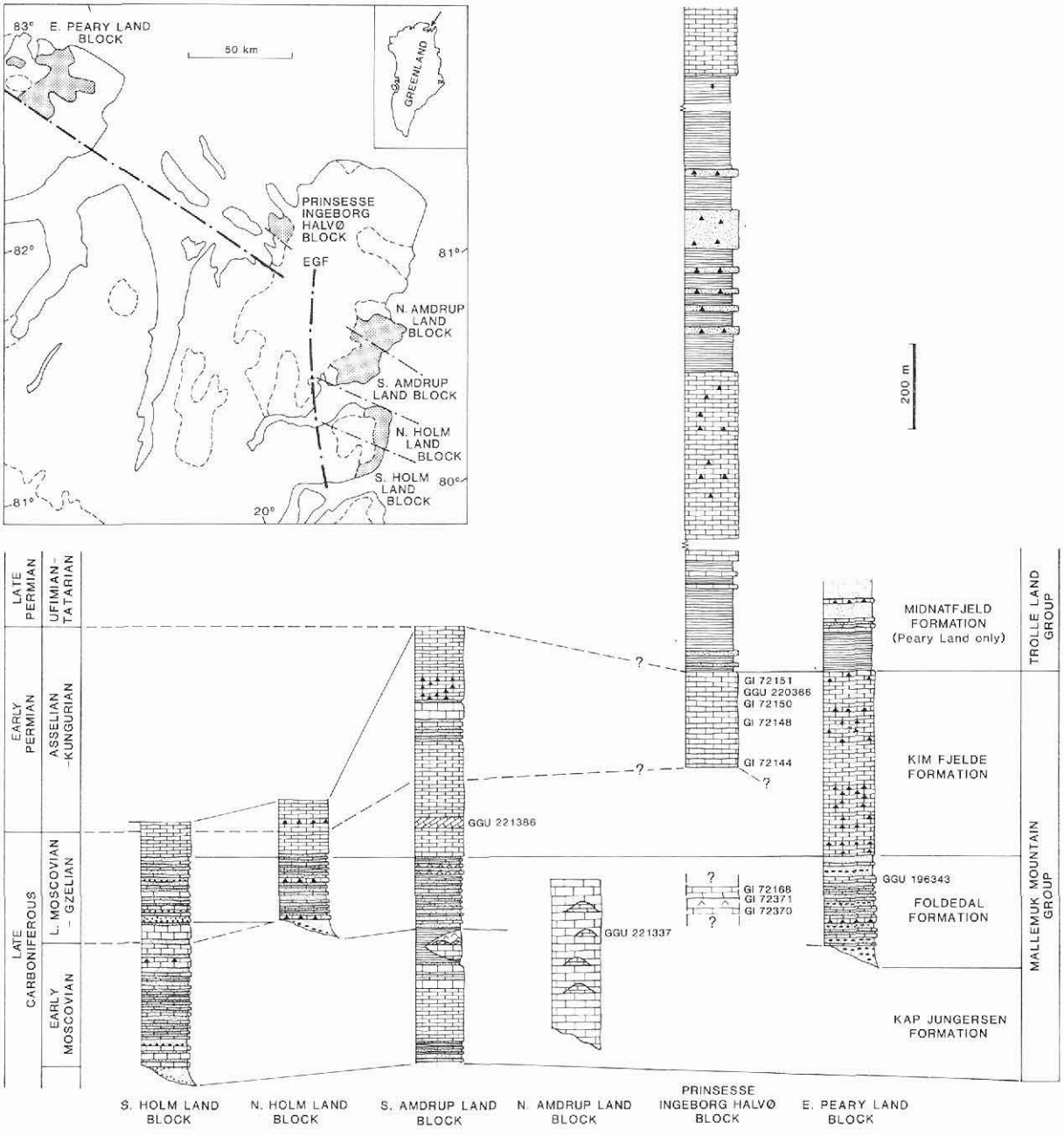


Fig. 2. Lithostratigraphic correlation of marine Upper Palaeozoic sediments in North Greenland with position of the fusulinid bearing samples. Solid lines indicate lithostratigraphic units; dotted line suggested biostratigraphic correlation by Stemmerik & Håkansson (1989). Inset map shows distribution of Upper Palaeozoic sediments. From Nilsson *et al.* (1991).

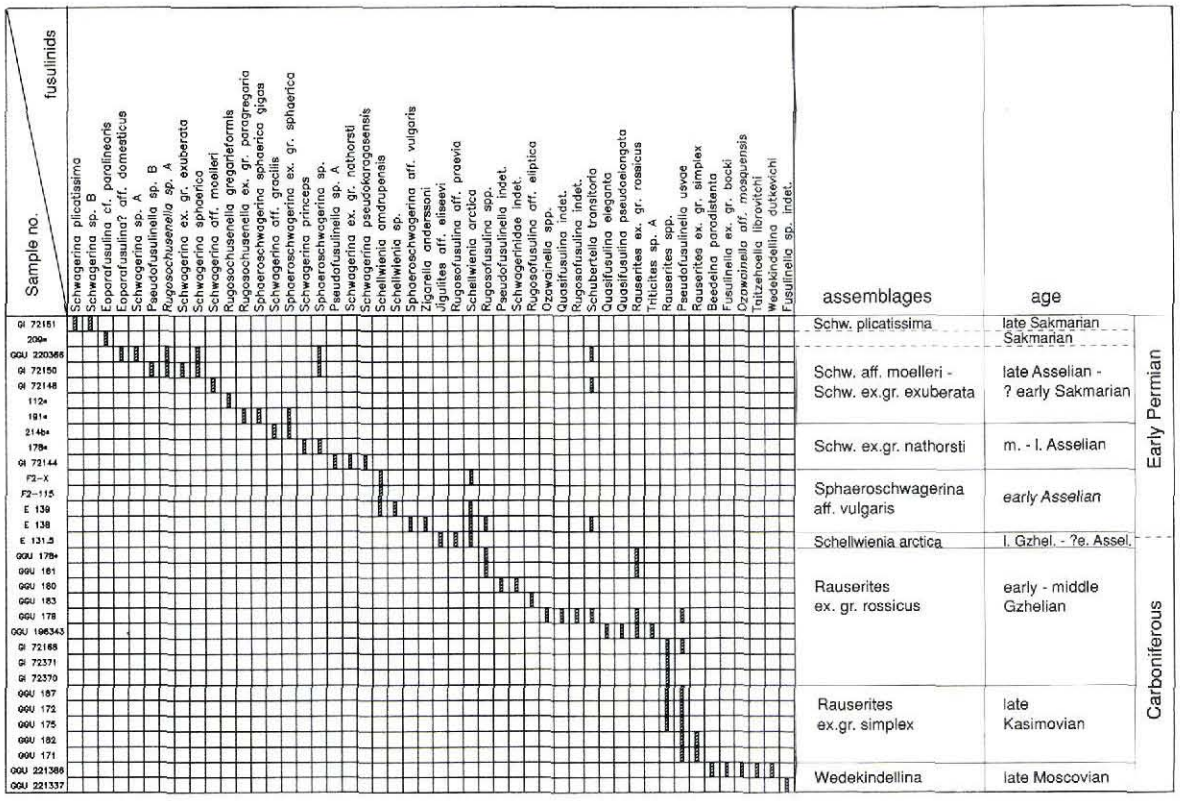


Fig. 3. Composite-distribution chart of fusulinid species from North Greenland. * = loose block.

in the Russian Platform (Rosovskaya, 1958) and the Urals (Davydov *in* Chuvashov *et al.*, 1986) while only this species is common in upper Kasimovian beds of Spitsbergen (in the *Rauserites quasiarcticus* zone of Nilsson & Davydov, 1993).

In the Peary Land section the *Rauserites* ex. gr. *simplex* assemblage is overlain by the *Rauserites* ex. gr. *rossicus* assemblage, indicating early–middle Gzhelian age (see discussion below). No distinct lower Gzhelian fauna occurs in the *Rauserites* ex. gr. *simplex* assemblage and the age of this assemblage is therefore suggested to be no younger than late Kasimovian.

Rauserites ex. gr. *rossicus* assemblage (early–middle Gzhelian)

The '*Triticites*' fauna stratigraphically higher in the eastern Peary Land section (samples 178, 179, 181, 183 of Petryk, 1977) is more advanced than *Rauserites* ex. gr. *simplex* (Schellwien). The investigated specimens show close affinity to *Rauserites* ex. gr. *rossicus* (Schellwien). *Rauserites rossicus* (Schellwien) is an index species in lower Gzhelian strata of the Russian Platform and the Urals, but the species group may also range into middle–upper Gzhelian beds (Rauser-Chernousova *et al.*, 1979). *Quasifusulina*? sp. and *Rugosofusulina* aff. *R. eliptica* Rosovskaya occur in the same levels as *Rauserites* ex. gr. *rossicus* (Schellwien) (Fig.3). Due to lack of typical upper Gzhelian fusulinids the assemblage is suggested as being of early–middle Gzhelian age.

Sample GGU 196343 from the upper part of the Foldedal Formation in eastern Peary Land contains *Rauserites rossicus* (Schellwien), *Rugosofusulina*? sp., *Quasifusulina eleganta* (Schlykova), *Q. pseudoelongata* Miklukho-Maclay and *Triticites* sp. A (Fig. 3). This fauna corresponds well to the beds with the *Rauserites* ex. gr. *rossicus* assemblage.

The *Rauserites* ex. gr. *rossicus* assemblage is also recognized in the Foldedal Formation of Prinsesse Ingeborg Halvø (samples GI 72168, GI 72370, GI 72371) (Figs 1, 3). The fauna is poor, but it contains *Rauserites* spp. and *Pseudofusulinella usvae* (Dutkevich; Fig. 3). The presence of this fusulinid assemblage represents the first evidence of Upper Carboniferous sediments in Kronprins Christian Land (Nilsson *et al.*, 1991).

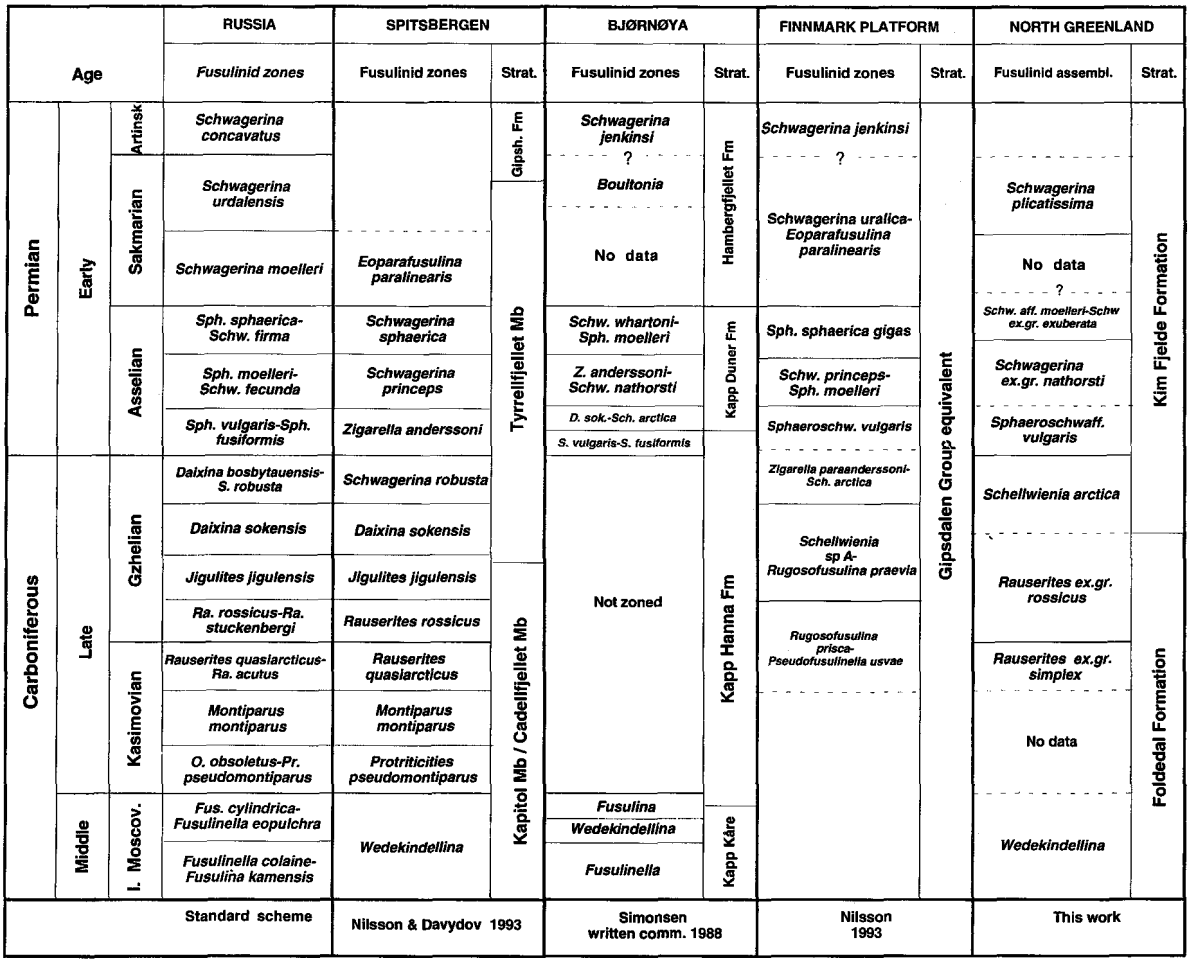


Fig. 4. Biostratigraphical correlation of fusulinid zones in the present Arctic region.

Schellwienia arctica assemblage (late Gzhelian – ?earliest Asselian)

Schellwienia arctica (Staff & Wedekind), *Schubertella transitoria* Staff & Wedekind and *Rugosofusulina* sp. are present in the lower part of the '*Pseudoschwagerina*' zone of Dunbar *et al.* (1962) in northern Holm Land (sample E 131 1/2) while *Sphaeroschwagerina* aff. *S. vulgaris* (Scherbovich) is recognized only in the upper part of the zone (see below). *Schellwienia arctica* (Schellwien) occurs in upper Gzhelian – lower Asselian beds in Spitsbergen (Nilsson, 1993). This species was previously assigned as an index species for the upper Kasimovian Stage in the Russian Platform and the Urals (e.g. Rauser-Chernousova *et al.*, 1979). The upper Kasimovian specimens of '*Triticites*' (i.e. *Schellwienia*) *arcticus* have, however, been restudied, and these specimens do not belong to *Schellwienia arctica* (Schellwien), but to a more primitive species called *Rauserites quasiarcticus* (Solovieva) (e.g. Davydov *et al.*, 1990).

Species of the genus *Rugosofusulina* are usually long-ranging, occurring in Upper Carboniferous – Lower Permian strata. *Schubertella transitoria* Staff & Wedekind is also present throughout Upper Carboniferous – lowermost Permian strata. No distinct Asselian fauna occurs in the lower part of the '*Pseudoschwagerina*' zone of Dunbar *et al.* (1962) previously regarded as being of Early Permian age. The *Schellwienia arctica* assemblage is therefore suggested to be of late Gzhelian – ?earliest Asselian age.

Schellwienia arctica (Staff & Wedekind) is also recognized in the lower part of the '*Pseudoschwagerina*' zone of Dunbar *et al.* (1962) in southern Amdrup Land (sample F2-X), and this part of the section corresponds to the *Schellwienia arctica* assemblage of southern Holm Land.

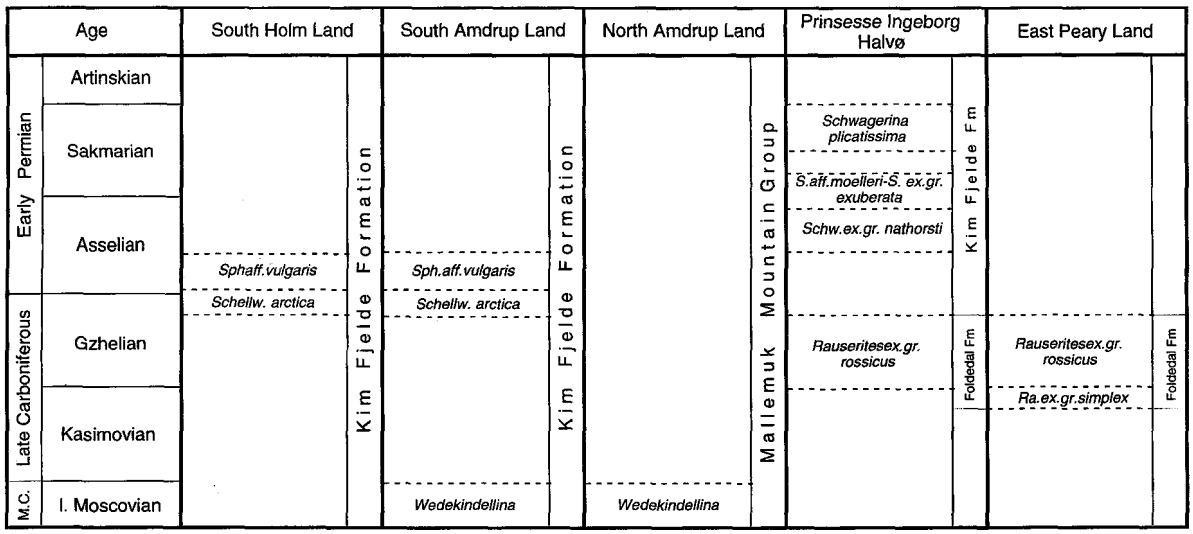


Fig. 5. Fusulinid assemblages and correlation between the investigated localities in North Greenland.

Sphaeroschwagerina aff. *S. vulgaris* assemblage (early Asselian)

Sample E-138 in the upper part of '*Pseudoschwagerina*' zone of Dunbar *et al.* (1962) in southern Holm Land includes: *Sphaeroschwagerina* aff. *S. vulgaris* (Scherbovich), *Schellwienia arctica* (Staff & Wedekind), *Zigarella anderssoni* (Schellwien) and *Schubertella transitoria* Staff & Wedekind. *Schellwienia* ex. gr. *arctica* (Staff & Wedekind) occurs slightly higher in the section (sample E-139).

Sphaeroschwagerina vulgaris (Scherbovich) is an index species for the lower Asselian strata of the Russian Platform and Urals (e.g. Rauser-Chernousova & Scherbovich, 1958; Davydov *et al.*, 1990). *Schellwienia arctica* (Staff & Wedekind) occurs in upper Gzhelian and lower Asselian strata of Spitsbergen (Nilsson, 1993). In Russia this species is most common in upper Gzhelian strata. *Zigarella anderssoni* (Schellwien) occurs in the uppermost Gzhelian to the middle Asselian in the Urals (Zolotova *et al.*, 1977) while this species characterizes lower Asselian beds in Spitsbergen (Nilsson & Davydov, 1993, Nilsson 1993). Based on the occurrence of *Sphaeroschwagerina* aff. *S. vulgaris* (Scherbovich) and *Zigarella anderssoni* (Schellwien) the age of the assemblage is assigned to the early Asselian.

In southern Amdrup Land *Schellwienia arctica* (Staff & Wedekind) occurs in the lower part of the '*Pseudoschwagerina*' zone (sample F2-X in Dunbar *et al.*, 1962) while *Schellwienia amdrupensis* (Ross & Dunbar) occurs stratigraphically higher in the section (sample F2-115). *Schellwienia amdrupensis* (Ross & Dunbar) is a more advanced form of the genus *Schellwienia* than *S. arctica* (Staff & Wedekind) and is probably no older than early Asselian age. The strata bearing this species is therefore suggested to correspond to the *Sphaeroschwagerina* aff. *S. vulgaris* assemblage of southern Holm Land.

Part of the collections that Ross & Dunbar (1962) described are from loose blocks. Although these samples have little stratigraphical significance, the recorded faunas give important taxonomic information. One sample (214b) from Amdrup Land (near Sophus Müller Næs) contains *Sphaeroschwagerina* sp. and *Schwagerina* ex. gr. *gracilis* (Sjomina). The former species indicates an Asselian age while the latter species occurs in upper Gzhelian or lower Asselian strata in the Urals and Russian Platform (Davydov *in* Chuvashov *et al.*, 1986; Davydov *et al.*, 1990). The fauna tentatively belongs to the *Sphaeroschwagerina* aff. *S.vulgaris* assemblage.

Schwagerina ex. gr. *nathorsti* assemblage (middle–late Asselian)

Sample GI 72144 from Prinsesse Ingeborg Halvø (Kim Fjelde Formation) contains: *Schwagerina* ex. gr. *nathorsti* (Staff & Wedekind), *Schwagerina pseudokaragasensis* Petocz and *Pseudofusulinella* sp. B (Fig. 3). In east–central Alaska *Schwagerina pseudokaragasensis* Petocz is identified in beds regarded as being of late Asselian – middle Sakmarian age (Petocz, 1970). *Schwagerina nathorsti* (Staff & Wedekind) was first described from the Kapp Duner Formation of Bjørnøya (Staff & Wedekind, 1910), and later studies show that this species is common in middle–upper Asselian beds in Bjørnøya (Simonsen, 1988; Nakrem *et al.*, 1992).

The *Schwagerina* ex. gr. *nathorsti* assemblage is sug-

gested to be of middle–late Asselian age. It is overlain by an assemblage suggested to be of latest Asselian – earliest Sakmarian age (see discussion below).

Schwagerina aff. *S. moelleri* – *Schwagerina* ex. gr. *exuberata* assemblage (latest Asselian – earliest Sakmarian)

In the upper part of the Kim Fjelde Formation at the Prinsesse Ingeborg Halvø section (GI 72148; Fig. 2) the following species occur: *Schwagerina* aff. *S. moelleri* (Schellwien), *Eoparafusulina*? aff. *E. domesticus* (Grozdilova & Lebedeva) and *Schubertella transitoria* Staff & Wedekind. Two overlying fusulinid-bearing samples (GI 72150, GGU 220366; Fig. 2) include *Sphaeroschwagerina* sp., *Schwagerina* ex. gr. *exuberata* (Shamov), *S.* ex. gr. *sphaerica* (Belyaev), *S.* sp. A, *Eoparafusulina*? aff. *E. domesticus* (Grozdilova & Lebedeva), *Rugosochusenella* sp. A and *Pseudofusulinella* sp.

In the Timan–Pechora Basin *Schwagerina moelleri* (Schellwien) and *Eoparafusulina? domesticus* (Grozdilova & Lebedeva) occur in beds of early Sakmarian age (Grozdilova & Lebedeva, 1961). *Schubertella transitoria* (Staff & Wedekind) is long-ranging, occurring in Upper Carboniferous as well as in Lower Permian strata. *Sphaeroschwagerina* species are common throughout the Asselian in the Urals and Russian Platform but this genus ranges into the Sakmarian in the Timan–Pechora Basin (Konovalova, 1991) and Central Asia (Leven & Scherbovich, 1978). *Schwagerina* ex. gr. *exuberata* (Shamov) occurs in the middle and upper Asselian and *S.* ex. gr. *sphaerica* (Belyaev) in upper Asselian beds in the Urals and Timan–Pechora Basin (e.g. Mikhailova, 1974; Konovalova, 1991).

The recorded assemblage from the Prinsesse Ingeborg Halvø section comprises a fauna which shows similarities to both upper Asselian and lower Sakmarian strata in Russia. The *Schwagerina* aff. *S. moelleri* – *Schwagerina* ex. gr. *exuberata* assemblage is tentatively suggested to be of latest Asselian – earliest Sakmarian age.

Sphaeroschwagerina sphaerica gigas (Rauser-Chernousova) and *Schwagerina* ex. gr. *sphaerica* (Belyaev) are recognized in a loose block from Amdrup Land (sample 178a). A loose block from Henrik Kröyer Holme (sample 191) contains *Sphaeroschwagerina sphaerica gigas* (Rauser-Chernousova) and *Rugosochusenella* ex. gr. *paragregaria* (Rauser-Chernousova). These faunas show close similarities to the *Schwagerina* aff. *S. moelleri* – *Schwagerina* ex. gr. *exuberata* assemblage of Prinsesse Ingeborg Halvø, and may correspond to that assemblage.

Schwagerina plicatissima assemblage (late Sakmarian)

Schwagerina plicatissima (Rauser-Chernousova) and *Schwagerina* sp. B occur in the uppermost part of the Kim Fjelde Formation at the Prinsesse Ingeborg Halvø section (GI 72151; Fig. 2). *Schwagerina plicatissima* (Rauser-Chernousova) is common in upper Sakmarian strata (*Schwagerina urdalensis* zone) in the Urals and Timan–Pechora Basin (e.g. Konovalova, 1991). The age of the assemblage is therefore regarded to be late Sakmarian.

A loose block from Amdrup Land contains specimens of *Eoparafusulina* cf. *E. paralinearis* (Thorsteinsson) (Ross & Dunbar, 1962). This species is common in beds of early Sakmarian age in Spitsbergen (Cutbill & Challinor, 1965; Nilsson & Davydov, 1993) and in Sakmarian strata of Arctic Canada (Thorsteinsson, 1960) and southwestern Barents Shelf (Nilsson, 1993). *Eoparafusulina* cf. *E. paralinearis* (Thorsteinsson) may correspond to the upper Sakmarian *Schwagerina plicatissima* assemblage or slightly older.

Correlation

Upper Moscovian strata of Holm Land (Foldedal Formation) and Amdrup Land (Foldedal and Kim Fjelde Formations) are characterized by the *Wedekindellina* assemblage zone which is correlated to the two upper Moscovian fusulinid zones of the stratotype area of the Russian Platform (Rauser-Chernousova *et al.*, 1951; Fig. 4). The upper Moscovian *Wedekindellina* assemblage zone is also reported from the Kapitol and Cadellfjellet Members of Spitsbergen (Cutbill & Challinor, 1965; Nilsson, 1988, 1993). Upper Moscovian beds of the Kapp Kåre and Kapp Hanna Formations of Bjørnøya are characterized by three fusulinid assemblages, respectively *Fusulinella*, *Wedekindellina* and *Fusulina* (Simonsen, written communication1988), and these assemblages contain species which also occur in upper Moscovian beds of the Wandel Sea Basin. Recently, upper Moscovian strata of the Sverdrup Basin (Arctic Canada) were divided into *Wedekindellina lata* – *W. uralica longa* and *Fusulinella eopulchra* zones, respectively (Rui Lin *et al.*, 1991). The *Wedekindellina* assemblage of the Wandel Sea Basin contains similar species as in the two upper Moscovian assemblages of the Sverdrup Basin.

Lower and middle Kasimovian fusulinids have so far not been recognized in North Greenland. The *Rauserites* ex. gr. *simplex* assemblage in the Foldedal Formation is suggested to be of late Kasimovian age. The assemblage shows similarities to the fauna in the upper Kasimovian *Rauserites quasiarcticus* zone in the Kapitol and Cadell-

fjellet Members in Spitsbergen (Nilsson & Davydov,1993; Nilsson, 1993). Upper Kasimovian fusulinids have not been reported from the succession of Bjørnøya, and the fauna of the upper Kasimovian – lower Gzhelian *Pseudofusulinella – Rugosofusulina* ex. gr. *prisca* assemblage of Finnmark Platform (Nilsson, 1993) shows no close similarities to the *Rauserites* ex. gr. *simplex* assemblage of North Greenland.

Lower to middle Gzhelian beds of North Greenland (Foldedal Formation) are characterized by the *Rauserites* ex. gr. *rossicus* assemblage. The *Rauserites* ex. gr. *rossicus* assemblage includes few species compared to the lower–upper Gzhelian fusulinid assemblages of Spitsbergen. The recorded assemblage corresponds to the *Rauserites rossicus* and *Jigulites jigulensis* assemblages of respectively early and middle Gzhelian ages in Spitsbergen (Fig. 4). Gzhelian fusulinid assemblages are not reported from Bjørnøya, and fusulinids belonging to the *Schellwienia* sp. A – *Rugosofusulina praevia* assemblage of the Finnmark Platform indicate only a middle–late Gzhelian age.

The *Schellwienia arctica* assemblage of North Greenland (Kim Fjelde Formation) is suggested to be of late Gzhelian – ?earliest Asselian age in comparison with faunas of Spitsbergen. *Schellwienia arctica* (Schellwien) occurs in the upper Gzhelian *Daixina sokensis* and *Schwagerina robusta* zones as well as in the lower Asselian *Zigarella anderssoni* zone of the Tyrrellfjellet Member of Spitsbergen (Nilsson & Davydov, 1993; Nilsson, 1993). The species is also common in uppermost Gzhelian – ?lowermost Asselian *Zigarella paraanderssoni – Schellwienia arctica* zone of the Finnmark Platform (Nilsson, 1993). In Bjørnøya this species is, however, present only in lower Asselian beds (*Daixina sokensis – Schellwienia arctica* zone) of the Kapp Duner Formation (Simonsen, written communication 1988; Nakrem *et al.*, 1992).

The *Schellwienia arctica* assemblage of North Greenland is overlain by the *Sphaeroschwagerina* aff. *S. vulgaris* assemblage which is no older than early Asselian due to the occurrence of *Sphaeroschwagerina* aff. *S. vulgaris* (Scherbovich). In Bjørnøya the base of the Asselian is marked by the appearance of the *Sphaeroschwagerina fusiformis – S. vulgaris* assemblage, and this zone is overlain by the *Daixina sokensis – Schellwienia arctica* zone (Simonsen, written communication 1988; Nakrem *et al.*, 1992). The *Sphaeroschwagerina* aff. *S. vulgaris* assemblage of North Greenland is correlated to these two lower Asselian assemblages of Bjørnøya, and to the lower Asselian *Zigarella anderssoni* assemblage of Spitsbergen (Nilsson & Davydov, 1993; Nilsson, 1993; Fig. 4). On the Finnmark Platform the *Sphaeroschwagerina* aff. *S. vulgaris* assemblage of Nilsson (1993) correlates well to the *Sphaeroschwagerina* aff. *S. vulgaris* assemblage of North Greenland.

Middle to upper Asselian strata of the Kim Fjelde Formation are characterized by the *Schwagerina* ex. gr. *nathorsti* assemblage. The recorded assemblage is poor compared to middle and upper Asselian faunas of Spitsbergen, Bjørnøya and the Finnmark Platform. The assemblage is overlain by the *Schwagerina* aff. *S. moelleri – Schwagerina* ex. gr. *exuberata* assemblage, suggested to be of late Asselian – early Sakmarian age. The fauna shows similarities to the upper Asselian *Schwagerina sphaerica* zone and lower Sakmarian *Eoparafusulina paralinearis* zone of Spitsbergen, and to the upper Asselian *Sphaeroschwagerina sphaerica gigas* zone of Finnmark Platform and *Schwagerina whartoni – Sphaeroschwagerina moelleri* zone of Bjørnøya.

The youngest fusulinid assemblage recorded in the succession of North Greenland (Kim Fjelde Formation) is of late Sakmarian age (*Schwagerina plicatissima* assemblage). In Spitsbergen the youngest fusulinid assemblage belongs to the lower Sakmarian *Eoparafusulina paralinearis* zone (Nilsson & Davydov, 1993; Nilsson, 1993). No distinct Sakmarian fusulinid fauna has been reported from Bjørnøya. The *Eoparafusulina paralinearis – Schwagerina uralica* zone of Finnmark Platform is of general Sakmarian age (Nilsson, 1993). Except for the specimens of *Eoparafusulina* cf. *E. paralinearis* (Thorsteinsson) in a loose block from Amdrup Land, there are no close similarities between the Sakmarian fauna of the Finnmark Platform and the Sakmarian fusulinids from North Greenland. However, both faunas include species which are common in the Sakmarian strata of the Urals or Timan–Pechora Basin (see e.g. Grozdilova & Lebedeva, 1961; Konovalova, 1991).

Summary and conclusions

Eight fusulinid assemblages are recorded in the Mallemuk Mountain Group, giving a more precise dating of this succession than previously reported.

The recorded fusulinid assembages show close similarities to faunas reported elsewhere in the present Arctic areas; i.e. North Russia, Southwest Barents sea (Finnmark Platform), Spitsbergen and Bjørnøya (Fig. 4).

The base of the Kim Fjelde Formation in Amdrup Land has been dated as late Moscovian (*Wedekindellina* assemblage) and places the transition from mixed carbonate and siliciclastic deposition to monotonous carbonate platform sedimentation earlier in time than previously supposed (see Håkansson & Stemmerik, 1989).

Petryk's (1977) collections from Peary Land (Foldedal Formation) contain two different fusulinid assemblages; the lower *Rauserites* ex. gr. *simplex* assemblage is of late

Kasimovian age and the upper *Rauserites* ex. gr. *rossicus* assemblage is suggested to be of early–middle Gzhelian age (Fig. 5).

The first evidence of Upper Carboniferous sediments of the Foldedal Formation is found in Prinsesse Ingeborg Halvø (*Rauserites* ex. gr. *rossicus* assemblage). Assemblages of middle–late Asselian (*Schwagerina* ex. gr. *nathorsti*), late Asselian – earliest Sakmarian (*Schwagerina* aff. *S. moelleri – Schwagerina* ex. gr. *exuberata*) and late Sakmarian (*Schwagerina plicatissima*) ages have been recognized stratigraphically higher in the succession (Fig. 5). These assemblages give a more precise dating of the upper part of the Kim Fjelde Formation than in other parts of North Greenland.

Re-examination of the '*Pseudoschwagerina*' zone of Dunbar *et al.* (1962) from samples collected in the lower part of the Kim Fjelde Formation in Holm Land and Amdrup Land gives a slightly older age for the lower part of this assemblage than was previously supposed. The '*Pseudoschwagerina*' zone is in the present study divided into a *Schellwiena arctica* assemblage of late Gzhelian – ?earliest Asselian age and a *Sphaeroschwagerina* aff. *S. vulgaris* assemblage of early Asselian age (Fig. 5).

Taxonomic remarks

Genus *Ozawainella* Thompson, 1935
Ozawainella aff. *O. mosquensis* Rauser-Chernousova, 1951

Plate 1, Figs 5, 6, 9

Stratigraphical distribution. *Ozawainella mosquensis* Rauser-Chernousova is reported in upper lower Moscovian (Kashirskian) and upper Moscovian strata in the Russian Platform (Rauser-Chernousova *et al.*, 1951) and Timan–Pechora Basin (Grozdilova & Lebedeva, 1961). The species occurs in upper Moscovian (Kapitol Member) of Spitsbergen (Nilsson, 1988).

Occurrence in North Greenland. Amdrup Land, Kim Fjelde Formation, GGU 221386, *Wedekindellina* assemblage.

Material. Three tangential sections and five randomly oriented sections.

Genus *Schubertella* Staff & Wedekind, 1910
Schubertella transitoria Staff & Wedekind, 1910

Plate 5, Figs 12, 13

1910 *Schubertella transitoria* Staff & Wedekind, p. 121, pl. 4, figs 7, 8.

Stratigraphical distribution. Lower Permian in Russia (e.g. Suleimanov, 1949), Middle Carboniferous (upper Moscovian) to Lower Permian (Asselian) strata in Spitsbergen (Nilsson, 1988), Lower Permian (Asselian) strata on Bjørnøya (Simonsen, written communication 1988) and eastern North Greenland (Dunbar *et al.*, 1962; Ross & Dunbar, 1962).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72148 and GGU 220366, *Schwagerina* aff. *S. moelleri – S.* ex. gr. *exuberata* assemblage.

Material. One axial section, two tangential sections and five randomly oriented sections.

Genus *Sphaeroschwagerina* Miklukho-Maclay, 1959
Sphaeroschwagerina sphaerica gigas (Rauser-Chernousova & Scherbovich, 1949)

Plate 5, Fig 7

1949 *Schwagerina sphaerica* var. *gigas* Rauser-Chernousova & Scherbovich, p. 101–102, pl. 10, figs 2, 3.
1962 *Pseudoschwagerina pavlovi* (Rauser-Chernousova) Ross & Dunbar (part), pl. 7, figs 10, 11.

Stratigraphical distribution. Middle and upper Asselian strata of the Urals (Rauser-Chernousova & Scherbovich, 1949) and Bjørnøya (Simonsen, written communication 1988), upper Asselian on Finnmark Platform (Nilsson, 1993).

Occurrence in North Greenland. Amdrup Land, Kim Fjelde Formation, sample 178a (loose block) and Henrik Kröyer Holme, sample 191 (loose block) from Dunbar *et al.* (1962).

Material. One axial oriented section and some randomly oriented sections.

Sphaeroschwagerina ex. gr. *sphaerica* (Scherbovich, 1949)

Plate 4, Fig. 11, Plate 5, Fig. 11

Remarks. Ross & Dunbar (1962) described this species as *Pseudoschwagerina pavlovi* (Rauser-Chernousova), but the figured specimens in figs 5, 8 and 9 in their plate 7 are more closely related to *Sphaeroschwagerina* ex. gr. *sphaerica* (Scherbovich, 1949).

Stratigraphical distribution. Sphaeroschwagerina sphaerica (Scherbovich) is an index species for the upper Asselian in the stratotype area of the Urals, although this species group also occurs in middle Asselian strata (Rauser-Chernousova & Scherbovich, 1949).

Occurrence in North Greenland. Amdrup Land, Kim Fjelde Formation, sample 214b (loose block) from Ross & Dunbar (1962), and Henrik Kröyer Holme, sample 191 (loose block) from Dunbar *et al.* (1962).

Material. One axial oriented section and some oblique oriented sections.

Sphaeroschwagerina aff. *S. vulgaris* (Scherbovich, 1949)

Plate 3, Fig. 10

Stratigraphical distribution. Lower Asselian beds of the Urals (Rauser-Chernousova & Scherbovich, 1949), Timan–Pechora Basin (Konovalova, 1991), Bjørnøya (Simonsen, written communication 1988; Nakrem *et al.*, 1992) and Finnmark Platform (Nilsson, 1993).

Occurrence in North Greenland. Southern Holm Land, Kim Fjelde Formation, sample E 138 from Ross & Dunbar (1962).

Material. One slightly oblique oriented section and some randomly oriented sections.

Sphaeroschwagerina sp.

Plate 5, Figs 5, 8, 10, 14

Remarks. The investigated shells are rather compressed and damaged in the outer volutions, but the specimens have a tightly coiled juvinarium of four volutions. Proloculus is minute. Small chomata are present on the inner four volutions. The spirotheca is thin in the juvinarium, thickening rapidly in the succeeding volutions. Because of the damaged tests it is impossible to determine the pattern of the septal-fluting.

The recorded specimens show close similarities to forms of the genus *Sphaeroschwagerina.*

Stratigraphical distribution. Sphaeroschwagerina is present in the Lower Permian (Asselian to Sakmarian) (e.g. Loeblich & Tappan, 1988).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GGU 220366, GI 72150, *Schwagerina* aff. *S. moelleri – S.* ex. gr. *exuberata* assemblage.

Material. Ten randomly oriented sections.

Genus Fusulinella von Möller, 1877
Fusulinella ex. gr. *bocki Möller, 1877*

Plate 1, Fig. 4

Stratigraphical distribution. Fusulinella bocki Möller occurs in upper Moscovian strata on the Russian Platform (Rauser-Chernousova *et al.*, 1951), Timan (Lebedeva, 1966), Spain (van Ginkel, 1965), Bjørnøya (Simonsen, written communication 1988) and Spitsbergen (Nilsson, 1988).

Occurrence in North Greenland. Amdrup Land, Kim Fjelde Formation, GGU 221386, *Wedekindellina* assemblage.

Material. One randomly oriented section.

Plate 1

Figs 1,3. *Wedekindellina dutkevichi* Rauser-Chernousova & Belyaev; 1, 3, GGU 221386, × 20.

Figs 2,7. *Beedeina paradistenta* (Safanova); 2, 7, GGU 221386, × 20.

Fig. 4. *Fusulinella* ex. gr. *bocki* Möller; 4, GGU 221386, × 20.

Figs 5,6,9. *Ozawainella* aff. *mosquensis* Rauser-Chernousova; 5, 6, 9, GGU 221386, × 40.

Figs 8,11. *Taitzehoella librovitchi* (Dutkevich); 8, 11, GGU 221386, × 20.3.

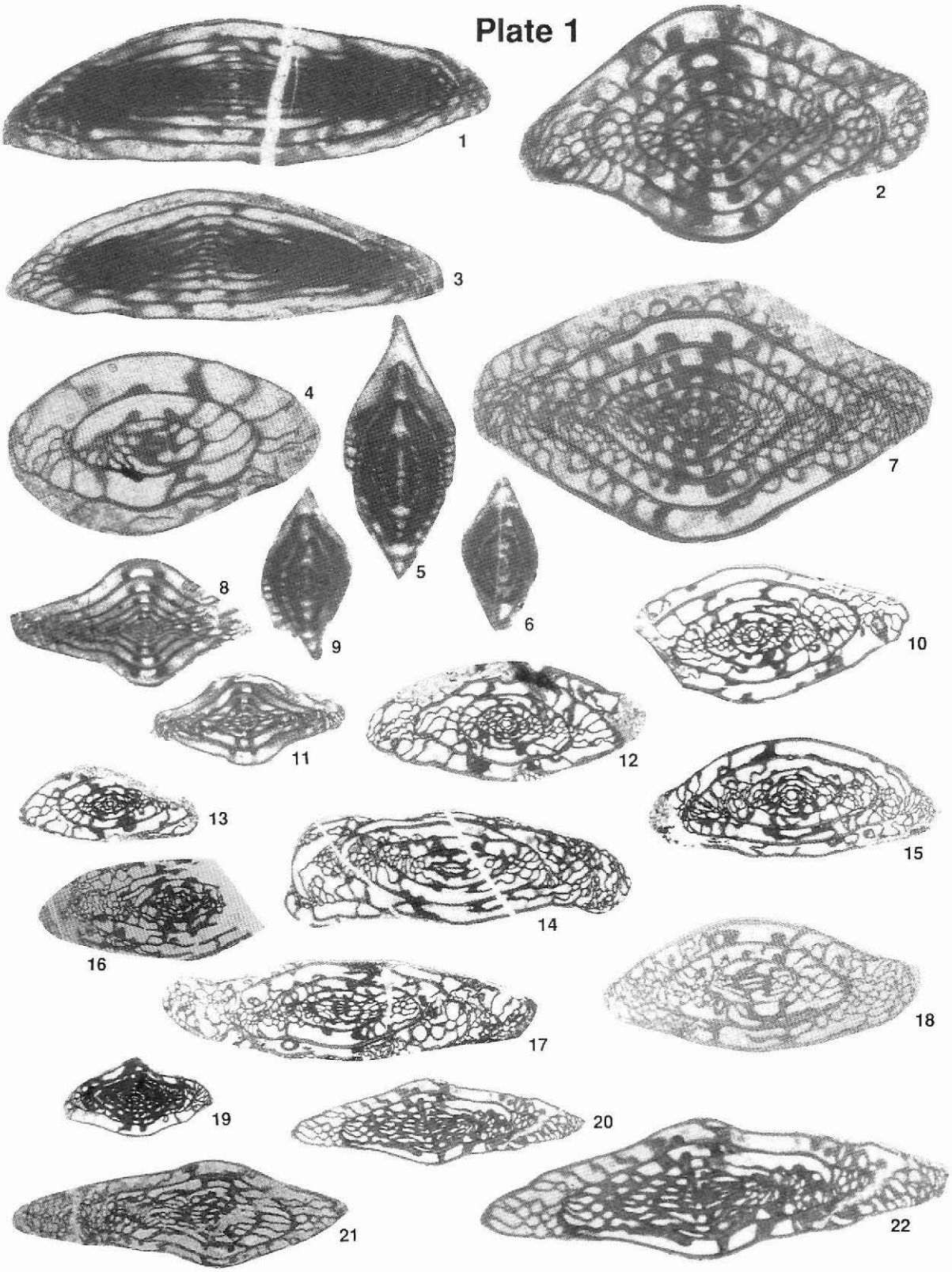
Figs 10,12,15,18. *Rauserites* aff. *R. simplex* (Schellwien); 10, 12, 15, 18, sample 182 of Petryk (1977), × 10.

Figs 13,14,16,17. *Rauserites* aff. *R. irregularis* (Schellwien & Staff); 13, sample 172 of Petryk (1977); 14, 16, sample 182 of Petryk (1977); 17, sample 171 of Petryk (1977), × 10.

Fig. 19. *Pseudofusulinella* sp. A; 19, sample 181 of Petryk (1977), × 10.

Figs 20–22. *Pseudofusulinella usvae* (Dutkevich); 20, 21, sample 187 of Petryk (1977), × 10; 22, the same × 20.

Plate 1



Genus *Pseudofusulinella* Thompson, 1951
Pseudofusulinella usvae (Dutkevich, 1932)

Plate 1, Figs 20–22; Plate 2, Fig. 12

1932 *Fusulinella usvae* Dutkevich, p. 15–16, no illustration.
1934 *Fusulinella usvae* Dutkevich, p. 53–57 Russian, p. 88–80 English, pl. 6, figs 1–11.

Stratigraphical distribution. Upper Carboniferous and Lower Permian (Asselian–Sakmarian) strata in Russia (e.g. Rauser-Chernousova *et al.*, 1979) and Spitsbergen (Nilsson, 1993).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Foldedal Formation, GI 72168, *Rauserites* ex. gr. *rossicus* assemblage.

Material. Two tangential oriented sections and some randomly oriented sections.

Pseudofusulinella sp. A

Plate 1 , Fig. 19

Remarks. A specimen of 6 volutions reaches a length of 4.2 mm and a diameter of 1.0 mm. It is different from the *Pseudofusulinella usvae* group in having more intensively fluted septa at the pole regions, more massive chomata and a more elongated test.

Stratigraphical distribution. Pseudofusulinella species is usually long ranging, occurring in Upper Carboniferous as well as in Lower Permian (Asselian–Sakmarian) strata (e.g. Loeblich & Tappan, 1988).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72144, *Schwagerina* ex. gr. *nathorsti* assemblage.

Material. One slightly tangential oriented section.

Pseudofusulinella sp. B

Plate 5, Fig. 9

Remarks. Only randomly oriented specimens were examined. The shape of the test seems to be inflated fusiform with bluntly to sharply pointed poles. Number of volutions is 7. *Pseudofusulinella* sp. B is different from *Pseudofusulinella* ex. gr. *usvae* in having a shorter and more inflated fusiform shape. *Pseudofusulinella* sp. B is shorter and more globose than *Pseudofusulinella* sp. A.

Stratigraphical distribution. Upper Carboniferous – Lower Permian (Asselian–Sakmarian) strata (eg. Loeblich & Tappan, 1988).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72150, *Schwagerina* aff. *S. moelleri – S.* ex. gr. *exuberata* assemblage.

Material. Three randomly oriented sections.

Pseudofusulinella sp. C

Plate 4, Fig. 6

Stratigraphical distribution. Upper Carboniferous to Lower Permian (Asselian–Sakmarian) strata (eg. Loeblich & Tappan, 1988).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72144, *Schwagerina* ex. gr. *nathorsti* assemblage.

Material. One tangential oriented section.

Plate 2

All figures × 10, except noted

Figs 1–3. *Rugosofusulina* aff. *R. eliptica* Rosovskaya; 1, 2, 3, sample 183 of Petryk (1977).

Figs 4–10. *Rauserites* ex. gr. *rossicus* (Schellwien); 4, sample 181 of Petryk (1977); 6, sample 178 10 of Petryk (1977); 5,7–10, GGU-196343.

Figs 11,14. *Rauserites* sp.; 11, 14, GI 72168.

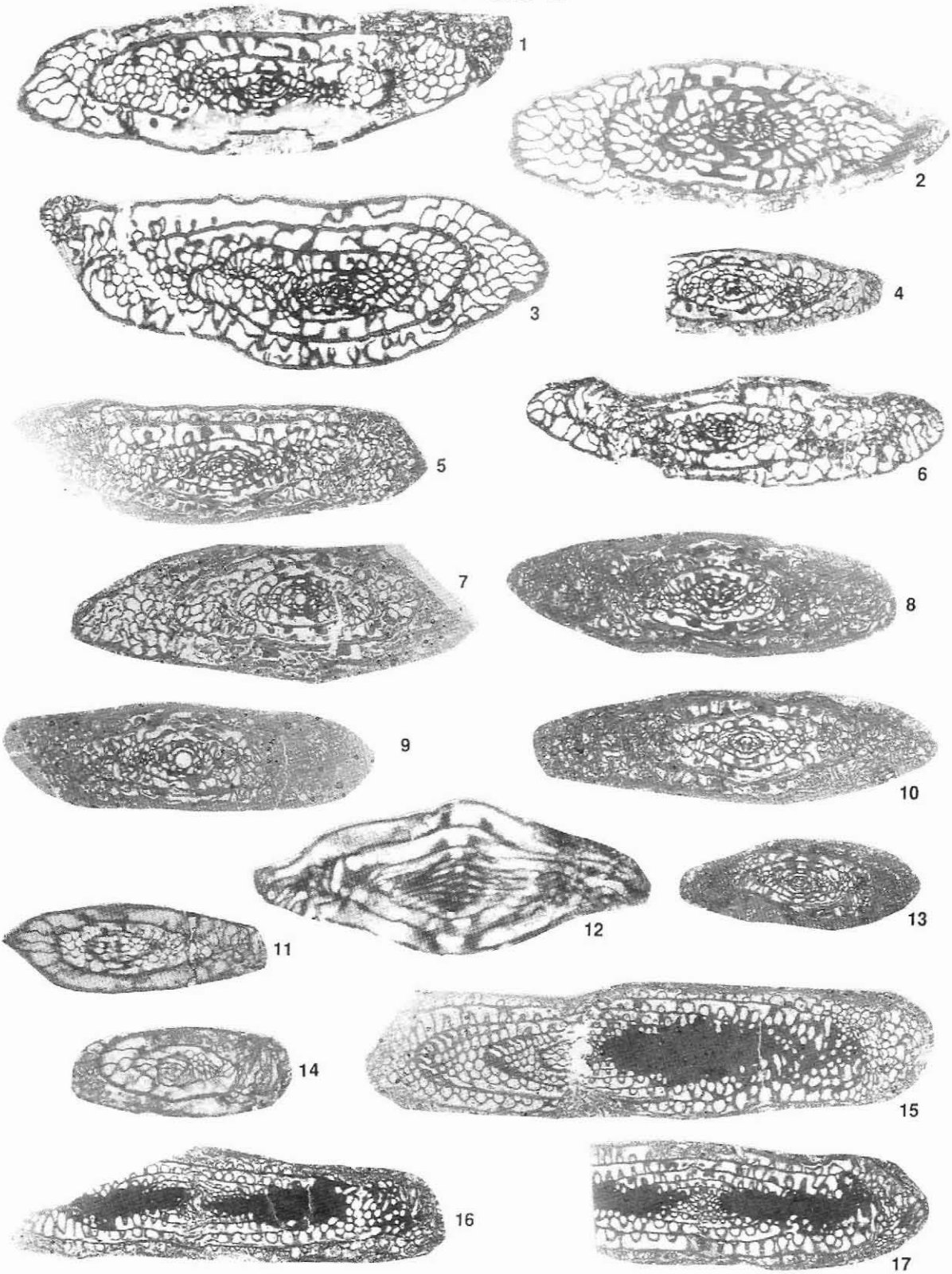
Fig. 12. *Pseudofusulinella* aff. usvae (Dutkevich); 12, GI 72168, × 20.

Fig. 13. *Triticites* sp. A; 13, GGU 196343.

Fig. 15. *Quasifusulina pseudoelongata* Miklukho-Maclay; 15, GGU 196343.

Figs 16–17. *Quasifusulina eleganta* Schlykova; 16, 17, GGU 196343.

Plate 2



Genus *Taitzehoella* Sheng, 1951
Taitzehoella librovitchi (Duktevich, 1934)

Plate 1, Figs 8, 11

1934 *Fusulinella librovitchi* Dutkevich, p. 43, 81, pl. 5, figs 1–5.
1958 *Taitzehoella librovitchi* (Dutkevich) Sheng, p. 84, no illustration.

Stratigraphical distribution. This species was orginally described from the Moscovian stage of the Urals (Dutkevich, 1934). The species has earlier been reported in upper Moscovian strata from Holm Land of eastern North Greenland (Dunbar *et al.*, 1962; Ross & Dunbar, 1962).

Occurrence in North Greenland. Amdrup Land, Kim Fjelde Formation, GGU 221386, *Wedekindellina* assemblage.

Material. Three slightly tangential oriented sections.

Genus *Beedeina* Galloway, 1933
Beedeina paradistenta (Safonova, 1951)

Plate 1, Figs 2, 7

1951 *Fusulina paradistenta* Safonova *in* Rauser-Chernousova *et al.*, p. 291, pl. 48, figs 3, 4.

Stratigraphical distribution. Upper Moscovian in the Russian Platform (Rauser-Chernousova *et al.*, 1951), 'Lower Marine Group' (i.e. lower Mallemuk Mountain Group) in eastern North Greenland (Dunbar *et al.*, 1962; Ross & Dunbar, 1962).

Occurrence in North Greenland. Amdrup Land, Kim Fjelde Formation, GGU 221386, *Wedekindellina* assemblage.

Material. Two axial oriented sections, two slightly tangential oriented sections and several randomly oriented sections.

Genus *Quasifusulina* Chen, 1934
Quasifusulina eleganta Schlykova, 1948

Plate 2 , Figs 16, 17

1948 *Quasifusulina longissima* var. *eleganta* Schlykova, p. 131–132, pl. 6, figs 3–6.
1958 *Quasifusulinqa eleganta* (Schlykova) Rosovskaya, p. 77, pl. 1, figs 2, 3.

Stratigraphical distribution. Upper Carboniferous in Russia (Rosovskaya, 1958; Grozdilova, 1966), Upper Carboniferous – Lower Permian in Carnic Alps (Kahler, 1973).

Occurrence in North Greenland. Peary Land, Foldedal Formation, GGU 196343, *Rauserites* ex. gr. *rossicus* assemblage.

Material. Three axial oriented sections and two tangential oriented sections.

Quasifusulina pseudoelongata Miklukho-Maclay, 1949

Plate 2, Fig. 15

1949 *Quasifusulina longissima* var. *pseudoelongata* Miklukho-Maclay, p. 62–63, pl. 1, figs 3, 4.
1958 *Quasifusulina pseudoelongata* (Miklukho-Maclay) Rosovskaya, p. 78, pl. 1, fig. 4.

Stratigraphical distribution. Upper Carboniferous (Kasimovian) in Russia (Rosovskaya, 1958; Grozdilova, 1966), Upper Carboniferous and Lower Permian in Carnic Alps (Kahler, 1973).

Occurrence in North Greenland. Peary Land, Foldedal Formation, GGU 196343, *Rauserites* ex. gr. *rossicus* assemblage.

Material. One axial oriented section.

Plate 3

All figures × 10.

Figs 1–4. *Rugosofusulina* aff. *R. praevia* Shlykova; 1–4, sample E131 1/2 of Ross & Dunbar (1962).

Fig. 5. *Jigulites* aff. *J. eliseevi* Mikhailova; 5, sample E131 1/2 of Ross & Dunbar (1962).

Figs 6–9,11. *Schellwienia arctica* (Schellwien); 6, 7, sample E131 1/2 of Dunbar *et al.* (1962); 8, 9, 11, sample E138 of Dunbar *et al.* (1962).

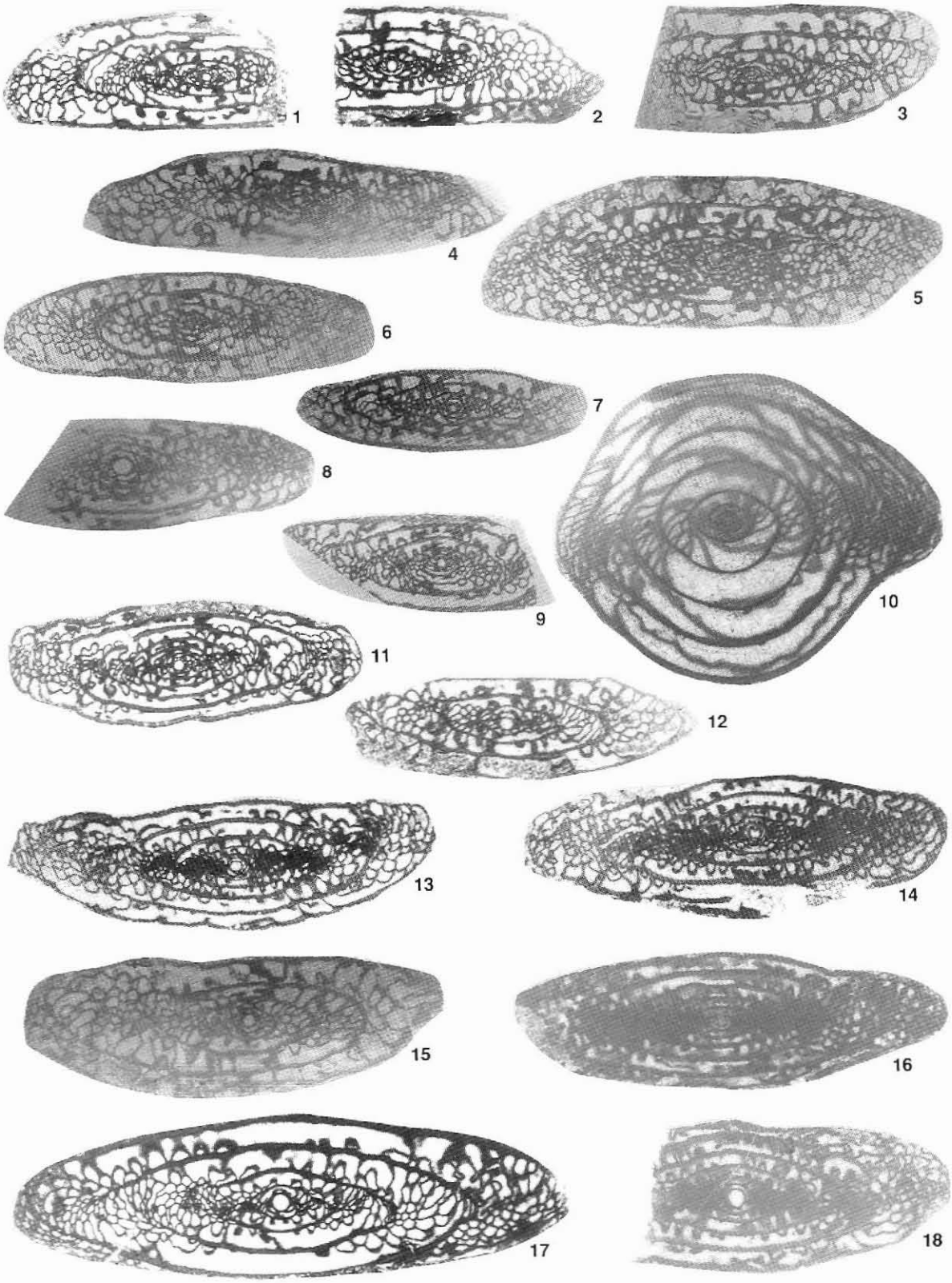
Fig. 10. *Sphaeroschwagerina* aff. *S. vulgaris* (Scherbovich); 10, sample E138 of Dunbar *et al.* (1962).

Figs 12,15,17. *Schellwienia amdrupensis* (Ross & Dunbar); 12, 15, sample E139 of Dunbar *et al.* (1962); 17, sample F_2–115 (holotype) of Ross & Dunbar (1962).

Figs 13,14,16. *Rugosofusulina arianica* Leven & Scherbovich; 13, 14, 16, sample E138 of Dunbar *et al.* (1962).

Fig. 18. *Zigarella anderssoni* (Staff & Wedekind); 18, sample E138 of Dunbar *et al.* (1962).

Plate 3



Genus *Wedekindellina* Dunbar & Henbest, 1933

Wedekindellina dutkevichi Rauser-Chernousova & Belyaev, 1936

Plate 1, Figs 1, 3

1936 *Wedekindellina dutkevichi* Rauser-Chernousova & Belyaev, p.183, 185, no illustration.

Stratigraphical distribution. Upper Moscovian in the Russian Platform (Rauser-Chernousova *et al.*, 1951), Timan (Lebedeva, 1966), 'Lower Marine Group' (i.e. lower Mallemuk Mountain Group) in eastern North Greenland (Dunbar *et al.*, 1962; Ross & Dunbar, 1962), Cadellfjellet and Kapitol Members of the Nordenskiöldbreen Formation in Spitsbergen (Cutbill & Challinor, 1965; Cutbill, 1968; Nilsson, 1988) and upper part of Kapp Kåre Formation on Bjørnøya (Simonsen, written communication 1988).

Occurrence in North Greenland. Amdrup Land, Kim Fjelde Formation, GGU 221386, *Wedekindellina* assemblage.

Material. One axial oriented section and several randomly oriented sections.

Genus *Triticites* Girty, 1904

Triticites sp. A

Plate 2 , Fig. 13

Remarks. Specimen of 6.5 volutions reaching a length of 3.8 mm and a diameter of 1.4 mm; form ratio of 2.7. Outside diameter of proloculus measures 100 microns.

Occurrence in North Greenland. Peary Land, Foldedal Formation, GGU 196343, *Rauserites* ex. gr. *rossicus* assemblage.

Material. One axial oriented section and two oblique oriented sections.

Genus *Jigulites* Rosovskaya, 1950

Jigulites aff. *J. eliseevi* (Mikhailova, 1974)

Plate 3, Fig. 5

Stratigraphical distribution. Upper Gzhelian (*Daixina sokensis* zone) to lower Asselian (*Sphaeroschwagerina fusiformis – S. vulgaris* zone) in the Urals (Mikhailova, 1974) and upper Gzhelian in Spitsbergen (Nilsson, 1993).

Occurrence in North Greenland. Southern Holm Land, Kim Fjelde Formation, sample E-131 1/2 of Ross & Dunbar (1962), *Schellwienia arctica* zone.

Material: One axial oriented section.

Genus *Rauserites* Rosovskaya, 1949

Rauserites aff. R. irregularis (Schellwien & Staff, 1912)

Plate 1, Figs 13, 14, 16, 17

Stratigraphical distribution. Upper Kasimovian in the Urals (Rosovskaya, 1958).

Occurrence in North Greenland. Peary Land, Foldedal Formation, samples 171, 172 and 182 of Petryk (1977), *Rauserites* ex. gr. *simplex* assemblage.

Material. Two oblique oriented and three tangential oriented sections.

Rauserites ex. gr. *rossicus* (Schellwien, 1908)

Plate 2, Figs 4–10

Stratigraphical distribution. Upper Carboniferous (Gzhelian) strata in Russia (e.g. Rosovskaya, 1958; Rauser-Chernousova *et al.*, 1979); lower Gzhelian in Spitsbergen (Nilsson, 1993).

Occurrence in North Greenland. Peary Land, Foldedal Formation, GGU 196343, *Rauserites* ex. gr. *rossicus* assemblage.

Plate 4

All figures × 10, except noted

Figs 1–3. *Schwagerina pseudokaragasensis* Petocz; 1, 2, 3, GI-72144.

Figs 4,5,7. *Schwagerina* ex. gr. *nathorsti* (Staff & Wedekind); 4, 5, 7, GI-72144.

Fig. 6. *Pseudofusulinella* sp. C; 6, GI-72144, × 20.

Fig. 8. *Schwagerina* aff. *S. moelleri* (Schellwien); 8, GI-72148.

Figs 9,10,13. *Schwagerina* aff. *S. gracilis* (Sjomina); 9, 10, 13, sample 214b of Dunbar *et al.* (1962).

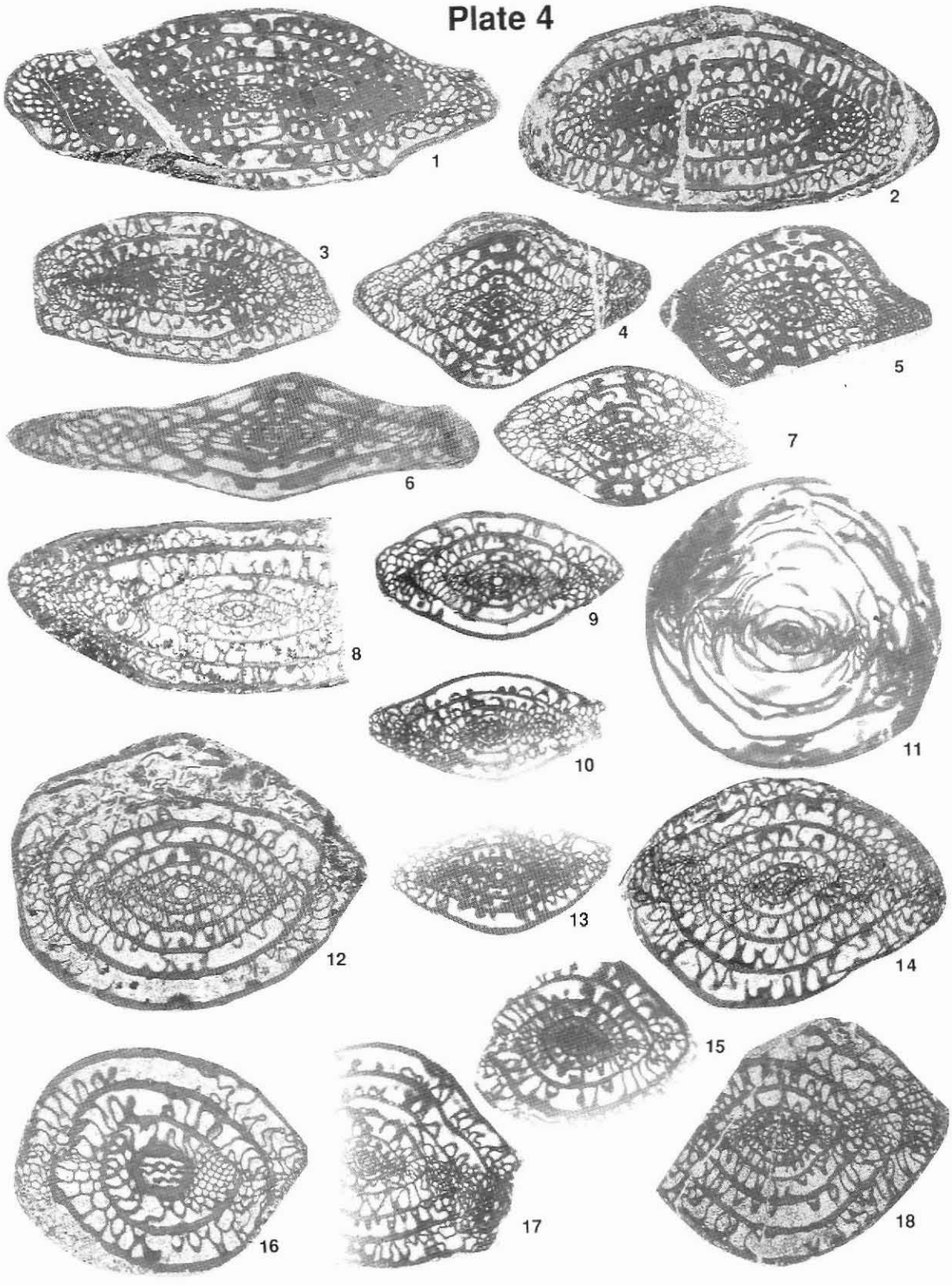
Fig. 11. *Sphaeroschwagerina* ex. gr. *sphaerica* (Scherbovich); 11, sample 214b of Dunbar *et al.* (1962).

Figs 12,16. *Schwagerina* sp. A; 12, 16, GGU-220366.

Fig. 14. *Schwagerina sphaerica* (Belyaev); 14, GI-72150.

Figs 15,17,18. *Schwagerina* ex. gr. *princeps* (Ehrenberg, sensu Dunbar & Skinner); 15, 17, sample 178 of Dunbar *et al.* (1962); 18, GGU-220366.

Plate 4



Material. Six axial oriented sections, two slightly tangential oriented sections and several randomly oriented sections.

Rauserites aff. *R. simplex* (Schellwien, 1908)

Plate 1, Figs 10, 12, 15, 18

Stratigraphical distribution. Upper Kasimovian and lower Gzhelian in the Russian Platform (Rauser-Chernousova, 1938; Rosovskaya, 1958; Mikhailova, 1974) and the Urals (Davydov, 1986), upper Kasimovian (Cadellfjellet and Kapitol Members) in Spitsbergen (Nilsson, 1993).

Occurrence in North Greenland. Peary Land, Foldedal Formation, samples 171, 182 and 175 of Petryk (1977), *Rauserites* ex. gr. *simplex* assemblage.

Material. Two axial oriented sections and some oblique oriented sections.

Rauserites sp.

Plate 2, Figs 11, 14

Remarks. The recorded species show affinities to primitive *Rauserites* species which are common in upper Kasimovian to lower Gzhelian strata in the Russian Platform (see e.g. Rosovksaya, 1950, 1958).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Foldedal Formation, GI 72168), *Rauserites* ex. gr. *simplex* assemblage.

Material. Three tangential oriented sections and some randomly oriented sections.

Genus *Schellwienia* Staff & Wedekind, 1910

Schellwienia arctica (Schellwien, 1908)

Plate 3, Figs 6–9, 11

1908 *Fusulina arctica* Schellwien, p. 173, pl. 16, figs 3–9.
1960 *Triticites arcticus* (Schellwien) Forbes, p. 216, pl. 32, figs 10–17.
1962 *Pseudofusulina* (*Rugosofusulina*) *arctica* (Schellwien) Ross & Dunbar (part), p. 41, pl. 6, figs 1, 2, 5–7.

Stratigraphical distribution. Upper Gzhelian in the Urals, Central Asia, Donets basin (Davydov *in* Chuvashov *et al.*, 1986), upper Gzhelian – lower Asselian in the Tyrrellfjellet Member of Spitsbergen (Nilsson, 1993) and Finnmark Platform (Nilsson, 1993), lower Asselian in the Kapp Duner Formation of Bjørnøya (Simonsen, written communication 1988).

Occurrence in North Greenland. Holm Land and Amdrup Land, Kim Fjelde Formation, samples E 131 1/2, E 138 , E 139 and F2-X of Ross & Dunbar (1962), *Schellwienia arctica* assemblage.

Material. Three axial oriented sections and some oblique oriented sections.

Schellwienia amdrupensis (Ross & Dunbar, 1962)

Plate 3, Figs 12, 15, 17

1962 *Pseudofusulina* (*Daixina*) *amdrupensis* Ross & Dunbar, p. 39, 40, pl. 6, figs 14–16.

Stratigraphical distribution. Lower Permian in eastern North Greenland (Dunbar *et al.*, 1962), Asselian in the Kapp Duner Formation of Bjørnøya (Simonsen, written communication 1988).

Occurrence in North Greenland. Amdrup Land, Kim Fjelde Formation, sample F2–115 of Ross & Dunbar (1962), *Sphaeroschwagerina* aff. *S. vulgaris* assemblage.

Material. Three axial oriented sections.

Plate 5

All figures × 10, except noted

Figs 1–4. *Schwagerina* ex. gr. *exuberata* (Shamov); 1–4, GI-72150.

Figs 5,8,10,14. *Sphaeroschwagerina* sp.; 5, 8, 14, GGU-220366; 10, GI-72150.

Fig. 6. *Eoparafusulina?* aff. *E. domesticus* (Grozdilova & Lebedeva); 6, GGU-220366.

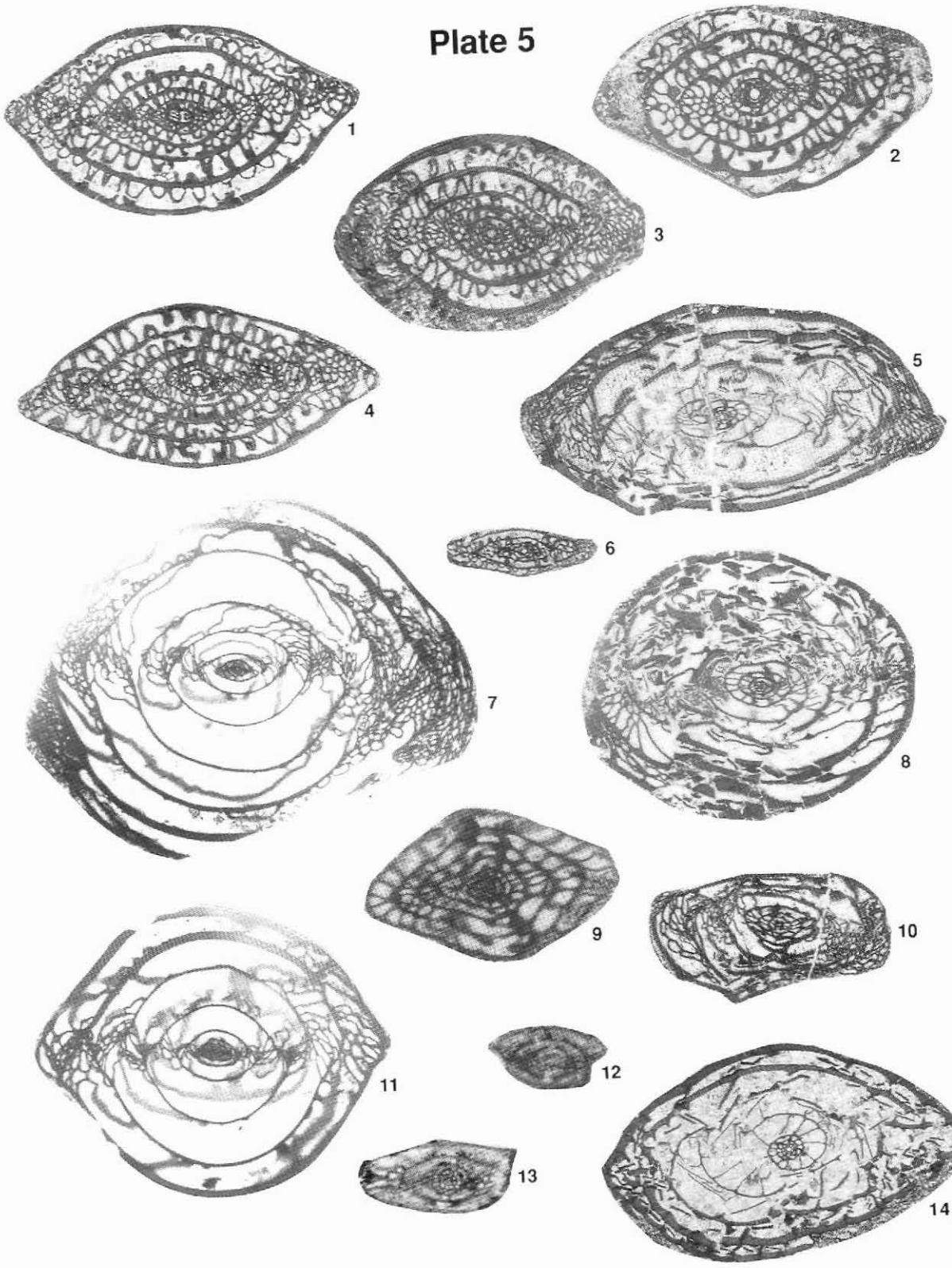
Fig. 7. *Sphaeroschwagerina sphaerica gigas* (Rauser-Chernobova & Scherbovich); 7, sample 191 of Dunbar *et al.* (1962).

Fig. 9. *Pseudofusulinella* sp. B; 9, GI-72150, × 20.

Fig. 11. *Sphaeroschwagerina* ex. gr. *sphaerica* (Scherbovich); 11, sample 191 of Dunbar *et al.* (1962).

Figs 12,13. *Schubertella transitoria* Staff & Wedekind; 12, GGU-220366; 13, GI-72148, both × 40.

Plate 5



Genus *Schwagerina* von Möller, 1877
Schwagerina ex. gr. *exuberata* (Shamov, 1958)

Plate 5, Figs 1–4

Stratigraphical distribution. Lower Permian (middle–upper Asselian) in Russia (Shamov, 1958; Sjomina, 1961) and Spitsbergen (Nilsson, 1993).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72150, *Schwagerina* aff. *S. moelleri* – *S.* ex. gr. *exuberata* assemblage.

Material. One axial oriented section, one oblique oriented section and four tangential oriented sections.

Schwagerina aff. *S. gracilis* (Sjomina, 1971)

Plate 4, Figs 9, 10, 13

Remarks. Ross & Dunbar (1962) identified these specimens as *Schwagerina krotowi* (Schellwien). However, part of their figured specimens (figs 10–13 in pl. 6) are more closely related to *Schwagerina gracilis* group of Sjomina (1971).

Stratigraphical distribution. Lower Asselian in the Russian Platform and Urals (Kireeva *et al.*, 1971; Chuvashov *et al.*, 1986), upper Gzhelian in South Ural (Davydov *et al.*, 1990), upper Gzhelian – lower Asselian in Finnmark Platform and Spitsbergen (Nilsson, 1993).

Occurrence in North Greenland. Amdrup Land, Kim Fjelde Formation, sample 214b (loose block) of Ross & Dunbar (1962).

Material. Three axial oriented sections and one tangential oriented section.

Schwagerina aff. *S. moelleri* (Schellwien, 1908)

Plate 4, Fig. 8

Stratigraphical distribution. Schwagerina moelleri (Schellwien) is an index species for the lower Sakmarian strata in the Timan–Pechora Basin of Russia (Grozdilova & Lebedeva, 1961; Konovalova, 1991).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72148, *Schwagerina* aff. *S. moelleri* – *S.* ex. gr. *exuberata* assemblage.

Material. One axial oriented section and two randomly oriented sections.

Schwagerina ex. gr. *nathorsti* (Staff & Wedekind, 1910)

Plate 4, Figs 4, 5, 7

Remarks. The subrhomboidal shell with distinct pseudochomata shows similarities to the types of *Schwagerina nathorsti* (Staff & Wedekind) from Bjørnøya, but the investigated specimens are different from the type specimens in having a shorter shell and more inflated test.

Stratigraphical distribution. Schwagerina nathorsti (Staff & Wedekind) is present in middle–upper Asselian strata on Bjørnøya (Simonsen, written communication 1988, Nakrem *et al.*, 1992) and Spitsbergen (Nilsson, 1988, 1993).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72144, *Schwagerina* ex. gr. *nathorsti* assemblage.

Material. Two slightly oblique oriented section and two randomly oriented sections.

Schwagerina plicatissima (Rauser-Chernousova, 1940)

Plate 6, Figs 7–10

1940 *Pseudofusulina plicatissima* Rauser-Chernousova, p. 87, pl. 4, figs 5, 6, pl. 5, figs 1–3.

Stratigraphical distribution. Lower Permian (upper Sakmarian) in the Timan–Pechora Basin (Grozdilova & Lebedeva, 1961; Konovalova, 1991).

Plate 6

All figures × 10

Figs 1–3. *Rugosochusenella* sp. A; 1, 2, 3, GGU 220366.

Fig. 4. *Rugosochusenella* ex. gr. *paragregaria* (Rauser-Chernousova); 4, loose block-sample of Dunbar *et al.* (1962).

Fig. 5. *Rugosochusenella gregarieformis* (Rauser-Chernousova & Scherbovich); 5, loose block-sample of Dunbar *et al.* (1962).

Fig. 6. *Eoparafusulina* cf. *E. paralinearis* (Thorsteinsson); 6, loose block-sample of Dunbar *et al.* (1962).

Figs 7–10. *Schwagerina plicatissima* (Rauser-Chernousova); 7, 8, 9, 10, GI 72151.

Fig. 11. *Schwagerina* sp. B; 11, GI 72151.

Plate 6

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72151, *Schwagerina plicatissima* assemblage.

Material. Two slightly oblique oriented sections, one saggital oriented section and several tangential and randomly oriented sections.

Schwagerina ex. gr. *princeps* (Ehrenberg, *sensu* Dunbar & Skinner, 1936)

Plate 4, Figs 15, 17, 18

Stratigraphical distribution. Middle–upper Asselian in Spitsbergen (Nilsson, 1993).

Occurrence in North Greenland. Amdrup Land, Kim Fjelde Formation, sample 178 (loose block) of Dunbar *et al.* (1962) and Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GGU 220366, *Schwagerina* aff. *S. moelleri* – *S.* ex. gr. *exuberata* assemblage.

Material. Two axial and one oblique oriented sections.

Schwagerina pseudokaragasensis Petocz, 1970

Plate 4, Figs 1–3

1970 *Schwagerina pseudokaragasensis* Petocz, p. 43–46, pl. 1, figs 19–26.

Stratigraphical distribution. Lower Permian (upper Asselian – middle Sakmarian) in east–central Alaska Range (Petocz, 1970).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72144, *Schwagerina* ex. gr. *nathorsti* assemblage.

Material. One slightly oblique oriented section, two tangential oriented sections and some randomly oriented sections.

Schwagerina sphaerica (Belyaev, 1938)

Plate 4, Fig. 14

1938 *Pseudofusulina uralica* var. *sphaerica* Belyaev *in* Belyav & Rauser- Chernousova, p. 185–187, pl. 2, figs 5–7.
1961 *Pseudofusulina sphaerica sphaerica* (Belyaev) Grozdilova & Lebedeva, p. 200–201, pl. 7, figs 5–6.

Remarks. In Nilsson *et al.* (1991) the recorded specimens were assigned to *Schwagerina* ex. gr. *princeps*. However, the investigated specimens are more closely related to *Schwagerina sphaerica* (Belyaev, 1937).

Stratigraphical distribution. Upper Asselian in the Urals (Belyaev & Rauser-Chernousova, 1938; Shamov, 1958; Mikhailova, 1974), Timan–Pechora Basin (Grozdilova & Lebedeva, 1961, Konovalova, 1991) and Spitsbergen (Nilsson & Davydov, 1993; Nilsson, 1993).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72150, GGU 220366, *Schwagerina* aff. *S. moelleri* – *S.* ex. gr. *exuberata* assemblage.

Material. One axial oriented section, one slightly oblique oriented section and several randomly oriented sections.

Schwagerina sp. A

Plate 4, Figs 12, 16

Remarks. Specimen of 6.5 volutions reach length of 5.9 mm and diameter of 4.6 mm, giving form ratio of 1.3.

Proloculus is large, outside diameter 300 microns.

The large proloclulus, the coiling of the volutions and the shape of the test indicate some similarities to *Schwagerina globosa* (Schellwien & Dyhrenfurth), but the septal fluting is less regular and the size of shell is much smaller. The recorded specimens of *Schwagerina* sp. A were incorrectly assigned as *Schwagerina globosa* (Schellwien & Dyhrenfurth) by Nilsson *et al.* (1991).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GGU 220366, *Schwagerina* aff. *S. moelleri* – *S.* ex. gr. *exuberata* assemblage.

Material. One axial oriented section and two tangential oriented sections.

Schwagerina sp. B

Plate 6, Fig. 11

Remarks. Specimen of 6.5 volutions has a length of 7.1 mm and a diameter of 4.1 mm, which gives a form ratio of 1.7. The outside diameter of the proloculus measures 360 microns. The examined specimen shows some similarities to the *Schwagerina uralica* group of Rauser-Chernousova.

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GI 72151, *Schwagerina plicatissima* assemblage.

Material. One axial oriented section and two randomly oriented sections.

Genus *Zigarella* Davydov, 1982
Zigarella anderssoni (Schellwien, 1908; non Rauser- Chernousova *et al.*, 1936)

Plate 3, Fig. 18

1908 *Pseudofusulina anderssoni* Schellwien, p. 192, 193, no illustrations.
1910 *Schellwienia anderssoni* (Schellwien) Staff & Wedekind, p. 119, 120, pl. 3, figs 1–5.

Stratigraphical distribution. Lower Asselian in Spitsbergen (Nilsson & Davydov, 1993; Nilsson, 1993); middle Asselian in Bjørnøya (Simonsen, written communication 1988; Nakrem *et al.*, 1991).

Occurrence in North Greenland. Southern Holm Land, Kim Fjelde Formation, sample E 138 of Ross & Dunbar (1962).

Material. One axial oriented section and two randomly oriented sections.

Genus *Eoparafusulina*
Eoparafusulina cf. *E. paralinearis* (Thorsteinsson, 1960)

Plate 6, Fig. 6

Stratigraphical distribution. Wolfcampian in the Sverdrup Basin (Thorsteinsson, 1960), lower Sakmarian in Spitsbergen (Cutbill & Challinor, 1965; Nilsson & Davydov, 1993; Nilsson, 1993).

Occurrence in North Greenland. Amdrup Land, loose block.

Material. One axial oriented section.

Eoparafusulina? aff. *E.? domesticus* (Grozdilova & Lebedeva, 1961)

Plate 5, Fig. 6

Stratigraphical distribution. Lower Sakmarian in the Timan–Pechora Basin (Grozdilova & Lebedeva, 1961; Konovalova, 1991).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GGU 220366, *Schwagerina* aff. *S. moelleri – S.* ex. gr. *exuberata* assemblage.

Material. One slightly oblique section and one randomly oriented section.

Genus *Rugosofusulina* Rauser-Chernousova, 1937
Rugosofusulina arianica Leven & Scherbovich, 1978

Plate 3, Figs 13, 14, 16

1978 *Rugosofusulina arianica* Leven & Scherbovich, p. 94, 95, pl. 4, figs 8, 9.

Stratigraphical distribution. Upper Gzhelian in the Donets Basin (Chuvashov *et al.*, 1986); lower Asselian in Darvas (Leven & Scherbovich, 1978).

Occurrence in North Greenland. Southern Holm Land, Kim Fjelde Formation, sample E 138 of Dunbar *et al.* (1962), *Sphaeroschwagerina* aff. *S. vulgaris* assemblage.

Material. Three axial oriented sections.

Rugosofusulina aff. *R. eliptica* Rosovskaya, 1958

Plate 2, Figs 1–3

Stratigraphical distribution. Gzhelian in the Urals (Rosovskaya, 1958).

Occurrence in North Greenland. Eastern Peary Land, Foldedal Formation, sample 183 of Petryk (1977), *Rauserites* ex. gr. *rossicus* assemblage.

Material. Five oblique oriented sections.

Rugosofusulina aff. *R. praevia* Shlykova, 1948

Plate 3, Figs 1–4

Remarks. These specimens were assigned to '*Pseudofusulina* (*Rugosofusulina*) *arctica*' (Schellwien) by Ross & Dunbar (1962, p. 41–43, pl. 6, figs 3, 5). However, *Schellwienia arctica* (Schellwien) has no real rugosity in wall-structure, and specimens showing rugosity should not be included in that species.

Stratigraphical distribution. Upper Carboniferous (lower Gzhelian) in the Urals (Rosovskaya, 1958); Gzhelian in the Finnmark Platform (Nilsson, 1993).

Occurrence in North Greenland. Southern Holm Land, Kim Fjelde Formation, sample E 131 1/2 of Ross & Dunbar (1962), *Schellwienia arctica* assemblage.

Material. Three axial oriented and one oblique oriented sections.

Genus *Rugosochusenella* Skinner & Wilde, 1965

Rugosochusenella ex. gr. *paragregaria* (Rauser- Chernousova, 1940)

Plate 6, Fig. 4

Remarks. This specimen was included in *Pseudofusulina* (*Rugosofusulina*) sp. A of Ross & Dunbar (1962, pl. 7, fig. 4).

Stratigraphical distribution. Uppermost Gzhelian in Darvas (Chuvashov *et al.*, 1986) and Asselian in the Russian Platform and Urals (Rauser-Chernousova, 1940).

Occurrence in North Greenland. Henrik Kröyer Holme, ?Kim Fjelde Formation, sample 191 (loose block) of Ross & Dunbar (1962).

Material. One axial oriented section.

Rugosochusenella gregarieformis (Rauser-Chernousova & Scherbovich, 1958)

Plate 6, Fig. 5

1958 *Pseudofusulina gregarieformis* Rauser-Chernousova & Scherbovich, p. 34, 35, pl. 2, figs 11, 12.
1962 *Pseudofusulina* (*Rugosofusulina*) sp. A Ross & Dunbar (part), p. 43–45, pl. 7, fig. 2.

Stratigraphical distribution. Uppermost Gzhelian in South Ural and lower Asselian in the Russian Platform (Chuvashov *et al.*, 1986).

Occurrence in North Greenland. Kap Jungersen, ?Kim Fjelde Formation, sample 112 (?loose block) of Ross & Dunbar (1962).

Material. One axial oriented section.

Rugosochusenella sp. A

Plate 6, Figs 1–3

Stratigraphical distribution. Rugosochusenella is present in Lower Permian (Asselian–Sakmarian) strata (e.g. Loeblich & Tappan, 1988).

Occurrence in North Greenland. Prinsesse Ingeborg Halvø, Kim Fjelde Formation, GGU 220366, *Schwagerina* aff. *S. moelleri – S.* ex. gr. *exuberata* assemblage.

Material. One slightly oblique oriented section and five tangential oriented sections.

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