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Palaeozoic carbonates and fossils of the Mendeleev Rise (eastern Arctic): A study of dredged seafloor material

O.L. Kossovaya[a,e], T.Yu. Tolmacheva[a,*], O.V. Petrov[a], T.N. Isakova[b], R.M. Ivanova[c], E.S. Mirolyubova[d], P.V. Rekant[a], E.A. Gusev[d]

[a] A.P. Karpinskyi Russian Geological Research Institute, 74 Sredny pr., 199106 Saint Petersburg, Russia
[b] Geological Institute of the Russian Academy of Science, Moscow, Russia
[c] Institute of Geology and Geochemistry, Urals branch of RAS, Ekaterinburg, Russia
[d] -VNIIOkeangeologia, Saint Petersburg, Russia
[e] Kazan Federal University, Kazan, Tatarstan, Russia

A R T I C L E I N F O

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A B S T R A C T

Fossiliferous carbonate rocks dredged during the "Arctic-2012" cruise on the Mendeleev Rise (eastern Arctic) provide proof of the presence of Upper Silurian(?)–Middle Devonian, Famennian–Tournaisian, Bashkirian–Kasimovian, Gshelian–lower Asselian(?) and Kungurian–Kazanian carbonate deposits. The wide spectrum of facies includes deposits of both photic zone (with fusulinids, algae, relicts of microbial and coral reefs) and deeper dysphotic areas (with trilobites, deep-water tentaculitids and ostracods). The results obtained suggest that there were at least three periods of carbonate platform sedimentation during the latest Silurian(?) to Permian.

The Late Silurian?–Devonian biota do not show biogeographical differentiation, but rather are distributed globally. Shallow-water foraminifera and some algae of early Pennsylvanian–basal Cisuralian age belong to the warm-water province. These forms are unknown in the Moscovian–Permian of the Boreal Realm (Taimyr, New Siberian Islands, Verkhoyanie, Omolon Massif) but are typical for Alaska and Arctic Canada, Wrangel Island, Chukotka, Polar Urals and Svalbard. The disappearance of warm-water biota during late Artinskian-Kungurian times led to a subsequent predominance of smaller foraminifera: this assemblage with *Protonodosaria* is widely distributed in Permian deposits of Novaya Zemlya, Urals, Barents Sea and the eastern Arctic.

The warm-water Bashkirian-Asselian biota suggests that the Mendeleev-Chukotka-Wrangel block was a low-latitude shallow basin with predominant carbonate sedimentation, being part of the Arctida supercontinent, connected temporarily with the eastern margin of Laurasia (Chukcha-Alaska block).

1. Introduction

The first published data on the sedimentary seafloor rocks obtained from the deep eastern Arctic Basin appeared during the expedition "Arctic – 2000". However, for the first time the scientific value of the dredged material had been demonstrated after pioneering geological expeditions and studies of seafloor rock fragments between 1950 and 1970 in the Barents Sea (Dibner et al., 1970). The Late Palaeozoic and Mesozoic ages of seafloor samples collected during vessel cruises in 1940, 1946, 1947, 1948, 1960 and 1964 in the Barents Sea were determined based on macrofaunas and microfossils (foraminifera, spores and pollen). Onshore, the first data on middle Pennsylvanian fusulinids from the Franz Josef Land were obtained in 1955. The occurrence of Upper Palaeozoic rocks in the Barents shelf was confirmed by later boreholes on Kolguev Island, the Franz Josef Land, the shelf of the Pechora Sea and by shallow boreholes on the Finnmark Platform (Bugge et al., 1993).

Geological studies in the eastern Arctic Ocean in the late 20th and early 21 st centuries have been stimulated by the Arctic countries within the framework of national programmes for the delineation of extended shelves. However, seismic surveys of the Mendeleev Rise did not result in a complete picture of the geological structure of offshore areas, and direct geological observations remained few and scattered.

Dredged samples of various sizes collected in the absence of drillings are practically the only source of information on the rock composition of the basement of the eastern Arctic Basin. The coarse rock fragments sampled from the seafloor can be divided into two main groups: (1) so-called ice-rafted rocks, transported to the Arctic deep-water basin by

* Corresponding author.
E-mail address: tatiana_tolmacheva@vsegei.ru (T.Y. Tolmacheva).

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drifting ice and icebergs, and (2) autochthonous material, derived from outcrops. Some researchers believe that the transport of large-sized debris to the Arctic Ocean is linked mainly to icebergs and sea ice (Lisitsyn, 1994), whereas others (Kaban'kov et al., 2004a,b, 2008) propose that the entire suite of large-sized rock fragments collected on the Mendeleev Rise area is exclusively of local origin. Reliable evidence of the existence of a Palaeozoic sedimentary crust in the eastern Arctic came from drilling of Palaeozoic carbonate rocks in Chukcha Sea. Here, the Palaeozoic-Mesozoic succession can be subdivided into lower Ellesmerian-Upper Devonian to Permian sequence and, and upper Ellesmerian (Permian to Jurassic sequence) (Dinkelman et al., 2008). Recently, direct observation and sampling from subaqueous outcrops revealed Upper Ordovician (?)–Silurian and Devonian bedrock dolomites and limestones in the southwestern part of the Mendeleev Rise (Skolotnev et al., 2017). So far there are no conclusive criteria for distinguishing between ice-drifted and autochthonous materials, except for indirect features: (1) the Beaufort Gyre passes the Mendeleev Rise from the north, and could not transport Palaeozoic carbonates from Arctic Canada to the central part of the Mendeleev Rise (Rekant et al., 2013); (2) samples with Pennsylvanian fusulinids were found by cruise Arctic-2012 in the same part of the Mendeleev Rise as during Arctic-2000/2004 cruises (Kaban'kov et al., 2004a,b, 2008). Sampling by the diesel icebreaker "Captain Dranitsyn" and research submarines of the Ministry of Defence of the Russian Federation were carried out in 2012. Abundant igneous and sedimentary rocks from a large area of the Mendeleev Rise were recovered (Gusev et al., 2014). It was noted that the upper part of the unlithified sedimentary cover contained an admixture of coarse clastic material, and the amount increased noticeably near seafloor outcrops. It can be assumed that the bottom rocks dredged by the cruise Arctic-2012 are predominantly of local origin, possibly with some ice-rafted fragments.

2. Material and methods

During the cruise of the "Arctic-2012", a representative collection of rocks was sampled at 10 sites on steep escarpments of the Mendeleev Rise (Fig. 1, 6 sites with determinable fauna are shown; Fig. 2) by means of drag, grab, hydrostatic core, an autonomous drilling rig and a manipulator of a research submarine (Morozov et al., 2013). The samples included many fossiliferous carbonate fragments with Palaeozoic biota (crinoids, ostracods, foraminifera, conodonts, bryozoans, corals, gastropods, bivalves, cephalopods, tentaculitids, trilobites, "fish" remains, sponge spicules and calcareous algae). Six sites yielded fragments of fauna and algae, which allowed more precise age determinations. The macrofauna was studied via standard external preparation and in thin sections. The microfauna was extracted by acid digestion or studied in thin sections. The carbonates collected by one dredge received individual numbers: they included fragments of fauna and flora of different ages or of the same age. The second-order number was given to each fragment. The results of palaeontological studies of the dredged samples from six sites of cruise "Arctic-2012" are presented below.

3. Distribution and petrographic composition of dredged samples of cruise "Arctic-2012"

The lithological analysis of the material collected shows an uneven distribution of coarse rock fragments dredged from different sites and bathymetric levels. As a rule, large fragments are very rare in extended depressions and on flat tops of seamounts. Rock fragments are abundant and unsorted, with a significant admixture of gravel and pebble material, when dredging and selecting samples by grab took place at the base of the Mendeleev Rise.

The petrographic composition differs from site to site (Fig. 3). The amount of carbonate fragments reaches 60–80% among all collected varieties of rocks and prevail at all sites. The carbonate rocks (limestones and secondary dolomites) contain identifiable faunas and algae in 6 out of 10 sites. Some dolomitic rocks also include remains of fauna or algae. About 30% of the rock fragments obtained were dated by biostratigraphical methods. Dolomites prevail at all sites: only in a single case (KD-12-01-30d) do limestone fragments approximate 50% (Fig. 4).

4. Palaeontological and biostratigraphical study of carbonate rocks

4.1. Previous studies

Samples were collected during expedition "Arctic-2000" and carefully processed, permitting age assessment of carbonate deposits at the bottom of the Trukshin Mountain (to the east of Alfa Ridge). It has been found that the bottom sediments along the trajectory of cruise "Arctic-2000" are a complex of psammitic-pelitic sediments with unevenly distributed pebble-gravel fragments and rare blocks of rock. The host deposits had a Cenozoic age. Well-preserved Palaeozoic foraminifera, some "fish" remains and conodonts were determined in blocks of carbonates (Kaban'kov et al., 2004a,b, 2008). The conodont *Ozarkodina* cf. *exavata* (Branson & Mehl) and the "fish" *Nostolepis* ex gr. *striata* Pander indicate a Late Silurian-Early Devonian age. Foraminifera of early-middle Pennsylvanian age were found higher on the slope. The assemblage included *Millerella elongata* Rauser-Chernousova, *Pseudoendothyra* aff. *preobrajenskyi* (Dutkevich), *Tetrataxis planolocula* Lee & Chen, Fusulinidae gen. et sp. indet., along with recrystallised remains of the family Endothyridae and some other faunal elements of poor preservation. Latest Bashkirian–Early Permian foraminifera were collected at the very top: *Schubertella obscura* Lee & Chen, *S. compressa* Rauser-Chernousova, *S. gracilis* Rauser-Chernousova and *Protonodosaria proceraeformis* Gerke. Such a distribution of fragments of different ages led to the assumption of a subhorizontal bedding structure of the bedrocks (Kaban'kov et al., 2004a). Earlier, data had been published on a wide range in age of Palaeozoic rocks in the area of the Northwind Range, bounding the Canadian Basin in the southwest (Clark et al., 1997; Grantz et al., 1998). The rock fragments dated in the Northwind Breccia indicated a latest Cambrian to Ordovician age. Following a hiatus, which was correlated with the Ellesmerian unconformity, a middle Pennsylvanian to latest Permian age range was determined on the basis of fauna found in carbonates, but also in sandstones (Fig. 5).

In 2012 the presence of Upper Silurian, Lower and Middle Devonian, lower–middle Pennsylvanian and Lower Permian carbonate rocks was determined based on seafloor samples collected from the Mendeleev Rise and Upper Cambrian-Upper Permian deposits extracted from the Northwind Range.

4.2. New palaeontological and biostratigraphic data from the Mendeleev Rise

4.2.1. Site KD-12-00

Sampling site KD-12-00, located on the northeastern slope of an unnamed seamount, at N 79°04′ W 174°39′ (Fig. 1). The water depth at the sampling site ranges from 1900 to 2300 m. The slope steep is $30-45°$. It is complicated by submarine canyons with dividing ridges and crests. Outcrops of bedrock were studied. In the lower part of the slope, this outcrop is characterised by an irregular surface separated into large blocks by deeply gaping fissures. Some of these fissures probably represent disjunctive dislocations that extend for tens of metres. The slope has a northeasterly exposure in a northeasterly direction (gradient 30–45). More than 4000 pieces of angular fragments of limestone, dolomite, sandstone, quartzite, siltstone, mudstone, basalt and tuff have been dredged at this site.

Determinable carbonates are rather variable. The bryozoan-ostracod packstone contains crinoids, trilobites and algal remains. The alga *Anthracoporella setosa* Schuysky (thin section KD-12-00-07d-153; Figs.

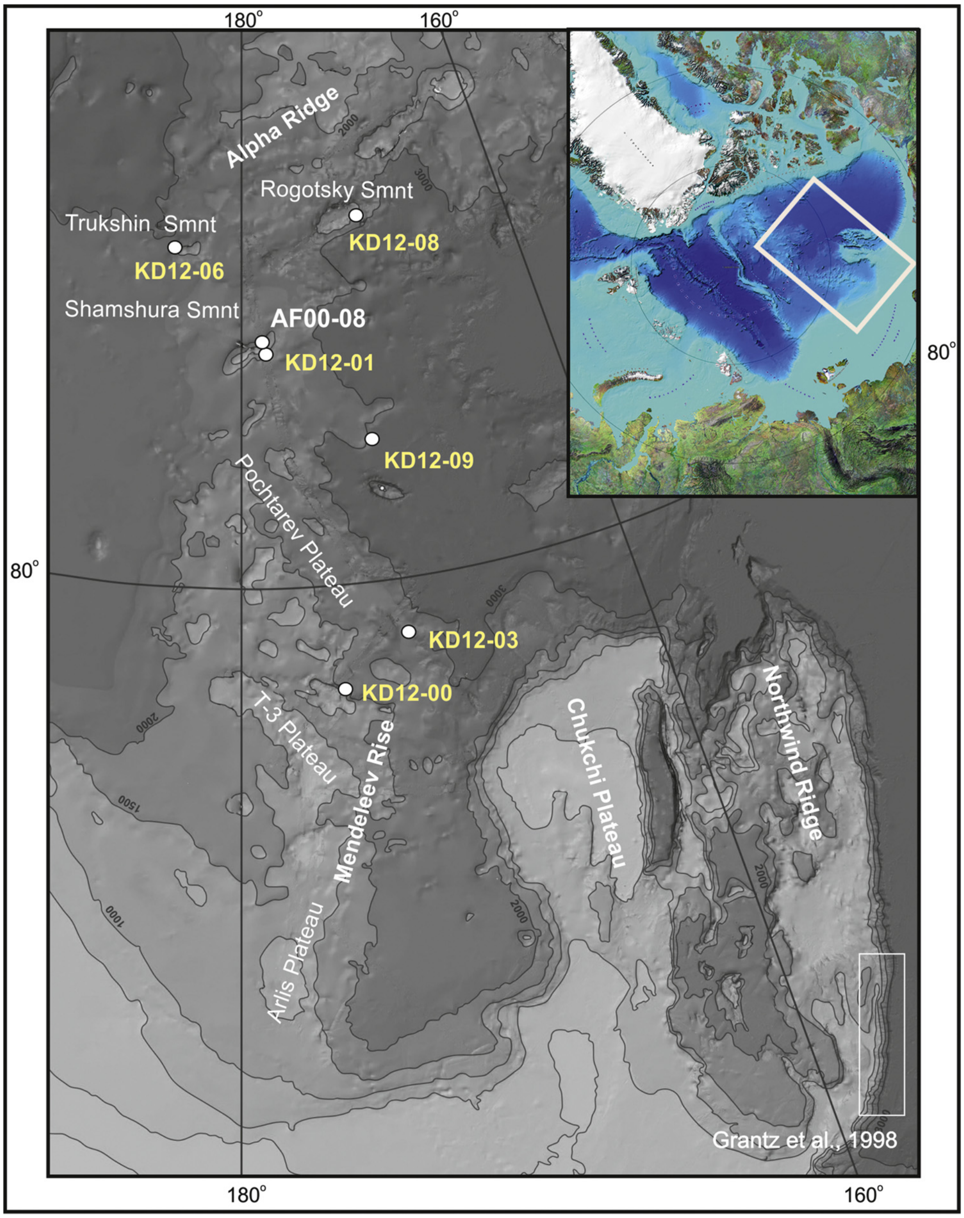


Fig. 1. Location of sites from which fossils were dredged during Expedition Arctic −12 on the Mendeleev Rise. AF − point with faunal remains collected during cruise "Arctic −2000".

6, 7.I, 9A, B) indicates an early Middle Devonian date, based on its original definition in Lower Devonian deposits of the western Urals (Schuysky, 1973). In the Novaya Zemlya Archipelago, this species was found in contemporaneous reef deposits (Schuysky and Patrunov, 1991). Fenestellids and fragments of the rugose coral *Cyathaxonia*? sp. occur in the crinoid-ostracod-ooid pack-grainstone in thin section KD12-00-07d-80 (Fig. 9B). The genus has a wide age range, from the early Famennian to the Permian. Famennian species occur rather rarely in western Europe (Poland, France) (Berkowski, 2002). From the Early Carboniferous to Early Permian the genus had a global distribution (Kossovaya, 2007). In the Arctic, it is known from Mississippian deposits of southern Alaska (Palaeontological database of Alaska). It has recently been identified on Kotelnyi Island in upper (formerly middle) Tournaisian strata (authors data, unpublished).

The alga *Nanopora undata* R. Ivanova (KD-12-00-07d-88; Fig. 7C, D) was known from the upper Tournaisian-Serpukhovian of the Urals and Ukraine, but is here found together with *Epimastopora* sp. (Ivanova, 2013). *Epimastopora* ex gr. *piae* Bilgutay (KD-12-00-07d-176; Fig. 8E) was described from the Guadalupian of Croatia, Slovenia and China, as well as from the Lower Permian of Turkey. Most species of *Epimastopora* Pia are known from the Permian of the Carnic Alps, Turkey, Arctic Canada and the Urals. Some *Epimastopora* occur in Bashkirian, upper Moscovian and upper Pennsylvanian deposits of the southern Urals (Chuvashov, Anfimov, 2015; Ivanova, 2013). Two species, *Epimastopora* sp. and *E. grandis* Tchuvashov & Anfimov, were originally described from Pennsylvanian deposits of the southern Urals. We consider the age of this sample to be based on the occurrence of the youngest taxon. Representatives of the genus were also found to co-occur with early Moscovian fusulinids in a limestone block from Zhokhov Island (De Longa Archipelago) (Davydov, 2016). Forms similar to the genus *Gyroporella* Gümbel, emend. Benecke (Fig. 8K), identified in open nomenclature, do not allow a precise age determination. This genus occurs more frequently in Permian than in Carboniferous deposits, but single species are known from the uppermost middle and upper Pennsylvanian of the Urals, Spain and Arctic Canada. Some species of Asselian age were described from the Urals (Ivanova, 2013). Thus, the fauna and

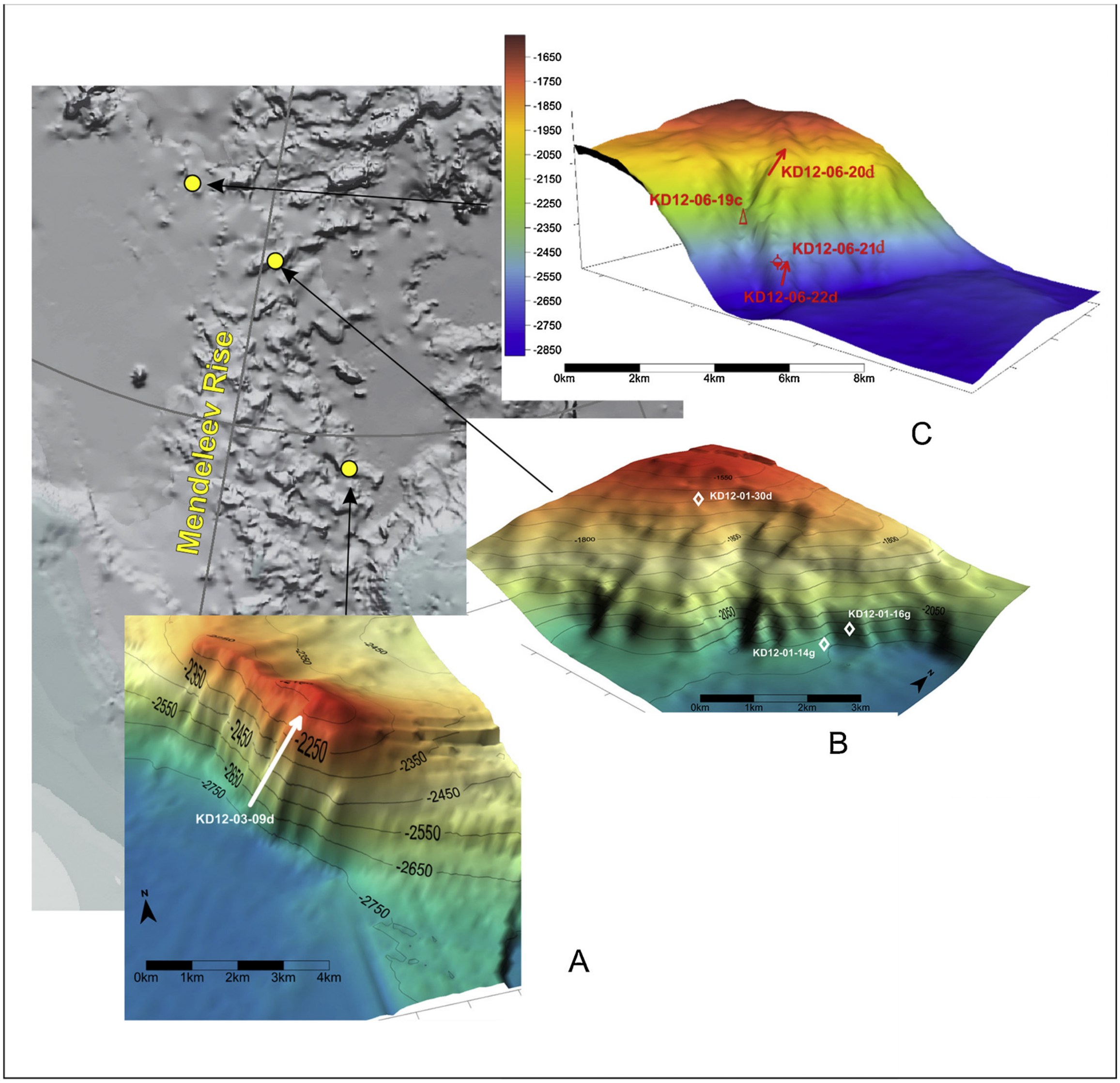


Fig. 2. Bathymetry of sampling levels at different sites (A – site KD-12-00; B – site KD-12-01; C – site KD-12-03).

algae characteristic of carbonate rocks at site *KD-12-00* indicate the Early-Middle Devonian, and Pennsylvanian or? Permian age of the rocks (Fig. 2).

4.2.2. Site KD-12-01

Sampling site KD-12-01 is located on the southeastern slope of the Shamshura seamount, N 82°05′, W 178°16, at a sea depth of 1700–2200 m (Figs. 1 and 2). According to visual observation, the southeastern slope of the Shamshura seamount slopes under angles of 25–45° (Gusev et al., 2014). The steepest areas are located at the slope foot and at slopes of canyons and ridges. The loose sediment becomes thinner at the steep slopes or is absent. Bedrock that cropped out in the lower part of the ridge rolled out from the top of the seamount. The surface of the exposure is uneven; the rocks form outcrops and alluvial-diluvial taluses. Mainly angular fragments of carbonates have been dredged (Gusev et al., 2014). Identifiable faunal remains were found at three sampling points: KD-12-01–14 g, KD-12-01–16 g and KD-12-01-30d, of varying bathymetry (Fig. 2B).

4.2.3. Lower-Middle Devonian.

A limestone from the lower level is represented by bioturbated, ostracod-algal packstone with brachiopods and patches of secondarily dolomitised limestone and microbial framestone (Fig. 9C, D). The fasciculate colony *Dendrostella* sp. aff. *D. rhenana* (Frech) (thin section KD12-01-14g-74; Fig. 9C) known from the Middle Devonian of Heceta and Tuxekan Island of southeastern Alaska (Oliver et al., 1975) and from Eifelian deposits of the southern island of the Novaya Zemlya Archipelago (Stolbova, 2013) was identified; it is typical of reef facies. Species of this genus occurred in the Middle Devonian of Nevada and in the Blue Fiord Formation of Canada (Pedder, 2010). The genus is distributed worldwide, including the northern Urals and the Timan-Pechora region, mostly during the Middle Devonian (Tsyganko, 1981).

4.2.4. Upper Devonian-Lower Carboniferous.

Thin section KD12-01-16g-9 (Fig. 9C, D) contains two varieties of carbonates: secondary dolomite and foraminiferal-ostracod packstone, with clusters of trilobites, large ostracods and small foraminifera of the genus *Septabrunsiina* Lipina (family Pseudoammodiscidae). The genus is characteristic of Famennian-Visean deposits of the eastern European Platform, the Urals, Kazakhstan, Kuzbass as well as Belgium, France, Denmark, USA and Iran (Ghasemi-Nejad, 2002). In the western part of the Arctic it occurs in upper Famennian deposits of the Timan-Petchora region (River Talota) (Eremenko et al., 2009a, 2009b). In Alaska the genus was recorded from the middle Tournaisian (Mamet et al., 1993). *Septabrunsiina* (*S. krainica* (Lipina)) is known in northern Kharaulakh (northern Verkhoyanie, Yakutia) from the Bastakh Formation of late

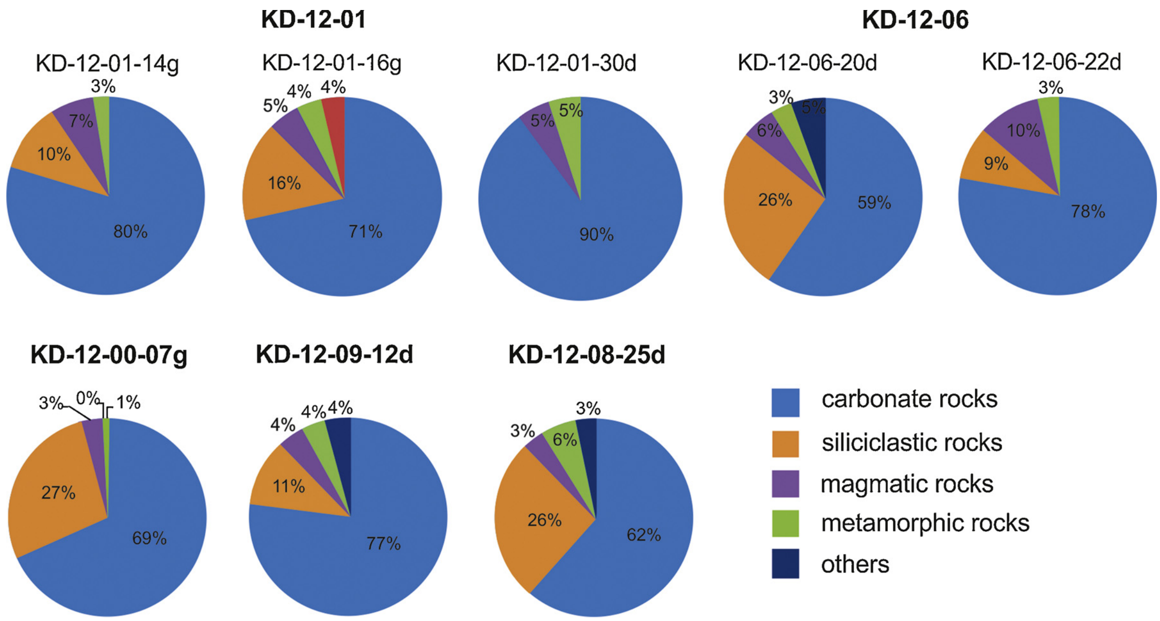


Fig. 3. Diagram of petrographic composition of dredged rocks from the seafloor.

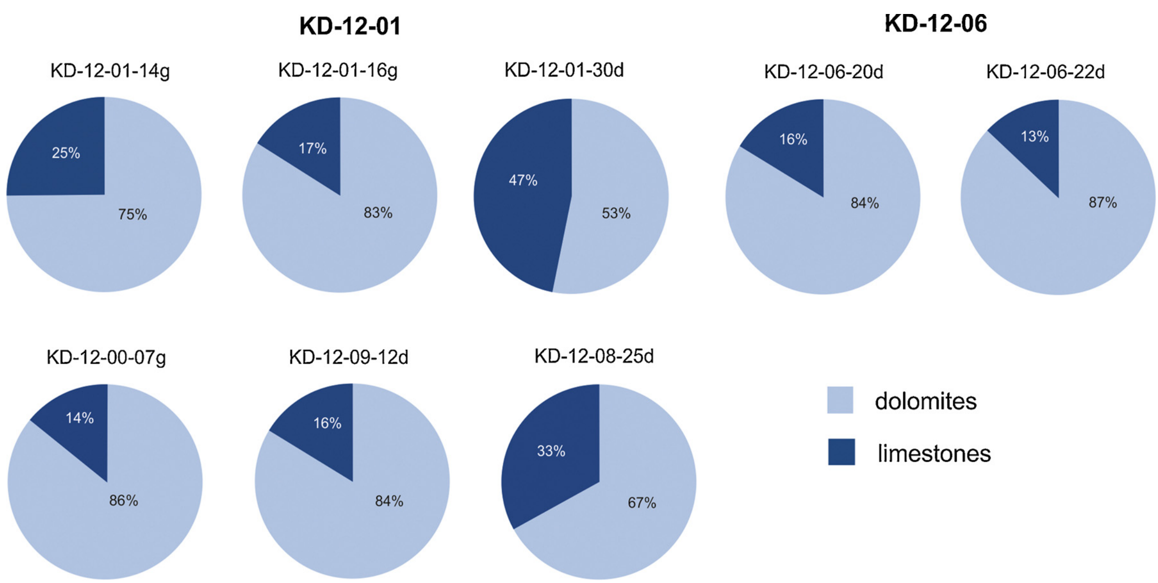


Fig. 4. Percentage of dolomite and limestone at different sites.

Tournaisian age (Bogush and Yuferev, 1966). Recently the occurrence of *Septabrunsiina* sp. has been recorded from the Taidon Formation of Kuzbass. The host deposits are correlated with the Hastarian (Colpaert et al., 2017). Thus, we consider the age to be probably Tournaisian.

4.2.5. Carboniferous-Lower Permian (Cisuralian)?

The carbonate deposits assigned to this interval include numerous calcareous algae and foraminifera. The appearance of fusulinids is most important for climatic and palaeogeographical interpretations. The large dasycladacean alga *Anthracoporella* Pia is fairly abundant (thin section KD-12-01–14 g) (Fig. 7). The genus is well known from the Bashkirian-Moscovian of the Urals (4 species; see Ivanova, 2013), the Lower Carboniferous of Kazakhstan (Maslov, 1956), the Tyumen-Kustanay depression (Ivanova, 2008) and Japan, the Gzhelian-Asselian of the Carnic Alps, Karavanke Mountains and Texas (Bebout and Coogan, 1964), and the uppermost Moscovian-Gzhelian in the Cantabrian Mountains of Spain (Mamet and Villa, 2004). It was found in the Nansen Formation (Canadian Arctic) in the Pennsylvanian–Lower Permian (Ivanova, 2013).

The fusulinid-algal grain-packstone (sample KD12-01–16 g, thin section 413/265) includes the following assemblage: *Eostaffella designata* (Zeller) (Figs. 10 and 11.R), *Eostaffella pseudoovoides* Reitlinger (Fig. 11.T), *Schubertella obscura mosquensis* Rauser-Chernousova (Fig. 11N) and *Ozawainella* sp. (ex gr. *O. loerentheyi* Sosnina) (Figs. 10 and 11O, P).

Eostaffella designata (Zeller) is known from basal Bashkirian deposits of the southern Urals, Tian-Shan (Kulagina et al., 1992, 2001) and the Donets Basin (Efimenko, 2013). The range of *Eostaffella pseudoovoides* Reitlinger in the Urals is late Serpukhovian-late Bashkirian (Kulagina et al., 2001; Stepanova and Kucheva, 2009).

The appearance of *Ozawainella* Thompson is characteristic of the lower Pennsylvanian, but the genus ranges upwards into the Permian. It is distributed worldwide, with records from the Klawak Formation (middle Pennsylvanian) of southeastern Alaska (Douglass, 1971), the Kap Jungersen Formation of Greenland and the lower Moscovian Nansen Formation in Arctic Canada (Ellesmere Island) (Davydov et al.,

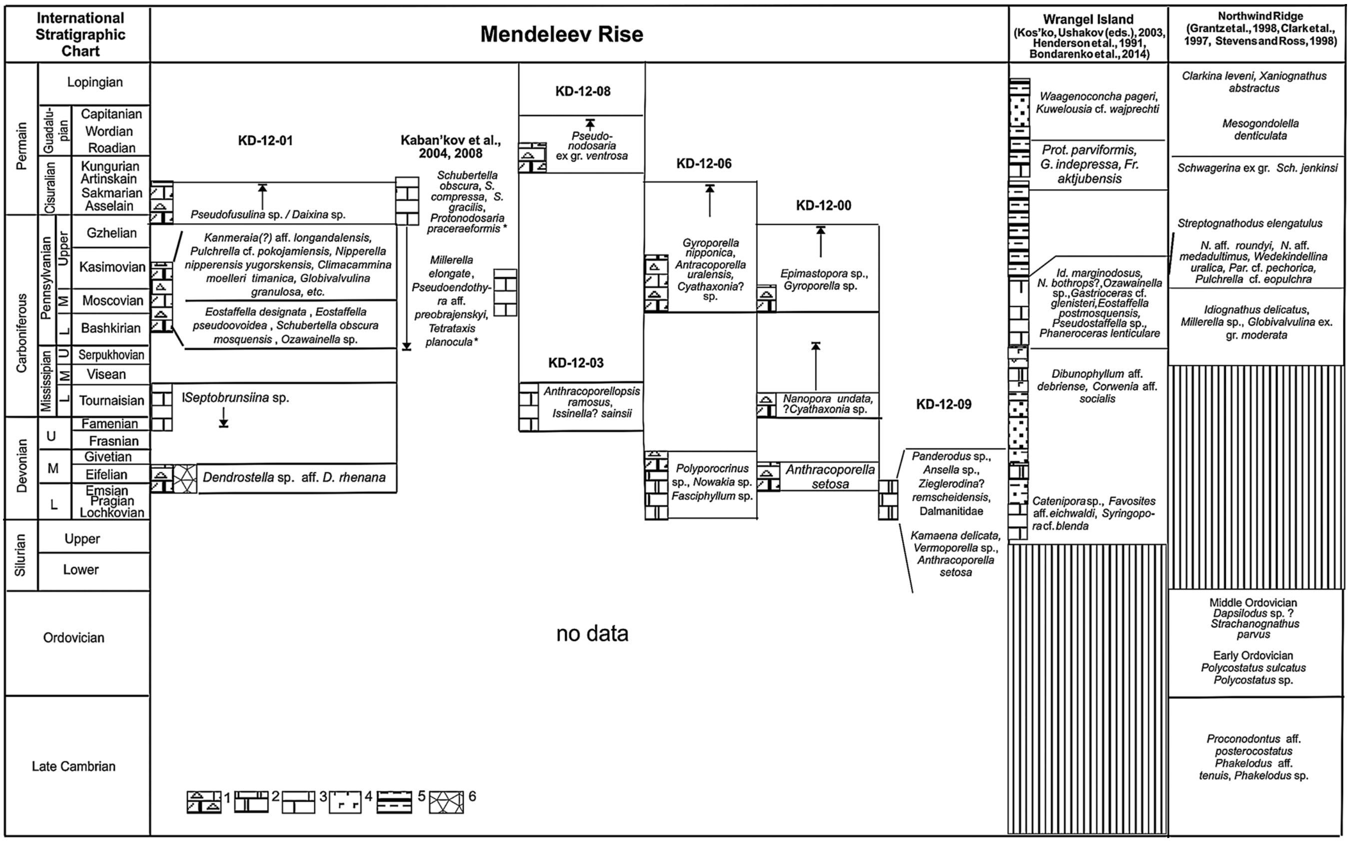


Fig. 5. Comparison of biostratigraphic data of the Mendeleev Rise, Northwind Range and Wrangel Island. Legend: 1 − bioclastic limestone; 2 − dolomite; 3 − limestone; 4 − magmatic and metamorphic rocks; 5 − siliciclastic rocks (mostly siltstone and metamorphic siltstone); 6 − reef boundstone and framestone; 7 − sandstone. Abbreviations: *A.* − *Anthracoporellopsis*; *Par.* − *Parawedekindellina*; *N.* − *Neognathodus*; *G.* − *Geinitzina*; *F.* − *Frondicularia*; *Id.* − *Idiognathoides*; *Pr.* − *Protonodosaria.*

2001). The genus also occurs in the Minkinfjellet Member in central Spitsbergen (Lønøy, 1995). The species *Ozawainella* ex gr. *O. loerentheyi* Sosnina (KD 12-01–16 g, thin section 413/265) was found in the Podolskian Substage of the Donets Basin (Khodjanyazova and Davydov, 2013), but it was also mentioned from the Vereyan Substage of the same region (Davydov et al., 2010). However, according to the frequency of *Ozawainella* ex gr. *O. loerentheyi* Sosnina the age of the sample is considered as late early Bashkirian-early Moscovian. The green alga *Beresella polyramosa* Kulik was found in the same thin section KD12-01–16 g, 413/265. The type species was described from the Moscovian Stage in the Orenburg region, southern Urals (Kulik, 1964). The species occurs rather rarely in the Visean and Serpukhovian. It is more typical of the Bashkirian and Moscovian of the Urals (Ivanova, 2013). In the Arctic Realm the genus *Beresella* Machaev is widespread during Moscovian times, i.e., the Kap Jungensen Formation of Greenland (Mamet and Stemmerik, 2000). Thus, the range of this taxon does not contradict the proposed late early Bashkirian–early Moscovian age of the sample. The co-occurrence of species of *Eostaffella* and *Ozawainella* is characteristic of the uppermost Bashkirian in the New Siberian Islands, Wrangel Island and Chukotka (Solovieva, 1975).

Sample KD12-01-30d-3 was collected (dredged) at the same sampling site and yielded *Fusulinella* (*Uralofusulinella*) sp., *Schubertella* aff. *lata* Lee & Chen, *Climacammina* sp., *Bradyina* sp. and staffellids. The assemblage indicates a late Moscovian–early Kasimovian date based on co-occurrence of *Fusulinella* (*Uralofusulina*) sp. and *Schubertella* aff. *lata*. The first genus is distributed in the central and southern Urals from the Kasimovian to the late Artinskian. *Schubertella lata* is known from Moscovian strata of the Urals, the Pennsylvanian of North America and elsewhere.

A more diverse assemblage of the same age was determined in crinoid–foraminifer grainstone that also contains bryozoan fragments. It includes *Kanmeraia*? aff. *logandalensis* (Cassity & Langenheim) (KD-12-01–67 g; Fig. 11.E, F), *Pulchrella* cf. *pokojamiensis* (Lebedeva) (KD12-01-30d, thin section 5; Fig. 11.G–I), *Schubertella gracilis* Rauser-Chernousova (Fig. 11.K), *Climacammina timanica* Reitlinger, *Bradyina* cf. *samarica* Reitlinger and *Globivalvulina* sp.

The genus *Kanmeraia* Ozawa occurs in Pennsylvanian-Cisuralian strata, being fairly widely distributed in the Arctic Realm and also known from contemporaneous deposits around the Pacific: northwestern North America, Japan, the Arctic region and the Ural Mountains (Ozawa, 1967). It was recently found in the upper Bashkirian-Kasimovian of Wrangel Island. *Kanmeraia*? aff. *logandalensis* (Cassity & Langenheim) was originally described from the lower-middle Kasimovian of the Bird Spring Group, Nevada (Cassity and Langenheim, 1966). The species was found in upper Moscovian (Myachkovian) deposits of the Tumba-Sale Formation in the northern Pay-Khoy (Solovieva, 1984), in the basal Kasimovian of the Malaya Pokayama section, northern Timan (Remizova, 2004), in Upper Palaeozoic pebbles collected in Jurassic conglomerates of Franz-Josef Land (Ershova et al., 2017). It is also recorded from transitional Moscovian-Kasimovian deposits studied in the core of boreholes drilled in the Pechora Sea (Lopatin and Rybalko, 2014). By frequency, the species is considered to be typical of the Arctic Realm. Thus, the age of the carbonate deposits in sample KD-12-01–67 g is late Moscovian-middle Kasimovian.

Pulchrella pokojamiensis (Lebedeva) was originally described from northern Timan. It is known from the Myachkovian (uppermost Moscovian) of the Urals (Ivanova, 2008) and the Malaya Pokayama section of northern Timan (Remizova, 2004). In boreholes of the Kolguev Island, a Gzhelian age of the host deposits was indicated (Davydov, 1997). One of the species of *Pulchrella* (*P. pulchra* Rauser-

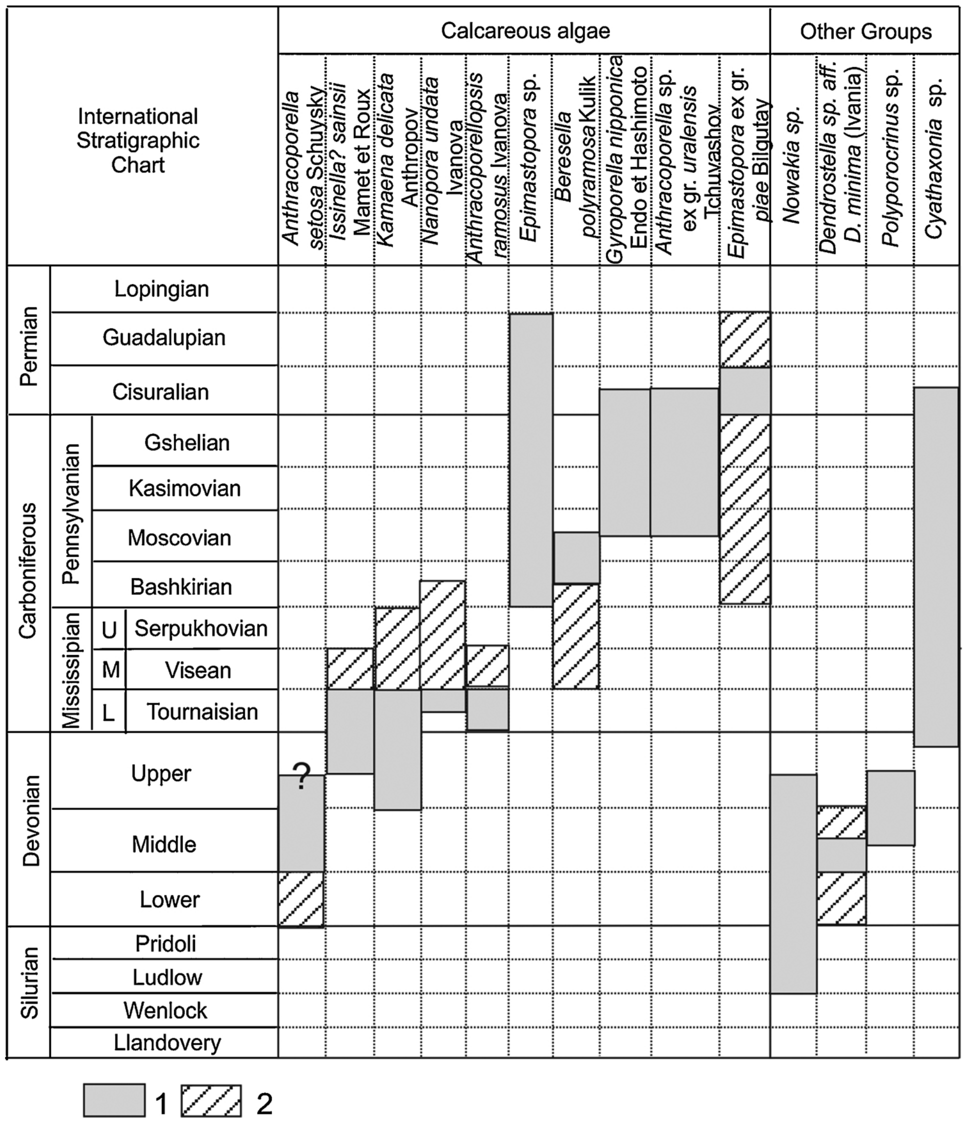


Fig. 6. Stratigraphic distribution of calcareous algae and other fauna found in carbonate rocks of the Mendeleev Rise. Legend: 1 − stratigraphic range adopted in this article; 2 − stratigraphic range of genera/species outside the region.

Chernousova & Belyaev) was also described from the basal fusulinid zone of the Kasimovian in the Kolosseum section in central Spitsbergen (Davydov and Nilsson, 1999). *Pulchrella* cf. *eopulchra* (Rauser-Chernousova) was also determined in the Northwind Ridge (Stevens and Ross, 1997; Grantz et al., 1998). In the Medyn' boreholes of the Pechora Sea, *Pulchrella pokojamiensis* (Lebedeva) was found in an assemblage assigned to the Moscovian (Suvorova, 2012). We consider the age of limestone KD12-01-30d, thin section 5, to be late Moscovian-early Kasimovian. Six species of *Pulchrella*, including *P. pokajamensis* (Lebedeva), and two species of *Kanmeraia* (*K. zelleri* Thompson and *K. devexa* Thompson) occur in the Nansen Formation of the Sverdrup Basin, Arctic Canada in Moscovian-age (= Desmoinesian) deposits (Lin et al., 1991).

Schubertella obscura mosquensis Rauser-Chernousova is widely distributed on the Russian Platform. It is characterised by single appearances in the upper Bashkirian, but becomes abundant in the lower Moscovian (Rauser-Chernousova et al., 1951). It also occurs in the Pennsylvanian of the southeastern Urals (Malakhova, 1980), the Timan-Pechora region (Konovalova, 1991), the Donets Basin (Fohrer et al., 2007) and in the Cantabrian Mountains of Spain (Ginkel, 1965). It was also recorded from the uppermost Moscovian of the Nansen Formation, Arctic Canada (Lin et al., 1991). In the southern part of the Timan-Pechora region, it appears later (*Montiparus montiparus* Zone, Kasimovian).

Schubertella gracilis Rauser-Chernousova is mostly characteristic of the lower-middle Pennsylvanian and is distributed worldwide. In the Arctic Realm, it was found on De Longa Island in lower Moscovian strata (Davydov, 2016).

Climacammina timanica Reitlinger is known from the lower part of the Myachkovian (latest Moscovian) of southern Timan (Reitlinger, 1950). The genus *Climacammina* Brady is a long-lived taxon that is distributed worldwide from the Lower Carboniferous (Visean) to the Lower Permian. The fragment of the crinoid-foraminiferal grainstone KD12-01-30d-5, dredged from the same site KD12-01, contains a slightly different assemblage of foraminifera. This fauna includes: *Nipperella nipperensis yugorskensis* Solovieva (Fig. 10.D), *Pulchrella* cf. *pokojamiensis* (Lebedeva), *Ozawainella* sp., *Globivalvulina granulosa* Reitlinger, *Bradyina magna* Roth & Skinner, *Bradyina* cf. *samarica* Reitlinger, *Ammovertella vaga* Reitlinger, *Pseudoglomospira* sp. and *Tolypammina* sp.

Nipperella nipperensis yugorskensis Solovieva was originally described from uppermost Moscovian (Myachkovian) deposits of the Tumba-Sale Formation, Ugra Penninsula, northern Urals (Solovieva, 1984). Wilde (1990) suggested that the earliest primitive forms of *Wedekindellina*, such as *Wedekindellina*? *matura* and *Wedekindellina*? *gephyrea*, should be

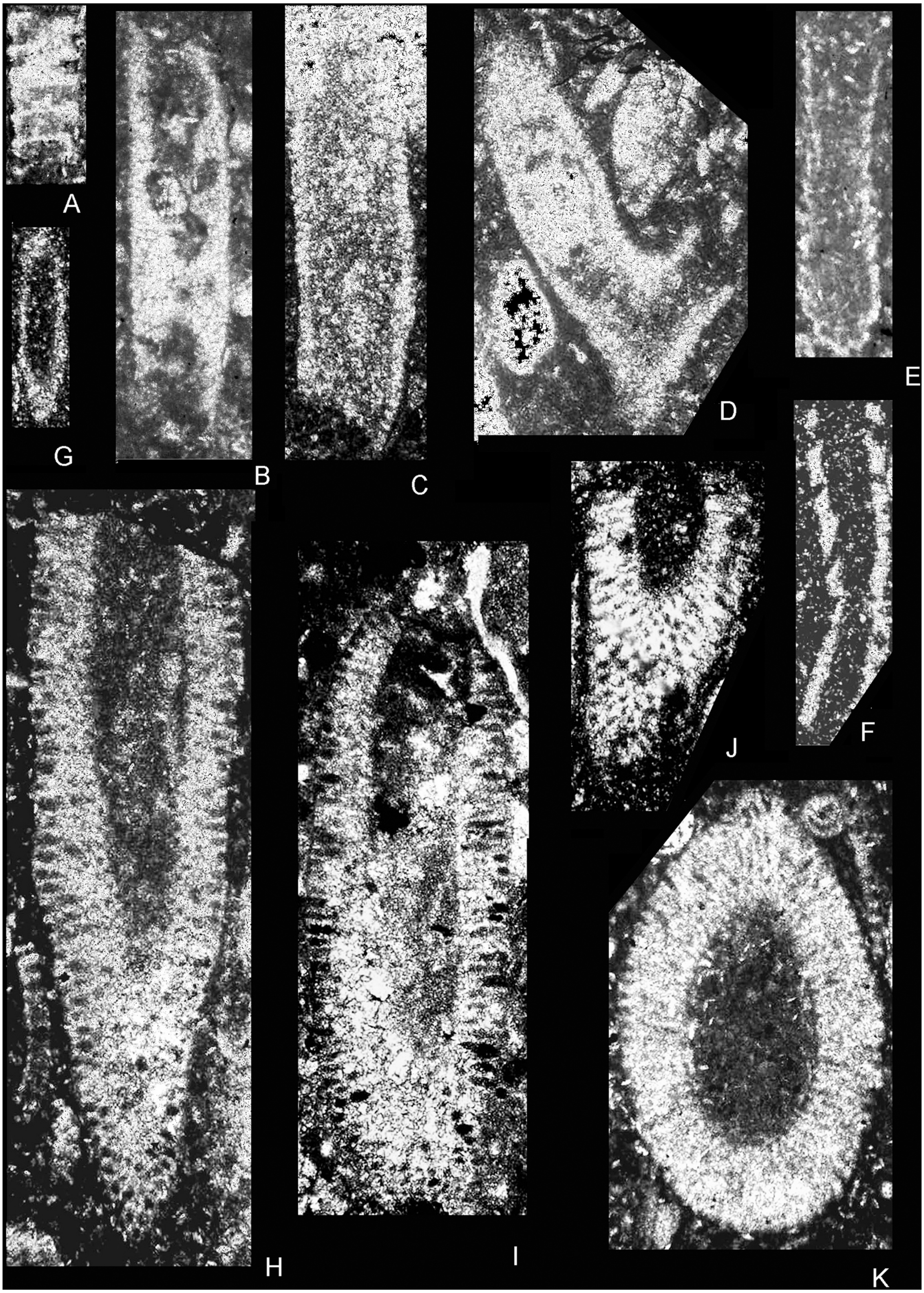


Fig. 7. Paleozoic algae in carbonate rocks of the Mendeleev Rise. 7.A. *Kamaena delicata* Anthropov (x 45), thin section KD-12-09-11g-36; Lower-Middle Devonian; 7.B. *Anthracoporellopsis ramosus* R. Ivanova (x 60), thin section KD-12-03-9d-355; Lower Carboniferous (Tournaisian); 7.C, D. *Nanopora undata* R. Ivanova (x 40), thin section KD-12-00-07d-88, Lower Carboniferous (Tournaisian); 7.E, F. *Vermiporella* sp. (x 40); 7.E. thin section KD-12-09-11g-36, Devonian; 7.F. thin section KD-12-03-09d-233, Devonian-base of Lower Carboniferous. 7.G. *Issinella* (?) *sainsii* Mamet & Roux (x 40), thin section KD12-03-09d-233, Famennian-Tournaisian; 7.H, I. *Anthracoporella setosa* Schuysky (x 40); 7.H. thin section KD-12-09-11g-36, typically Lower-Middle Devonian; 7.I. thin section KD-12-00-07d-153, Lower-Middle Devonian (D_{1-2}); 7.J. *Anthracoporella* sp. (x 40), thin section KD-12-03-09d-233, Devonian-Asselian; 7.K. *Anthracoporella setosa* Schuysky (x 40), thin section KD-12-09-11g-36, typically Lower-Middle Devonian (D_{1-2}).

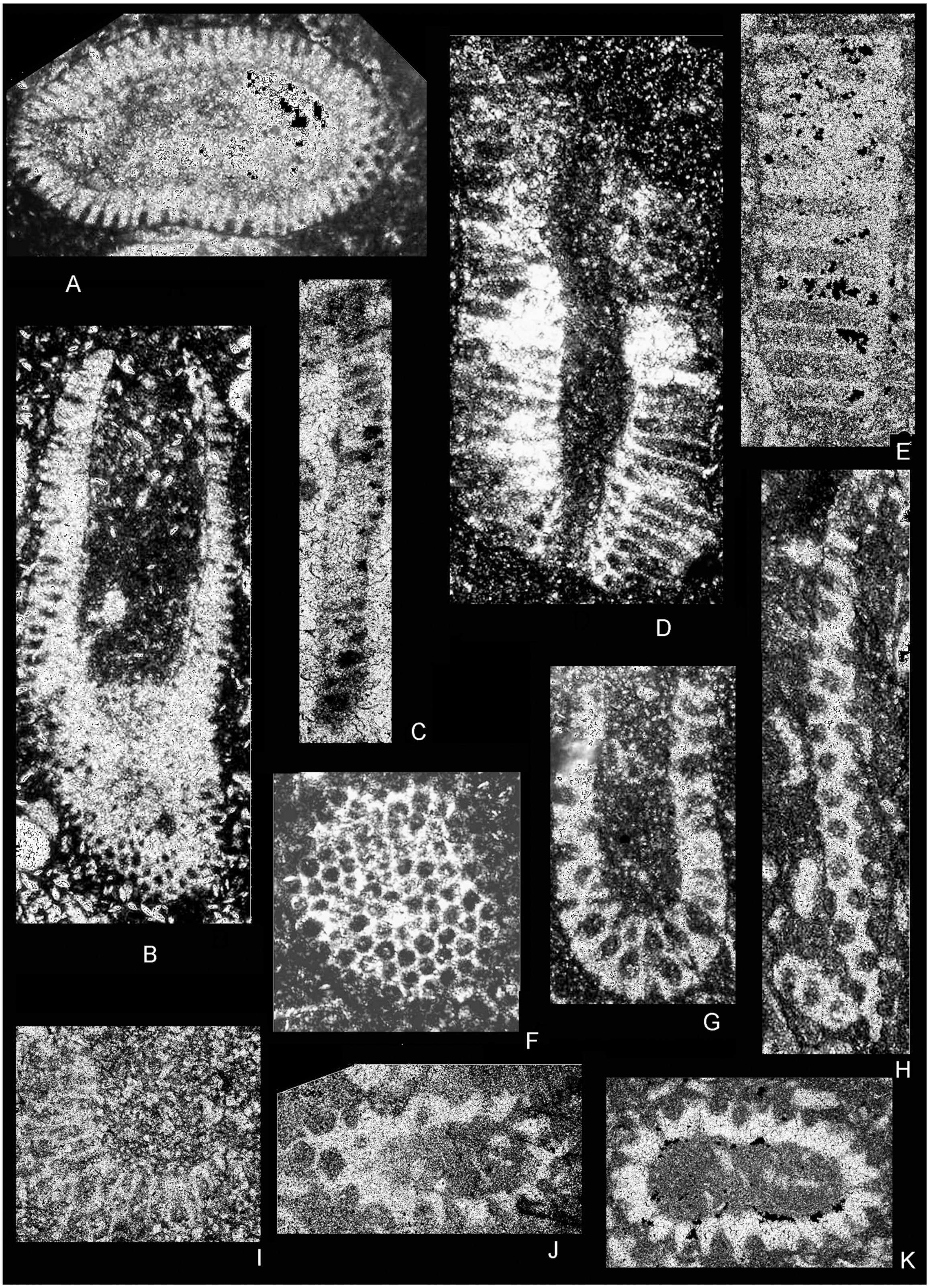


Fig. 8. Palaeozoic algae in carbonate rocks of the Mendeleev Rise. 8.A, B. *Anthracoporellopsis ramosus* R. Ivanova (x40): 8.A, B. thin section KD12-03-9d-355, Lower Carboniferous (probably Tournaisian); 8.C. *Anthracoporella* sp. (ex gr. *uralensis* Tchuvachov), thin section KD12-06-20d-56, Pennsylvanian-Asselian (x 40); 8.D, E. *Epimastopora* ex gr. *piae* Bilgutay: 8.D. (x 40), thin section KD12-03-09d-233, not below middle Pennsylvanian; 8.E, (x 60), thin section KD12-00-07d-176, of same age; 8.F.I. *Epimastopora* sp. (x 40): thin section KD12-00-07d-88, not below middle Pennsylvanian; 8. I. thin section KD12-03-09d-500, Moscovian; 8.G, H. *Gyroporella nipponica* Endo & Hashimoto (x 40): 8.G thin section KD12-03-09d-233; 8.H. thin section KD12-06-20d-37, not below Moscovian; 8.J., K *Gyroporella* sp. (x 40), thin section KD12-00-07d-176, not below Moscovian.

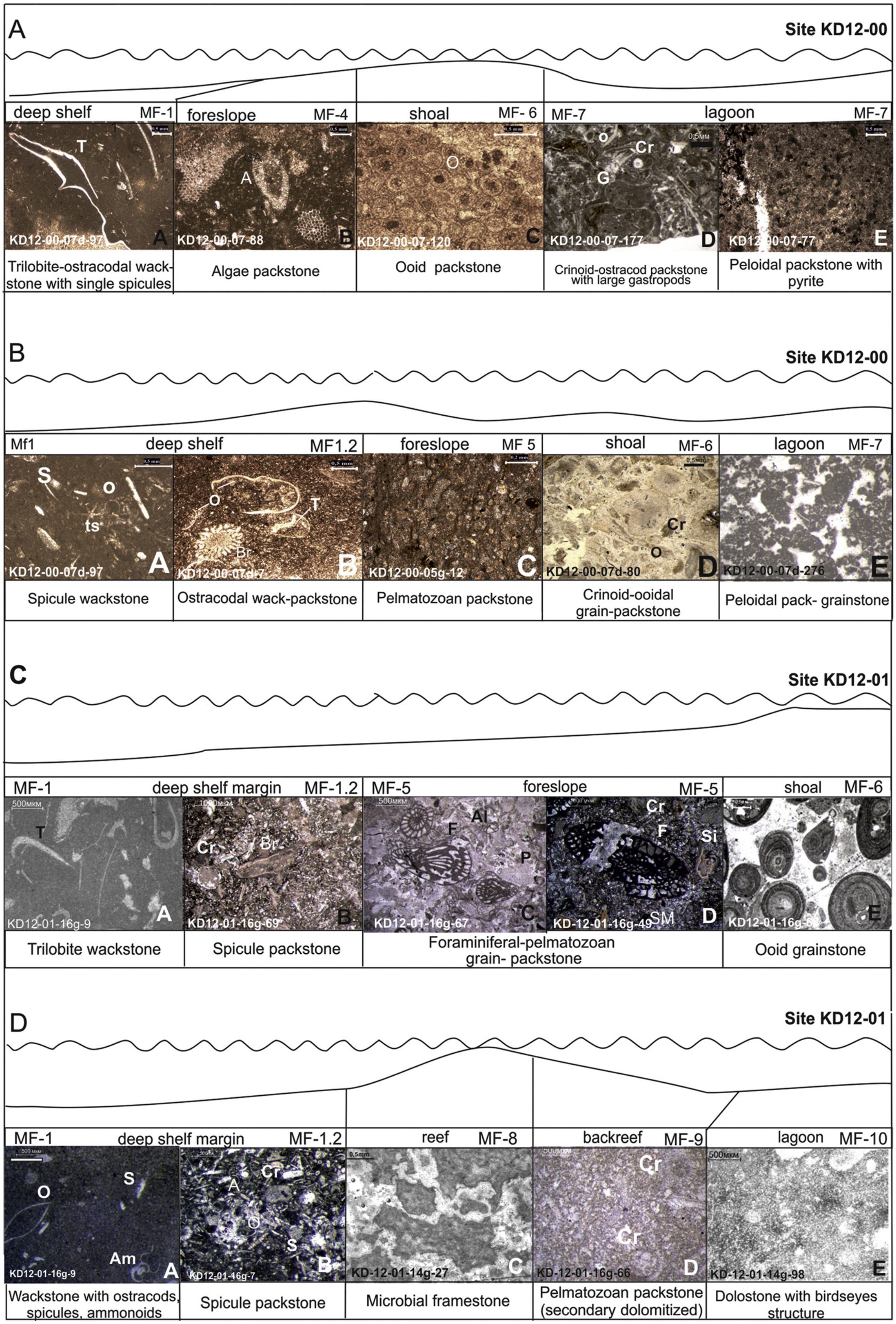


Fig. 9. Provisional facies zonation and types of microfacies (MF) in carbonate rocks of the Mendeleev Rise. A, B. types of microfacies at sampling sites KD-12-00; C, D. microfacies at sampling site KD12-01.

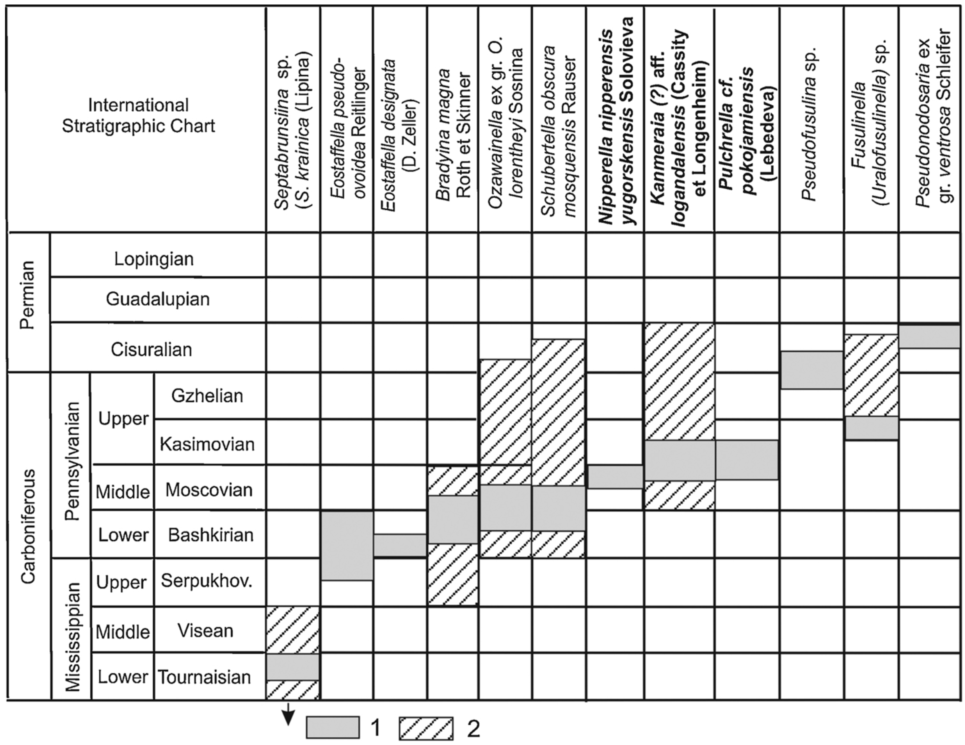


Fig. 10. Distribution of the main foraminifera species found in dredged carbonates of the Mendeleev Rise. Taxa characteristic for the Arctic region are shown in bold. 1- age of species or genera accepted for the age determination; 2 – age of species or genera outside of Arctic region.

referred to the Eurasian genus *Nipperella* Solovieva, which occurred near the upper Desmoinesian boundary in the United States (Wahlman, 2013). Thus, the genus is distributed along the northern margin of Pangea during the Myachkovian.

Two species of *Bradyina* Möller have been found: (1) *Bradyina* cf. *samarica* Reitlinger is a long-lived taxon. It occurs in the Chisia Formation of late early Permian-Guadalupian age in China, and in the upper Pennsylvanian of Austria/Italy. *Bradyina magna* Roth & Skinner (2) occurs in the Atoka (upper lower Pennsylvanian-lower middle Pennsylvanian) of North America, in the upper lower Moscovian and in the lowermost upper Moscovian of southern Timan and South China (Krainer et al., 2005). The species also was recorded from the upper Moscovian deposits of the southern Urals (Ivanova, 2008).

Glabivalvulina granulosa Reitlinger was originally described from Moscovian deposits of the Russian Platform (Rauser-Chernousova and Reitlinger, 1954). It is a typical Moscovian species (as was shown in the phylogeny proposed by Gaillot and Vachard, 2007). The species was also found in a carbonate block of early Moscovian age collected on Zhokhov Island (De Longa Islands, eastern Arctic) (Davydov, 2016).

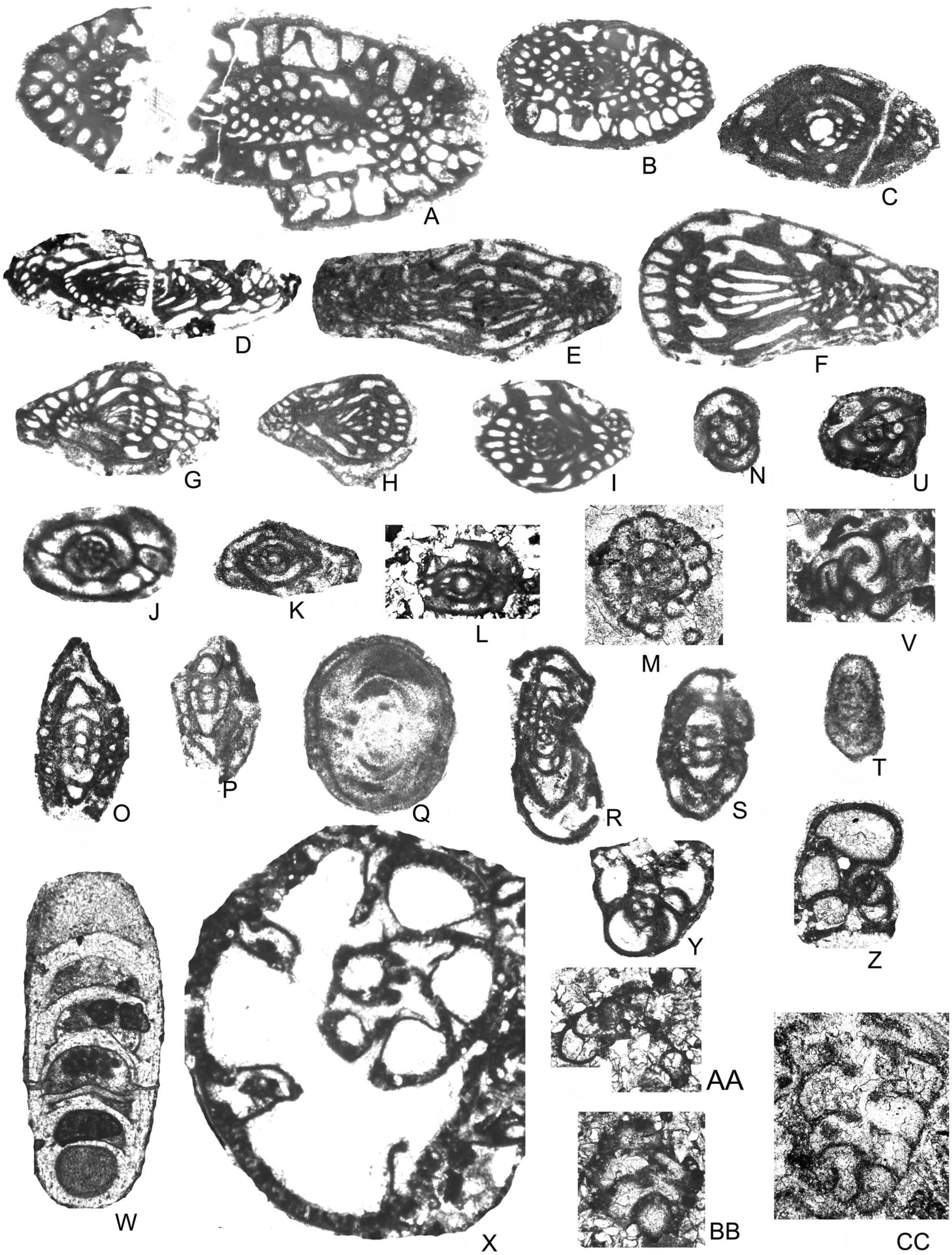
Schubertella sp., *Tetrataxis* sp. and fusulinids with a clear keriothecal wall related to the genus *Pseudofusulina* Dunbar & Skinner or *Daixina* Rozovskaia were found in fusulinid-crinoid-bryozoan packstone (Fig. 10.A, B). The host deposit is of late Gzhelian-early Cisuralian age according to the frequency of occurrence of these taxa. Two fragments of small foraminifera-ostracod wackestone contains rare crinoids and fenestellids (KD12-01–16 g, thin section 161/95, KD12-01–16 g, thin section 161/96). Thus, the fauna of carbonate rocks dredged at site KD-12-01 is indicative of an early-middle Devonian, Late Devonian–Early Carboniferous, Bashkirian-early-middle? Kasimovian and late Gzhelian-Asselian age.

4.2.6. Site KD-12-03

Sampling site KD-12-03 located at the southwestern slope of an unnamed seamount in Pochtarev Plateau, in the south of the eastern side of the Mendeleev Rise, N 79°27′ W 171°59′. The sea depth of the sampling site is 2770 m (Figs. 1 and 2C). The steepness of the slope is 7–33°. A video tracking of the seafloor showed that stone fragments are extremely rare and evenly scattered on the bottom. About 500 fragments of carbonate rocks were recovered. A poor algal assemblage includes *Anthracoporellopsis ramosus* R. Ivanova (thin section KD-12-03-9d-355; Figs. 7B, 8A, B) and *Issinella*? *sainsii* Mamet & Roux (KD-12-03-09d-233; Fig. 7G). *Anthracoporellopsis ramosus* R. Ivanova was originally described from Tournaisian deposits of Kuzbass (Siberia) and from the Urals (Bogush et al., 1990). *Issinella*? *sainsii* Mamet & Roux was recorded from the Famennian of France, but it is also found in the Famennian-Tournaisian-Visean of the Urals, Siberia, northeastern Russia and Ukraine (Ivanova and Bogush, 1988; Bogush et al., 1990; Berchenko, 2003; Ivanova, 2013). In the Arctic Realm, it is known from the upper Visean of the Peratrovich Formation of southeastern Alaska (Prince of Wales Island) (Mamet and Pinard, 1985). The species is more frequent in the upper Famennian-Tournaisian of Siberia and in northeastern Russia. Thin section KD12-03-09d-233 includes the mixed uppermost Devonian-Upper Pennsylvanian assemblage of algae. The good preservation of the Devonian-Tournaisian species and their rather high diversity evidences against far distant transportation. The mixture can be a result of onlap on the erosional surface of Famennian-Tournaisian limestone. The occurrence of *Epimastopora* sp. (Fig. 8.J; thin section KD12-03-09d-500) is not known below the middle Pennsylvanian (see above) and is characteristic of shallow warm water. Thus, a probable late Famennian-Tournaisian and middle Pennsylvanian (Moscovian) age were determined for carbonate rocks at site KD-12-03.

4.2.7. Site KD-12-06

Sampling site KD-12-06 is located on the western slope of the Trukshin seamount, N 83°03.067′, E 177°20.167′, depth is 1800–2700 m (Fig. 2C). The slope of the seafloor reaches 35 – 50°. The steepest areas are located at the slopes of a large canyon that cuts the slope. According to seismic studies, the thickness of the sediments at the canyon bottom is 20 m, whereas on the steep slopes it is only 1–2 m. At the canyon mouth, a talus of boulders up to 10–15 m in size was found.



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Apparently, the blocks were transported from the seamount slope by a rockslide flow. A small outcrop occurs up to the seamount: the surface of its bedrock is uneven, fractured with an abrupt step. About 3000 angular and slightly rounded fragments of predominantly carbonate rocks were collected. Samples also included fragments of a breccia with clasts of basalts, sandstones and granitoids.

The tentaculitid *Nowakia* sp. was found in secondarily dolomitised wackestone (thin section KD-12-06-20d-44; Fig. 8.A). *Nowakia* appeared in the Late Silurian, became abundant from the end of the Lochkovian to Eifelian age and went extinct at the Frasnian-Famennian boundary. It is distributed worldwide in the northern and southern hemispheres (Czech Republic, Germany, Austria, China, Australia, Nevada, Alaska and Canada). In the late Early Devonian–Middle Devonian, the genus occurs on the Taymyr Peninsula (Proskurnin et al., 2016) and on Novaya Zemlya (Lopatin and Rybalko, 2014). In Canada, the genus is known from the Stuart Bay Formation of Devonian age

Fig. 11. Palaeozoic foraminifera from sites KD-12-01 and KD-12-08. 11.A, B. *Pseudofusulina* sp. (x 20), sample KD-12-01-16g-49, upper Pennsylvanian-Permian; 11.C. *Fusulinella* (*Uralofusulinella*)(?) sp. − *Fusulina* sp. (?) (x 20), sample KD-12-01-30d, thin section 3, Pennsylvanian-Permian; 11.D. *Nipperella nipperensis yugorskensis* Solovieva (x 20), sample KD-12-01-30d, thin section 5, upper Moscovian-lower Kasimovian (Myachkovian-Kreviakinian); 11. E. *Kanmeraia*(?) aff. *longdalensis* (Cassity & Langenheim) (x 20), sample KD-12-01g-67, upper Moscovian-lower Kasimovian (Myachkovian-Kreviakinian); 11.F. *Kanmeraia*(?) sp. (x 20), as previous; 11.G-I. *Pulchrella* cf. *pokojamiensis* (Lebedeva) (x 20); 11.G, I, thin section KD12-01-30d, thin section 5; 11.H, thin section KD-12-01g-67, upper Moscovian-lower Kasimovian (Myachkovian-Kreviakinian); 11.J. *Schubertella* aff. *lata* Lee & Chen (x 40), sample KD12-01–16 g, thin section 161/96, Carboniferous. 11.K. *Schubertella gracilis* Rauser-Chernousova (x 40), thin section KD-12-01–67 g, upper Moscovian-lower Kasimovian (Myachkovian-Kreviakinian); 11.L. *Schubertella* aff. *mjachkovensis* Rauser-Chernousova (x 40), sample KD12-08-25d, thin section 32, upper Moscovian; 11.M. *Schubertella* sp. (x 80), sample KD 12-01–16 g, thin section 413/265, Bashkirian. 11.N. *Schubertella obscura mosquensis* Rauser-Chernousova (x 80), sample KD12-01–16 g, thin section 413/265, Bashkirian. 11.O, P. *Ozawainella* sp. (ex gr. *O. loerentheyi* Sosnina) (x 40); 11.O. sample KD 12-01–16 g, thin section 413/265; 11.P. sample KD12-01-30d, thin section 5, Bashkirian. 11.Q. *Parastaffelloides pseudosphaeroidea* (Dutkevich) (x 40), sample KD12-08–28 g, thin section 209, Kungurian- Roadian? 11.R. *Eostaffella designata* (D. Zeller) (x 40), sample KD12-01–16 g, thin section 413/265, Bashkirian; 11.S. *Eostaffella* sp. (x 80), sample KD12-01-16s, thin section 413/265, Bashkirian; 11.T. *Eostaffella pseudoovoidea* Reitlinger (x 8), sample KD12-01–16 g, thin section 413/265, Bashkirian; 11.U. *Pseudoglomospira* sp. (x 40), sample KD12-08–28 g, thin section 209, Carboniferous-Permian; 11.V. *Ammovertella vaga* Reitlinger (x 40), sample KD12-01-30d, thin section 5, upper Moscovian-lower Kasimovian (Myachkovian-Kreviakinian); 11.W. *Pseudonodosaria* ex gr. *ventrosa* Schleifer (x 80), sample KD12-08-25a, thin section 155/10, Lower Permian, Kungurian-Middle Permian (P_1^2-P_2); 11.X. *Bradyina magna* Roth & Skinner (x 20), sample KD12-01-30d, thin section 5, upper Moscovian-lower Kasimovian (Myachkovian-Kreviakinian); 11.Y, Z. *Globivalvulina granulosa* Reitlinger (x 40), sample KD12-01-30d, thin section 5, upper Moscovian-lower Kasimovian (Myachkovian-Kreviakinian); 11.AA. *Globivalvulina*(?) sp. (x 40), sample KD12-08-25d, thin section 32, upper Pennsylvanian-Lower Permian; 11.BB. *Climacammina* sp. (x 40), sample KD12-08-25d, thin section 32, as previous; 11.CC. *Climacammina moelleri timanica* Reitlinger (x 40), KD-12-01–67 g, upper Moscovian-lower Kasimovian (Myachkovian-Kreviakinian).

(Andrechuk, 1977). Thus, we propose an Early Devonian–Middle Devonian age for the host sediments. At the highest point KD12-06-20d-56 (Fig. 2C), the transverse section of a fragmentary *Cyathaxonia*? sp. was found. The coral-bearing rock is an alternation of ostracod grain-packstone and dolomitised algal-peloidal wackestone with the traced of compaction. *Anthracoporella* sp. A. aff. *uralensis* Tchuvashov was determined in the same thin section (KD12-06-20d-56; Fig. 8C). The species was originally described from Asselian deposits of the western slope of the central Urals (Chuvashov, 1974) but it is also distributed in the Moscovian of the Urals. Thus, the range of the species is Moscovian (abundant in the upper Moscovian) to Asselian (Ivanova, 2013).

The alga *Gyroporella nipponica* Endo & Hashimoto (KD12-06-20d-37; Fig. 8.H) is distributed in the uppermost middle Pennsylvanian (Urals, Spain), Gzhelian of the Urals, the upper Gzhelian-lower Sakmarian in Austria, Italy, the Upper Permian of Japan, Middle Pennsylvanian-Cisuralian of the USA and Canadian Arctic (Mamet et al., 1987; Vachard and Krainer, 2001; Ivanova, 2008, 2013).

The range of carbonate rocks includes two levels: Early Devonian–Middle Devonian and probably uppermost Moscovian-Sakmarian? based on the distribution in the Arctic region. The age succession coincides with the bathymetric levels of sampling. Thus, at this sampling site we assume the presence of Lower Permian deposits.

Devonian sandstone (age determined by Pb/U on Shrimp in the Centre of Isotopic Research, VSEGEI, Saint Petersburg) is located bathymetrically below the carbonate occurrences (sample KD-12-06-22d-2).

4.2.8. Site KD-12-08

Sampling site *KD-12-08* is located on the southern slope of Rogotskyi Seamount, N 83°11′, E 172°25′. Water depth is 2670 m (Figs. 1 and 2E). The steepest escarpments are situated on the upper part of the slope, which flattens out towards the foot. The tilt of the slopes reaches up to 30 − 35°. The slope is dissected by submarine ridges and canyons, with a depth up to 80 m. The boulders and blocks, found at the mouth of one of those canyons, reach 5–25 m in size and have uneven surfaces. Apparently, large rock boulders fell down into the canyon from the upper steep part of Rogotskyi Seamount. The presence of Permian rocks has been determined in a bryozoan packstone containing the foraminiferan *Pseudonodosaria* ex gr. *ventrosa* Schleifer (Fig. 11.W). The species is characteristic of the Kungurian of the Kozhim River section, Polar Urals (Sukhov, 2007) and of the Lower Permian of northern Verkhoyanie (Gerke and Sosipatrova, 1975). The deposits of the Baykura Formation in the Taymyr Peninsula, containing *Pseudonodosaria* ex gr. *ventrosa* Schleifer, were assigned a Kazanian (Roadian) age (Proskurnin et al., 2015). Its occurrence in the assemblage XII of the upper part of the Starostin Formation on Svalbard was correlated with the Solikamskian Regional Stage (upper Kungurian) of the eastern European Platform (Sosipatrova, 1967). *Globivalulina* sp. (Fig. 11.AA) and *Climacammina* sp. (Fig. 11.BB) were also found in this sample (identification by T.V. Filimonova). Diverse limestones were observed: an ostracod packstone, mudstone, secondary dolomitic rock with peloid clusters and a few crinoids, sedimentary breccia, bryozoan-crinoid packstone and wackestone and spiculite.

4.2.9. Site KD-12-09

Sampling site KD-12-09 is located on the eastern slope of an unnamed seamount, N 81°15′, E 171°55′. The water depth is 2800–3100 m (Fig. 2F). Some few angular fragments, mainly of carbonate rocks with faunal remains, were collected on the eastern slope (inclined up to 27°). A large sample of limestone yielded conodonts: *Panderodus* sp., *Ansella* sp., *Zieglerodina*? *remscheidensis* (Ziegler) (Fig. 12). *Zieglerodina*? *remscheidensis* (Ziegler) was restricted to the Lower Devonian (Murphy et al., 2004; Carls et al., 2007). The species is known from Upper Silurian(?)–Lower Devonian deposits of Italy, Austria, Estonia, Tajikistan and Australia. *Zieglerodina*? *remscheidensis* (Ziegler) occurs in Pridolian deposits in the Polar Urals (Sokolova, 2014). It was also recorded from boreholes on Kolguev Island, in the Pechora Sea and in the Timan-Pechora region (Lopatin and Rybalko, 2014).The same sample contains a pygidium and thorax of a trilobite belonging to the family Dalmanitidae Reed (identification by I.Y. Gogin) (Fig. 12I, J). This family ranges from the Ordovician to Devonian (Bohemian facies). Further micro- and macrofauna include small remnants of dacryoconarids, inarticulate brachiopods, scolecodonts and “fish” (Figs. 12 and 13). Preliminary determinations (by Dr. Tiiu Märss) of an assemblage of thelodonts with *Nikolivia auriculata* Märss, *Talivalia longata* (Karatajute-Talimaa) and *Canonia grossi* Vieth (Fig. 12). The species composition shows some similarity to coeval fauna known Canada (Märss et al., 2002, 2006). Dacryoconarids are assigned to *Nowakia* cf. *zlichovensis* Bouček & Prantl, which occurs in the middle part of the Emsian Stage in Eurasia.

Conodonts, dated as Early Devonian, demonstrate a colour index CAI = 0.5 suggesting a minimal degree of thermal alteration of part of the dredged limestones.

Samples collected bathymetrically below were studied in thin sections KD-12-09-11d-36 and KD-12-09-12d-19. These are dolomites and dolomitised bioturbated packstone with uncertain organic remains, ostracods and crinoids. The Devonian (Emsian-Givetian) age is indicated by crinoid stems of *Polyporocrinus* sp., found in an ostracod-crinoidal wackestone with large crinoids and small ostracods of the family Palaeocopidae. The genus occurs in the Emsian-Eifelian of central Asia, Rudny Altai and the southern Urals (Rakhmonov, 2011).

A rather diverse assemblage of green algae includes *Kamaena delicata* Anthropov (KD-12-09-11g-36, Fig. 7.A). The latter is distributed

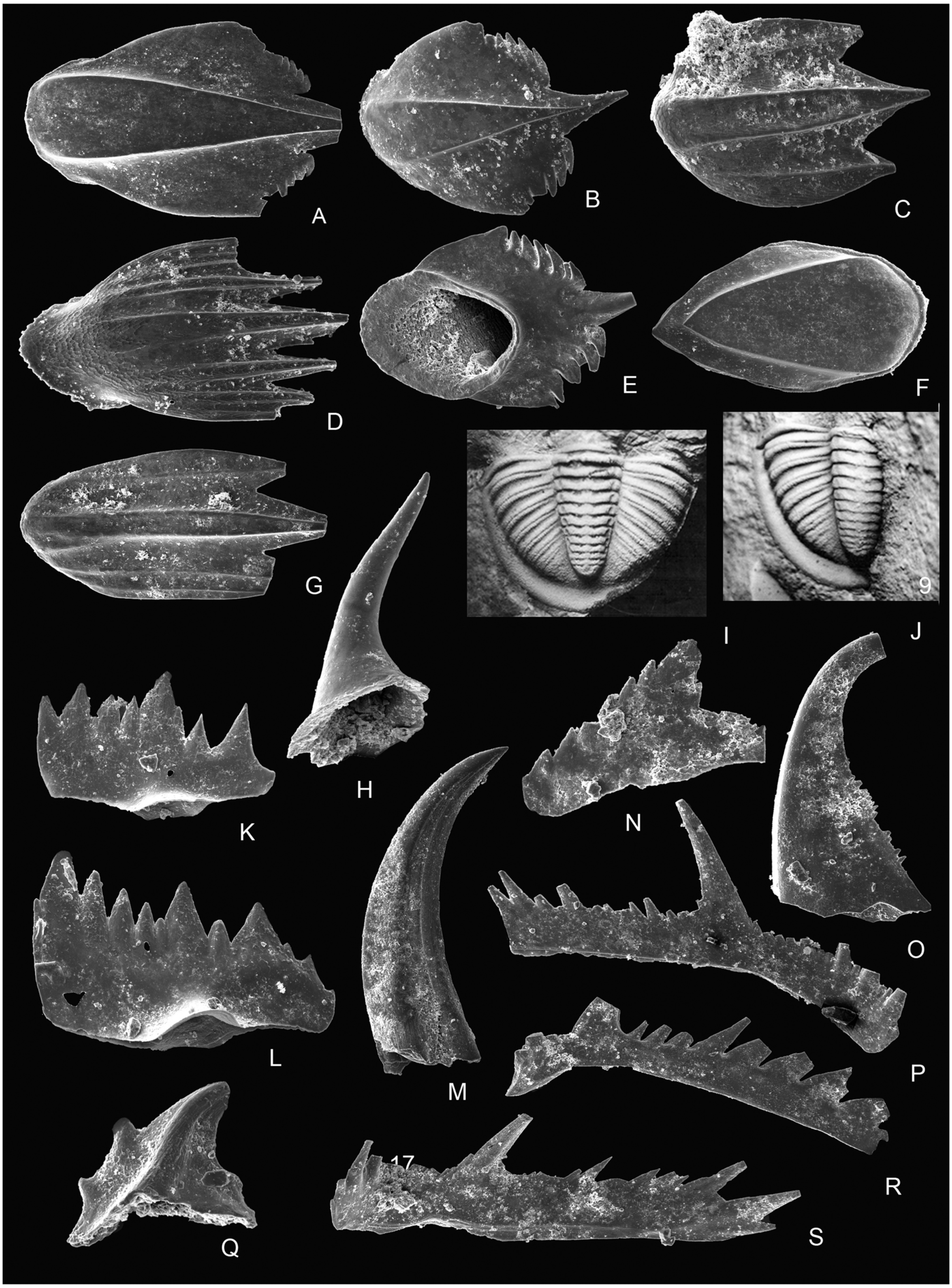

Fig. 12. Upper Silurian-Lower Devonian limestone from the eastern slope of the unnamed seamount at site KD-12-09, sample KD-12-09-12d-85. 12.A-H. Fish remains: 12.A, B. *Nikolivia auriculata* Märss, x60; 12.C, D, G. *Canonia grossi* Vieth, x60; 12.E. *Nikolivia auriculata* Märss; 12.F, H. *Talivalia elongata* (Karatajute-Talimaa), x55; 12.I, J. Trilobites of the family Dalmanitidae Reed, 1905, x1.5. 12.K-S. Conodonts: 12.M. *Panderodus* sp., x75; 12.O. *Ansella* sp., x65; 12.K, L, N-S. *Zieglerodina*? *remscheidensis* (Ziegler), x50–75.

worldwide in the uppermost Devonian-Tournaisian, and is less abundant in the Visean and Serpukhovian. The species occurs in the Famennian-Serpukhovian of the Urals (Ivanova, 2013; Anfimov, 2015), in the Famennian of western Siberia (Stepanova et al., 2011). In the Arctic Realm it is known in the middle Famennian of Vaigach Island (Zhuravlev et al., 2011); it was reported from the Devonian-Tournaisian transition of the Kugurorok Formation (Mamet and Preat, 2010) and in the upper Visean of the Peratrovich Formation in southeastern Alaska

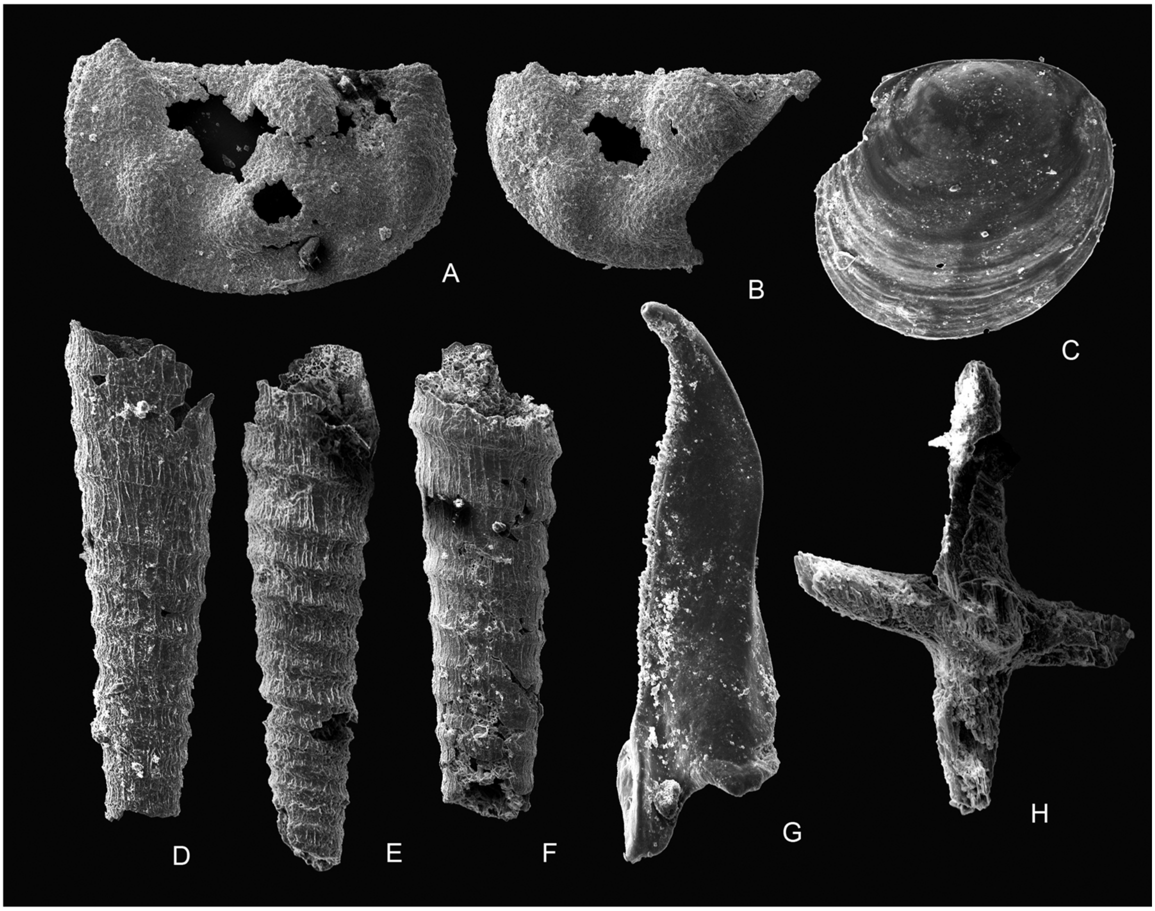

Fig. 13. Microfauna from Devonian limestone, sample KD-12-09-12d-85; 13. A, B. Ostracods, order Palaeocopida, x30; 13. D-F. Dacryoconarids, *Nowakia* cf. *zlichonensis* Bouček & Prantl, x28; 13.C. Inarticulate brachiopods, *Lingula* sp., x25; 13.G. Scolecodonts, x57; 13. H. Sponge spicules, x34.

(Mamet and Pinard, 1985). *Vermiporella* sp. (Fig. 7.E) and *Anthracoporella setosa* Schuysky (KD-12-09-11g-36; Fig. 7.H,K) are characteristic of the Lower-Middle Devonian (distribution: see above). The co-occurrence of *Anthracoporella setosa* Schuysky and *Kamaena delicata* Antropov indicates a probable Middle-Late Devonian age for specimens KD12-09-11g-36 and KD12-09-12d-19.

Results obtained from fragmentary carbonate rocks show that the well-documented range of carbonate fragments is late Early Devonian-Middle Devonian, Famennian-Tournaisian, Early-Middle Pennsylvanian up to Early-early/middle Kasimovian and more rarely Gshelian-Asselian. The younger deposits, i.e., Kungurian or probably basal Guadalupian, occurred in the northern part of the Mendeleev Rise.

5. Microfacies analysis and environments

Carbonate rocks are dominant among the samples collected. Most of the limestone comprise various bioclasts which are evidence of a Middle-Late Palaeozoic age. The better-dated samples belong to mostly shallow shelf carbonates: algal packstone, crinoid-ostracod packstone, fusulinid-algal, fusulinid-bryozoan packstone etc., but trilobites, conodonts and tentaculites were more characteristic of deeper marine environments. The nodular limestone suggests the rather steep outer slope. The unremarkable siliciclastic influx, succession of facies typical of carbonate sedimentation, shoal and lagoon facies accumulation and probable evaporatic deposition allow to consider the basin as a rimmed carbonate platform with rather distant southerly area. The succession of major facies belts on rimmed tropical carbonate platforms and standard facies zonation were described by Wilson (1975). The extended facies model added by Standard Microfacies Zonation (SMF) by Flügel (2004) was used in interpretations of the present study. The microfacies selected in carbonate rocks collected from the Mendeleev Rise are based on these models and classification of carbonate rocks of Dunham (1962). Eleven microfacies types (MF), characteristic of deep shelf, foreslope, lagoon, reef, backreef and shoal environments, are described below (Figs. 9 and 14).

MF1. Pelagic spicule wackestone with trilobite fragments and thin-shelled ostracods. Skeletal grains also include sponge spicules (Fig. 9AA, BA, CA). Some of the trilobite fragments are less fragmentary (Fig. 9AA) and juvenile carapaces are also well preserved (Fig. 14G). Trilobite fragments are of different sizes, from 0,3-0,5 mm (Fig. 14.G) up to 5 mm (Fig. 9.B). Thin shells of ostracods occur rather rarely. The ostracod carapaces occasionally are not fragmented (Fig. 9.DA). Monaxon or tetraxone spicules (Desmospongiae) are found (Fig. 9.BA). The latter suggests rapid sedimentation and slow dissolution (Flügel, 2004). Small ammonoid shells co-occur (Fig. 9.A). The accumulation of skeletal grains is uneven. In one thin section (Fig. 14.G) is present spicule-radiolarians packstone, whereas in the another of the same sample the structure is ostracod wack-packstone with bryozoan fragments, small remains of trilobites (Fig. 9.BB). The thin shells of ostracods are of different preservation, but often packstone includes predominantly the single thin shells. Pelmatozoans are rather rare. Small spicules also occur (Fig. 9.BB). Cement in all variations is micrite. The facies is deep shelf deposits accumulated in rather quiet environments, probably in the outer slope of the platform (SMF-2, Flügel, 2004). MF 1 was determined at sampling sites KD12-01 and KD12-00.

MF1.2. Spiculite packstone with pelmatozoan and bryozoan skeletal grains (thin section KD-01-16g-69; Fig. 9.C,B). Two other examples of the same depositional setting is a spiculite packstone with

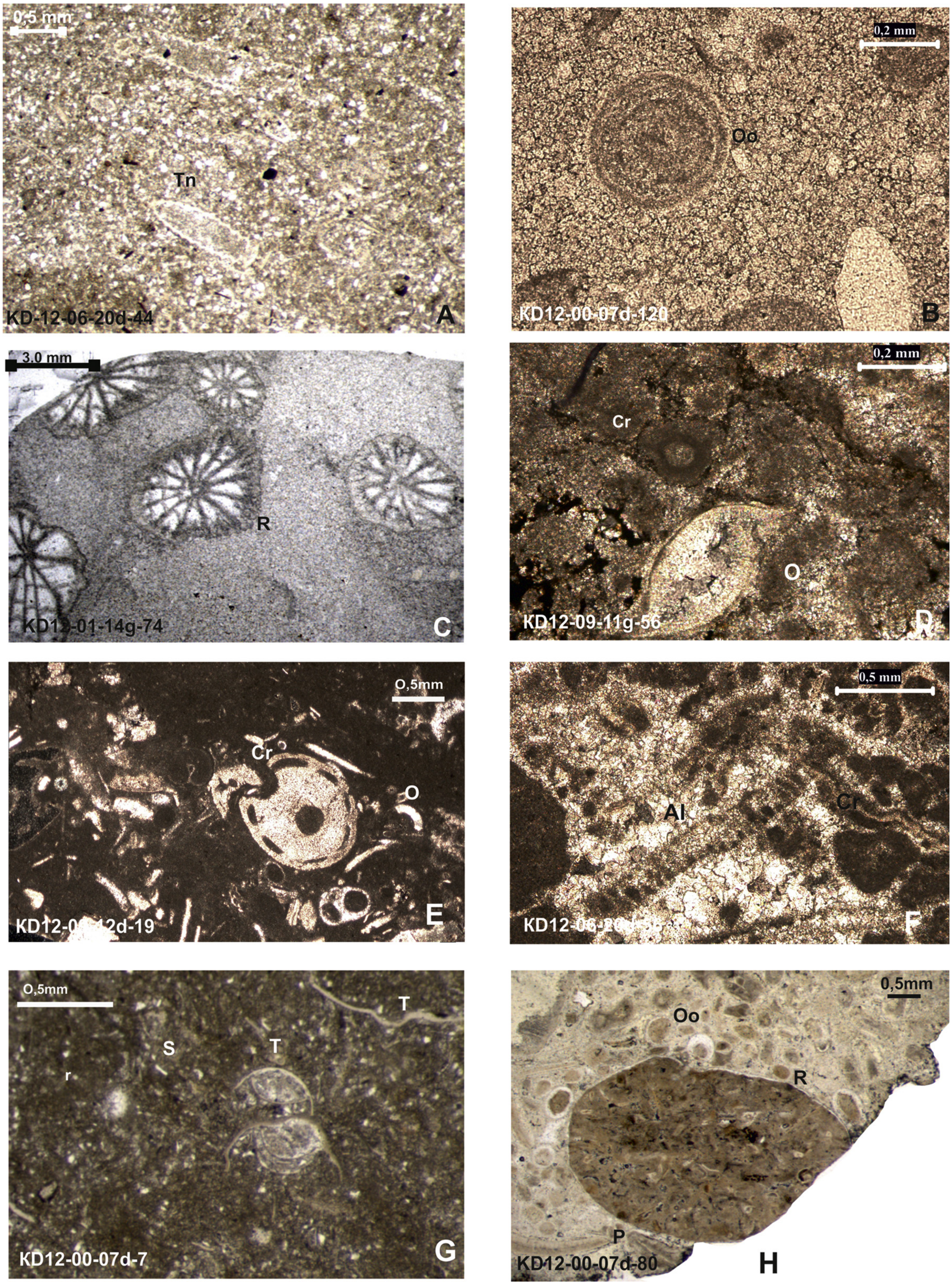

Fig. 14. Microfacies of carbonate rocks of the Mendeleev Rise. 14. A. Dolomitised wackstone with tentaculitid *Nowakia* sp. The parallel orientation of bioclasts reflects palaeocurrent, MF-2, thin section KD-12-06-20d-44, outer shelf, Early-Middle Devonian; 14. B. Secondarily dolomitised ooid wackstone, thin section KD12-00-07d-120, Palaeozoic, shoal environments; 14.C. Dolomitised wackestone with fasciculate rugose corals *Dendrostella* sp. aff. *D. rhenana* (Frech), thin section KD12-01-14g-74, inner shelf or reef environments, Middle Devonian. 14.D. Nodular limestone. Ostracod-crinoid packstone and rounded micritic intraclasts. Rare relicts of sparite cement. Boundaries are marked by dark clay seams resulting from incipient pressure solution. Deep-marine depositional setting. Thin section KD12-09-11g-56, probably Devonian; 14.E. Crinoid-ostracod packstone, crinoids, *Polyporocrinus* sp., thin section KD12-09-12d-19, inner shelf, Early-Middle Devonian; 14.F. Peloid packstone. Sparitic cement as infill of a burrow. Thin section KD-12-06-20d-56. A filament of the dasycladacean algae *Beresella* (1 mm) is located in the burrow. Thin section KD12-06-20d-56, inner shelf, Middle Pennsylvanian (Moscovian); 14.G. Spicule-radiolarian wackstone, thin section KD12-00-07d-7, skeletal grains-trilobites. Pelagic sediments of deep shelf. Presumably of Devonian age; 8.H. Oolite–ooids grain/packstone with redeposited rugose coral, thin section Kd-12-00-07d-153, Early Carboniferous, shoal or inner shelf; Abbreviations: Tn – tentaculitids; T – trilobites, R – rugose corals; O – ostracods; Cr – crinoids; Oo – oolites/ooids; Al – calcareous algae; s – spicules, R – radiolarian.

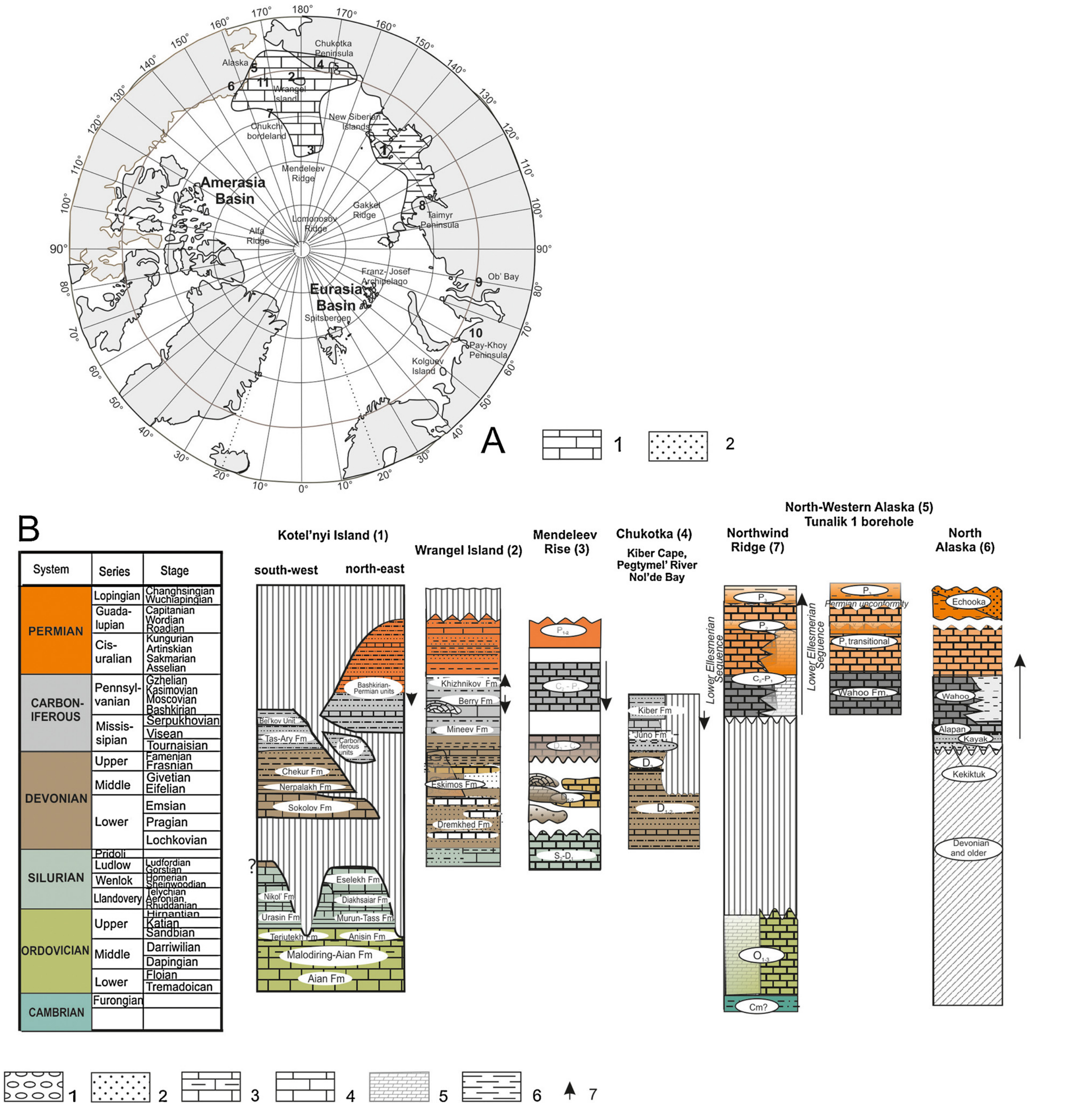

Fig. 15. Correlation of the Palaeozoic strata in the main sections of the Eastern Arctic. A- Circum polar projection of Arctic. Numbers − the sections included in correlation and mentioned in the text. Legend: 1- area with carbonate sedimentation and warm-water fauna (Moscovian); 2- area with predominant siliciclastic sedimentation (Moscovian).

B – Correlation of the main Paleozoic sections in the Eastern Arctic.

1. – Kotelnyi Island (Lopatin, 1999); 2 – Wrangel Island (Kos'ko and Ushakov, 2003; Koren' and Kotlyar, 2009); 3. – Mendeleev Island, authors data; 4 – Chukotka (Zhuravlev et al., 2011, Koren' and Kotlyar, 2009); 5 – North-Western Alaska, borehole Tunalik 1 (Miller et al., 2002); 6 – North Alaska (Embry, 1989); 7 – Northwind Ridge (Grantz et al., 1998); 8 – Taimyr, 9 – Ob' Bay; 10 – Pay-Khoy; 11 – Chuchi shelf; Popcorn borehole (Miller et al., 2002) (8–11 on the map and in the text). Legend: 1 – conglomerate; 2 – sandstone; 3 – mudstone; 4 – limestone; 5 – dolostone; 6 – siltstone; 7 – the interval of carbonate sedimentation and warm-water (Chlorozoan) biota. B – Schematic lithofacies map of the eastern Arctic. Legend: 1–land; 2–coastal-marine environments (fluvial-deltaic plain); 3–marine; 4–inner shelf; 5–outer shelf; 6–sandstone; 7–siltstone; 8–mudstone (argillite); 9–limestone; 10–clayey limestone; C – reconstruction of the position of the Mendeleev-Chukotka-Wrangel block as part of Arctida during the early- middle Pennsylvanian (Bashkirian-Moscovian).

pelmatozoans, mollusc shells and thin shells of ostracods. Bioclasts are typical of deep and non-tropical environments. Skeletal grains are not orientated (Figs. 9.DB, 14.E). Cement-micrite. Deep shelf margin with high water energy.

MF.2. The dolomitised wackestone with tentaculitids (Lower-Middle Devonian) (Fig. 14.A). Tentaculitids were mostly planktonic or nekto-planktonic organisms abundant in open deep-marine shelves, but they are also characteristic of basinal settings (Flügel, 2004). The orientation of shells reflects the direction of bottom palaeocurrents. The accumulation is characteristic of the outer slope of a carbonate platform (Flügel, 2004: SMF 3).

MF.3. Bio-retexturing process leads to destruction of primary structure of packstone. In thin section KD-12-06-20d-56 (Fig. 14.F) the cement is pelmicrite; the sparitic cement is preserved in a burrow created by soft-bodied organisms. The outer boundary of the bioclasts is rounded and corroded. The fragment of some Siphonocladaceae (algae) is located inside the burrow. There is no orientation of bioclasts. Shallow, warm-water environments: lagoon or foreslope of the platform. Middle Pennsylvanian (Moscovian).

MF 4. Algal packstone with rare ostracods. Calcareous dasycladacean algae are abundant (Fig. 8A,B; thin section KD-12-00-07-88). In one of the unillustrated thin sections of the same sample − a fragment of rugose coral without dissepiments and large lithoclast of dolomite occur. Cement micrite. Shallow tropical, warm-water carbonates accumulated in the photic zone of the foreslope with rather low water energy conditions.

MF 5. The fusulinid-pelmatozoan pack-grainstone. Fragments of dasycladacean algae and smaller foraminifers generally occur. There are fragments of siliceous nodules. The carbonate fabric was formed under the high energy of water in the foreslope of a platform (Figs. 9.BC, .CC, .CD) (SMF 18; Flügel, 2004).

MF 6. Shoal environments are rather widespread. At sampling site KD-12-01, an ooid grainstone with sparitic cement accumulated in a high water envoronment. Size of ooids up to 1 mm. The ooid grainstone with concentric structure of ooids is also formed in tidal bars (Fig. 14B) (SMF 15). Some of the oolitic grainstones include also fragments of crinoids or rugose corals and algae (KD-12-00-07d-80; Figs. 9BD, 14H). Laminated ooid-oolitic grainstone is intercalated with secondarily dolomitized mudstone with birds-eyes structure. The depositional setting is a shoal or lagoon (Fig. 9AC) (SMF 13).

MF 7. Lagoon facies varies from peloidal grain-packstone (Fig. 9.BE) to peloidal packstone (Fig. 9AE). Pyrite concentrations (Fig. 9AE) are possible in the restricted areas. Some thin sections contain a large number of variable-sized gastropod shells (Fig. 9AD). The lagoonal deposits typically are secondarily dolomitized and bioturbated (Fig. 9DE). (SMF 16). Birdseyes structure is characteristic. Peloidal packstone is accumulated in lagoons with moderate water circulation and periodical exposure.

MF 8. Only a single sample was attributed to microbial reef facies. The framestone has a relict reef structure. Reef facies is also indicated by the occurrence of reef-building corals of Early-Middle Devonian age (SMF 6). Bafflestone with fasciculate coral colony shows accumulation of sediments (secondarily dolomitised micrite) between corallites (Fig. 14C) (SMF 6). These colonies are typical of Devonian reefs.

MF 9. Nodular limestone. Ostracod-crinoid packstone. Micritic intraclasts are rounded. Some spaces have a sparitic cement infill. Dark clay seams resulting from incipient pressure solution mark boundaries between intraclasts. Deep-marine depositional setting at the edge of slope. Thin section KD12-09-11g-56 (Fig. 14D).

MF 10. Evaporites are represented by dolostone with birdseyes structure (Fig. 9E).

6. Palaeozoic biota of the Mendeleev Rise: comparison with adjacent areas – bio- and palaeogeographical aspect

6.1. Comparison of the Palaeozoic biota

On the basis of composition and palaeobiogeographical affinities, the biota studied have been subdivided into three groups. The first, Late Silurian to Middle Devonian, assemblage does not reveal any distinct biogeographical differentiation and is similar to faunas that are distributed across western Europe, the polar Urals, Siberia and Canada. The presence of fasciculate rugose colonies points to a warm-water setting.

In the eastern Arctic, some tropical Devonian and Lower Carboniferous carbonate rocks are found on Wrangel Island (Kos'ko and Ushakov 2003). The assemblage includes some tabulate colonies of *Favosites*, *Stelliporella*?, *Syringopora* and others, plus rugose corals such as *Zelolasma* sp. and *Lyrielasma*? sp. The age of this assemblage was determined as Late Silurian-Early Devonian. The overlying Givetian–Frasnian deposits are mostly siliciclastics (conglomeratic sandstones, siltstones and mudstones) with lenses of limestone. The latter have yielded a foraminiferal assemblage with *Nanicella* and *Tikhinella*; these genera are known from Frasnian rocks in western Europe, Canada, USA, the east-European Platform and the Urals (Figs. 5 and 15).

Contrary to Wrangel Island, where Cambrian-Lower Silurian deposits are unknown, the Lower Palaeozoic succession in Taymyr Peninsula is widely exposed. In some part of this territory, it includes a carbonate-siliciclastic alternation of deep-water deposits with graptolites and conodonts. In coeval levels with permanent carbonate sedimentation conodonts are fairly abundant and co-occur with a rich benthic fauna. Upper Silurian-Lower Devonian deposits are characterised by carbonates (dolomites) that have been dated by tentaculitids as Pragian–Emsian. This level probably corresponds with the oldest carbonate deposits that have been distinguished on Mendeleev Rise and assigned to the late Early to Middle Devonian. The Upper Devonian limestone developed in Taymyr Peninsula in the “carbonate zone” contains abundant warm-water colonial rugose and tabulate corals typical of tropical basins. Colonial Late Devonian corals were not found on Wrangel Island, where this time interval is characterised by an accumulation of clastic deposits, nor on Mendeleev Rise. The probable Late Silurian-Middle Devonian fauna from Mendeleev Rise shows some similarity to that from the Canadian Arctic (telodonts, rugose corals). Conodonts and rugose corals are distributed in Eurasian basins of the Barents Sea region.

The break of carbonate sedimentation on Wrangel Island probably reflects the Ellesmerian unconformity, preceding carbonate sedimentation of the Lower Ellesmerian Sequence (Mississippian-Permian) in the western part of Chukchi Sea and North-Western Alaska (Miller et al., 2002). Silurian-Devonian fauna has not been recorded from the Northwind Ridge, where older (Cambrian-Ordovician) rocks have been dated by conodonts (Grantz et al., 1998). The absence of palaeontological data on the Upper Devonian on Mendeleev Rise probably indicates a hiatus or probable deposition of clastic rocks (sandstone) similar to Wrangel Island.

The onset of carbonate sedimentation on Mendeleev Rise during the early Mississippian is weakly dated by our research. A more diverse Famennian-Tournaisian foraminiferal assemblage was collected from carbonates in the southern part of Mendeleev Rise (Skolotnev et al., 2017). This level coincides approximately with the accumulation of limestone with a shallow-water tropical fauna on Wrangel Island (Kos'ko and Ushakov, 2003; Bondarenko et al., 2014). The Early Carboniferous algal assemblages from Mendeleev Rise bear some similarity to those of the American exotic terranes (Peratrovich type) (Mamet, 1992), which have certain Tethyan affinities but basically are cosmopolitan. The latter can explain the presence of Siberian and Uralian elements.

The mid-Carboniferous glaciation led to increased faunal provincialism and a stronger climatic zonation all over the world. The appearance of a typical warm-water fusulinid assemblage in the Pennsylvanian on Mendeleev Rise is crucial as far as biogeographical conclusions are concerned. In the eastern Arctic fusulinid assemblages ranged from the upper Serpukhovian to Bashkirian (Fig. 5), but the latest appearance datum depends on the palaeogeography of the region.

The first assemblage which has stratigraphical and biogeographical meaning is that of *Eostaffella–Ozawainella*. The occurrence of a nonboreal fauna is known from Serpukhovian − Bashkirian deposits of Kotelnyi Island (New Siberian Islands) in the Tas-ary section. It is represented by *Eostaffella* Rauser-Chernousova and *Eostaffellina* Reitlinger. Both genera have a wide geographical distribution (Gerke and Sosipatrova, 1975; Solovieva, 1975). The assemblage (as part of the *Eosigmolina explicata-Eostaffellina paraprotvae* and *Planoarchaediscus stilus-Eostaffelina pseudostruvei* zones) has been correlated with the late Serpukhovian and early Bashkirian fauna that is widely distributed in the Urals and the East-European Platform. An additional occurrence of

Eostaffella was noted in the Yangyugansk parametric well (Fig. 15,A), 100 km east of the town of Salekhard, the northern marginal part of western Siberia (Remizov et al., 2014). Its co-occurrence with calcareous algae typical of carbonate sedimentation was documented from the upper shale/carbonate part of the section that was assigned a Visean-Bashkirian age.

On Mendeleev Rise the oldest faunal assemblage is characterised by the co-occurrence of *Eostaffella* and *Ozawainella* of late Bashkirian-early Moscovian age. It is comparable only with a simultaneous fauna from Chukotka, Wrangel Island (Solovieva, 1975) and Northwind Range (Grantz et al., 1998). In the last-named area, the assemblage is generally determined by other taxa, but also includes *Millerella* sp. (belonging also to the family Ozawainellidae Thompson & Foster). However, the scope of the Bashkirian Stage has changed since 1975; we consider the stratigraphical rank of units distinguished by Solovieva (1975) in accordance with modern subdivisions of the Russian Stratigraphic Chart. An assemblage of early Moscovian fusulinids was also found in a limestone block from Zhokhov Island (De Long Archipelago) in the Eastern Siberian Sea, the easternmost of the New Siberian Islands. The assemblage from Zhokhov Island includes, among many others, taxa: the fusulinids *Novella, Millerella* (also belonging to the Ozawainellidae) and algae *Epimastopora* (distributed in tropical and subtropical basins; see above). There is no direct taxonomic comparison between biota from Mendeleev Rise with simultaneous ones from Zhokhov Island, with the exception of *Epimastopora*. *Novella* also occurs in Chukotka (Solovieva, 1975). In spite of some difference in the taxonomic composition, the position of the fauna from Zhokhov Island had been considered to belong to the biochore of the other New Siberian Island assemblages of tropical/subtropical affinities (Davydov, 2016). This is the only Middle Pennsylvanian probably warm-water fauna from the New Siberian Island, but the origin of the sample is still equivocal.

In contrast to the other New Siberian Islands (including Kotelnyi Island, Burguto et al., 2016; Solovieva, 1975), Taimyr (Proskurnin et al., 2015), Verhoyanie (Klets, 2005), Omolon (Koren’ and Kotlyar, 2009) and eastern Siberia, following the early Bashkirian, deposition of warm-water carbonates continued in Chukotka, Mendeleev Rise, Northwing Ridge, Chukchi Sea (Alaska) and in some terranes of Alaska, but the upper limit was not isochronous. In this higher stratigraphical level late Moscovian-Kasimovian genera are important for biogeographical implications.

A few genera are considered to be indicative of the Arctic, including the northern and polar part of the Urals, namely *Kanmeraia, Pulchrella* and *Nipperella*. In the eastern Arctic some representatives of *Pulchrella* and *Kanmeraia* were found on Mendeleev Rise. *Pulchrella* (*P. eopulchra* Rauser-Chernousova) has also been recorded from upper Moscovian-Desmonesian rocks in the Northwind Range, together with *Wedekindellina* and *Parawedekindellina* (Grantz et al., 1998). A few species of *Pulchrella* (assigned there to *Fusulinella*) were described by Lin et al. (1991) from the Nansen Formation (south-eastern belt of the Sverdrup Basin, Ellesmere Island, Arctic Canada) of late Moscovian age.

On Wrangel Island contemporaneous deposits of a late Moscovian date contain a fairly diverse assemblage of conodonts (Henderson et al., 1991) comparable with the Northwind Range data and a few species of *Kanmeraia* (*K.* aff. *pseudozelleri* Solov'yova, *Kanmeraia* sp.). The genus is widely distributed in the western Arctic in the Barents Sea and Kara Sea regions, but it is also known from the Nansen Formation of the Sverdrup Basin (Lin et al., 1991). It has also been noted from some regions of the USA and Tadzhikistan, but some taxonomic uncertainties deter us from more detailed consideration.

In spite of the fact that *Wedekendellina* was not found on Mendeleev Rise, it seems that it is one of the most widely distributed taxa in the Arctic Realm. It is known from the western Arctic in Svalbard (Davydov and Nilsson, 1999), the Nansen Formation of the Sverdrup Basin, Arctic Canada (Thorsteinsson, 1974; Lin et al., 1991), in southern Ambrup Land, Greenland (Davydov et al., 2001). In the eastern Arctic it has been described from upper Pennsylvanian rocks of the Northwind Range (Stevens and Ross, 1997; Grantz et al., 1998). Outside of the Arctic region it is also fairly abundant, occurring in the central and polar Urals, but also in USA, Mexico, Slovenia, Donbass and Spain.

Much less is known about *Nipperella* Solovieva, which was differentiated from the genus *Fusulinella* (Solovieva, 1984). That author referred some species that had previously been placed in *Fusulinella* to her new genus; these were from northern Pay-Khoy and USA (Arizona, Colorado, Utah and New Mexico) and was found in the Mendeleev Rise.

6.2. Biogeography

The similarity of faunas from the northern Urals, Arctic Canada and Svalbard was noted by Solovieva (1984). Later, these regions were added to the Arctic Fusulinid Province, which included the Canadian Arctic Archipelago, Spitsbergen, Greenland, possibly Yukon Territory and central British Columbia (Lin et al., 1991). Based on the similarity of Pennsylvanian −Early Permian fusulinid faunas of the Northwind Range, Stevens and Ross (1997) extended the Arctic Palaeogeographic Province. They pointed out that, “the position of the Northwind Escarpment in that time was originally adjacent to, or a part of, the Carboniferous-Permian shelf margin extended from the western Canadian Arctic Island along the Barents shelf, and into the North part of the western Ural Mountains” (Stevens and Ross, 1997, p. 359). The distribution of algal assemblages allowed Mamet (1992) to select three palaeogeographical regions, one of which joined the Arctic margins of America and the Siberian biogeographic Realm; however, most algae of Siberia are different. The Asian marginal territories were subsequently considered as Arctic Realm situated at the boundary of the Mediterranean and Siberian realms (Ivanova, 2013).

During the Pennsylvanian and Permian, main regions in the eastern Arctic, Chukotka, Wrangel Island, northern Alaska, Mendeleev Rise and Northwind Range, experienced carbonate sedimentation with a probable, albeit unremarkable, heterochrony of the upper and lower limits. The fauna of four of these areas has revealed such close similarities that they can be considered part of the shelf basin close to the margin of Pangea. The warm-water fauna includes fusulinids, dasycladacean algae, corals (few) and conodonts.

Faunal development since the late Cisuralian contrasts with the eastern Arctic, where some Tethyan fusulinids and conodonts were found in Northwind Range. The samples comprise warm-water *Schwagerina jenkinsi* Thorsteinsson that is characteristic of a late Artinskian–Kungurian age and is also known from the upper part of the early Permian Belcher Channel Formation of the Canadian Arctic Archipelago and in the Artinskian Hamberg Fjellet Formation on Bjornoya, Svalbard (Stevens and Ross, 1997). The gradual change to carbonate-siliciclastic sedimentation continued nearly to the end of the Permian (boreholes Tunalik, Popcorn and others, Alaska) (Miller et al., 2002; Dinkelman et al., 2008). In contrast, only smaller foraminifera (of a similar taxonomic composition) occur in upper Artinskian?-Roadian carbonates on Mendeleev Rise and Wrangel Island (*Protonodosaria parviformis* Gerke, *Geintzina inderpressa* Tscherdyntcev, *G. parva* Lipina, *Frondicularia actjubensis* Igonin, *Nodosaria lata* Sossipatrova, implying an Artinskian–Kungurian date), but also in siliciclastic deposits of Kotelnyi Island (Burguto et al., 2016). This drastic change is indicative of the onset of a eustatic-climatic event that earlier was demonstrated for marginal basins of Pangea (Barents Sea Basin). (Kossovaya et al., 2002; Bensing et al., 2008; Blomeier et al., 2010).

6.3. Palaeogeography

The new data from Mendeleev Rise show that at least during the Carboniferous and probably Early Permian, carbonate deposition, synchronous in this interval with the Lower Ellesmerian sequence of Alaska and Chukcha Sea and Arctic Canada, took place in low latitudes. Data obtained coincide with the palaeogeographical history of Arctida

(Golonka et al., 2003; Vernikovsky et al., 2013, Fig. 10). According to these models, to the Late Devonian, the Chukotka-Alaska block was associated to the megacontinent Arctida (Fig. 15). The new data allow us to assume that the Mendeleev-Wrangel-Chukotka block once was a part of this supercontinent. However, the faunal differentiation indicates that Kotelnyi Island (New Siberian Islands) was located closer to the Siberian palaeocontinent and northeast of the Mendeleev-Wrangel-Chukotka block. This arrangement is supported by similarities in lithology and fauna of Late Silurian-Early Permian assemblages from Kotelnyi Island to northern Siberian sections, including Taimyr Peninsula and by differences in assemblages, stratigraphical succession and lithology from the Mendeleev-Wrangel-Chukotka block since the Moscovian (Fig. 15).

The presence of typical indicators such as green algae during the Devonian and Carboniferous, and fusulinids during the Pennsylvanian-Lower Permian demonstrates warm and shallow–water environments of low- (or probably mid-) latitude sedimentary basins.

7. Discussions

Some contradiction exists between the occurrence of Lower Palaeozoic sedimentary rocks (Cambrian-Ordovician) in the Northwind Ridge and those in the Mendeleev Rise and Wrangel Peninsula. A proposed reconstruction considered them as Laurentian basement based on both fauna (conodonts, trilobites) and U-Pb relative age. This demonstrates the connection of the Northern Slope subterrane of Arctic Alaska–Chukotka terrane and coeval strata of North Laurentia (Strauss et al., 2013). Probably, it can explain only the occurrence of Early Palaeozoic fauna in the Northwind Range. Their absence in Wrangel Island and Mendeleev Rise has no explanation so far.

There are two principal differences in the proposed plate-tectonic reconstructions for the Carboniferous and Permian. The Arctic-Alaska-Chukotka microplate (Miller et al., 2017) is located between Angaycham Basin, Greenland and the Uralian passive margin. Based on taxonomical and lithological composition, the Mendeleev-Wrangel-Chukotka block have to be included in the area of carbonate sedimentation of the shelf basin. The end of carbonate sedimentation in the wide area of shelf basin in the Eurasian Basin during the Artinskian-Kungurian was, probably, trigged by climatic changes. At the Guadalupian, all terranes were located in the 50° of the Northern Hemisphere via clockwise rotation (Stemmerik, 2000). It contradicts the data from Northwind Ridge, where warm-water fauna occurred nearly up to the end of the Permian. The position of Taimyr near to the Siberian craton in the Moscovian-Permian is supported by paleontological and sedimentological data. More complex is the location of New Siberian Island. According to paleontological and sedimentological data it has great similarity with Siberian, and especially the geological history of Taimyr. The relevant location with the separation of the Chukotka-Alaska block and New Siberian block was shown in plate tectonic reconstructions proposed by Vernikovsky et al. (2013, Fig. 10). Here the New Siberian block was accreted to the Siberian craton at 50°NL and Chukotka − Alaska block was located in the Emerasian Basin at 30° NL. The latter position is probable for the Mendeleev-Wrangel-Chukotka block.

8. Conclusions

1. The ages of the studied dredged carbonate rocks ranges from the Late Silurian to early Middle Permian. Based on the new data, the Palaeozoic cover of Mendeleev Rise included a significant part of Upper Silurian-lower? Middle Permian carbonate rocks with assumed subhorizontal bedding planes. Probably the completeness of the section increased northwards.
2. The lithofacies of carbonate rocks are typical of warm shallow-water basins of a low- (mid-) latitude located near the eastern margin of Pangea. The similarity in faunal composition with assemblages from contemporaneous deposits of Wrangel Island and Chukotka allows us to consider these rocks as fragments of the Palaeozoic carbonate platform of the superterrane of Arctida.
3. A similarity in faunal composition of the Mendeleev-Wrangel-Chukotka block with assemblages from contemporaneous deposits of the Northwind Range and some terranes in Alaska, and probably the Ellesmere shelf deposits (Arctic Canada), bears paleontological and biostratigraphic witness to the unification of basins of the superterrane of Arctida during the Palaeozoic. A great number of genera and species in common in western and eastern Arctic basins supports the existence of gateways to other Eurasian epicontinental basins, including the northern Urals, Timan and Barents Sea shelf.
4. The principal differences of the fauna composition and sedimentology of the New Siberian Islands and the Mendeleev Rise point towards separation in the Middle Pennsylvanian − Lower Permian. The following similarity can be explained by the climatic conditions after Kungurian time.

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