# Paleozoogeographic regionalization of Northern Hemisphere Late Cretaceous basins based on foraminifera

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## ABSTRACT

Late Cretaceous foraminifera were studied from separate provinces of three paleobiogeographic belts: Arctic, Boreal, and Tethys. Characteristic planktonic and benthic foraminifera are established for each belt and region. Regions of the various belts, as well as the belts themselves, differ by endemism, or in the absence of higher taxa (orders, families). Higher order endemics are characteristic for benthic foraminifera, while among planktonic foraminifera endemism is on a generic level. Provinces are established on the basis of endemic species, and to a lesser degree, endemic genera. The districts of western Siberia are distinguished on the basis of species endemism and the composition of the foraminiferal assemblages.

The study of Cretaceous foraminifera from western Siberia and contiguous basins permits the establishment of paleobiogeographic subdivisions for the Cenomanian to early Senonian and for the late Senonian. For three timeslices: early Turonian, early Santonian, and early Maastrichtian, paleobiogeographic districts are defined based on characteristic foraminifera. The distribution of western Siberian foraminiferal assemblages are presented for the three time-slices.

## INTRODUCTION

Analysis of Late Cretaceous foraminifera from western Siberia and to a lesser extent from other regions and a comparison with paleogeographic reconstructions and published works enable an understanding of their distribution in basins of past geological stages. These data form the basis of the paleozoological subdivision of western Siberia and the other basins of the northern Hemisphere.

Late Cretaceous foraminifera in the northern hemisphere basins comprise three sublatitudinal faunas: Polar, Temperate, and Tropical. These Late Cretaceous faunas have been studied respectively in three paleobiogeographic belts: Arctic, Boreal, and Tethyan.

## PALEOBIOGEOGRAPHIC BELTS

**Arctic.** Arctic belt foraminifera consist of benthics and to a lesser extent planktonics. The latter occur as single specimens and are represented by two main genera - *Rugoglobigerina* and *Guembelina* (= *Heterohelix* auct.). In comparison with the other provinces, the benthic foraminifera of this belt are relatively monotonous (about 40 genera), and dominated by agglutinated forms. The most characteristic are representatives of *Rhabdammina, Bathysiphon, Psammosphaera, Saccammina, Hyperammina, Reophax, Labrospira, Haplophragmoides, Adercotryma, Recurvoides, Recurvoidella, Cribrostomoides, Cyclammina, Ammobaculites, Haplophragmium, Ammoscalaria, Spiroplectammina, Trochammina, Verneuilinoides, Pseudoclavulina, Gaudryinopsis, Arenogaudryina,* and other genera. The representatives of the Lituolidae, Placopsilinidae, Globotruncanidae, Orbitoididae, Bolivinitidae are not found in this belt.

**Boreal.** Both planktonic and benthic foraminifera are widespread in the Boreal belt. They differ from Arctic belt foraminifera in the diversity and composition of the assemblages. Planktonic foraminifera are represented here by nine genera: *Biglobigerinella, Globigerinelloides, Schackoina, Hedbergella, Globotruncana, Rugoglobigerina, Guembelina, Heterohelix.* Benthic foraminifera are much more diverse (over 110 genera), among which calcareous forms such as Lagenida, Rotaliida, and Buliminida are most numerous. The most widespread genera are: *Nodosaria, Dentalina, Marginulina, Lagena, Lenticulina, Planularia, Robulus, Guttulina, Globulina, Discorbis, Valvulineria, Globorotalites, Gyroidinoides, Stensioeina, Eponides, Alabamina, Epistomina, Epistominoides, Reinholdella, Pseudolamarkina, Ceratobulimina, Cibicides, Gavelinella, Anomalina, Brotzenella, Pullenia, Nonionella, Cymbalopora, Praebulimina, Bulimina, Reussella, Neobulimina, Angulogerina, Pleurostomella, Bolivinoides, Bolivina.*

The group of agglutinated foraminifera with calcareous cement is also widely developed: *Lituola, Verneuilina, Gaudryina, Siphogaudryina, Dorothia, Clavulina, Orbignyna, Ataxophragmium, Marssonella.* These belong to families that are usually absent from the Arctic belt. The boreal agglutinated foraminifera are subordinate in the epicontinental seas, but dominate the assemblages of the deep basins. On the

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whole, almost all known Cretaceous foraminifera are encountered in the Boreal belt, with the exception of Orbitoididae and some Globotruncanidae.

**Tethys.** The Late Cretaceous foraminifera are most abundant and diverse in the Tethyan belt. Here we encounter genera such as *Helvetoglobotruncana, Praeglobotruncana, Globotruncanella, Rotalipora,* and *Abathomphalus,* which are usually lacking in the Boreal belt. Planktonic foraminifera of the Tethyan belt are distinguished by the unusual development of species of each genus. Benthic foraminifera are similar to the Boreal belt in systematic composition, but may contain well-developed Orbitoididae. Of the species known from the Boreal belt, the Rotaliida, Buliminida, and Heterohelicida are best developed. Their systematic composition is monotonous and they are rare in comparison to the planktonic forms (Colom, 1969; Papp, 1956; Doreen, 1974; Koch, 1968; Said & Kenawy, 1957).

## WESTERN SIBERIA & CONTIGUOUS BASINS

The study of Cretaceous foraminifera from West Siberia and contiguous basins allows the establishment of separate paleozoogeographic subdivisions for the Cenomanian to early Senonian and the late Senonian timeslices (Figs. 1, 2). These schemes show conditional boundaries between the biogeographical belts. Boundaries of regions and provinces are not shown because of a shortage of information.

### Cenomanian to early Senonian

**1. The Arctic belt.** In this belt, I studied different associations of benthic foraminifera from basins in western Siberia (Figs. 3-5), northern Alaska, the North Pacific, and from a large part of Canada. I can distinguish two regions: an Arctic region and a North Pacific one (Fig. 1). Planktonic foraminifera in all the regions are similar and characterised by a *Guembelina* association (Northern belt according to Morosova, 1973). Due to the predominance of species of *Labrospira, Haplophragmoides, Trochammina, Pseudoclavulina, Gaudryinopsis,* and *Verneuilinoides,* the benthic foraminifera of the western Siberian, Canadian, and northern Alaskan basins are referred to the Haplophragmiidae- Trochamminidae- Ataxophragmiidae-type assemblage. The location of the Arctic Region is delineated by the extent of this assemblage in the above basins. In the territory of Kamchatka, agglutinated foraminiferal assemblages distinguished by the predominance of Haplophragmiidae and Rzehakininae are observed (N.M. Petrina, personal communication). This assemblage appears restricted to Kamchatka. The conditional establishment of a North Pacific region is based on this occurrence (Table 1).

In the Arctic basins, the benthic foraminifera are divided into two groups: West Siberian and Canadian. The foraminiferal assemblages from northern Alaska are considered in the latter group. The similarity of the assemblages at the generic and species levels in these basins and the predominance of agglutinated forms suggest that this fauna was also present in the central regions of the Arctic basin, and its further extent into lower latitudes. Agglutinated foraminifera are widespread in shallow, remote basins of western Siberia, which is explained by their unrestricted migration from the Arctic Basin. Agglutinated forms are represented by species of *Psammosphaera, Saccammina, Reophax, Ammodiscus, Glomospira, Labrospira, Haplophragmoides, Adercotryma, Cribrostomoides, Cyclammina, Recurvoides, Recurvoidella, Ammobaculites, Haplophragmium, Ammomarginulina, Ammoscalaria, Spiroplectammina, Trochammina, Verneuilinoides, Gaudryinopsis, Pseudoclavulina,* and *Arenogaudryina*. Many of these forms are also encountered in the Canadian and northern Alaskan assemblages. A greater similarity is observed in the generic composition of these assemblages, especially where the genera *Eponides, Valvulineria, Cibicides, Cibicidoides, Anomalinoides, Praebulimina, Bulimina, Neobulimina* occur in the outlying districts of western Siberia where the waters of the basins were warmer.

The western Siberian foraminiferal assemblages include a great number of endemic species. In the Cenomanian-Turonian assemblages the number of endemics does not exceed a quarter of the total. In sediments of this age, western Siberian subspecies of the above-mentioned Canadian forms have been recognised (Podobina, 1978). In the lower Senonian

| Belt | Regions | Benthic Foram Associations | Planktonic Foram Assoc. |
|---|---|---|---|
| Arctic | Arctic | Haplophragmiidae- Trochamminidae - Ataxophragmiidae | *Guembelina* |
| I | North Pacific | Haplophragmiidae- Rzehakininae | |
| Boreal | Boreal Atlantic | Discorbidae- Anomalinidae- Buliminidae | *Hedbergella - Rugoglobigerina - Guembelina* |
| II | Boreal Pacific | Nodosariidae- Discorbidae- Rzehakininae | |
| Tethyan | Mediterranean | Nodosariidae- Bolivinitidae- Orbitoididae | *Globotruncana- Rugoglobigerina* |
| III | Central Pacific | not established | |

**Table 1.** Paleozoographic subdivisions and types of foraminiferal associations in the Late Cretaceous of the Northern Hemisphere.

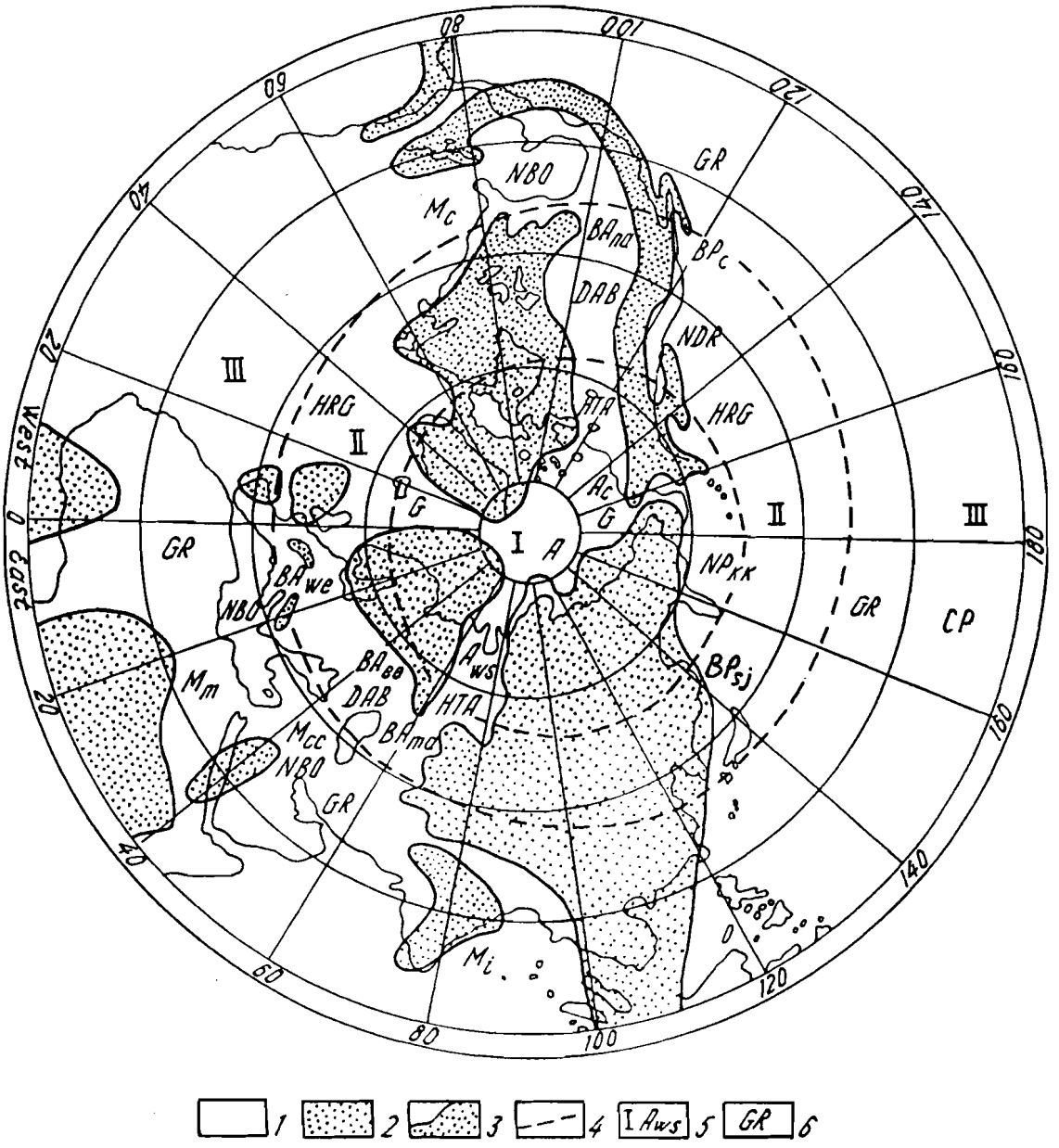


**Figure 1.** Proposed paleozoogeographic subdivisions of the Northern Hemisphere in the Cenomanian to early Senonian. Legend to Figs 1 & 2: **1.** sea, **2.** land, **3.** shore lines, **4.** boundaries of the zoogeographic belts, **5.** zoogeographic subdivisions, **6.** foraminiferal associations. **I.** Arctic Circumpolar belt, HTA- Haplophragmiidae-Trochamminidae- Ataxophragmiidae assemblage, HR- Haplophragmiidae-Rzehakininae assemblage. A- Arctic region, $A_{WS}$- West Siberian Province, $A_C$- Canadian province, NP- North Pacific region, $NP_{kk}$- Korjak-Kamchatka province. **II.** Boreal belt. HRG- *Hedbergella-Rugoglobigerina- Guembelina* assemblage. DAB- Discorbidae-Anomalinidae-Buliminidae assemblage, NDR- Nodosariidae-Discorbidae-Rzehakininae assemblage. BA- Boreal Atlantic region, $BA_{ma}$- Middle Asia province, $BA_{ee}$- eastern european province, $BA_{we}$- western Europe province, $BA_{na}$ North American province, BP- Boreal Pacific, region $BP_{sj}$ Sakhalin-Japanese province, $BP_C$ Californian province. **III.** Tethyan belt. GR- *Globotruncana-Rugoglobigerina* assemblage, NBO- Nodosariidae- Bolivinitidae- Orbitoididae assemblage, M- Mediterranean region, $M_m$- Mediterranean province, $M_{cc}$- Crimea- Caucasian province, $M_C$- Caribbean province, $M_i$- Indian province, CP- Central Pacific region.

the taxonomic differences are more pronounced, particularly in the Santonian when the connections between the basins were less stable due to the elevation of the Arctic basin and isolation of some of the outlying basins. The presence of 16 endemic species (about half of the total) is characteristic for the Santonian assemblage (the *Ammobaculites dignus, Psaudoclavulina hastata* Zone), when compared with Canadian assemblages of the same age. Eight additional forms which are geographic subspecies of the typical Canadian forms can be added to this total. The differences in the generic composition and the high degree of endemism on a species level permit the western Siberian and Canadian basins to be separate provinces of the Arctic belt. The exact boundary between them may be drawn after the deep Arctic basins have been drilled.

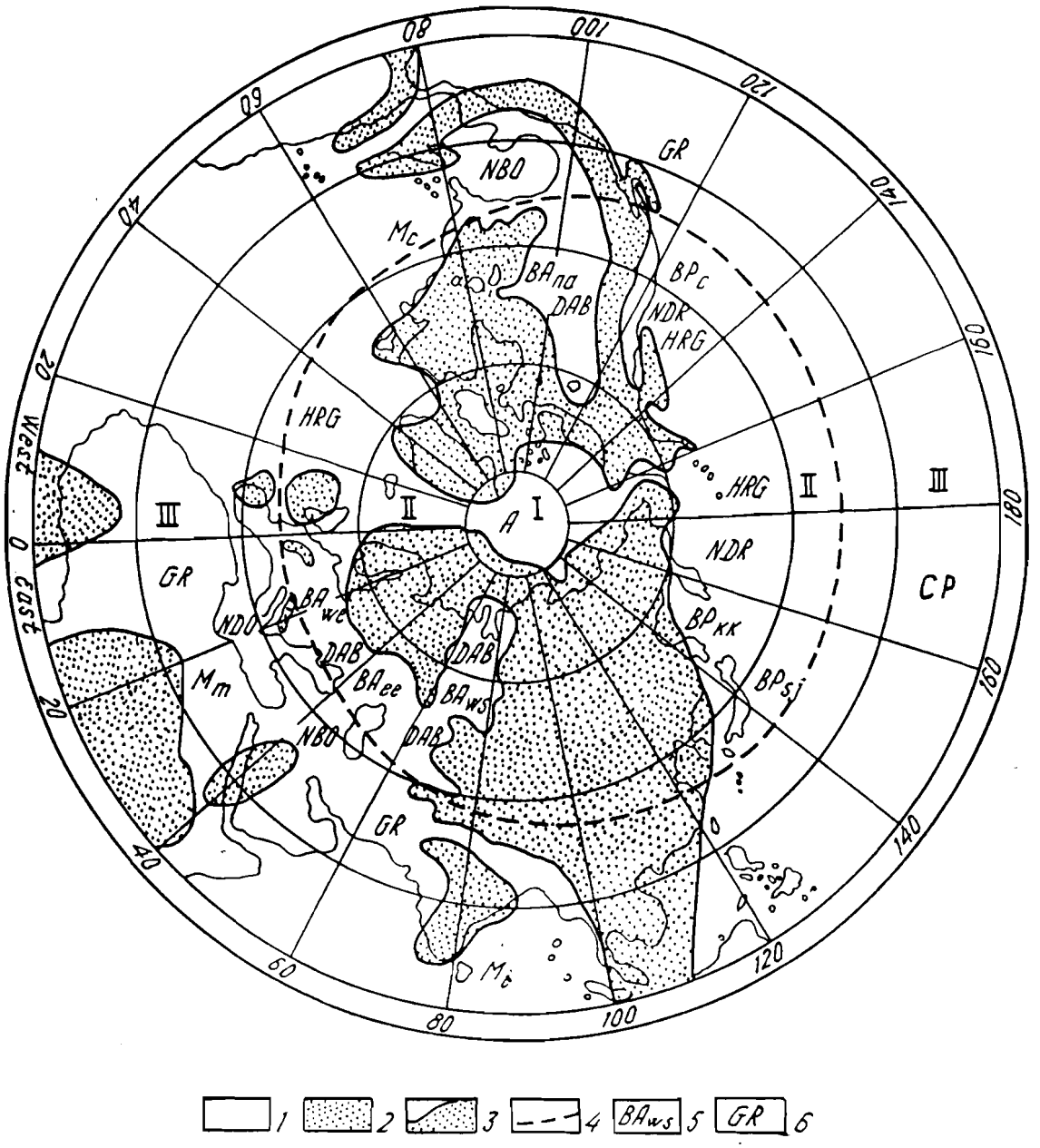


**Figure 2.** Proposed paleozoogeographic subdivisions of the Northern Hemisphere in the late Senonian. **I.** Arctic Circumpolar belt, foraminiferal assemblages not established. A- Arctic region. II. Boreal belt. HRG- *Hedbergella-Rugoglobigerina- Guembelina* assemblage. DAB- Discorbidae-Anomalinidae-Buliminidae assemblage, NDR- Nodosariidae-Discorbidae- Rzehakininae assemblage. BA- Boreal Atlantic region, $BA_{ma}$- Middle Asia province, $BA_{ee}$- eastern european province, $BA_{we}$- western Europe province, $BA_{na}$ North American province, BP- Boreal Pacific region, $BP_{sj}$ Sakhalin-Japanese province, $BP_c$- Californian province. **III.** Tethyan belt. GR- *Globotruncana-Rugoglobigerina* assemblage, NBO- Nodosariidae- Bolivinitidae- Orbitoididae assemblage, M- Mediterranean region, $M_m$- Mediterranean province, $M_{cc}$- Crimea- Caucasian province, $M_c$- Caribbean province, $M_i$- Indian province, CP- Central Pacific region.

The North Pacific region is singled out because of the dominance of Haplophragmiidae and Rzehakininae in a number of places (Fig. 1). In Kamchatka, Cenomanian to early Senonian foraminiferal assemblages are comprised of the genera *Haplophragmoides, Cyclammina, Alveolophragmium, Rzehakina, Silicosigmoilina*, and some endemic species (e.g. *Silicosigmoilina compacta* Serova).

**2. The Boreal Belt.** In the Cenomanian to early Senonian assemblages, the greatest differences are observed between the benthic foraminifera of the Boreal Atlantic and the Boreal Pacific regions. In the Boreal Atlantic region, the most widespread foraminifers belong to the genera *Discorbis, Valvulineria, Gyroidinoides, Eponides, Epistomina, Cibicidoides, Anomalinoides, Gavelinella, Anomalina, Brotzenella, Praebulimina, Bolivina*, and comprise the Discorbidae-

Anomalinidae-Buliminidae type of benthic foraminiferal association. In this association the most characteristic agglutinated foraminifera belong to the Ammodiscida and Ataxophragmiida, with the latter being the most numerous and diverse. This group is comprised of *Gaudryina, Siphogaudryina, Dorothia, Arenobulimina, Marssonella, Orbignyna, and Ataxophragmium*. Within the shelf seas of the Boreal Pacific region, the most widespread genera are *Nodosaria, Dentalina, Lenticulina, Marginulina, Lagena, Oolina, Discorbis, Eponides, Valvulineria, Gyroidinoides, Epistomina, Nuttalides*, and *Pleurostomella*. The Rzehakininae are rather numerous and consist of numerous characteristic *Rzehakina* and *Silicosigmoilina*. This benthic foraminiferal association is here designated the Nodosariidae-Discorbidae-Rzehakininae association. The occurrence of these forms distinguish the Boreal Pacific region from the Boreal Atlantic (Fig. 1, Table 1).

The Boreal Pacific region includes the basins of Sakhalin, California, and Japan, which themselves differ in the composition of foraminiferal genera and species. The information about the Central Pacific is not yet available. In Sakhalin and Japan, the representatives of various nodosariids, which inhabited the deeper shelves and upper bathyal zone, are well developed. The proportion of agglutinated foraminifera is not as great as on Kamchatka. The Cenomanian to early Senonian foraminiferal assemblages are comprised of *Bathysiphon, Saccammina, Ammodiscus, Glomospira, Haplophragmoides, Rzehakina, Spirosigmoilinella, Silicosigmoilina, Dentalina, Astacolus, Planularia, Nuttalides*, and *Globorotalites*. Agglutinated foraminifera are still rather diverse at the generic level. The most characteristic are *Rzehakina, Spiroplectammina*, and *Silicosigmoilina*, most of them being endemic species (Turenko, 1972). Japanese assemblages are differentiated by their greater number and diversity of Lagenida, Rotaliida, Buliminida. However, all the above-mentioned genera are found here too (Takayanagi, 1960). On the whole, the presence of some genera characteristic for the basins of Sakhalin and Japan as well as a considerable number of endemic species (up to a third) justify placing the areas in the same faunal province.

The Boreal Atlantic region includes the northern part of the basins of central Asia, the Russian Platform, central and northern Europe, the North Atlantic, and North America (USA). The composition of these assemblages, with the exception of the North Atlantic, was discussed by Podobina (1978).

### Late Senonian

In the northern hemisphere basins two Late Senonian foraminiferal faunas are recognised: Boreal and Tethyan. These correspond to the Boreal and Tethyan biogeographic belts (Podobina, 1975).

**Boreal.** Planktonic and benthic foraminifera of nearly the same systematic composition as in the Cenomanian - early Senonian are widespread in this belt. Two associations are distinguished based on differences in families and subfamilies: a Discorbidae-Anomalinidae-Buliminidae association in the Boreal Atlantic region, and a Nodosariidae-Discorbidae-Rzehakininae association in the Boreal Pacific region (Table 1). Within the Boreal Atlantic region, differences in the foraminiferal assemblages on the generic and species levels enable me to define a number of provinces (Fig. 2). Details of these assemblages were given by Podobina (1978).

In the Late Senonian, the basins of the western Siberian plain were part of the Boreal Atlantic region, which is proved by their strong similarity to the assemblages from Central Asia, Europe, and North America. In the basins of this region, Cretaceous foraminifera are comprised mainly of Miliolida, Lagenida, Rotaliida, Buliminida, and Heterohelicida, with subordinate agglutinated and planktonic forms. However, the western Siberian basins can be considered as belonging to a separate province, based on the characteristic occurrence of calcareous benthic forms belonging to the genera *Dentalina, Nodosaria, Marginulina, Lenticulina, Astacolus, Eponides, Valvulineria, Gyroidinoides, Cibicides, Cibicidoides, Gavelinella, Anomalinoides, Praebulimina, Bulimina, Angulogerina*, and *Bolivina*. Agglutinated forms are of lesser importance, and belong to the genera *Gaudryina, Siphogaudryina, Dorothia, Heterostomella, Martinotiella, Orbignyna*, and others. The latter forms are more common in the southernmost part of the Siberian basin where the sea was warmer. In the northern part of the Siberian plain the foraminiferal assemblages are poorer in the numbers of taxa. The Ob River marks the approximate boundary between the northern and southern districts of this province.

The systematic composition of the western and eastern European, North American, and Central Asian provinces is similar to that of the Cenomanian - early Senonian. The boundaries of the Boreal Atlantic region in the Late Senonian have been expanded to include more of the territory of western Siberia.

The second biogeographic region of the Boreal belt - the Boreal Pacific region - was more constant within its boundaries during the Late Senonian. This area was still characterised by the Nodosariidae-Discorbidae-Rzehakininae type of benthic association. These associations were recognised in the Maastrichtian of the Korjak Upland (Vassilenko, 1971), and in the upper Senonian of Kamchatka (N.M. Petrina, personal communication). The characteristic of these assemblages enable me to define a Korjak- Kamchatka province. In addition, the Sakhalin-Japanese and Californian foraminiferal provinces are distinguished (Turenko, 1971; Takayanagi, 1960; Trujillo, 1960; Bandy, 1951). The former is marked by a variety of nodosariids belonging to the genera *Nodosaria, Dentalina, Lagena, Oolina, Marginulina, Astacolus, Robulus, Saracenaria, Frondiculina*, and *Citharina*. The genera *Eponides, Gyroidinoides, Epistomina, Pleurostomella*, and *Nuttalides* are less common and diverse. The Maastrichtian assemblages of Sakhalin

are represented by agglutinated forms belonging to the genera *Bathysiphon, Saccammina, Glomospira, Ammodiscus, Haplophragmoides (Asanospira), Trochammina, Haplostiche, Cyclammina,* and *Alveolophragmium.*

Different regions of the various belts as well as the belts themselves differ in the endemism or absence of certain higher taxa. Higher-level endemism applies only to benthic forms, while planktonic forms display endemism on a generic level. Provinces are recognised on the basis of endemism on a species level, and in the case of the districts of the western Siberian province, these are based on both endemic species and the structure of the foraminiferal assemblages.

**Summary**

Analysis of Late Cretaceous foraminiferal assemblages from western Siberia reveals that they are generally composed of agglutinated foraminifera. The foraminiferal assemblages can be used to solve problems of paleozoogeography of the Late Cretaceous basins. Regionalization of the assemblages was most pronounced during times when foraminifera were widespread (early Turonian, early Santonian, and early Maastrichtian). Among the species, both cosmopolitan and narrowly-distributed forms can be singled out. By correlating these forms, it is possible to recognise the paleozoogeographic districts of the western Siberian province shown on three schemes (Figs. 3-5). In the centre of the province, corresponding to the deeper parts of the basin, agglutinated foraminifera dominated. In shallower parts of the basin, calcareous benthic forms were also present.

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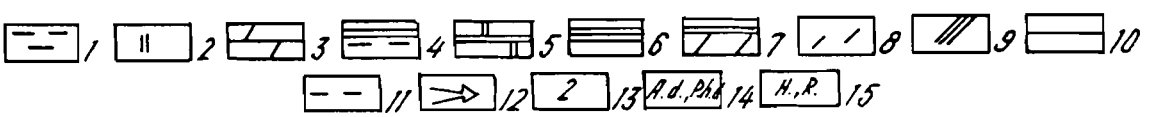


**Key to symbols in Figs. 3-5: 1.** clays, **2.** biosiliceous clays, **3.** calcareous clays (1-3 are relatively deep-water facies), **4.** aleuritic clays, **5.** aleuritic siliceous clays (4-5 are shallow facies), **6.** aleurolites, **7.** calcareous aleurolites and sands (6-7 are near-shore facies), **8.** shoreline - lacustrine, **9.** lacustrine, **10.** established boundary between paleozoogeographic regions, **11.** proposed boundary between paleozoogeographic regions, **12.** Proposed pathways of foraminiferal migration, **13.** districts (1 - west, 2 - central, 3 - east, 4 - south, 5 - north), **14.** foraminiferal assemblages, **15.** predominant foraminiferal taxa of the assemblages.

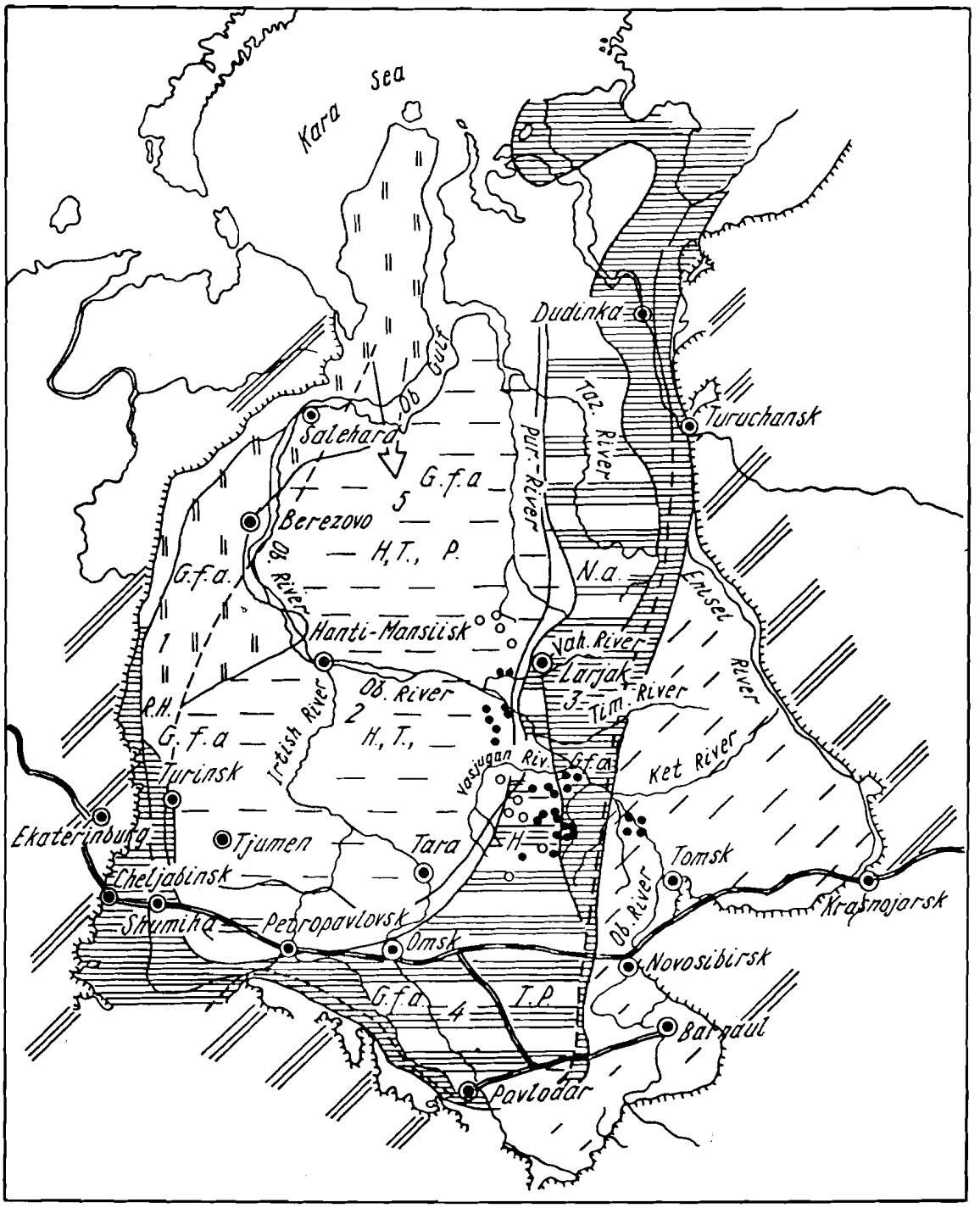


**Figure 3.** Early Turonian Paleozoogeography of western Siberia.
Foraminiferal assemblages of the *Gaudryinopsis filiformis angusta* Zone: **1.** western district: R - *Reophax* dominant, H - *Haplophragmoides* dominant, G.f.a. - Single specimens of the index form *G. filiformis angusta*, without representatives of the genera *Ammomarginulina, Uvigerinammina*, and *Neobulimina*. Assemblages contain roughly equal numbers of species, and agglutinated tests are medium- to coarse- grained. **2.** central region: The index species *G. filiformis angusta*, (G.f.a.), Haplophragmiidea (H), and *Trochammina* (T) are found in large numbers. Agglutinated tests are medium to finely grained, tests are small (Subbotina *et al.*, 1964; Podobina, 1966; 1975). **3.** eastern region: Foraminiferal assemblages with *Neobulimina albertensis*.(N.a.). In association with low numbers of agglutinated taxa, small numbers of calcareous benthic species appear (*Quinqueloculina, Nodosaria, Dentalina, Epistomina, Gyroidinoides, Gavelinella, Cibicides, Praebulimina, and Neobulimina*). In the easterly direction, along the Tim River, the index taxon *Neobulimina albertensis* dominates the assemblages (Subbotina *et al.*, 1964; Podobina, 1966; 1975). **4.** southern region: Often assemblages contain low numbers of tests. Representatives of the genera *Pseudoclavulina* (P) and Haplophragmiidea (H) are often encountered. Agglutinated tests are medium- to coarse-grained. **5. northern district:** Some sections (e.g. on the Ob River) contain representatives of the genera *Haplophragmoides* (H), *Trochammina* (T), *Pseudoclavulina* (P), and *G. filiformis angusta* (G.f.a.), *Gavelinella* (*G. moniliformis* (Reuss) (G.m,)), *Neobulimina*, and others (Podobina & Tanacheva, 1967).

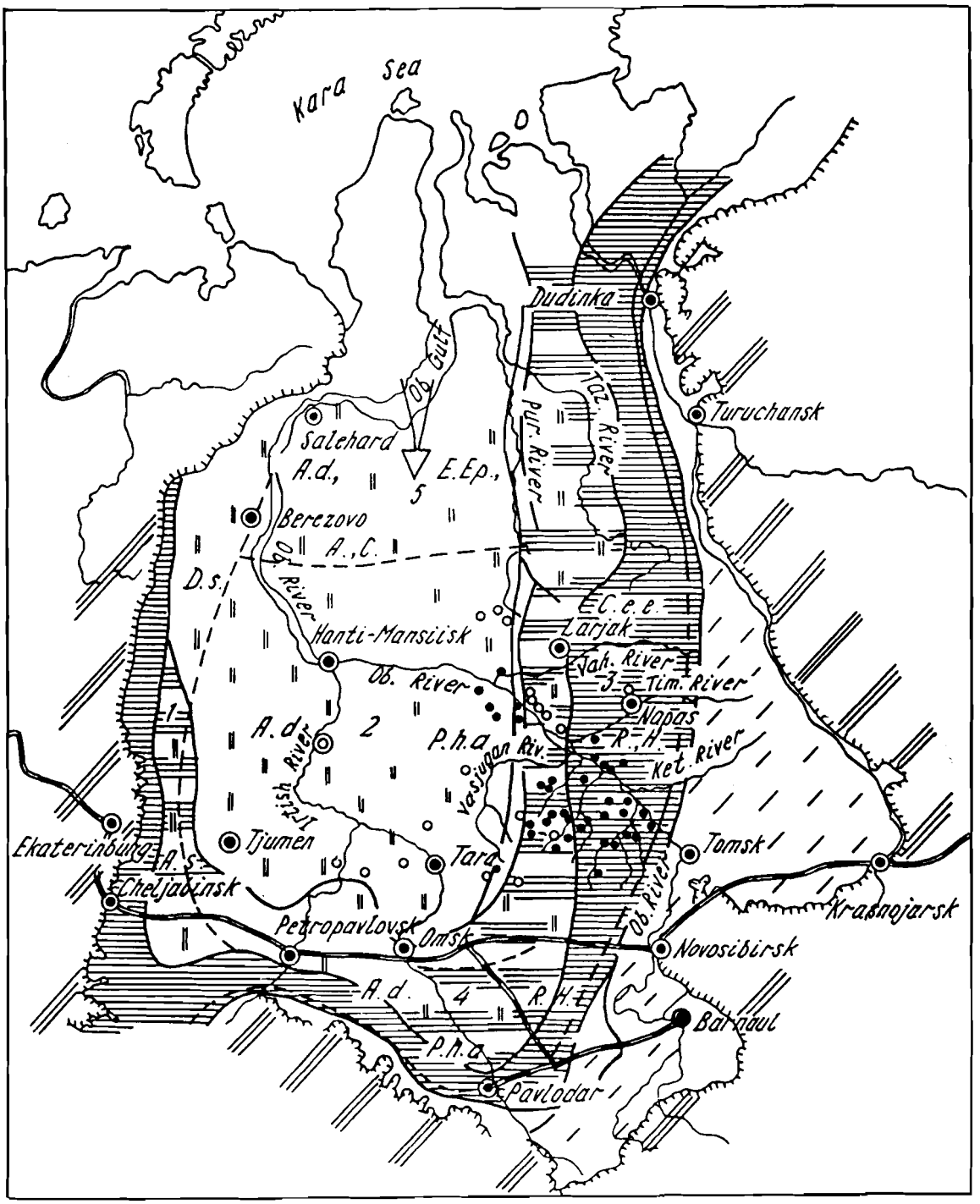


**Figure 4.** Early Santonian Paleozoogeography of western Siberia.
Foraminiferal assemblages of the *Ammobaculites dignus - Pseudoclavulina hastata admota* Zone. **1.** The genera *Discorbis* (*D. sibiricus* Dain), *Valvulineria, Anomalina* (*A. sibirica* Dain), *Bulimina*, and others are found. Beds with *D. sibericus* are characterised by calcareous benthics belonging to the Miliolida, Rotaliida, Buliminida, and Heterohelicida. Agglutinated foraminifera of the *Ammobaculites dignus - Pseudoclavulina hastata admota* assemblage are not established in this region (Kiprianova, 1961; Eremeeva & Belousova, 1961). **2.** The *A. dignus, P. hastata admota* assemblage (A.d., P.b.a.) is very abundant and diverse, and often contains increased numbers of primitive forms such as *Bathysiphon, Hyperammina, Ammodiscus*, and Haplophragmiidea (H.), and single specimens of Rotaliida. Fine to medium-grained agglutinated forms predominate (;Subbotina *et al.*, 1964; Podobina, 1966; 1975). **3.** Assemblages contain many specimens of *Reophax* (R.) and Haplophragmiidea (H.). In the easterly direction, along the Tim and Vah Rivers, calcareous taxa of the genera *Eponides, Gyroidinoides, Epistomina, Cibicidoides, Cibicides, Praebulimina* (the *Cibicidoides eriksdalensis eriksdalensis* assemblage - C.e.e.) are encountered (Podobina, 1966, 1975). **4.** An assemblage with small-sized tests and increased numbers of *Reophax* & *Haplophragmoides, Ammobaculites, Ammoscalaria* (Subbotina *et al.* 1964; Podobina, 1966, 1975). **5.** An assemblage containing all the main forms, but sometimes *A. dignus* is more abundant and *P. hastata admota* is absent. Together with the agglutinated forms, single specimens of the calcareous genera *Epistomina* (E), *Eponides* (Ep), *Anomalinoides* (A), *Cibicides* (C), and others are encountered (Podobina & Tanacheva, 1967). In a northerly direction (Gulf of Ob, New Port), single representatives of the Miliolida (*Quinqueloculina*), Lageniida (*Nodosaria, Dentalina, Lenticulina, Guttulina*), Rotaliida (*Eponides, Gyroidinoides, Epistomina, Anomalinoides, Cibicides, Cibicidoides*), and Buliminiida (*Buliminida* and others) were found.

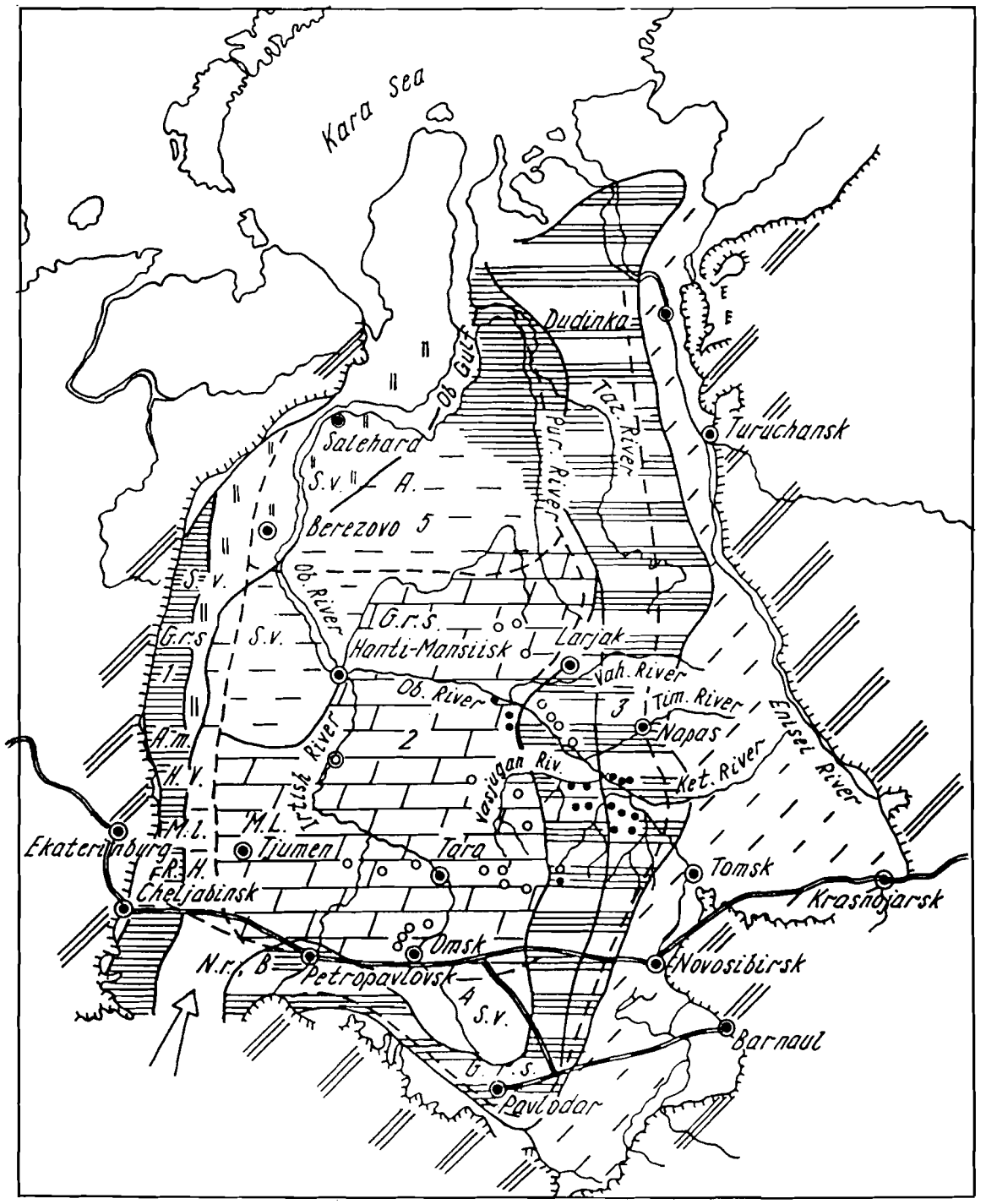


**Figure 5.** Early Maastrichtian Paleozoogeography of western Siberia.
Foraminiferal assemblages of the *Spiroplectammina variabilis - Gaudryina rugosa spinulosa* Zone. **1.** The diversity and abundance of foraminiferal assemblages is poor to the north, and more variable and richer to the south. The presence of the index taxa (S.v.; G.r.s.) is typical for this zone. In the calcareous-terrigenous facies of the southern part of the district, increased numbers of calcareous taxa are observed, while in the north carbonate-poor deposits contain some calcareous-cemented agglutinated forms such as *Dorothia, Gaudryina*, and *Ataxophragmium*, as well as *Haplophragmoides* (H), *Ammoscalaria* (A), *Trochammina* (T), and *Verneuilinoides* (V). The latter group consists mainly of medium- to coarsely-agglutinated taxa. (Kiprianova, 1961; Eremeeva & Belousova, 1961). **2.** Diverse assemblages rich in Rotaliida and Buliminiida (especially *Eponides, Gyroidinoides, Anomalinoides, Cibicides, Bulimina, Reussella*, and others). Bolivinids are rare (Podobina, 1975). **3.** The second index species (G.r.s.) and ataxophragmiids are rare, but *S. variabilis* is abundant. To the east (on the Tim River) the assemblage is poorer. Some rotaliids are present, represented by *Quinqueloculina, Lenticulina, Ceratobulimina, Nonionella, Eponides, Gyroidinoides*, and *Epistomina* (Podobina, 1975; 1989). **4.** Assemblages are much poorer. The second index species (G.r.s.) is sometimes abundant, and the Ataxophragmiidae are varied. Single specimens of *Neoflabellina reticulata* (Reuss) are present; and the Bolivinitidae are variable in terms of species and abundance. **5.** A monotonous sparse assemblage, with single specimens of *Spiroplectammina* and various calcareous forms (*Eponides, Gyroidinoides, Epistomina, Cibicides, Cibicidoides*, and others). The second index species (G.r.s.) is absent. In the direction of the Gulf of Ob, New Port, the assemblages contain single specimens of *Spiroplectammina, Eponides, Gyroidinoides, Cibicides, Praebulimina, Bulimina*, and others (Podobina & Tanacheva, 1967).