# Changes in foraminiferal associations of Western Siberia, Russia, at the Cretaceous/Paleogene boundary

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**Abstract:** West-Siberian microfaunal associations of the Cretaceous/Paleogene boundary deposits (Maastrichtian to Selandian) have been studied. This stratigraphical interval is represented by clastic clays and siltstones containing carbonate in the upper part of the Gankinskian horizon and by the lower beds of the Talitskian horizon (without carbonate). In the West-Siberian province, foraminiferal associations of this stratigraphic interval were controlled mainly by the comparatively low temperatures of epicontinental basins connected with the Arctic ocean. The Maastrichtian to Danian foraminiferal assemblages were dominated by impoverished benthic calcareous secreted and agglutinated forms.

The Late Maastrichtian microfaunal associations of the southern part of the West-Siberian province differ considerably in their composition and structure from those of the northern part of the province. In the upper part of the Gankinskian horizon calcareous secreted and agglutinated forms predominate among the benthic foraminifera. Here planktic forms are rare; these are predominantly species of the genera *Rugoglobigerina* BRÖNNIMANN, 1952 and *Heterohelix* EHRENBERG, 1843. In the upper part of this horizon several new species have been recorded that are characteristic of the Early Danian, among which are species belonging to the planktic genera *Subbotina* BROTZEN & POZARYSKA, 1961 and *Globorotalia* CUSHMAN, 1927.

In the upper deposits of the Talitskian horizon the foraminiferal associations differ from those of the Gankinskian by the quartz-siliceous composition of their tests. Both these quartz-siliceous forms as well as calcareous species of the Talitskian associations known from Transuralia are assigned to the Selandian Stage. This horizon represents a unique ecosystem formed during the Selandian Boreal transgression.

**Keywords:** Foraminifera, Western Siberia, Upper Cretaceous, Lower Paleogene, Sedimentation

## 1. INTRODUCTION

One of the most important crises in the development of the Phanerozoic ecosystem coincided the global extinction event at the end of the Late Cretaceous. The long term evolution of the biota was affected by a considerable global fall in temperature as well as by tectonic events that resulted in uplift and exposure of numerous land areas in the Northern Hemisphere. At the Cretaceous/Paleogene boundary, the substantial biotic rearrangements affected the simplest forms, among which were the foraminifera studied

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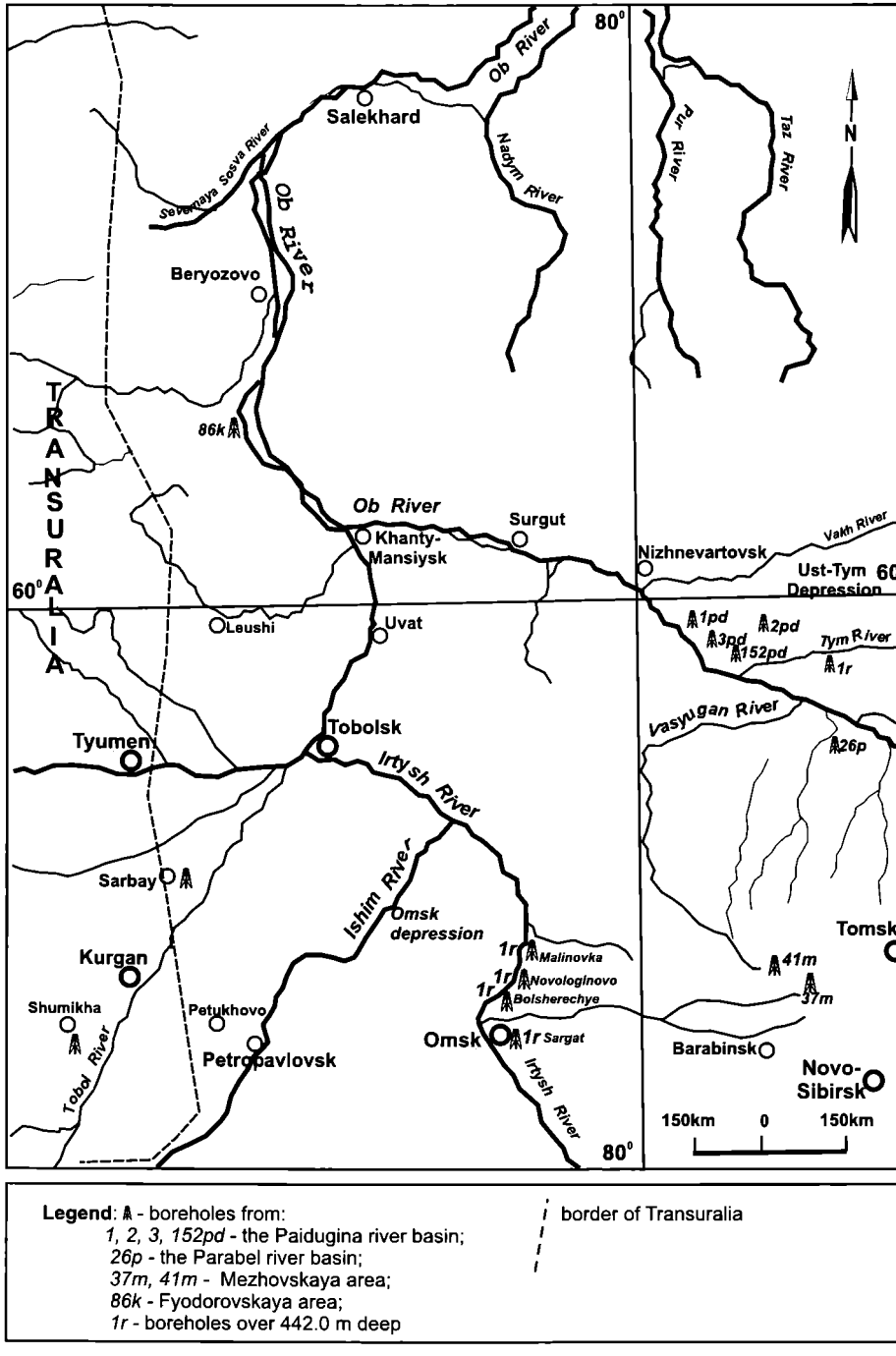


**Legend**: A - boreholes from:
*1, 2, 3, 152pd* - the Paidugina river basin;
*26p* - the Parabel river basin;
*37m, 41m* - Mezhovskaya area;
*86k* - Fyodorovskaya area;
*1r* - boreholes over 442.0 m deep

border of Transuralia

Fig. 1: Schematic map of sections investigated from the south-east of Western Siberia.

in the present paper. In this faunal group the most specialized forms (some Lituolidae DE BLAINVILLE, 1827; Ataxophragmiidae SCHWAGER, 1877; Globotruncaninae BROTZEN, 1942; Bolivinitidae CUSHMAN, 1927 and others) became extinct. At the beginning of the Danian new species of more primitive planktic forms (Globigerinidae CARPENTER, PARKER & JONES, 1862) appeared. Less highly specialized benthic forms of the Maastrichtian persisted into the Paleogene. Together with them new genera and species common only to the Paleocene came into existence. Hence the Danian may be considered in some respects as a transition stage between the Cretaceous and the Paleogene in terms of foraminiferal evolution (PODOBINA & KSENEVA, 1989; GRADSTEIN et al, 1992; BUBIK et al., 1997).

## 2. FORAMINIFERAL ASSOCIATIONS OF THE WEST-SIBERIAN PROVINCE

In the West-Siberian province foraminiferal assemblages were forming during the Maastrichtian – Paleocene interval in the comparatively low temperatures of an epicontinental sea connected with the Arctic basin. The influence of southern, warmer water currents

<table>
<tr><th rowspan="2">System</th><th rowspan="2">Subsystem</th><th rowspan="2">Stage</th><th rowspan="2">Planktic foraminiferal zones (Resolutions of ISC, 1989)</th><th colspan="2">Benthic foraminiferal zones and beds (Podobina, 1998)</th><th rowspan="2">Horizon</th></tr>
<tr><th>Western and Central areas</th><th>Eastern area</th></tr>
<tr><td rowspan="4">Paleogene</td><td rowspan="3">Paleocene</td><td>Selandian</td><td>Morozovella conicotruncata<br><br>Morozovella angulata</td><td>Ammoscalaria friabilis</td><td>Beds with Cyclammina coksuvorovae</td><td rowspan="2">Talitskian</td></tr>
<tr><td rowspan="2">Danian</td><td>Acarinina inconstans</td><td>Beds with Cibicidoides incognitus</td><td rowspan="2">Beds with Bathysiphon nodosarieformis, Glomospira charoides</td></tr>
<tr><td>Globoconusa daubjergensis Globigerina taurica</td><td>Brotzenella praeacuta</td><td rowspan="2">Gankinskian</td></tr>
<tr><td>Cretaceous</td><td>Upper</td><td>Maastrichtian</td><td>Abathomphalus mayaroensis</td><td colspan="2">Spiroplectammina kasanzeri<br>Bulimina rosenkrantzi</td></tr>
</table>

Fig. 2: Biostratigraphical scheme of the Cretaceous – Paleogene boundary in Western Siberia.

was minor. The Maastrichtian and Danian microfaunas of the province (see Fig. 2 for stratigraphic overview) were dominated by low diversity assemblages of benthic calcareous secreted (e.g. *Valvulineria*, *Anomalinoides*, *Cibicides*) and agglutinated forms (e.g. *Gaudryina*, *Siphogaudryina*, *Dorothia*; for an explanation of the used classification of wall structures of agglutinated foraminifera see PODOBINA & TATYANIN, 2000). These assemblages are found in the grey clays and siltstones of the upper part of the Gankinskian "horizon", a regional lithostratigraphic unit. During the Maastrichtian the West-Siberian province formed the eastern borderland of the Boreal-Atlantic realm. Mixed clastic-carbonate sedimentation was common to the entire province, in contrast to the carbonate-rich, chalk-dominated European part of the realm. Due to the cooler water temperatures, many taxa, including keeled planktic foraminifera, are absent in Western Siberia. A sedimentary peculiarity of the West-Siberian province was the replacement of the mixed clastic-carbonate sedimentation by siliciclastic deposition at the end of the Late Cretaceous. During the Danian this change in the type of deposition initiated a decrease in the silicium content which resulted in changes in the foraminiferal assemblages and even in extinction of Maastrichtian specialized groups of calcareous benthic and planktic forms, as well as some other abundant groups of different organisms.

### 2.1. Maastrichtian

Within the West-Siberian province the Late Maastrichtian microfaunal associations of its southern part (southward of the latitude of the river Ob; Fig. 1) differed considerably in their systematic composition and wall structure from those of its northern part. The southern associations comprised calcareous secreted (80%; e.g. *Nodosaria*, *Dentalina*, *Discorbis*, *Valvulineria*, *Anomalinoides*, *Cibicides*, *Cibicidoides*) and calcareous agglutinated tests (15%, e.g. *Gaudryina*, *Siphogaudryina*, *Dorothia*, *Ataxophragmium*; PODOBINA & TATYANIN, 2000). Quartz-siliceous agglutinated forms (e.g. *Labrospira*, *Haplophragmoides*, *Cribrostomoides*, *Recurvoides*) comprised only up to 5% of the total fauna.

The Late Maastrichtian associations were of greater taxonomic diversity than those of the Danian and included up to 48 genera and more than 120 species (PODOBINA, 1975; PODOBINA & KSENEVA, 1990). The most characteristic Maastrichtian species are illustrated in Plate I.

The Late Maastrichtian assemblages of the northern part of the province in the Beryozovo area (Fig. 1) comprised predominantly quartz-siliceous secreted-agglutinated and agglutinated forms of the the genus *Spiroplectammina* and the family Haplophragmoididae, i.e. more primitive foraminifera. Calcareous secreted forms were rare or absent.

### 2.2. Danian

The Danian deposits were protected from erosion in the more depressed areas of Western Siberia and are preserved locally in the south-west (Omsk depression, Fig. 1) and in the east (Ust-Tym depression, Fig. 1). Microfaunal associations of diverse systematic compositions, with different groupings of foraminiferal ecological types are restricted to these deposits.

The south-western Danian association with *Brotzenella praeacuta* is more diverse taxonomically than that from eastern areas and consists of 28 genera and 57 species. Whereas many Maastrichtian species were dying out, in the Danian new Paleocene species appeared in the assemblages for the first time. Overall, the Danian associations of the south-west plain indicate shallower water and are similar to those from the underlying Maastrichtian. The Danian assemblage reported by DAIN (1961) from the Transuralian Shumikhinskian section (borehole near Shumikha) is analogous in its systematic composition to the assemblages of several other sections from this part of Western Siberia, such as Novologinovo, Sargat, Bolsherechie and Tara (Fig. 1). *Gaudryina gigantica* (SUBBOTINA), *Clavulina parisiensis* D'ORBIGNY, *Parrella lens* (BROTZEN), *Cibicides spiropunctatus* GALLOWAY & MORREY, *Anomalinoides danicus* (BROTZEN), *Brotzenella praeacuta* (VASILENKO) are the most typical species in this part of the province. In spite of the relative species diversity, many taxa (genera and species) are lacking, principally benthic foraminifera typical of the Upper Maastrichtian. Small, rounded planktic forms, mostly of the genera *Subbotina* BROTZEN & POZARYSKA, 1961 and *Globorotalia* CUSHMAN, 1927, occur rarely. The most characteristic Danian species are illustrated in Plates II–III.

In the continuous Cretaceous – Paleogene sections in the eastern part of Western Siberia (Ust-Tym depression: boreholes 1pd, 2pd, 3pd, 152pd in the Tym and Paidugina river basin), PODOBINA (1998) has distinguished deposits of a deeper water facies with primitive agglutinated foraminifera of the *Bathysiphon nodosarieformis – Glomospira charoides* assemblage (Fig. 2). These deposits correlate with those containing the shallower water *Brotzenella praeacuta* assemblage (PODOBINA & KSENEVA, 1989).

Similar foraminiferal associations, restricted to shallow- and deep-water facies respectively, were described by GLAESSNER (1937) and SUBBOTINA (1950) from the Danian sections of the Northern Caucasus. It is not improbable that they also inhabited a comparatively cold-water basin. The Danian shallow-water assemblages comprise mainly benthic forms with calcareous secreted walls. In the Tym and Paidugina sections of Western Siberia, as well as in the correlative deposits of the Northern Caucasus, the following presumably deeper water species were found: *Bathysiphon nodosarieformis* SUBBOTINA, *Glomospira gordialiformis* PODOBINA, *Spiroplectammina kasanzevi* DAIN, *Trochamminoides irregularis* WHITE, *Haplophragmoides* sp., *Adercotryma* aff. *glomeratoformis* (ZAPELOVA) and others. The presence of many relict Maastrichtian forms, recorded by SUBBOTINA & KISELMAN (1961), is characteristic of the Danian associations in Western Siberia, as well as in the other provinces. SUBBOTINA & KISELMAN (1961) were the first to establish the earliest appearance of species of Globigerinidae in the south-western sections – *Subbotina varianta* (SUBBOTINA), *S. trivialis* (SUBBOTINA), *Globorotalia pseudobulloides* PLUMMER, together with diverse benthic forms amongst which typical Danian species were also recorded. Only primitive agglutinated forms were found in the coeval Tym and Paidugina sections in the eastern part of Western Siberia.

### 2.3. Selandian

The overlying Paleocene deposits in Western Siberia, which, in other provinces (North-Western Europe – Denmark) contain the younger planktic foraminifera *Morozovella angulata* and *M. conicotruncata*, are correlatable, using foraminifera, with the Selandian Stage. In the Selandian stratotype section near Copenhagen in Denmark clastic deposits

consisting of glauconitic clays and marls rest with erosive contact on Danian carbonates. The Selandian rocks contain a foraminiferal association that is totally different from that in the underlying Danian. It consists mainly of calcareous benthic and rare planktic forms. The Selandian benthic foraminifera are widely distributed throughout the territory of Northern Eurasia. In the microfaunal assemblage of the Danish stratotype section (samples of which had been kindly provided by Professor Naidin), PODOBINA (1998) recognized 32 species attributed to 22 genera. A similar assemblage from Sweden, in which *Cibicidoides proprius* BROTZEN predominates, was first described in detail by BROTZEN (1948). This species is the index taxon not only for the Swedish assemblage but also for other microfaunal associations of the Boreal-Atlantic realm and, in particular, for the West-Siberian province. The following planktic species were recorded from the Selandian stratotype: *Subbotina triloculinoides* (PLUMMER), *Globigerina moskvini* SCHUTZKAJA, *Globorotalia pseudobulloides* (PLUMMER), *Morozovella kubanensis* SCHUTZKAJA, *M.* aff. *angulata* (WHITE), *M. elegans* (BROTZEN), *M. lobata* (BROTZEN), *Acarinina spiralis* BOLLI, *Chiloguembelina crinita* (GLAESSNER). These species indicate the *Morozovella* zones (Fig. 2).

In the territory of Western Siberia, a large part of the Talitskian horizon – the *Ammoscalaria friabilis* Zone – is assigned to the Selandian Stage. The basal Talitskian beds with *Cibicidoides incognitus* established by FREIMAN (1960) below this zone in the Novologinovo sections (Omsk depression – see Fig. 1), correlate with the Upper Danian *Acarinina inconstens Zone*. The Talitskian horizon represents a unique ecosystem formed during the time of the Selandian boreal transgression. The occurrence of the lower association with *Cibicidoides incognitus* is geographically restricted, compared with that of the superjacent *Ammoscalaria friabilis* association. The analogous *Cibicidoides proprius* microfaunal associations of the Transuralian shallow-water facies include rare planktic forms together with the benthic forms. Species from this association, with calcareous forms predominating, were found in the borehole 86k section of the Fedorovskaya area (Fig. 1), and in other sections of Middle Transuralia. This species occurred in both the lower and middle part of the *Ammoscalaria friabilis* Zone of the Talitskian horizon. Separate calcareous forms of the *Cibicidoides proprius* association were recorded there throughout the whole zone, together with agglutinated taxa typical of the Selandian *Ammoscalaria friabilis* association. Podobina has studied the species composition of the calcareous forms and observed their great similarity with the Danish and Swedish assemblages.

In the eastern part of Western Siberia (Ust-Tym depression), Selandian impoverished associations of agglutinated quartz-siliceous foraminifera with the index species *Cyclammina coksuvorovae* were found.

## 3. CONCLUSION

Based on studies of the foraminiferal assemblages, the West-Siberian province formed the eastern borderland of the Boreal-Atlantic realm during the Maastrichtian. Mixed clastic-carbonate sedimentation predominated during this time. In the uppermost beds of the Gankinskian unit, assigned to the Early Danian, siliciclasticsediments predominated. At this stratigraphical level numerous highly advanced groups of Maastrichtian forms became extinct in Western Siberia and other regions.

The Danian deposits were protected from erosion in the more depressed areas of Western Siberia and are preserved locally in the south-west (Omsk depression) and in the east (Ust-Tym depression).

The Danian *Brotzenella praeacuta* Zone of the south-western part of the province is correlatable with beds in the east (Ust-Tym depression) containing the *Bathysiphon nodosarieformis* and *Glomospira charoides* deeper water assemblages. However, Maastrichtian species were also occasionally recorded here. In some sections of the south-western area (lower part of the Talitskian horizon) the uppermost Danian beds with *Cibicidoides incognitus* FREIMAN, corresponding to the *Acarinina inconstans* Zone, were recognized. The upper part of the Talitskian horizon contains the Selandian *Ammoscalaria friabilis* Zone with quartz-siliceous forms. Throughout the western area (Transuralia), the assemblage of this zone includes calcareous species from the Selandian stratotype and from Swedish sections (BROTZEN, 1948). In the eastern part of Western Siberia (Ust-Tym depression) the beds with *Cyclammina coksuvorovae* correspond to the *Ammoscalaria friabilis* Zone. Both assemblages at this stratigraphical level are composed mainly of quartz-siliceous agglutinated foraminifera.

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## Descriptions of plates

*All specimens are deposited in the Paleontological Museum of Tomsk State University and illustrated by O. M. Lozovaya.*

**Plate 1** (after Podobina, 2000, Pl. XI)

**The Upper Maastrichtian *Spiroplectammina kasanzevi, Bulimina rosenkrantzi* Zone**
***a*** – lateral/dorsal view; ***b*** – lateral/apertural view; ***c*** – ventral view

Fig. 1: *Spiroplectammina kasanzevi* Dain
Specimen No. 1291. Western Siberia, Tomsk region, Paidugina basin, borehole 1-pd, depth 500.6 m; × 80

Fig. 2: *Heterostomella foveolata* (Marsson)
Specimen No. 273a. Western Siberia, Tyumen region, Malinovskaya area, borehole 1-r, depth range 626.0 – 620.0 m; × 50

Fig. 3: *Quinqueloculina fusiformis* Putrja
Specimen No.729. Western Siberia, Tomsk region, Parabel basin, borehole 26-p, depth 240.0 m, × 80

Fig. 4: *Anomalinoides justus* Podobina
Specimen No.605. Western Siberia, Novosibirsk region, Mezhovskaya area, borehole 37-m, depth 418.0 m, × 80

Fig. 5: *Brotzenella pseudopapillosa* (Carsey)
Specimen No. 641. Western Siberia, Novosibirsk region, Mezhovskaya area, borehole 41-m, depth 325.5 m, × 80

Fig. 6: *Bulimina rosenkrantzi* Brotzen
Specimen No.1311. Western Siberia, Tomsk region, Tym basin, borehole 1-r, depth 442.0 m; × 90

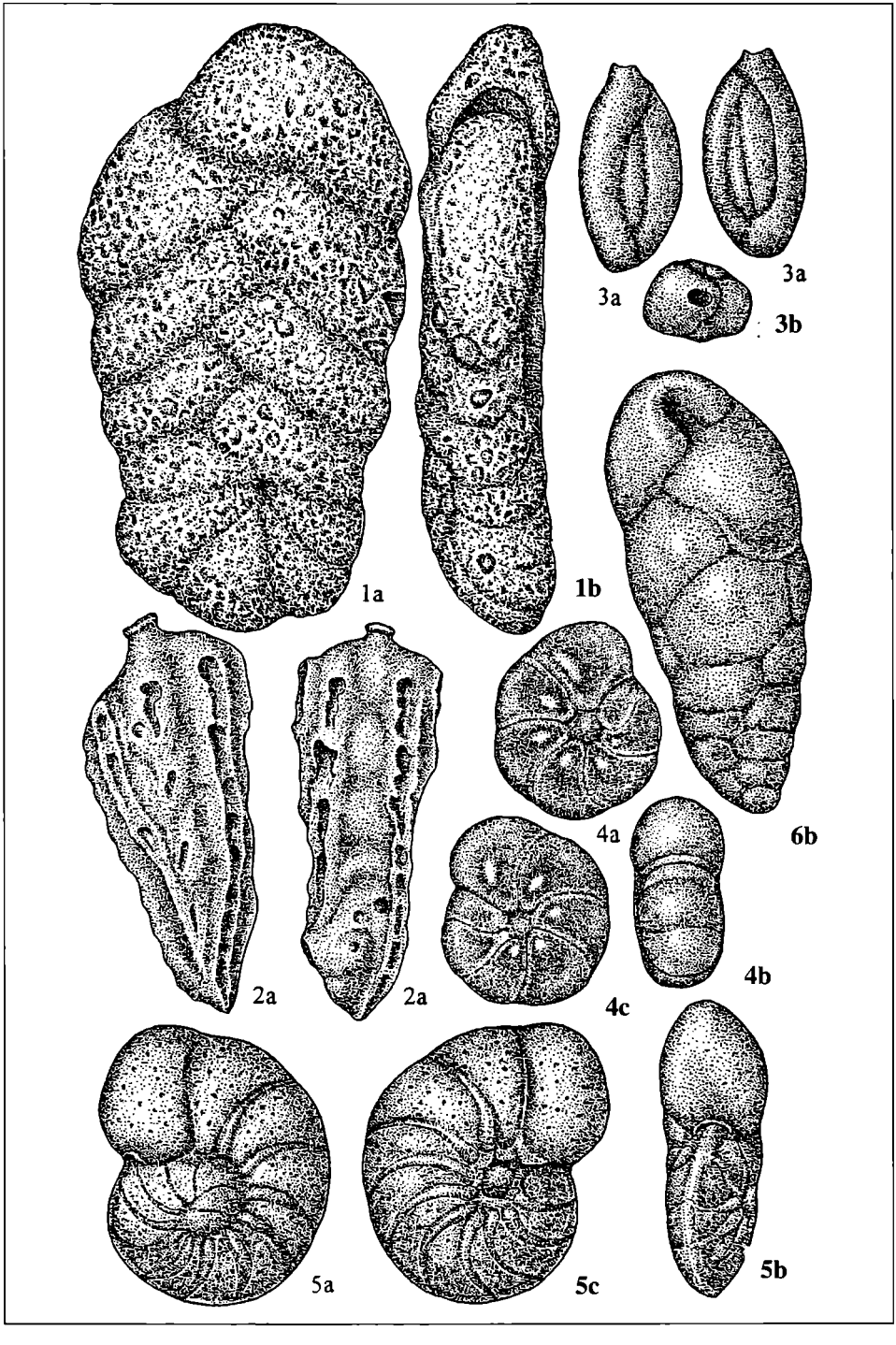
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**Plate 2** (after PODOBINA, 1998, Pl. II)

**The Lower Paleocene (Danian) *Brotzenella praeacuta* Zone**
***a*** – lateral/dorsal view; ***b*** – lateral/ventral view; ***c*** – apertural view.

Fig. 1–2: *Lenticula inusitata* (KISELMAN)
1 – Specimen No. 1355, 2 – Specimen No. 1356. Western Siberia, Omsk region, s.Sargat, borehole 1-r, depth range 558.83–552.18 m; × 80

Fig. 3–4: *Parrella lens* BROTZEN
3 – Specimen No. 1353, 4 – Specimen No. 1354. Western Siberia, Omsk region, s.Sargat, borehole 1-r, depth range 558.83–552.18 m; × 80

Fig. 5: *Cibicides spiropunctatus* GALLOWAY & MORREY
Specimen No. 1357. Western Siberia, Omsk region, s. Sargat, borehole 1-r, depth range 558.83–552.18 m; × 80

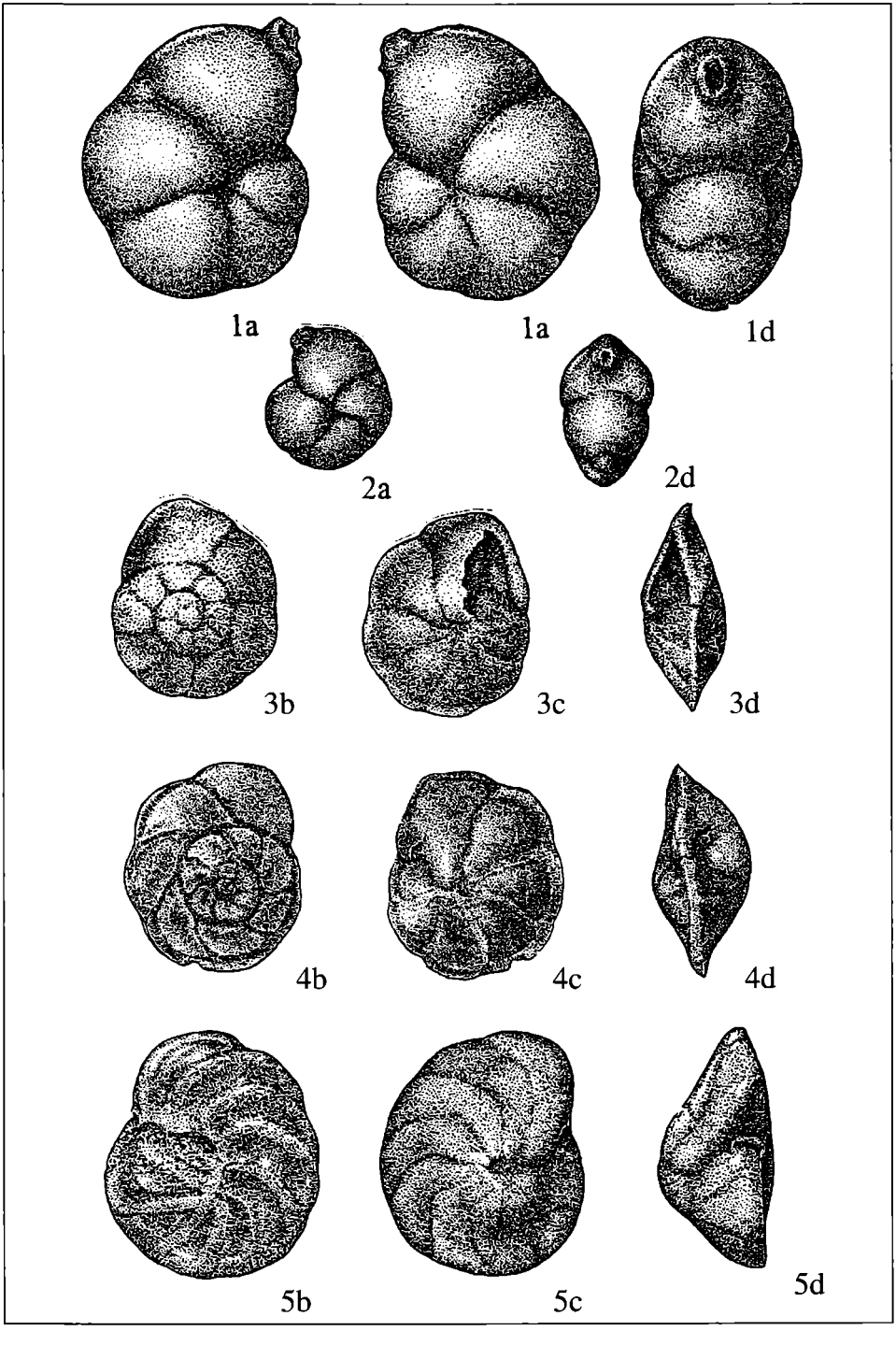
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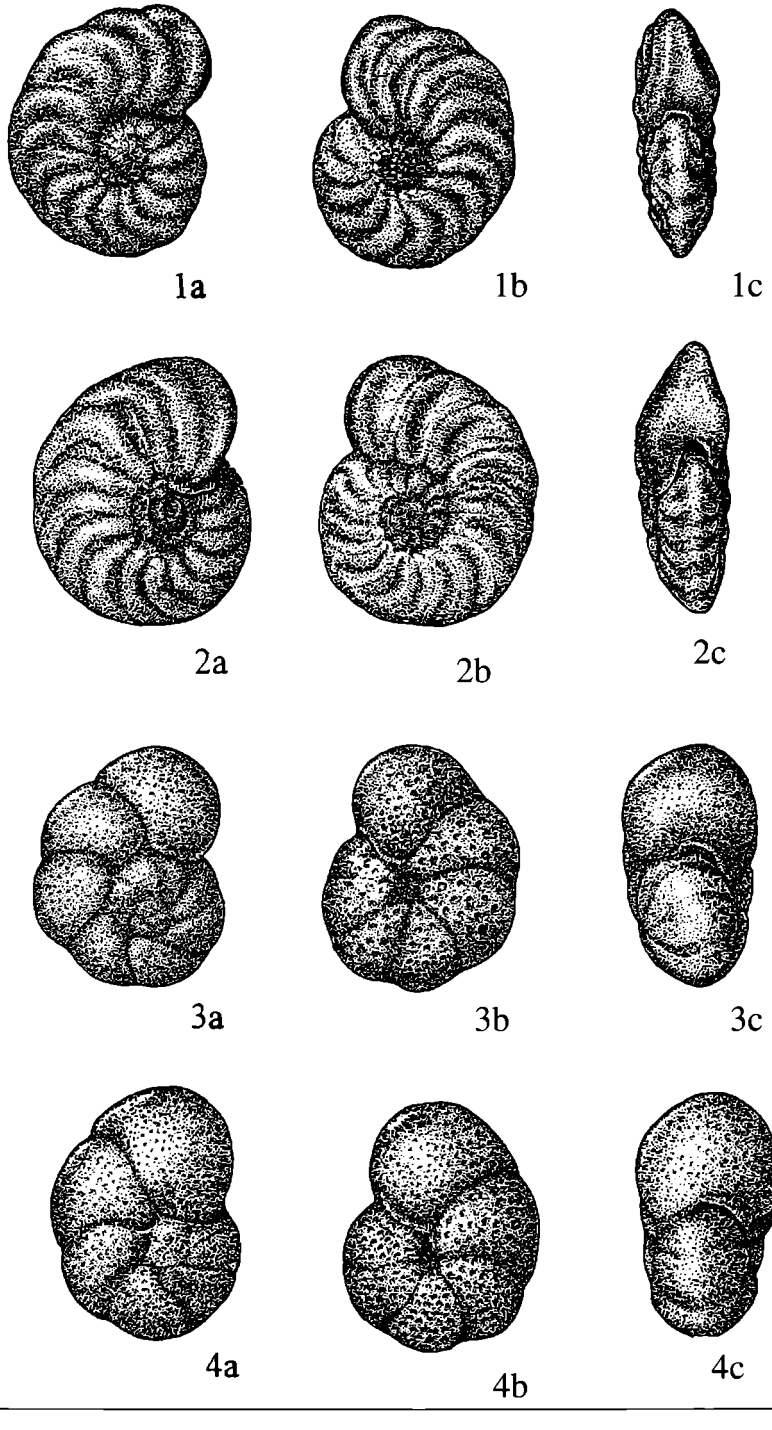
**Plate 3** (after PODOBINA, 1998, PL. III)

**The Lower Paleocene (Danian) *Brotzenella praeacuta* Zone**
***a*** – dorsal view; ***b*** –ventral view; ***c*** – apertural view.

Fig. 1–2: *Brotzenella praeacuta* (VASILENKO)
1 – Specimen No. 1360, 2 – Specimen No. 1361. Western Siberia, Omsk region, s.Sargat, borehole 1-r, depth range 558.83–552.18 m; × 80

Fig. 3–4: *Anomalina danica* (BROTZEN)
1 – Specimen No. 1360, 2 – Specimen No. 1361. Western Siberia, Omsk region, s.Sargat, borehole 1-r, depth range 558.83–552.18 m; × 80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