
Change of micropaleontological assemblages at the Cretaceous-Paleogene Boundary in Western Siberia

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The foraminiferal and spore-pollen complexes were studied at the boundary of Maastrichtian-Danian (Cretaceous-Paleogene) in Western Siberia. Terrigenous-argillaceous rocks with admixture of carbonaceous material from upper part of Gankinsky Suite and lower layers of Talitsky Suite belong to this stratigraphical interval. Carbonaceous secreted and secreted-agglutinated shells predominate among benthic Foraminifers. Planktonic forms were seldom and consist of representatives of the genera — *Rugoglobigerina* and *Guembelina* in the Maastrichtian and genera *Globigerina* and (rarely) *Globorotalia* in the Danian. At the Cretaceous-Paleogene Boundary, palynocomplexes consist of group of angiosperm pollen. The flora producing *Triprojectacites* - type pollen became extinct in Late Maastrichtian. The active settling of western Siberia by "Norma" flora was confined to the beginning of the Palaeogene. Parallel with *Normapolles* representatives of Myricaceae, Fagaceae, Ulmaceae, Juglandaceae, Betulaceae, etc. originated and formed. They forced out the short-lived group of large-pollen "Norma" by the end of Paleocene.

Key-words—Cretaceous-Tertiary Boundary, Foraminiferal zones, Palynocomplex, Maastrichtian, Danian, Russia, Siberia.

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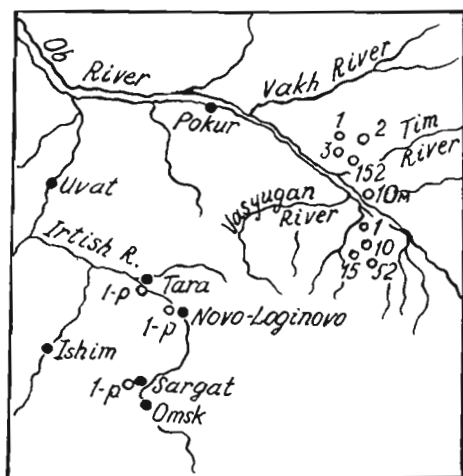
पश्चिमी साइबेरिया में क्रीटेशियस-पेलियोजीन सीमा पर सूक्ष्मपुरातात्विक समुच्चयों में परिवर्तन

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पश्चिमी साइबेरिया में मास्ट्रिक्शियन-डेनियन (क्रीटेशियस-पेलियोजीन) सीमा से प्राप्त फोरामिनीफरी एवं बीजाणु-परागकण समुच्चयों का अध्ययन किया गया है। गेनकिन्सकी के ऊपरी भाग तथा तालिस्की की निचली तहों से कार्बनमय सामग्री से युक्त स्थलजात-आर्जिलेसीय चट्टानों इस स्तरिक इकाई से सम्बद्ध हैं। बेथिक फोरामिनीफरों में कार्बनमय स्रावित एवं स्रावित एग्लूटिनेट शैलों की बाहुल्यता है। प्लवकीय प्ररूप काफी कम हैं तथा मास्ट्रिक्शियन काल में *रुगोग्लोबीजेरीना* एवं *गुएम्बेलीना* नामक दो प्रजातियाँ मिलती हैं जबकि डेनियन काल में *ग्लोबीजेरीना* एवं *ग्लोबोरोटेलेिया* (कम) नामक दो प्रजातियाँ विद्यमान हैं। क्रीटेशियस-पेलियोजीन सीमा पर आवृतबीजी परागकण मिलते हैं। अनंतिम मास्ट्रिक्शियन काल में *ट्राइप्रोजेक्टेसाइटिस* प्रकार के परागकण विलुप्त हो गये थे। मिरिकेसी, फैगेसी, अल्मेसी, जुगलेन्डेसी, बिटुलेसी आदि कुलों के अवयव नोर्मापॉलिस के समानान्तर विकसित हुए तथा पेलियोजीन के अन्त तक इन्होंने "नोर्मा प्रकार" के बड़े परागकणों को समाप्त कर अपना प्रभुत्व स्थापित कर लिया था।

THE development of physical-geographical situation at the Cretaceous-Paleogene (Maastrichtian-Danian) Boundary is mainly connected with the climatic factor. Two large palaeobiogeographical regions, viz., Boreal-Atlantic and Mediterranean, were distinguished by Podobina (1984) for this time interval on the Eurasia's territory. The first one which is of our interest, extends from the southern Scandinavia through the Polish Lowland to the East European Platform including western Siberia. Boreal basins within this region were under the influence of the northern Atlantic and the Arctic; chiefly terrigenous-

carbonaceous and terrigenous rocks enclosing diverse palaeontological residues were accumulated there. In western Siberia, terrigenous-argillaceous rocks with an admixture of carbonaceous material occurring in the upper part of Gankinsky Suite and lower layers of Talitsky Suite, represent the Maastrichtian-Danian stratigraphic interval. The most widely spread foraminiferal and spore-pollen assemblages were selected for investigation among palaeontological residues found in these sediments. Danian deposits in this area were discovered only in the lows of relief, where they were preserved from the subsequent



Text-figure 1

erosion by water. Maastrichtian-Danian foraminifera and palynocomplexes within Omsk depression were investigated in subsurface sections, viz., near Sargat, borehole 1-p; near Novo-Loginovo, borehole 1-p; Tarskaya key-borehole 1-p; on the left bank of the Ob, in the basin of the Parbig, boreholes 1, 10, 15, 52; on the right bank of the Ob, in basins of the Tim and the Paidugina-boreholes 1, 2, 3, 152 (Ust-Tim depression) (Text-figure 1).

Maastrichtian-Danian palaeocoenoses of western Siberia had been formed under conditions of comparatively low temperature in epicontinental basins that were under the influence of Arctic. Waters of southern seas penetrating through the Turgai trough affected the formation of indicated palaeocoenoses to a lesser extent. They differ by the peculiar correlation between different types of benthic forms and almost by the complete absence of planktonic ones. Carbonaceous secreted and secreted-agglutinated shells of uncertain systematic position predominate among benthic forms; many taxa characteristic for European palaeocoenoses are absent. Planktonic forms are rare and consist of representatives of the genera — *Rugoglobigerina* and *Guembelina* in the Maastrichtian and *Globogertina* and *Globorotalia* (rarely) in the Danian. The change in ecological factors at the end of the Late Cretaceous, expressed by some fall in temperature and shallowing of the basin, led to considerable transformations in the systematic composition of the Danian palaeocoenosis in the southwestern part of the plain. The southeastern palaeocoenosis, on the contrary, is considerably impoverished in number of species as well as

quantitatively; sharply differs from the underlying Maastrichtian palaeocoenoses. Investigated palaeocoenoses are from upper layers of Gankinsky Suite, including transitional or lower layers of Talitsky Suite. Late Maastrichtian foraminiferal palaeocoenosis with *Sptroplectammina kasanzevi* and *Bulimina rosenkrantzii* and the Danian palaeocoenosis with *Brotzenella praeacuta* on the southeast and *Bathysiphon nodosarieformis*, and *Glomospira charoides* on the southwest are distinguished among them. Late Maastrichtian palaeocoenoses differ considerably in composition and structure on the south and the north of western Siberia. The palaeocoenosis from the southern part of western Siberia consists approximately 80 per cent of carbonaceous secreted benthic forms; secreted-agglutinated forms account for 15 per cent and quartz-siliceous agglutinated forms only 5 per cent. On the north of western Siberia (to the north of latitudinal flow of the Ob), Late Maastrichtian palaeocoenosis is represented predominantly (up to 80-90 %) by secreted-agglutinated and (up to 10-12 %) quartz-siliceous forms. About 20 genera and 120 species comprise the southern palaeocoenosis and about one third or lesser of indicated taxa are present in the northern palaeocoenosis. The southwestern Danian palaeocoenosis with *Brotzenella praeacuta* consists of 38 genera and 57 species. Parallel with the disappearance of many benthic Maastrichtian species, Palaeocene species including new planktonic forms appeared for the first time in the indicated paleocoenosis. The latter are, however, single and west Siberian paleocoenoses differ from palaeocoenoses of the same age from other regions in this aspect, too. Carbonaceous secreted-agglutinated and secreted benthic species, viz., *Gaudryina gigantea* (Subbotina), *Clavulina paristensts* Orb., *Parella lens* (Brotzen), *Cibicides sptropunctatus* Galloway et Morrey, *Anomalinoides danicus* (Brotzen), *Brotzenella praeacuta* (Vassilenko) and many other ones are present in rocks from borehole 1-p (int. 558.83-552.18 m), near Sargat that was chosen as the key-section for the Danian. As for planktonic forms, the presence of *Globigerina varianta* Subbotina, *G. trivialis* Subbotina, *Globorotalia pseudobullotides* Plummer, etc. must be noted. As a whole, according to ecological foraminiferal types, the Danian paleocoenosis in the southwest of the plain (Omsk depression) is closer to the underlying Maastrichtian one. Benthic carbonaceous secreted-agglutinated forms predominate here, as well as in the Late

Table 1

System	Series	Stage	Suite	Zones of Benthic Foraminifers	
				South Western region (Omsk depression)	Eastern region (Ust-Tim depression)
Paleogene	Paleocene	Selandian	Talitsky	<i>Ammoscalaria friabilis</i>	Layers with <i>Cyclammina coksuvorovae</i>
		Danian		<i>Brotzenella praeacuta</i>	Layers with <i>Bathysiphon nodosarieformis</i> , <i>Glomospira charoides</i>
Cretaceous	Upper	Maastrichtian	Gankinsky	<i>Spiroplectammina kasanzevi</i> , <i>Bulimina rosenkrantzi</i>	

Maastrichtian of the southern palaeocoenosis (borehole 1-p, near Sargat, int. 558.83-552.18 m; borehole 1-p, near Novo-Loginovo, int. 607.15-602.55 m; borehole 1-p, near Tara, depth 595 m).

On the east (the right bank of the Ob, Ust-Timskaya depression), the other palaeocoenosis, (probably Danian) with *Bathysiphon nodosarieformis*, *Glomospira charoides* was found. In addition to the

Table 2

System	Series	Stage	Suite	Palynocomplexes of eastern region	
				Basin of Parbig River	
Paleogene	Paleocene	Selandian	Talitsky	Predominant: Taxodiaceae, Pinaceae, Normapollens Characteristic: <i>Extratropipollenites</i> spp., <i>Trudopollis menneri</i> , <i>T. conector</i> , <i>Nudopollis endangulatus</i> , <i>N. thirgartii</i> , <i>Oculopollis sibirica</i> , <i>Basopollis</i> sp., <i>B. vestibulatus</i> , Myricaceae, Ulmaceae, Juglandaceae, Betulaceae.	
		Danian		Predominant: Taxodiaceae, Pinaceae Characteristic: <i>Orbiculapollis globosus</i> , <i>Ulmoideipites tricostatus</i> , <i>Trudopollis nonperfectus</i> , <i>T. conector</i> , <i>T. fossulotrudens</i> , <i>Oculopollis sibirica</i> , <i>Aquilapollenites</i> spp., <i>Tripopollenites robustus</i> , <i>Myrica</i> spp., <i>Triatripollenites</i> spp. Rare: <i>Mancicorpus</i> , <i>Aquilapollenites</i> .	
Cretaceous	Upper	Maastrichtian	Gankinsky	Predominant: Pinaceae, Taxodiaceae Characteristic: <i>Orbiculapollis globosus</i> , <i>Wodehouseia</i> spp., <i>Tricolporites gracilis</i> , <i>Aquilapollenites</i> spp., <i>Ulmoideipites</i> spp., <i>Ephedra</i> sp. Rare: Normapollens. Abundant: <i>Membranosphaera maastrichtica</i> and <i>Deflandrea bakeri</i> .	

above species, more highly organised representatives of *Trochammina* aff. *proteus* Karrer, met in Palaeocene, and *Spiroplectammina* aff. *kasanzevi* Dain of Late Maastrichtian age were discovered there.

The palaeocoenosis of mixed systematic composition, consisting of relict Maastrichtian and appearing Palaeocene species, is usually characteristic for the Danian in western Siberia too. However, here primitive quartz-siliceous agglutinated forms predominate (Ust-Tim depression, basins of the Tim and Paidugina, borehole 1, int. 470-460 m; borehole 2, int. 484-480 m; borehole 3, int. 413-390 m; borehole 152, int. 420-418 m) indicating more shallow- and cold-water basin. Consequently, the considerable change of foraminiferal palaeocoenoses at the Late Cretaceous-Danian boundary was caused by substantial alterations of environment, by reconstruction of physical-geographical conditions at the latitudinal distribution because of change in climatic zonality and the revival of tectonic regime to the beginning of Palaeocene.

Late Maastrichtian palynocomplex, controlled by *Spiroplectammina kasanzevi*-*Bulimina rosenkrantzi* Zone (Podobina, 1988), is distinguished by the authors on the left bank of the Ob in the section of Parbigskaya borehole 52 (int. 262-254 m) in the lower part of the Gankinsky Suite. It is represented by dark-grey, rarely black or greenish-grey, clay with interlayers containing glauconite and sideritic concretions. The palynocomplex is poor in spore content. *Sphagnum* (*S. regium* Drozh., *S. australe* (Nook.) Drozh.) and monolete spores of Polypodiaceae are appreciably represented. Spores of *Gletchenta* sp., *Cyathea* sp., *Matonia* sp., *Os-munda* sp. etc. are very rare. Among the gymnosperms, pollen of Taxodiaceae predominate. *Pinus* spp. and *Cedrus* spp. are found more often, *Pinus araltica* Bolchovitina is sparse. *Dacrydiumites* sp. and *Ephedra* are represented by single specimens. Pollen of angiosperms is diverse; there is no prevalence. The participation of *Quercites sparsus* (Mart.) Samoilovich is noticeable. The following common Upper Cretaceous forms are present: *Liliacidites*, *Myrica* spp., Myrtaceae, Hamamelidaceae, *Corylopsis compacta* (Mart.) Samoil., *Platanus*, Loranthaceae, *Engelhardtia* sp., *Celtis* sp., *Ulmoideipites tricostatus* And., *Tricolpopollenites* spp., *Triatripollenites* spp.,

Triporopollenites spp., *Tricolporopollenites* spp., *Aquilapollenites* spp., *Triprojectus* spp., *Parviprojectus striatus* Mtchedishirili, *Orbiculapollis globosus* Chlonova and *Orbiculapollis lucidus* Chlonova. A single grain of *Castanea* sp. was found. Aquatic forms of *Membranosphaera maastrichtica* Samoilovich-type, and various dinocysts are abundant including *Deflandrea bakert* Defl. Higher in the section (int. 220-206 m) in the same suite of clays (but not characterized by fauna), a palynocomplex is distinguished which is similar to the known Danian palynocomplex (Zaklinskaya, 1977). Here *Triprojectacites* with accompanying list of Late Cretaceous plants is still found, but the percentage of *Ulmoideipites* And. increases, *Orbiculapollis globosus* Chlonova was also found in considerable numbers; the diversity of *Normapollis* (*Trudopollis nonperfectus* Pflug., *Trudopollis pompeckji* Pflug, *Oculopollis baculotrudens* (Pflug) Zaklinskaya) and *Triatriopollenites* spp. increases. *Membranosphaera maastrichtica* Samoilovich and *Deflandrea bakert* Deflandre are very rare. Shrinking of the marine basin had apparently occurred. Similar regularity was observed in the section of Vasuganskaya borehole 10-I (the mouth of the Vasugan, the left tributary of the Ob), where in palynospectra from the upper layers of Gankinsky Suite the percentage of representatives of Ulmaceae (*Ulmoideipites* And.), Myricaceae, Juglandaceae, Betulaceae increases; the flash of *Orbiculapollis* Chlonova and *Ephedra* is marked against a background of the sharp lowering role of *Triprojectacites* (Grigoryeva, 1970).

An Early Palaeogene palynocomplex (Danian, by convention) has been distinguished from 15 m thick dark-grey clay in the cover of Gankinsky Suite (Parbigkaya borehole 15). Deposits within the interval of 258-232 m are datable by foraminiferal-*Spiroplectamina kasanzevi*-*Bulimina rosenkrantzi* Zone and layers with Late Maastrichtian palynocomplex. In rocks from depth 223 m, the palynocomplex was described, where the spore part and the composition of gymnosperm pollen hadn't undergone alteration. Notable changes in the direction of increasing quantity and pollen diversity of stemma *Normapollis* had occurred in the composition of angiosperms. *Trudopollis* spp., *T. fossulotrudens* Pflug, *T. conrektor* Pflug, and *Oculopollis sibirica* Zaklinskaya (amounting to 4.5-9.0 %) are marked here. *Alnus* sp., *Myrica* spp.,

Comptonia sp., *Carya* sp., *Pterocarya* sp., *Castanea* sp., *Quercus* sp., Caprifoliaceae (cf. *Lonicera*), *Ulmoideipites tricostatus* And., *Anacolostites* sp., *Nyssa* sp., *Tricolpopollenites* sp., *Triatriopollenites* spp., *Triporopollenites robustus* Pflug and *Tricolporopollenites* sp. are associated forms. *Aquilapollenites* sp. and *Mancicorpus* sp. are met sporadically. Layers with analogical complex, of Lower Paleocene age by convention, was traced in the base of Palaeogene section, Parbig area (boreholes 1, 10, 52). Early Palaeocene *Triporopollenites robustus*-*Ulmoideipites* palynocomplex has been established (Nagorskaya *et al.*, 1978) in Orlovsky layers which are scantily developed in the cover of Symsky Suite (continental analogue of Gankinsky Suite) on the right bank of the Ob.

Layers with *Trudopollis mennert*-*Nudopollis endangulatus*-*Oculopollis giganteus* palynocomplex (Early Palaeocene, Zelandian ?) were distinguished by Ilyenok (1968) in lower subsuite of Talitsky Suite (Oázovsky borehole 1-D). In the upper layers of underlying deposits (Gankinsky Suite, int. 439.9-396.5 m), Late Maastrichtian *Spiroplectamina kasanzevi* Zone had been distinguished by Kiselman (1974). Foraminiferal assemblage with *Parella lens* (Brotz.) (Danian, by convention) was defined by her above these rocks within the interval of 371.6-369.0 m. A palynocomplex was described from deposits in the interval of 390.5-298.0 m. The spore pollen composition does not show any change. Characteristic Cretaceous relicts were observed as before among angiosperms, the percentage of *Quercites sparsus* (Mart.) Samoilovich is noticeable. The role of diverse pollen, attributed to stemma *Normapollis* (28 %) - *Extratriporopollenites* spp., *Trudopollis conrektor* Pflug, *T. proparvus* Pflug, *Oculopollis* spp., *Basopollis* sp., *B. vestibulatus* Zaklinskaya, *Nudopollis endangulatus* Pflug, *N. thiergartii* Pflug increased significantly. Palaeocene (Zelandian) *Ammoscalaria friabilis* Zone was distinguished by Podobina in the lower half of Talitsky Suite.

The successive comparative analysis of palynocomplexes at the Cretaceous-Palaeogene Boundary shows that Late Maastrichtian and Maastrichtian to Danian palynocomplexes characterize the upper part of Gankinsky Suite having marine and coastal-marine genesis. It con-

firms greatly the conclusions of Zaklinskaya (1960, 1977), Mchedlishvili (1961), Grigoryeva (1968), and Khlonova (1974). The palynocomplex of dismembered Maastrichtian was distinguished for the upper subsuite of Symsky Suite. Early Palaeocene palynocomplex (Danian, by convention) was traced discretely in boundary layers in the cover of Gankinsky and Symsky suites - lower part of Talitsky Suite and its continental analogues. *Trudopollis menneri* - *Nudopollis endangulatus*-*Oculapollis gigantheus* palynocomplex of Early Palaeocene (Zelandian?) age is confined to the lower subsuite of Talitsky Suite.

The most noticeable changes in the development of Late Cretaceous-Palaeogene flora occurred in the composition of representatives of angiosperms. Their rise, mass settling and decline covered just this restricted time interval. In Late Maastrichtian flora "Aquila", plants producing *Triprojectactites* pollen died out. The active settling of western Siberia by flora "Norma" was confined to the beginning of the Palaeogene. The reduction of marine basin was probably favourable to this process during the Danian regression. Parallel with Normapollis representatives of Myricaceae, Fagaceae, Ulmaceae, Juglandaceae, Betulaceae, Salicaceae, etc. originated and formed; they forced out short-lived group of large-pollen "Norma" by the end of Palaeocene.

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