Part 2. New Data on Carboniferous Stratigraphy
Часть 2. Новые данные по стратиграфии карбона

STRATOTYPE OF GZHELIAN STAGE (UPPER CARBONIFEROUS) IN MOSCOW BASIN, RUSSIA

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СТРАТОТИП ГЖЕЛЬСКОГО ЯРУСА (ВЕРХНИЙ КАРБОН) В ПОДМОСКОВЬЕ, РОССИЯ

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Современное расчленение каменноугольной системы на подсистемы, отделы и ярусы в Международной стратиграфической шкале было недавно ратифицировано и получило официальный статус. Российские ярусы верхнего карбона (верхнего пенсильвания) зафиксированы, но глобальные стратотипы границ еще не выбраны. Гжельский ярус и его региональные подразделения на территории ВЕП обоснованы, в настоящее время, обновленными зональными последовательностями, разработанными по фузулинидам и конодонтам. В статье приведено описание разреза исторического стратотипа, расположенного между деревнями Речицы и Трошково около железнодорожной станции Гжель и положение уровня первого появления *Idiognathodus simulator* [Heckel et al, 2008], выбранного в качестве глобального маркера нижней границы гжельского яруса. Показано распределение фузулинид и различных групп макрофауны (ругозы, брахиоподы).

Introduction

Gzhelian Stage — one of the seven stages of the Carboniferous system — was established by S.N. Nikitin in 1890 and became one of the stages in the General Stratigraphic Chart of the USSR.

Recently subdivision of the Carboniferous system into subsystem, series and stages in the International Stratigraphic Chart was ratified by International Geological Union and achieved official status [Gradstein et al., 2004; Heckel, Clayton, 2006]. Russian stages of the Upper Carboniferous (Upper Pennsylvanian) are fixed, but their GSSP have not been chosen yet. In the Unified Stratigraphic Chart of the East-European Platform, approved in 1988 [Kagarmanov, Donakova, 1990], the Gzhelian Stage is subdivided into three regional substages. They are (from below) Dobryatinian, Pavlovoposadian, and Noginskian. The Melekhovian, uppermost substage, was added later [Makhlina, Isakova 1997]. Each of these substages corresponds to one provincial or local fusulinid zone and several zones on conodonts.

The basis of the lithostratigraphic subdivisions of the Gzhelian Stage in the southern part of Moscow Syneclise (Moscow Basin) was created by B.M. Danshin [1947]. E.A. Ivanova and S.E. Rozovskaya [1967],

and later M.Kh. Makhlina et al. [1979] published the complete description of Gzhelian lithostratigraphy. In the type region the lower lithological boundary of the stage was shown at the top of the variegated shales and dolomites of the Troshkovo Formation of the Dorogomilovian or between *Triticites* (*Triticites*) *irregularis* – *T.* (*T.*) *acutus* и *Triticites* (*T.*) *rossicus* – *Triticites* (*Rauserites*) *paraarcticus* zones [Makhlina et al., 1979]. The historical stratotype of the Gzhelian Stage is located in the Ramenskoe District of the Moscow Region nearby the railway station Gzhel between Rechitsy and Troshkovo villages. Only lower part of the stage is exposed here. However the formal lower boundary of the stage is not visible in the quarry and its characteristics is available only from borehole 6k drilled in this area [Makhlina, 1975].

Historical review

In 1890 the outstanding Russian geologist S.N. Nikitin subdivided the upper part of the Carboniferous of the Moscow Basin into two stages — Moscovian (lower) and Gzhelian (upper), and supposed that they will be used widely. In contrast with the contemporaneous terrestrial coal-bearing succession of the Western Europe the Gzhelian strata in the Moscow Basin are the marine carbonates with abundant marine fossils and they are traceable in far distance around the East European Platform and in other regions of the World. Gzhelian Stage was based on the occurrence of the specific assemblage of macrofossils (mainly brachiopods) found in the layers exposed in small quarries that existed at the end of the XIX century near Gzhel and Rusavkino villages and studied by S.N. Nikitin [1890b]. This site is located in the south-east from Moscow within the southern limb of Moscow Syneclise. The series of outcrops in the quarries near the Rechitsy Village is considered as a Gzhelian stratotype. Here Nikitin [1890a, site 508, p. 148] observed "brown-yellow clayey dolomite limestone alternating with the layers of sandstone marl of the same color and containing abundant fauna specific for Moscow Basin". In more western quarries this dolomite limestone with thickness of 2 m is underlain by white dense limestone with visible thickness near 2 m. Similar characteristics of this section was later given by B.M. Danshin [1947, p. 211–212], N.N. Smirnov [1930, p. 125], E.A. Ivanova and I.V. Khvorova [1955, p. 209–212], A.B. and A.A. Aprodov [1963]. B.M. Danshin attributed these deposits to originally proposed Rusavkino Formation of the *Omphalotrochus* Horizon.

The most comprehensive description of the stratotype was done by M.Kh. Makhlina and E.A. Ivanova in the Guidebook published to the VIII International Congress on Carboniferous Stratigraphy and Geology took place in 1975 [Makhlina, Ivanova 1975]. The set of detailed sections composed from the bed by bed lithological description was published additionally for the participants of the geological excursion in the Moscow Basin. The description here includes (bottom-up):

Rusavkinian. Rechitsy Formation.

1. Limestone white, weakly clayey, bioclastic with abundant small solitary corals, bryozoans, algae, small foraminifers, with bioclasts of echinoderms and brachiopods, partly replaced by chalcedony. Limestone contents spherical chert nodules. Thickness 2.5 m.

2. Limestone white thin-grained, with scattered bioclasts of crinoids, brachiopods, algae fragments with trace fossils filled with cloddy sediment. Thickness 0.7 m.

3. Yellow-brown thin-grained dolomite with abundant gastropod molds. The clay layer containing the carbonate rock fragments underlies the dolomite. Thickness 1.1 m.

4. Limestone and diagenetic dolomite partly recrystallized, fine- and thin-grained containing gastropods, brachiopods, bryozoans, trilobites, small foraminifers (Textulariidae) and fusulinids. Thickness 1.2 m.

5. Limestone yellow, fine- and thin-grained containing solitary corals, other fauna and algae. Thickness 1.6 m.

The abundant fossil assemblage was found in beds 4 and 5: fusulinids *Quasifusulina longissima* (Möller), *Triticites* (*Triticites*) *rossicus* (Schellwien), *T.* (*Rauserites*) *pararcticus* Rauser, rugose corals *Gshelia rouilleri* Stuckenberg, *Pseudobradyphyllum nikitini* (Stuckenberg), the diverse bryozoans, and brachiopods *Chonetinella uralica* (Möller), *Neochonetes dalmanoides* (Nikitin), *Lissochonetes geinitzianus* (Waagen), *Waagenoconcha humboldti* (d'Orbigny), *Calliprotonia fasciata* (Kutorga), "*Buxtonia*" *subpunctata* (Nikitin), *Linoproductus lineatus* (Waagen), *Chaoiella boliviensis* (d'Orbigny), *Neospirifer poststriatus* (Nikitin), *Choristites supramosquensis* (Nikitin), гастроподы *Omphalotrochus rossicus* Likharev and many others.

E.A. Ivanova and S.E. Rozovskaya [1967] raised the rank of the Rusavkino Formation to regional substage, but later the latter was renamed into Retchitsian Regional Substage [Makhlina et al., 1979]. The name

Rusavkino was considered as belonging to formation. In developing the Unified Chart of the Carboniferous of the Russian Platform [Kagarmanov, Donaklova, 1990] the name Retchitsian was replaced by Dobryatinian, because it joined the previously separate Retchitsian and Amerevian regional substages belonging to the same fusulinid zone.

Based on the recent drillings within the territory of Moscow City [Alekseev et al., 1998] and investigation of the Rusavkino section it was discovered that the Rusavkino Formation consist of five units. Some of these units are separated by hiatuses of unknown duration. These five units are grouped into three members. The Lower and Middle members of the Rusavkino Formation are constituted by shallow-water limestones and clays which is overlaid by white mudstone showing an erosion surface at the top. Upper member (unit 5) overlays the middle one with distinct disconformity.

In December 2007 the International Subcomission on Carboniferous Stratigraphy is made the decision on the establishing of the lower boundary of the Gzhelian Stage at the level of the first appearance of the conodont *Idiognathodus simulator* (s. s.) [Villa and Task Group, 2007; Heckel et al., 2008]. In the Moscow Basin this event was established in the lower part of the Upper member of the Rusavkino Formation (unit 5), in 5–6 m above the traditional boundary of the Kasimovian and Gzhelian stages [Alekseev, Goreva, 2007].

Description of the section

Nowadays the stratotype is a part of an old quarry scarp with height of 5–6 m located in to the west from the Rechitsy Village near by the railway platform 55th km. Geographical coordinates are 55° 36' 38,8" N, 38° 25' 22,9" E. The absolute altitude of the bottom of section is about 132 m. In the northern wall of the quarry in the distance of 50 m there is an outcrop of the upper part of Rusavkino Formation.

Kasimovian
Dorogomilovian
Rusavkino Formation. Middle member, upper part. Unit 4

1. Limestone white, fine-grained (mudstone) porcelain-like at the top and includes stylolites. The limestone is strongly fractured and contents varicolored chert nodules of predominant spherical shape (up to 15 cm in diameter). Scarce brachiopods and fairly numerous solitary rugose corals which skeletons are often replaced by silica occur in this bed. Conodonts *Streptognathodus firmus* Kozitskaya and *S.* aff. *S. vitali* Chernykh, *Hindeodus minutus* (Ellison) were found in the lower part of the limestone. Visible thickness it up to 2 m, but the lower part of the bed is covered by debris. Nowadays nonexistent quarry situated southward from the Gzhel railway station. The visible thickness of the white limestones in this quarry reached up 3.2 m.

Gzhelian
Dobryatinian
Rusavkino Formation. Upper member. Unit 5

2. Green and red clay laying on the irregular surface of the white limestone. Sometimes in the clay large (up to 10 cm) flattened calcareous pebbles occur. The clay blows out laterally along the strike. Thickness 0–0.15 m.

3. Dolomite light-brown, yellow-brown, weakly clayey. Some levels content the aggregations of cavities appeared after leaching of the gastropod and bivalve shells. The cavities after fusulinid shells dissolution are observed rather rare. Some dissolutrion cavities opens filled with the calcite and quartz crystals. The flattened brown siliceous nodules often occur near the top of the bed. Conodonts *Adetognathus* sp. и *Idiognathodus toretzianus* Kozitskaya were found and the juvenile specimen of *I. simulator* occur at the top of the bed (sample 103). Thickness 0.6 m.

4. Limestone dolomitized light-brown-brown containing the large amount of the fusulinids. The dominate species are *Quasifusulina longissima* (Möller), *Q. ultima* (Kanmera), *Q. eleganta* (Schlykova), *Q.* ex gr. t*enuissima* (Schellwien). Also *Rauserites paraarcticus* (Rauser) и *R. postarcticus* (Rauser) occur, but not so often. Sporadic *Ozawainella* sp. (probably, *O.* ex gr. *angulata*) was found also. In the upper part of the bed

single *Rauserites* sp. (*R.* aff. *rossicus*) appear. The assemblage of small foraminifers includes rare *Textularia* and *Tuberitina*. The limestone top demonstrates abundant *Zoophycos* trace fossils and brachiopod shells. The conodonts in this bed are numerous: *Idiognathodus toretzianus* Kozitskaya, *Streptognathodus pawhuskaensis* Gunnell и *Idiognathodus simulator* (Ellison). Thickness 0.5 m.

5. Limestone yellow-gray with visible glauconite grains and numerous conodont elements *Streptognathodus pawhuskaensis* Gunnell, *Idiognathodus tersus* Ellison, *I. simulator* (Ellison). Among them the deep-water genus *Gondolella* appears. Foraminifers are rare and their assemblage includes *Quasifusulina* sp. (*Q.* ex gr. *longissima*), *Ozawainella* sp., *Textularia* sp. Thickness 0.1 m.

6. Limestone yellow-gray, bioclastic, weackly dolomitized. The abundant elongated and curved light-grey and brown siliceous concretions with white cover are typical for this bed. Their diameter is between 5–7 cm. The concretions are oriented mainly sub-vertically and resembles the filling of the burrows. Sometimes thin (up to 1 cm) layer of green clay is visible at the bottom of limestone. Abundant conodonts are represented by the same species as in the bed 5. In the upper part of the bed the microspicules of the siliceous sponges appear. Thickness 0.4 m.

7. Yellow-brown marl and clay limestone with characteristic wave-like bedding. It contents numerous remains of silicified brachiopods, bryozoans, and corals. The spicules of siliceous sponges found in the rock show the often aggregation in bunches. Because of the subsistent amount of spicules the rock can be called by spiculite. Thickness 0.4 m.

8. Clay green-brown partly compacted into shale with thin (5–7 cm) lenticular layers of yellow-brown coarse-grain limestone. The latter contents numerous bryozoans, brachiopods, solitary rugose corals, fragments of crinoid stems. The remains of fauna are often silicified, the sponge spicules are numerous. This bed is characterized by mass accumulation of the fusulinid shell belonging to *Rauserites rossicus* (Schellwien). Among them there are single *Rauserites paraarcticus* (Rauser) и *R. postarcticus* (Rauser). The assemblage of conodonts became impoverished. The sparse shallow water representatives of *Adetognathus* appear. Thickness 0.8 m.

9. Limestone brown-yellow, sometimes grey and reddish, thin-grained, thin frag-like containing large (up to 20 cm) siliceous concretions. It is visible as separate blocks, sometimes displaced. Thickness up to 0.3 m.

The Carboniferous deposits are overlain by the Kriushino Formation of the Callovian Stage (Middle Jurassic). The Kriushino Formation consists of reddish-yellow calcareous clay and sandstone with sparse limonitic oollites and reworked Carboniferous fossils, pebbles (5 cm) of chert and quartz.

Biostratigraphic analysis

Fusulinids (Fig. 1; Plates 1, 2). Fusulinids were found in the upper part of the sections (beds 4–8). Four levels with fusulinids were distinguished, but only in two of them they are common. One level is in the middle part of the bed 4 and includes abundant *Quasifusulina longissima* (Möller) (sample 104). The numerous *Rauserites rossicus* (Schellwien) were found in the lower part of the bed 8 (sample 112) where they co-occurred with scarce *Rauserites postarcticus* (Rauser), *R. paraarcticus* (Rauser), single *Ozawainella* sp. (*O.* ex gr. *angulata*) and *Textularia* sp. The vertical fusulinid distributions in the section demonstrate two ecological assemblages replacing each other upwards. The first (lower) one in beds 4 and 5 integrates the numerous population of *Quasifusulina* dominated over the *Rauserites*. This assemblage includes *Quasifusulina longissima* (Möller), *Q. ultima* (Kanmera), *Q. eleganta* (Schlykova), *Q.* ex gr. *tenuissima* (Schellwien), *Rauserites postarcticus* (Rauser), *R. paraarcticus* (Rauser), *R.* sp. (*R.* aff. *rossicus* Schellwien), *Textularia* sp. and single *Ozawainella* sp. (*O.* ex gr. *angulata*). The second (upper) assemblage in bed 8 includes the rich population of *Rauserites*. The species *Rauserites rossicus* (Schellwien) is the absolute dominant of this assemblage. *R. postarcticus* (Rauser) and *R. paraarcticus* (Rauser) are minor components. However taxonomic diversity of fusulinids in this section is impoverished.

The Gzhel section is a *locus typicus* for species *Rauserites rossicus* (Schellwien) which was discussed recently as one of the markers of the lower boundary of the Gzhelian Stage. In 1908 Ernst Schellwien described the new variety within the group *Fusulina alpina – Fusulina alpina* var. *rossica* [Schellwien, taf. XV, fig. 5–12; taf. XVI, fig. 1, 2]. Following changes of the taxonomical status of *F. alpina* var. *rossica* [Rauser-Chernousova, 1938; Davydov, 1990; Rauser-Chernousova et al., 1996] allow to consider *F. alpina* var. *rossica*

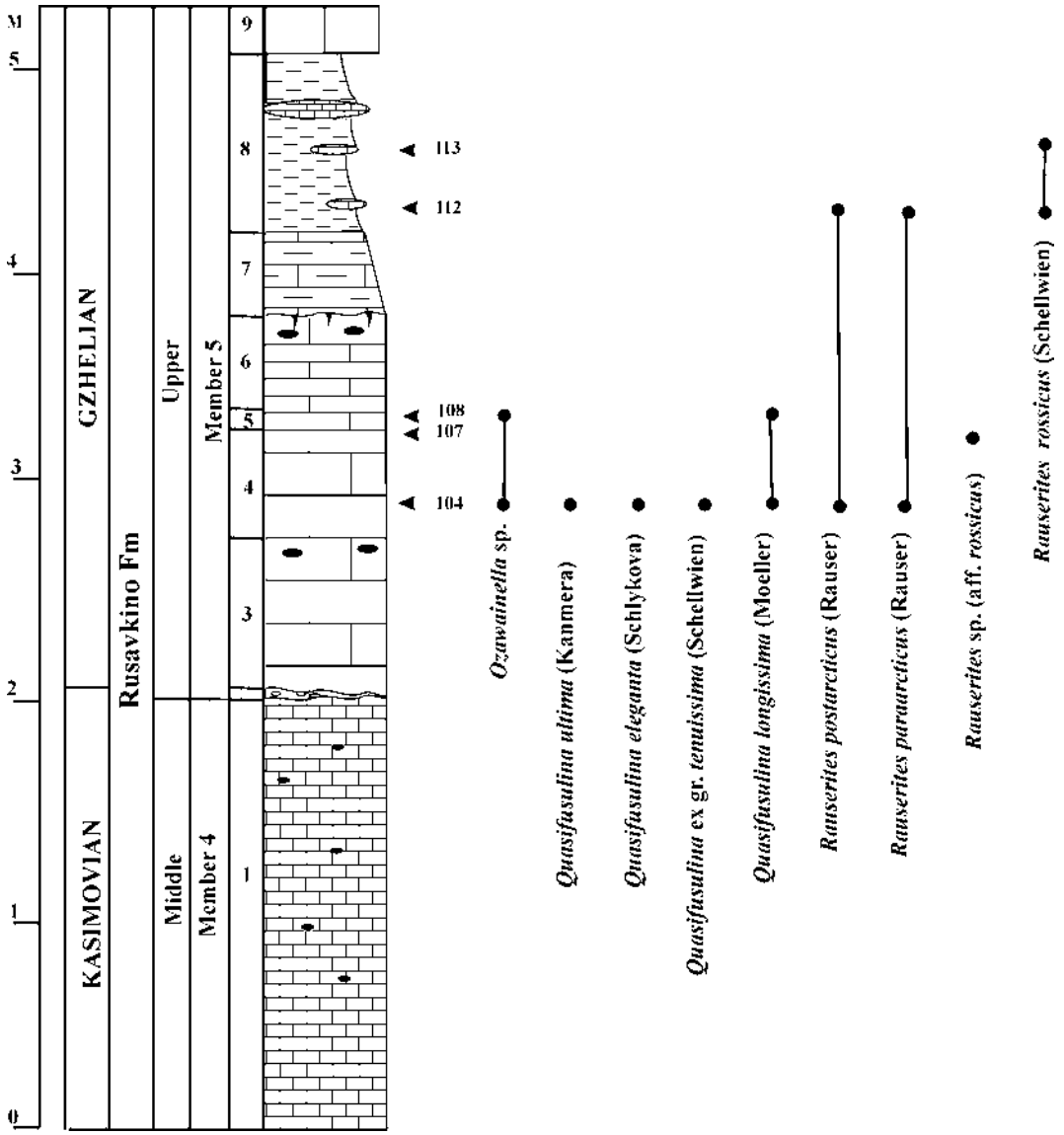


Fig. 1. Distribution of the fusulinids at the Gzhel Section

as a separate species *Rauserites rossicus* (Schellwien). The available and recently collected specimens of this species from bed 8 show the differentiation of the population. The groups corresponding to forms *typica*, *regularis* and *atypica* are distinguished [Isakova, Ueno, 2007; Isakova, 2008]. Each group is characterized by the specific morphological features, distinguishing them from the other ones. But there some specimens with transitional features, so that the limits between groups in population are changeable and flexible. Variation of the morphological features observed in the available material shows that the extreme morphotypes in the variability range belong to forms *regularis* and *atypica*, and species *R. rossicus* (Schellwien) seems to be polymorphic. Thus we have to take into the account the polymorphic status of this species when using it as a marker of the global boundary of the Gzhelian.

Conodonts. This section contents 19 levels with conodonts (Fig. 2; Plate 3). There were found about 2000 conodont elements. A few *Streptognathodus firmus* Kozitskaya distinguishing the zone of the same name have been found at the base of the bed 1 (unit 4). The lower part of the unit 5 (bed 3) contains mostly shallow-water *Adethognathus* and sparse *Idiognathodus toretzianus* Kozitskaya. The single juvenile specimen of *I. simulator* occurs in top of bed 3 (sample 103). The remarkable renovation of the conodont taxonomical composition was established from the level of the sample 104 where *Streptognathodus pawhuskaensis* Harris et Hollingsworth and *Idiognathodus tersus* Ellison has first appearance. The number of conodont elements increases sharply in sample 105. Sometimes the abundance of conodonts is above 200 specimens/kg.

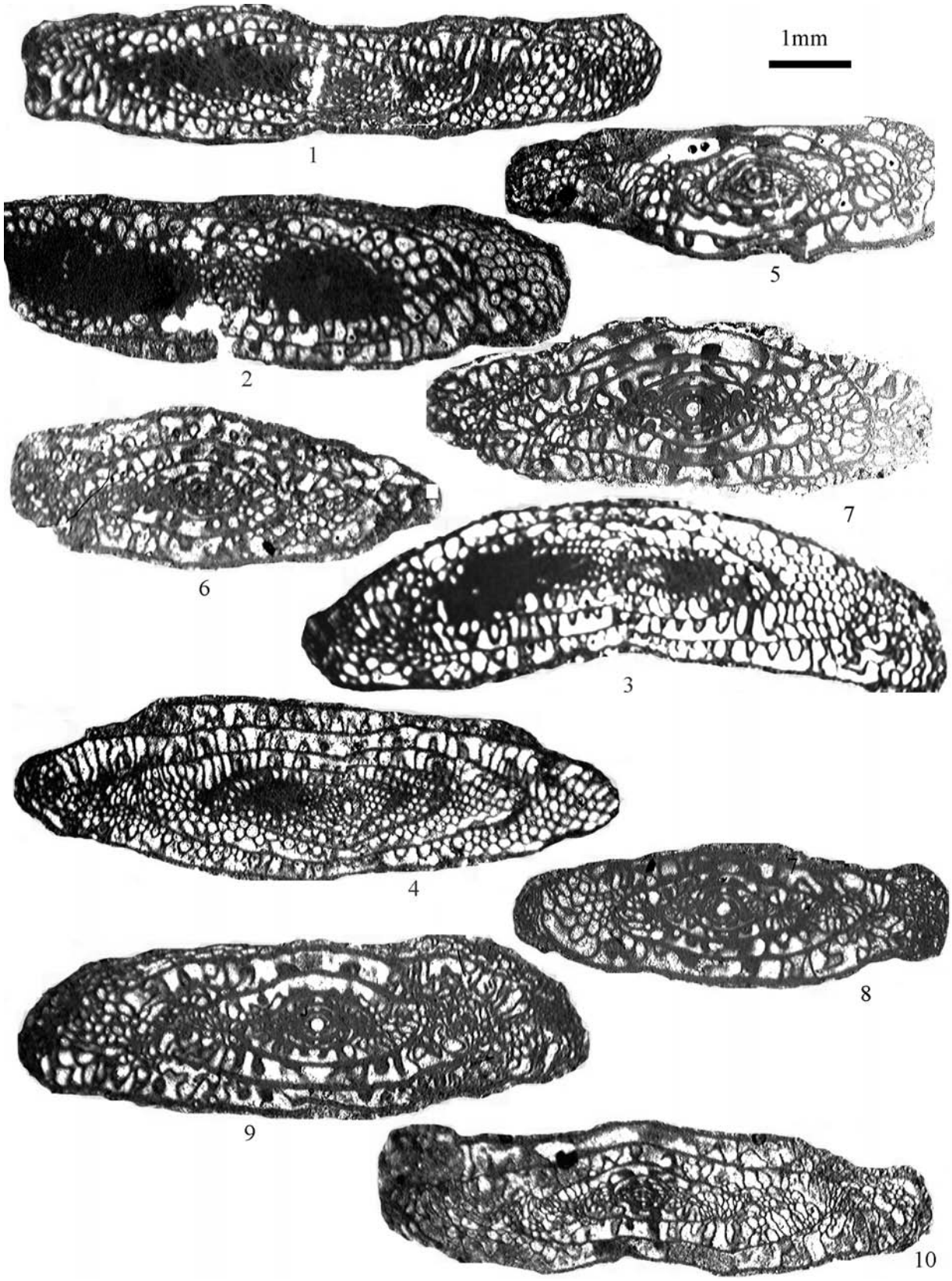


Plate 1. Fusulinids from Gzhel section, bed 4, sample 104, ×20

1, 2 — *Quasifusulina longissima* (Möller): 1 — №4790/1; 2 — №4790/2. **3** — *Quasifusulina ultima* (Kanmera), №4790/3. **4** — *Quasifusulina* ex gr. *tenuissima* (Schellwien), №4790/4. **5, 8, 9** — *Rauserites postarcticus* (Rauser): 5 — №4790/5; 8 — №4790/6; 9 — №4790/7. **6, 7** — *Rauserites paraarcticus* (Rauser): 6 — №4790/8; 7 — №4790/9. **10** — *Rauserites* sp. (*R.* aff. *rossicus* Schellwien), №4790/10, upper part of bed 4, sample 107

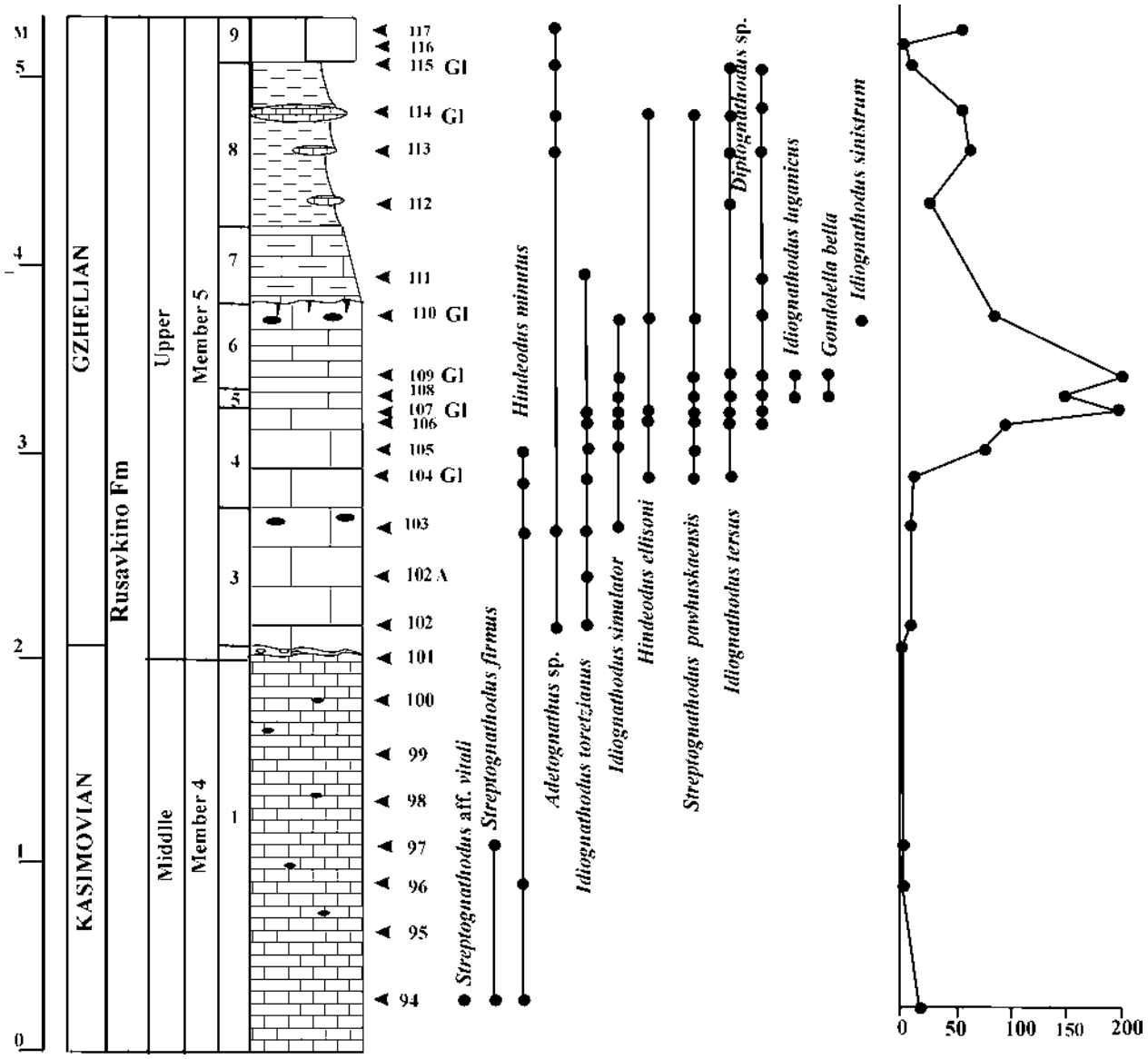


Fig. 2. Distribution of the conodonts at the Gzhel Section

The typical specimens of *Idiognathodus simulator* appear at this level. The first appearance of *I. simulator* marks the lower boundary of the conodont Zone bearing the same name and the base of the Gzhelian in its new definition [Heckel et al., 2008]. The short range and wide geographical distribution allows to consider the first appearance of the species as a good tool for correlation of this boundary. *I. simulator* group is well studied [Barrick et al., 2008] and occurs in many marine sections of the Upper Pennsylvanian both in Northern America and Eurasia. The level of the first appearance of this species was proposed for definition of the base of the Gzelian Stage in the Moscow Basin [Barskov et al., 1980; Alekseev, Goreva, 2007] and the Urals [Chernykh, Reshetkova, 1988].

The assemblage of the *I. simulator Zone* is very specific and well recognizable. Besides the index species it includes *Streptognathodus pawhuskaensis* Harris et Hollingsworth, *Idiognathodus tersus* Ellison, *I. toretzianus* Kozitskaya, *I. luganicus* Kozitskaya, *I. sinistrum* Chernykh, and *Gondolella bella* Stauffer et Plummer.

The lower boundary of the Gzhelian has to be situated inside of Rusavkino Formation (close to the base of its upper member). Despite the proposed boundary is located somewhat above the base of the Rusavkino Formation, this will not affect the regional and interregional correlation.

The conodonts collected in the stratotype of the Rusavkino Formation (the lower part of the Gzhelian Stage) nearby the Rusavkino Village and from borehole 6k, drilled northward the Gzhel railway station near the

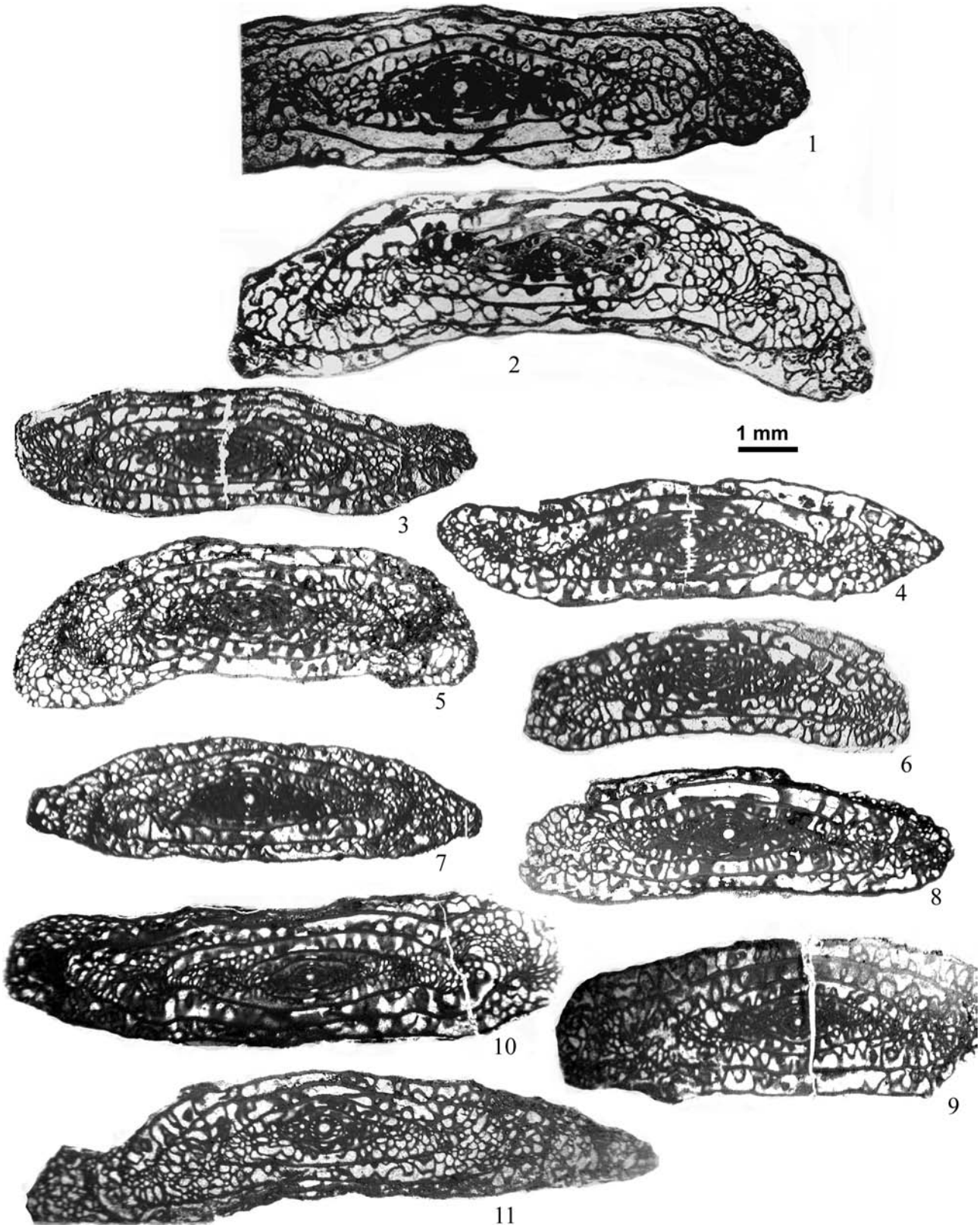


Plate 2.Fusulinids from Gzhel section, all specimens (besides 1 and 2) from bed 8, sample 112

1, 2 — *Rauserites rossicus* (Schellwien). Photo from Schellwien E. Monographie der Fusulinen. Teil I. 1908–1909; ×13.5. **3–7** — *Rauserites rossicus* (Schellwien) forma *typica*: 3 — №4790/11; 4 — №4790/12; 5 — №4790/13; 6 — №4790/14; 7 — №4790/15. **8–10** — *Rauserites rossicus* (Schellwien) forma *regularis*: 8 — №4790/16; 9 — №4790/17; 10 — №4790/18. **11** — *Rauserites rossicus* (Schellwien) forma *atypica*, №4790/19

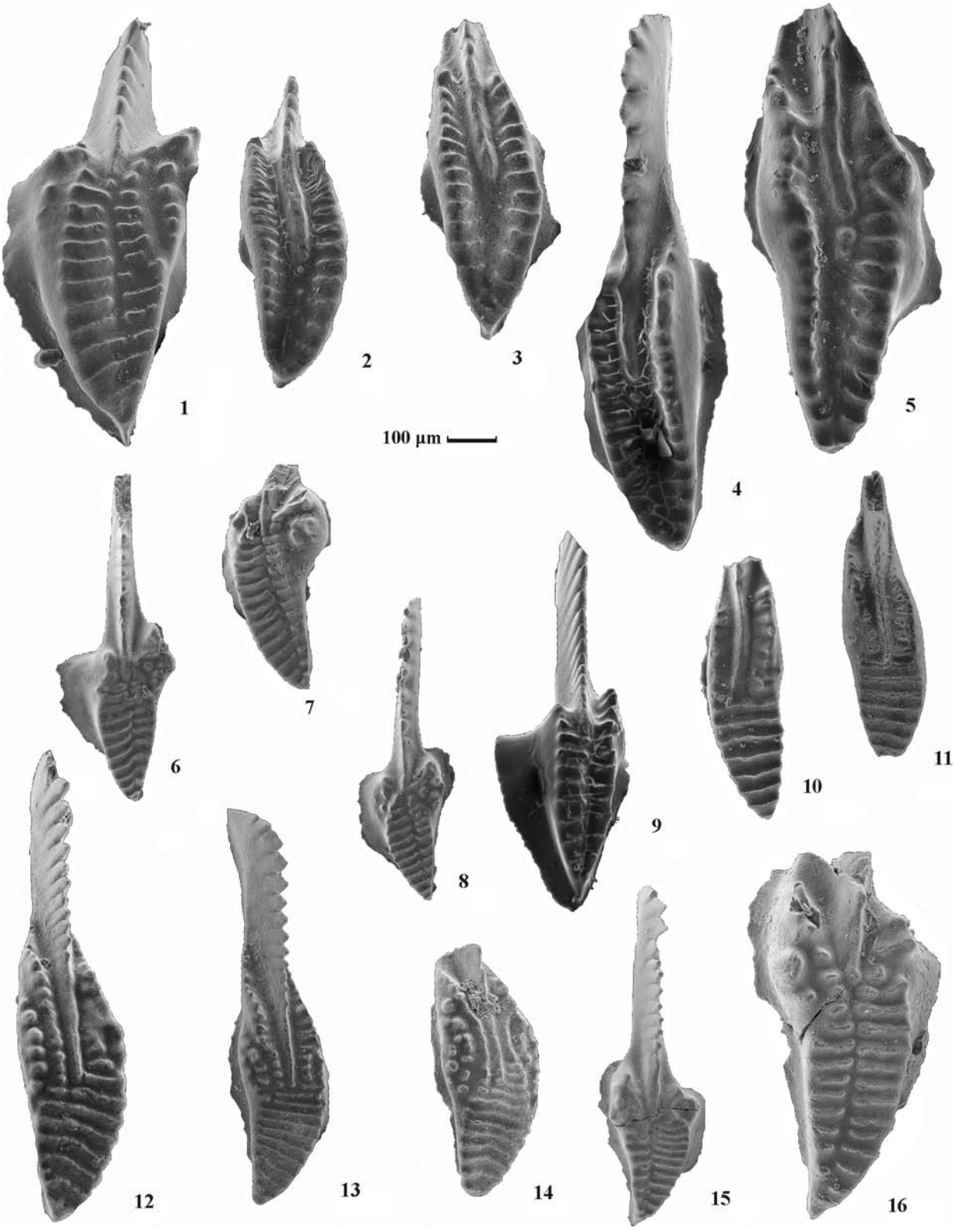


Plate 3. Pa elements of conodonts from Gzhel section. Scale bar represents 100 µm

1 — *Idiognathodus* aff. *sinistrum* (Chernykh); bed 4, sample 108. **2–5** — *Streptognatodus pawhuskaensis* Harris et Hollingsworth; bed 4; 2, 5 — sample 106; **3** — sample 104; 4 — sample 107. **6–8** — *Idiognathodus simulator* (Ellison); 6, 8 — bed 6, sample 110; 7 — bed 5, sample 108, **9** — *Idiognathodus luganicus* (Kozitskaya); bed 4, sample 106. **10, 11** — *Idiognathodus tersus* Ellison; 10 — bed 4, sample 104; 11 — bed 8, sample 112. 12–14 — *Idiognathodus toretzianus* Kozitskaya; **12, 14** — bed 4, sample 105; 13 — bed 4, sample 104. **15, 16** — *Idiognathodus* ex gr. *simulator* (Ellison); 15 — bed 6, sample 110; 16 — bed 5, sample 108

Konyashino Village have been re-studied additionally. Our recent investigation shows that *Idiognathodus* aff. *simulator* (= *I. eudoraensis* Barrick et al., 2008) considered as a possible ancestor of *I. simulator,* appears in the Moscow Basin succession in Troshkovo Formation (Dorogomilovian, Kasimovian Stage) and occurs also in the lower and middle members of the overlaying Rusavkino Formation. The level of the first appearance of *Idiognathodus simulator* is close to the first appearance of *Rauserites rossicus* (Schellwien) in the Moscow Basin.

The upper part of the unit 5 contains an impoverished conodont assemblage with predominant *Adetognathus* and *Diplognathodus.*

Rugose corals (Plate 4). A.A. Stuckenberg [1888] described Gzhelian rugose corals collected near the villages Rusavkino and Gzhel. The most comprehensive study was made by T.A. Dobrolyubova [1940]. She proposed a new diagnosis for genus *Gshelia* Stuckenberg and a new genus name *Pseudobradyphyllum* for *Zaphrentis nikitini* Stuckenberg. Dobrolyubova described four species from the outcrops nearby Rusavkino and Gzhel villages: *Cyathaxonia cornu* Michelin var. *orientalis* Dobrolyubova, *Pseudobradyphyllum nikitini* (Stuckenberg), *Pseudobradyphyllum serpens* Dobrolyubova, *Gshelia rouilleri* Stuckenberg. As a result of the revision of the Stuckenberg's collection the neotypes of *Gshelia rouilleri* Stuckenberg and *Pseudobradyphyllum nikitini* Stuckenberg were selected [Ivanovsky, 1987]. But the neotype of *Gshelia* is a mature stage only, so it is not sufficient for identification of this species. A difference between early and mature stages is the most remarkable feature of this genus (and species). The early ontogenetic stage of *Gshelia rouilleri* Stuckenberg demonstrates presence of columella, but the mature stage is a typical "caninomorphic type" bearing no axial structure. Making a revision of Eichwald [1861] collection J. Fedorowski [Fedorowski, Gorianov, 1973] assigned some specimens from Myachkovian (Upper Moscovian) to *G. rouilleri*. Also these specimens are in early ontogenetic stage and demonstrate the connection of cardinal septa with columella that contradicts the diagnosis of *G. rouilleri.* The absence of mature stages does not allow to observe the transition to "caninomorphic" structure and we do not consider the Myachkovian specimens as *G. rouilleri* Stuckenberg.

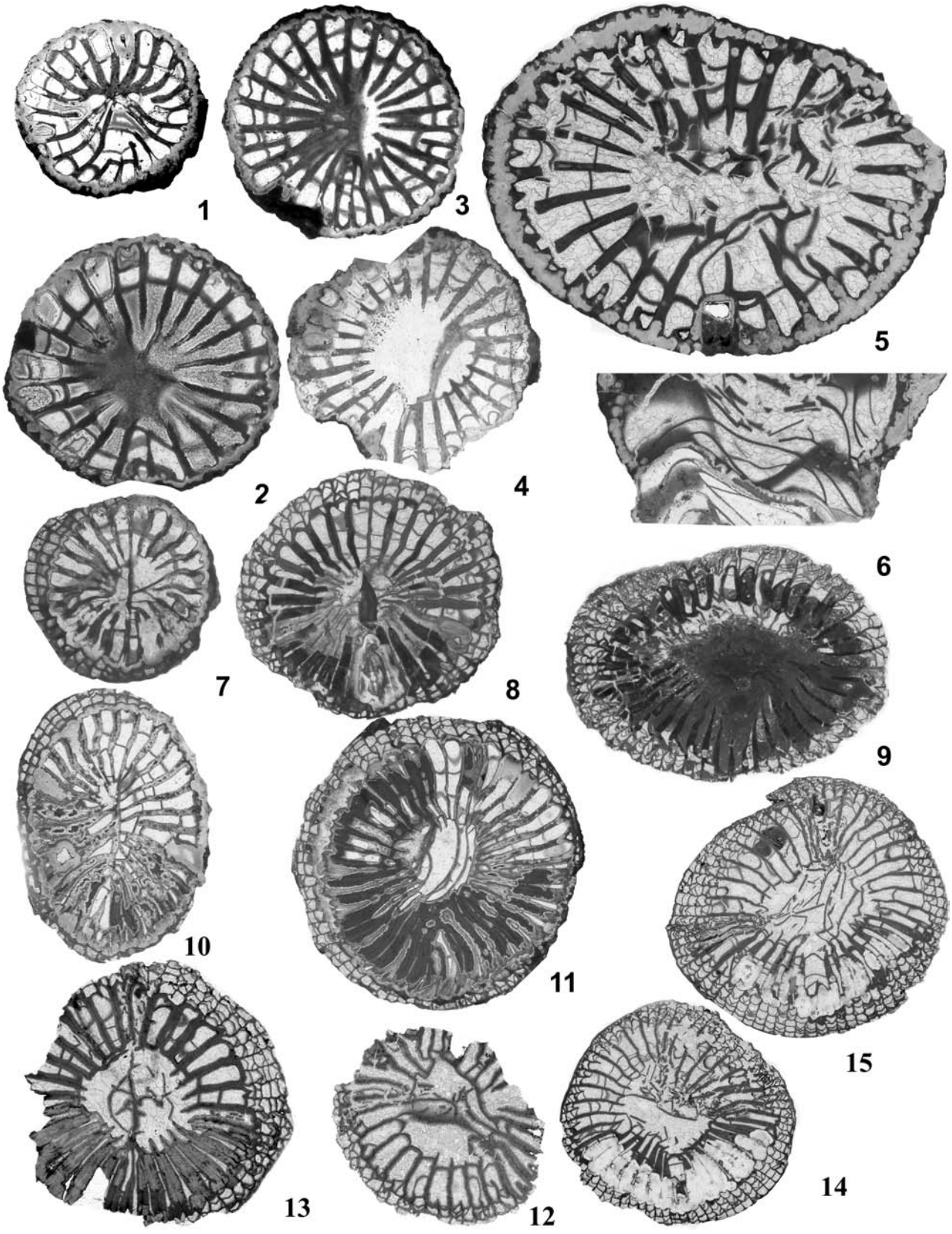
E.A. Ivanova and I.V. Khvorova [1955, p. 210] assigned the mentioned list of species to bed 10 of the upper part of the Gzhel-Rusavkino composite section. It was added by *Gshelia rouilleri breviseptata* Dobrolyubova et Kabakovich [1948]. However latter subspecies occurs only in the contemporaneous strata of the Oka-Tsna Swell. Later the part of the specimens assigned to *Gshelia rouilleri breviseptata* Dobrolyubova et Kabakovich was included in *Arctophyllum intermedium* (Toula) [Fedorowski, 1975]. *Pseudobradyphyllum nikitini* (Stuckenberg) was assigned to *Paracaninia* [Weyer 1980; Iljina, 1984], but because of the difference in early ontogeny we leave this species in *Pseudobradyphyllum* (Plate 3, fig. 1–6).

The appearance of *G. rouilleri* is considered as a marker feature for lower part of the Gzhelian. It is rather widespread geographically and appear in the lower part of Gzhelian in different regions. In Russian Platform it is known from stratotype Gzhel section and was also found in Dyukino and Melekhovo quarries (Oka-Tsna Swell). Its upper limit of stratigraphical range is not absolutely clear now, but data from Oka-Tsna Swell supposed it duration up to Upper Gzhelian including *Daixina sokensis* fusulinid Zone [O.L. Kossovaya, unpublished data]. *G. rouilleri* is also known from the Yablonevyi Ovrag section (Samarskaya Luka), where it is also occur from *Rauserites stuckenbergi* Zone to *Daixina sokensis* Zone [Kossovaya, 1986]. In the Orel section (Middle Urals) it was found in the lower part of Gzhelian. Because of its stratigraphical value, the species was included in zonal succession of rugose corals [Zonal stratigraphy, 2006] as a basal zone of Gzhelian in its traditional understanding. The précised data supported the appearance of *G. rouilleri* at the bed 5 [Makhlina, Ivanova, 1975] or according the more detailed new description in the beds 7 and 8 (see above) that is close to the first appearance of *I. simulator*. In spite of the some uncertainty of its first appearance *Gshelia rouilleri* is considered as a marker taxon for the lower part of the Gzhelian.

The other macrofaunal groups. Beds 7 and 8 contain diverse macrofossil assemblage: bivalve *Exochorhynchus curtus* Astafieva-Urbajtis, 1981; gastropods *Omphalotrochus canaliculata* (Trautschold, 1874), *O. kalitvaensis*

Plate 4. Rugose corals from Gzhel section. 1–6 — Pseudobradyphyllum nikitini (Stuckenberg); 1–5 — specimen 39, transversal serial sections: 1, 2 — transversal section of the young stages, ×5; 3 — the same ×4; 4 — transversal section of neanic stage, ×4; 5— transversal section of mature stage, ×4; 6 — longitudinal section, ×4. The old quarry in the vicinity of railway station Gzhel, bed 7, Dobryatinian, Rusavkino Fm., Gzhelian. 7–15 — transversal serial sections. **7–9** — Gshelia rouilleri Stuckenberg; 7–9 — specimen 38: 7 — early ontogenetic stage, ×5; 8 — late neanic stage; 9 — mature stage, ×2. **10, 11** — specimen 50: 10 — early ontogenetic stage; 11 — late neanic stage. **12–15** — specimen 1a: 12, 13 — early ontogenetic stages; 14–15 — mature stages, ×2. The old quarry in the vicinity of railway station Gzhel, bed 7, Dobryatinian, Rusavkino Fm., Gzhelian

Plate 4



(Likharev), *Straparollus* (*Euomphalus*) *moniliformis* (Romanovsky), *Platyceras* (*Orthonychia*) *egorovi* Mazaev, 1996), *Retshitsella egorovi* Mazaev, 1998, *Sregocoelia gzheliensis* Mazaev, 2001, *Goniasma gzheliensis* Mazaev, 2004; several taxa of nautiloids; trilobite *Ditomopyge ivanovi* (Weber, 1937); more than 20 species of bryozoans revised recently by I.P. Morozova and D.V. Lisitsyn [2002]; brachiopods *Spiriferella gjeliensis* Stepanov, 1948, *Gjelispinifera gerasimovi* E. Ivanova, 1975, "*Neospirifer poststriatus*" (Nikitin, 1890), *Choristites supramosquensis* (Nikitin, 1890), *Hustedia pseudocardium* Nikitin, 1890, *Stenoscisma gjelis* Lazarev, *Laiporella modesta* E. Ivanova, 1975, *Cleiothyridina gzheleiensis* Grunt, 1980, *Neochonetes dalmanoides* (Nikitin, 1890), *Chonetinella uralica* (Möller, 18), *Lissochonetes gainitzianus* (Waagen), *Paramesolobus ivanovae* Afanasieva, 1975, *Kozlowskia borealis* (Ivanov, 1935), *Waagenoconcha humboldti* (d'Orbigny, 1840), *Calliprotonia fasciata* (Kutorga, 1834) etc; crinoid *Belashovicrinus gjelensis* Arendt et Zubarev, 1993; echinoid *Archaeocidaris nikitini* Faas, 1939.

Chemostratigraphy. Limited data on oxygen and carbon isotope composition of bulk rock are available [unpublished data by Buggisch et al.] and on oxygen isotope ratios in phosphatic material of conodont elements [unpublished data by Joachimski et al.].

Conservation. The type Gzhelian exposure is a natural reserve in Moscow Region and its renovated protection statute is under official registration.

Conclusions

In spite of hiatus at the base of Upper Member of the Rusavkino Formation below first appearance datum of Idiognathodus simulator (Ellison) and strong influence of glacioeustatic depth changes on faunal assemblages, the Gzhelian stratotype has powerful potential for long distance correlations in this stratigraphic interval.

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