

# BASHKIRIAN-MOSCOVIAN TRANSITION IN DONETS BASIN: THE KEY FOR TETHYAN-BOREAL CORRELATION

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The traditional position of the base of the **Moscovian Stage** in the Moscow Basin (MB) is at the base of the continental Azov Series [Khvorova, 1953]. Fusulinids *Aljutovella aljutovica* (Rauser) and *Schubertella pauciseptata* Rauser that were found in the overlying Aljutovo Formation are considered as practical indexes to define the base of Moscovian Stage in western Pangaea [Rauser-Chernousova and Reitlinger, 1954]. The Moscovian of the MB was redefined recently with its lower boundary at the base of the marine Aljutovo Formation, slightly above the traditional position [Makhlina et al., 2001b]. Sharp contact and unconformity at the base of Moscovian Stage in MB is preventing in principal the understanding of fusulinid phylogenies within the Bashkirian-Moscovian transition in the region. Besides this, Boreal fusulinids are dominated in MB that makes correlation of Moscovian and its subdivisions even with nearest successions in Tethys difficult [Fohrer et al., 2007; Leven et al., 2006]. Donets Basin (DB) in this respect is a key region because first the Moscovian-Bashkirian marine transition there is essentially complete. Second, the region, being close to MB, possesses both Boreal and Tethyan fusulinid taxa, although the latter are dominated in assemblages.

Thanks to F.S. Putrja, N.E. Brazhnikova, G.D. Kireeva, V.F. Manukalova and many other foraminiferal workers, the fusulinid taxonomy and refined biostratigraphy for the Bashkirian-Moscovian transition in DB has been established. The base of Moscovian in the Donets Basin was placed either at the I<sub>2</sub> limestone [Grozdilova, 1966], at the K<sub>1</sub> limestone [Kireeva, 1951], or up to the K<sub>3</sub> limestone where *Aljutovella aljutovica* (Rauser) was first reported [Aizenverg et al., 1963; Putrja, 1956]. The conodont species *Declinognathodus donetzianus* designated from DB [Nemyrovska, 1999] has been proposed as an index of the base of the global Moscovian Stage [Groves and Group, 2007]. The FAD of this species in DB is at the K<sub>1</sub> limestone [Ueno, Nemirovskaya, 2008]. Conodont *Diplognathodus ellesmerensis* Bender, recently proposed as another potential index for the base of the global Moscovian Stage [Wang et al., 2007], appears in the DB at the K<sub>3</sub> limestone [Nemyrovska et al., 1999].

In this study the following fusulinid assemblages were recognized within Bashkirian-Moscovian transition in DB (Fig. 1):

**I<sub>2</sub> Limestone:** *Eostaffella lepida* Grozdilova and Lebedeva, *E. korobcheevi* Rauser, *Ozawainella nikitovkensis* (Brazhnikova), *O. pararhomboides* Manukalova, *O. plana* Potievskaya, *O. crassiformis* Putrja, *Neostaffella pseudoquadrata* (Manukalova), *Profusulinella pseudorhomboides* Putrja, *Pr. rhomboides* (Lee and Chen), *Aljutovella skelnevatica* (Putrja), *Verella prolixa* (Sheng).

Most of *Ozawainella* in this assemblage appear in late Bashkirian and ranged into early Moscovian. *Neostaffella pseudoquadrata* (Manukalova) originally described from K<sub>3</sub><sup>1</sup> and K<sub>8</sub> Limestone in DB, and is an index of lower Vereian fusulinid zone in S. Hissar, C. Asia [Bensch, 1969]. *Pr. pseudorhomboides* Putrja, and *Al. skelnevatica* described from K<sub>3</sub>–K<sub>5</sub> Limestone in DB [Putrja, 1956] and known from Aljutovo Fm in MB [Makhlina et al., 2001a] and in upper Vereian in S. Hissar, C. Asia. *Verella prolixa* with weak septal fluting originally described from Hsiaoshin Lm of lower Penchi Series somewhat transitional in morphology between *V. varsanofieva* (latest Bashkirian in east of Russian Platform, Central Asia and C. Urals) and *Verella? transiens* Ginkel and Villa from Vereian of Cantabrian Mountains [van Ginkel, 1987].

**I<sub>3</sub> Limestone** — *Verella? transiens* Ginkel and Villa transitional form to *Paraeofusulina* with well developed septal fluting described from the base of Lena Fm in Cantabrian Mnt and correlates with middle Vereian [van Ginkel, 1987].

**I<sub>4</sub> Limestone** — *Ozawainella paraumbonata* Potievskaya, *Aljutovella skelnevatica* (Putrja), *Al. aff. skelnevatica* (Putrja), *Profusulinella?* sp. More advanced forms of *Al. skelnevatica* group occur in this Lm, but none of the species in this assemblage provide precise correlation with type section in Moscow Basin.

**K<sub>1</sub> Limestone** — *Novella intermedia* Rauser, *Millerella symmetrica* Manukalova, *Ozawainella pseudotingi* Putrja, *O. pararhomboides* Manukalova, *Oz. mosquensis* Rauser, *Hanostaffella aff. pseudoquadrata* (Manukalova),

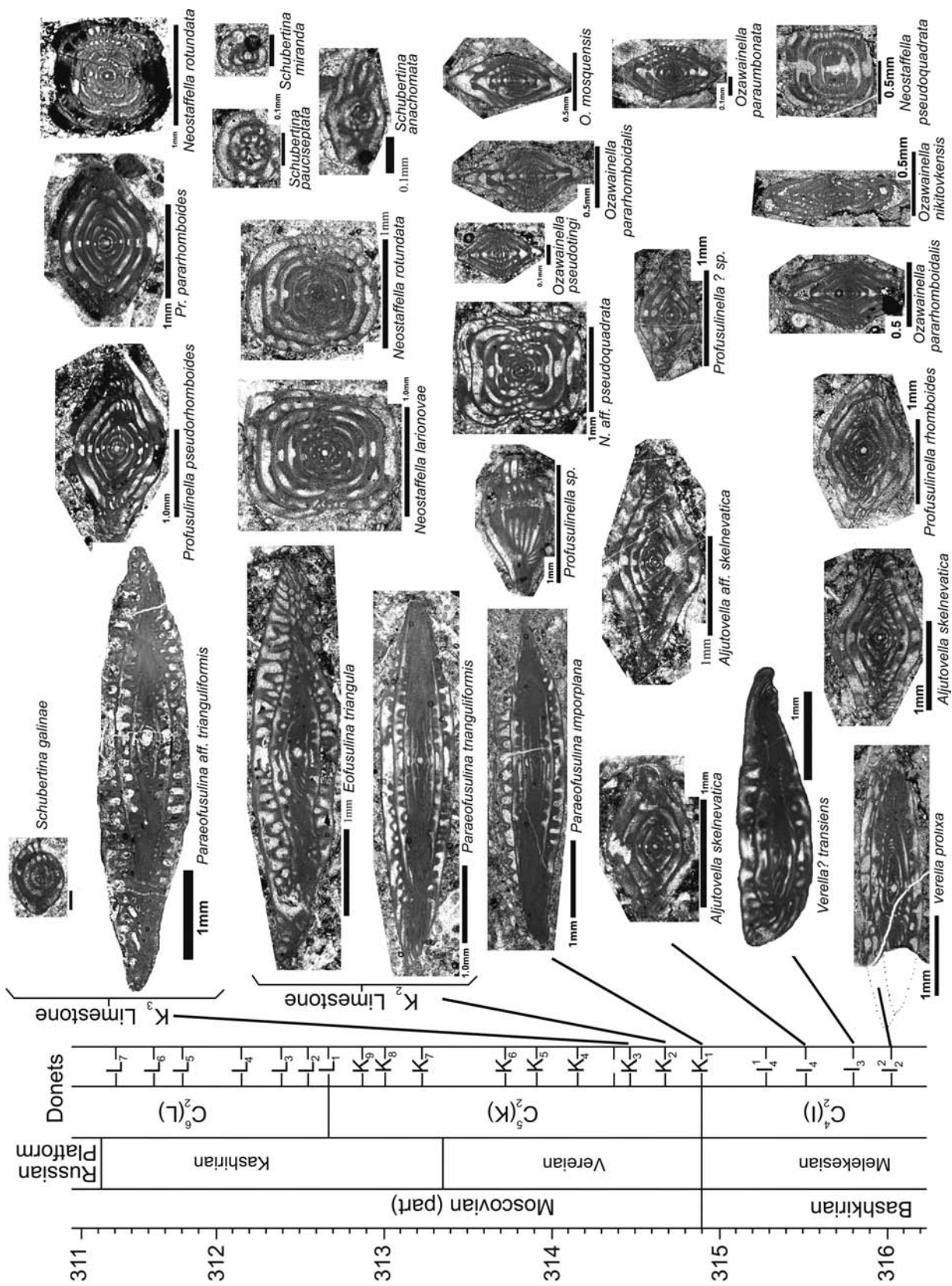


Fig. 1. Distribution of fusulinids within the Bashkirin–Moscovian transition in Donets Basin

*Paraeofusulina imporplana* (Rumjantzeva), *Profusulinella* sp. The assemblage possesses several new and prominent elements. *Oz. mosquensis* usually considered characteristic for early Kashirian and younger sediments. First *Paraeofusulina*, i.e. *P. imporplana* described from lower Moscovian in Central Kizilkum in association with *Al. aljutovica* and other typical Vereian species [Rumjantzeva, 1974]. The rest of the taxa are range from upper Bashkirian into lower Moscovian.

**K<sub>2</sub> Limestone** — *Eostaffella grozdilovae* Maslo and Vachard, *E. levenconica* Manukalova, *Millerella angusta* (Kireeva), *M. uralica* Kireeva, *M. symmetrica* Manukalova, *Ozawainella mosquensis* Rauser, *Oz.* cf. *nikitovkensis* (Brazhnikova), *Oz. concinna* Dzhenchuraeva, *Grovesella tabasensis* Davydov and Arefifard, *Schubertina miranda* (Leontovich), *Sch. pauciseptata* (Rauser), *Sch. anachomata* (Rauser), *Neostaffella rotundata* (Bensh), *N. syzranica* (Rauser and Safonova), *N. larionovae* (Rauser and Safonova), *Eofusulina triangula* (Rauser and Beljaev), *E. ozawai* (Tor.), *Paraeofusulina trianguliformis* Putrja.

The limestone undoubtedly correlates with Vereian because it has several typical species and genera. First of all, abundant *Schubertina* are found in this assemblage, including *Sch. pauciseptata* — an index of lower Vereian in MB [Makhlina et al., 2001 a]. Advanced *Neostaffella*, i.e. *N. larionovae*, *N. syzranica* and *N. rotundata* reported from Kashirian Horizon and its analogues [Bensh, 1969; Makhlina et al., 2001 a]. First *Eofusulina*, i.e. *E. triangula*, is ranging from Vereian upwards. Although *Paraeofusulina trianguliformis* described from K<sub>5</sub> Lm, it is first appears in K<sub>2</sub> Lm.

**K<sub>3</sub> Limestone** — *Eostaffella grozdilovae* Maslo and Vachard, *Schubertina galinae* (Safonova), *Neostaffella rotundata* (Bensh), *Profusulinella pararhomboides* Rauser and Beljaev, *Pr. pseudorhomboides* Putrja, *Paraeofusulina rasdorica* (Putrja). *Profusulinella* that were found in this Lm characterize the Vereian Horizon in MB [Makhlina et al., 2001 a].

**K<sub>4</sub> Limestone** (Plate 1) — *Eostaffella grozdilovae* Masl. and Vach., *E. acutissima* Kireeva, *E. kashirica* Rauser, *Millerella carbonica* Grozdilova and Lebedeva, *Ozawainella vozghalica* Safonova, *Oz. mosquensis* Rauser, *Schubertina acuta* (Rauser), *Sch. pseudoglobulosa* (Safonova), *Sch. miranda* (Leontovich), *Sch. gracilis* (Rauser), *N. larionovae* Rauser and Safonova, *N. vozghalica* (Safonova), *Profusulinella rhomboides* (Lee and Chen), *Pr. arta kamensis* Safonova, *Aljutovella postaljutovica* Safonova, *Al. dilucida* Leontovich, *Al. tumida* Bensh, *Eofusulina triangula* (Rauser and Beljaev), *Eo. gissarica* Bensh, *Eo. aff. binominata* Putrja, *Paraeofusulina aff. trianguliformis* Putrja, *Neofusulina* sp. nov.

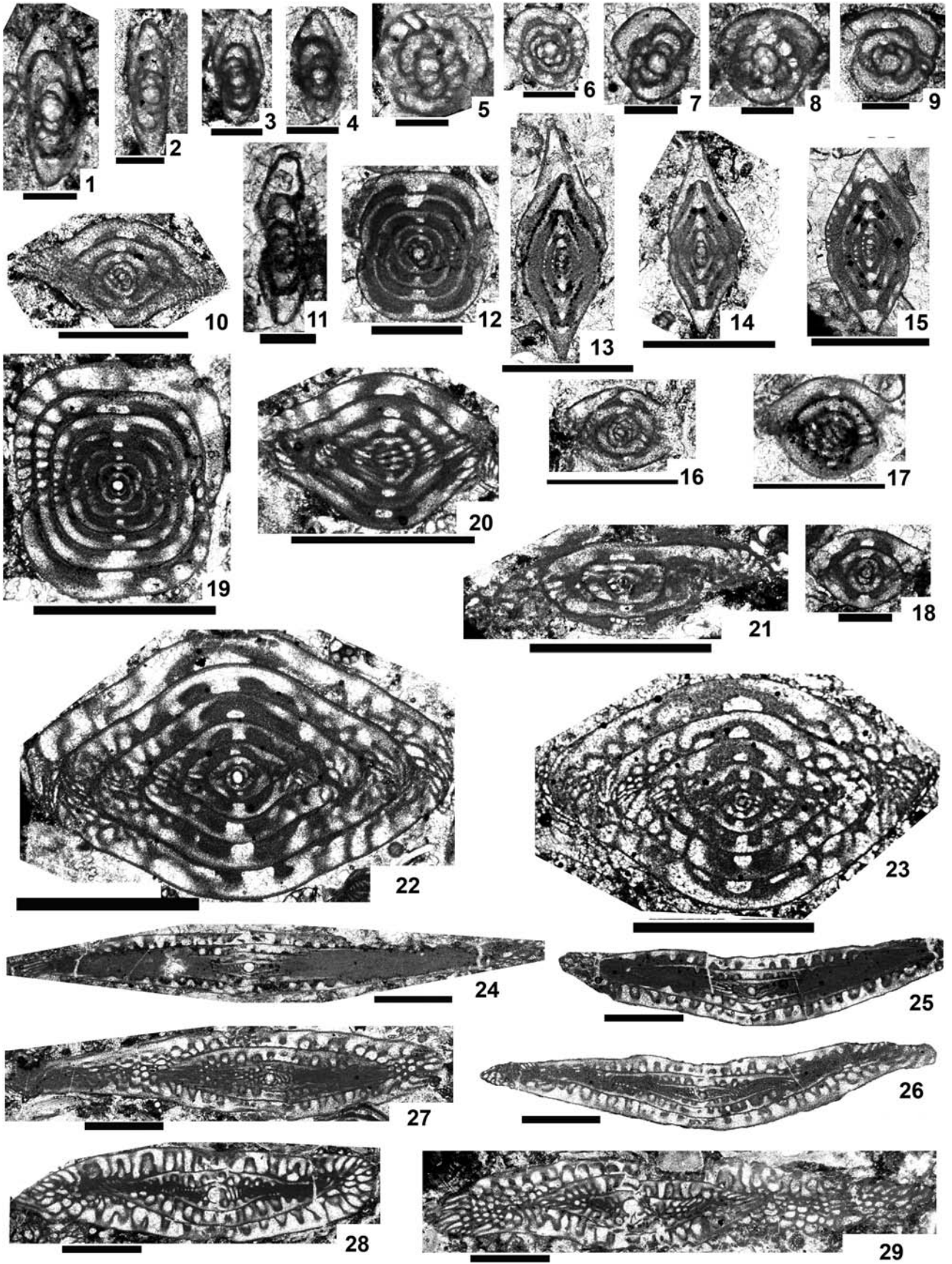
The assemblage from this Lm is quite diverse. Very prominent *Aljutovella postaljutovica*, *Al. dilucida*, and *Al. tumida* with strongly fluted septa first appear there. Such forms believed to characterize Kashirian Horizon in MB [Makhlina et al., 2001 a]. Abundant *Schubertina* including quite developed *Sch. acuta* that considered being Kashirian are also found. *Pr. arta kamensis* occurs in upper Vereian, Ordynka Fm of MB [Makhlina et al., 2001 a]. First *Neofusulina*, i.e. *Paraeofusulina* — like forms with multiple tunnels appear in this Lm as well.

## Conclusions

1. In Donets Basin some important taxonomical elements that usually considered “typical Moscovian” appear in latest Bashkirian, i.e. earlier than in MB.
2. I<sub>2</sub>, I<sub>3</sub> and I<sub>4</sub> Lms most probably are pre-Vereian (Azov Series) in age although possess some taxa that in MB characterize only Moscovian Stage.
3. K<sub>1</sub>–K<sub>3</sub> Lms most likely correlate with Aljutovo and Sknigov Fms in Moscow Basin.
4. It seems that FAD’s of *Paraeofusulina* and *Eofusulina* are best events to designate the base of Moscovian in Tethys.

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**Plate 1. Fusulinids from K<sub>4</sub> Limestone.** 1 — *Eostaffella grozdilovae* Maslo and Vachard; 2 — *E. acutissima* Kireeva; 3–4 — *E. kashirica* Rauser-Chernousova; 5–6 — *Schubertina pseudoglobulosa* (Safonova); 7–9 — *Sch. miranda* (Leontovich); 10 — *Sch. acuta* (Rauser-Chernousova); 11 — *Millerella carbonica* Grozdilova and Lebedeva; 12 — *Neostaffella cuboides* (Rauser); 13–14 — *Ozawainella vozghalica* Safonova; 15 — *Oz. mosquensis* Rauser-Chernousova; 16–18 — *Schubertina gracilis* (Rauser-Chernousova); 19 — *Neostaffella larionovae* (Rauser and Safonova); 20 — *Profusulinella rhombiformis* Brazhnikova and Potievskaya, 1948; 21 — *Pr. arta kamensis* Safonova; 22 — *Aljutovella tumida* Bensh; 23 — *Aljutovella postaljutovica* Safonova; 24–26 — *Paraeofusulina trianguliformis* Putrja; 27 — *Eofusulina triangula* (Rauser-Chernousova and Beljaev); 28–29 — *E. aff. binominata* Putrja. **Scale bars:** 1–9, 18 — 0.1 mm; 10, 12–17 — 0.5 mm; 19–29 — 1.0 mm



5.  $K_4$  Lm with advanced *Aljutovella* and *Pr. arta* might be an analogue of lower Ordynka Fm. The FAD of *Neofusulina* could be an index of Ordynka Fm (upper Vereian) in Tethys.

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