



Radiolarians from the upper Oxfordian to lower Kimmeridgian (Upper Jurassic) Domodedovo Section, Moscow Region, Central Russia

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Received 25 March 2025; received in revised form 29 June 2025; accepted 28 July 2025

Available online 31 July 2025

Abstract

A well-preserved radiolarian assemblage was studied from the Upper Jurassic of the Domodedovo quarry, Moscow Region, Central Russia. Radiolarians were found within the Ermolino Formation (upper Oxfordian to lower Kimmeridgian), in phosphatic concretions. The radiolarian assemblage is represented by 29 species of 13 genera and has a boreal affinity with some southern influence indicated by the presence of *Pantanellium*. The assemblage is characterized by the abundance of *Praeconocaryomma*, common presence of *Praeparvicingula*, and rare presence of *Phantum*, *Acanthocircus*, *Pantanellium* and *Nordvikella*. Four new species are described: *Acastea laevispina* n. sp., *Praeconocaryomma blomei* n. sp., *Phantum robustum* n. sp., *Nordvikella simplex* n. sp. © 2025 Elsevier B.V. and Nanjing Institute of Geology and Palaeontology, CAS. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

Keywords: Radiolaria; biostratigraphy; paleobiogeography; Jurassic; Central Russia

1. Introduction

Jurassic radiolarian assemblages of European Russia are known from the 20th century (Khudyaev, 1931; Khabakov, 1937; Gerasimov, 1969) when they were studied in thin sections. Modern studies of these planktonic microfossils started in the 1970s (Kozlova, 1971, 1973, 1994; Bragin, 1997; Vishnevskaya, 1998, 2001; Vishnevskaya and Baraboshkin, 2001; Vishnevskaya and Murchey, 2002; Vishnevskaya and Kozlova, 2012; Bragin and Kiselev, 2013; Ustinova et al., 2014; Palechek and Ustinova, 2020). Only some of these studies contain taxonomic descriptions of radiolarians, partly due to poor preservation of material. A detailed study of the Upper Oxfordian

radiolarian assemblage from the Moscow Region (Rybaki Section) was published recently (Bragin et al., 2024). This radiolarian assemblage has low diversity (23 species of 11 genera) and Boreal affinity due to the presence of Boreal taxa, such as representatives of genus *Praeparvicingula* (with apical horn) and taxa of the Boreal family Echinocampidae.

Such features as low diversity and presence of characteristic Boreal taxa are comparable with other Upper Jurassic and Lower Cretaceous radiolarian assemblages of European Russia, Western Siberia, and the northern part of Eastern Siberia, as was shown in a recent review (Bragin and Bragina, 2025). In comparison with data of the Upper Jurassic and Lower Cretaceous Tethyan radiolarian assemblages (Baumgartner et al., 1995), knowledge of Boreal radiolarians is still scarce. Biostratigraphic analysis of Boreal radiolarian assemblages and erection of a zonal scale

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for Boreal regions has been done recently for the uppermost Jurassic (Volgian) and lowermost Cretaceous (Ryazanian) of Western Siberia (Vishnevskaya et al., 2020).

Radiolarians were an important part of the planktonic assemblage of the Jurassic marine basins within the Boreal Superrealm (Bragin and Bragina, 2018). Further study is of great importance for understanding the paleoecology and paleobiogeography of Mesozoic radiolarians, including the biostratigraphic potential of this planktonic group for Boreal-Tethyan correlation. Another important fact is the common presence of radiolarians in key sections of the Upper Jurassic and Lower Cretaceous of Russia, including in the regional Volgian and Ryazanian stages. The presence of radiolarians in the sections characterized by zonal ammonoid assemblages allows calibration with radiolarian zones.

This paper deals with well-preserved upper Oxfordian to lower Kimmeridgian radiolarian assemblages from the Domodedovo (Moscow Region) (Fig. 1). Radiolaria were found in strata characterized by ammonites, permitting determination of the stratigraphic position and age of this assemblage. Such work represents a new step in our investigation of Upper Jurassic radiolarians of Central Russia, providing further progress in local radiolarian biostratigraphy and correlation of the Upper Jurassic strata of Russia with Tethyan regions. Our new data allow significant additions to our knowledge of taxonomy and paleobiogeography of the Jurassic Boreal radiolarians.

2. Geological setting

The main geological structure of European Russia is the East European Craton, a large stable lithosphere block formed in the Precambrian. The Moscow Region is located in the centre of the Eastern European Craton, within the Moscow Syncline (Fig. 1A), a sedimentary basin filled by sedimentary successions from Upper Proterozoic to Mesozoic (Middle Jurassic to Upper Cretaceous). In the Moscow Region marine Jurassic strata are represented by Callovian (clays and marls), Oxfordian and Kimmeridgian (clays with phosphate nodules) and Volgian (clayey sands and aleurites with phosphorite horizons) deposits (Fig. 1B). Jurassic deposits are characterized by abundant macro- and microfossils, especially ammonites that provide detailed biostratigraphy (using ammonite zones and biohorizons), bivalves and foraminifers and represent an

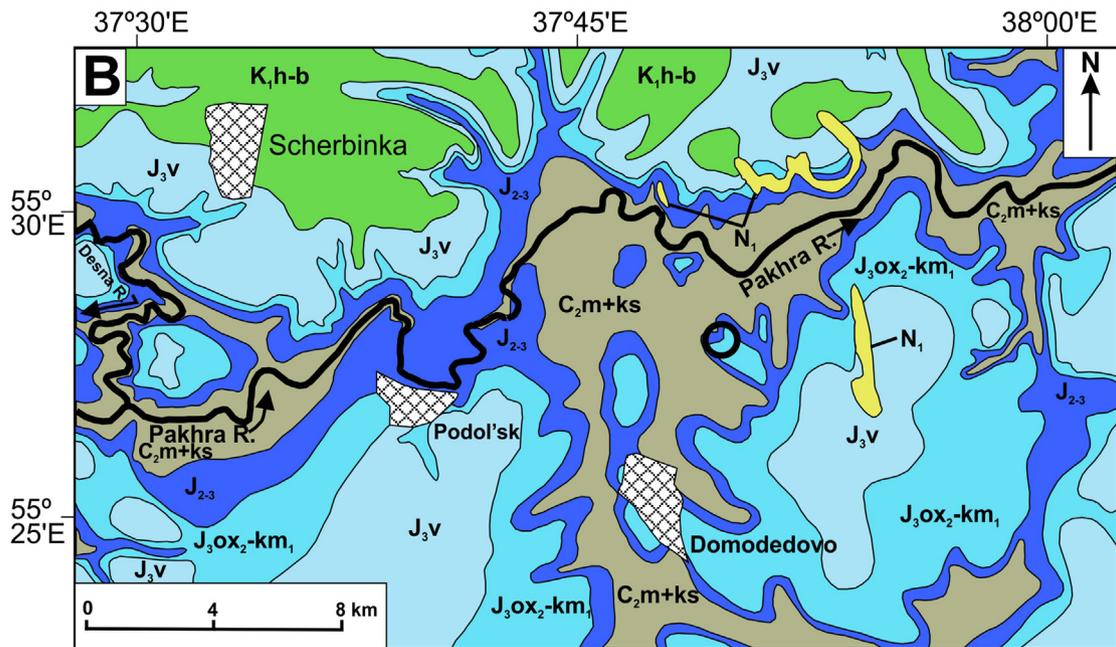
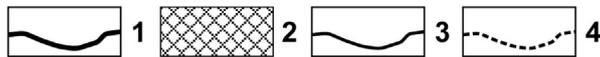
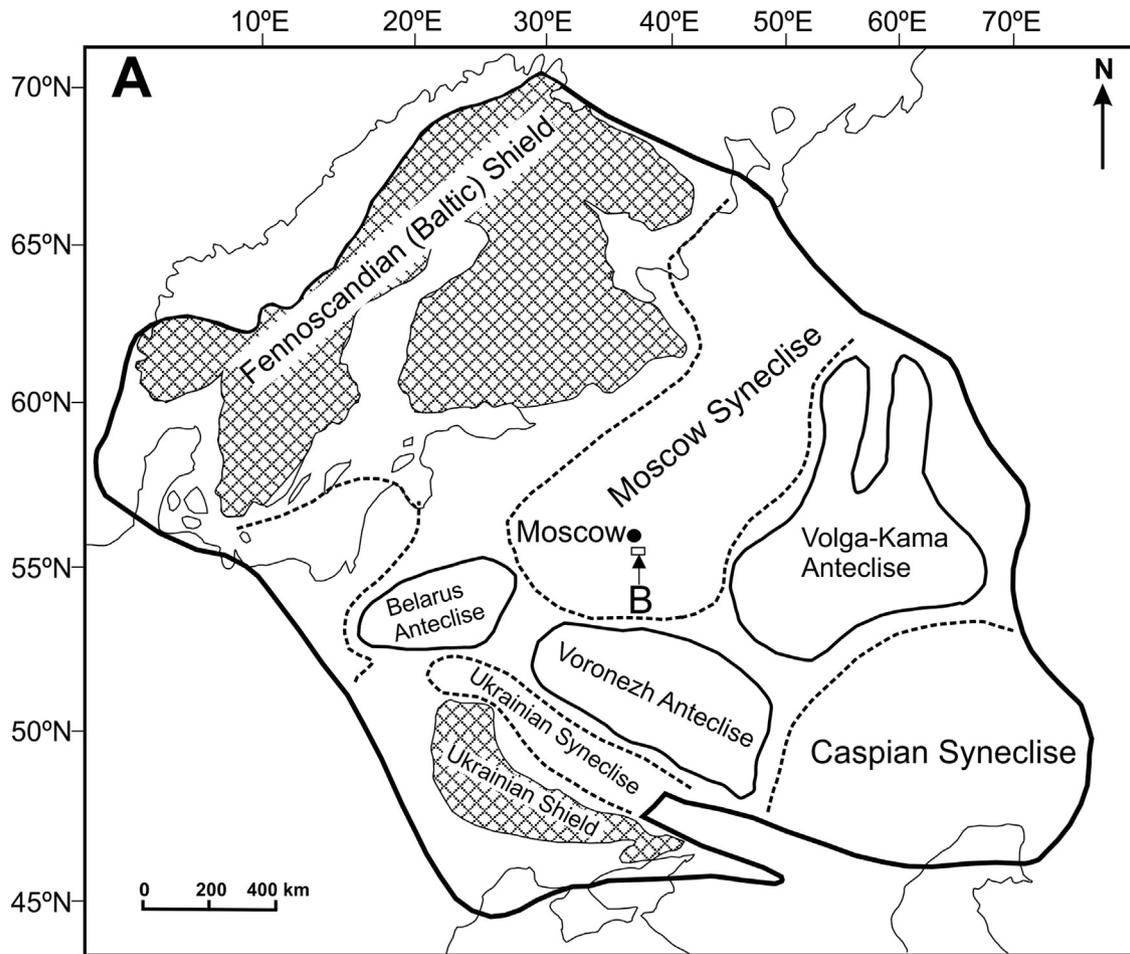
excellent opportunity to calibrate ranges of radiolarian taxa and radiolarian units.

The Domodedovo Section is located southeast from Moscow in the Domodedovo district of the Moscow Region, in the eastern part of the Domodedovo limestone quarry with the coordinates 55°28'09.17"N, 37°47'33.31"E (Fig. 1B). This section of the quarry (Figs. 2, 3A) is represented in ascending order by:

1. White to light-grey limestones with subordinate interbeds of marls and dolomites. Upper Carboniferous, Moscovian Stage, Myatchkovo Formation and Kasimovian Stage, Suvorov Formation. Thickness 20–25 m.
2. Dark-grey aleuritic platy highly bioturbated clay with ammonite *Multicardioceras tenuiserratum* (Oppel) (determination by M.A. Rogov). Upper Jurassic, middle Oxfordian. Podmoskovnaya Formation. Thickness 0.6 m.
3. Black and dark-grey platy clays with thin layers of dark-brownish-grey to dark-greenish-grey highly bioturbated aleurites. Two horizons of spherical to elliptical solid black to brownish-black phosphate concretions (2–10 cm in diameter) (Fig. 3B) are present in the levels 1.66 m and 1.9 m from the base of unit. Upper Jurassic, upper Oxfordian to lower Kimmeridgian, Ermolino Formation. Thickness 6–7 m.
4. Coarse- to medium grained yellowish-grey sands. Quaternary. Thickness 3–5 m.

The lower part of the Ermolino Formation is characterized in various locations of the Moscow Region by upper Oxfordian ammonites *Amoeboceras alternans* (Buch), *A. tuberculatoalternans* Nikitin, and by a foraminiferal assemblage with *Epistomina uhligi* Myatluk and *Lenticulina russiensis* (Myatluk). The upper part is dated as Lower Kimmeridgian by the ammonite *Amoeboceras kitchini* Salfeld and a foraminiferal assemblage with *Epistomina praetartariensis* (Umanskaya) and *Lenticulina kuznetsovae* (Umanskaya) (Artemieva et al., 2001; Olfieriev, 2012). In the lower 0.5 m of unit 3 we found the upper Oxfordian ammonite *Amoeboceras* sp. cf. *A. alternans* (Buch) (determination by M.A. Rogov). The Ermolino Formation may attain 12 m thickness, but in the Domodedovo quarry only half of this can be observed. Probably only part of the stratigraphic interval of the Ermolino Formation is present here. Clays of the upper part of the Ermolino Formation yield abundant radiolarians (Olfieriev, 2012). The Middle Jurassic to lower Oxfordian interval is not present in this

Fig. 1. Location of the study area and the Upper Jurassic Domodedovo Section. (A) Generalized map showing main geological structures of the Eastern European Craton (Milanovsky, 1996); 1 – boundary of Eastern European Craton; 2 – territories of Fennoscandian (Baltic) and Ukrainian shields; 3 – boundaries of anticlines; 4 – boundaries of synclines. (B) Simplified geological map of the vicinity of Podol'sk and Domodedovo, south to southeast of Moscow (Artemieva et al., 2001); 1 – Upper Carboniferous, Moscovian and Kasimovian, limestones, dolomites, marls; 2 – Middle to Upper Jurassic, middle Callovian to middle Oxfordian, grey to black clays; 3 – Upper Jurassic, upper Oxfordian to lower Kimmeridgian, black clays and aleurites with phosphatic concretions; 4 – Upper Jurassic, Volgian, sands and aleurites with phosphatic concretions; 5 – Lower Cretaceous, Hauterivian to Barremian, sands, aleurites and clays; 6 – Miocene, sands with intercalations of clays; 7 – position of locality of Domodedovo Section.



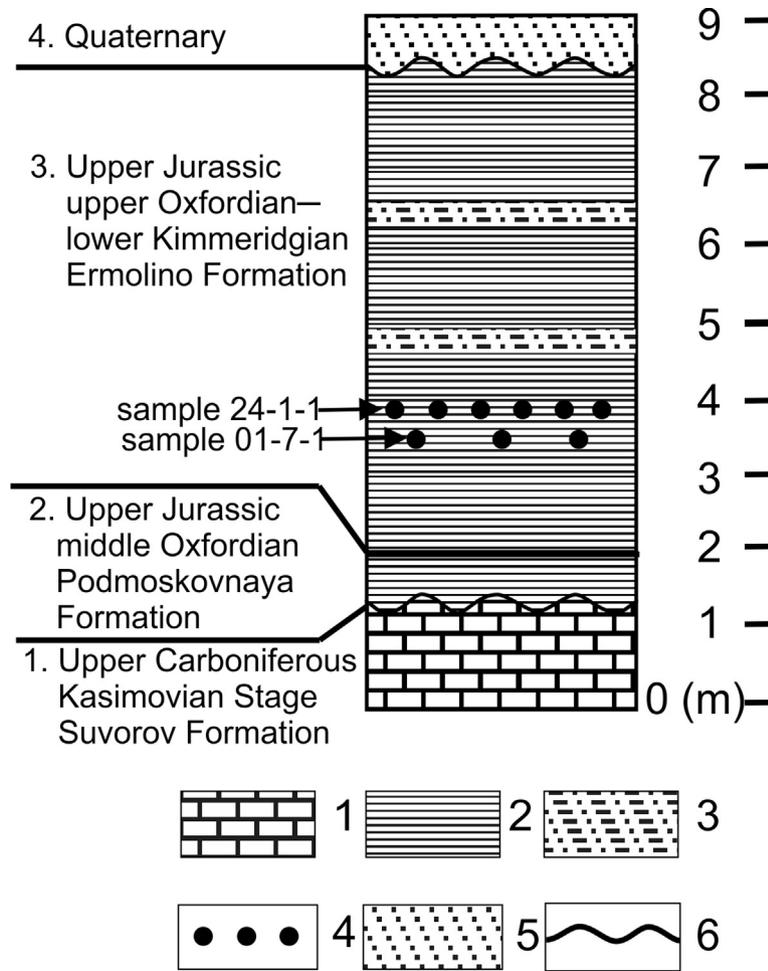


Fig. 2. Stratigraphic column of the Domodedovo Section. 1 – limestones; 2 – clays; 3 – aleurites; 4 – phosphatic concretions; 5 – sands; 6 – unconformity.

locality, probably due to erosion in middle-late Oxfordian time.

3. Materials and methods

Sample 01-7-1 was taken from the lower part of unit 3 (Ermolino Formation), 1.66 m from the base. It is a spherical phosphate concretion 3 cm in diameter. Sample 24-1-1 was taken from the level 1.9 m from the base. It is represented by six phosphate concretions, four spherical and two elliptical, the largest 10 cm in diameter (Fig. 3B). Several thin sections were made from these concretions. They were studied and photographed using a light microscope BioOptic CP-400 with camera 6.3 MPx USB 3.0 Aptina.

Samples were treated by diluted (15–20%) nitric acid (HNO_3). The residue was rinsed with water, dried, and studied under light microscope LOMO-MBS-10. Microfossils were collected, mounted, studied in detail and photographed with a scanning electron microscope TESCAN 2300 in the Geological Institute of Russian Academy of Sciences. The material is stored in the Geological Institute of Russian Academy of Sciences, Moscow.

Taxonomy of radiolarian genera follows the classification of O'Dogherty et al. (2009).

4. Radiolarian assemblage and its stratigraphical and paleobiogeographical significance

Radiolarians are present both in clays and phosphate concretions. They are well-preserved in the concretions while in clays they commonly have poor preservation. Thin section analysis of the phosphate concretions reveals dense, well preserved radiolarian tests and siliceous spongy elements filled or replaced by pyrite or phosphate minerals, which likely shielded them from post-depositional dissolution and compaction (Fig. 4). Thin morphological elements of radiolarians can be observed in thin sections, like the medullary shells of spherical spumellarians (Fig. 4A, B), spines and cortical shell of *Pantanellium* sp. (Fig. 4B), apical spine of nassellarian (probably *Praeparvicingula* sp.) (Fig. 4C), and the internal cavity of nassellarian, divided into chambers (Fig. 4D). By contrast, the clay matrix shows lower compaction resistance, higher porosity, and more extensive recrystallization or dissolution features of

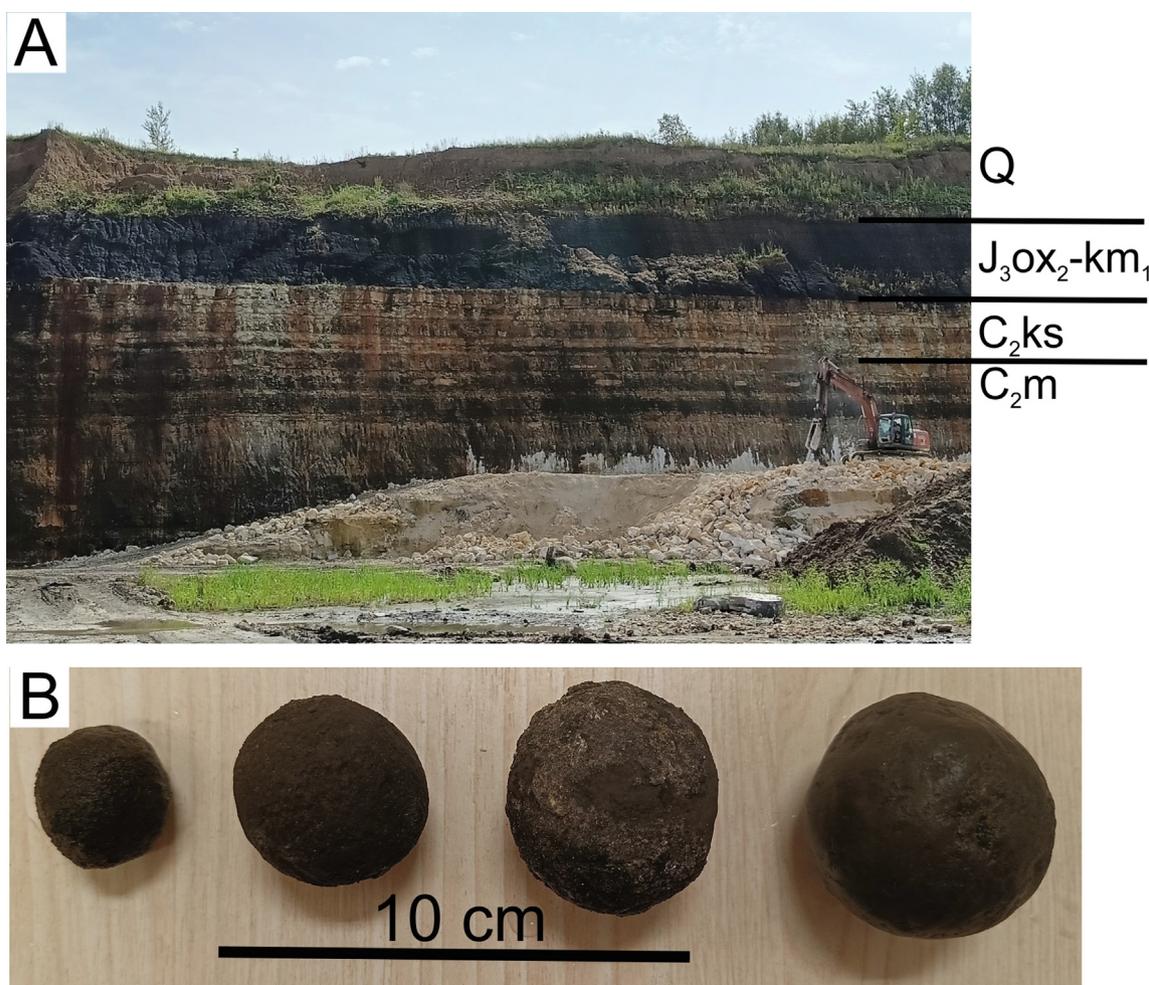


Fig. 3. Outcrop of the Jurassic deposits in the eastern slope of the Domodedovo quarry and phosphatic concretions. (A) View of outcrop with Upper Carboniferous (white to light-yellowish-grey limestones), Upper Jurassic (black clays) and Quaternary (grey sands). (B) Spherical phosphatic concretions from the Domodedovo quarry.

radiolarians. The deposits of the Ermolino Formation were formed in reducing conditions due to oxygen deficiency. Such conditions are well-marked by the presence of such minerals as pyrite and vivianite which are common in clays of the Ermolino Formation. These conditions determined common replacement of biogenic silica by pyrite and their further recrystallization in clays, while their sedimentation was slow and without any obvious reworking. There is no obvious difference in taxonomic composition of radiolaria from clays and phosphates, except the absence of some rare and fragile morphotypes in clay samples (like Saturnaliidae).

Radiolarians were studied from two levels of the section — sample 01-7-1 (1.66 m from the base) and sample 24-1-1 (1.9 m from the base). Both samples are dominated by *Praeconocaryomma scatebra* Hull and *P. blomei* n. sp., whereas *Paronaella obesa* (Yang), *P. aff. tripla* De Wever and *Praeparvicingula donnae* Bragin are common. Other taxa are represented by very rare or single specimens. The association from sample 01-7-1 consists of 12 species of 7 genera. The association from sample 24-1-1 is more diverse

and include 25 species of 13 genera (Table 1). This difference can be related to more detailed sampling of the second horizon of concretions (sample 24-1-1). Generally, the assemblage of the Domodedovo Section displays low taxonomic diversity and consists in total of 13 genera and 28 species.

The studied assemblage from the upper Oxfordian–lower Kimmeridgian is higher stratigraphically than previously studied assemblages from the middle Oxfordian (Bragin and Kiselev, 2013) and upper Oxfordian (Bragin et al., 2024) of Central Russia. It is older than a previously studied upper Kimmeridgian assemblage from Moscow (Bragin, 1997, 2025). Therefore, it is interesting to compare the taxonomic composition of the mentioned assemblages to analyze the stratigraphic potential of Boreal Upper Jurassic Radiolaria (Fig. 5). There are species with long stratigraphic ranges like *Praeconocaryomma decora* Yeh, *P. scatebra* Hull, *Paronaella obesa* (Yang), *Praeparvicingula donnae* Bragin. Other taxa have more restricted ranges: all representatives of Pantanelliidae are present only in the upper Oxfordian and Kimmeridgian. *Phantum*

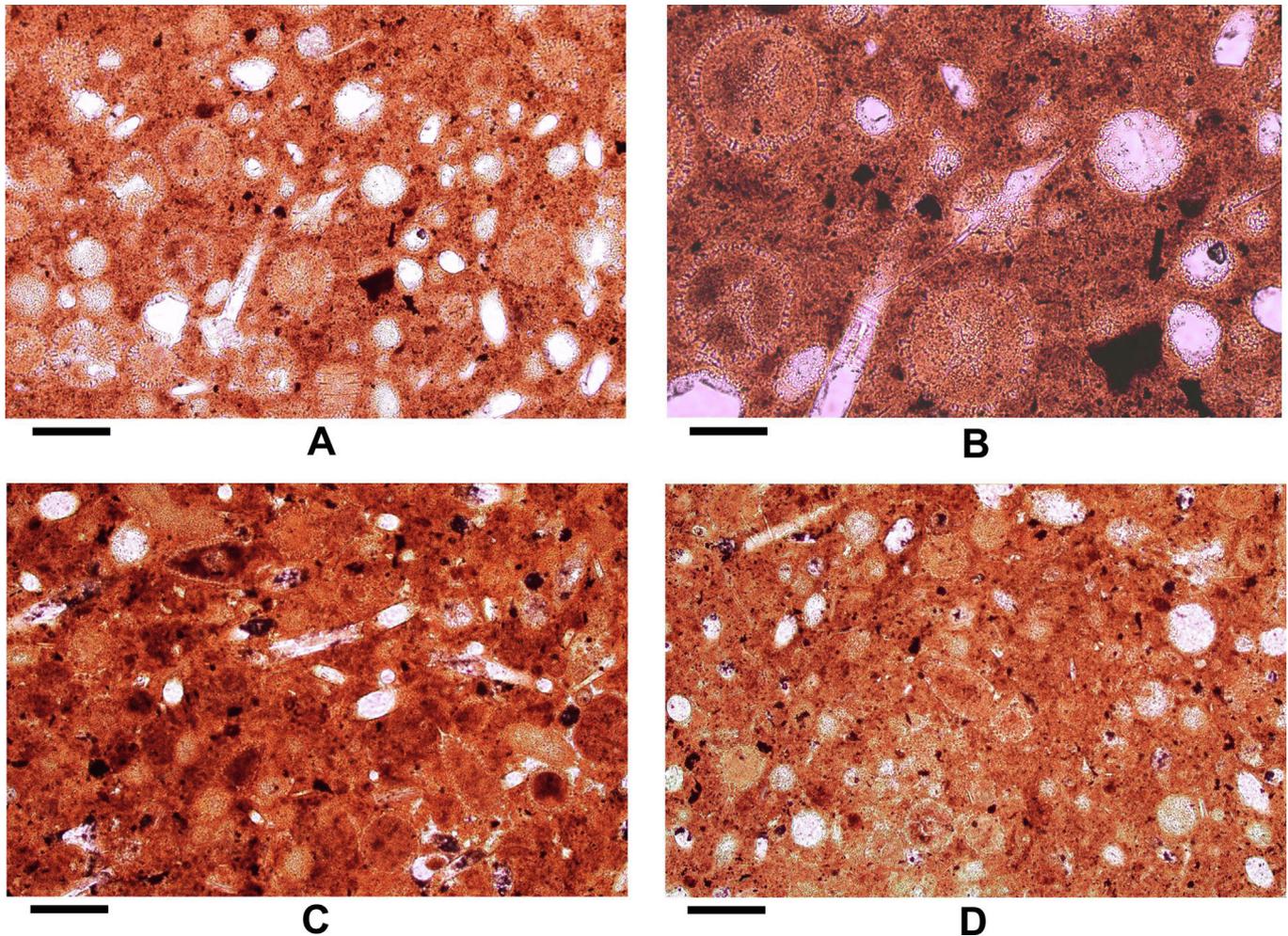


Fig. 4. Thin sections of phosphate concretions from the Domodedovo Section. (A) Phosphorite with numerous spumellarian radiolarians and siliceous sponge spicules. (B) Detail of (A) with *Pantanellium* sp. in the center. (C, D) Phosphorites with nassellarian radiolarians together with spumellarians and sponge spicules. Scale bars = 200 μm (A, C, D), 100 μm (B).

robustum n. sp., *Acastea laevispina* n. sp. and *Nordvikella simplex* n. sp. are present in the upper Oxfordian–lower Kimmeridgian, whereas *Praeparvicingula blackhorsensis* (Pessagno and Whalen) and *Triactoma rossica* Bragin are known from the upper Oxfordian (Fig. 5). Analysis of the stratigraphic distribution of radiolarians in the sections of the Boreal Upper Jurassic show significant changes in the composition of assemblages (Bragin and Bragina, 2025). This is most clearly manifested in the sections of Western Siberia, where, for example, the Bazhenov Formation is characterized by facies consistency, continuity and the ubiquitous presence of radiolarians. Due to this, local zones for radiolarians have been recognized in the West Siberian boreholes (Vishnevskaya et al., 2020). We have clear evidence that Boreal Upper Jurassic radiolarian assemblages of Central Russia changed in time, but it is difficult to propose any stratigraphic scheme for this region now, because well-preserved assemblages are rare and are only known from isolated localities. We need to study successive radiolarian assemblages of good preservation from continuous sections, but it is very difficult in Central Russia

due to the limited number of accessible outcrops. Hence in this area the best prospects for radiolarian research are through the study of borehole samples.

The radiolarian assemblage from the Domodedovo Section provides insights into Late Jurassic radiolarian paleobiogeography. The assemblage is characterized by the presence of genus *Pantanellium*, represented by the phylogenetic line *P. meraceibaense*, which indicates southern influence in Boreal regions (Pessagno et al., 1987; Bragin, 1997; Bragin and Bragina, 2018; Bragin et al., 2024). Though specimens of *Pantanellium* are very rare in the upper Oxfordian–lower Kimmeridgian, they are common in the upper Kimmeridgian of Central Russia (Bragin, 1997; Bragin and Kiselev, 2013) and in the Kimmeridgian of the Pechora Depression (Kozlova, 1971, 1994). The appearance of *Pantanellium* in the upper Oxfordian–lower Kimmeridgian may reflect the beginning of a regional warming episode or start of penetration of southern sea currents into Central Russia. The latter alternative seems more probable due to recent studies of oxygen isotopes that indicate a constant water temperature in the seas of the

Table 1
Taxonomic composition and abundance of radiolarian assemblage from the Domodedovo Section. A – abundant, C – common, R – rare.

Species	01-7-1	24-1-1
<i>Pantanellium</i> sp. D sensu Pessagno and MacLeod in Pessagno et al., 1987	R	
<i>Pantanellium</i> sp.		R
<i>Pantanellium quintachillaense</i> Pessagno and MacLeod in Pessagno et al., 1987		R
<i>Heliosestarium?</i> sp.		R
<i>Actinomma</i> sp.		R
<i>Acastea tenuis</i> Hull, 1997		R
<i>Acastea laevispina</i> n. sp.		C
<i>Praeconocaryomma scatebra</i> Hull, 1997	C	A
<i>Praeconocaryomma decora</i> Yeh, 1987		C
<i>Praeconocaryomma blomei</i> n. sp.	C	A
<i>Phantum robustum</i> n. sp.		R
<i>Crucella squama</i> (Kozlova, 1971)	C	
<i>Crucella mexicana</i> Yang, 1993		R
<i>Orbiculiforma</i> sp. aff. <i>O. teres</i> Hull, 1997	R	R
<i>Orbiculiforma</i> sp.		R
<i>Paronaella obesa</i> (Yang, 1993)	C	R
<i>Paronaella</i> sp. aff. <i>P. tripla</i> De Wever, 1981	C	C
<i>Paronaella longoriai</i> (Yang, 1993)		R
<i>Paronaella</i> sp. aff. <i>P. longoriai</i> (Yang, 1993)		R
<i>Paronaella</i> sp. aff. <i>P. pristidentata</i> Baumgartner, 1980		R
<i>Paronaella</i> sp. A		R
<i>Archaeospongoprimum</i> sp. aff. <i>A. helense</i> Blome, 1984		R
<i>Acanthocircus yaoi</i> Yang, 1993		R
<i>Acanthocircus</i> sp.		R
<i>Nordvikella</i> sp. cf. <i>N. scabiosa</i> Bragin in Bragin et al., 2024	R	
<i>Nordvikella simplex</i> n. sp.	R	R
<i>Praeparvicingula sencilla</i> Hull, 1995	R	
<i>Praeparvicingula donnae</i> Bragin, 1997	C	C
<i>Praeparvicingula elementaria</i> (Carter in Carter et al., 1988)	R	R

East European Craton from the Callovian to the late Kimmeridgian (Wierzbowski et al., 2018). It was possible due to the transgression that started on the East European Craton in the Oxfordian and continued into the Kimmeridgian, opening the way for warm currents which triggered migration of warm-water taxa like the radiolarian genus *Pantanellium* and Tethyan ammonites that are common in the sub-boreal Kimmeridgian (Rogov, 2017).

This supposition is supported by the taxonomic diversity of the typically Boreal family Echinocampidae. They are represented in the upper Oxfordian by five species of two genera (Bragin et al., 2024), in the upper Oxfordian–lower Kimmeridgian by two species of one genus (this paper) and in the upper Kimmeridgian by two species of one genus (Bragin, 2025). The diversity of Echinocampidae

may decline due to warming episodes or influence of warm currents.

The studied assemblage is characterized by a number of species previously described from the western regions of North America where Mesozoic radiolarians are represented by highly diverse assemblages including both Tethyan and Boreal taxa (Yang, 1993; Hull, 1997). Some of these taxa are found in Central Russia for the first time, such as the genus *Phantum* and species *Acastea tenuis* Hull, *Crucella mexicana* Yang, *Acanthocircus yaoi* Yang, all of which have Boreal affinity.

The upper Oxfordian–lower Kimmeridgian assemblage from the Domodedovo Section demonstrates features of high-latitude origin: low taxonomic diversity, the presence of characteristic taxa common only in high-latitude regions (e.g. family Echinocampidae, and representatives of *Praeparvicingula* with apical spine), the absence of numerous taxa that are common and abundant in low-latitude regions (e.g. subfamily Vallupinae, genera *Mirifusus*, *Ristola*, *Spongocapsula*, *Tritrabs*, *Tetratrabs*, *Emiluvia*, etc.). In comparison with previously studied assemblages from the upper Oxfordian (Bragin et al., 2024) and upper Kimmeridgian (Bragin, 1997, 2025), this assemblage has an intermediate position: it represents more Boreal features than the upper Kimmeridgian ones, but also has evidence of warm influences that are not present in the upper Oxfordian fauna.

5. Systematic paleontology

Order Spumellaria Ehrenberg, 1875

Family Pantanelliidae Pessagno, 1977b sensu Pessagno and MacLeod in Pessagno et al., 1987

Subfamily Pantanelliinae Pessagno, 1977b sensu Pessagno and Blome, 1980

Genus *Pantanellium* Pessagno, 1977a sensu Pessagno and Blome, 1980

Type species: *Pantanellium riedeli* Pessagno, 1977a.

Pantanellium sp. D sensu Pessagno and MacLeod in Pessagno et al., 1987 (Fig. 6A)

1987 *Pantanellium* sp. D – Pessagno and MacLeod in Pessagno et al., p. 25, pl. 2, figs. 4, 5, 19, 23.

Material: One specimen.

Description: Cortical shell spherical with pentagonal and hexagonal pore frames with thin bars and weakly developed nodes at vertices. Five pore frames visible in cortical shell along main spines and in line perpendicular to main spines. Main spines moderately long, thin, triradiate, one spine longer.

Measurements: Dimension of cortical shell along the spines 95 µm, dimension of cortical shell perpendicular to spines 80 µm, length of longer spine 70 µm, length of shorter spine

Species	Age	Upper Jurassic				
		Oxfordian			Kimmeridgian	
		Lower	Middle	Upper	Lower	Upper
<i>Perispyridium neotamanense</i> Yang						
<i>Pantanellium huazalingoense</i> Pessagno and McLeod						
<i>Pantanellium moscowiense</i> Bragin						
<i>Pantanellium tierrablankaense</i> Pessagno and MacLeod						
<i>Pantanellium quintachillaense</i> Pessagno and MacLeod						
<i>Pantanellium</i> sp. D sensu Pessagno and MacLeod						
<i>Acastea tenuis</i> Hull						
<i>Acastea laevispina</i> n. sp.						
<i>Triactoma rossica</i> Bragin						
<i>Triactoma blakei</i> (Pessagno)						
<i>Praeconocaryomma decora</i> Yeh						
<i>Praeconocaryomma scatebra</i> Hull						
<i>Praeconocaryomma blomei</i> n. sp.						
<i>Phantum robustum</i> n. sp.						
<i>Crucella squama</i> (Kozlova)						
<i>Crucella mexicana</i> Yang						
<i>Paronaella obesa</i> (Yang)						
<i>Paronaella</i> sp. aff. <i>P. tripla</i> De Wever						
<i>Pseudocrucella ehrenbergii</i> Hull						
<i>Archaeospongoprimum</i> sp. aff. <i>A. helense</i> Blome						
<i>Praeparvicingula blackhorsensis</i> (Pessagno and Whalen)						
<i>Praeparvicingula donnae</i> Bragin						
<i>Praeparvicingula enormis</i> (Yang)						
<i>Praeparvicingula elementaria</i> (Carter)						
<i>Echinocampe modestum</i> Bragin						
<i>Nordvikella gutta</i> Bragin						
<i>Nordvikella simplex</i> n. sp.						
<i>Nordvikella plana</i> Bragin						

Fig. 5. Stratigraphic ranges of selected radiolarian species in the Upper Jurassic of Central Russia; Bragin and Kiselev (2013) – middle Oxfordian; Bragin et al. (2014) – upper Oxfordian; this paper – uppermost Oxfordian to lower Kimmeridgian (grey interval); Bragin (1997, 2025) – upper Kimmeridgian.

45 μm , width of longer spine at its base 30 μm , length of shorter spine at its base 25 μm .

Remarks: Differs from *Pantanellium squinaboli* (Tan) by more rounded cortical shell with smaller pore frames (up to 5 frames in axial lines of cortical shell) with thin bars and weakly developed nodes at vertices.

Occurrence: Upper Jurassic, Oxfordian to upper Tithonian, Mexico, Central Russia.

Pantanellium quintachillaense Pessagno and MacLeod in Pessagno et al., 1987 (Fig. 6C)

1987 *Pantanellium quintachillaense* – Pessagno and MacLeod in Pessagno et al., p. 23, pl. 5, figs. 7, 9, 13, 15; pl. 7, fig. 3.

1993 *Pantanellium quintachillaense* Pessagno and MacLeod – Yang, p. 15, pl. 2, figs. 4, 21.

1993 *Pantanellium* sp. A – Yang, p. 19, pl. 2, figs. 1, 16, 19.

1997 *Pantanellium quintachillaense* Pessagno and MacLeod – Hull, p. 58, pl. 22, fig. 15.

1999 *Pantanellium quintachillaense* Pessagno and MacLeod – Kiessling, p. 22, pl. 4, figs. 6, 12.

2017 *Pantanellium quintachillaensis* Pessagno and MacLeod – Vennari and Pujana, fig. 7.3, 7.7.

Material: One specimen.

Measurements: Dimension of cortical shell along the spines 90 μm , dimension of cortical shell perpendicular to spines 78 μm , length of longer spine 80 μm , length of shorter spine 45 μm , width of longer spine at its base 35 μm , length of shorter spine at its base 30 μm .

Remarks: Differs from *Pantanellium cantuchapai* Pessagno and MacLeod by thicker spines with more prominent ridges and grooves.

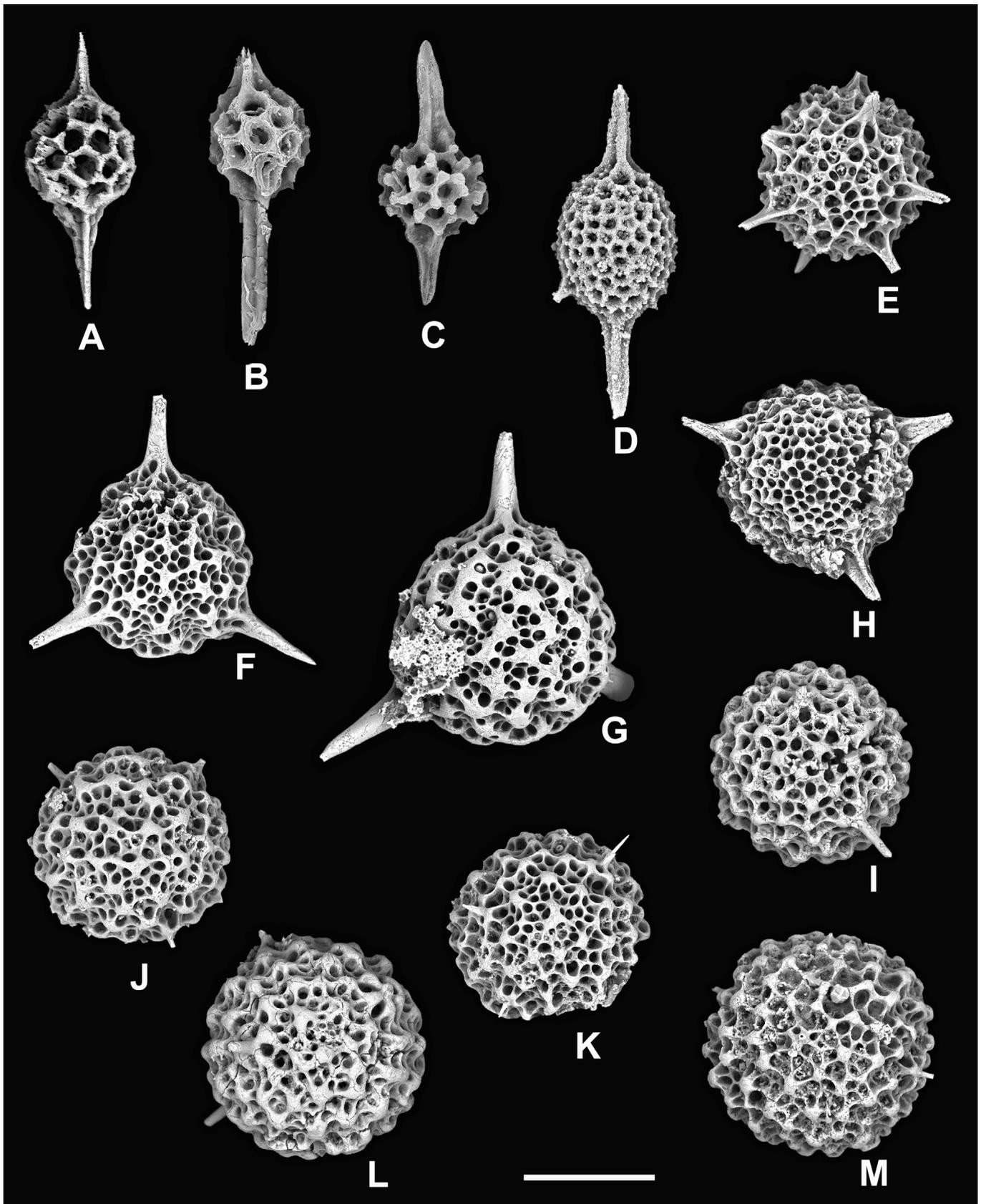


Fig. 6. Spumellaria (*Pantanellium* and *Praeconocaryomma*) from the Domodedovo section. (A) *Pantanellium* sp. D sensu Pessagno and MacLeod, GIN 4850-01-12. (B) *Pantanellium* sp., GIN 4850-24-1. (C) *Pantanellium quintachillaense* Pessagno and MacLeod, GIN 4850-24-2. (D) *Heliosestarium?* sp., GIN 4850-24-11. (E) *Actinomma* sp., GIN 4850-24-12. (F, G) *Acastea laevispina* n. sp.; (F) holotype, GIN 4850-24-13; (G) GIN 4850-24-14. (H) *Acastea tenuis* Hull, GIN 4850-24-14. (I–M) *Praeconocaryomma scatebra* Hull; (I) GIN 4850-24-22; (J) GIN 4850-24-23; (K) GIN 4850-24-24; (L) GIN 4850-24-25; (M) GIN 4850-24-26. (A) Sample 01-7-1; (B–M) sample 24-1-1. Scale bar = 100 μ m.

Occurrence: Upper Jurassic, Oxfordian to upper Tithonian of Mexico, Antarctic Peninsula, Argentina, Central Russia.

Pantanellium sp.
(Fig. 6B)

Material: One specimen.

Measurements: Dimension of cortical shell along the spines 80 µm, dimension of cortical shell perpendicular to spines 70 µm, length of spine 110 µm.

Remarks: Detailed determination is difficult because only one spine is preserved.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Family Sphaerostylidae [Haeckel, 1881](#)

Genus *Heliosestarium* [Campbell and Clark, 1944](#)

Type species: *Heliosestarium cretaceum* [Campbell and Clark, 1944](#).

Heliosestarium? sp.
(Fig. 6D)

Material: One specimen.

Description: Test elongate, elliptical in shape, with latticed cortical shell composed of small pentagonal to hexagonal pore frames with weak nodes at vertices. Two polar spines triradiate with deep grooves and smooth ridges. Spines are unequal; length of one spine is equal to 4/5 length of another. Small secondary spine is present.

Measurements: Length of test 115 µm, width of test 90 µm, length of longer spine 75 µm, length of shorter spine 65 µm.

Remarks: This specimen, tentatively assigned to *Heliosestarium*, differs from *H. cretaceum* [Campbell and Clark](#) by small and rare secondary spines and by a more elongate test.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Family Actinommididae [Haeckel, 1862](#)

Genus *Actinomma* [Haeckel, 1862](#)

Type species: *Haliomma trinacrium* [Haeckel, 1860](#).

Actinomma sp.
(Fig. 6E)

1999 *Actinomma* (?) sp. B – [Kiessling](#), p. 17, pl. 1, fig. 16.

Material: One specimen.

Measurements: Diameter of test 125 µm, length of spines more than 50 µm.

Remarks: The studied specimen has more regular meshwork in comparison with specimen illustrated by [Kiessling \(1999\)](#).

Occurrence: Upper Jurassic, Kimmeridgian to lower Tithonian of Antarctic Peninsula, upper Oxfordian–lower Kimmeridgian of Central Russia.

Family Acaeniotyliidae [Yang, 1993](#)

Genus *Acastea* [Yang, 1993](#)

Type species: *Acaeniotytle diaphorogona* [Foreman, 1973](#).

Acastea tenuis [Hull, 1997](#)
(Fig. 6H)

1997 *Acastea tenuis* – [Hull](#), p. 35, pl. 10, figs. 8–10, 15, 22.

Material: One specimen.

Measurements: Diameter of test 150 µm, length of spines 45 µm.

Occurrence: Upper Jurassic, Tithonian of Mexico, upper Oxfordian to lower Kimmeridgian of Central Russia.

Acastea laevispina n. sp.
(Fig. 6F, G)

Etymology: *Laevis* – smooth, *spina* – spine (Latin).

Holotype: GIN (Geological Institute of Russian Academy of Sciences) 4850-24-13, Fig. 6F, housed in Geological Institute of Russian Academy of Sciences (RAS), Moscow, Russia, from the upper Oxfordian–lower Kimmeridgian of Domodedovo Section, Moscow Region.

Material: Two specimens.

Diagnosis: *Acastea* with smooth spines without longitudinal grooves and ridges.

Description: Test small, spherical, surface of test with small smooth tubercles, sometimes joined by smooth short ribs. Pores subcircular to oval, enclosed in weakly developed polygonal pore frames. Groups of 6 and more pores are usually enclosed in roughly polygonal structures formed by tubercles and ribs. Spines moderately long, pointed, with circular cross-section, smooth, without longitudinal grooves and ridges.

Measurements: Diameter of test 150–170 µm, length of spines 65–70 µm.

Remarks: Differs from *Acastea acer* [Yang, 1993](#) by smooth spines with circular cross-section and by smooth ribs between tubercles on the surface of test. Differs from *Acastea tenuis* [Hull](#) by smooth spines and by massive smooth nodes at the surface of cortical shell.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Family Conocaryommididae [Lipman, 1969](#)

Genus *Praeconocaryomma* [Pessagno, 1976](#)

Type species: *Praeconocaryomma universa* [Pessagno, 1976](#).

Praeconocaryomma scatebra [Hull, 1997](#)
(Fig. 6I–M)

1997 *Praeconocaryomma scatebra* – [Hull](#), p. 65, pl. 12, figs. 10, 11, 13.

1997 *Praeconocaryomma* sp. cf. *P. scatebra* – [Hull](#), p. 66, pl. 8, fig. 13.

1999 *Praeconocaryomma scatebra* Hull – Kiessling, p. 27, pl. 3, fig. 13.

2006 *Praeconocaryomma scatebra* Hull – Danelian et al., pl. 2, fig. 2.

2020 *Praeconocaryomma scatebra* Hull – Palechek and Ustinova, pl. 2, figs. 1, 3, 5, 13; pl. 7, fig. 5.

Material: 22 specimens.

Measurements: Diameter of test from 150 μm to 170 μm , length of spines 30–40 μm .

Remarks: This species is characterized by small thin spines protruding from centers of mammae, which sometimes can be almost or completely absent (probably due to preservation).

Occurrence: Upper Jurassic, middle Oxfordian to lower Tithonian, Mexico, Antarctic Peninsula, France, Central Russia.

Praeconocaryomma decora Yeh, 1987

(Fig. 7A, B)

1987 *Praeconocaryomma decora* – Yeh, p. 39, pl. 6, fig. 15; pl. 20, figs. 1, 2, 9, 16, 19.

1987 *Praeconocaryomma* sp. A – Yeh, p. 40, pl. 2, figs. 17, 22; pl. 20, fig. 4.

1990 *Praeconocaryomma decora* Yeh – Nagai, pl. 6, fig. 6.

1998 *Praeconocaryomma decora* Yeh – Yeh and Cheng, p. 15, pl. 11, figs. 1, 5.

2001 *Praeconocaryomma* cf. *decora* Yeh – McCarthy et al., fig. 9.8.

2002 *Praeconocaryomma* sp. A – Whalen and Carter, p. 108, pl. 8, fig. 5.

2003 *Praeconocaryomma* spp. – Goričan et al., p. 291, pl. 1, fig. 10 only.

2006 *Praeconocaryomma decora* gr. Yeh – Goričan et al., p. 324, pl. PRY01, figs. 1–8.

2020 *Praeconocaryomma decora* Yeh – Palechek and Ustinova, pl. 2, figs. 2, 4, 6, 12?, 14; pl. 5, fig. 8.

2024 *Praeconocaryomma* sp. aff. *P. decora* Yeh – Bragin et al., p. 398, fig. 5N–P.

Material: 5 specimens.

Measurements: Diameter of test 150–160 μm .

Remarks: Previously studied specimens from the Rybaki Section (Bragin et al., 2024) can be assigned to *Praeconocaryomma decora* s.l.

Occurrence: Jurassic, Pliensbachian to Kimmeridgian, worldwide.

Praeconocaryomma blomei n. sp.

(Fig. 7C–K)

1984 *Praeconocaryomma* sp. A – Blome, p. 355, pl. 8, figs. 3, 9, 15, 16, 19; pl. 16, fig. 17.

2024 *Praeconocaryomma* sp. A – Bragin et al., p. 398, fig. 6A–D.

Etymology: Species is named after Charles Blome, in honor of his contributions to understanding of morphology and taxonomy of Mesozoic radiolarians.

Holotype: GIN 4850-24-45, Fig. 7F, housed in Geological Institute RAS, Moscow, Russia, from the upper Oxfordian–lower Kimmeridgian of Domodedovo Section, Moscow Region.

Material: 9 specimens.

Diagnosis: *Praeconocaryomma* with 6 to 10 smooth long spines that represent external prolongations of radial beams connecting cortical and medullary shells.

Description: Test spherical, cortical shell with small prominent smooth mammae; each mamma with five to six subcircular to elliptical pores. Mammae usually not have protruding spines. Six to ten long smooth radial spines represent prolongations of radial beams connecting cortical and medullary shells. Proximal parts of spines triangular in cross-section, distally they have circular cross-section. Outer medullary shell subspherical with circular pores (Fig. 7C, D), radial beams become wide and triradiate in cross-section near connections with first medullary shell. Inner medullary shell small, subspherical (Fig. 7E).

Measurements: Diameter of test 150–175 μm , maximal length of spines 75 μm , diameter of outer medullary shell 50 μm .

Remarks: Differs from *P. magnimamma* Pessagno, 1977a by stout radial spines with triangular cross section of their basal parts. Differs from *P. scatebra* Hull by longer and thicker spines that represent prolongations of radial beams connecting cortical and medullary shells.

Occurrence: Middle Jurassic, Callovian of Alaska and Oregon. Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Genus *Phantum* Hull, 1997

Type species: *Phantum insperatum* Hull, 1997.

Phantum robustum n. sp.

(Fig. 8A–D)

Etymology: Robustum – strong (Latin).

Holotype: GIN 4850-24-60, Fig. 8A, housed in Geological Institute RAS, Moscow, Russia, from the upper Oxfordian–lower Kimmeridgian of Domodedovo Section, Moscow Region.

Material: Four specimens.

Diagnosis: *Phantum* with 3–5 stout long curved spines surrounding latticed cavity.

Description: Test subspherical, with latticed cavity surrounded by only 3–5 primary spines that are stout, long, curved to the cavity and have triradiate cross-section. Secondary spines are absent. Wall of test with pores that variable in size, subcircular to oval or rounded triangular. Pores are enclosed in irregular polygonal pore frames with prominent nodes at some vertices. 4–6 stout spines with triangular cross-section arise radially from the surface of test,

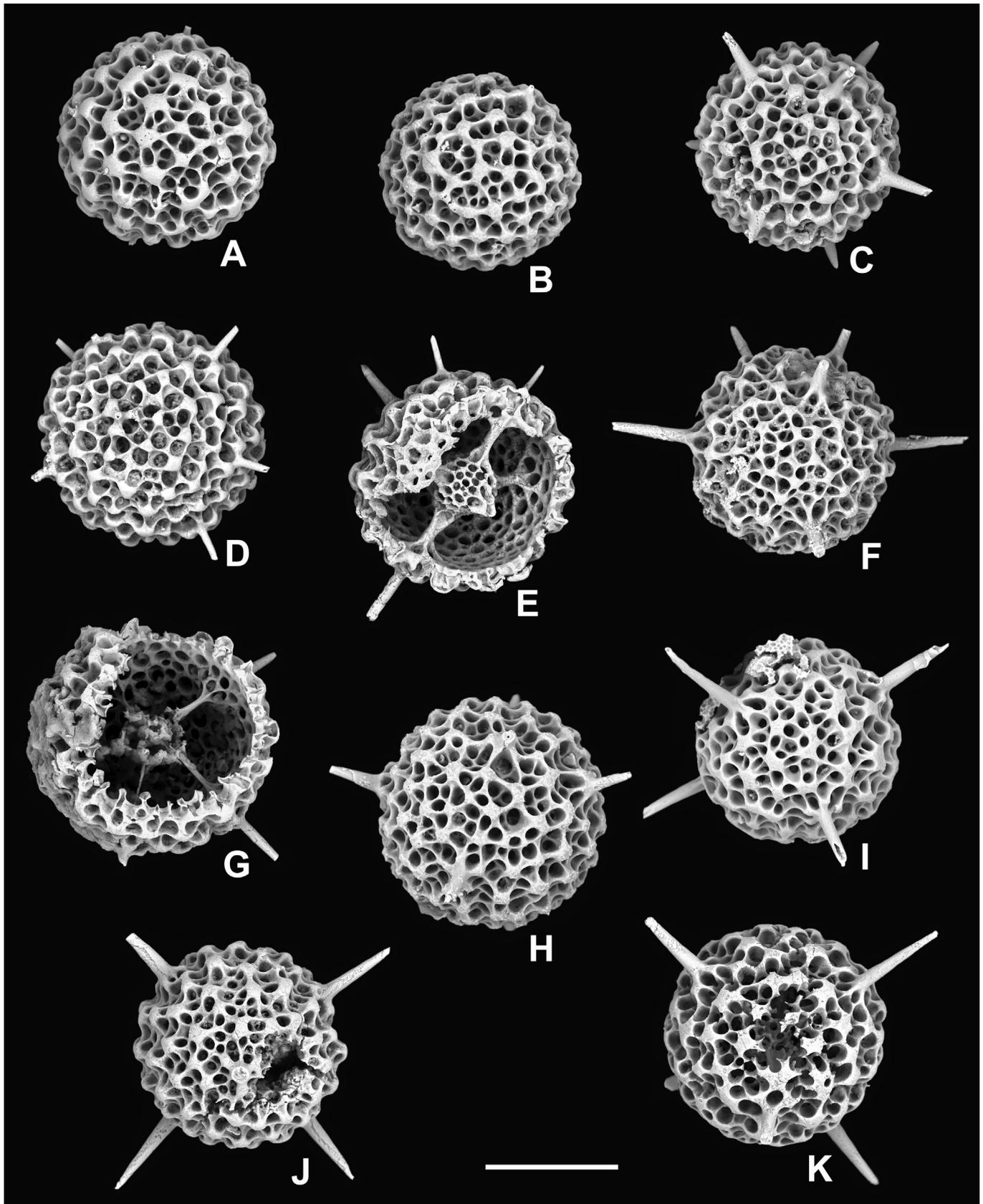


Fig. 7. Spumellaria (*Praeconocaryomma*) from the Domodedovo section. (A, B) *Praeconocaryomma decora* Yeh; (A) GIN 4850-24-30; (B) GIN 4850-24-31. (C–K) *Praeconocaryomma blomei* n. sp.; (C) GIN 4850-24-42; (D) GIN 4850-24-43; (E) GIN 4850-24-44; (F) holotype, GIN 4850-24-45; (G) GIN 4850-24-46; (H) GIN 4850-24-47; (I) GIN 4850-24-48; (J) GIN 4850-24-49; (K) GIN 4850-24-50. All specimens are from sample 24-1-1. Scale bar = 100 μ m.

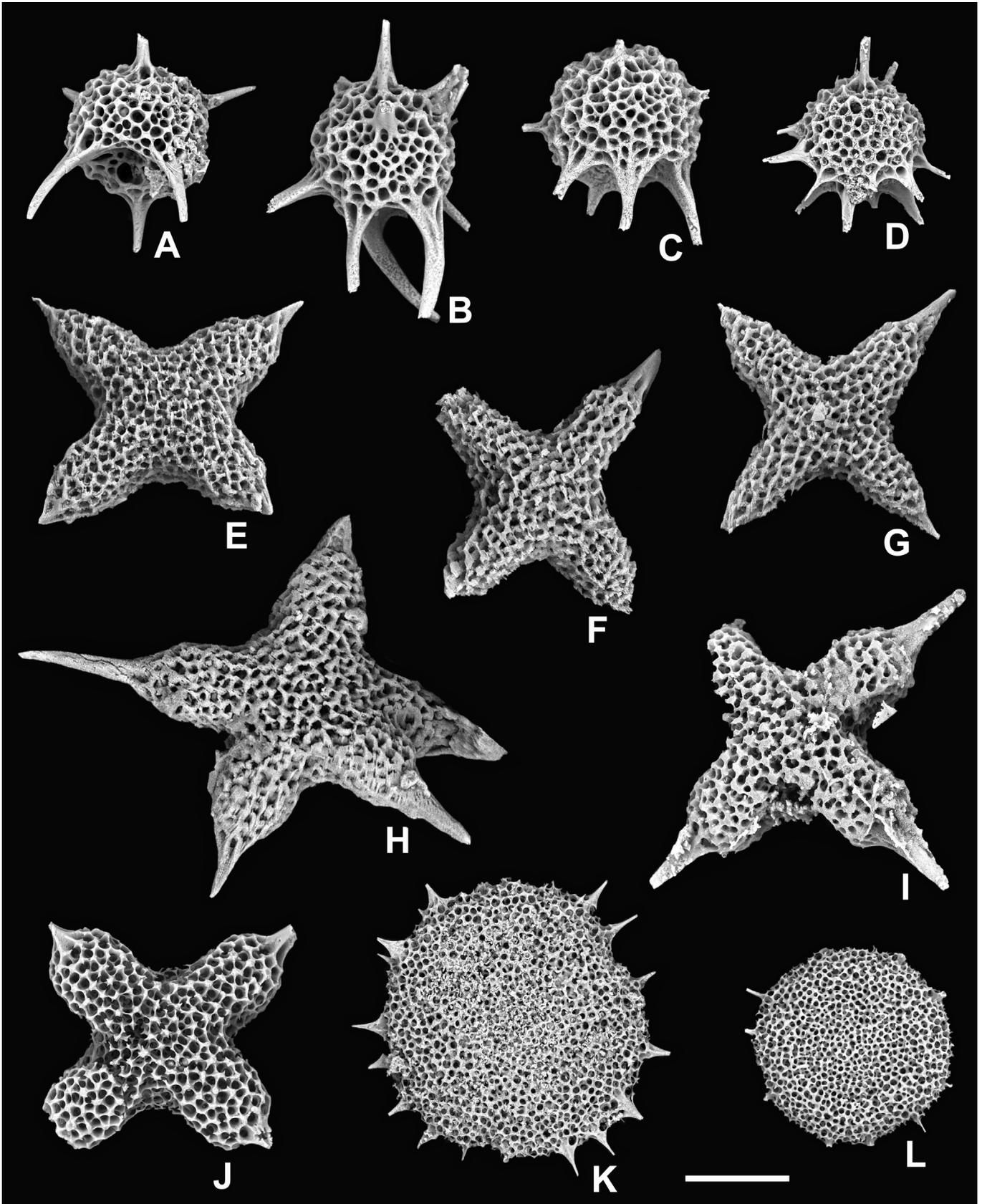


Fig. 8. Spumellaria (*Phantum*, *Crucella* and *Orbiculiforma*) from the Domodedovo section. (A–D) *Phantum robustum* n. sp.; (A) holotype, GIN 4850-24-60; (B) GIN 4850-24-61; (C) GIN 4850-24-62; (D) GIN 4850-24-63. (E–H) *Crucella squama* (Kozlova); (E) GIN 4850-01-13; (F) GIN 4850-01-14; (G) GIN 4850-01-15; (H) GIN 4850-01-16. (I, J) *Crucella mexicana* Yang; (I) GIN 4850-24-51; (J) GIN 4850-24-52. (K) *Orbiculiforma* sp. aff. *O. teres* Hull, GIN 4850-24-53. (L) *Orbiculiforma* sp., GIN 4850-24-54. (A–D, I–L) Sample 24-1-1, (E–H) sample 01-7-1. Scale bar = 100 μ m.

their basal parts have triangular cross-section, while their distal part are smooth, with circular cross-section.

Measurements: Diameter of test 125–150 μm , length of spines surrounding cavity 100–125 μm , length of radial spines 50–60 μm .

Remarks: Differs from *Phantum insperatum* Hull by absence of secondary spines surrounding latticed cavity, by more massive and curved primary spines and by more regular meshwork of test wall. Hull (1997, p. 76, pl. 30, figs. 4, 7, 8) illustrated *Phantum* sp. with two latticed cavities. This specimen could be interpreted as radiolarian Siamese twins, and the same interpretation can be used for our specimen illustrated in Fig. 8D. Twin-like skeletons were described for many taxa of Mesozoic radiolarians (Dumitrica, 2013).

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Family Hagiastriidae Riedel, 1971

Genus *Crucella* Pessagno, 1971

Type species: *Crucella messinae* Pessagno, 1971.

Crucella squama Kozlova, 1971

(Fig. 8E–H)

1971 *Hagiastrum squama* – Kozlova, pl. 1, fig. 10 (nomen nudum).

1973 *Hagiastrum squama* – Kozlova, p. 59, pl. 18, fig. 8.

1981 *Crucella squama* (Kozlova) – De Wever, p. 38, pl. 5, fig. 7.

1994 *Crucella squama* (Kozlova) – Kozlova, pl. 2, fig. 3.

1997 *Crucella squama* (Kozlova) – Bragin, p. 290, pl. 1, fig. 15.

non 1997 ?*Crucella squama* (Kozlova) – Hull, p. 20, pl. 4, figs. 10, 19.

non 1998 *Crucella squama* (Kozlova) – Vishnevskaya, fig. 7f.

non 2001 *Pseudocrucella squama* (Kozlova) – Vishnevskaya, pl. 121, fig. 2.

2002 *Crucella squama* (Kozlova) – Suzuki et al., p. 176, fig. 7D.

2002 *Crucella squama* (Kozlova) – Whalen and Carter, p. 106, pl. 2, figs. 2, 5.

non 2002 *Crucella squama* (Kozlova) – Vishnevskaya and Murchey, pl. 7, fig. 3.

2020 *Higumastra inflata* Baumgartner – Vishnevskaya et al., pl. 2, fig. 7, non fig. 8.

2024 *Crucella squama* (Kozlova) – Bragin et al., p. 398, figs. 6E–G.

Material: Six specimens.

Measurements: Length of rays 95–120 μm , length of spines 40–50 μm .

Remarks: Specimen in Fig. 9H displays five rays that are not orientated in one plane, and should be interpreted as pathological.

Occurrence: Jurassic, Hettangian–Sinemurian to Tithonian, worldwide.

Crucella mexicana Yang, 1993

(Fig. 8I, J)

1993 *Crucella mexicana* – Yang, p. 40, pl. 4, figs. 10, 11, 14, 16; pl. 5, figs. 10, 21.

1996 *Crucella mexicana* Yang – Kiessling and Scasso, pl. 1, fig. 7.

1999 *Crucella mexicana* Yang – Kiessling, p. 38, pl. 7, fig. 5.

Material: Two specimens.

Measurements: Length of rays 100–110 μm , length of spines up to 75 μm .

Remarks: Specimens in Figs. 8I, J are slightly different due to various preservation. Test wall of specimen 8I is partly dissolved.

Occurrence: Upper Jurassic, Oxfordian to Tithonian, Mexico, Antarctic Peninsula, Central Russia.

Genus *Orbiculiforma* Pessagno, 1973

Type species: *Orbiculiforma quadrata* Pessagno, 1973.

Orbiculiforma sp. aff. *O. teres* Hull, 1997

(Fig. 8K)

aff. 1997 *Orbiculiforma teres* – Hull, p. 16, pl. 1, figs. 10, 11, 15, 19.

Material: Two specimens.

Measurements: Diameter of test 270 μm , maximal length of peripheral spines 35 μm , maximal thickness of peripheral spines 20 μm .

Remarks: Differs from *O. teres* Hull by twice thicker and longer peripheral spines. Differs from *O. (?) incognita* Blome by less abundant and thicker peripheral spines.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Orbiculiforma sp.

(Fig. 8L)

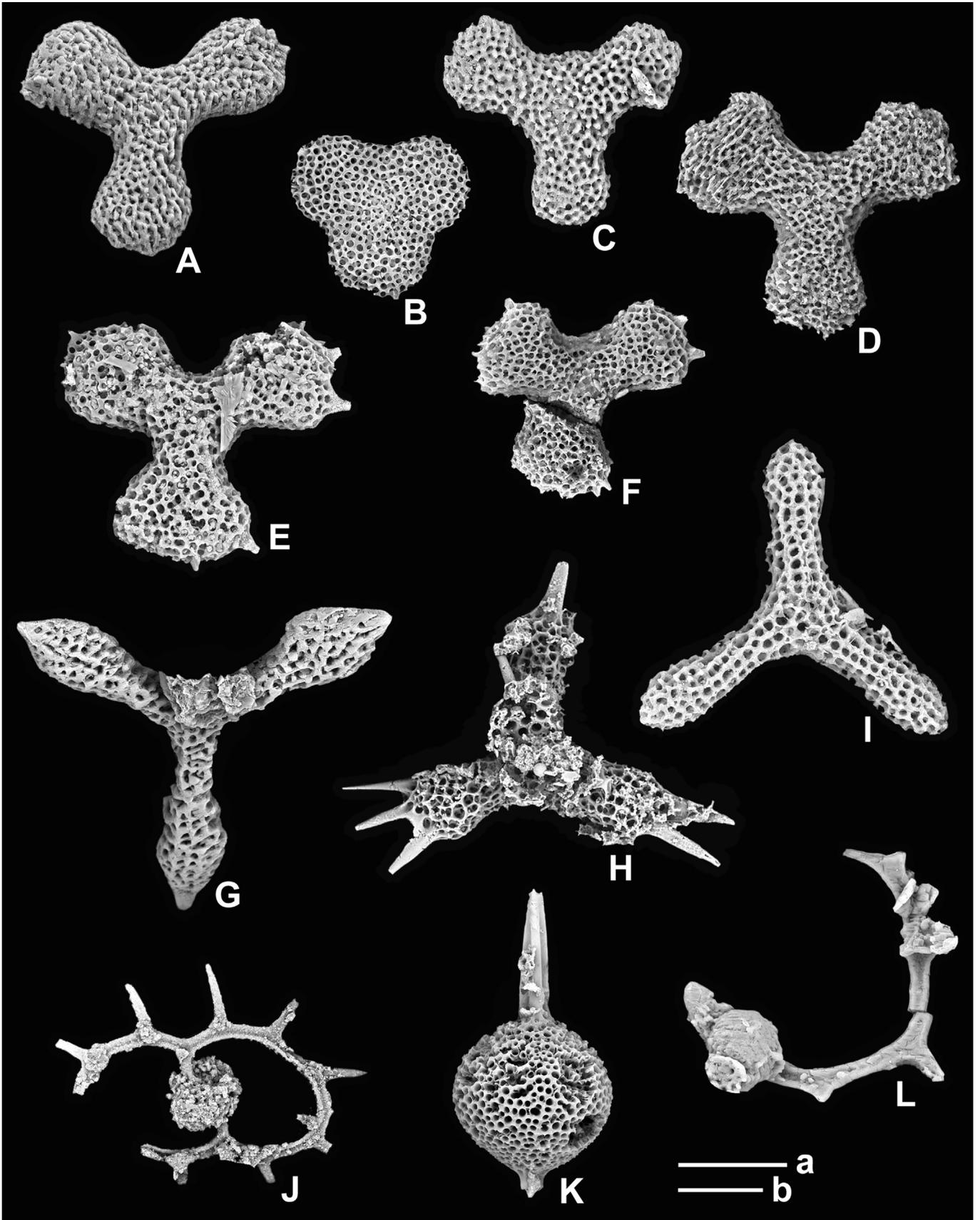
Material: One specimen.

Measurements: Diameter of test 200 μm , maximal length of peripheral spines 20 μm .

Remarks: Differs from *O. (?) incognita* Blome by rare peripheral spines.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Fig. 9. Spumellaria (*Paronaella*, *Archaeospongoprimum* and Saturnalidae) from the Domodedovo section. (A, C) *Paronaella obesa* (Yang); (A) GIN 4850-01-25; (C) GIN 4850-24-55. (B) *Paronaella* sp. A, GIN 4850-24-56. (D–F) *Paronaella* aff. *tripla* De Wever; (D) GIN 4850-01-26; (E) GIN 4850-24-57; (F) GIN 4850-01-27. (G) *Paronaella* sp. aff. *P. longoriai* (Yang), GIN 4850-24-58. (H) *Paronaella* sp. aff. *P. pristidentata* Baumgartner, GIN 4850-24-59. (I) *Paronaella longoriai* (Yang), GIN 4850-24-60. (J) *Acanthocircus yaoui* Yang, GIN 4850-24-66. (K) *Archaeospongoprimum* sp. aff. *A. helense* Blome, GIN 4850-24-65. (L) *Acanthocircus* sp., GIN 4850-24-67. (A, D, F) Sample 01-7-1, (B, C, E, G–L) sample 24-1-1. Scale bar a = 100 μm (A–I, K), b = 100 μm (J, L).



Family Angulobracchiidae Baumgartner, 1980

Genus *Paronaella* Pessagno, 1971

Type species: *Paronaella solanoensis* Pessagno, 1971.

Paronaella obesa (Yang, 1993)
(Fig. 9A, C)

1993 *Santonaella obesa* – Yang, p. 52, pl. 4, figs. 5, 6, 22; pl. 7, fig. 10.

1997 *Paronaella obesa* (Yang) – Hull, p. 24, pl. 6, fig. 1.

2009 *Paronaella obesa* (Yang) – Yeh, text-fig. 5b.9.

2013 *Paronaella* sp. aff. *P. obesa* (Yang) – Bragin and Kiselev, pl. 1, figs. 3, 5, 6.

Material: Four specimens.

Measurements: Length of rays from center of test 170–180 µm, maximal thickness of rays 100–115 µm.

Occurrence: Middle to Upper Jurassic, Bathonian to Tithonian, Mexico, Oregon, Central Russia.

Paronaella sp. aff. *P. tripla* De Wever, 1981
(Fig. 9D–F)

aff. 1981 *Paronaella tripla* – De Wever, p. 34, pl. 3, figs. 5, 6.

2013 *Paronaella* sp. aff. *P. broennimanni* Pessagno – Bragin and Kiselev, pl. 1, figs. 1, 2.

Material: Three specimens.

Measurements: Length of rays from center of test 110–150 µm, maximal thickness of rays 80–120 µm.

Remarks: Differs from *P. tripla* De Wever by thicker rays with several massive secondary spines. Differs from *P. broennimanni* Pessagno by short and thick rays with irregular arrangement of pores.

Occurrence: Upper Jurassic, upper Oxfordian–lower Kimmeridgian.

Paronaella sp. A
(Fig. 9B)

Material: One specimen.

Measurements: Length of rays from center of test 80 µm, maximal thickness of rays 80 µm.

Remarks: This small simple specimen with very short and thick rays has some affinity with *P. coalescenda* Kiessling (see Kiessling, 1999, pl. 7, fig. 18), but lacks characteristic V-shaped notch on one ray.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Paronaella longoriai (Yang, 1993)
(Fig. 9I)

1993 *Santonaella longoriai* – Yang, p. 50, pl. 4, figs. 7, 9, 17, 18; pl. 7, fig. 6.

1997 *Paronaella* sp. cf. *P. longoriai* (Yang) – Hull, p. 23, pl. 6, fig. 7.

Material: One specimen.

Measurements: Length of rays from center of test 130 µm, maximal thickness of rays 60 µm, length of spines 65 µm.

Occurrence: Upper Jurassic, upper Oxfordian to Tithonian, Mexico, Central Russia.

Paronaella sp. aff. *P. longoriai* (Yang, 1993)
(Fig. 9G)

aff. 1993 *Santonaella longoriai* – Yang, p. 50, pl. 4, figs. 7, 9, 17, 18; pl. 7, fig. 6.

Material: One specimen.

Measurements: Length of rays from center of test 190 µm, maximal thickness of rays 50 µm.

Remarks: Differs from *P. longoriai* (Yang) by tipped terminations of rays and by less regular arrangement of pores.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Paronaella sp. aff. *P. pristidentata* Baumgartner, 1980
(Fig. 9H)

aff. 1980 *Paronaella pristidentata* – Baumgartner, p. 304, pl. 9, fig. 7; pl. 12, fig. 3.

Material: One specimen.

Measurements: Length of rays from center of test 180 µm, maximal thickness of rays 65 µm, length of spines 65 µm.

Remarks: Differs from *P. pristidentata* Baumgartner by longer and thinner rays.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Family Archaeospongopruidae Pessagno, 1973

Genus *Archaeospongoprimum* Pessagno, 1973

Type species: *Archaeospongoprimum venadoensis* Pessagno, 1973.

Archaeospongoprimum sp. aff. *A. helense* Blome, 1984
(Fig. 9K)

aff. 1984 *Archaeospongoprimum helense* – Blome, p. 349, pl. 1, figs. 1, 2, 6, 7, 14, 15.

2024 *Archaeospongoprimum* sp. aff. *A. helense* Blome – Bragin et al., p. 400, fig. 6J.

Material: One specimen.

Measurements: Length of test on the line of main spines 130 µm, width of test 140 µm, length of remained spine 110 µm.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Family Saturnaliidae Deflandre, 1953

Genus *Acanthocircus* Squinabol, 1903

Type species: *Acanthocircus irregularis* Squinabol, 1903.

Acanthocircus yaoi Yang, 1993

(Fig. 9J)

1993 *Acanthocircus yaoi* – Yang, p. 87, pl. 14, figs. 3, 4, 7, 12, 18.

1996 *Acanthocircus polymorphus* (Squinabol) – Kiessling and Scasso, pl. 1, fig. 1.

1999 *Acanthocircus yaoi* Yang – Kiessling, p. 37, pl. 7, figs. 1–3, 20.

Material: One specimen.

Measurements: Length of main spines 80 µm, length of external rays 85 µm, maximal diameter of ring 320 µm.

Occurrence: Upper Jurassic to Lower Cretaceous, Oxfordian to Albian, worldwide.

Acanthocircus sp.

(Fig. 9L)

Material: One specimen.

Measurements: Maximal diameter of ring 330 µm, length of external rays 55 µm.

Remarks: Species cannot be determined due to poor preservation.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Order Nassellaria Ehrenberg, 1875

Family Echinocampidae Bragin, 2009

Genus *Nordvikella* Bragin, 2009

Type species: *Nordvikella elegans* Bragin, 2009.

Nordvikella sp. cf. *N. scabiosa* Bragin in Bragin et al., 2024 (Fig. 10A)

cf. 2024 *Nordvikella scabiosa* — Bragin in Bragin et al., p. 408, fig. 9P–S.

Material: One specimen.

Measurements: Length of test (without apical horn) 150 µm, maximal width of test 95 µm, length of apical horn 15 µm.

Remarks: Differs from typical *N. scabiosa* by smaller size of test. Prolongations of elements E were not observed.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Nordvikella simplex n. sp.

(Fig. 10B–D)

Etymology: Simplex (Latin) – simple, ordinary.

Holotype: GIN (Geological Institute of Russian Academy of Sciences) 4850-01-31, Fig. 10B, housed in Geological Institute RAS, Moscow, Russia, from the upper Oxfordian–lower Kimmeridgian of Domodedovo Section, Moscow Region.

Material: Three specimens.

Diagnosis: *Nordvikella* with small slender test without external strictures, with three rows of simple circular pores in each postabdominal segment.

Description: Test small, with subconical apical part and subcylindrical to barrel-like apertural part. Cephalis small, subconical, poreless. Apical horn short, straight, pointed. Prolongation of element V tiny, short, located near the base of apical horn, oriented on angle 45° to the apical horn. Prolongation of element D short, tiny, located near the base of apical horn, oriented on angle 90° to the apical horn. Prolongations of elements I short, deviate from the base of cephalis at angle of 60° to the longitudinal axis of test. Prolongations of elements L twice longer than other elements, thin, pointed, partly incorporated in the test wall. Strictures between cephalis, thorax, abdomen and postabdominal segments absent. Thorax and abdomen truncate-conical, with circular pores displaying tendency to form transversal rows. 5 to 6 postabdominal segments subcylindrical with 3 rows of circular pores in thin hexagonal to pentagonal pore frames. Pores of test mostly uniform in size. Nodes are not present, aperture constricted.

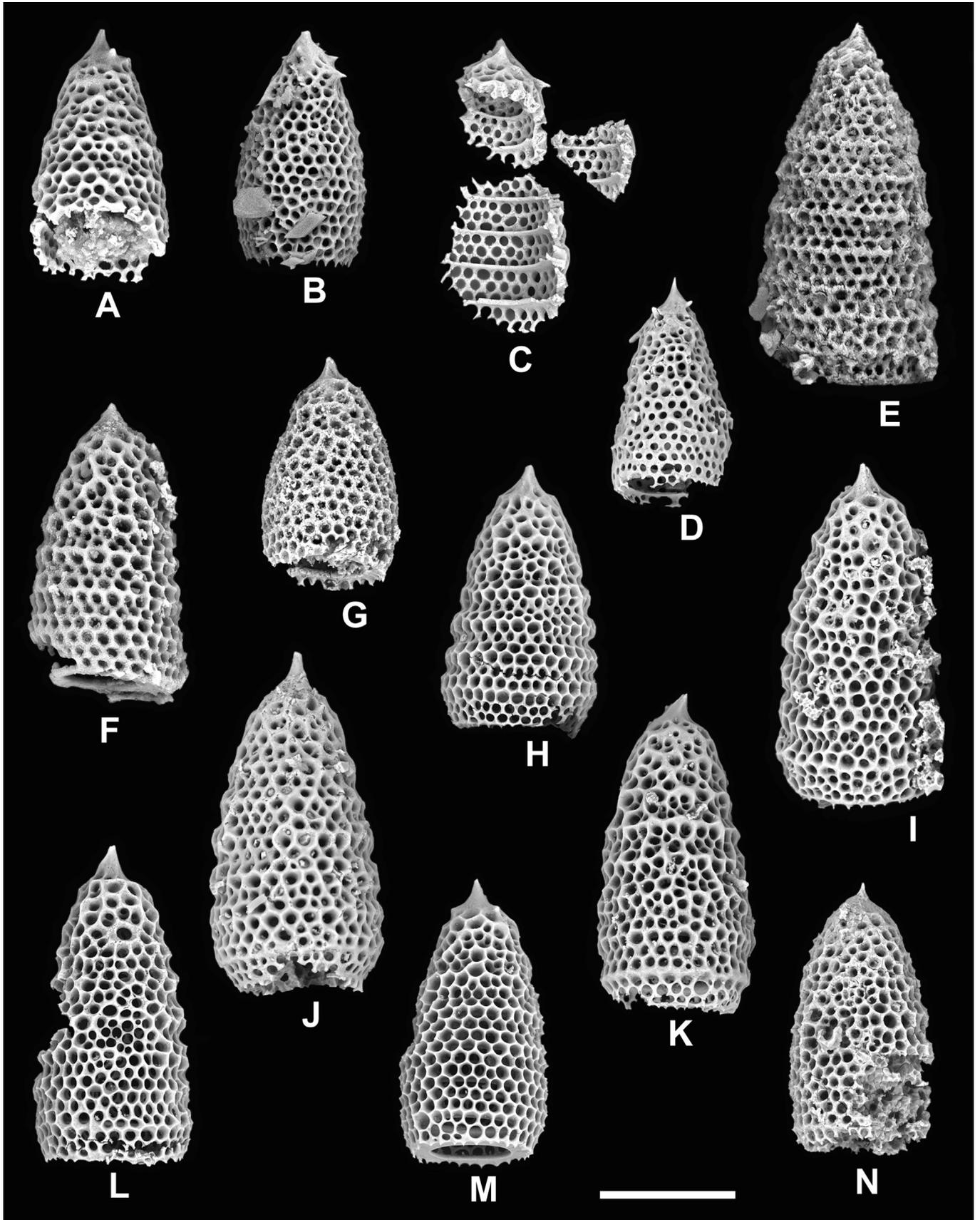
Measurements: Length of test (without apical horn) 175–190 µm, maximal width of test 95–100 µm, length of apical horn 20 µm.

Remarks: Differs from *N. plana* Bragin, 2025 by small apical horn and small, tiny prolongations of other cephalic elements, by apertural stricture and by uniform pores grouped in three regular transversal rows in each postabdominal segment.

Occurrence: Upper Jurassic, upper Oxfordian to lower Kimmeridgian of Central Russia.

Family Parvicingulidae Pessagno, 1977a

Fig. 10. Nassellaria from the Domodedovo section. (A) *Nordvikella* sp. cf. *N. scabiosa* Bragin, GIN 4850-01-35. (B–D) *Nordvikella simplex* n. sp.; (B) holotype, GIN 4850-01-31; (C) GIN 4850-24-70; (D) GIN 4850-24-71. (E) *Praeparvicingula sencilla* Hull, GIN 4850-01-30. (F, H–M) *Praeparvicingula donnae* Bragin; (F) GIN 4850-24-73; (H) GIN 4850-24-75; (I) GIN 4850-24-76; (J) GIN 4850-24-77; (K) GIN 4850-24-78; (L) GIN 4850-24-79; (M) GIN 4850-24-80. (G) *Praeparvicingula elementaria* (Carter), GIN 4850-24-74. (N) *Praeparvicingula enormis* (Yang), GIN 4850-24-81. (A, B, E) Sample 01-7-1; (C, D, F–N) Sample 24-1-1. Scale bar = 100 µm.



Genus *Praeparvicingula* Pessagno, Blome and Hull in Pessagno et al., 1993

Type species: *Parvicingula profunda* Pessagno and Whalen, 1982.

Praeparvicingula sencilla Hull, 1995
(Fig. 10E)

1995 *Praeparvicingula sencilla* – Hull, p. 42, pl. 8, figs. 9, 10, 15, 16.

Material: One specimen.

Measurements: Length of test 275 µm, maximal width of test 135 µm, length of apical horn 15 µm.

Occurrence: Upper Jurassic, Tithonian of Mexico, upper Oxfordian to lower Kimmeridgian of Central Russia.

Praeparvicingula donnae Bragin, 1997
(Fig. 10F, H–M)

1971 *Eucyrtidium haeckeli* (Pantaneli) – Kozlova, fig. 1.17.

1994 *Parvicingula elegans* Pessagno and Whalen – Kozlova, pl. 4, figs. 3, 4.

1994 *Parvicingula haeckeli* (Pantaneli) – Kozlova, pl. 3, figs. 1, 2.

1994 *Parvicingula papulata* – Kozlova, pl. 5, figs. 5, 6, 10 (nomen nudum).

1994 *Parvicingula* sp. C – Kozlova, pl. 4, fig. 10, non fig. 11.

1995 *Praeparvicingula* sp. cf. *P. sencilla* Hull – Hull, p. 42, pl. 8, fig. 11.

1997 *Praeparvicingula donnae* – Bragin, p. 292, pl. 2, figs. 3, 4.

1998 *Parvicingula burnsensis* Pessagno and Whalen – Vishnevskaya, fig. 8k.

1998 *Parvicingula* aff. *burnsensis* Pessagno and Whalen – Vishnevskaya, fig. 8b, f.

1998 *Parvicingula* ex gr. *burnsensis* Pessagno and Whalen – Vishnevskaya, fig. 8s.

1998 *Parvicingula haeckeli* (Pantaneli) – Vishnevskaya, figs. 8g, 12c.

1998 *Parvicingula* aff. *haeckeli* (Pantaneli) – Vishnevskaya, fig. 8l.

1998 *Parvicingula inornata* Blome – Vishnevskaya, fig. 12g.

1998 *Parvicingula?* *enormis* Yang – Vishnevskaya, fig. 12b.

1999 *Parvicingula?* *enormis* Yang – Vishnevskaya and Pralnikova, p. 81, pl. 2, fig. 12, non fig. 11.

2001 *Parvicingula* ex gr. *burnsensis* Pessagno and Whalen – Vishnevskaya, pl. 121, fig. 8.

2001 *Parvicingula* aff. *elegans* Pessagno and Whalen – Vishnevskaya, pl. 121, fig. 7.

2001 *Parvicingula haeckeli* (Pantaneli) – Vishnevskaya, pl. 121, fig. 3.

2001 *Parvicingula papulata* Kozlova – Vishnevskaya, pl. 121, fig. 10.

2002 *Parvicingula* ex gr. *burnsensis* Pessagno and Whalen – Vishnevskaya and Murchey, pl. 7, figs. 9, 10.

2020 *Parvicingula papulata* Kozlova and Vishnevskaya – Palechek and Ustinova, pl. 6, figs. 2, 3, 24, non figs. 4–6, 22, 23 (= *Praeparvicingula enormis*).

2020 *Parvicingula* aff. *rothwelli* Pessagno – Palechek and Ustinova, pl. 6, fig. 1.

2024 *Praeparvicingula donnae* Bragin — Bragin et al., p. 402, figs. 7F–V, 8A–D.

Material: 24 specimens.

Measurements: Length of test 200–260 µm, maximal width of test 120–150 µm, length of apical horn 25 µm.

Occurrence: Upper Jurassic, middle Oxfordian–Kimmeridgian of Central Russia, Moscow Region, Kimmeridgian of Pechora Depression (cis-Uralian northeastern European Russia), Tithonian of California, USA.

Praeparvicingula elementaria (Carter in Carter et al., 1988)
(Fig. 10G)

1988 *Eucyrtidium elementarius* – Carter et al., p. 60, pl. 17, fig. 13.

1988 *Parvicingula* sp. B – Carter et al., p. 56, pl. 18, figs. 3, 4.

1994 *Excingula bifaria* – Kozlova, pl. 3, fig. 7 (nomen nudum).

2001 *Excingula bifaria* Kozlova – Vishnevskaya, pl. 121, fig. 5.

2001 *Eucyrtidium* ex gr. *elementarius* Carter – Vishnevskaya, p. 162, pl. 60, fig. 9; pl. 69, figs. 6–8.

2001 *Laxtorum?* *jurassicum* Isozaki and Matsuda – Vishnevskaya, p. 166, pl. 69, fig. 4 only.

2006 *Praeparvicingula elementaria* (Carter) – Goričan et al., p. 334, pl. PVG02, figs. 1, 2.

2020 *Praeparvicingula* aff. *elementaria* (Carter) – Palechek and Ustinova, pl. 6, figs. 8, 12, non figs. 9–11 (= *P. enormis*).

2024 *Praeparvicingula elementaria* (Carter) — Bragin et al., p. 403, fig. 8E–L.

Material: 3 specimens.

Measurements: Length of test 155 µm, maximal width of test 105 µm, length of apical horn 15 µm.

Occurrence: Lower to Middle Jurassic, upper Toarcian to Bathonian of Haida Gwaii, British Columbia, Canada, Middle Jurassic, Bajocian of Koryak Range, Northeastern Russia, Upper Jurassic, Kimmeridgian of Pechora Depression (cis-Uralian northeastern European Russia), upper Oxfordian to lower Kimmeridgian of Central Russia, Moscow Region.

Praeparvicingula enormis (Yang, 1993)
(Fig. 10N)

1993 *Parvicingula?* *enormis* – Yang, p. 118, pl. 19, figs. 6, 13, 18; pl. 20, figs. 5, 6, 15, 22.

non 1998 *Parvicingula?* *enormis* Yang – Vishnevskaya, fig. 12b (= *P. donnae* Bragin).

non 1999 *Parvicingula?* *enormis* Yang – Vishnevskaya and Pralnikova, p. 81, pl. 2, figs. 11, 12.

2020 *Parvicingula papulata* Kozlova – Palechek and Ustinova, pl. 6, figs. 4–6, 22, 23, non figs. 2, 3, 24 (= *Praeparvicingula donnae*).

2024 *Praeparvicingula enormis* (Yang) – Bragin et al., p. 405, fig. 8M–U.

Material: One specimen.

Measurements: Length of test without apical horn 195 µm, maximal width of test 100 µm, length of apical horn 10 µm.

Occurrence: Upper Jurassic, Tithonian of Mexico, Upper Jurassic, upper Oxfordian–lower Kimmeridgian of Central Russia, Moscow Region.

6. Conclusions

1. An abundant and well-preserved radiolarian assemblage was obtained from the upper Oxfordian–lower Kimmeridgian (Upper Jurassic) of the Domodedovo Section near Moscow, Central Russia. Radiolarians were extracted from spherical clayey phosphatic concretions.
2. Spherical Spumellaria are most abundant in this assemblage: *Praeconocaryomma decora* Yeh, *P. scatebra* Hull, *P. blomei* n. sp. Common are *Acastea laevispina* n. sp., *Crucella squama* (Kozlova), *Paronaella obesa* (Yang) and *P. sp. aff. P. tripla* De Wever. Other Spumellaria are rare: *Pantanellium* sp. D sensu Pessagno and MacLeod, *P. quintachillaense* Pessagno and MacLeod, *P. sp.*, *Phantum robustum* n. sp., *Acanthocircus yaoi* Yang. Nassellaria are quantitatively less abundant: only species *Praeparvicingula donnae* Bragin is common, others are rare: *Praeparvicingula sencilla* Hull, *P. elementaria* (Carter). Rare representatives of Echinocampidae include *Nordvikella simplex* n. sp. and *N. sp. cf. N. scabiosa* Bragin.
3. The radiolarian assemblage displays low taxonomic and morphological diversity. It is characterized by the common presence of typical Boreal taxa (*Nordvikella*, *Praeparvicingula*) and taxa of Southern Boreal affinity (representatives of *Pantanellium meraceibaense* taxonomic line). The assemblage represents a typically high-latitude fauna with southern influence related to warming episode or penetration of warm currents.
4. Four species are described herein, namely, *Acastea laevispina* n. sp., *Praeconocaryomma blomei* n. sp., *Phantum robustum* n. sp., *Nordvikella simplex* n. sp.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This study was supported by Russian Government Program FMMG-2021-0003 (Geological Institute RAS). We highly appreciate valuable comments on manuscript given by Špela Goričan (Ivan Rakovec Institute of Palaeontology, Ljubljana, Slovenia) and an anonymous reviewer.

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