Triassic Radiolarians of Kotel’nyi Island (New Siberian Islands, Arctic)

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Received January 30, 2008

ISSN 0031-0301, Paleontological Journal, 2011, Vol. 45, No. 7, pp. 1–68. © Pleiades Publishing, Ltd., 2011

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Abstract—Triassic radiolarians from Kotel'nyi Island (New Siberian Islands, Arctic Region) are studied. Radiolarians occur in the Middle and Upper Triassic beds, which are well dated by ammonoids, nautiloids, and bivalves. In the Middle Triassic beds, which are composed of dark gray and black clays and claystones with interbeds of combustible schist, siltstone, clayey limestone, and many phosphatic concretions, the following two assemblages are recognized: (1) a Late Anisian assemblage, including *Glomeropyle clavatum* Bragin, sp. nov., *G. boreale* Bragin, *G. manihepuaensis* Aita, *G. insulanum* Bragin, sp. nov., *Triassospongosphaera multispinosa* (Kozur et Mostler), *Tetraspongodiscus hibernus* Bragin, sp. nov., *T. borealis* Bragin, sp. nov., *Eptingium abditum* Bragin, sp. nov., *E. manfredi* Dumitrica, *Spongostephanidium japonicum* (Nakaseko et Nishimura), and *Ladinocampe vicentinensis* Kozur et Mostler; (2) Late Ladinian assemblage, with *Muelleritortis firma* (Gorican), *M. kotelnyensis* Bragin, sp. nov., *Tiborella nivea* Bragin, sp. nov., *Pseudostylosphaera goestlingensis* (Kozur et Mostler), *P. omolonica* Bragin, *Triassospongosphaera multispinosa* (Kozur et Mostler), *Sarla cincinnata* Bragin, sp. nov., *S. obscura* Bragin, sp. nov., *S. prava* Bragin, sp. nov., and *Eonapora stiriaca* Bragin, sp. nov. The Upper Triassic beds, composed of gray and black clays and claystones with lenses of clayey limestones, with sideritic and phosphatic–calciferous concretions have yielded (1) an Early Carnian assemblage, with *Pentactinocarpus colum* Bragin, sp. nov., *Glomeropyle cuneum* Bragin, sp. nov., *G. algidum* Bragin, sp. nov., *G. aculeatum* Bragin, sp. nov., *Kahlerosphaera isopleura* Bragin, sp. nov., *Stauracanthocircus folium* Bragin, sp. nov., *Tetraspongodiscus uncatus* Bragin, sp. nov., *Poulpus costatus* (Kozur et Mostler), *Eonapora robusta* Kozur et Mostler, *Planispinocyrtis kotelnyensis* Bragin, sp. nov., *Annulotriassocampe baldii* (Kozur), and *Pseudoeucyrtis annosus* Bragin, sp. nov.; (2) a Middle–Late Carnian assemblage with *Pseudostylosphaera glabella* Bragin, sp. nov., *P. gracilis* Kozur et Mock, *P. voluta* Bragin, sp. nov., *P. gelida* Bragin, sp. nov., *Kahlerosphaera unca* Bragin, sp. nov., *K. aspinosa* Kozur et Mock, *K. fuscinula* Bragin, sp. nov., *K. acris* Bragin, sp. nov., *Capnuchosphaera kuzmichevi* Bragin, sp. nov., *C. triassica* De Wever, *C. angusta* Bragin, sp. nov., *Sarla intorta* Bragin, sp. nov., *S. compressa* Bragin, sp. nov., *S. aequipeda* Bragin, sp. nov., *Betraccium irregulare* Bragin, *B. kotelnyensis* Bragin, sp. nov., *Spongotortilispinus carnicus* Kozur et Mostler, *S. subtilis* Bragin, sp. nov., *Dumitricasphaera simplex* Tekin, *D. aberrata* Bragin, sp. nov., *D. arbustiva* Bragin, sp. nov., *Zhamojdasphaera epipeda* Bragin, sp. nov., *Z. proceruspinosa* Kozur et Mostler, *Vinassaspongus subsphaericus* Kozur et Mostler, *Palaeosaturnalis triassicus* Kozur et Mostler, *Paronaella concreta* Bragin, sp. nov., *P. aquilonia* Bragin, sp. nov., *Tetraspongodiscus cincinnalis* Bragin, sp. nov., *Annulotriassocampe baldii* (Kozur), *Canoptum zetangense* Wang et Yang, *Whalenella speciosa* (Blome), *Syringocapsa turgida* Blome, *Droltus gelidus* Bragin, sp. nov., and *D. niveus* Bragin, sp. nov.; (3) an Early Norian assemblage with *Pseudostylosphaera glabella* Bragin, sp. nov., *P. gelida* Bragin, sp. nov., *P. voluta* Bragin, sp. nov., *Kahlerosphaera retunsa* Bragin, sp. nov., *Capnuchosphaera deweveri* Kozur et Mostler, *Sarla globosa* Bragin, sp. nov., *Palaeosaturnalis mocki* Kozur et Mostler, *Paronaella aquilonia* Bragin, sp. nov., *Syringocapsa turgida* Blome, and *Droltus gelidus* Bragin, sp. nov.; (4) a Middle Norian assemblage with *Sarla globosa* Bragin, sp. nov., *Sarla* sp., *Syringocapsa turgida* Blome, *Canoptum* sp., and *Laxtorum?* sp. The fact that these assemblages include taxa that are recorded more southerly, including paleotropical localities, and support dating based on mollusks, enables the use of these data for Boreal–Tethyan correlation. The greatest similarity to Tethyan associations is observed in the Late Carnian and Early Norian, that is, the periods of the greatest penetration of thermophilic mollusks into this basin. A total of 69 radiolarian species of 3 orders, 18 families, and 29 genera are described; 44 species are newly described; the stratigraphic and geographical ranges of the majority of taxa are improved considerably.

Keywords: Radiolaria, new taxa, Triassic, stratigraphic and geographical ranges, New Siberian Islands, Kotel'nyi Island.

DOI: 10.1134/S003103011107001X

INTRODUCTION

Radiolarians are a group that has actively been used in stratigraphy only recently. The use of radiolarians was initially restricted to the questions of dating and stratification of siliceous strata, which usually contain scarce, if any, fossil specimens of other groups; subsequently, radiolarians were additionally used for solving the questions of the general stratigraphic scale. Several zonal schemes for the Triassic System have been developed based on radiolarians (Kozur and Mostler, 1994; Sugiyama, 1997; Bragin, 2000).

It is well known that, during the Triassic Period, biogeographical differences between faunas of low and high latitudes gradually increased (Dagys et al., 1979; Konstantinov et al., 2003). As a result, the taxonomic composition of stratigraphically valuable groups of organisms (primarily cephalopods and bivalves) became differentiated too deeply to use them for reliable comparisons of sections. This extremely complicates the correlation of high- and low-latitude sections of the Triassic and prevents the establishment of the boundaries of particular units of the general scale in the boreal paleobiochores. Therefore, direct Boreal–Tethyan correlation of the Upper Triassic beds based on mollusks is rarely performed; "intermediate" sections containing a mixed fauna (British Columbia) are usually used for this purpose (Tozer, 1994).

Triassic radiolarians also show significant differences in taxonomic composition between high and low latitudinal assemblages. Nevertheless, this plankton group includes many species with wide geographical ranges (or cosmopolitans) in both extant and extinct faunas. The first studies of the boreal Triassic (Bragin, 1994; Egorov and Bragin, 1995; Aita and Bragin, 1999; Bragin and Egorov, 2000) have shown characteristic features of boreal radiolarian assemblages; they always include certain species known in more southerly regions, which are widespread species, or probably even cosmopolitans. At the same time, these assemblages often include or even are dominated by typical high-latitude taxa, which are absent from southern regions, but sometimes show bipolar distribution.

Note that the knowledge of Triassic boreal radiolarians is rather poor; to date, they have been recorded in a few sections (Egorov and Bragin, 1995; Bragin and Egorov, 2000; Tekin et al., 2006); and only radiolarians from the Ladinian of the Omolon Massif have been described in detail (Aita and Bragin, 1999; Bragin and Egorov, 2000). Therefore, each new find of Triassic boreal radiolarians is of great interest, expanding the knowledge of the taxonomic composition, similarities and differences from associations of other regions, and stratigraphic and paleobiogeographical distribution of many species. The data on widespread species are of great interest for stratigraphy, since they are important for direct Boreal–Tethyan correlation. The data on strictly high-latitude species are interesting for paleobiogeography, because the distribution of these species indicates the boundaries of boreal paleobiochores. The dynamics and character of development of boreal assemblages are of particular interest, showing the stepwise character of evolution (for boreal taxa) and important changes in assemblages, which reflect shifts of conditions and migration of thermophilic organisms, caused by either warming or transgressions, which result in the expansion of links between basins and, hence, an increase in similarity in the taxonomic composition of assemblages from different paleobiochores. However, it is possible to solve these questions only after a thorough study and paleontological description of radiolarians.

The purpose of the present study is examination of Triassic radiolarians of Kotel'nyi Island. This area belongs to the Arctic Region, which is extremely poorly understood with reference to Triassic radiolarians. At the same time, good preservation, relatively diverse taxonomic composition, and co-occurrence of radiolarians with key ortho- and parastratigraphic macrofossils provide rather complete information on the composition of radiolarian assemblages and their stratigraphical position, which is important with reference to the methodical aspect. In addition, this study has certain regional significance and gives the first example of the use of radiolarians for local stratigraphy of the Triassic.

CHAPTER 1. SECTIONS OF TRIASSIC BEDS OF CENTRAL KOTEL'NYI ISLAND

The Triassic strata occur in northern, central, and extreme southern Kotel'nyi Island. Triassic outcrops are particularly large in the central part, where our field work was performed. The Triassic strata outcrop in the middle reaches of the Balyktakh River and valleys of its tributaries: the Pryamaya, Tikhaya, Sheina, Tuguttakh, and Tuor-Yuryakh rivers (Fig. 1). This section of Triassic beds was repeatedly studied by various researchers and described in a number of works (Preobrazhenskaya et al., 1975; Korchinskaya, 1977; Egorov et al., 1987). The Triassic is represented by its three series, with the greatest stratigraphical completeness of the Upper Triassic.

The Induan Stage on Kotel'nyi Island is established tentatively, based on the stratigraphical position between the confidently outlined Permian and Olenekian beds. In the central part of the island, the presumable Induan is represented by speckled silty clays, with claystone and siltstone interbeds with a tuffite admixture, rare dolomite interbeds, and rare concretions of brown siderites. The total thickness of the strata is up to 15 m. These beds contain only rare lingulids, while radiolarians have not been recorded.

The Olenekian Stage is represented by interbedding bituminous limestones and clays with ammonoids and bivalves of 12-m-thick strata of the lower substage, which is overlain by clays with interbeds of clayey limestones and small phosphatic con-

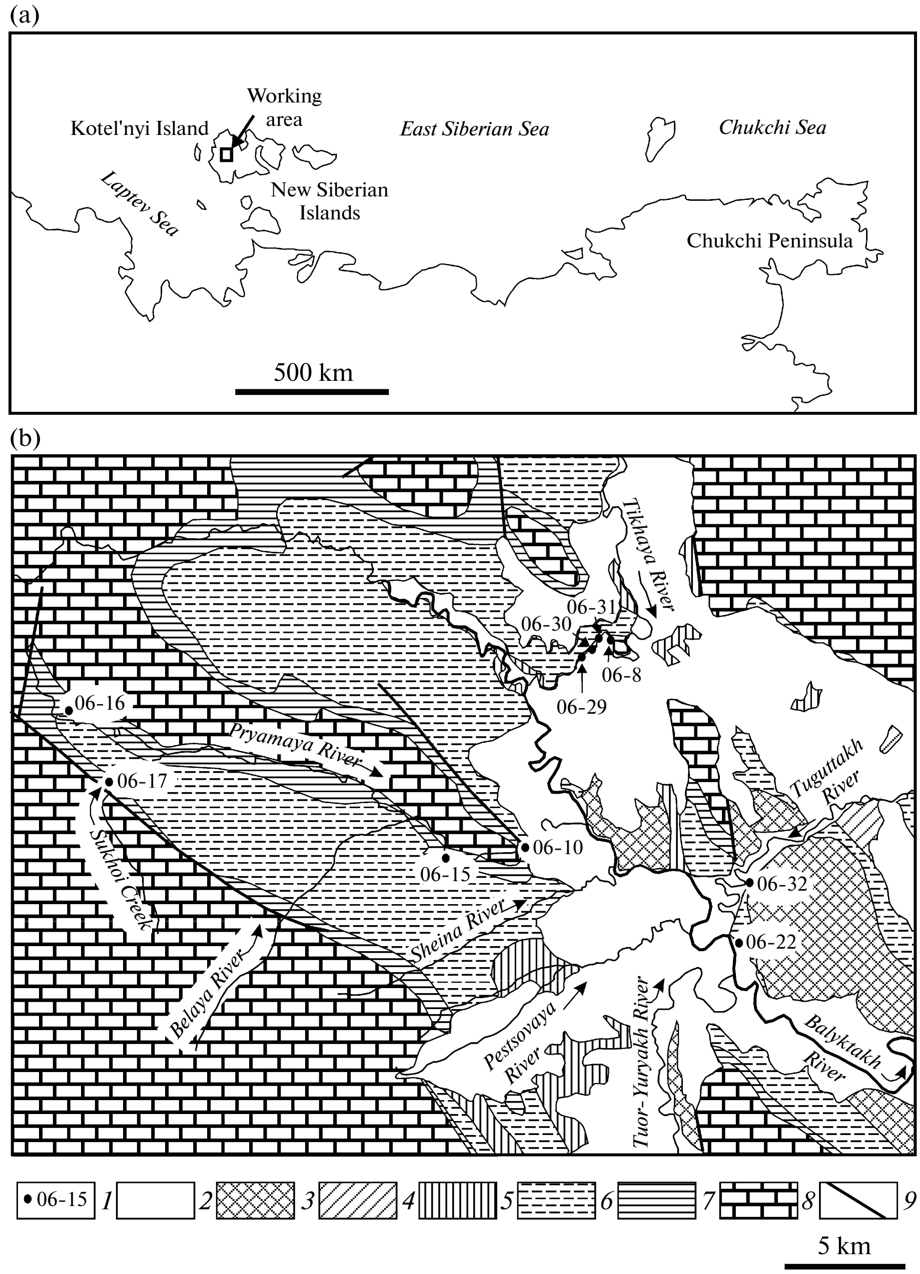


Fig. 1. Scheme of location and geological structure of the working area: (a) geographical position of the New Siberian Islands and working area; (b) geological structure of central Kotel'nyi Island. Designations: (*1*) sections and outcrops where radiolarians have been recorded; (*2*) Quaternary; (*3*) Lower Cretaceous; (*4*) Lower Jurassic; (*5*) Rhaetian–Liassian; (*6*) Upper Triassic; (*7*) Lower and Middle Triassic; (*8*) Paleozoic; and (*9*) fractures.

cretions, with mollusks of the upper substage, reaching 20 m in thickness. These beds have not yielded radiolarians.

A complete section of the Anisian Stage was previously investigated in the north of the island, near the Stantsiya lagoon (Egorov et al., 1987). In the central part of the island, the lower and upper substages are only recorded, the Middle Anisian strata are missing. The Lower Anisian strata are composed of clays with interbeds of combustible schist, clayey limestone lenses, and phosphatic concretions with ammonoids; these strata are approximately 15 m thick. Radiolarians have not been recorded here. The upper substage is represented by clays with interbeds of combustible schist and abundant phosphatic concretions; these strata have yielded ammonoids, bivalves, and a radiolarian assemblage.

A complete Ladinian section is known in the north of the island (Egorov et al., 1987), while, in the central part, only the upper series is recorded with certainty; it has yielded bivalves, ammonoids, and radiolarians; these Ladinian strata are more than 20 m thick, composed of clays, with interbeds combustible schist and phosphatic and phosphatic–carbonaceous concretions.

The Carnian beds are up to 20 m thick, represented by clays with abundant sideritic and rare phosphatic–calciferous concretions, with ammonoids and bivalves of the lower substage. They are overlain by clays with interbeds of clayey limestones, phosphatic and siderite concretions, with a fauna of ammonoids, nautiloids, and bivalves of the upper substage; the strata are up to 40 m thick. Over the entire Carnian section, there are rich radiolarian assemblages.

The Norian strata of central Kotel'nyi Island are rather thick and complete. The Lower Norian strata are about 150 m thick, represented by clays with interbeds of clayey limestones, with frequent siderite concretions and rare phosphatic–calciferous concretions; the fauna includes ammonoids, nautiloids, bivalves, and radiolarians. The Middle Norian strata are up to 50 m thick, similar in lithologic composition, contains a rich mollusk fauna. Radiolarians are in rare, with an impoverished composition. The Upper Norian strata are about 250 m thick, represented by clays with clayey limestone lenses and many siderite concretions, contain a representative bivalve assemblage. Radiolarians are extremely scarce and poorly preserved.

The roof of the Triassic section of central Kotel'nyi Island is composed of flyschoid strata of rhythmical interbedding of clay, siltstone, siderite, and clayey limestones, containing foraminifers and tentatively referred to the Rhaetian Stage (Preobrazhenskaya et al., 1975; Korchinskaya, 1977). These strata are about 100 m thick, radiolarians have not been recorded here.

Thus, in central Kotel'nyi Island, radiolarians have been investigated in the Upper Anisian, Upper Ladinian, entire Carnian, and Lower and Middle Norian. The sections of these beds are described in detail below. During field work, macrofossils were also collected; ammonoids were determined by A.G. Konstantinov; nautiloids, by E.S. Sobolev; and bivalves, by I.V. Polubotko. In addition, the data of the previous studies are used (Preobrazhenskaya et al., 1975; Korchinskaya, 1977; Egorov et al., 1987; Konstantinov et al., 2003).

The most complete Middle Triassic section was investigated at the upper reaches of the Pryamaya River, on the right board of its unnamed left tributary, 1.5 km southwest from eminence 126.4 (point 06-16) (Fig. 1). The coordinates of the beginning and end of the section are 75°30.769′ N, 138°10.363′ E and 75°30.834′ N 139°09.602′ E, respectively. The section covers a Middle Triassic (without bottoms) and bottom of a Carnian (Fig. 2). The following beds are exposed here from the bottom upwards:

$T_2a_3^1$ 1. Dark gray and black laminated clays, with interbeds (20–30 cm thick) of black bituminous thin-sliced claystones and thin interbeds of yellowish gray clays with jarosite (1–5 cm), with rare spherical and pancaked phosphatic concretions. At the level of 3 m from the sole of the bed, the bivalves *Daonella* sp. cf. *D. moussoni* Merian, *D. americana* Smith of the lower Upper Anisian are recorded (sample 06-16-1d). Exposed thickness is 6 m.

T_2a_3 2. Dark gray and black laminated clays, with brown ferruginous clay interbeds (noncoherent) with many spherical and, less often, flattened phosphatic concretions. At 3.5 m above the sole of the bed, there was the ammonoid *Indigirophyllites* sp. ex gr. *I. spetsbergensis* (Oeberg) of the Upper Anisian (sample 06-16-1A), *nevadanus* Zone. At the same level and below it the bivalves *Daonella* sp. cf. *D. americana* Smith, *Daonella* sp. ex gr. *D. americana* Smith, *Daonella* sp. cf. *D. moussoni* Merian, *Daonella* sp. of the Upper Anisian (sample 06-16-2d and 06-16-3d) and the radiolarians *Glomeropyle boreale* Bragin, *Triassospongosphaera multispinosa* (Kozur et Mostler), and *Tetraspongodiscus hibernus* Bragin, sp. nov. (sample 06-16-2r) have been recorded. The upper layers of this bed have yielded the bivalves *Daonella* sp. cf. *D. subtenuis* Kittl. and *Daonella* sp. cf. *D. dubia* Gabb. of the Upper Anisian (sample 06-16-4d) and the radiolarians *Glomeropyle clavatum* Bragin, sp. nov., *G. boreale* Bragin, *Triassospongosphaera multispinosa* (Kozur et Mostler), *Tetraspongodiscus hibernus* Bragin, sp. nov., *Eptingium abditum* Bragin, sp. nov., and *Eptingium manfredi* Dumitrica (sample 06-16-4r). The bed is 8 m thick.

T_2a_3 3. Dark gray and black laminated clays, interbedding with dark gray clayey limestones. These clays and limestones have yielded spherical phosphatic concretions. At 1 m above the sole of the bed, there were the bivalves *Daonella* sp. cf. *D. lindstroemi* Mojs., *Daonella* sp. cf. *D. subtenuis* Kittl., *Daonella* sp. ex gr. *D. americana* Smith of the Upper Anisian (sample 06-16-5d) and the radiolarians *Glomeropyle clavatum* Bragin, sp. nov., *G. boreale* Bragin, *G. manihepuaensis* Aita, *G. insulanum* Bragin, sp. nov., *Triassospongosphaera multispinosa* (Kozur et Mostler), *Tetraspongodiscus hibernus* Bragin, sp. nov., *T. borealis* Bragin, sp. nov., *Eptingium abditum* Bragin, sp. nov., *E. manfredi* Dumitrica, *Spongostephanidium japonicum* (Nakaseko et Nishimura), and *Ladinocampe vicentinensis* Kozur et Mostler (sample 06-16-5r). In the upper layers of the bed, there were the bivalves *Daonella* sp. cf. *D. subtenuis* Kittl., *Daonella* sp. cf. *D. prima* Kipar., *Daonella* sp. ex gr. *D. frami* Kittl., and *Daonella* sp. ex gr. *D. dubia* Gabb., which are characteristic of the boundary beds of the Upper Anisian and Lower Ladinian (sample 06-16-6d). The bed is 3 m thick.

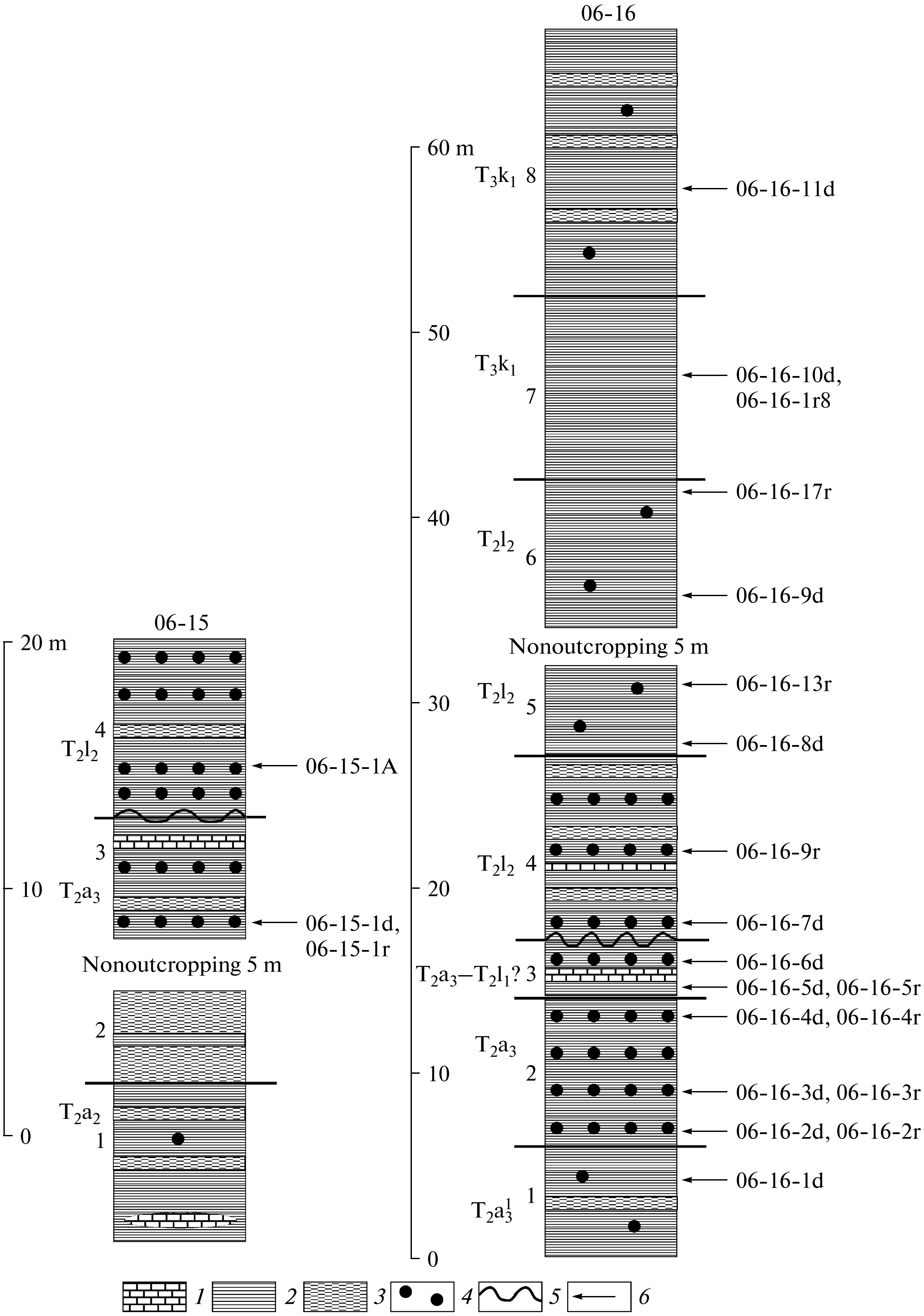


Fig. 2. Structure of the Middle Triassic sections at the middle (06-15) and upper (06-16) reaches of the Pryamaya River and the stratigraphic position of mollusk and radiolarian records. The numbers of beds, indices, and scale bars are to the left of the lithologic columns. Designations: (*1*) limestone, (*2*) clay and claystone, (*3*) siltstone and combustible slate, (*4*) phosphorite concretions, (*5*) unconformity, and (*6*) levels of records of macro- and microfossils, with the numbers of samples.

T_2l_2 4. Dark gray and black, claystone-like, leaflike clays, without pronounced lamination, with black combustible schist interbeds (0.1–0.2 m thick), with frequent spherical, less often, pancaked phosphatic concretions. The interbeds (0.1 m thick) of dark gray clayey bituminous limestones and rusty brown, sometimes, grayish yellow clays with jarosite are occasionally observed. The bivalves *Daonella frami* Kittl., *Magnolobia* sp. cf. *M. subarctica* (Popow), indicating the middle Upper Ladinian (sample 06-16-7d), and the radiolarians *Muelleritortis firma* (Gorican), *M. kotelnyensis* Bragin, sp. nov., *Tiborella nivea* Bragin, sp. nov., *Pseudostylosphaera goestlingensis* (Kozur et Mostler), *P. omolonica* Bragin, *Triassospongosphaera multispinosa* (Kozur et Mostler), *Sarla cincinnata* Bragin, sp. nov., *S. obscura* Bragin, sp. nov., *S. prava* Bragin, sp. nov., *Eonapora stiriaca* Bragin, sp. nov., and *Glomeropyle* sp. (sample 06-16-9r) have been recorded there. The bed is 10 m thick. The Lower Ladinian and lower Upper Ladinian are probably completely or partially absent from the section because of a concealed sedimentation break.

T_2l_2 5. Dark gray and black laminated clays, without interbeds of limestones, with scattered phosphatic concretions, spherical and pancaked, with frequent horizons a yellowish gray and rusty brown jarosite clays. In the upper layers of the bed, there are concretions of mixed (phosphate–carbonaceous) composition. These strata have yielded the bivalves *Daonella* sp. ex gr. *D. frami* Kittl., juv., *Daonella* sp. cf. *D. subtenuis* Kittl., and *Mytilus* sp. aff. *M. anceps* Kur. of the Upper Ladinian (sample 06-16-8d) and also all radiolarian species recorded in the previous bed (sample 06-16-13r). Exposed thickness is 5 m; in addition, 5 m do not outcrop.

T_2l_2 6. A poorly outcropping site. Dark gray clays with phosphatic and phosphatic–calciferous concretions. Rare fragments of crinoid limestones occur in debris. The bed has yielded the bivalves *Magnolobia?* sp. cf. *M. neraensis* (Trusch). and *Daonella* sp. ex gr. *D. frami* Kittl. (juv.) of the Upper Ladinian (sample 06-16-9d) and the radiolarians *Muelleritortis kotelnyensis* Bragin, sp. nov., *Tiborella nivea* Bragin, sp. nov., *Pseudostylosphaera omolonica* Bragin, *Triassospongosphaera multispinosa* (Kozur et Mostler), *Glomeropyle* sp., and *Sarla* sp. (sample 06-16-17r). Exposed thickness is 8 m. Further, there is a flexural bend with a partial repeat of the section.

T_3k_1 7. Dark gray, laminated, friable clays, without concretions, with rare interbeds of yellow and rusty, jarosite clays, with the bivalves *Primahalobia zhilnensis* (Polubotko), *Daonella* vel *Primahalobia* sp. of the Lower Carnian (*Primahalobia zhilnensis* Zone) (sample 06-16-10d) and the radiolarians *Glomeropyle cuneum* Bragin, sp. nov., *G. algidum* Bragin, sp. nov., and *Tetraspongodiscus uncatus* Bragin, sp. nov. (sample 06-16-18r). The bed is 10 m thick.

T_3k_1 8. Dark gray, laminated, friable clays, with interbeds of black bituminous schistose claystones, with rare pancaked phosphatic–calciferous concretions, with the bivalve *Primahalobia zhilnensis* (Polubotko) (sample 06-16-11d) of the Lower Carnian. Exposed thickness is 15 m.

Another Middle Triassic section was investigated previously (Egorov et al., 1987) at the middle reaches of the Pryamaya River. It is situated on the right bank of the Pryamaya River, 6 km upstream from its inflow in the Balyktakh River and 1 km northeast of eminence 52.6 (point 06-15) (Fig. 2). The coordinates of the beginning of the section are 75°26.844′ N 138°47.240′ E.

The following beds are exposed here from the bottom upwards (Fig. 2):

T_2a_1 1. Dark gray and gray laminated clays, with jarosite and gypsum, with interbeds of black laminated combustible schist, with rare pancaked phosphatic concretions. The lower part of the bed contains a horizon of large lenses of gray clayey limestones. Previously, Egorov et al. (1987) recorded there the ammonoids *Karangatites evolutus* Popow and *Stenopopanoceras* sp. of the Lower Anisian (*Grambergia taimyrensis* Zone, *Karangatites evolutus* Subzone). Exposed thickness is 7 m.

2. Yellow and brownish yellow indistinctly layered siltstones with sideritic cement, passing into dark gray calcareous siltstones, with interbeds of gray and dark gray clays. The bed is 4 m thick.

20 m do not outcrop.

T_2a_3 3. Dark gray clays, with interbeds of gray clayey bituminous limestones, black laminated combustible schist, with many phosphatic concretions. The bivalves *Daonella* sp. cf. *D. dubia* Gabb. (juv.), *Daonella* sp. cf. *D. moussoni* Merian (Upper Anisian, *Daonella dubia* Zone) (sample 06-15-1d) and the radiolarians *Glomeropyle clavatum* Bragin, sp. nov., *G. boreale* Bragin, *G. manihepuaensis* Aita, *G. insulanum* Bragin, sp. nov., *Triassospongosphaera multispinosa* (Kozur et Mostler), *Tetraspongodiscus hibernus* Bragin, sp. nov., *T. borealis* Bragin, sp. nov., *Eptingium abditum* Bragin, sp. nov., *E. manfredi* Dumitrica, *Spongostephanidium japonicum* (Nakaseko et Nishimura), *Ladinocampe vicentinensis* Kozur et Mostler, *Spongopallium* sp., and *Triassocampe* sp. (sample 06-15-1r) occur there. The bed is 5 m thick.

T_2l_2 4. Poorly exposed strata of dark gray clays, with many spherical and, less often, pancaked phosphatic concretions, with a microfauna and *Tasmanites* sp. The interbeds of dark gray siltstones are observed. Here, in a debris, there were the ammonoids *Indigirophyllites* sp. ex gr. *I. oimekonensis* Popow and the bivalve *Daonella* sp. cf. *D. frami* Kittl. (sample 06-15-1A); lower Upper Ladinian. Exposed thickness is 5–10 m.

The strongly dislocated deposits of the Middle Triassic and, partially, Upper Triassic were investigated on the left bank of the lower reaches of the Sukhoi Creek (tributary of the Pryamaya River), 2 km east of eminence 126.5 (point 06-17) (Fig. 1). The coordinates of the section are 75°28.446′ N 138°15.889′ E (beginning) and 75°28.633′ N 138°16.398′ E (end). Here from the bottom upwards, the following beds are observed:

T_1o_1 1. Isolated bedrock outcrops and placers of dark gray, black, and brownish gray bituminous, fine-crystalline, platy limestones, black thin-sliced combustible schists, with the bivalves *Peribositria* sp. of the Olenekian Age, yellow fine-crystalline dolomites (?). These outcrops are observed for 50 m downstream the creek.

Further, 35 m along strike are not exposed.

T_2a_3 2. Black and dark gray laminated clays, with frequent interbeds of black thin-sliced combustible schists, frequently, with abundant *Tasmanites* sp.; with interbeds of strongly bituminous black massive siltstones (?), with *Tasmanites* sp. Spherical and, less often, pancaked phosphatic concretions with pyritized microfauna are widespread. Many concretions contain bivalve shells, which are frequently pyritized and oriented along strike. The roof of the member contains a layer (0.3 m thick) of black schistose claystones, with abundant *Daonella* sp., including *Daonella* sp. cf. *D. subtenuis* Kittl., *Daonella* sp. ex gr. *D. moussoni* Merian, *D. dubia* Gabb., and *D. americana* Smith, which are indicative of the middle of the Upper Anisian, the *Daonella americana* Zone (sample 06-17-1d, 06-17-2d). Poorly preserved radiolarians, such as *Eptingium?* sp. and *Glomeropyle* sp., are recorded. Exposed thickness is 6 m.

T_2l 3. Black and dark gray friable laminated clays, with rare interbeds of black combustible schist and yellowish gray clays with rare phosphatic concretions, with the bivalves *Magnolobia?* sp. ex gr. *M. prima* (Kipar.) juv., and *Magnolobia?* sp., most likely, of the Ladinian Age (sample 06-17-3d). Exposed thickness is 12 m.

Further, 25 m along strike do not outcrop. In this site, only a few placers of dark gray clays with phosphatic concretions are observed.

T_2l_2–T_3k_1 4. Dark gray and black clays with interbeds (0.05–0.1 m thick) of gray bituminous marls and pancaked phosphatic concretions, with the bivalve *Daonella* vel *Primahalobia* of the Upper Ladinian–Lower Carnian (sample 06-17-4d). Exposed thickness is 2 m.

1 m is not exposed. A break? Debris of bituminous siltstones, with *Tasmanites* sp.

T_2l_2 5. Dark gray and black clays, with interbeds of black combustible schists and phosphatic concretions, with the bivalves *Mytilus* sp. and *Daonella* sp. cf. *D. neraensis* Trusch. of the Upper Ladinian (06-17-5d). Exposed thickness is 20 m.

6. Dark gray and black clays, with interbeds of black combustible schists, with rare phosphatic concretions. Exposed thickness is 20 m.

15 m along the strike are not exposed.

T_3k_1 7. Black and dark gray clays, with interbeds of combustible schists, with frequent phosphatic concretions. This member is intensely crumpled, contains the bivalve *Daonella* vel *Primahalobia* sp. cf. *P. zhilnensis* (Polubotko) of the Lower Carnian (sample 06-17-6d). Exposed thickness is 15 m.

70 m along the strike are not exposed. Isolated placers and outcrops of dark gray clays.

T_3k_{1-2} 8. Gray laminated clays, with concretion interbeds of yellow and brown siderites and rare spherical phosphatic concretions with the bivalve *Zittelihalobia* sp. aff. *Z. seimkanensis* (Polubotko) of the Carnian Age (06-17-7d). This bed probably belongs to the boundary beds of the Lower and Upper Carnian, upper part of the *I. popowi* Zone–lower part of the *Z. ornatissima* Zone. A rich radiolarian assemblage is recorded here, with *Pseudostylosphaera glabella* Bragin, sp. nov., *P. gracilis* Kozur et Mock, *P. voluta* Bragin, sp. nov., *P. gelida* Bragin, sp. nov., *Kahlerosphaera unca* Bragin, sp. nov., *K. aspinosa* Kozur et Mock, *K. fuscinula* Bragin, sp. nov., *K. acris* Bragin, sp. nov., *Capnuchosphaera kuzmichevi* Bragin, sp. nov., *C. triassica* De Wever, *C. angusta* Bragin, sp. nov., *Sarla intorta* Bragin, sp. nov., *S. compressa* Bragin, sp. nov., *S. aequipeda* Bragin, sp. nov., *Betraccium kotelnyensis* Bragin, sp. nov., *Spongostylus carnicus* Kozur et Mostler, *S. subtilis* Bragin, sp. nov., *Dumitricasphaera simplex* Tekin, *D. aberrata* Bragin, sp. nov., *D. arbustiva* Bragin, sp. nov., *Zhamojdasphaera epipeda* Bragin, sp. nov., *Z. proceruspinosa* Kozur and Mostler, *Vinassaspongus subsphaericus* Kozur et Mostler, *Palaeosaturnalis triassicus* Kozur et Mostler, *Paronaella concreta* Bragin, sp. nov., *P. aquilonia* Bragin, sp. nov., *Tetraspongodiscus cincinnalis* Bragin, sp. nov., *Annulotriassocampe baldii* (Kozur), *Canoptum zetangense* Wang et Yang, *Whalenella speciosa* (Blome), *Syringocapsa turgida* Blome, *Droltus gelidus* Bragin, sp. nov., and *D. niveus* Bragin, sp. nov. (sample 06-17-12r, 06-17-13r). Exposed thickness is 5 m.

9. Gray laminated clays, with frequent concretions of siderites and rare phosphatic–calciferous concretions. Exposed thickness is 8 m.

Further, there is a weak exposure for 80–100 m, with isolated outcrops of gray clays and claystones with sideritic and phosphatic–calciferous concretions and interbeds of limestones with *Halobia* (*Perihalobia*) *aotii* Kobayashi et Ichikawa, *H.* (*P.*) *litvinovi* (Polubotko), and *Primahalobia?* sp. cf. *P. dorofeevi* (Polubotko) of the Lower Norian (Vizualninskii Horizon).

A section of the Lower Carnian was investigated at the lower reaches of the Pryamaya River, 3 km upstream from its mouth and 6 km southeast of eminence 127.7 (point 06-10) (Fig. 1). Here, on the left bank of the Pryamaya River, at the point with coordinates 75°27.384′ N 138°53.764′ E, the following beds are exposed from the bottom upwards (Fig. 3):

T_3k_1 1. Dark gray and rusty brown laminated clays, with jarosite and limonite, with a network of narrow dense gypsum veins oriented along strike, with rare interbeds of siltstones, containing *Halobia* sp. Exposed thickness is 6 m.

2. The same clays, but with frequent siderite concretions–septaria, with interbeds (up to 1 m thick) of halobian coquinas, thin-layer siltstones. The bed is 6 m thick.

Subvertical break.

3. Dark gray and brown gray, laminated clays, with interbeds of densely packed *Halobia*, with pyrite concretions of irregular shape, with ellipsoidal calciferous–phosphatic concretions, with the radiolarians *Glomeropyle cuneum* Bragin, sp. nov., *G. algidum* Bragin, sp. nov., *G. aculeatum* Bragin, sp. nov., *Kahlerosphaera* sp., *Tetraspongodiscus uncatus* Bragin, sp. nov., *Annulotriassocampe baldii* (Kozur), and *Pseudoeucyrtis* sp. (sample 06-10-3r). The bed is 8 m thick.

4. Dark gray laminated clay, passing into dark gray, thin-sliced, nonlaminated claystones, with rare interbeds of dark gray clayey limestones, yellowish gray on the weathered surface, with rare phosphatic–calciferous concretions. The upper layers of the bed contain a bone lens with rib fragments and vertebrae of ichthyosaurs. The radiolarian assemblage includes *Glomeropyle cuneum* Bragin, sp. nov., *G. algidum* Bragin, sp. nov., *G. aculeatum* Bragin, sp. nov., *Kahlerosphaera isopleura* Bragin, sp. nov., *Tetraspongodiscus uncatus* Bragin, sp. nov., *Eonapora robusta* Kozur et Mostler, *Planispinocyrtis kotelnyensis* Bragin, sp. nov., *Annulotriassocampe baldii* (Kozur), and *Pseudoeucyrtis annosus* Bragin, sp. nov. (sample 06-10-5r) is found. The bed is 6 m thick.

5. Dark gray, leaflike, nonlaminated clays, with interbeds of gray and yellowish gray thin-sliced wavy-layered limestones and frequent phosphatic and phosphatic–calciferous concretions, with the ammonoid *Arctophyllites taimyrensis* Popow, the bivalve *Zittelihalobia* sp. ex gr. *Z. zhilnensis* (Polubotko), the brachiopod *Aulacothyroides bulkutensis* Dagys of the Lower Carnian, *Protrachyceras omkutchanicum* Zone (sample 06-10-1A, 06-10-2A), and a radiolarian assemblage with *Pentactinocarpus colum* Bragin, sp. nov., *Glomeropyle cuneum* Bragin, sp. nov., *G. algidum* Bragin, sp. nov., *G. aculeatum* Bragin, sp. nov., *Kahlerosphaera isopleura* Bragin, sp. nov., *Stauracanthocircus folium* Bragin, sp. nov., *Tetraspongodiscus uncatus* Bragin, sp. nov., *Poulpus costatus* (Kozur et Mostler), *Eonapora robusta* Kozur et Mostler, *Planispinocyrtis kotelnyensis* Bragin, sp. nov., *Annulotriassocampe baldii* (Kozur), and *Pseudoeucyrtis annosus* Bragin, sp. nov. (samples 06-10-8r, 06-10-10r). Exposed thickness is 8 m.

Further, along a subvertical break, there is tectonic contact with the overlaying Upper Norian beds.

The most complete Upper Triassic section was previously described by Egorov et al. (1987) at the lower reaches of the Tikhaya River (tributary of the Balyktakh River.). The beginning of the section (Lower Carnian deposits) is in a large bend, on the right bank of the Tikhaya River, 800 m downstream from the inflow of the Svetlyi Creek (coordinates are 75°32.220′ N 139°02.693′ E, point 06-8). The end of the section (presumably Rhaetian deposits) is on the right bank of the Tikhaya River, 0.5 km upstream from the point of confluence with the Balyktakh River (coordinates are 75°31.404′ N 138°56.053′ E, point 06-25) (Fig. 1).

At this point, the Carnian section is represented by the following sequence of beds (from the bottom upwards) (point 06-8) (Fig. 3):

T_3k_1 1. Gray and dark gray, leaflike, nonlaminated clays, with frequent ferruginous interbeds, with large (0.5 m thick) pancaked and irregular-shaped siderite concretions, small pancaked phosphatic–calciferous concretions, and pancaked pyritic nodes. The bed has yielded the ammonoid *Arctophyllites* sp. cf. *A. taimyrensis* (Popow), the bivalves *Primahalobia zhilnensis* (Polubotko) and *Primahalobia* sp. [two fragments of imprints with ribbing more typical for *P. korkodonica* (Polubotko)], and the coleoid *Atractites* sp. (sample 06-8-1N) here are met. The bed probably belongs to the *Protrachyceras omkutchanicum* Ammonoid Zone, or *Primahalobia zhilnensis* Bivalve Zone, of the Lower Carnian. The radiolarians *Pentactinocarpus colum* Bragin, sp. nov., *Glomeropyle cuneum* Bragin, sp. nov., *G. algidum* Bragin, sp. nov., *G. aculeatum* Bragin, sp. nov., *Kahlerosphaera isopleura* Bragin, sp. nov., *Kahlerosphaera* sp., *Tetraspongodiscus uncatus* Bragin, sp. nov., *Poulpus costatus* (Kozur et Mostler), *Eonapora robusta* Kozur et Mostler, *Planispinocyrtis kotelnyensis* Bragin, sp. nov., *Planispinocyrtis?* sp., *Annulotriasso-*

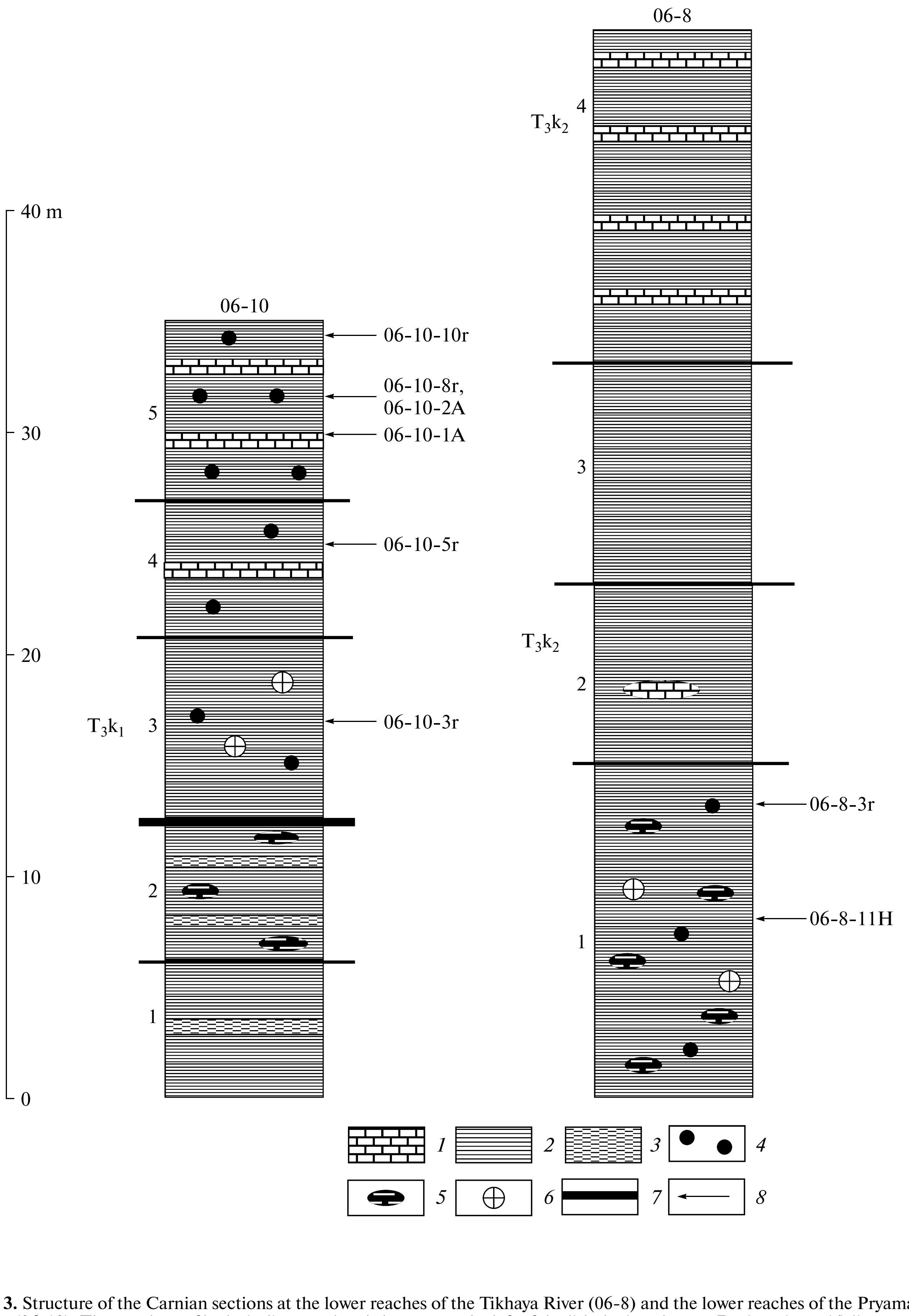


Fig. 3. Structure of the Carnian sections at the lower reaches of the Tikhaya River (06-8) and the lower reaches of the Pryamaya River (06-10). The numbers of beds, indices, and scale bars are to the left of the lithologic columns. Designations: (*1*) limestone, (*2*) clay and claystone, (*3*) siltstone and combustible slate, (*4*) phosphorite concretion, (*5*) siderite concretions, (*6*) pyrite concretions, (*7*) breaks, and (*8*) levels of records of macro- and microfossils, with the numbers of samples.

campe baldii (Kozur), *Triassocampe?* sp., and *Pseudoeucyrtis annosus* Bragin, sp. nov. also occur here (sample 06-8-2r). Exposed thickness is 15 m.

2. Dark gray and dark brown leaflike, nonlaminated clays, with rare small lenses of dark gray clayey limestones. The bed is 8 m thick.

3. Gray and dark gray leaflike, nonlaminated, clays, frequently with jarosite, without concretions. The bed is 10 m thick.

T_3k_2 4. Yellowish gray and brown gray clays, with interbeds of gray and yellowish gray thin-sliced clayey limestones with the ammonite *Yakutosirenites pentastichus* (Vozin) and the bivalves *Halobia popowi* Polubotko, *Zittelihalobia ornatissima* (Smith), and *H. omkutchanica* Polubotko of the Upper Carnian. Exposed thickness is 15 m.

The coordinates of the end of this Carnian section are 75°32.353′ N 139°02.165′ E. Downstream the Tikhaya River, 3.8 km upstream from the inflow in the Balyktakh River, beginning from the point with coordinates 75°32.359′ N 139°01.555′ E (point 06-31), the section expands upwards (Fig. 1). The Upper Carnian and Lower Norian beds are strong dislocated in this area; therefore, the reconstruction of this section is approximate (Fig. 4) and differs considerably from the interpretation proposed by Egorov et al. (1987). The following sequence of beds is exposed here from the bottom upwards:

$T_3k_2^1$ 1. Dark gray and dark brown–gray, nonlaminated, leaflike clays, with rare large concretions of gray clayey limestone with the ammonoids *Yakutosirenites pentastichus* (Vozin); *Yakutosirenites* sp., *Proarcestes winnemae* Smith, *Clionites* (*Stantonites*) *evolutus* Smith, and *Arctophyllites* sp.; the nautiloids *Proclydonautilus triadicus* (Mojsisovics) and *P.* sp. ex gr. *P. pseudoseimkanensis* Sob.; the orthoceratid *Trematoceras* sp.; the coleoid *Belemnococeras darkense* Popow; and the bivalve *Zittelihalobia ornatissima* (Smith) of the Upper Carnian (*pentastichus* Zone, probably its lower part). The presence of the ammonoids *Proarcestes winnemae* Smith and *Clionites* (*Stantonites*) *evolutus* Smith, which are characteristic of the *Trachyceras* Subzone of the *Tropites subbulatus* Zone of California (Smith, 1927), suggests that the host rock is equivalent of the lower zone of the Upper Carnian (*Tropites dilleri*). Exposed thickness is 15 m.

Break.

$T_3k_2^2$ 2. Dark gray and black clays, with rare concretions of gray clayey limestone and frequent spherical phosphatic concretions. The member is strongly crumpled. The ammonoids *Sirenites yakutensis* Kiparisova, *Sirenites* sp. aff. *S. yakutensis* Kiparisova, and *Proarcestes* sp. of the upper part of the Upper Carnian, *Sirenites yakutensis* Zone have been recorded (sample 06-31-25m-A). The radiolarian assemblage includes *Pseudostylosphaera glabella* Bragin, sp. nov., *P. gracilis* Kozur et Mock, *P. voluta* Bragin, sp. nov., *P. gelida* Bragin, sp. nov., *Kahlerosphaera unca* Bragin, sp. nov., *K. aspinosa* Kozur et Mock, *K. fuscinula* Bragin, sp. nov., *K. acris* Bragin, sp. nov., *Capnuchosphaera kuzmichevi* Bragin, sp. nov., *C. triassica* De Wever, *C. angusta* Bragin, sp. nov., *Sarla intorta* Bragin, sp. nov., *S. compressa* Bragin, sp. nov., *S. aequipeda* Bragin, sp. nov., *Betraccium irregulare* Bragin, *B. kotelnyensis* Bragin, sp. nov., *Spongotortilispinus carnicus* (Kozur et Mostler), *S. subtilis* Bragin, sp. nov., *Dumitricasphaera simplex* Tekin, *D. aberrata* Bragin, sp. nov., *D. arbustiva* Bragin, sp. nov., *Zhamojdasphaera epipeda* Bragin, sp. nov., *Z. proceruspinosa* Kozur and Mostler, *Vinassaspongus subsphaericus* Kozur et Mostler, *Palaeosaturnalis triassicus* Kozur et Mostler, *Paronaella concreta* Bragin, sp. nov., *P. aquilonia* Bragin, sp. nov., *Tetraspongodiscus cincinnalis* Bragin, sp. nov., *Canoptum zetangense* Wang et Yang, *Whalenella speciosa* (Blome), *Syringocapsa turgida* Blome, *Droltus gelidus* Bragin, sp. nov., and *D. niveus* Bragin, sp. nov. (sample 06-31-2r). Exposed thickness is 5 m.

Break.

T_3n_1 3. Dark gray clays, with beaded horizons of siderite concretions, with rare calciferous and phosphatic concretions. The bed has yielded the ammonoid "*Striatosirenites*" *kinasovi* Bytschkov and the bivalve *Zittelihalobia indigirensis* (Popow) (10 m above the sole of the bed, sample 06-31-33m-A). The ammonoids "*Striatosirenites*" sp. ex gr. "*S.*" *kinasovi* Bytschkov, *Arcestes* sp. juv., *Neosirenites* sp., and *Arctophyllites* sp. juv. are recorded 15 m above the soles of the bed (sample 06-31-42m-A); the nautiloid *Germanonautilus* sp. ex gr. *G. popowi* Sobolev and the brachiopod *Sulcorhynchia tibetica* (Bittner) of the Lower Norian ("*Striatosirenites*" *kinasovi* Zone) are 18 m above the sole of bed (sample 06-31-1N). The radiolarian assemblage includes *Pseudostylosphaera* sp., *Capnuchosphaera* sp. cf. *C. deweveri* Kozur et Mostler, and *Syringocapsa turgida* Blome (10 m above the sole of the bed, sample 06-31-3r). The member is folded. Exposed thickness is at most 20 m.

Break.

4. Dark gray, thin-sliced and leaflike, nonlaminated clays, with scattered sideritic, rare calciferous, and phosphatic concretions. The lower part of the member contains platy sideritic interlayers. The bed has yielded the ammonoids *Arctophyllites* sp. ex gr. *A. popovi* (Archipov) (lower part of the member, Lower Norian, *Pinacoceras ver-*

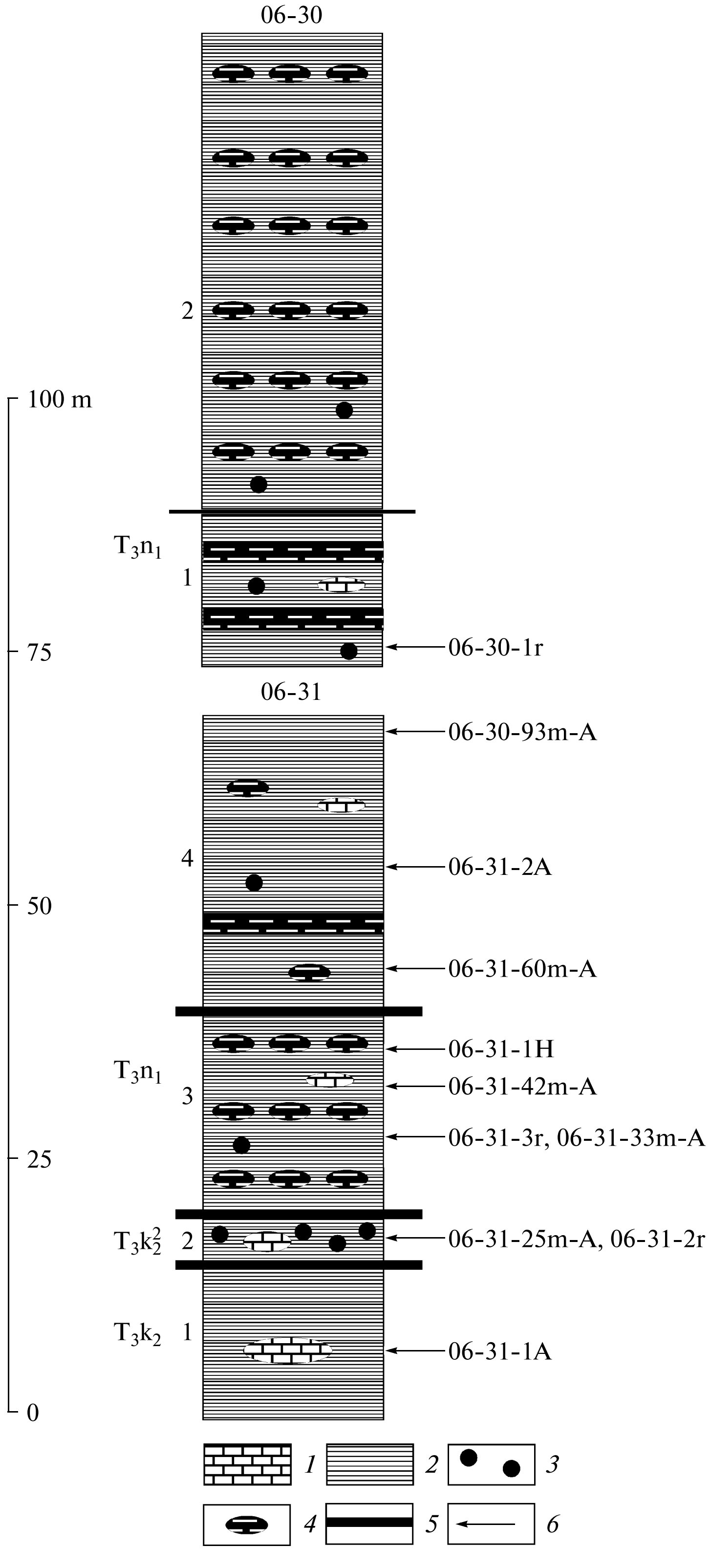


Fig. 4. Structure of the Upper Carnian and Lower Norian sections at the lower reaches of the Tikhaya River (06-30 and 06-31). The numbers of beds, indices, and scale bars are to the left of the lithologic columns. Designations: (*1*) limestone, (*2*) clay and claystone, (*3*) phosphorite concretions, (*4*) siderite concretions and interbeds, (*5*) breaks, and (*6*) levels of records of macro- and microfossils, with the numbers of samples.

chojanicum Zone) (7 m above the sole of the bed, sample 06-31-60m-A), "*Striatosirenites*" sp., Lower Norian, *kinasovi* Zone (15 m above the sole of the bed, sample 06-31-2A), and *Cladiscites tolli* Diener (upper part of the member, Lower Norian, upper part of the *Pinacoceras verchojanicum* Zone, corresponding to the beds with *Norosirenites obručevi*) (28 m above the sole of the member, sample 06-31-93m-A) (Konstantinov and Sobolev, 1999). Exposed thickness is 30 m. The coordinates of the end of this section are 75°32.301′ N 139°01.392′ E.

To the south, on the right bank of the Tikhaya River, 3.5 km from its mouth, there is a Lower Norian section (point 06-30). The coordinates of the section are 75°32.176′ N 139°01.139′ E (beginning) 75°32.082′ N 139°00.851′ E (end).

From the bottom upwards, the following beds are exposed (Fig. 4):

T_3n_1 1. Dark gray, leaflike, nonlaminated clays, with frequent interbeds (0.2–0.3 m thick) of dark gray (brown on the weathered surface) siderites, with lenticular interbeds of gray limestones with brachiopods, with small phosphate–carbonaceous concretions. Konstantinov et al. (2003) have recorded here the ammonoid *Arcestes* sp. ex gr. *A. colonus* Mojsisovics, the nautiloid *Germanonautilus* sp. ex. gr. *G. popowi* Sobolev, the conodont *Norigondolella navicula* (Huckriede), and the bivalves *Halobia aotii* Kobayashi et Ichikawa and *Zittelihalobia indigirensis* (Popow) of the Lower Norian. The radiolarian assemblage includes *Pseudostylosphaera glabella* Bragin, sp. nov., *P. gelida* Bragin, sp. nov., *Kahlerosphaera retunsa* Bragin, sp. nov., *Capnuchosphaera deweveri* Kozur et Mostler, *Sarla globosa* Bragin, sp. nov., *Palaeosaturnalis mocki* Kozur et Mostler, *Syringocapsa turgida* Blome, and *Droltus gelidus* Bragin, sp. nov. (sample 06-30-1). Exposed thickness is 15 m.

2. Dark gray, thin-sliced and leaflike, nonlaminated clays, with frequent (at a distance of 1 m of thickness) beaded horizons of siderite concretions and rare small phosphate–carbonaceous concretions (only in the lower part of the bed). The upper layers of the bed contain rare calciferous concretions. Konstantinov et al. (2003) have recorded here the ammonoid *Norosirenites obruchevi* (Bajarunas) (lower part of the bed) and the bivalves *Halobia aotii* Kobayashi et Ichikawa and *Zittelihalobia fallax* (Mojsisovics) of the Lower Norian. Exposed thickness is 60 m.

Lower Norian radiolarians were also found in an outcrop on the left bank of the Tuguttakh River, 2 km above the point of confluence inflow its tributaries of the Balyktakh River (point 06-32) (Fig. 1) are higher. The coordinates of this locality 75°26.056′ N 139°14.362′ E. The following beds are exposed here:

T_3n_1. Black thin-sliced, nonlaminated, brecciated claystones, with interbeds (0.1 m thick) of dark gray clays, with abundant large (0.3–0.4 m thick) of pancaked, ellipsoidal, and irregular siderite concretions and spherical, flattened spherical, flattened ellipsoidal phosphatic concretions, frequently with bivalve remains; these concretions are 0.1 m thick or smaller. The bed has yielded the bivalves *Halobia* (*Perihalobia*) *aotii* Kobayashi et Ichikawa, H. (P). sp. cf. *H. litvinovi* Polubotko, *Primahalobia* (*?*) sp. ex gr. *P. dorofeevi* (Polubotko) (sample 06-32d) and the radiolarians *Pseudostylosphaera glabella* Bragin, sp. nov., *P. voluta* Bragin, sp. nov., *Sarla globosa* Bragin, sp. nov., *Palaeosaturnalis* sp., *Paronaella aquilonia* Bragin, sp. nov., *Syringocapsa turgida* Blome, and *Droltus gelidus* Bragin, sp. nov. (sample 06-32r). Exposed thickness is 30 m.

The Middle Norian beds were previously described by Egorov et al. (1987) from a section on the Tikhaya River (point 06-29). They are observed on the right bank of the Tikhaya River, 3 km upstream from its mouth (point 06-29) (Fig. 1). The coordinates of the section are 75°31.807′ N 138°59.921′ E (beginning) and 75°31.805′ N 138°59.702′ E (end). The following beds are exposed here from the bottom upwards:

T_3n_2 1. Gray, dark gray, and yellowish gray nonlaminated clays, with abundant ellipsoidal and rounded siderite concretions, rare phosphate–carbonaceous concretions and interbeds of thin-sliced yellow clayey siderites. The bed has yielded the ammonoids *Cyrtopleurites* sp. ex gr. *C. altissimus* Mojs., *Megaphyllites insectus* (Mojs.), *Placites polydactylus* (Mojs.), *Arcestes* sp. ex gr. *A. subdistinctus* Mojs., *Cladiscites beyrichi* Welter, and *Rhacophyllites debilis* (Hauer); the nautiloid *Proclydonautilus* sp. cf. *P. natosini* McLearn; the coleoids *Atractites* sp. cf. *A. conicus* (Mojsisovics) and *Mojsisovicsteuthis* sp.; and the bivalve *Eomonotis pinensis* (Westermann) from the Middle Norian, *Eomonotis pinensis* Zone (sample 06-29N) as well as the radiolarians *Sarla globosa* Bragin, sp. nov., *Sarla* sp., *Syringocapsa turgida* Blome, *Canoptum* sp., and *Laxtorum?* sp. (sample 06-29-1r). Exposed thickness is 50 m.

2. Dark gray clays, with abundant siderite concretions varying in size (0.1–0.5 m thick) and shape (ellipsoidal, pancaked), with of dark gray clayey limestone lenses, with rare small carbonate–clayey concretions, with wood fragments. The bed is 10 m thick.

3. Gray and dark gray clays, with large siderite concretions. The bed is poorly outcropping. Exposed thickness is 30 m.

In addition, Middle Norian radiolarians were found in an outcrop on the left bank of the Balyktakh River, 200 m downstream from the mouth of the

Tuguttakh River (point 06-22) (Fig. 1). The coordinates of the point are 75°25.093′ N 139°13.253′ E. The bed exposed here is as follows:

T_3n_2. Placers and individual outcrops of black leaflike claystones, with abundant irregularly ellipsoidal siderite concretions up to 30–40 cm thick. In addition, there are small (at most 5 cm thick), irregularly pancaked or, less often, subspherical, phosphate–carbonaceous concretions, with the coleoidean *Mojsisovicsteuthis* sp. and juvenile bivalve *Eomonotis daonellaeformis* (Kiparisova) of the Middle Norian (apparently the *Eomonotis daonellaeformis* Zone) (sample 06-22N), and the radiolarians *Sarla globosa* Bragin, sp. nov., *Sarla* sp., *Paronaella aquilonia* Bragin, sp. nov., *Syringocapsa turgida* Blome, *Canoptum* sp., and *Laxtorum?* sp. (sample 06-22r)

The above data provide the complete list of presently known radiolarian localities of central Kotel'nyi Island. The overlying beds of the Upper Norian contain only poorly preserved sporadic radiolarian remains.

CHAPTER 2. RADIOLARIAN ASSEMBLAGES FROM THE MIDDLE AND UPPER TRIASSIC OF KOTEL'NYI ISLAND AND THEIR STRATIGRAPHIC AND PALEOBIOGEOGRAPHICAL SIGNIFICANCE

When examining Triassic radiolarian assemblages of Kotel'nyi Island, note that they are of interest for both biostratigraphy and paleobiogeography. To date, extensive data on Triassic radiolarians have been accumulated in various regions of the world, including North America (Pessagno et al., 1979; Blome, 1983, 1984; Carter, 1993), Western Europe (Dumitrica et al., 1980; Kozur and Mostler, 1981, 1994; Kozur et al., 1996), eastern Mediterranean (Tekin, 1999; Bragin, 2007), Japan (Sugiyama, 1997), and eastern Russia (Bragin, 1991). Based on these radiolarian data, detailed zonal schemes of Triassic stratification were elaborated and successfully applied to the circumtropical belt. At the same time, the data on Triassic high-latitude radiolarians are insufficient. Therefore, the data on Kotel'nyi Island are applicable to both local dating and stratification and correlation of the Triassic beds of Kotel'nyi Island with southerly regions. In addition, new data essentially expand our knowledge of high-latitude Triassic radiolarians, which have been investigated in a few sequences of few regions (Aita and Bragin, 1999; Bragin and Egorov, 2000). The study of migrations of southern taxa in northern regions is of particular interest, since it was previously investigated using cephalopods from Kotel'nyi Island as an example (Konstantinov et al., 2003). Finally, the stratigraphic distribution of all species from the Triassic of Kotel'nyi Island is particularly significant (Table 1). Therefore, each assemblage is analyzed with reference to both stratigraphic and paleobiogeographical aspects.

The most ancient radiolarian assemblage with *Glomeropyle clavatum* was recorded in the Upper Anisian beds, in the sections at the upper (06-16) and middle reaches (06-15) of the Pryamaya River. The following species occur here: *Glomeropyle clavatum, G. boreale, G. manihepuaensis, G. insulanum, Triassospongosphaera multispinosa, Tetraspongodiscus hibernus, T. borealis, Eptingium abditum, E. manfredi, Spongostephanidium japonicum*, and *Ladinocampe vicentinensis.* Five species listed here are known from other regions. *Glomeropyle boreale* was described from the Middle Triassic (Ladinian) deposits of the Omolon Massif and recorded in the Lower Ladinian of New Zealand (Aita and Bragin, 1999; Bragin and Egorov, 2000). *Glomeropyle manihepuaensis* is only known in the Lower Ladinian of New Zealand (Aita and Bragin, 1999). *Triassospongosphaera multispinosa* occurs within a wide stratigraphic range (Anisian–Carnian) of Austria, Hungary, and Slovakia (Kozur and Mostler, 1979, 1981). *Eptingium manfredi* is recorded from the Upper Anisian to the Lower Ladinian of a broad geographic range: it is known in Western Europe (Dumitrica, 1978; Dumitrica et al., 1980; Kozur and Mostler, 1994; Kozur et al., 1996), Japan (Nakaseko and Nishimura, 1979), and the Far East of Russia (Bragin, 1991). *Spongostephanidium japonicum* is also widespread, occurring in the Anisian of Japan (Nakaseko and Nishimura, 1979), Philippines (Cheng, 1989; Yeh, 1990), and Western Europe (Gorican and Buser, 1990; Ramovs and Gorican, 1995; Kozur et al., 1996). To date, the species *Ladinocampe vicentinensis* has only been recorded in the Lower Ladinian of Italy (Kozur and Mostler, 1994). The Late Anisian dating of the assemblage, which was based on ammonoids and bivalves, is supported by the co-occurrence of *Eptingium manfredi* and *Spongostephanidium japonicum*, which are widespread and well known, since the overlap of their ranges is the Upper Anisian. The presence of *Ladinocampe vicentinensis*, which has previously been recorded only in the Lower Ladinian, should not be regarded as a contradiction, because the vertical distribution of this species is incompletely understood. Representatives of the genus *Glomeropyle* have previously been examined in two isolated stratigraphic segments, Ladinian (Aita and Bragin, 1999; Bragin and Egorov, 2000) and Upper Olenekian (Hori et al., 2003); thus, the time of emergence of *Glomeropyle boreale* and *G. manihepuaensis* remains uncertain.

In central Kotel'nyi Island, the Lower Ladinian apparently falls on a stratigraphic break, considerably complicating analysis. Radiolarians have previously been described from the Lower Ladinian of New Zealand (Aita and Bragin, 1999) and the Ladinian of the Omolon Massif (Aita and Bragin, 1999; Bragin and Egorov, 2000); these assemblages have much in common with the assemblage from the Upper Anisian of Kotel'nyi Island. These assemblages share distinct

Table 1. Occurrence of radiolarian species in the Middle and Upper Triassic beds of Kotel'nyi Island

Stage	Anisian	Ladinian		Carnian		Norian	
Substage / Radiolarian species	Upper	Lower	Upper	Lower	Upper	Lower	Middle
Glomeropyle clavatum	—						
Glomeropyle boreale	—						
Glomeropyle manihepuaensis	—						
Glomeropyle insulanum	—						
Triassospongosphaera multispinosa	—		—				
Tetraspongodiscus hibernus	—						
Tetraspongodiscus borealis	—						
Eptingium abditum	—						
Eptingium manfredi	—						
Spongostephanidimn japonicum	—						
Ladinocampe vicentinensis	—						
Muelleritortis firma			—				
Muelleritortis kotelnyensis			—				
Tiborella nivea			—				
Pseudostylosphaera goestlingensis			—				
Pseudostylosphaera omolonica			—				
Sarla cincinnata			—				
Sarla obscura			—				
Sarla prava			—				
Eonapora stiriaca			—				
Pentactinocarpus colum				—			
Glomeropyle cuneum				—			
Glomeropyle algidum				—			
Glomeropyle aculeatum				—			
Kahlerosphaera isopleura				—			
Stauracanthocircus folium				—			
Tetraspongodiscus uncatus				—			
Poulpus costatus				—			
Eonapora robusta				—			
Planispinocyrtis kotelnyensis				—			
Annulotriassocampe baldii				—	—		
Pseudoeucyrtis annosus				—			
Pseudostylosphaera glabella				—	—	—	
Pseudostylosphaera gracilis				—	—		
Pseudostylosphaera voluta				—	—	—	
Pseudostylosphaera gelida				—	—	—	
Kahlerosphaera unca				—	—		
Kahlerosphaera aspinosa				—	—		
Kahlerosphaera fuscinula				—	—		
Kahlerosphaera acris				—	—		
Capnuchosphaera kuzmichevi				—	—		
Capnuchosphaera triassica				—	—		

Table 1 (Contd.)

Stage	Anisian	Ladinian		Carnian		Norian	
Radiolarian species / Substage	Upper	Lower	Upper	Lower	Upper	Lower	Middle
Capnuchosphaera angusta				—	—		
Sarla intorta				—	—		
Sarla compressa				—	—		
Sarla aequipeda				—	—		
Betraccium irregulare				—	—		
Betraccium kotelnyensis				—	—		
Spongostylus carnicus				—	—		
Spongostylus subtilis				—	—		
Dumitricasphaera simplex				—	—		
Dumitricasphaera aberrata				—	—		
Dumitricasphaera arbustiva				—	—		
Zhamojdasphaera epipeda				—	—		
Zhamojdasphaera proceruspinosa				—	—		
Vinassaspongus subsphaericus				—	—		
Palaeosaturnalis triassicus				—	—		
Paronaella concreta				—	—		
Paronaella aquilonia				—	—	—	
Tetraspongodiscus cincinnalis				—	—		
Canoptum zetangense				—	—		
Whalenella speciosa				—	—		
Syringocapsa turgida				—	—	—	—
Droltus gelidus				—	—	—	
Droltus niveus				—	—		
Kahlerosphaera retunsa						—	
Capnuchosphaera deweveri						—	
Sarla globosa						—	—
Palaeosaturnalis mocki						—	

quantitative domination of species of the genus *Glomeropyle*, which were previously shown to have bipolar (boreal–notal) distribution (Aita and Bragin, 1999). Other species of these assemblages occur in southerly regions and apparently have wide paleobiogeographic distribution. The Late Anisian assemblage of Kotel'nyi Island includes taxa, which previously have not been recorded in the Middle Triassic of high latitudes, i.e., *Eptingium manfredi* and *Spongostephanidium japonicum*. It is possible that they appeared because of a warming episode; however, available data are insufficient to state this with certainty.

The Upper Ladinian of the upper reaches of the Pryamaya River (06-16) has yielded an assemblage with *Muelleritortis kotelnyensis*, including *Muelleritortis firma, M. kotelnyensis, Tiborella nivea, Pseudostylosphaera goestlingensis, P. omolonica, Triassospongosphaera multispinosa, Sarla cincinnata, S. obscura, S. prava, Eonapora stiriaca*, and *Glomeropyle* sp. It includes only four previously described species; however, they confirm the dating obtained previously based on bivalves. *Muelleritortis firma* occurs in the Upper Ladinian of Slovenia (Gorican and Buser, 1990). *Pseudostylosphaera goestlingensis* appears in the Upper Ladinian and occurs to the upper Lower Carnian in Western Europe, Turkey, and Japan (Kozur and Mostler, 1979, 1981; Sugiyama, 1997; Tekin, 1999). The boreal species *Pseudostylosphaera omolonica* occurs from the Upper Ladinian to the Lower Carnian (probably only basal Lower Carnian) (Bragin and Egorov, 2000). The wide range of *Triassospongosphaera multispinosa* is not in conflict with these conclusions. The presence in this assemblage of representatives of the family Muelleritortidae is particularly important, since these radiolarians are widespread in the Upper Ladinian–Lower Carnian of low-latitude regions and important for the zonation of the upper Middle Triassic and lower Upper Triassic (Kozur and Mostler, 1994; Sugiyama, 1997; Bragin, 2000). Previously, these taxa have not been recorded in the boreal sections. This allows the correlation of boreal and Tethyan sections.

Note that, based on co-occurrence of ammonoids, the radiolarian assemblage from the reference section of Dzhugadzhak of the Omolon Massif was dated as the Late Ladinian (Bragin and Egorov, 2000). In this study, it was indicated that the assemblage contains several radiolarian species that are characteristic to the Lower Ladinian and lacks typical Upper Ladinian representatives of the family Muelleritortidae. The new data support the Early Ladinian age of the assemblage from the Dzhugadzhak River.

The Lower Carnian of Kotel'nyi Island has yielded a radiolarian association with *Glomeropyle cuneum*, including *Pentactinocarpus colum, Glomeropyle cuneum, G. algidum, G. aculeatum, Kahlerosphaera isopleura, Stauracanthocircus folium, Tetraspongodiscus uncatus, Poulpus costatus, Eonapora robusta, Planispinocyrtis kotelnyensis, Annulotriassocampe baldii*, and *Pseudoeucyrtis annosus*. It comes from in two localities (06-8 and 06-10). This assemblage includes a few previously known species. *Poulpus costatus* was recorded in the Lower Carnian of Austria (Kozur and Mostler, 1981) and *Eonapora robusta*, only once, in the Upper Anisian of Hungary (Kozur and Mostler, 1981). *Annulotriassocampe baldii* is a thoroughly investigated species with a wide geographical range distribution, which occurs from the Carnian to the Lower Norian (Kozur and Mostler, 1994; Tekin, 1999; Wang et al., 2002; Bragin, 2007). A deficiency of data prevents direct correlation of the Lower Ladinian of Kotel'nyi Island with the sections of the southern regions.

At the same time, some new species of this assemblage are of great interest. This concerns primarily representatives of the genus *Glomeropyle*, which, in the Middle Triassic, are considered to be bipolar cold-water taxa. The, high-latitude occurrence is apparently characteristic of this genus in the Late Triassic. The basis for this conclusion is the presence of *Glomeropyle algidum* in the Lower Carnian beds of Spitsbergen (Tekin et al., 2006) and *Glomeropyle* in the Lower Carnian of the Omolon Massif (Bragin and Egorov, 2000). In addition, these members of the genus are apparently the latest in the fossil record, since the genus *Glomeropyle* has not been recorded upwards in the section. It is also noteworthy that the same beds have yielded the saturnalid *Stauracanthocircus folium*; this family has not been recorded in the Triassic of high latitudes.

The Upper Carnian radiolarian assemblage with *Capnuchosphaera triassica*, which was recorded in two localities (06-17, 06-31) of Kotel'nyi Island is most interesting. First, the record from the 06-17 section is dated based on bivalves as the upper Lower Carnian–lower Upper Carnian, and the record from the 06-31 section is dated based on ammonoids and bivalve as the upper Upper Carnian; at the same time, radiolarian assemblages from these localities are essentially similar. Probably, radiolarian assemblages from high latitudes of that time changed at a low rate. Second, this assemblage shows the most diverse taxonomic composition. It comprises 34 species, including many taxa recorded in the southern regions. The assemblage consists of *Pseudostylosphaera glabella, P. gracilis, P. voluta, P. gelida, Kahlerosphaera unca, K. aspinosa, K. fuscinula, K. acris, Capnuchosphaera kuzmichevi, C. triassica, C. angusta, Sarla intorta, S. compressa, S. aequipeda, Betraccium irregulare, B. kotelnyensis, Spongotortilispinus carnicus, S. subtilis, Dumitricasphaera simplex, D. aberrata, D. arbustiva, Zhamojdasphaera epipeda, Z. proceruspinosa, Vinassaspongus subsphaericus, Palaeosaturnalis triassicus, Paronaella concreta, P. aquilonia, Tetraspongodiscus cincinnalis, Annulotriassocampe baldii, Canoptum zetangense, Whalenella speciosa, Syringocapsa turgida, Droltus gelidus*, and *D. niveus*. These data support the dating based on mollusks. In particular, *Kahlerosphaera aspinosa* is recorded in the Upper Carnian and Lower Norian of Western Europe (Kozur and Mostler, 1981) and Turkey (Tekin, 1999). *Capnuchosphaera triassica* is a thoroughly investigated species recorded from the Lower Carnian to the Lower Norian of Western Europe (De Wever et al., 1979; Lahm, 1984; Halamic and Gorican, 1995), East Mediterranean (De Wever et al., 1979; Tekin, 1999; Bragin, 2007), the Tibet (Wang et al., 2002), the Philippines (Yeh, 1990), and Japan (Nakaseko and Nishimura, 1979). *Betraccium irregulare* is described from the Lower Norian of Cyprus (Bragin, 2007); in other localities, it has not been recorded. *Spongostylus carnicus* is another thoroughly investigated species, occurring in the Carnian–Lower Norian of Western Europe (Kozur and Mostler, 1979; Lahm, 1984; Halamic and Gorican, 1995; Danelian et al., 2000), western regions of the United States and Canada (Carter et al., 1989; Yeh, 1989), eastern Mediterranean (Bragin and Krylov, 1999; Tekin, 1999; Bragin, 2007), Transcaucasia (Knipper et al., 1997), the Tibet (Wang et al., 2002), and New Zealand (Grapes et al., 1990). *Dumitricasphaera simplex* has only been recorded in the middle part of the Carnian Stage of Turkey (Tekin, 1999); this is close to the presumable age of the sample. *Zhamojdasphaera proceruspinosa* is known from the Carnian beds of Austria (Kozur and Mostler, 1981; Lahm, 1984) and the Lower Norian beds of Cyprus (Bragin, 2007). *Vinassaspongus subsphaericus* occurs from the Upper Ladinian to the Upper Carnian of Western Europe (Kozur and Mostler, 1979; Lahm, 1984; Gorican and Buser, 1990), Japan (Kido, 1982), and Turkey (Tekin, 1999). *Palaeosaturnalis triassicus* is recorded in the Carnian–Lower Norian of Western Europe (Kozur and Mostler, 1972, 1981, 1983; Lahm, 1984; Dozstaly, 1993), eastern Mediterranean (Tekin, 1999; Bragin and Krylov, 1999; Bragin, 2007), and the Tibet (Wang et al., 2002). *Canoptum zetangense* has previously been recorded only from the Carnian Stage of the Tibet (Wang et al., 2002). *Whalenella speciosa* and *Syringocapsa turgida* are described from the Upper Carnian–Middle Norian of the western United States (Blome, 1984; Blome and Reed, 1995) and occurs in the Upper Carnian–Lower Norian of Turkey (Tekin, 1999). The data on previously known radiolarian species of this assemblage suggest that it should be dated to the Late Carnian, which agrees with the data on mollusks.

A total of 11 species has previously described, which is considerably less than the number of new species described from this assemblage (23); this is a feature characteristic of all known high-latitude radiolarian associations of the Triassic. However, the great number of species in this assemblage, which distinguishes it from others, requires explanation. This increase in diversity is probably connected with the penetration of a number of species from southerly water areas, resulting from a warming episode or expansion of marine links (e.g., because of transgressions). The mixed pattern of the fauna from this stratigraphic range is supported by the co-occurrence of archaic and rare in low latitudes taxa, such as the genus *Pseudostylosphaera*, and representatives of the family Capnuchosphaeridae that are typical of paleotropical associations.

The Early Norian assemblage with *Palaeosaturnalis mocki* is recorded in the 06-30 and 06-32 localities and includes *Pseudostylosphaera glabella, P. gelida, P. voluta, Kahlerosphaera retunsa, Capnuchosphaera deweveri, Sarla globosa, Palaeosaturnalis mocki, Paronaella aquilonia, Syringocapsa turgida*, and *Droltus gelidus*. It is noteworthy that this assemblage includes some species of an earlier, Late Carnian, assemblage. In addition, it contains species recorded in southern regions. *Capnuchosphaera deweveri* is a widespread species recorded in the Carnian–Lower Norian of Western Europe (De Wever et al., 1979; Kozur and Mostler, 1979; Lahm, 1984), eastern Mediterranean (De Wever et al., 1979; Bragin and Krylov, 1999; Bragin, 2007), Japan (Nakaseko and Nishimura, 1979), the western United States and Canada (Blome, 1983, 1984), New Zealand (Aita and Sporli, 1994), and the Philippines (Yeh, 1990). *Palaeosaturnalis mocki* occurs in the Lower Norian of Western Europe (Kozur and Mostler, 1983) and eastern Mediterranean (Bragin and Krylov, 1999; Tekin, 1999; Bragin, 2007). *Syringocapsa turgida* occurs in the Upper Carnian–Middle Norian of Oregon (Blome, 1984) and in the Upper Carnian–Lower Norian of Turkey (Tekin, 1999). This assemblage is impoverished relative to the previous one; nevertheless, it is of interest, since it contains several thoroughly investigated thermophilic aquatic species. It was shown that, in the Early Norian, heat-loving mollusks (ammonoids and nautiloids) and conodont penetrated into Kotel'nyi Island (Konstantinov et al., 2003). The authors of this paper indicated that this penetration is not confined to a certain stratigraphic level, but occurred within the entire Lower Norian. As compared with the data on radiolarians, it is evident that the maximum number of radiolarian species from southern regions falls on the Upper Carnian, where the maximum taxonomic diversity of the assemblage is observed. This is probably something more than a mere incident.

The Middle Norian radiolarian assemblage of Kotel'nyi Island is very poor. It comes from the 06-29 and 06-22 localities and includes *Sarla globosa, Sarla* sp., *Syringocapsa turgida*, *Canoptum* sp., and *Laxtorum?* sp. The two taxa identified with certainty to species are recorded in the Lower Norian. A decrease in taxonomic diversity of radiolarians coincides with a decrease in diversity of cephalopods and almost complete replacement of phosphatic concretions by sideritic ones. Poorly preserved sporadic radiolarians occur in the Upper Norian.

The dynamics of the proportions of southern and new species in assemblages is illustrated by the graph, which shows the total number of species in assemblages, the number of species known in the southern regions, and the ratio of the latter to the former (Fig. 5). During the Anisian–Early Carnian, the total number of species was small and approximately constant; in the Late Carnian, it increased considerably and, in the Early Norian, returned to the former value; finally, it decreased abruptly in the Middle Norian. Approximately the same dynamics is characteristic of the number of species in southern regions. The ratio of southern species to the total number of species remains approximately constant. This probably suggests that the enrichment of assemblages and increase in the total number of southern species in the Late Carnian is connected with the expansion of links between the basins rather than with a warming, since the proportion of southern species changed insignificantly.

It is possible to compare Triassic radiolarian assemblages of Kotel'nyi Island to typical zonal associations of southerly regions because they share at least one-fourth of the total number of species (Fig. 6). However, it is presently impossible to recognize true boreal radiolarian biostratons in the sections of Kotel'nyi Island primarily because of insufficient material, which shows gaps between assemblages. At present, only isolated segments are characterized by radiolarians. In particular, the Upper Anisian and Upper Ladinian beds are separated by a stratigraphic break; and the Carnian and Norian beds show tectonic contact in the sections under study. The relationship between assemblages with *Glomeropyle cuneum* and with *Capnuchosphaera triassica* is incompletely understood.

To summarize, the following showed by emphasized: extensive material of true boreal radiolarian

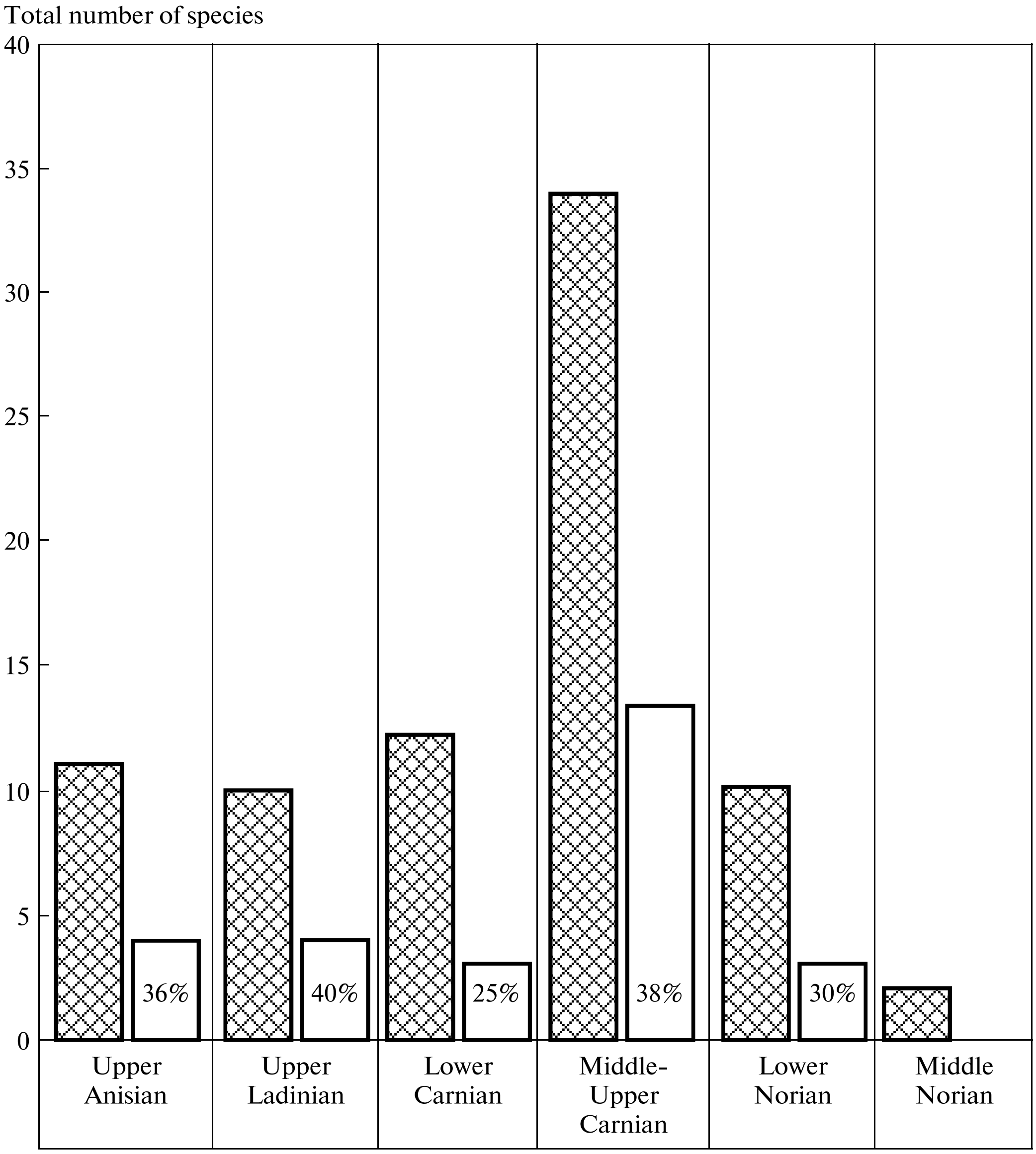


Fig. 5. Composition of radiolarian assemblages in the Triassic sections of Kotel'nyi Island and their changes in time. Hatched columns are the total number of species, white columns are the number of species known in southern regions; the percent of southern species relative to the total number of species is shown inside white columns.

assemblages is obtained for the first time; in addition, the data on the Middle Triassic are enlarged. All Triassic boreal assemblages are similar in the presence of a certain proportion of taxa widespread in low-latitude regions (from 25 to 40% of the total number of species). Some of these species are probably cosmopolitans or extremely widespread taxa; however, they possibly include thermophilic aquatic species, which migrated into high-latitude regions; this is particularly probable for Upper Carnian and Lower Norian taxa. The remaining part of these assemblages includes species that are presently known only in high latitudes. They are mostly new species, although some were described from the Triassic of the Omolon Massif and New Zealand. However, the great number of new species is connected with the fact that, in this study, boreal assemblages of the Upper Carnian and Lower Norian are described for the first time and these periods show a peak of taxonomic diversity. Further studies of these species, primarily their paleobiogeographic distribution, are necessary to recognize true high-latitude (or boreal) endemics. At the generic level, boreal radiola ian faunas are primarily distinguished by the presence of the indicator genus *Glomeropyle*, which shows bipolar distribution and occurs from the Olenekian to Lower Carnian, including sections of Kotel'nyi Island, where it is represented by several species, which usually dominate in assemblages. Other genera recorded in Kotel'nyi Island are widespread, but are not endemic to high latitudes. It was previously

Stage	Substage	Radiolarian-based zones (Bragin, 2000)	Radiolarians assemblages (this work)
Norian	Middle	*Capnodoce crystallina*	
	Lower		Palaeosaturnalis mocki
Carnian	Upper	*Capnuchosphaera theloides*	*Capnuchosphaera triassica*
	Lower	*Tritortis kretaensis kretaensis*	*Glomeropyle cuneum*
Ladinian	Upper	*Muelleritortis cochleata*	*Muelleritortis kotelnyensis*
		Falcispongus falciformis	
	Lower	*Oertlispongus inaequispinosus*	
		Triassocampe scalaris	
Anisian	Upper	*Triassocampe deweveri*	*Glomeropyle clavatum*
	Middle	*Triassocampe diordinis*	

Fig. 6. Stratigraphic position of radiolarian assemblages compared with the Triassic zonal scheme based on radiolarians (Bragin, 2000). Hatched sites are stratigraphic breaks, or the absence of radiolarians in the Triassic section of Kotel'nyi Island.

reported that boreal assemblages of Triassic radiolarians lacked some families, such as the Muelleritortidae, Eptingiidae, and Capnuchosphaeridae (Bragin, 1994; Bragin and Egorov, 2000). At present, this hypothesis is abandoned, since representatives of these families are recorded in a number of sections of Kotel'nyi Island in the Upper Anisian, Upper Ladinian, and Upper Carnian (note that, previously, radiolarians of these stratigraphic levels of the boreal Triassic were unknown or very poorly investigated). At the same time, the poor biodiversity of boreal radiolarian faunas of the Triassic compared to low-latitude faunas is confirmed; in particular, this concerns and the families indicated, which are only represented by a few species of few genera.

CHAPTER 3. PALEONTOLOGICAL DESCRIPTIONS

This chapter describes all species recorded in the material collected and meeting the requirements of the nomenclature standard (taxa in open nomenclature are excluded from consideration). In addition, the diagnoses of genera, families (if necessary, subfamilies and superfamilies), and brief characteristics of orders are provided. The systematics of Triassic radiolarians follows the concepts generally accepted by experts.

Phylum Sarcodina Dujardin, 1838

CLASS RADIOLARIA MÜLLER, 1858

SUBCLASS EURADIOLARIA LAMEERE, 1931

Superorder Polycystina Ehrenberg, 1838

Order Entactinaria Kozur et Mostler, 1982

D i a g n o s i s. Polycystina with primary skeleton of main spicule or its derivatives. Elements of spicule nondifferentiated or slightly differentiated (into apical or basal), located in different or single planes. Only one spicule always present, usually located at center of skeleton or, sometimes, displaced to outer shell or beyond it. Spicule skeleton-forming or restricted to first (smallest) shell. From one to three spherical, subspherical, discoidal, or prunoid shells usually present; sometimes, they reduced. Shells porous, latticed, or reticular. Skeleton with concentric growth pattern.

C o m p o s i t i o n. Paleozoic–Recent. In the Triassic, the families Entactiniidae Riedel, 1967, Polyentactiniidae Nazarov, 1975, Pentactinocarpidae Dumitrica, 1978, Sepsagonidae Kozur et Mostler, 1981, Hexapylomellidae Kozur et Mostler, 1979, Multiarcusellidae Kozur et Mostler, 1979, Hindeosphaeridae Kozur et Mostler, 1979, Muelleritortidae Kozur, 1988a, and Austrisaturnalidae Kozur et Mostler, 1983 have been recorded.

Family Muelleritortidae Kozur, 1988

Muelleritortidae: Kozur, 1988a, p. 51.

D i a g n o s i s. Entactinaria with subspherical or subdiscoid, double-layered outer shell. From two to five main spines present, located in equatorial plan of shell. One spine with straight sculpture, others with spiral coiling. Small inner shell present, including eccentrically positioned spicule without median bar, with four basal and three or four apical spines.

G e n e r i c c o m p o s i t i o n. *Ditortis* Kozur, 1988, *Tritortis* Kozur, 1988, *Muelleritortis* Kozur, 1988, and *Pentatortis* Kozur, 1988 from the Middle and Upper Triassic (Upper Ladinian–Lower Carnian).

C o m p a r i s o n. This family differs from the Hindeosphaeridae in one of the main spines, which is always straight, while others have a spiral coiling.

Genus *Muelleritortis* Kozur, 1988

Muelleritortis: Kozur, 1988a, p. 52.

T y p e s p e c i e s. *Emiluvia* (*?*) *cochleata* Nakaseko et Nishimura, 1979; Japan; Middle Triassic, Ladinian.

D i a g n o s i s. Four main spines present, of which spine with straight sculpture somewhat longer than others. Outer shell subspherical, subcylindrical, or subsquare.

S p e c i e s c o m p o s i t i o n. Seven species from the Upper Ladinian and basal Lower Carnian of the Mediterranean and Pacific regions.

C o m p a r i s o n. *Muelleritortis* differs from other genera of the family in the presence of four spines.

***Muelleritortis firma* (Gorican, 1990)**

Plate 1, fig. 1

Plafkerium? firmum: Gorican and Buser, 1990, p. 152, pl. 6, figs. 3–6.

H o l o t y p e. Paleontological Institute of Ivan Rakovec, no. VR 5, 88/265/9; Slovenia, Ljubljana; Middle Triassic, Upper Ladinian.

D e s c r i p t i o n. The test is small, subcylindrical, flattened in the plane of spines. The shell is latticed; the pores are enclosed in irregular polygonal frames, articulations of which have massive circular tubercles, which make the shell similar to the pseudoaulophacoid pattern. Four spines are in one plane, positioned crosswise, at equal angles to each other. All spines are thick, massive, Y-shaped in cross section, with a blunt ends, deep grooves, and wide smoothed ridges. One spine is twice as long as the others, its grooves and ridges are straight. The other three spines show a very weak dextral coiling, less than one-fourth coil along the spine.

M e a s u r e m e n t s in μm. Shell diameter, 130–135; Length of the large spine, 120–150; length of smaller spines, 75–90.

C o m p a r i s o n. *M. firma* differs from *M. cochleata* (Nakaseko et Nishimura, 1979) in the very weak coiling of spines.

R e m a r k s. In the diagnosis of the species, Gorican (1990) indicated that all spines are straight. However, some forms (Gorican, 1990, pl. 6, fig. 5) show weak dextral coiling, which was marked by other researchers (Kozur and Mostler, 1996).

O c c u r r e n c e. Middle Triassic, Upper Ladinian of Slovenia and Kotel'nyi Island.

M a t e r i a l. Eight specimens from one locality.

***Muelleritortis kotelnyensis* Bragin, sp. nov.**

Plate 1, figs. 2–4.

E t y m o l o g y. From Kotel'nyi Island.

H o l o t y p e. GIN (Geological Institute of the Russian Academy of Sciences), no. 7438-06-4; Kotel'nyi Island, Pryamaya River; Middle Triassic, Upper Ladinian.

D e s c r i p t i o n. The test is subspherical, flattened in the plane of spines. The shell is latticed, the pores are in irregular polygonal frameworks, with relatively low, rounded tubercles at articulations. Four spines are in one plane, positioned crosswise, at equal angles to each other. All spines are thin, Y-shaped in cross section, with pointed ends, deep grooves, and smoothed moderately wide ridges. One spine is noticeably longer than others, its grooves and ridges are straight. The other three spines show weak dextral coiling, at most one-fourth coil along the spine.

M e a s u r e m e n t s in μm. Outer shell diameter, 120–130; length of the large spine, 100–120; length of other spines, 60–80.

C o m p a r i s o n. The new species differs from *M. cochleata* (Nakaseko et Nishimura) in the thin spines with weak coiling.

O c c u r r e n c e. Middle and Upper Triassic, Upper Ladinian; Kotel'nyi Island.

M a t e r i a l. Nineteen specimens from one locality.

Family Hindeosphaeridae Kozur et Mostler, 1979

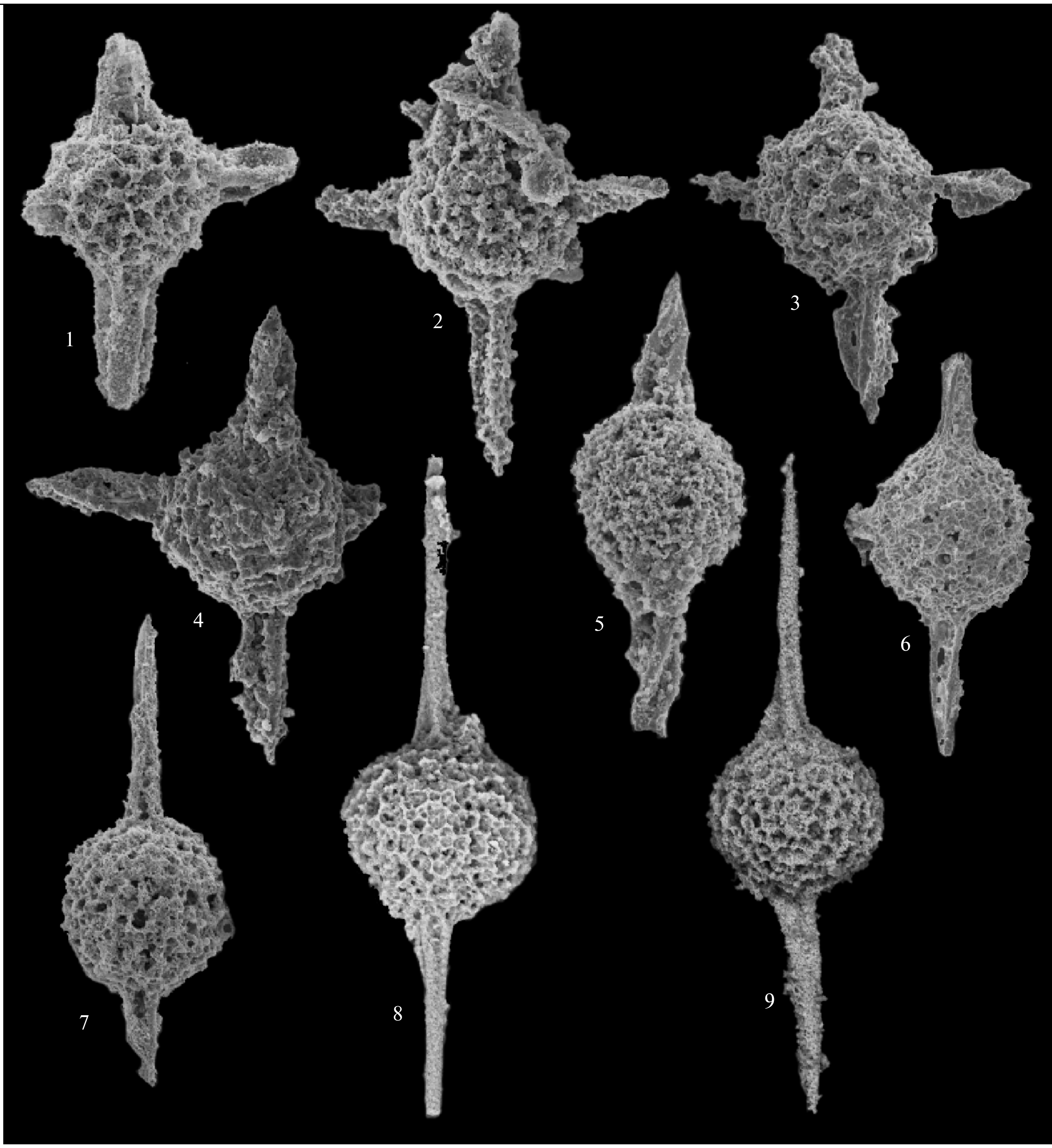
Hindeosphaeridae: Kozur and Mostler, 1979.

D i a g n o s i s. Prunoid or spherical forms, with latticed outer shell, one or two main spines in polar position, and inner shell, with eccentrically positioned spicule without median bar, with four basal and three apical spines.

G e n e r i c c o m p o s i t i o n. *Pseudostylosphaera* Kozur et Mostler, 1981 and *Hindeosphaera* Kozur et Mostler, 1979 from the Lower, Middle, and Upper Triassic.

C o m p a r i s o n. This family differs from Muelleritortiidae Kozur, 1988 in the presence of one or two main spines and in the polar position of these spines.

Plate 1



Explanation of Plate 1

Fig. 1. *Muelleritortis firma* (Gorican, 1990), GIN, no. 7438-06-1, sample 06-16-9r, Pryamaya River; Middle Triassic, Upper Ladinian, ×220.

Figs. 2–4. *Muelleritortis kotelnyensis* Bragin, sp. nov. from sample 06-16-9r, Pryamaya River, Middle Triassic, Upper Ladinian, ×220: (2) paratype GIN, no. 7438-06-2, (3) paratype GIN, no. 7438-06-3, and (4) holotype GIN, no. 7438-06-4.

Fig. 5. *Pseudostylosphaera goestlingensis* (Kozur et Mostler, 1979), GIN, no. 7438-06-5, sample 06-16-13r, Pryamaya River, Middle Triassic, Upper Ladinian, ×300.

Figs. 6 and 7. *Pseudostylosphaera omolonica* Bragin, 2000 from sample 06-16-17r, Pryamaya River, Middle Triassic, Upper Ladinian, ×160: (6) GIN, no. 7438-06-6 and (7) GIN, no. 7438-06-7.

Figs. 8 and 9. *Pseudostylosphaera glabella* Bragin, sp. nov.: (8) paratype GIN, no. 7438-06-8, sample 06-30-1r, Tikhaya River, Upper Triassic, Lower Norian, ×230; (9) holotype GIN, no. 7438-06-9, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×230.

Genus *Pseudostylosphaera* Kozur et Mostler, 1981

Type species. *Pseudostylosphaera gracilis* Kozur et Mock, 1981 (in Kozur et Mostler, 1981); Slovakia, Western Carpathians, village of Sulov; Upper Triassic, Lower Carnian (shingle from Middle Cenomanian conglomerates).

Diagnosis. Outer shell from subspherical to distinctly prunoid, with two main spines in polar position. By-spines usually absent. Spicule positioned perpendicular to axial line of skeleton, coinciding in direction with main spines. In addition to extensions of main spines, inner shell connected to outer shell by three bars, one of which positioned opposite to spicule, and other two positioned perpendicular.

Species composition. About 20 species from the terminal Lower Triassic, Middle Triassic, and Carnian Stage of the Mediterranean, Japan, the Far East of Russia, British Columbia, Oregon, the Philippines, New Zealand, and the Omolon Massif.

Comparison. *Pseudostylosphaera* differs from *Hindeosphaera* Kozur et Mostler, 1981 in the presence of two main spines.

Pseudostylosphaera goestlingensis (Kozur et Mostler, 1979)

Plate 1, fig. 5

Stylosphaera? goestlingensis: Kozur and Mostler, 1979, p. 59, pl. 17, fig. 5; pl. 18, fig. 1.

Pseudostylosphaera goestlingensis: Kozur and Mostler, 1981, p. 31; Sugiyama, 1997, p. 186, text-fig. 48.19; Tekin, 1999, p. 128, pl. 25, fig. 9.

Holotype. Austria, Göstling; Upper Triassic, Lower Carnian (Kozur and Mostler, 1979, pl. 18, fig. 1). Collection number and depository are not indicated.

Description. The test is subspherical, slightly ellipsoidal in outline. The wall is pierced by very small, irregularly arranged pores; the wall surface is finetuberculate. There are two spines located on two poles of the test, along the long axis of the ellipse. The spines are massive, Y-shaped in cross section; moderately long, approximately as long as the long diameter of the shell; gradually narrowing along the entire extent; pointed at the ends; with deep and wide longitudinal grooves separated by high and massive ridges. The spines have well-pronounced dextral coiling, about one coil along the spine.

Measurements in μm. Shell diameter along the long axis, 90–100; spine length, 80–90.

Comparison. *P. goestlingensis* differs from *P. hellenica* (De Wever, 1979) in the spines gradually tapering along the entire extent, without club-shaped expansions. It differs from *P. gracilis* Kozut et Mock, 1981 in the dextral coiling of spines.

Occurrence. Middle and Upper Triassic (Upper Ladinian–Lower Carnian) of Austria, Turkey, Japan, and Kotel'nyi Island.

Material. Twelve specimens from one locality.

Pseudostylosphaera omolonica Bragin, 2000

Plate 1, figs. 6 and 7

Pseudostylosphaera omolonica: Bragin and Egorov, 2000, p. 370, pl. 4, figs. 7–9.

Holotype. GIN, no. 4738-89-2; Omolon Massif, section on the Dzhugadzhak River; Upper Triassic, Lower Carnian.

Description. The test is regularly spherical. The shell is porous, with small, irregularly arranged pores. The shell surface is covered with small, relatively low tubercles. There are two spines in the polar position. The spines long, longer than the shell diameter; thin, Y-shaped in cross section, with pointed ends, deep grooves, high narrow ridges, and very weak dextral coiling or without it.

Measurements in μm. Shell diameter, 170–200; spine length, 180–220.

Comparison. *P. omolonica* differs from *P. goestlingensis* (Kozur et Mostler, 1979) in the weak coiling and the thinner spines.

Occurrence. Middle–Upper Triassic, Upper Ladinian–Lower Carnian of the Omolon Massif and Kotel'nyi Island.

Material. Twenty-two specimens from one locality.

Pseudostylosphaera glabella Bragin, sp. nov.

Plate 1, figs. 8 and 9

Etymology. From the Latin *glabellus* (hairless, smooth, naked).

Holotype. GIN, no. 7438-06-9; Kotel'nyi Island; Upper Triassic, Upper Carnian.

Description. The test is regularly spherical in outline. The shell is double-layered, latticed. The external layer of the shell has larger pores in the polygonal, usually hexagonal or irregular, irregularly arranged frameworks. Small circular pores of the internal layer are visible through pores of the external layer. The spines are located opposite each other. The spines are very thin and long, gradually tapering towards the pointed ends. At the base and further distally to the half-length, the spines are Y-shaped in cross section; in the distal part, they become smooth, circular in cross section. The grooves of spines are narrow, relatively shallow; the ridges are relatively low, smoothed. The proximal part of spines shows weak sinistral coiling, up to one-third coil.

Measurements in μm. Outer shell diameter, 130–135; spine length, 210–220.

Comparison. The new species differs from *P. omolonica* Bragin in the spines, the distal half of which is circular in cross section.

Occurrence. Upper Triassic, Upper Carnian and Lower Norian of Kotel'nyi Island

Material. Twenty-four specimens from three localities.

***Pseudostylosphaera gracilis* Kozur et Mock, 1981**

Plate 2, fig. 1

Pseudostylosphaera gracilis Kozur et Mock: Kozur and Mostler, 1981, p. 32, pl. 66, fig. 1; Sugiyama, 1997, p. 186, text-fig. 48.19; Tekin, 1999, p. 128, pl. 25, figs. 10 and 11; Tekin and Mostler, 2005, p. 1, text-fig. 4.1; Tekin and Goncuoglu, 2007, pl. 2, figs. 19–21.

Pseudostylosphaera hellenica: Lahm, 1984, p. 35, figs. 1 and 2.

H o l o t y p e. Slovakia, village of Sulov; Upper Triassic, Carnian (Kozur and Mostler, 1981, pl. 66, fig. 1); collection number and depository are not indicated.

D e s c r i p t i o n. The test is ellipsoidal in outline, slightly extended. The shell is porous; the pores are small, arranged irregularly; the shell surface is covered with small tubercles. Two spines are at opposite poles of the ellipsoidal test, extending along the long axis of the test. The spines are massive, gradually thickening to the distal fourth of the extent, then, they become narrower and terminate in a short, narrow, pointed end. The spines are Y-shaped in cross section, with deep and wide grooves and narrow high ridges, and well-pronounced sinistral coiling, up to one complete coil along the spine.

M e a s u r e m e n t s in μm. Shell length without spines, 120; shell width, at most 100; spine length, 130.

C o m p a r i s o n. *P. gracilis* differs from *P. hellenica* (De Wever, 1979) in the sinistral coiling of spines.

O c c u r r e n c e. Middle and Upper Triassic, Upper Ladinian–Carnian; Austria, Japan, Turkey, Kotel'nyi Island.

M a t e r i a l. Five specimens from two localities.

***Pseudostylosphaera voluta* Bragin, sp. nov.**

Plate 2, figs. 2–10

E t y m o l o g y. From the Latin *voluta* (twisted).

H o l o t y p e. GIN, no. 7438-06-14; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is regularly spherical. The shell is latticed, with small pores in thin, polygonal, mostly hexagonal, usually regular frameworks, with small tubercles on articulations. Two spines are moderately long; within the proximal third of the extent, they gradually decrease in width; then, in the middle part, the spines become gradually thicker; and in the distal part, they narrow to the pointed ends. The spines are Y-shaped in cross section, with wide deep grooves; the ridges are thickened and smooth at the spine bases, becoming thin and high in the distal part. In the middle part of spines, distinct sinistral coiling is observed, varying from half to one complete coil along the spine.

M e a s u r e m e n t s in μm. Diameter of the outer shell, 105–120; spine length, 140–160; maximum spine thickness, 35–60.

C o m p a r i s o n. The new species differs from *P. gracilis* Kozur et Mock in the middle part of spines, which is thickened and shows limited coiling.

R e m a r k s. The new species varies widely in the extent of thickening in the middle part of spines and coiling.

O c c u r r e n c e. Upper Triassic, Upper Carnian–Lower Norian of Kotel'nyi Island.

M a t e r i a l. Tens specimens from four localities.

***Pseudostylosphaera gelida* Bragin, sp. nov.**

Plate 3, figs. 1–3

E t y m o l o g y. From the Latin *gelidus* (cold, icy).

H o l o t y p e. GIN, no. 7438-06-21; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is regularly spherical. The shell is latticed, double-layered; the pores in the external layer are irregularly rounded in outline, varying in size, enclosed in thin irregularly polygonal frameworks with small tubercles on articulations. The pores in the internal layer are smaller, rounded. The spines are Y-shaped in cross section, moderately long, with wide grooves and thin ridges. The spines are thick at the base and gradually narrow to the pointed ends, with weak sinistral coiling, less than half coil along the spine.

M e a s u r e m e n t s in μm. Diameter of the outer shell, 120–125; spine length, 150–170.

C o m p a r i s o n. The new species differs from *P. omolonica* in the sinistral coiling and from *P. voluta* in the weaker coiling and the absence of a thickening in the middle part of spines.

O c c u r r e n c e. Upper Triassic, Upper Carnian–Lower Norian of Kotel'nyi Island.

M a t e r i a l. Fourteen specimens from three localities.

Family Pentactinocarpidae Dumitrica, 1978

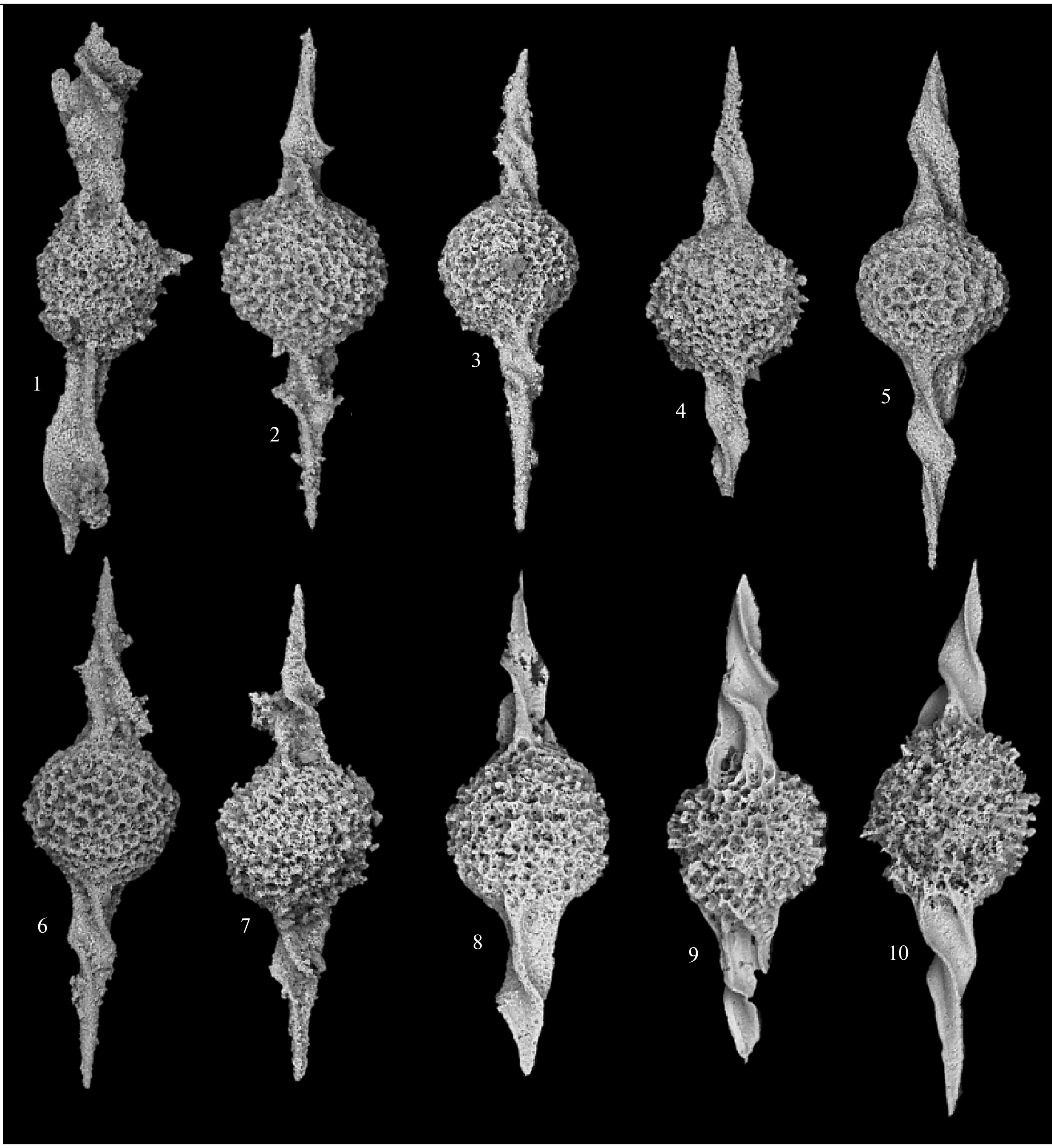
Pentactinocarpidae: Dumitrica, 1978b, p. 41.

D i a g n o s i s. Entactinaria with pentactine spicule having one apical and four basal spines, and positioned external to first shell. All spines smooth, rounded in cross section, positioned in different planes. One or two porous or reticular shells present, first of which developing from basal spines.

G e n e r i c c o m p o s i t i o n. *Pentactinocarpus* Dumitrica, *Pentactinorbis* Dumitrica, *Lobactinocapsa* Dumitrica, and *Pentactinocapsa* Dumitrica. Middle and Upper Triassic.

C o m p a r i s o n. The family differs from the Sepsagonidae Kozur et Mostler, 1981 and Multiarcusellidae Kozur et Mostler, 1979 in the pentactine spicules, which are positioned external to the first shell.

Plate 2

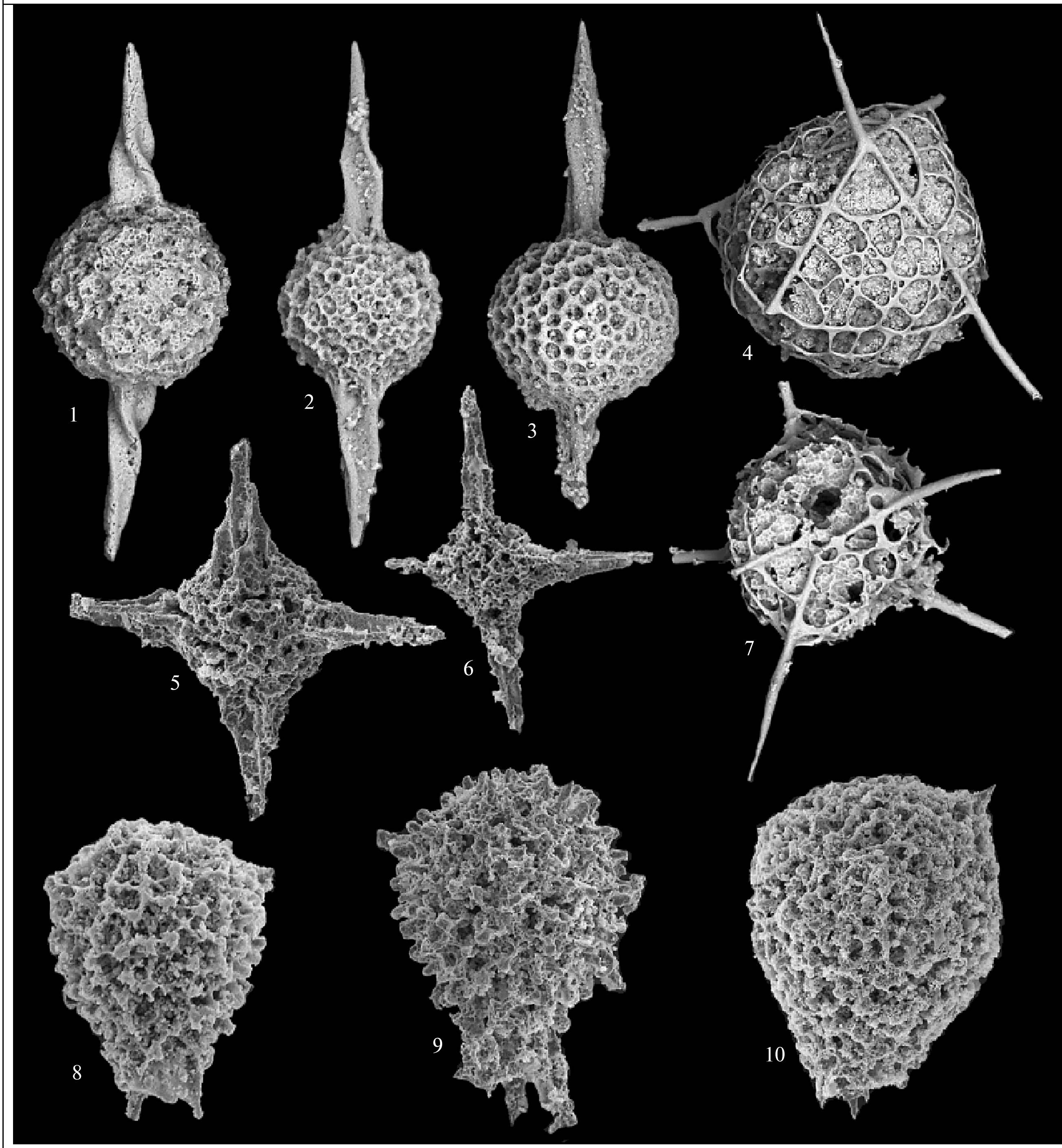


Explanation of Plate 2

Fig. 1. *Pseudostylosphaera gracilis* Kozur et Mock, 1981, GIN, no. 7438-06-10, sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×200.

Figs. 2–10. *Pseudostylosphaera voluta* Bragin, sp. nov., ×210: (2) paratype GIN, no. 7438-06-11, sample 06-17-13r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian; (3) paratype GIN, no. 7438-06-12, sample 06-17-13r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian; (4) GIN, no. 7438-06-13, sample 06-31-1, Tikhaya River, Upper Triassic, Upper Carnian, (5) holotype GIN, no. 7438-06-14, sample 06-17-13r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian; (6, 7) sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian: (6) GIN, no. 7438-06-15, (7) GIN, no. 7438-06-16; (8) GIN, no. 7438-06-17, sample 06-30-1r, Tikhaya River, Upper Triassic, Lower Norian; (9, 10) sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian: (9) GIN, no. 7438-06-18, (10) GIN, no. 7438-06-19.

Plate 3



Genus *Pentactinocarpus* Dumitrica, 1978

Pentactinocarpus: Dumitrica, 1978b, p. 43.
Oertlisphaera: Kozur and Mostler, 1979, p. 53.
Praedruppatractylis: Kozur and Mostler, 1979, p. 82.

T y p e   s p e c i e s. *Pentactinocarpus fusiformis* Dumitrica, 1978b; southern Alpes; Lower Ladinian.

D i a g n o s i s. One porous subspherical or prunoid shell, connected to distal parts of basal spines of spicule. Proximal parts of basal spines of spicule framing large subtriangular pores in apical part of skeleton, opposite end of which having antapical spine.

S p e c i e s   c o m p o s i t i o n. Five species from the Middle and Upper Triassic of the Far East of Russia, Mediterranean, Japan, the Philippines, and British Columbia.

C o m p a r i s o n. This genus differs from *Lobactinocapsa* Dumitrica, 1978 in the absence of additional lobes of the outer shell in the apical part of the shell, from *Pentactinorbis* Dumitrica, 1978 in the presence of one shell, and from *Pentactinocapsa* Dumitrica, 1978 in the presence of an antapical spine.

Pentactinocarpus colum **Bragin, sp. nov.**

Plate 3, figs. 4 and 7

E t y m o l o g y. From the Latin *colum* (sieve, fish-trap).

H o l o t y p e. GIN, no. 7438-06-23; Kotel'nyi Island; Upper Triassic, Lower Carnian.

D e s c r i p t i o n. The test is very large, almost circular, with a conical apical part. The shell is reticular; the pores are rounded polygonal, varying in size up to very large pores. The apical spine is long, narrow, smooth, rounded in cross section, with a pointed end. The basal spines are very long, narrow, smooth. The proximal half of each basal spine is included in the shell; the dorsal part deviates from the shell, curving slightly proximally. The basal spines are connected by arches in the apical part of the shell and at the points of divergence of spines from the shell wall.

M e a s u r e m e n t s in µm. Shell diameter, 340; length of the apical spine, 180–200; length of the basal spine, 390–400.

C o m p a r i s o n. The new species differs from *P. tetracanthus* Dumitrica, 1978 in the twice as large shell, very thin and long apical and basal spines, and in the coarse-reticular shell.

O c c u r r e n c e. Upper Triassic, Lower Carnian; Kotel'nyi Island.

M a t e r i a l. Six specimens from one locality.

Family Tiborellidae Kozur et Mostler, 1994

Tiborellidae: Kozur and Mostler, 1994, p. 51.

D i a g n o s i s. Outer shell subspherical, flattened, latticed, with four main spines positioned in one plane. Inner shell with hexactine spicule, having median bar.

G e n e r i c c o m p o s i t i o n. *Tiborella* Dumitrica, Kozur et Mostler, 1980 from the Lower and Middle Triassic

C o m p a r i s o n. This family differs from Muelleritortidae Kozur, 1988 in the hexactine spicule with the median bar.

Genus *Tiborella* Dumitrica, Kozur et Mostler, 1980

Tiborella: Dumitrica et al., 1980, p. 18.

T y p e s p e c i e s. *Tiborella magnidentata* Dumitrica, Kozur et Mostler, 1980; Italy, southern Alpes, Recoaro; Middle Triassic, Lower Ladinian, Buchenstein Formation.

D i a g n o s i s. Outer shell subdiscoid, latticed, with large hexagonal and pentagonal porous frameworks and four main spines, positioned crosswise in one plan. Inner shell subspherical, porous, having inside hexactine spicule with median bar.

C o m p o s i t i o n. Five species from the Lower and Middle Triassic (Olenekian–Lower Ladinian) of the Mediterranean Region, Japan, the Far East of Russia, and Philippines.

Tiborella nivea **Bragin, sp. nov.**

Plate 3, figs. 5 and 6.

E t y m o l o g y. From the Latin *niveus* (snow, snowy).

H o l o t y p e. GIN, no. 7438-06-25; Kotel'nyi Island; Middle Triassic, Upper Ladinian.

D e s c r i p t i o n. The test is subsquare in outline, flattened in the plane of spines. The shell is latticed; the pores are relatively small, enclosed in irregular polygonal frameworks, with relatively low, massive tubercles on articulations. The spines are moderately long, Y-shaped in cross section, with a thick proximal part (up to one-fourth of the length); further distally, they abruptly narrow and, then, gradually taper to the pointed ends. The grooves of spines are wide and deep, the ridges are thin and high. The spines lack a spiral coiling.

←

E x p l a n a t i o n o f P l a t e 3

Figs. 1–3. *Pseudostylosphaera gelida* Bragin, sp. nov., ×150: (1) GIN, no. 7438-06-20, sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian; (2) holotype GIN, no. 7438-06-21, sample 06-30-1r, Tikhaya River, Upper Triassic, Lower Norian; (3) paratype GIN, no. 7438-06-22, sample 06-30-1r, Tikhaya River, Upper Triassic, Lower Norian.

Figs. 4 and 7. *Pentactinocarpus colum* Bragin, sp. nov.: (4) holotype GIN, no. 7438-06-23, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×90; (7) paratype GIN, no. 7438-06-24, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×70.

Figs. 5 and 6. *Tiborella nivea* Bragin, sp. nov.: (5) holotype GIN, no. 7438-06-25, sample 06-16-17r, Pryamaya River, Middle Triassic, Upper Ladinian, ×220; (6) paratype GIN, no. 7438-06-26, sample 06-16-17r, Pryamaya River, Middle Triassic, Upper Ladinian, ×180.

Figs. 8 and 9. *Glomeropyle clavatum* Bragin, sp. nov.: (8) holotype GIN, no. 7438-06-27, sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian, ×145; (9) paratype GIN, no. 7438-06-28, sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian, ×170.

Fig. 10. *Glomeropyle boreale* Bragin, 1999, no. 7438-06-29, sample 06-15-1r, Pryamaya River, Middle Triassic, Upper Anisian, ×190.

M e a s u r e m e n t s in μm. Diagonal length of the shell, 100–110; spine length, 70–100.

C o m p a r i s o n. The new species differs from *T. florida* (Nakaseko et Nishimura, 1979) in the longer spines without spiral coiling.

O c c u r r e n c e. Middle Triassic, Upper Ladinian; Kotel'nyi Island.

M a t e r i a l. Eight specimens from one locality.

Entactinaria incertae familiae

Genus *Glomeropyle* Aita et Bragin, 1999

T y p e s p e c i e s. *Glomeropyle aurora* Aita, 1999; New Zealand, Manihepua section; Middle Triassic, Lower Ladinian.

D i a g n o s i s. Test subspherical, varying in size, with rounded open aperture and pylome; pylome occasionally having bordering spines. Inside shell, there heptactine spicule with short MB, three apical and four basal spines connected to internal surface of test, but lacking external continuation. Shell wall very thick, multilayer, spongy. Spines short, occasionally absent, varying in number and position.

S p e c i e s c o m p o s i t i o n a n d o c c u r r e n c e. Seven species from the Middle and Upper Triassic of New Zealand and the Omolon Massif. The genus occurs only in high latitudes of the Northern and Southern hemispheres and has not been recorded in thermophilic aquatic assemblages.

C o m p a r i s o n. This genus differs from other Mesozoic Entactinaria in the development of one pylome.

R e m a r k s. *Glomeropyle* is similar to members of the subfamily Hexapylomellinae in the character of the spicule and in the absence of connection between rays of the spicule and external spines.

Glomeropyle clavatum Bragin, sp. nov.

Plate 3, figs. 8 and 9

E t y m o l o g y. From the Latin *clavatus* (cone-shaped, tuberculate).

H o l o t y p e. GIN, no. 7438-06-27; Kotel'nyi Island; Middle Triassic, Upper Anisian.

D e s c r i p t i o n. The test is teardrop-shaped, extended and narrowing towards the aperture. The shell is latticed, the pores are enclosed in irregular polygonal frameworks, articulations of which have large, high, massive, rounded tubercles; therefore, the shell is similar to the pseudoaulophacoid shell. The apertural part of the test extends to form a short tube. The aperture is rounded, with three short smooth basal feet.

M e a s u r e m e n t s in μm. Maximum shell length with basal feet, 200–220; maximum shell width, 150–155; length of basal feet, up to 45.

C o m p a r i s o n. The new species differs from *G. boreale* Bragin, 1999 in the small shell, large massive tubercles on its surface, and in the absence of subsidiary spines.

O c c u r r e n c e. Middle Triassic, Upper Anisian; Kotel'nyi Island.

M a t e r i a l. Eighteen specimens from two localities.

Glomeropyle boreale Bragin, 1999

Plate 3, fig. 10; Plate 4, figs. 1 and 2

Pylentonemidae (?) gen. indet.: Egorov and Bragin, 1995, text-fig. 2 (10–12).

Glomeropyle boreale: Bragin in Aita and Bragin, 1999, p. 516, text-figs. 9A–9F; Bragin and Egorov, 2000, pl. III, figs. 2, 3, 5–12.

H o l o t y p e. GIN, no. 7438-89-1; Omolon Massif, Dzhugadzhak River; Middle Triassic, Ladinian Stage.

D e s c r i p t i o n. The test is teardrop-shaped, extending and narrowing towards the aperture. The shell is latticed; the pores are small, arranged irregularly, enclosed in irregular polygonal porous frameworks, articulations of which have relatively low, rounded tubercles. From one to three thin, smooth spines, which are rounded in cross section and have pointed ends, deviate radially from the shell surface. The aperture is rounded, bordered by three short smooth basal feet, and lacks a distinct terminal tube.

M e a s u r e m e n t s in μm. Maximum shell length with the basal feet, 250–270; maximum shell width, 210–220; length of the basal feet, 70–80.

C o m p a r i s o n. *G. boreale* differs from *G. manihepuaensis* Aita, 1999 in the coarser structure of the external layer of the shell, with larger and distinct porous frameworks with massive tubercles.

O c c u r r e n c e. Middle Triassic, Upper Anisian and Ladinian; Omolon Massif and Kotel'nyi Island.

M a t e r i a l. Tens specimens from two localities.

Glomeropyle manihepuaensis Aita, 1999

Plate 4, figs. 3 and 6

Glomeropyle manihepuaensis: Aita, 1999, p. 520, text-figs. 13A–13J.

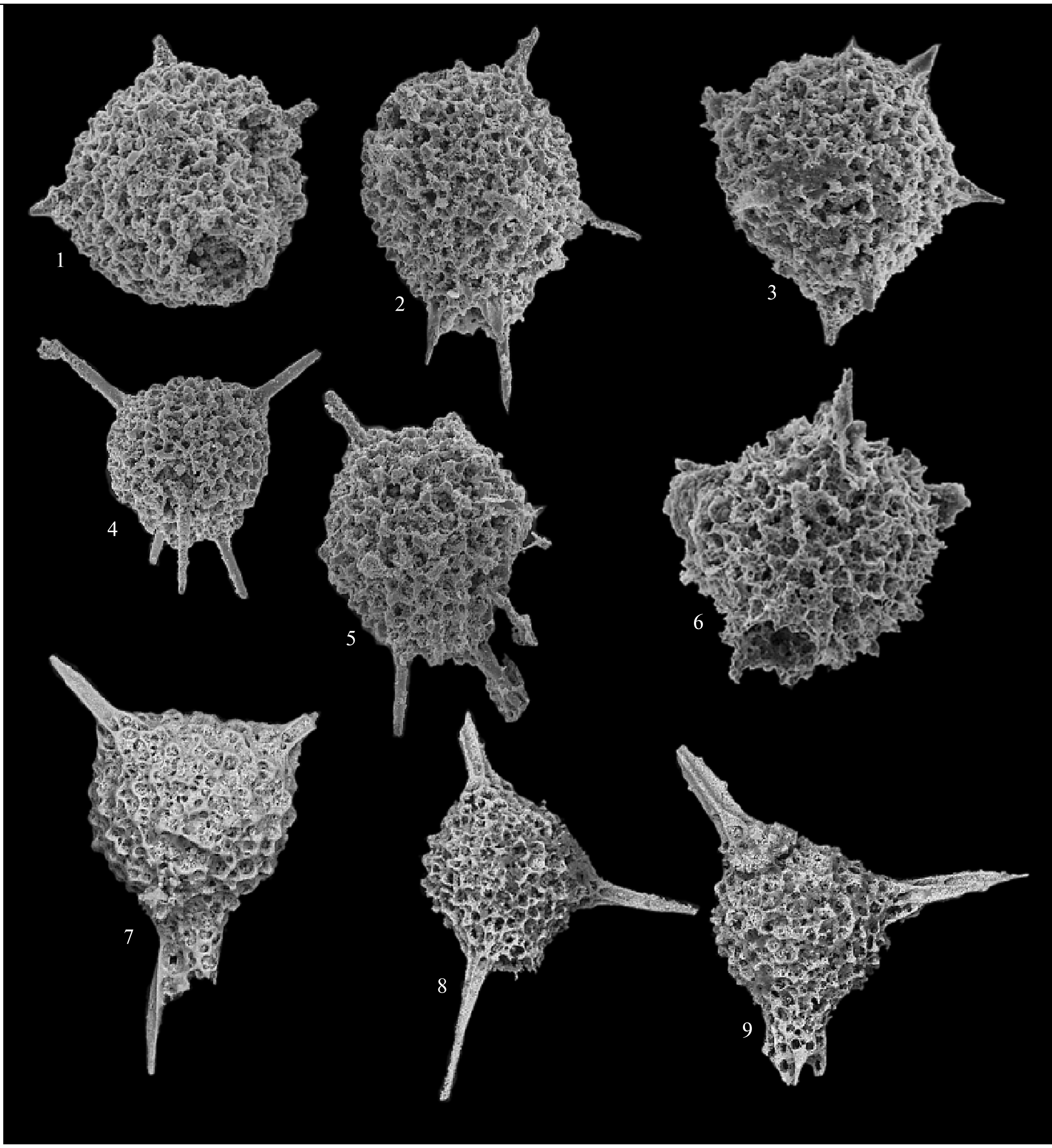
H o l o t y p e. University of Utsunomia (Japan), no. UTU111; New Zealand; Middle Triassic, Lower Ladinian.

D e s c r i p t i o n. The test is small, rounded teardrop-shaped, slightly extending towards the aperture. The shell is latticed; the pores are small, arranged irregularly. The shell surface is covered with small tubercles. Several short radial spines rounded in cross section are present. The aperture is small, rounded, bordered by several smooth basal feet, one of which is larger than the others.

M e a s u r e m e n t s in μm. Shell length with basal feet, 180–190; maximum shell width, 120–130; length of the largest basal foot, up to 20.

C o m p a r i s o n. *G. manihepuaensis* differs from *G. boreale* Bragin in the smaller size, fine-tuberculate surface of the shell, the presence of one enlarged spine among basal feet.

Plate 4



Explanation of Plate 4

Figs. 1 and 2. *Glomeropyle boreale* Bragin, 1999, sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian, ×190: (1) GIN, no. 7438-06-30, (2) GIN, no. 7438-06-31.

Figs. 3 and 6. *Glomeropyle manihepuaensis* Aita, 1999, (3) GIN, no. 7438-06-32, sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian, ×210; (6) GIN, no. 7438-06-33, sample 06-15-1r, Pryamaya River, Middle Triassic, Upper Anisian, ×210.

Figs. 4 and 5. *Glomeropyle insulanum* Bragin, sp. nov.: (4) holotype GIN, no. 7438-06-34, sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian, ×100; (5) paratype GIN, no. 7438-06-35, sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian, ×170.

Figs. 7–9. *Glomeropyle cuneum* Bragin, sp. nov.: (7) holotype GIN, no. 7438-06-36, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×140; (8) paratype GIN, no. 7438-06-37, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×90; (9) paratype GIN, no. 7438-06-38, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×110.

O c c u r r e n c e. Middle Triassic, Lower Ladinian of New Zealand, Upper Anisian of Kotel'nyi Island.

M a t e r i a l. Sixteen specimens from two localities.

Glomeropyle insulanum **Bragin, sp. nov.**

Plate 4, figs. 4 and 5

E t y m o l o g y. From the Latin *insulanus* (insular).

H o l o t y p e. GIN, no. 7438-06-34; Kotel'nyi Island; Middle Triassic, Upper Anisian.

D e s c r i p t i o n. The test is teardrop-shaped, slightly extending and narrowing towards the aperture. The shell is latticed; the pores are small, arranged irregularly, enclosed in irregular polygonal porous frameworks, articulations of which have relatively low rounded tubercles. Two long, narrow, smooth spines, which are rounded in cross section and pointed at the ends, deviate radially from the shell surface to the side opposite to the aperture. The aperture is rounded, without a pronounced terminal tube bordered by three long smooth basal feet.

M e a s u r e m e n t s in μm. Maximum shell length with basal feet, 260–270; maximum shell width, 200; length of the basal feet, more than 100.

C o m p a r i s o n. The new species differs from *G. boreale* Bragin in the long basal feet and in the subsidiary spines.

O c c u r r e n c e. Middle Triassic, Upper Anisian; Kotel'nyi Island.

M a t e r i a l. Thirteen specimens from two localities.

Glomeropyle cuneum **Bragin, sp. nov.**

Plate 4, figs. 7–9

E t y m o l o g y. From the Latin *cuneum* (wedge).

H o l o t y p e. GIN, no. 7438-06-36; Kotel'nyi Island; Upper Triassic, Lower Carnian.

D e s c r i p t i o n. The test is large, teardrop-shaped, rounded triangular in outline, narrowing towards the aperture and extending to form a terminal tube. The shell is latticed, double-layered; the external layer has large irregularly polygonal pores enclosed in massive porous frameworks with small nodes on the articulations; the internal layer has small, rounded, irregularly arranged pores. One long narrow basal foot with a Y-shaped section extends along the terminal tube. The shell part opposite to the aperture has two long, narrow radial spines, which are Y-shaped in cross section and positioned at a right or somewhat greater angle to each other.

M e a s u r e m e n t s in μm. Shell length with the terminal tube and without spines, 300–310; maximum shell width, 200–220; spine length, up to 200.

C o m p a r i s o n. The new species differs from *G. galagala* Aita, 1999 in the larger shell with three very long spines, one of which is an apertural spine.

O c c u r r e n c e. Upper Triassic, Lower Carnian; Kotel'nyi Island.

M a t e r i a l. Tens specimens from three localities.

Glomeropyle algidum **Bragin, sp. nov.**

Plate 5, figs. 1 and 2

Ferresium sp.: Bragin and Egorov, 2000, pl. IV, fig. 2 (non fig. 5).

?Eptingium sp.: Tekin et al., 2006, pl. 1, fig. 7.

Pylostephanidium sp.: Tekin et al., 2006, pl. 1, fig. 9.

E t y m o l o g y. From the Latin *algidus* (cold).

H o l o t y p e. GIN, no. 7438-06-39; Kotel'nyi Island; Upper Triassic, Lower Carnian.

D e s c r i p t i o n. The test is relatively small, subspherical, with a wide open aperture, without a terminal tube. The shell is double-layered; the external layer has large pores in massive, irregular polygonal porous frameworks, with nodes on articulations; the internal layer has small rounded pores. Three short, narrow, smooth spines rounded in cross section; one is a basal spine; the other two are in the shell part opposite to the aperture, positioned at an angle slightly more than 90° to each other.

M e a s u r e m e n t s in μm. Shell length, 200–220; maximum shell width, 200; spine length, up to 70.

C o m p a r i s o n. The new species differs from *G. cuneum* Bragin, sp. nov. in the smaller size, the absence of a terminal tube, and in the short spines rounded in cross section.

O c c u r r e n c e. Upper Triassic, Lower Carnian; Spitsbergen and Kotel'nyi Island.

M a t e r i a l. Twenty-three specimens from two localities.

E x p l a n a t i o n o f P l a t e 5

Figs. 1 and 2. *Glomeropyle algidum* Bragin, sp. nov.: (1) holotype GIN, no. 7438-06-39, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×150; (2) paratype GIN, no. 7438-06-40, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×150.

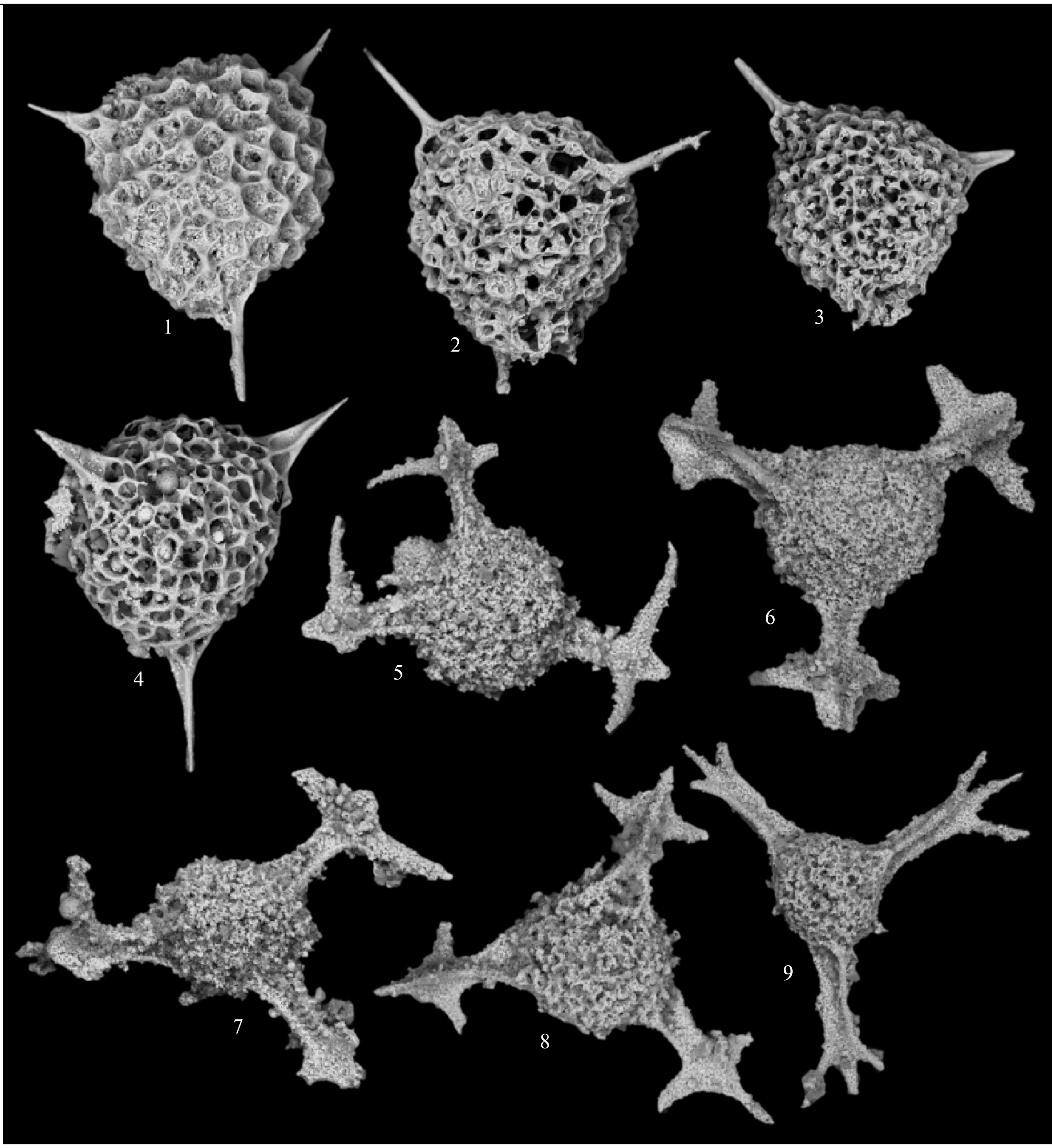
Figs. 3 and 4. *Glomeropyle aculeatum* Bragin, sp. nov.: (3) paratype GIN, no. 7438-06-41, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×115; (4) holotype GIN, no. 7438-06-42, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×170.

Figs. 5–7. *Kahlerosphaera unca* Bragin, sp. nov.: (5) holotype GIN, no. 7438-06-43, sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×150; (6) paratype GIN, no. 7438-06-44, sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×150; (7) GIN, no. 7438-06-45, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×150.

Fig. 8. *Kahlerosphaera aspinosa* Kozur et Mock, 1981, GIN, no. 7438-06-46, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×180.

Fig. 9. *Kahlerosphaera fuscinula* Bragin, sp. nov., holotype GIN, no. 7438-06-47, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×140.

Plate 5



Glomeropyle aculeatum **Bragin, sp. nov.**

Plate 5, figs. 3 and 4

E t y m o l o g y. From the Latin *aculeatus* (spiny, thorny, covered with spines).

H o l o t y p e. GIN, no. 7438-06-42; Kotel'nyi Island; Upper Triassic, Lower Carnian.

D e s c r i p t i o n. The test is rounded triangular in outline. The shell is latticed, with closely spaced rounded pores in polygonal, usually irregular hexagon or pentagonal frameworks, with a greater or lesser developed tubercles on articulations. The pores range from large and massive to very small. Three short spines are present; they are Y-shaped in cross section at the base, narrowing to the pointed ends and becoming distally rounded in cross section. One of these spines is apertural, the other two are in the shell part opposite to the aperture, positioned at more than 90° (up to 120°) to each other.

M e a s u r e m e n t s in μm. Shell length, 200–220; maximum shell width, 200; spine length, up to 70.

C o m p a r i s o n. The new species differs from *G. algidum* in the spines with Y-shaped section at the bases.

O c c u r r e n c e. Upper Triassic, Lower Carnian; Kotel'nyi Island.

M a t e r i a l. Fourteen specimens from two localities.

Order Spumellaria Ehrenberg, 1875

D i a g n o s i s. Polycystina with primary framework represented by pierced initial shell, varying in outlines and structure, with varying number of shells varying in shape and structure, with concentric mode of skeleton growth.

C o m p o s i t i o n. Silurian?–Recent. In the Triassic, the order is represented by the superfamilies Actinommoidea Haeckel, 1862 and Spongodiscoidea Haeckel, 1862.

C o m p a r i s o n. The order Spumellaria differs from Entactinaria Kozur et Mostler, 1982 in the primary framework represented by the initial shell without a spicule.

S u p e r f a m i l y Actinommoidea Haeckel, 1862

Actinommatida: Haeckel, 1862, p. 440.
Actinommida: Haeckel, 1887, p. 251.

D i a g n o s i s. Spumellaria with primary framework represented by spherical or subspherical, porous initial shell in center of skeleton, with one or several spherical or subspherical shells, with varying numbers of external spines or without spines.

C o m p o s i t i o n. Silurian?–Recent. In the Triassic, the superfamily is represented by the families Actinommidae Haeckel, 1881, Capnuchosphaeridae De Wever, 1979, Pantanelliidae Pessagno, 1977, Ferresiidae Carter, 1993, and Stylosphaeridae Haeckel, 1882.

C o m p a r i s o n. The superfamily Actinommoidea differs from Spongodiscoidae Haeckel, 1962 in the primary framework of spherical or subspherical porous shell in the center of the skeleton.

Family Actinommidae Haeckel, 1862

Actinommatida: Haeckel, 1862, p. 440.
Actinommida: Haeckel, 1887, p. 251.

D i a g n o s i s. Actinommoidea with spherical microsphere, with several porous single-layered, or, less often, spongy single-layered shells and varying numbers of simple radial spines never occupying polar positions.

G e n e r i c c o m p o s i t i o n. Triassic–Recent. In the Triassic, the family is represented by the genera *Archaeocenosphaera* Pessagno et Yang, 1989, *Carinaheliosoma* Kozur et Mostler, 1981, *Kahlerosphaera* Kozur et Mostler, 1979, and *Triassospongosphaera* Kozur et Mostler, 1979.

C o m p a r i s o n. The family Actinommidae is distinguished from Capnuchosphaeridae by the single-layered outer shells and from Stylosphaeridae by the main spines which do not occupy a polar position.

Genus *Kahlerosphaera* Kozur et Mostler, 1979

Kahlerosphaera: Kozur and Mostler, 1979, p. 66.
Fontinella: Carter, 1993, p. 43.

T y p e s p e c i e s. *Kahlerosphaera parvispinosa* Kozur et Mostler, 1979; Austria, Göstling; Middle Carnian.

D i a g n o s i s. Outer shell subspherical, latticed. Each of three main spines Y-shaped in cross section, with three distal branches connected to ridges of proximal parts of spines.

S p e c i e s c o m p o s i t i o n. About ten species from the Carnian–Rhaetian of the Mediterranean and Pacific regions.

C o m p a r i s o n. *Kahlerosphaera* differs from *Triactoma* Rust, 1885 in the presence of branches of ridges in the distal parts of spines.

***Kahlerosphaera unca* Bragin, sp. nov.**

Plate 5, figs. 5–7

E t y m o l o g y. From the Latin *uncus* (curved, arched, hooked, clawed, equipped with curved claws).

H o l o t y p e. GIN, no. 7438-06-43; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is subspherical, slightly flattened in the plane of spines. The shell is porous with many small tubercles on the surface. The pores are small, arranged irregularly. The spines are short, moderately thick, Y-shaped in cross section, with wide grooves and narrow ridges, without coiling. The apophyses are narrow, deviate from spines at an angle of 90°, rounded in cross section; in completely preserved specimens, they are almost as long as spines. The ends of apophyses curve slightly towards the shell wall. The ends of spines distal to the apophyses are short, pointed.

M e a s u r e m e n t s in μm. Shell diameter along the line of one spine, 120–125; spine length, 90–100; apophysis length, 80–90.

C o m p a r i s o n. The new species differs from *K. aspinosa* Kozur et Mock in the rounded cross section of apophyses and the curvature of apophyses towards the shell.

O c c u r r e n c e. Upper Triassic, Upper Carnian; Kotel'nyi Island.

M a t e r i a l. Eight specimens from two localities.

Kahlerosphaera aspinosa **Kozur et Mock, 1981**

Plate 5, fig. 8

Kahlerosphaera? aspinosa Kozur et Mock: Kozur and Mostler, 1981, p. 36, pl. 47, fig. 3; Tekin, 1999, p. 64, pl. 1, figs. 3 and 4.

H o l o t y p e. Upper Triassic, Lower Norian of Slovakia (Kozur and Mostler, 1981, pl. 47, fig. 3); collection number and depository are not indicated.

D e s c r i p t i o n. The test is rounded triangular in outline, slightly flattened in the plane of spines. The shell is porous, covered with small tubercles; the pores are small, arranged irregularly. The spines are short, located at the apices of the rounded triangular shell, Y-shaped in cross section, have wide and deep grooves and narrow ridges without coiling. The apophyses are short, look like thin plates, tapering towards the pointed ends, deviate from spines at an angle of 75° to the shell surface; then, in some specimens, they curve slightly approaching the position perpendicular to spines. The spine ends are short, pointed.

M e a s u r e m e n t s in μm. Shell diameter along the line of one spine, 110; spine length, 100; apophysis length, up to 35.

C o m p a r i s o n. *K. aspinosa* differs from *Kahlerosphaera unca* in the apophyses in the shape of plates, with nonrounded section.

O c c u r r e n c e. Upper Triassic, Upper Carnian–Lower Norian of Slovakia, Turkey, and Kotel'nyi Island.

M a t e r i a l. Four specimens from one locality.

Kahlerosphaera fuscinula **Bragin, sp. nov.**

Plate 5, fig. 9

E t y m o l o g y. From the Latin *fuscinula* (small trident, fork).

H o l o t y p e. GIN, no. 7438-06-47; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is small, subspherical, slightly flattened in the plane of spines. The shell is porous, smooth, with small, irregularly arranged pores. The spines are long, Y-shaped in cross section, with relatively shallow grooves, which are slightly longer than ridges. The apophyses are short, smooth, rounded in cross section, deviate from spines at an angle of 45° to the ends of spines. The ends of spines are short, pointed.

M e a s u r e m e n t s in μm. Shell diameter along the line of one spine, 90; spine length, 125; apophysis length, 40–45.

C o m p a r i s o n. The new species differs from *K. norica* Kozur et Mock in the rounded cross section of the apophyses, which are strongly deviated towards the spine ends.

O c c u r r e n c e. Upper Triassic, Upper Carnian; Kotel'nyi Island.

M a t e r i a l. Three specimens from one locality.

Kahlerosphaera retunsa **Bragin, sp. nov.**

Plate 6, fig. 1

E t y m o l o g y. From the Latin *retunsus* (blunt).

H o l o t y p e. GIN, no. 7438-06-48; Kotel'nyi Island; Upper Triassic, Lower Norian.

D e s c r i p t i o n. The test is regularly spherical. The shell is latticed; the pores are rounded, varying in size, enclosed in polygonal, often pentagonal and hexagonal frameworks, with very small tubercles on articulations. The spines are moderately long, Y-shaped in cross section, with relatively shallow grooves and smoothed ridges, without coiling. The apophyses are very short, smooth, with blunt ends, deviate from spines at an angle of 60° to spine ends. The ends of spines are pointed, several times as long as the apophyses.

M e a s u r e m e n t s in μm. Shell diameter along the line of one spine, 125; spine length, 110.

C o m p a r i s o n. The new species differs from *K. unca* in the very short apophyses, which are several times shorter than the spine ends.

O c c u r r e n c e. Upper Triassic, Upper Carnian–Lower Norian; Kotel'nyi Island.

M a t e r i a l. Six specimens from two localities.

Kahlerosphaera acris **Bragin, sp. nov.**

Plate 6, fig. 2

E t y m o l o g y. From the Latin *acer* (sharp).

H o l o t y p e. GIN, no. 7438-06-49; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is regularly spherical. The shell is porous, with irregularly arranged pores, varying in size. The spines are short, Y-shaped in cross section, with superficial grooves and smoothed ridges, without coiling. The apophyses are long, three-bladed in cross section, with pointed ends, deviate from spines at an angle of 60° to the end of spines. The spine ends are narrow, pointed.

M e a s u r e m e n t s in μm. Shell diameter along the line of one spine, 145; spine length, 140.

C o m p a r i s o n. The new species differs from *K. norica* Kozur et Mock in the very short spines and in the apophyses with the three-bladed cross section.

O c c u r r e n c e. Upper Triassic, Upper Carnian; Kotel'nyi Island.

M a t e r i a l. Four specimens from two localities.

Kahlerosphaera isopleura **Bragin, sp. nov.**

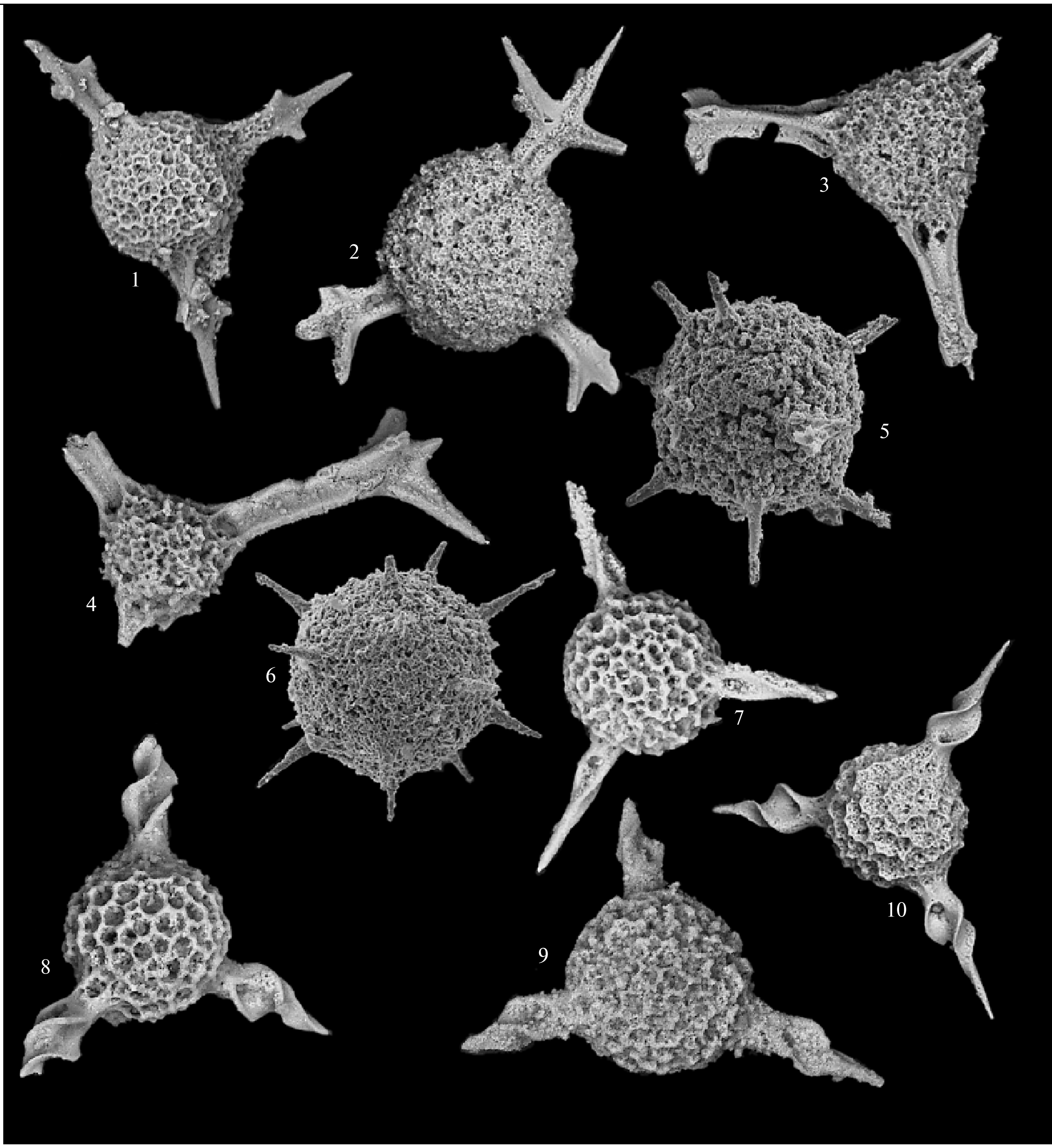
Plate 6, figs. 3 and 4

E t y m o l o g y. From the Greek *isopleuros* (equilateral).

H o l o t y p e. GIN, no. 7438-06-51; Kotel'nyi Island; Upper Triassic, Lower Carnian.

D e s c r i p t i o n. The test is small, rounded triangular in outline. The outer shell is latticed, with small, irregularly arranged pores, enclosed in irregular polygonal frameworks. The spines are long, thick, massive, Y-shaped in cross section, with high narrow ridges and

Plate 6



wide grooves. The apophyses are long, massive, Y-shaped in cross section, deviate from spines at an angle of 60° to short pointed ends of spines.

M e a s u r e m e n t s in µm. Shell diameter, 110–125; spine length, 170; apophysis length, 80.

C o m p a r i s o n. The new species differs from *K. acris* in the rounded triangular shape of the shell and long, massive spines.

O c c u r r e n c e. Upper Triassic, Lower Carnian; Kotel'nyi Island.

M a t e r i a l. Ten specimens from two localities.

Genus *Triassospongosphaera* Kozur et Mostler, 1981

Triassospongosphaera: Kozur and Mostler, 1981, p. 66.

T y p e s p e c i e s. *Spongechinus triassicus* Kozur et Mostler, 1979.

D i a g n o s i s. Spherical forms, with two shells, latticed internal shell and spongy outer shell, with varying number (up to 30) of radial spines.

S p e c i e s c o m p o s i t i o n. Four species from the Middle and Upper Triassic of the Mediterranean–Alpine Region and New Siberian Islands.

C o m p a r i s o n. *Triassospongosphaera* differs from *Carinaheliosoma* Kozur et Mostler, 1981 in the presence of spongy outer shell.

Triassospongosphaera multispinosa (Kozur et Mostler, 1979)

Plate 6, figs. 5 and 6

Acanthosphaera? multispinosa: Kozur and Mostler, 1979, p. 50, pl. 20, fig. 3.

Triassospongosphaera multispinosa: Kozur and Mostler, 1981, p. 67, pl. 58, fig. 3.

H o l o t y p e. Göstling, Austria; Upper Triassic, Lower Carnian (Kozur and Mostler, 1979, pl. 20, fig. 3); collection number and depository are not indicated.

D e s c r i p t i o n. The test is subspherical. The shell is spongy, fine-tuberculate, with many small, irregularly arranged pores. Up to 15 short, narrow, smooth radial spines are present; they are rounded in cross section and have pointed ends. The spines extend from low conical projections of the shell and, hence, the test is smoothed polygonal in outline. The spines are arranged irregularly.

M e a s u r e m e n t s in μm. Shell diameter, 155–160; spine length, 50–60.

C o m p a r i s o n. *T. multispinosa* differs from *T. triassica* (Kozur et Mostler, 1979) in the smoothed polygonal shell and in the greater number of spines.

O c c u r r e n c e. Middle and Upper Triassic, Anisian–Carnian of Austria, Hungary, Slovakia, and Kotel'nyi Island.

M a t e r i a l. Tens specimens from three localities.

Family Capnuchosphaeridae De Wever, 1979

Capnuchosphaeridae: De Wever et al., 1979, p. 81.

D i a g n o s i s. Actinommoidea with spherical or flattened double-layered porous outer shell, with several radial main spines, including tumidaspines, spines with distinct division into three regions. Proximal region of tumidaspines (spinal channel) often hollow. Middle region (spinal tumor) usually having spiral sculpture, with three pores, if spinal channel hollow. Distal region (spinal shaft) relatively narrow. Number of tumidaspines ranging from one to four; in addition, usual spines sometimes present. Spines connected by radial bars to initial shell.

C o m p o s i t i o n. Two subfamilies, Capnuchosphaerinae De Wever, 1982 and Sarlinae De Wever, 1982, from the Upper Triassic.

C o m p a r i s o n. This family differs from other families of Actinommoidea in the presence of tumidaspines.

Subfamily Capnuchosphaerinae De Wever, 1982

Capnuchosphaerinae: De Wever, 1982, p. 149.

D i a g n o s i s. Capnuchosphaeridae with hollow tumidaspines.

G e n e r i c c o m p o s i t i o n. *Capnuchosphaera* De Wever, 1979, *Sarla* Pessagno, 1979, *Plafkerium* Pessagno, 1979, *Icrioma* De Wever, 1979, *Catoma* Blome, 1983, *Weverella* Kozur et Mostler, 1981, *Kinyrosphaera* Bragin, 1999, *Dicapnuchosphaera* Tekin, 1999, *Monocapnuchosphaera* Tekin, 1999, *Paricrioma* Tekin, 1999, and *Braginastrum* Tekin, 1999 in the Ladinian–Norian.

C o m p a r i s o n. This subfamily differs from the Sarlinae De Wever in the presence of cavities in tumidaspines.

Genus *Capnuchosphaera* De Wever, 1979

Capnuchosphaera: De Wever et al, 1979, p. 82.

Divatella: Kozur and Mostler, 1981, p. 75.

T y p e s p e c i e s. *Capnuchosphaera triassica* De Wever, 1979; Sicily; Upper Carnian.

D i a g n o s i s. Outer shell subspherical or discoidal spherical, with three tumidaspines positioned in one plane. Spinal channels thick, hollow. Spinal

E x p l a n a t i o n o f P l a t e 6

Fig. 1. *Kahlerosphaera retunsa* Bragin, sp. nov., holotype GIN, no. 7438-06-48, sample 06-30-1r, Tikhaya River, Upper Triassic, Lower Norian, ×210.

Fig. 2. *Kahlerosphaera acris* Bragin, sp. nov., holotype GIN, no. 7438-06-49, sample 06-17-13r, Pryamaya River, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×210.

Figs. 3 and 4. *Kahlerosphaera isopleura* Bragin, sp. nov. from sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×260: (3) paratype GIN, no. 7438-06-50; (4) holotype GIN, no. 7438-06-51.

Figs. 5 and 6. *Triassospongosphaera multispinosa* (Kozur et Mostler, 1979): (5) GIN, no. 7438-06-52, sample 06-15-1r, Pryamaya River, Middle Triassic, Upper Anisian, ×280; (6) GIN, no. 7438-06-53, sample 06-16-9r, Pryamaya River, Middle Triassic, Upper Ladinian, ×280.

Fig. 7. *Capnuchosphaera deweveri* Kozur et Mostler, 1979, GIN, no. 7438-06-54, sample 06-30-1r, Tikhaya River, Upper Triassic, Lower Norian, ×210.

Figs. 8–10. *Capnuchosphaera kuzmichevi* Bragin, sp. nov.: (8) holotype GIN, no. 7438-06-55, sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×200; (9) GIN, no. 7438-06-56, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×200; (10) paratype GIN, no. 7438-06-57, sample 06-17-13, Sukhoi Creek; Upper Triassic, boundary beds of the Lower and Upper Carnian, ×200.

tumors massive, with three pores, often with spiral surface sculpture. Spinal shafts narrow, varying in length.

Species composition. About 20 species from the Middle Carnian–Middle Norian of the Mediterranean, Japan, Mexico, Oregon, British Columbia, the Far East of Russia, and the Philippines.

Comparison. *Capnuchosphaer*a differs from *Dicapnuchosphaera* Tekin, 1999 in the presence of three tumidaspines, from *Kinyrosphaera* Bragin, 1999 in the development of a porous shell on the proximal parts of tumidaspines.

Capnuchosphaera deweveri Kozur et Mostler, 1979

Plate 6, fig. 7

Capnuchosphaera triassica var. a: De Wever et al., 1979, p. 84, pl. 4, figs. 3–5; Nakaseko and Nishimura, 1979, p. 76, pl. 7, fig. 4.

Capnuchosphaera deweveri: Kozur and Mostler, 1979, p. 77, pl. 10, figs. 2, 4–8; pl. 12, fig. 1; De Wever, 1982, p. 152, pl. 3, figs. 10 and 11; pl. 4, figs. 1 and 2; Blome, 1983, p. 16, pl. 1, figs. 3, 8, 9, 16, and 18; pl. 11, figs. 1, 2, and 16; Blome, 1984, p. 28, pl. 3, fig. 9; Lahm, 1984, p. 81, pl. 14, fig. 7; Yeh, 1990, p. 8, pl. 2, fig. 5; pl. 10, fig. 8; Otsuka et al., 1992, pl. 3, fig. 3; Aita and Sporli, 1994, pl. 6, fig. 3; Bragin and Krylov, 1999, p. 547, text-fig. 4A; Bortolotti et al., 2006, pl. 1, fig. 3; Bragin, 2007, p. 974, pl. 3, figs. 3 and 5.

Non *Capnuchosphaera deweveri*: Tekin, 1999, p. 71, pl. 3, figs. 12 and 13 (=*Kinyrosphaera helicata* Bragin, 1999).

Holotype. Austria, Göstling; Middle Carnian (Kozur and Mostler, 1979, pl. 12, fig. 1); collection number and depository are not indicated.

Description. The test is regularly spherical. The shell is latticed, double-layered; the pores of the external layer are large, irregularly rounded, enclosed in thin irregularly polygonal porous frameworks, with small nodes on articulations. The tumidaspines are long, narrow; spinal tumors have well-pronounced dextral coiling, with large pores. The spinal shafts are narrow.

Measurements in µm. Shell diameter, 115–120; tumidaspine length, up to 110.

Comparison. *C. deweveri* differs from *C. triassica* De Wever, 1979 in the long and narrow tumidaspines, which are longer than the diameter of the outer shell.

Occurrence. Carnian–Lower Norian of Sicily, Greece, Turkey, Austria, Japan, Slovakia, Oregon, New Zealand, the Philippines, Cyprus, and Kotel'nyi Island.

Material. Eighteen specimens from three localities.

Capnuchosphaera kuzmichevi Bragin, sp. nov.

Plate 6, figs. 8–10

Etymology. The species is named in honor of A.V. Kuz'michev, leading expert on the geology of the New Siberian Islands.

Holotype. GIN, no. 7438-06-55; Kotel'nyi Island; Upper Triassic, Upper Carnian.

Description. The test is regularly spherical. The shell is latticed, with large rounded pores, enclosed in regular hexagonal or, less often, pentagonal frameworks, with small nodes on articulations. The tumidaspines are short, the spinal channels are very short and smooth, the spinal tumors are moderately large. The spinal shafts lack a distinct boundary with spinal tumors and gradually narrow towards pointed ends. The spinal tumors and shafts are Y-shaped in cross section, with wide grooves and narrow ridges; they show well-pronounced dextral coiling, up to one complete coil along the spine.

Measurements in µm. Diameter of the outer shell, 115–120; spine length, 100.

Comparison. The new species differs from *C. triassica* De Wever in the regular latticed structure of the external layer of the shell.

Occurrence. Upper Triassic, Upper Carnian; Kotel'nyi Island.

Material. Twenty-five specimens from two localities.

Capnuchosphaera triassica De Wever, 1979

Plate 7, figs. 1–3

Capnuchosphaera triassica: De Wever et al., 1979, p. 84, pl. 3, figs. 14–19; Nakaseko and Nishimura, 1979, p. 76, pl. 7, figs. 5 and 6; De Wever, 1982, p. 159, pl. 6, figs. 5 and 6; pl. 7, figs. 1 and 4; Nishizono et al., 1982, pl. 1, fig. 17; Lahm, 1984, p. 82, pl. 14, figs. 8 and 9; Sato et al., 1986, pl. 16, fig. 13; Yeh, 1990, p. 9, pl. 2, figs. 9, 10, and 16; pl. 3, figs. 5, 10, 14, and 15; Yeh, 1992, pl. 9, fig. 11; Fujii et al., 1993, pl. 3, fig. 14; Halamic and Gorican, 1995, pl. 2, fig. 9; Tekin, 1999, p. 72, pl. 4, figs. 4 and 5; Wang et al., 2002, p. 326, pl. 1, figs. 15–17; Tekin and Goncuoglu, 2007, pl. 2, fig. 15.

Capnuchosphaera n. sp. aff. *triassica*: Kozur and Mostler, 1979, p. 75, pl. 10, fig. 3.

Capnuchosphaera tricornis: Yeh, 1992, pl. 9, fig. 12.

Holotype. Sicily, Monte Cammarata; Upper Carnian (De Wever et al., 1979, pl. 3, figs. 14, 17); stored in the Natural History Museum in Paris; collection number is not indicated.

Description. The test is subspherical, slightly flattened in the plane of tumidaspines. The shell is irregularly latticed, close to a pseudoaulophacoid shell; the pores are very small, arranged irregularly, enclosed in small, irregularly polygonal frameworks, with small thorns on articulations. The tumidaspines are moderately long, with short smooth spinal channels, moderately developed spinal tumors, and gently tapering, pointed spinal shafts. The spinal tumors are Y-shaped in cross section, with wide grooves and very thin, high ridges, with moderately developed dextral coiling, about half coil along the spine.

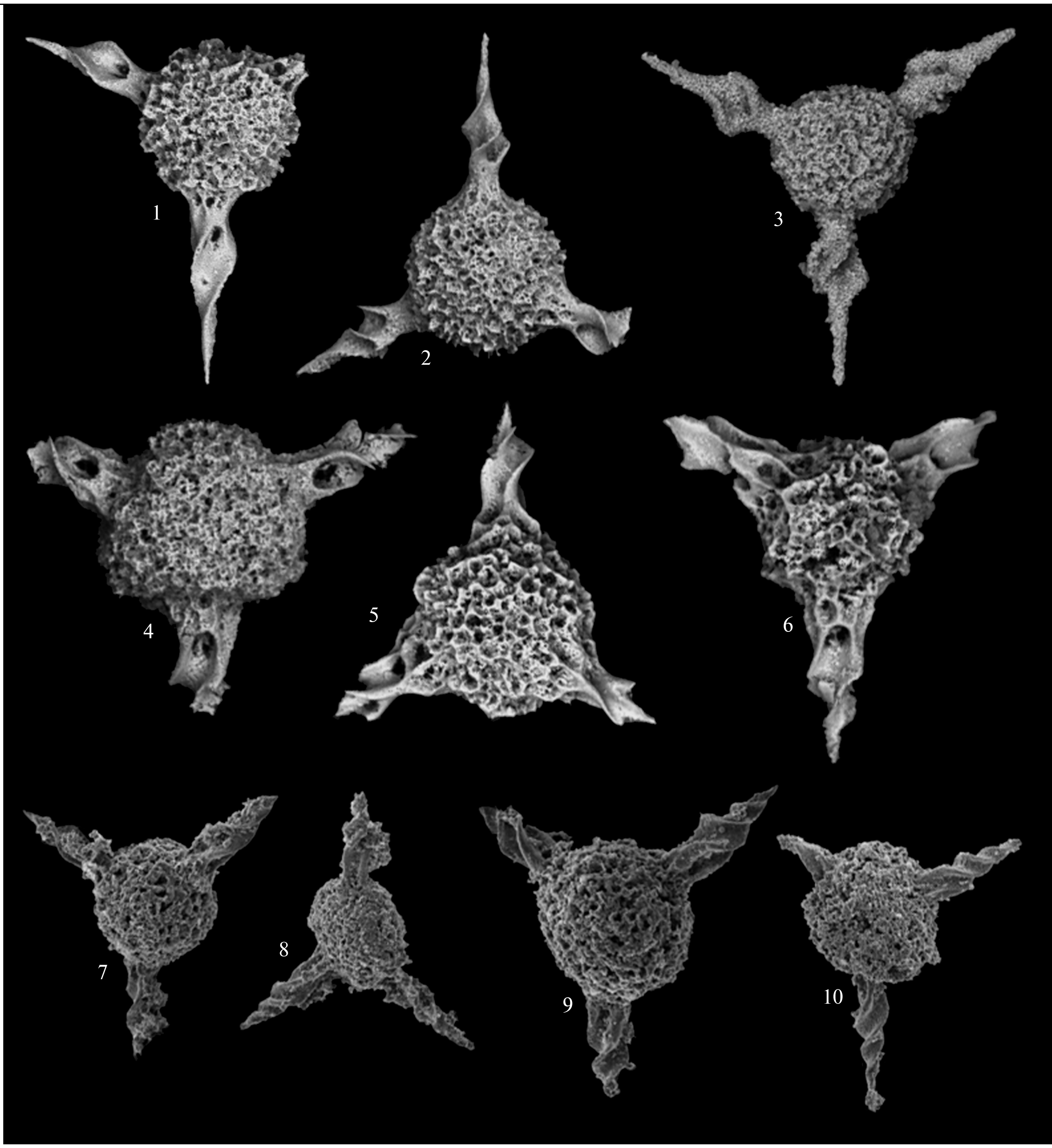
Measurements in µm. Shell diameter, 105–110; spine length, up to 120.

Comparison. *C. triassica* differs from *C. kuzmichevi* in the irregular polygonal, fine-porous external layer of the shell, which resembles in structure pseudoaulophacoid shells.

Occurrence. Lower Carnian–Middle Norian of Greece, Sicily, Turkey, Austria, the Philippines, Japan, Croatia, Tibet, Cyprus, and Kotel'nyi Island.

Material. Eight specimens from two localities.

Plate 7



Explanation of Plate 7

Figs. 1–3. *Capnuchosphaera triassica* De Wever, 1979: (1, 2) sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×190: (1) GIN, no. 7438-06-58, (2) GIN, no. 7438-06-59; (3) GIN, no. 7438-06-60, sample 06-17-12r, Sukhoi Creek; Upper Triassic, boundary beds of the Lower and Upper Carnian, ×180.

Figs. 4–6. *Capnuchosphaera angusta* Bragin, sp. nov.: (4) GIN, no. 7438-06-61, sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×180; (5, 6) sample 06-31-2r, Tikhaya River; Upper Triassic, Upper Carnian, ×180: (5) holotype GIN, no. 7438-06-62, (6) paratype GIN, no. 7438-06-63.

Figs. 7–10. *Sarla cincinnata* Bragin, sp. nov. from sample 06-16-13r, Pryamaya River; Middle Triassic, Upper Ladinian, ×140: (7) holotype GIN, no. 7438-06-64, (8–10) paratypes GIN, nos. 7438-06-65, 7438-06-66, and 7438-06-67.

***Capnuchosphaera angusta* Bragin, sp. nov.**

Plate 7, figs. 4–6

E t y m o l o g y. From the Latin *angustus* (closely packed, narrow, shortened).

H o l o t y p e. GIN, no. 7438-06-62; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is subspherical, slightly flattened in the plane of tumidaspines. The shell is latticed, double-layered; large pores of the external layer are enclosed in irregularly polygonal frameworks with tubercles on articulations. The tumidaspines are very short, thick, Y-shaped in cross section; the pores open close to their bases; the spinal channels are poorly developed; the spinal tumors are poorly pronounced; the spinal shafts are relatively long, with pronounced dextral coiling (up to one complete coil), wide deep grooves, and thin ridges.

M e a s u r e m e n t s in μm. Shell diameter, 120–130; spine length, 65.

C o m p a r i s o n. The new species differs from *C. kuzmichevi* in the very short tumidaspines, poorly developed spinal channels, and in the irregular polygonal structure of the external layer of the shell.

O c c u r r e n c e. Upper Triassic, Upper Carnian; Kotel'nyi Island.

M a t e r i a l. Ten specimens from two localities.

Subfamily Sarlinae De Wever, 1982

Sarlinae: De Wever, 1982, p. 165.

D i a g n o s i s. Capnuchosphaeridae with spines lacking inner cavities.

G e n e r i c c o m p o s i t i o n. Two genera: *Sarla* Pessagno, 1979 and *Braginastrum* Tekin, 1999 in the Upper Triassic.

C o m p a r i s o n. This subfamily differs from the Capnuchosphaerinae De Wever, 1982 in the absence of inner cavities of spines.

Genus *Sarla* Pessagno, 1979

Sarla: Pessagno et al., 1979, p. 174.

T y p e s p e c i e s. *Sarla prietoensis* Pessagno; Mexico; Norian.

D i a g n o s i s. Outer shell subspherical, with three straight radial spines positioned in one plane, lacking inner cavities; with or without spiral coiling.

S p e c i e s c o m p o s i t i o n. Up to 15 species in the Upper Carnian–Norian of Mexico, Oregon, British Columbia, Mediterranean, Japan, and the Far East of Russia.

C o m p a r i s o n. *Sarla* differs from *Braginastrum* Tekin, 1999 in the straight spines.

***Sarla cincinnata* Bragin, sp. nov.**

Plate 7, figs. 7–10

E t y m o l o g y. From the Latin *cincinnatus* (curly, with curly hair).

H o l o t y p e. GIN, no. 7438-06-64; Kotel'nyi Island; Upper Triassic, Lower Carnian.

D e s c r i p t i o n. The test is subspherical, slightly flattened in the plane of spines. The shell is porous, smooth; the pores are small, arranged irregularly. The spines are positioned in one plane, at equal angles to each other, as long as the shell diameter, or slightly longer. The spines are Y-shaped in cross section, with deep grooves and massive ridges, wide and smooth in the proximal part of spines, becoming narrower and pointed distally. From the base to the middle, the spines are thick and massive; beginning from the middle, they gradually decrease in thickness to the pointed ends. The spines show distinct dextral coiling, ranging from one to two complete coils along the spine.

M e a s u r e m e n t s in μm. Diameter of the outer shell, 115–120; spine length, 90–120.

C o m p a r i s o n. The new species differs from *S. transita* (Kozur et Mock) in the dextral coiling of spines.

O c c u r r e n c e. Middle and Upper Triassic, Upper Ladinian–Lower Carnian; Kotel'nyi Island.

M a t e r i a l. More than 30 specimens from one locality.

***Sarla obscura* Bragin, sp. nov.**

Plate 8, figs. 1 and 2

E t y m o l o g y. From the Latin *obscurus* (vague, uncertain).

H o l o t y p e. GIN, no. 7438-06-68; Kotel'nyi Island; Upper Triassic, Lower Carnian.

D e s c r i p t i o n. The test is subspherical, slightly flattened in the plane of spines. The shell is latticed; the pores are enclosed in irregular polygonal frameworks, articulations of which have small high tubercles. The spines are in one plane, at equal angles to each other; equal in length to the shell diameter, or slightly longer. The spines are Y-shaped in cross section, with deep grooves and massive wide smoothed ridges, extending along the entire spine length and slightly narrowing near the pointed ends of spines. The spine thickness is almost constant within the entire spine length, only slightly decreasing towards the end within the distal fourth of the length. The spines show poorly pronounced dextral coiling, up to one-fourth coil along the spine.

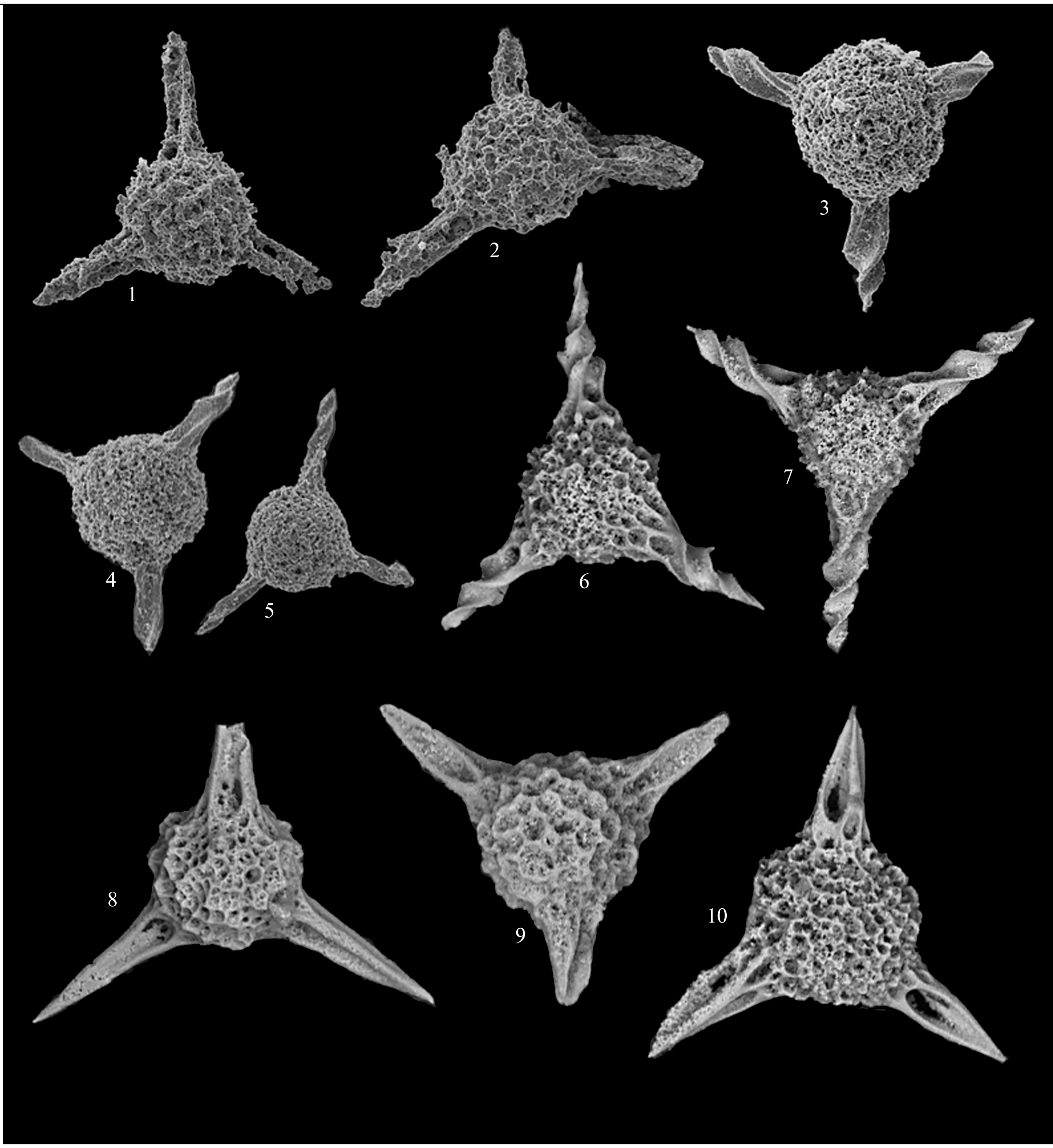
M e a s u r e m e n t s in μm. Diameter of the outer shell, 120–125; spine length, 120–130.

C o m p a r i s o n. The new species differs from *S. cincinnata* in the weak dextral coiling of spines.

O c c u r r e n c e. Middle and Upper Triassic, Upper Ladinian–Lower Carnian; Kotel'nyi Island.

M a t e r i a l. Eight specimens from one locality.

Plate 8



Explanation of Plate 8

Figs. 1 and 2. *Sarla obscura* Bragin, sp. nov. from sample 06-16-13r, Pryamaya River, Middle Triassic, Upper Ladinian, ×200: (1) holotype GIN, no. 7438-06-68 and (2) paratype GIN, no. 7438-06-69.

Figs. 3–5. *Sarla prava* Bragin, sp. nov. from sample 06-16-13r, Pryamaya River, Middle Triassic, Upper Ladinian: (3) holotype GIN, no. 7438-06-70, ×200; (4, 5) paratypes GIN, nos. 7438-06-71 and 7438-06-72, ×170.

Figs. 6 and 7. *Sarla intorta* Bragin, sp. nov. from sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×210: (6) holotype GIN, no. 7438-06-73 and (7) paratype GIN, no. 7438-06-74.

Figs. 8–10. *Sarla compressa* Bragin, sp. nov.: (8) paratype GIN, no. 7438-06-75, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×180; (9) GIN, no. 7438-06-76, sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×210; (10) holotype GIN, no. 7438-06-77, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×210.

Sarla prava **Bragin, sp. nov.**

Plate 8, figs. 3–5

Etymology. From the Latin *pravus* (crooked, wrong, bad).

Holotype. GIN, no. 7438-06-70; Kotel'nyi Island; Upper Triassic, Upper Carnian.

Description. The test is subspherical, slightly flattened in the plane of spines. The shell is fine-tuberculate, porous; the pores are very small, arranged irregularly. Three spines are present, positioned in one plane at angles of (1) 90°–100°, (2) 120°–130°, (3) 130°–150°. The spines are narrow, as long as the shell diameter in the plane of spines or slightly shorter. The spines are Y-shaped in cross section, with deep wide grooves and thin high ridges, with dextral coiling up to one complete coil along the spine.

Measurements in μm. Shell diameter, 100–110; spine length, 90–100.

Comparison. The new species differs from *S. viscainoensis* Pessagno, 1979 in the narrow spines positioned at different angles to each other.

Occurrence. Middle and Upper Triassic, Upper Ladinian–Lower Carnian; Kotel'nyi Island.

Material. Twenty specimens from one locality.

Sarla intorta **Bragin, sp. nov.**

Plate 8, figs. 6 and 7

Etymology. From the Latin *intortus* (twisted, curly).

Holotype. GIN, no. 7438-06-73; Kotel'nyi Island; Upper Triassic, Upper Carnian.

Description. The test is rounded triangular in outline, slightly flattened in the plane of spines. The shell is latticed, with very small irregularly arranged pores, enclosed in irregular polygonal frameworks. At the base of spines, the pores are relatively large, the frameworks are massive. The spines are located in one plane, although positioned at different angles to each other. The spines are Y-shaped in cross section, with wide grooves; the ridges are massive at the spine base, gradually tapering to the distal end. The spines show distinct dextral coiling, more than one coil along the spine.

Measurements in μm. Shell diameter, 130; spine length, 100–105.

Comparison. The new species differs from *S. vetusta* Pessagno, 1979 in the dextral coiling of spines.

Occurrence. Upper Triassic, Upper Carnian; Kotel'nyi Island.

Material. Thirteen specimens from two localities.

Sarla compressa **Bragin, sp. nov.**

Plate 8, figs. 8–10

Etymology. From the Latin *compressus* (dense, strong).

Holotype. GIN, no. 7438-06-77; Kotel'nyi Island; Upper Triassic, Upper Carnian.

Description. The test is subspherical, slightly flattened in the plane of spines. The shell is latticed, slightly tuberculate, with small irregularly arranged pores, enclosed in irregular polygonal frameworks. The spines are straight, moderately long, thick at the base and gradually tapering towards the pointed ends. The spines are Y-shaped in cross section, with deep grooves, which are somewhat wider than ridges. The spines lack distinct spiral coiling.

Measurements in μm. Shell diameter, 100–120; spine length, 105–110.

Comparison. The new species differs from *S. longispinosum* (Kozur et Mostler, 1979) in the short and thicker spines, tuberculate surface of the shell.

Occurrence. Upper Triassic, Upper Carnian; Kotel'nyi Island.

Material. Eighteen specimens from two localities.

Sarla aequipeda **Bragin, sp. nov.**

Plate 9, figs. 1 and 2

Etymology. From the Latin *aequipedus* (isosceles).

Holotype. GIN, no. 7438-06-79; Kotel'nyi Island; Upper Triassic, Upper Carnian.

Description. The test is regularly spherical. The shell is double-layered; the external layer is latticed, with rounded pores varying in size, enclosed in thin polygonal, usually hexagonal, frameworks. The internal layer with smaller pores is visible through pores of the external layer. The spines are moderately long, gradually narrowing from thick bases to pointed ends. The spines are Y-shaped in cross section, with deep grooves, which are somewhat wider than the ridges. Dextral coiling is well pronounced, with approximately 1.5 coils along the spine.

Measurements in μm. Shell diameter, 105; spine length, 105–110.

Comparison. The new species differs from *S. cincinnata* in the regularly spherical shell and regular polygonal latticed external layer of the shell.

Occurrence. Upper Triassic, Carnian; Kotel'nyi Island.

Material. Fourteen specimens from three localities.

Sarla globosa **Bragin, sp. nov.**

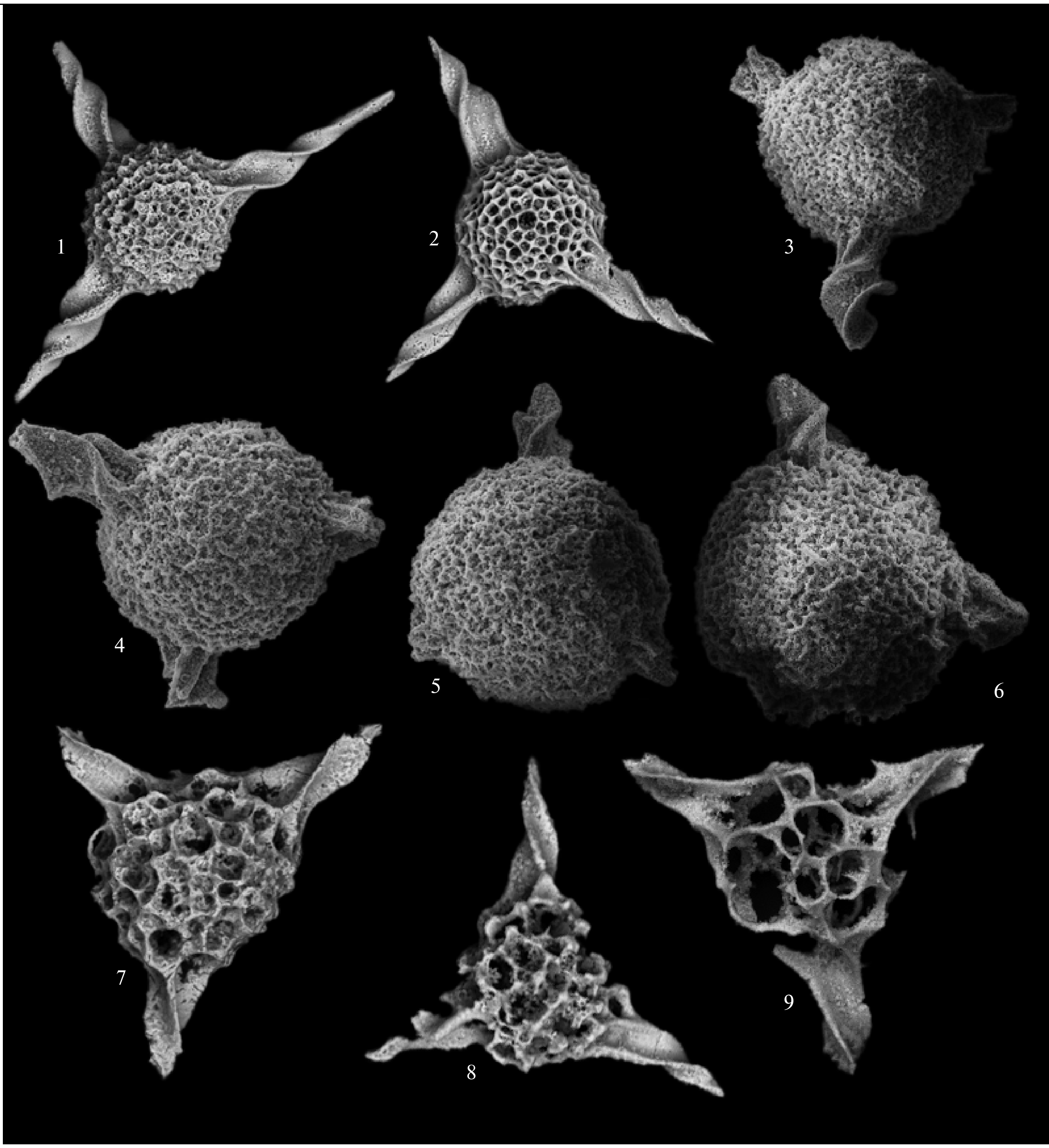
Plate 9, figs. 3–6

Etymology. From the Latin *globosus* (round, spherical).

Holotype. GIN, no. 7438-06-80; Kotel'nyi Island; Upper Triassic, Middle Norian.

Description. The test is large, regularly spherical. The external layer of the shell is spongy, with many small, irregularly arranged pores and many

Plate 9



Explanation of Plate 9

Figs. 1 and 2. *Sarla aequipeda* Bragin, sp. nov., sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×210: (1) paratype GIN, no. 7438-06-78 and (2) holotype GIN, no. 7438-06-79.
Figs. 3–6. *Sarla globosa* Bragin, sp. nov.: (3) holotype GIN, no. 7438-06-80, sample 06-29-1r, Tikhaya River, Upper Triassic, Middle Norian, ×150; (4) paratype GIN, no. 7438-06-81, sample 06-29-1r, Tikhaya River, Upper Triassic, Middle Norian, ×170; (5, 6) sample 06-22r, Balyktakh River, Upper Triassic, Middle Norian, ×170: (5) GIN, no. 7438-06-82, (6) GIN, no. 7438-06-83.
Fig. 7. *Betraccium irregulare* Bragin, 2007, GIN, no. 7438-06-84, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×250.

Figs. 8 and 9. *Betraccium kotelnyensis* Bragin, sp. nov., sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×250: (8) holotype GIN, no. 7438-06-85, (9) paratype GIN, no. 7438-06-86.

small tubercles. The spines are short, very massive, thick, with blunt ends, high massive ridges, and deep grooves, with well-pronounced dextral coiling, approximately one complete coil along the spine.

Measurements in μm. Shell diameter, 250–260; spine length, 90–100; spine thickness, 60.

Comparison. The new species differs from congeners in the spongy structure of the external shell layer and in the short and thick spines.

Occurrence. Upper Triassic, Lower and Middle Norian; Kotel'nyi Island.

Material. Eighteen specimens from two localities.

Family Pantanelliidae Pessagno, 1977

Pantanelliidae: Pessagno, 1977b, p. 32.

Diagnosis. Actinommoidea with spherical microsphere connected by bars to 2–4 main spines with polar or plane positions. Outer shell spherical or subdiscoid, coarse-porous, single-layered, always with well-pronounced porous hexagonal and pentagonal frameworks, with distinct nodes on articulations.

Composition. Upper Triassic–Lower Cretaceous. In the Triassic, the family is represented by two subfamilies, Pantanelliinae Pessagno, 1979 and Capnodocinae Pessagno, 1979.

Comparison. This family is closely similar to Stylosphaeridae Haeckel, 1882 in the character of the primary skeleton, its connection with the main spines, and in the arrangement of the main spines. The only substantial difference is the structure of the outer shell, which has large pores, enclosed in well-pronounced porous frameworks. This difference is probably insufficient for the differentiation of these families, since they may be synonyms. The difference from other families is the polar arrangement of spines.

Subfamily Pantanelliinae Pessagno, 1979

Pantanelliinae: Pessagno et al., 1979, p. 177.

Diagnosis. Pantanelliidae with 2–4 main spines with three-bladed or Y-shaped cross section and without inner cavities, and with spherical outer shell.

Generic composition. Upper Triassic–Lower Cretaceous. In the Triassic, the subfamily is represented by the genera *Betraccium* Pessagno, 1979, *Cantalum* Pessagno, 1979, *Gorgansium* Pessagno et Blome, 1980, and *Pantanellium* Pessagno, 1977.

Comparison. This subfamily differs from Capnodocinae Pessagno, 1979 in the three-bladed spines without inner cavities.

Genus *Betraccium* Pessagno, 1979

Betraccium: Pessagno et al., 1979, p. 177.

Type species. *Betraccium smithi* Pessagno, 1979; Mexico, California Peninsula; Middle–Upper Norian.

Diagnosis. Outer shell subspherical, with three equal spines, Y-shaped in cross section, usually spiral, positioned radially symmetrically in one plane.

Species composition. Five species from the Upper Norian–Rhaetian of Mexico, Oregon, British Columbia, Alaska, the Far East of Russia, Japan, the Philippines, New Zealand, Turkey, and Cyprus. Three species are recorded in the Hettangian of Bavaria.

Comparison. *Betraccium* differs from *Pantanellium* Pessagno, 1977 in the presence of three spines and from *Gorgansium* Pessagno et Blome, 1980 in the symmetrical arrangement and equal size of spines.

Betraccium irregulare Bragin, 2007

Plate 9, fig. 7

Betraccium irregulare: Bragin, 2007, p. 986, pl. 7, figs. 5–7.

Holotype. GIN, 4858-113; Cyprus, Akamas Peninsula; Lower Norian, Phasoula Formation, Mamonia Assemblage.

Description. The outer shell is small, subspherical, slightly flattened, with rounded pores varying in size in pentagonal and hexagonal porous frameworks, varying widely in size. Large frames usually occur at the base of spines, while small frames are concentrated in the middle part of the shell. Continuation of axial lines of spines have up to 8–10 frames. Three spines are moderately long, three-bladed, tapering towards the pointed ends, with well-pronounced sinistral coiling.

Measurements in μm. Shell diameter, 100–110; spine length, 110–125.

Comparison. *B. irregulare* differs from *B. smithi* Pessagno, 1979 in the irregularly arranged porous frameworks, varying widely in size.

Occurrence. Lower Norian of Cyprus, Upper Carnian and Lower Norian of Kotel'nyi Island.

Material. Thirteen specimens from two localities.

Betraccium kotelnyensis Bragin, sp. nov.

Plate 9, figs. 8 and 9

Etymology. From Kotel'nyi Island.

Holotype. GIN, no. 7438-06-85; Kotel'nyi Island; Upper Triassic, Upper Carnian.

Description. The test is subspherical, slightly flattened in the plane of spines. The shell is latticed; the pores are large, enclosed in large irregular hexagonal frameworks, with high bars and distinct tubercles on their articulations. The line continuing the spine has four frameworks. The spines are moderately long, massive, Y-shaped in cross section, with deep grooves, high and thin ridges, with well-pronounced sinistral coiling, up to one coil along the spine.

Measurements in μm. Shell diameter, 80–90; spine length, 85–90.

C o m p a r i s o n. The new species differs from *B. irregulare* Bragin in the smaller number of frameworks, which are larger and only slightly varying in size.

O c c u r r e n c e. Upper Triassic, Upper Carnian; Kotel'nyi Island.

M a t e r i a l. Eight specimens from two localities.

Family Stylosphaeridae Haeckel, 1881

Stylosphaerida: Haeckel, 1881, p. 449; 1887, p. 121.
Stylosphaeridae: Kozur and Mostler, 1979, p. 56.

D i a g n o s i s. Actinommoidea with microsphere connected to two polar main spines. Outer shell spherical or prunoid, fine-porous or spongy.

C o m p o s i t i o n. Two subfamilies, Stylosphaerinae Haeckel, 1881 and Spongopalliinae Kozur, Krainer et Mostler, 1996 from the Middle Triassic–Recent.

C o m p a r i s o n. This family differs from Pantanelliidae Pessagno in the spongy or fine-porous structure of the outer shell.

Subfamily Stylosphaerinae Haeckel, 1881

Stylosphaerida: Haeckel, 1881, p. 449; 1887, p. 121.
Stylosphaerinae: Kozur and Mostler, 1979, p. 56.

D i a g n o s i s. Stylosphaeridae with fine-porous single-layered outer shell, without distinct porous frameworks. Two main polar spines occasionally accompanied by several subsidiary spines.

G e n e r i c c o m p o s i t i o n. Middle Triassic–Recent. Triassic genera are *Spongotortilispinus* Kozur et Mostler, 2007, *Staurolonche* Haeckel, 1881, *Dumitricasphaera* Kozur et Mostler, 1979, *Zhamojdasphaera* Kozur et Mostler, 1979, and *Vinassaspongus* Kozur et Mostler, 1979.

C o m p a r i s o n. The subfamily Stylosphaerinae differs from Spongopalliinae in the porous single-layered outer shell.

Genus *Spongotortilispinus* Kozur et Mostler, 2007

Spongotortilispinus: Kozur et Mostler, 2007, p. 455 (in Moix et al., 2007).

T y p e s p e c i e s. *Spongotortilispinus moixi* Kozur et Mostler, 2007, Turkey; Upper Carnian.

D i a g n o s i s. Outer shell spherical or subspherical, spongy, with two polar spines. Inner cavity present, having small porous shell.

S p e c i e s c o m p o s i t i o n. About 20 species. Middle Triassic–Recent. Triassic representatives are known in the Mediterranean Region, Japan, Sikhote Alin, and British Columbia.

C o m p a r i s o n. *Spongotortilispinus* differs from *Dumitricasphaera* and *Zhamojdasphaera* in the spines uniform in thickness, without apophyses or blades.

Spongotortilispinus carnicus (Kozur et Mostler, 1979)

Plate 10, fig. 1

Spongostylus carnicus: Kozur and Mostler, 1979, p. 58, pl. 9, figs. 5, 6, 8, and 9; 1981, pl. 38, fig. 3; Lahm, 1984, p. 69, pl. 12, fig. 4; Carter et al., 1989, pl. 1, fig. 5; Yeh, 1989, p. 67, pl. 13, fig. 8; Grapes et al., 1990, text-fig. 8O; Halamic and Gorican, 1995, pl. 2, figs. 18 and 19; Knipper et al., 1997, pl. II, fig. 1; Bragin and Krylov, 1999, p. 552, text-fig. 7F; Tekin, 1999, p. 67, pl. 2, figs. 5 and 6; Danelian et al., 2000, fig. 3b; Wang et al., 2002, p. 330, pl. 2, figs. 27 and 28; Bortolotti et al., 2006, pl. 1, fig. 13; Bragin, 2007, p. 989, pl. 8, fig. 4.
Spongostylus aequicurvistylus: Lahm, 1984, p. 69, pl. 12, fig. 5.

H o l o t y p e. Austria, Göstling; Middle Carnian (Kozur and Mostler, 1979, pl. 9, fig. 8); collection number and depository are not indicated.

D e s c r i p t i o n. The outer shell is subspherical, small, spongy. The two main polar spines are long, three-bladed, with well-pronounced dextral coiling. Both spines are curved in the middle part almost at a right angle in the same or opposite directions.

M e a s u r e m e n t s in μm. Shell diameter, 120; length of preserved part of the spine, 120.

C o m p a r i s o n. *S. carnicus* differs from *S. tortilis* (Kozur et Mostler, 1979) in the curved spines.

O c c u r r e n c e. Upper Triassic, Carnian–Lower Norian of Austria, British Columbia, Oregon, New Zealand, Croatia, Transcaucasia, Cyprus, Turkey, Tibet, and the New Siberian Islands.

M a t e r i a l. Three specimens from one locality.

Spongotortilispinus subtilis Bragin, sp. nov.

Plate 10, figs. 2–5

E t y m o l o g y. From the Latin *subtilis* (thin, slender, tapering).

H o l o t y p e. GIN, no. 7438-06-88; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is subspherical, slightly extended along the axis of spines. The shell is spongy, with small and irregularly arranged pores. The spines are Y-shaped in cross section, with wide grooves and very thin high ridges. The spines are long, almost constant in width over two-thirds of the extent, and gradually taper in the last third towards the pointed end. The spines show well-pronounced dextral coiling, which is observed over the entire extent, with more than one, but less than two coils along the spine.

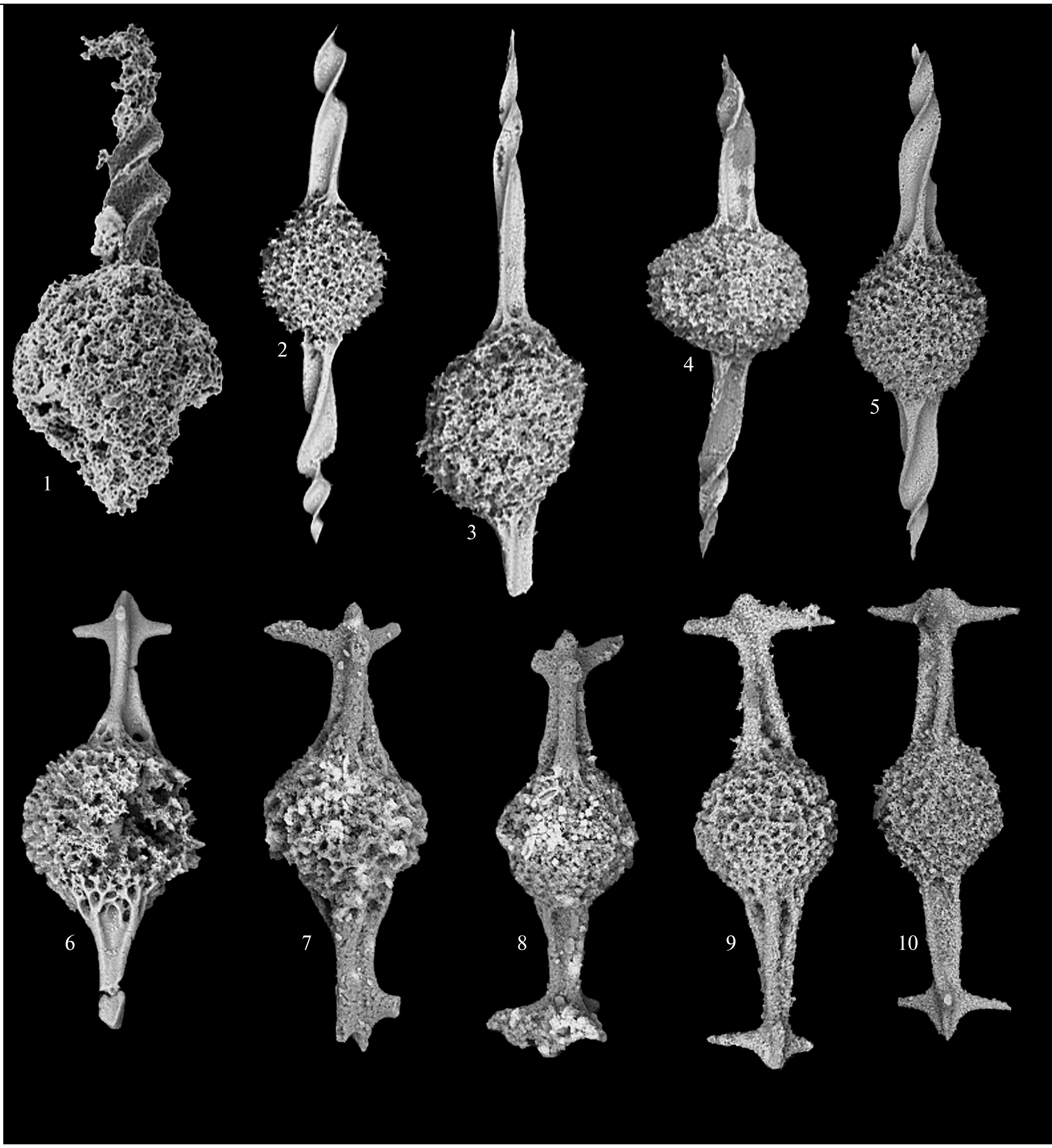
M e a s u r e m e n t s in μm. Shell diameter, 125; spine length, 180–200.

C o m p a r i s o n. The new species differs from *S. tortilis* (Kozur et Mostler, 1979) in the larger shell, smaller spines, and weaker coiling of spines (the last species has two or three coils along the spine). It differs from *S. bosniensis* Tekin et Mostler (Tekin and Mostler, 2005b) in the development of coiling over the entire extent of the spine.

O c c u r r e n c e. Upper Triassic, Upper Carnian of Kotel'nyi Island.

M a t e r i a l. Tens specimens from three localities.

Plate 10



Explanation of Plate 10

Fig. 1. *Spongotortilispinus carnicus* (Kozur et Mostler), GIN, no. 7438-06-87, sample 06-17-13r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×290.

Figs. 2–5. *Spongotortilispinus subtilis* Bragin, sp. nov., sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian: (2) holotype GIN, no. 7438-06-88, ×250; (3–5) paratypes GIN, nos. 7438-06-89, 7438-06-90, and 7438-06-91: (3) ×290 and (4, 5) ×250.

Figs. 6–10. *Dumitricasphaera simplex* Tekin, 1999: (6–8) sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×210: (6) GIN, no. 7438-06-92, (7) GIN, no. 7438-06-93, (8) GIN, no. 7438-06-94; (9, 10) sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×210: (9) GIN, no. 7438-06-95, (10) GIN, no. 7438-06-96.

Genus *Dumitricasphaera* Kozur et Mostler, 1979

Dumitricasphaera: Kozur et Mostler, 1979, p. 60; Lahm, 1984, p. 70.

Type species. *Dumitricasphaera goestlingensis* Kozur et Mostler, 1979; Austria; Middle Norian.

Diagnosis. Outer shell spherical, spongy, with two main polar spines. Main spines straight, with three symmetrically positioned apophyses at ends.

Species composition. Seven species from the Upper Triassic of Austria, Turkey, Cyprus, and the New Siberian Islands.

Comparison. *Dumitricasphaera* differs from *Spongostylus* in the presence of three apophyses at the distal ends of the main spines.

Dumitricasphaera simplex Tekin, 1999

Plate 10, figs. 6–10

Dumitricasphaera simplex: Tekin, 1999, p. 66, pl. 2, text-figs. 1 and 2.

Holotype. Turkey; Upper Triassic, Middle Carnian, (Tekin, 1999, pl. 2, fig. 1); stored in MTA, Ankara; collection number not indicated.

Description. The test is elliptic in outline, slightly extended along the spine axis. The shell is latticed; the pores are small, arranged irregularly, enclosed in small frameworks, which are irregularly polygonal in outline. The spines are moderately long, thick, Y-shaped in cross section, with ridges and grooves of equal width, extending to the apophyses and coiling. The proximal part of the spine is long and thick, about two-thirds of the total length. The apophyses deviate from spines at an angle of 90°; they are rounded in cross section and slightly curved towards the shell surface. The ends of spines are short, Y-shaped in cross section.

Measurements in μm. Shell length without spines, 135–140; spine length, 150–160.

Comparison. *D. simplex* differs from *D. aberrata* Bragin, sp. nov. in the shape of apophyses, which deviate from spines at 90° and curve towards the shell surface.

Occurrence. Upper Triassic, Carnian of Turkey and Kotel'nyi Island.

Material. Twenty specimens from two localities.

Dumitricasphaera aberrata Bragin, sp. nov.

Plate 11, figs. 1–3

Etymology. From the Latin *aberratus* (deviating).

Holotype. GIN, no. 7438-06-98; Kotel'nyi Island; Upper Triassic, Upper Carnian.

Description. The test is regularly spherical. The shell is latticed; the pores are small, rounded, arranged irregularly, enclosed in small thin irregularly polygonal frameworks. The spines are long, narrow, Y-shaped in cross section, with wide grooves, thin ridges, without coiling. The apophyses are narrow and long, deviate from spines at an angle of 60°–70° to the ends of spines; the spine ends are long and narrow.

Measurements in μm. Shell diameter, 110–120; spine length, up to 200.

Comparison. The new species differs from *D. elegans* Bragin, 2007 in the short spines with short straight apophyses, deviating towards the spine end.

Occurrence. Upper Triassic, Upper Carnian; Kotel'nyi Island.

Material. Fourteen specimens from two localities.

Dumitricasphaera arbustiva Bragin, sp. nov.

Plate 11, fig. 4

Etymology. From the Latin *arbustivus* (twisted).

Holotype. GIN, no. 7438-06-100; Kotel'nyi Island; Upper Triassic, Upper Carnian.

Description. The test is regularly spherical. The shell is latticed, slightly tuberculate, with small irregularly arranged pores in small irregularly polygonal frameworks. The spines are long, thick, Y-shaped in cross section, with wide grooves and narrow ridges, and weak sinistral coiling (about one-fourth coil along the spine). The proximal part of the spine long, more than four-fifth of the total spine length. The apophyses deviate from the spine at an angle of 60°–70°; they are thick at the base; distally, they abruptly taper to the pointed ends. The apophyses are smooth and rounded in cross section. Distal to the apophyses, spine ends are undeveloped.

Measurements in μm. Shell diameter, 125; spine length, 180–190.

Comparison. The new species differs from *D. aberrata* in the thick massive spines with sinistral coiling.

Occurrence. Upper Triassic, Upper Carnian; Kotel'nyi Island.

Material. Eight specimens from two localities.

Genus *Zhamojdasphaera* Kozur et Mostler, 1979

Zhamojdasphaera: Kozur and Mostler, 1979, p. 68.

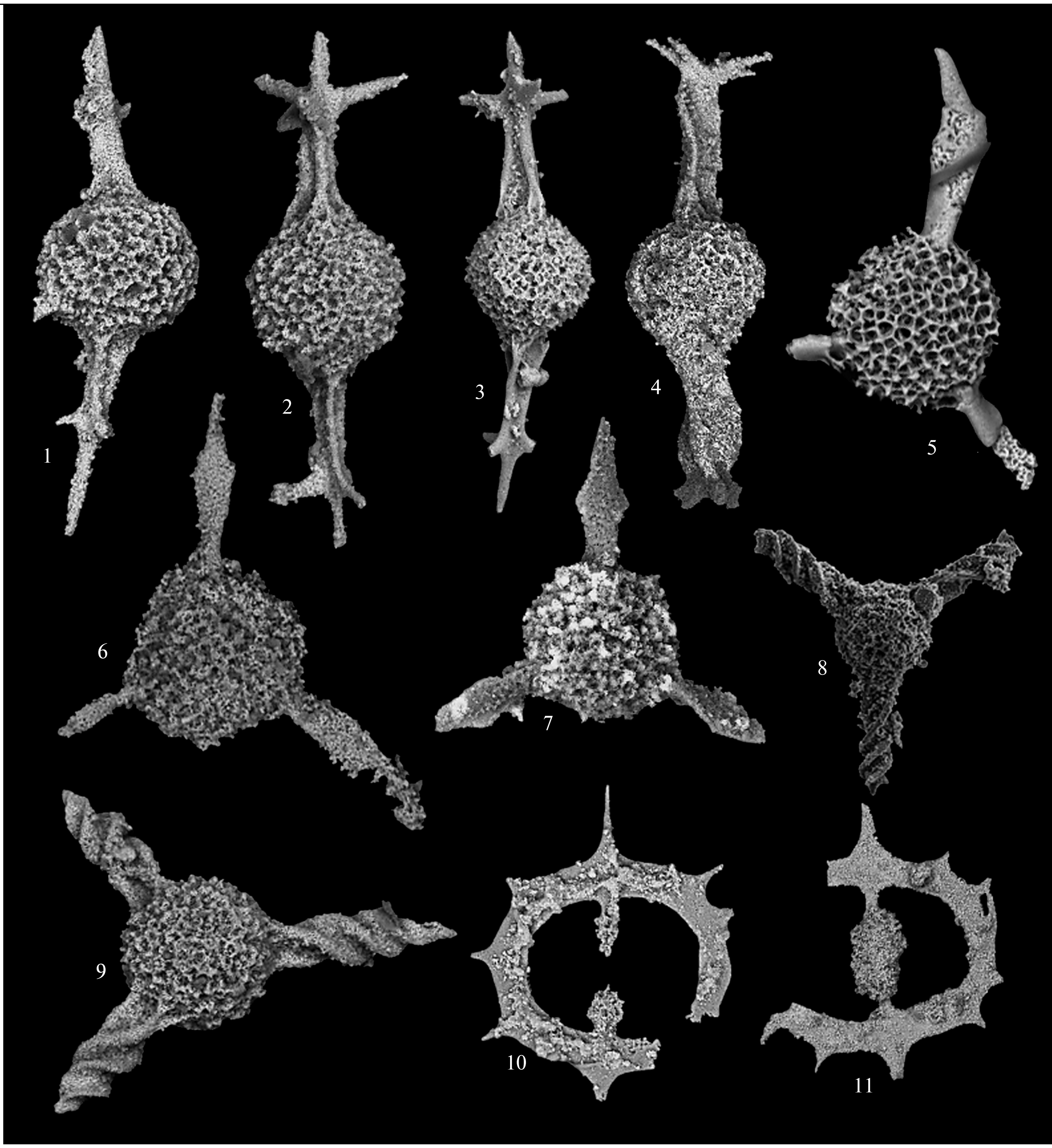
Type species. *Zhamojdasphaera latispinosa* Kozur et Mostler, 1979; Austria; Upper Carnian.

Diagnosis. Outer shell spherical, spongy, with three wide, flat, symmetrically positioned main spines forming blades.

Species composition. Two species from the Upper Carnian of the Mediterranean Region and New Siberian Islands.

Comparison. *Zhamojdasphaera* differs from *Spongotortilispinus* Kozur et Mostler, 2007 in the presence of three flat main spines.

Plate 11



Zhamojdasphaera epipeda **Bragin, sp. nov.**

Plate 11, figs. 5 and 6

E t y m o l o g y. From the Greek *epipedus* (flat, plane).

H o l o t y p e. GIN, no. 7438-06-101; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is regularly discoidal, flattened. The shell is latticed, resembling in structure the pseudoaulophacoid shell; the pores are in polygonal frameworks, varying from hexagonal to triangular, with nodes on articulations. Three spines are positioned in the plane of the discoidal shell. The spines are narrow, flat, smooth, without blades, with poorly developed dextral spiral curvature (about one-fourth coil along the spine).

M e a s u r e m e n t s in μm. Diameter of the outer shell, 115–125; spine length, 160–180.

Comparison. The new species differs from *Z. latispinosa* Kozur et Mostler, 1979 in the narrow spines, which do not form expanding blades.

Occurrence. Upper Triassic, Upper Carnian; Kotel'nyi Island.

Material. Seven specimens from two localities.

Zhamojdasphaera proceruspinosa Lahm, 1984

Plate 11, fig. 7

Zhamojdasphaera proceruspinosa: Lahm, 1984, p. 75, pl. 13, fig. 6; Bragin and Krylov, 1999, p. 547, text-fig. 8E; Bragin, 2007, p. 990, pl. 8, figs. 9 and 10.

Holotype. Slg. Munchen Prot. 3663; Austria, Grossreifling; Middle Carnian (Lahm, 1984, pl. 13, fig. 6); stored in the Institute of Paleontology and Historical Geology, Munich.

Description. The outer shell is relatively small, subspherical, spongy, with three main spines positioned symmetrically. The spines are wide, flat, straight, with narrow, pointed ends.

Measurements in μm. Diameter of the outer shell, 115–125; spine length, 110–140.

Comparison. *Z. proceruspinosa* differs from *Z. latispinosa* Kozur et Mostler, 1979 in the straight spines.

Occurrence. Carnian of Austria, Lower Norian of Cyprus, Upper Carnian–Lower Norian of Kotel'nyi Island.

Material. Six specimens from two localities.

Genus _Vinassaspongus_ Kozur et Mostler, 1979

Vinassaspongus: Kozur and Mostler, 1979, p. 65.

Type species. *Vinassaspongus subsphaericus* Kozur et Mostler, 1979; Austria, Göstling; Upper Triassic, Lower Carnian.

Diagnosis. Shell fine-porous, with three spines Y-shaped in cross section located in one plane.

Species composition. Three species from the Upper Triassic of the Mediterranean Region, Japan, and the New Siberian Islands.

Comparison. *Vinassaspongus* differs from *Zhamojdasphaera* in the Y-shaped cross section of spines.

Vinassaspongus subsphaericus Kozur et Mostler, 1979

Plate 11, figs. 8 and 9

Vinassaspongus subsphaericus: Kozur and Mostler, 1979, p. 66, pl. 3, figs. 5–7, pl. 5, fig. 5; Kido, 1982, pl. 2, fig. 8; Lahm, 1984, p. 73, pl. 13, fig. 2; Gorican and Buser, 1990, p. 160, pl. 2, fig. 6; Tekin, 1999, p. 68, pl. 2, figs. 11 and 12; Tekin and Goncuoglu, 2007, pl. 1, figs. 5 and 6.

Holotype. Austria, Göstling; Upper Triassic, Lower Carnian (Kozur and Mostler, 1979, pl. 3, fig. 5); collection number and depository are not indicated.

Description. The test is subspherical, slightly flattened in the plane of spines. The shell is porous, with small and relatively low tubercles, small irregularly arranged pores rounded in outline. Three spines are positioned in one plane, directed to the apices of an equilateral triangle, moderately long, massive, with constant width within the first two-thirds of the length and gradually narrowing towards the last third to the pointed ends. The spines are Y-shaped in cross section, with deep grooves and high ridges, developed widthwise, with distinct dextral coiling (approximately 1.5 coils along the spine).

Measurements in μm. Shell diameter, 125–130; spine length, up to 190.

Comparison. *V. subsphaericus* differs from *V. erendili* Tekin, 1999 in the smaller shell and the longer spines with coiling uniformly developed along the spine extent.

Occurrence. Middle and Upper Triassic, Upper Ladinian–Upper Carnian of Austria, Japan, Slovenia, Turkey, and Kotel'nyi Island.

Material. Twenty specimens from two localities.

Superfamily Spongodiscoidea Haeckel, 1862

Spongodiscida: Haeckel, 1862, p. 460.
Spongodiscoidea: Petrushevskaya, 1979, p. 110.

Diagnosis. Spumellaria with primary framework of very small skeletal polyhedron, usually with spongy or, less often, porous shell of discoidal, stau-

Explanation of Plate 11

Figs. 1–3. *Dumitricasphaera aberrata* Bragin, sp. nov.: (1) GIN, no. 7438-06-97, sample 06-17-13r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×210. (2, 3) sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian: (2) holotype GIN, no. 7438-06-98, ×210 and (3) paratype GIN, no. 7438-06-99, ×180.

Fig. 4. *Dumitricasphaera arbustiva* Bragin, sp. nov., holotype GIN, no. 7438-06-100, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×210.

Figs. 5 and 6. *Zhamojdasphaera epipeda* Bragin, sp. nov., sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×210: (5) holotype GIN, no. 7438-06-101; (6) paratype GIN, no. 7438-06-102.

Fig. 7. *Zhamojdasphaera proceruspinosa* Kozur and Mostler, 1981, GIN, no. 7438-06-103, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×200.

Figs. 8 and 9. *Vinassaspongus subsphaericus* Kozur et Mostler, 1979: (8) GIN, no. 7438-06-104, sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×180; (9) GIN, no. 7438-06-105, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×250.

Figs. 10 and 11. *Palaeosaturnalis mocki* Kozur et Mostler, 1983, sample 06-30-1r, Tikhaya River, Upper Triassic, Lower Norian, ×220: (10) GIN, no. 7438-06-106 and (11) GIN, no. 7438-06-107.

raxonic, prunoid, or spherical shape, with varying number of spines.

C o m p o s i t i o n. Triassic–Recent. In the Triassic, the superfamily was represented by the families Oertlispongidae Kozur et Mostler, 1980, Saturnalidae Deflandre, 1953, Sponguridae Haeckel, 1862, Orbiculiformidae Pessagno, 1973, and Patulibracchiidae Pessagno, 1971.

C o m p a r i s o n. This superfamily differs from Actinommoidea in the primary framework in the shape of a skeletal polyhedron.

Family Saturnalidae Deflandre, 1953

Saturnalidae: Deflandre, 1953, p. 419.

D i a g n o s i s. Spongodiscoidea with spongy, multilayer discoidal outer shell, with porous polyhedral microsphere in center. Sometimes (in Late Mesozoic and Cenozoic taxa), microsphere enclosed in another porous shell; in this case, external spongy shell may be reduced. Two (less often three, four, or more) main spines present, with their distal parts forming lateral projections connected into saturnalid ring. Varying numbers of subsidiary spines and external rays occasionally formed.

C o m p o s i t i o n. Subfamilies Parasaturnalinae Kozur et Mostler, 1972, Pseudacanthocircinae Kozur et Mostler, 1990, Saturnalinae Deflandre, 1953, and Veghicycliinae Kozur et Mostler, 1972; Carnian–Recent.

C o m p a r i s o n. The family Saturnalidae differs from Oertlispongidae in the ring formed by projections of the main spines.

Subfamily Parasaturnalinae Kozur et Mostler, 1972

Parasaturnalinae: Kozur and Mostler, 1972, p. 42.
Parasaturnalidae: Kozur and Mostler, 1983, p. 13.

D i a g n o s i s. Saturnalidae with flat, wide, rounded or polygonal ring, with two main spines or, less often, with greater number of spines, with or without subsidiary spines. External margin of saturnalid ring usually with many external rays; infrequently with two rays or without rays. Outer shell subspherical, spongy, multilayered.

G e n e r i c c o m p o s i t i o n. Carnian–Recent. In the Upper Triassic, the subfamily is represented by the genera *Palaeosaturnalis* Donofrio et Mostler, 1978, *Pseudoheliodiscus* Kozur et Mostler, 1981, *Heliosaturnalis* Kozur et Mostler, 1983, *Praemesosaturnalis* Kozur et Mostler, 1983, *Mesosaturnalis* Kozur et Mostler, 1983, *Praehexasaturnalis* Kozur et Mostler, 1983, *Stauracanthocircus* Kozur et Mostler, 1983, and *Liassosaturnalis* Kozur et Mostler, 1990.

C o m p a r i s o n. The subfamily Parasaturnalinae differs from the family Veghicyclinae in the compact ring without pores.

Genus *Palaeosaturnalis* Donofrio et Mostler, 1978

Palaeosaturnalis: Donofrio and Mostler, 1978, p. 33.

T y p e s p e c i e s. *Spongosaturnalis triassicus* Kozur et Mostler, 1972; Austria, Göstling; Middle Carnian.

D i a g n o s i s. Saturnalid ring single, with two main spines in polar positions, with many external rays. Subsidiary spines absent.

S p e c i e s c o m p o s i t i o n. About 20 species from the Upper Triassic and Lower Jurassic of the Mediterranean Region, Japan, and the Far East of Russia.

C o m p a r i s o n. *Palaeosaturnalis* differs from *Praehexasaturnalis* in the absence of subsidiary spines.

Palaeosaturnalis mocki Kozur et Mostler, 1983

Plate 11, figs. 10 and 11

Palaeosaturnalis mocki: Kozur and Mostler, 1983, p. 21, pl. 5, fig. 2; Bragin and Krylov, 1999, p. 556, figs. 9G and 9H; Tekin, 1999, p. 110, pl. 17, fig. 3; Bragin, 2007, p. 994, pl. 9, fig. 7.

H o l o t y p e. T 5843; Slovakia, village of Sulov; Lower Norian (Kozur and Mostler, 1983, pl. 5, fig. 2); depository not indicated.

D e s c r i p t i o n. The saturnalid ring is wide, regularly circular, with narrow main spines and 6–8 narrow, moderately long, symmetrically positioned external rays.

M e a s u r e m e n t s in μm. Saturnian ring diameter, 220–240; length of the main spines, 40–50; length of external rays, 50–80.

C o m p a r i s o n. *P. mocki* differs from *P. latiannulatus* Kozur et Mostler, 1983 in the greater number of external rays.

O c c u r r e n c e. Lower Norian of Slovakia, Cyprus, Turkey, and Kotel'nyi Island.

M a t e r i a l. Three specimens from one locality.

Palaeosaturnalis triassicus (Kozur et Mostler, 1972)

Plate 12, fig. 1

Spongosaturnalis triassicus: Kozur and Mostler, 1972, p. 40, pl. 1, fig. 10; pl. 4, figs. 1 and 2.

Non *Spongosaturnalis triassicus*: De Wever et al., 1979, p. 81, pl. 2, fig. 2.

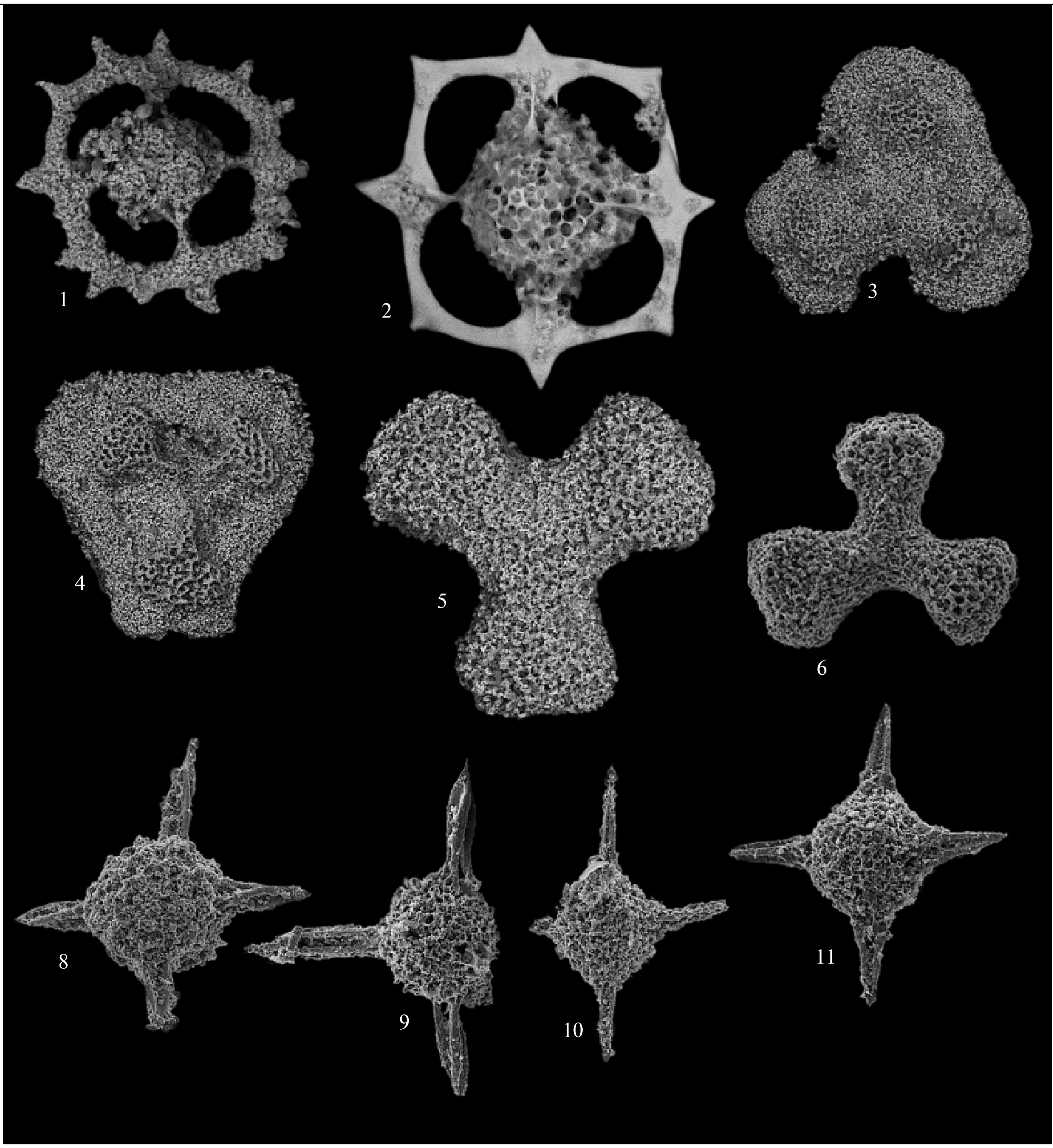
Non *Acanthocircus triassicus*: De Wever, 1982, p. 207, pl. 13, fig. 10.

Palaeosaturnalis triassicus: Kozur and Mostler, 1981, p. 55; Kozur and Mostler, 1983, pl. 6, fig. 2; Lahm, 1984, p. 97, pl. 17, fig. 11; Dozstaly, 1993, pl. 4, fig. 1; Bragin and Krylov, 1999, p. 555, figs. 9A, 9B, and 9E; Tekin, 1999, pl. 17, figs. 6 and 7; Wang et al., 2002, p. 329, pl. 1, figs. 1–3; Tekin and Goncuoglu, 2007, pl. 3, fig. 24; Bragin, 2007, p. 993, pl. 9, figs. 2 and 3.

H o l o t y p e. Austria, Göstling; Middle Carnian (Kozur and Mostler, 1972, pl. 4, fig. 2); collection number and depository are not indicated.

D e s c r i p t i o n. The saturnalid ring is wide, circular or slightly ovate, with 14–16 moderately long rays, widened at the base and gently narrowing to the slightly pointed ends, which are positioned symmetrically rela-

Plate 12



Explanation of Plate 12

Fig. 1. *Palaeosaturnalis triassicus* Kozur et Mostler, 1972, GIN, no. 7438-06-108, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×220.

Fig. 2. *Stauracanthocircus folium* Bragin, sp. nov., holotype GIN, no. 7438-06-109, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×350.

Figs. 3 and 4. *Paronaella concreta* Bragin, sp. nov., sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×220: (3) paratype GIN, no. 7438-06-110, (4) holotype GIN, no. 7438-06-111.

Figs. 5 and 6. *Paronaella aquilonia* Bragin, sp. nov.: (5) holotype GIN, no. 7438-06-112, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×220; (6) GIN, no. 7438-06-113, sample 06-30-1r, Tikhaya River, Upper Triassic, Lower Norian, ×180.

Figs. 7 and 8. *Tetraspongodiscus hibernus* Bragin, sp. nov., sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian, ×150: (7) holotype GIN, no. 7438-06-114, (8) paratype GIN, no. 7438-06-115.

Figs. 9 and 10. *Tetraspongodiscus borealis* Bragin, sp. nov., sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian, ×150: (9) paratype GIN, no. 7438-06-116, (10) holotype GIN, no. 7438-06-117.

tive to the main spines. Sometimes, the rays located on the axis of the main spines are longer than the others.

Measurements in μm. Diameter of the ring without external rays, 150–190; length of the main spines, 40–50; length of external rays, 60–90.

Comparison. *P. triassicus* differs from *P. dumitricai* Tekin, 1999 in the large number of the longer external rays; it differs from *P. hugluensis* Tekin, 1999 in the narrower ring and the narrower bases of the external rays.

Occurrence. Carnian–Lower Norian of Austria, Sicily, Hungary, Cyprus, Turkey, Tibet, and Kotel'nyi Island.

Material. Two specimens from one locality.

Genus *Stauracanthocircus* Kozur et Mostler, 1983

Stauracanthocircus: Kozur and Mostler, 1983.

Type species. *Pseudoheliodiscus concordis* De Wever, 1981, Lower Jurassic of Turkey.

Diagnosis. Saturnalid ring single, with two main polar spines and 2–4 symmetrically positioned subsidiary spines, with 4–6 external rays.

Composition. About 12 species from the Upper Triassic and Lower Jurassic.

Comparison. *Stauracanthocircus* differs from *Palaeosaturnalis* in the presence of 2–4 symmetrically positioned subsidiary spines.

Stauracanthocircus folium Bragin, sp. nov.

Plate 12, fig. 2

Etymology. From the Latin *folium* (leaf).

Holotype. GIN, no. 7438-06-109; Kotel'nyi Island; Upper Triassic, Lower Carnian.

Description. The test is very small, spongy, with large, irregularly arranged pores. The saturnalid ring is thin, regularly square in outline, with two main and two subsidiary spines directed from the shell to the middle of sides of the square saturnalid ring. Eight external rays are present; large rays coincide in direction with the main and subsidiary spines, small rays deviate from the apices of the square saturnalid ring.

Measurements in μm. Length of side of square saturnian ring, 110–120; length of large external rays, up to 20.

Comparison. The new species differs from *S. quadratus* Kozur et Mostler, 1990 in the equal size of the main and subsidiary spines and in the presence of eight instead of six external rays.

Occurrence. Upper Triassic, Lower Carnian; Kotel'nyi Island.

Material. Two specimens from one locality.

Family Patulibracchiidae Pessagno, 1971

Patulibracchiinae: Pessagno, 1971, p. 22.
Patulibracchiidae: Baumgartner et al., 1995, p. 26.

Diagnosis. Spongodiscoidea with spongy discoidal shell, with stauraxonic projections formed of spongy tissue and lacking internal rays or main spines. Bracchiopyle occasionally present.

Generic composition. Upper Triassic–Upper Cretaceous. In the Triassic, the family is represented by the genera *Bistarkum* Yeh, 1987, *Paronaella* Pessagno, 1971, *Triassocrucella* Kozur, 1984, and *Paratriassoastrum* Kozur et Mostler, 1981.

Comparison. The family Patulibracchiidae differs from Orbiculiformidae in the absence of rays inside stauraxonic projections.

Genus *Paronaella* Pessagno, 1971

Paronaella: Pessagno, 1971, p. 46.

Type species. *Paronaella solanoensis* Pessagno, 1971; California; Upper Cretaceous.

Diagnosis. Shell spongy, with three stauraxonic projections. Ends of rays either tapering or inflated, widened.

Species composition. Several tens species from the Upper Triassic–Upper Cretaceous throughout the world.

Comparison. *Paronaella* differs from *Bistarkum* in the presence of three stauraxonic projections of the shell.

Paronaella concreta Bragin, sp. nov.

Plate 12, figs. 3 and 4

Etymology. From the Latin *concretus* (grown together, fused, compacted).

Holotype. GIN, no. 7438-06-111; Kotel'nyi Island; Upper Triassic, Upper Carnian.

Description. The test is equilateral triangle in outline, with blunted–rounded apices. The central part of the shell has three rays marked by higher relief and terminating into rounded inflated ends, which are also elevated above the marginal parts of the shell, which are a considerably expanded patagium. The shell is spongy, with very small pores in the region of the patagium; in the region of rays, particularly at their ends, the pores are larger, varying in shape.

Measurements in μm. Shell diameter with the patagium along one ray, 320–330; ray length, 120; width of the ray ends, 110–115.

Comparison. The new species differs from *P. aquilonia* in the development of the patagium and considerable thickening of the ray ends.

Occurrence. Upper Triassic, Upper Carnian; Kotel'nyi Island.

Material. Eight specimens from two localities.

Paronaella aquilonia **Bragin, sp. nov.**

Plate 12, figs. 5 and 6

E t y m o l o g y. From the Latin *aquilonius* (northern).

H o l o t y p e. GIN, no. 7438-06-112; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is stauraxonic, with three relatively short thick rays, gradually expanding from the base and terminating into wide, slightly inflated, truncate or slightly rounded ends. The rays are uniform in length and vary in width in a series of specimens. The rays are directed to the apices of an equilateral triangle, but some specimens show slight deviations (slightly greater or lesser than 120°). The shell is spongy, with small, irregularly arranged pores; at the ray ends of some specimens, the pores are larger. Subsidiary spines, patagium, and tholus are absent.

M e a s u r e m e n t s in μm. Shell diameter along one ray, 190–200; maximum ray width, 100–130; ray length, 130–140.

C o m p a r i s o n. The new species differs from *P. concreta* in the absence of patagium and the less inflated ray ends.

O c c u r r e n c e. Upper Triassic, Upper Carnian and Lower Norian; Kotel'nyi Island.

M a t e r i a l. Tens specimens from three localities.

Family Relindellidae Kozur et Mostler, 1980

Relindellidae: Kozur and Mostler, 1980 (in Dumitrica et al., 1980), p. 8.

D i a g n o s i s. Discoidal taxa with spongy or latticed shell, with microsphere in center of shell, with 4–6 large main spines positioned in one plane deviating from microsphere.

G e n e r i c c o m p o s i t i o n. *Relindella* Kozur et Mostler, 1980, *Pentaspongodiscus* Kozur et Mostler, 1979, and *Tetraspongodiscus* Kozur et Mostler, 1979.

C o m p a r i s o n. The family Relindellidae differs from Orbiculiformidae Pessagno, 1973 in the obligatory development of large main spines.

Genus *Tetraspongodiscus* Kozur et Mostler, 1979

Tetraspongodiscus: Kozur and Mostler, 1979, p. 80.

T y p e s p e c i e s. *Tetraspongodiscus longispinosus* Kozur et Mostler, 1979; Austria, Göstling; Upper Triassic, Lower Carnian.

D i a g n o s i s. Shell discoidal, with four main spines, positioned crosswise in one plan.

S p e c i e s c o m p o s i t i o n. Four species from the Middle and Upper Triassic.

C o m p a r i s o n. *Tetraspongodiscus* differs from *Pentaspongodiscus* in the development of only four main spines.

Tetraspongodiscus hibernus **Bragin, sp. nov.**

Plate 12, figs. 7 and 8

E t y m o l o g y. From the Latin *hibernus* (winter, cold).

H o l o t y p e. GIN, no. 7438-06-114; Kotel'nyi Island; Middle Triassic, Upper Anisian.

D e s c r i p t i o n. The test is small, subspherical, strongly flattened in the plane of spines. The shell is latticed; the pores are small, arranged irregularly and enclosed in irregular polygonal frameworks, with massive tubercles on articulations. Four spines are positioned crosswise in one plane. The spines are Y-shaped in cross section, moderately long, with wide and deep grooves and thin high ridges, with poorly pronounced sinistral coiling, about 0.5 coils along the spine.

M e a s u r e m e n t s in μm. Maximum diameter of the outer shell, 120; spine length, 70–80.

C o m p a r i s o n. The new species differs from *T. borealis* in the spines with poorly pronounced sinistral coiling.

O c c u r r e n c e. Middle Triassic, Upper Anisian; Kotel'nyi Island.

M a t e r i a l. Twelve specimens from two localities.

Tetraspongodiscus borealis **Bragin, sp. nov.**

Plate 12, figs. 9 and 10

E t y m o l o g y. From the Greek *Boreas* (northern wind).

H o l o t y p e. GIN, no. 7438-06-117; Kotel'nyi Island; Middle Triassic, Upper Anisian.

D e s c r i p t i o n. The test is small, rounded subsquare in outline, flattened in the plane of spines. The shell is latticed; the pores are small, enclosed in thin hexagonal or, less often, pentagonal frameworks without distinct tubercles on articulations. The spines deviating from the apices of the subsquare shell are Y-shaped in cross section, moderately long, with relatively shallow grooves and relatively low ridges equal in width and having pointed ends. The spines lack spiral coiling.

M e a s u r e m e n t s in μm. Diagonal of the shell square, 100; spine length, 60–70.

C o m p a r i s o n. The new species differs from *T. hibernus* in the straight spines without spiral coiling.

O c c u r r e n c e. Middle Triassic, Upper Anisian; Kotel'nyi Island.

M a t e r i a l. Twenty-two specimens from two localities.

Tetraspongodiscus uncatus **Bragin, sp. nov.**

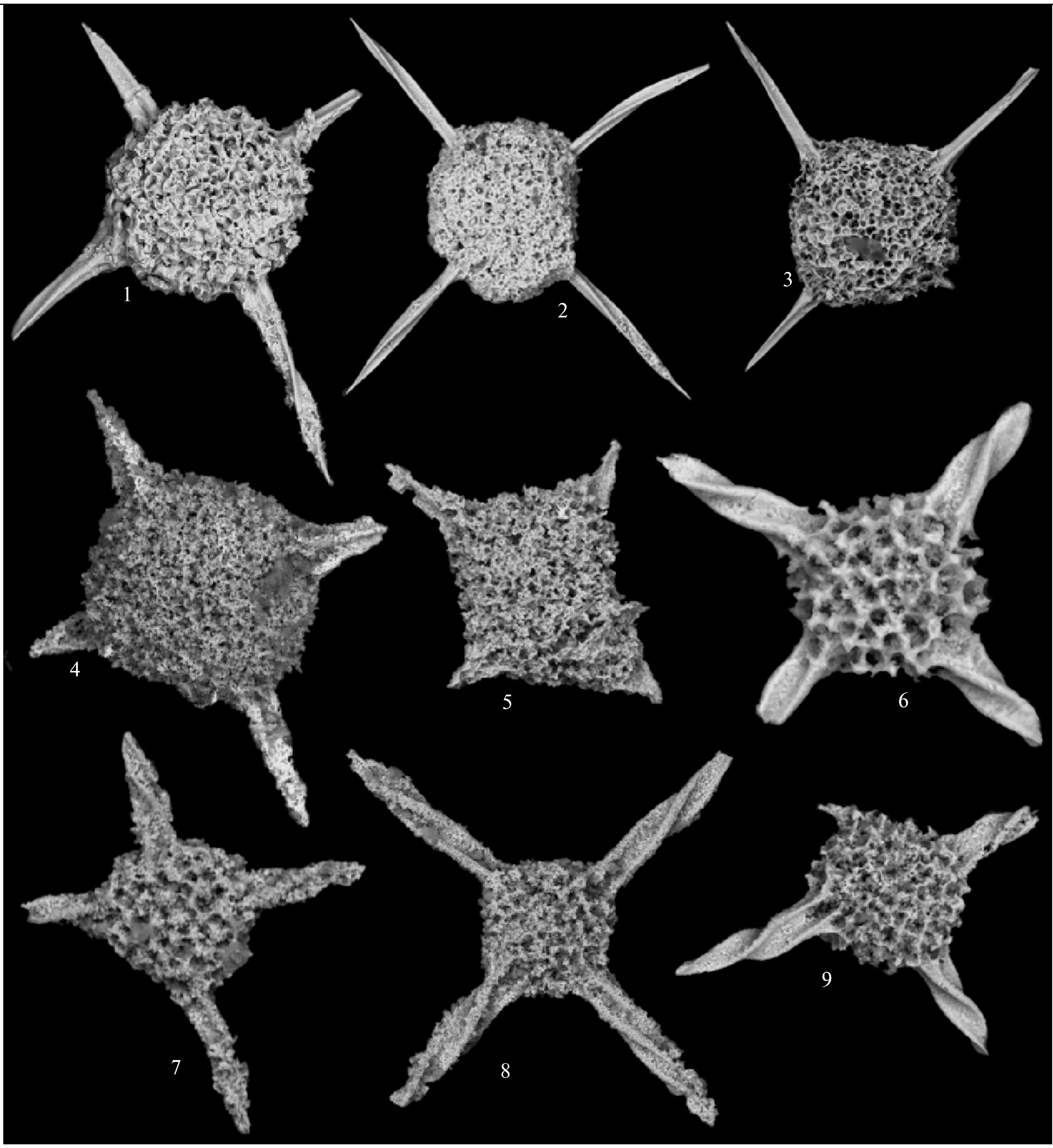
Plate 13, figs. 1–5

E t y m o l o g y. From the Latin *uncatus* (curved).

H o l o t y p e. GIN, no. 7438-06-118; Kotel'nyi Island; Upper Triassic, Lower Carnian.

D e s c r i p t i o n. The test is discoidal, rounded square in outline. The shell is spongy, with small,

Plate 13



Explanation of Plate 13

Figs. 1–5. *Tetraspongodiscus uncatus* Bragin, sp. nov.: (1) holotype GIN, no. 7438-06-118, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×220; (2, 3) sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×180: (2) paratypes GIN, no. 7438-06-119, (3) GIN, no. 7438-06-120; (4, 5) sample 06-8-2r, Tikhaya River, Upper Triassic, Lower Carnian, ×220: (4) GIN, no. 7438-06-121, (5) GIN, no. 7438-06-122.

Figs. 6–9. *Tetraspongodiscus cincinnalis* Bragin, sp. nov., sample 06-17-12, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian: (6) holotype GIN, no. 7438-06-123, ×250; (7–9) paratypes, ×180: (7) GIN, no. 7438-06-124, (8) GIN, no. 7438-06-125, and (9) GIN, no. 7438-06-126.

rounded, irregularly arranged pores. Four spines are positioned crosswise at equal angles to each other. All spines deviate from the apices of the rounded square shell. The spines are Y-shaped in cross section, as long as the diagonal diameter of the shell; the grooves of spines are shallow, the ridges are very thin. The spines are narrow, uniform in width up to the last fourth of the spine extent; further distally, they gradually taper to the pointed ends; some spines are slightly curved. All spines show moderate dextral coiling, at most half coil along the spine.

M e a s u r e m e n t s in μm. Shell diameter along diagonal, 180–190; spine length, 180–190.

C o m p a r i s o n. The new species differs from *Tetraspongodiscus cincinnalis* in the dextral coiling of spines and from *T. nazarovi* (Kozur et Mostler, 1981) in the weaker coiling, at most half coil.

O c c u r r e n c e. Upper Triassic, Lower Carnian of Kotel'nyi Island.

M a t e r i a l. Tens specimens from three localities.

Tetraspongodiscus cincinnalis Bragin, sp. nov.

Plate 13, figs. 6–9

E t y m o l o g y. From the Latin *cincinnalis* (twisted).

H o l o t y p e. GIN, no. 7438-06-123; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is discoidal, subsquare in outline. The shell is latticed, with rounded pores enclosed in irregular frameworks, which are usually hexagonal, arranged irregularly, with small nodes on articulations. Four spines are positioned crosswise in one plane at different angles to each other. All spines deviate from the apices of the shell with square outline. The spines are moderately thick, as long as the shell diagonal or longer, Y-shaped in cross section; the ends gently taper and are pointed; the grooves of spines are wide and deep; the ridges are narrow. All spines show well-pronounced sinistral coiling, up to one complete coil along the spine.

M e a s u r e m e n t s in μm. Shell diameter along diagonal, 80–100; spine length, 70–120.

C o m p a r i s o n. The new species differs from *T. nazarovi* (Kozur and Mostler, 1981) in the spines with well-pronounced sinistral coiling.

O c c u r r e n c e. Upper Triassic, Upper Carnian of Kotel'nyi Island.

M a t e r i a l. Eighteen specimens from two localities.

Order Nassellaria Ehrenberg, 1875

D i a g n o s i s. Polycystina with primary skeleton in shape of considerably differentiated spicule, with elements MB (median bar), A (apical spine), Vert (vertical spine), D (dorsal spine), L (large lateral spines), and l (small lateral spines). Elements of spicule located in different planes. Spicule always confined to first chamber of skeleton (cephalis). One, two, three, several, or many chambers present on axis of skeleton, according to linear mode of growth, with formation of true metamerism.

C o m p o s i t i o n. Triassic–Recent. In the Triassic, the order is represented by the families Eptingiidae Dumitrica, 1978, Tripedurnulidae Dumitrica, 1991, Sanfilippoellidae Kozur et Mostler, 1979, Hinedorcidae Kozur et Mostler, 1981, Ultranaporidae Pessagno, 1977, Pseudosaturniformidae Kozur et Mostler, 1979, Spongolophophaenidae Kozur et Mostler, 1994, Deflandrecyrtiidae Kozur et Mostler, 1979, Monicastericidae Kozur et Mostler, 1994, Syringocapsidae Foreman, 1973, Parvicingulidae Pessagno, 1977, Tetraspinocyrtiidae Kozur et Mostler, 1994, Triassocampidae Kozur et Mostler, 1981, Planispinocyrtidae Kozur et Mostler, 1981, and Bulbocyrtidae Kozur et Mostler, 1981.

C o m p a r i s o n. Nassellaria differs from Entactinaria in differentiated elements of the spicule and in the linear mode of growth of the shell.

R e m a r k s. In the system Recent and Cenozoic Nassellaria, a number of superfamilies were established. It is rather difficult to recognize relationships between them and Triassic nassellarians because the cephalic structures are insufficiently understood. Therefore, this review only considers the families of Triassic nassellarians, some of which are obviously artificial taxa.

Family Eptingiidae Dumitrica, 1978

Eptingiidae: Dumitrica, 1978, p. 29.

D i a g n o s i s. Nassellaria with skeleton composed of cephalis with internal spicule having sagittal ring and well-developed spines A, Lr, and Ll, giving rise to three large external spines positioned in one plane. Spine D sometimes reduced. Outer shell discoidal–stauraxonic.

G e n e r i c c o m p o s i t i o n. *Eptingium* Dumitrica, 1978, *Cryptostephanidium* Dumitrica, 1978, *Triassistephanidium* Dumitrica, 1978, *Spongostephanidium* Dumitrica, 1978, *Pylostephanidium* Dumitrica, 1978, *Busuanga* Yeh, 1990, and *Tetrarhopalus* Sugiyama, 1992 from the Olenekian–Rhaetian.

C o m p a r i s o n. The family Eptingiidae differs from Sanfilippoellidae in the presence of the sagittal ring of the spicule and in the discoidal–stauraxonic shape of the shell.

Genus *Eptingium* Dumitrica, 1978

Eptingium: Dumitrica, 1978, p. 32.

T y p e s p e c i e s. *Eptingium manfredi* Dumitrica, 1978b; Italy, southern Alpes, Recoaro; Middle Triassic, Lower Ladinian, Buchenstein Formation.

D i a g n o s i s. All elements of primary skeleton enclosed inside cephalic cavity. Aperture positioned between apical horn and one of spines formed by lateral elements of spicule.

S p e c i e s c o m p o s i t i o n. Three species occur in the Middle Triassic (Anisian–Ladinian) of the Mediterranean Region, Japan, the Far East of Russia, and the Philippines. Two species occur in the Upper Triassic (Rhaetian) of British Columbia.

Eptingium abditum Bragin, sp. nov.

Plate 14, figs. 1 and 4

E t y m o l o g y. From the Latin *abditus* (concealed, disguised).

H o l o t y p e. GIN, no. 7438-06-128; Kotel'nyi Island; Middle Triassic, Upper Anisian.

D e s c r i p t i o n. The test is rounded subtriangular. The shell is latticed; the pores are large, arranged randomly, enclosed in massive hexagonal and pentagonal frameworks, with small tubercles on articulations. Three spines are positioned in one plane, one of them (apical) is on the shell end opposite to the aperture, the other two are almost perpendicular to the apical spine and located close to one line opposite each other. The spines are short, thick, massive, Y-shaped in cross section, with pointed ends, deep and wide grooves, and high thin ridges, without coiling or with very poor sinistral coiling (less than one-fourth coil along the spine). The aperture is open, rounded.

M e a s u r e m e n t s in μm. Shell diameter from the aperture to the base of the apical spine, 105–135; spine length, up to 60.

C o m p a r i s o n. The new species differs from *E. manfredi* Dumitrica, 1978 in the short massive spines lacking coiling.

O c c u r r e n c e. Middle Triassic, Upper Anisian; Kotel'nyi Island.

M a t e r i a l. Twenty-five specimens from two localities.

Eptingium manfredi Dumitrica, 1978

Plate 14, fig. 2

Eptingium manfredi: Dumitrica, 1978, p. 33, pl. 3, figs. 3 and 4, pl. 4, figs. 1–3, 6, and 7; Pessagno et al., 1979, pl. 6, figs. 9–11; Dumitrica et al., 1980, p. 19, pl. 3, figs. 1–3, pl. 6, figs. 5–7; Bragin, 1991, p. 109, pl. 2, fig. 5; Kozur and Mostler, 1994, p. 42, pl. 1, fig. 3; Ramovs and Gorican, 1995, p. 184, pl. 5, figs. 6–8; Kozur et al., 1996, p. 204, pl. 10, figs. 1–4, 6, and 10; Gorican et al., 2005, pl. II, figs. 1–4.

Tripocyclia japonica: Nakaseko and Nishimura, 1979, pl. 73, pl. 4, figs. 4 and 5.

H o l o t y p e. Romania; Middle Triassic, Lower Ladinian (Dumitrica, 1978, pl. III, fig. 4); collection number and depository are not indicated.

D e s c r i p t i o n. The test is subspherical, flattened in the plane of spines. The shell is latticed; the pores are small, arranged irregularly, enclosed in small, mostly hexagonal frameworks, with small tubercles on articulations. Three spines are in the same plane; one (apical) spine is located at the shell end opposite to the aperture, the other two are positioned symmetrically, the angle between them is more than other angles, but less than 180°. The spines are moderately long, massive, Y-shaped in cross section, with pointed ends, deep grooves, and high ridges; without spiral coiling. The aperture is small, rounded.

M e a s u r e m e n t s in μm. Maximum shell diameter, 110–120; spine length, up to 90.

C o m p a r i s o n. *E manfredi* differs from *E. nakasekoi* Kozur et Mostler, 1994 in the different angles between the main spines.

O c c u r r e n c e. Middle Triassic, Upper Anisian–Lower Ladinian; Mediterranean, Japan, the Far East of Russia, and the New Siberian Islands.

M a t e r i a l. Three specimens from one locality.

Genus *Spongostephanidium* Dumitrica, 1978

Spongostephanidium: Dumitrica, 1978.

T y p e s p e c i e s. *Spongostephanidium spongiosum* Dumitrica, 1978; Romania; Middle Triassic, Lower Ladinian.

D i a g n o s i s. All elements of cephalic spicule located inside cephalic cavity; element D and aperture absent.

S p e c i e s c o m p o s i t i o n. Three species occur in the Middle Triassic.

C o m p a r i s o n. *Spongostephanidium* differs from *Eptingium* in the absence of aperture and element D.

E x p l a n a t i o n o f P l a t e 14

Figs. 1 and 4. *Eptingium abditum* Bragin, sp. nov., sample 06-15-1r, Pryamaya River; Middle Triassic, Upper Anisian, ×200: (1) paratype GIN, no. 7438-06-127, (4) holotype GIN, no. 7438-06-128.

Fig. 2. *Eptingium manfredi* Dumitrica, 1978, GIN, no. 7438-06-129, sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian, ×180.

Fig. 3. *Spongostephanidium japonicum* (Nakaseko et Nishimura, 1979), GIN, no. 7438-06-130, sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian, ×220.

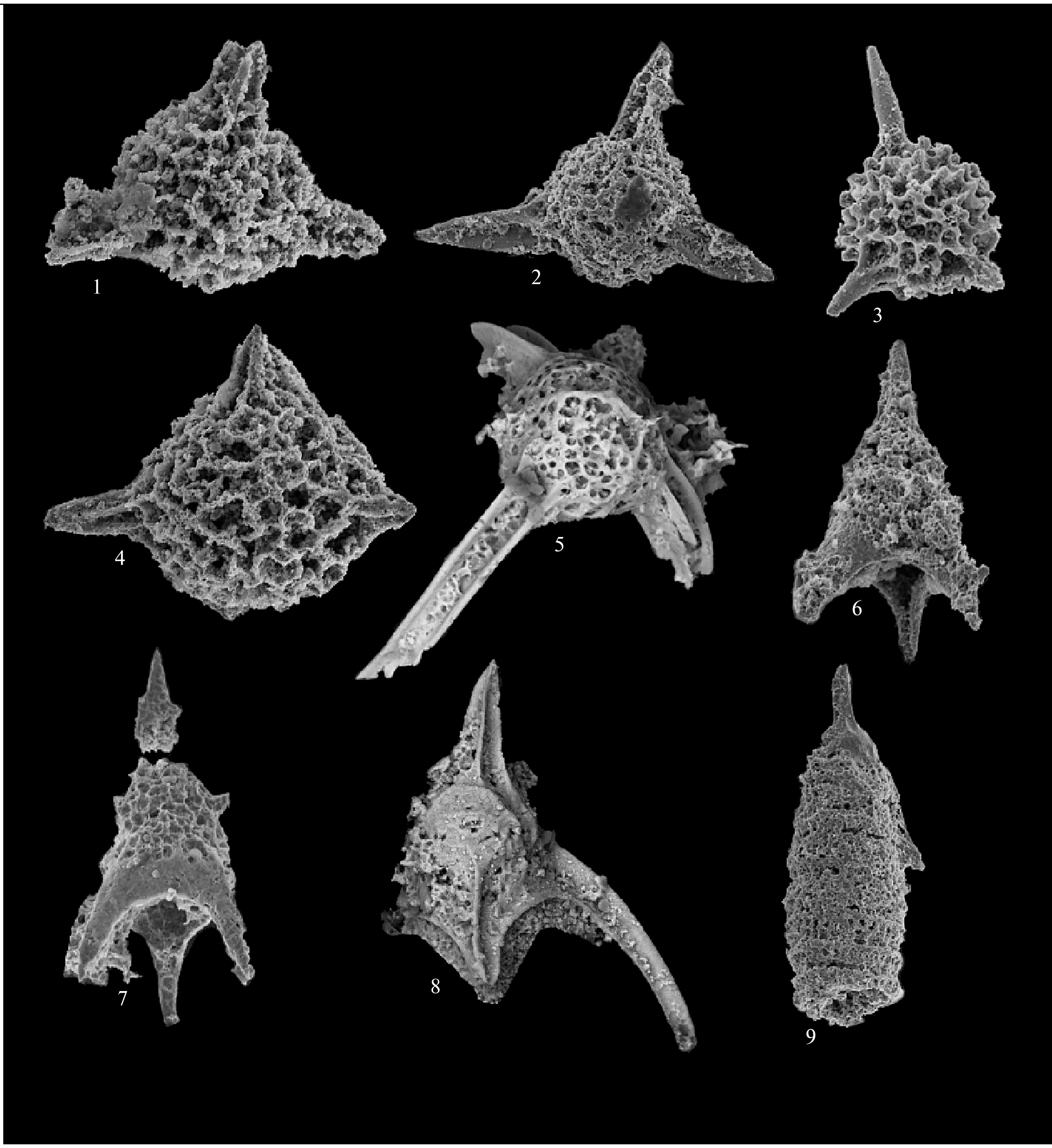
Fig. 5. *Poulpus costatus* (Kozur et Mostler, 1981), GIN, no. 7438-06-131, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×350.

Figs. 6 and 7. *Eonapora stiriaca* Bragin, sp. nov., sample 06-16-13r, Pryamaya River, Middle Triassic, Upper Ladinian, ×220: (6) holotype GIN, no. 7438-06-132, (7) paratype GIN, no. 7438-06-133.

Fig. 8. *Eonapora robusta* Kozur et Mostler, 1981, GIN, no. 7438-06-134, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×220.

Fig. 9. *Ladinocampe vicentinensis* Kozur et Mostler, 1994, GIN, no. 7438-06-135, sample 06-16-5r, Pryamaya River, Middle Triassic, Upper Anisian.

Plate 14



Spongostephanidium japonicum **(Nakaseko et Nishimura, 1979)**

Plate 14, fig. 3

Triolonche japonica: Nakaseko and Nishimura, 1979, p. 72, pl. 4, figs. 8 and 10.

Cryptostephanidium sp. *E*: Cheng, 1989, p. 148, pl. 7, fig. 6.

Spumellaria gen. et sp. indet.: Cheng, 1989, p. 147, pl. 6, fig. 8, pl. 7, figs. 1 and 2.

Cryptostephanidium japonicum: Yeh, 1990, p. 22, pl. 4, fig. 10, pl. 5, figs. 1, 2, and 7, pl. 10, fig. 11, pl. 11, fig. 18; Gorican and Buser, 1990, p. 142, pl. 8, fig. 5; Ramovs and Gorican, 1995, p. 184, pl. 5, fig. 1; Ohtaka et al., 1998, pl. 3, fig. 1.

Spongostephanidium japonicum: Kozur et al., 1996, p. 207, pl. 6, figs. 1–3; Gorican et al., 2005, pl. II, fig. 9.

H o l o t y p e. Osaka City University, no. MTSM 802-2; Japan; Middle Triassic, Upper Anisian, Sambosan Belt.

D e s c r i p t i o n. The test is small, subspherical. The shell is latticed, with large rounded pores enclosed in hexagonal and pentagonal frameworks, with high massive nodes on articulations. Three spines are moderately long, smooth, circular in cross section; up to the midlength, the spines are constant in thickness; further distally, they gradually taper to the pointed ends.

Measurements in μm. Shell diameter, 150; spine length, 100.

Comparison. *S. japonicum* differs from *S. longispinosum* Sashida, 1991 in the longer spines and the large high nodes on the articulations of porous frameworks.

Occurrence. Middle Triassic, Anisian of Japan, the Philippines, Austria, Hungary, Italy, Slovenia, and the New Siberian Islands.

Material. Fourteen specimens from two localities.

Family Sanfilippoellidae Kozur et Mostler, 1979

Sanfilippoellidae: Kozur and Mostler, 1979, p. 92.

Diagnosis. Nassellaria with monocyrtid shell with spicule, elements of which connected by arches AV, AL, VL, Ll, and lD. Three basal feet formed by continuations of L and D present, sometimes accompanied by velum. Some specimens with apical horn.

Generic composition. *Sanfilippoella* Kozur et Mostler, 1979, *Eonapora* Kozur et Mostler, 1979, *Hozmadia* Dumitrica, Kozur et Mostler, 1980, *Poulpus* De Wever, 1979, *Parapoulpus* Kozur et Mostler, 1981, and *Neopylentonema* Kozur, 1984 from the Lower Triassic–Lower Cretaceous.

Comparison. This family differs from Eptingiidae in the absence of a sagittal ring of the spicule and in the presence of basal feet.

Genus *Poulpus* De Wever, 1979

Poulpus: De Wever et al., 1979, p. 94.

Annulopoulpus: Kozur and Mostler, 1981, p. 83.

Spinopoulpus: Kozur and Mostler, 1981, p. 85.

Veghia: Kozur and Mostler, 1981, p. 86.

Type species. *Poulpus piabyx* De Wever, 1979; Turkey; Upper Triassic.

Diagnosis. Monocyrtid shell without velum or apical horn, with wide, open aperture.

Species composition. About 15 species occur in the Lower Triassic–Jurassic of the Mediterranean Region, Japan, western regions of the United States and Canada, the Far East of Russia, Philippines, and New Zealand.

Comparison. *Poulpus* differs from *Neopylentonema* Kozur, 1984 in the absence of an apical horn or other external spines, except for three basal feet; it differs from *Sanfilippoella* Kozur et Mostler, 1979 in the absence of both apical horn and velum.

Poulpus costatus (Kozur et Mostler, 1981)

Plate 14, fig. 5

Annulopoulpus costatus: Kozur and Mostler, 1981, p. 84, pl. 28, fig. 2.

Holotype. Austria, Göstling; Upper Triassic, Lower Carnian (Kozur and Mostler, 1981, pl. 28, fig. 2); collection number and depository are not indicated.

Description. The shell is monocyrtid; the cephalis is large, hemispherical, with a very small apical horn. The cephalic surface is pierced by many small, irregularly arranged pores and covered with a system of narrow smooth ridges, extending radially from the apical horn and forming narrow branches. The basal feet are long, thick, large, Y-shaped in cross section, smoothly curved towards the aperture. The aperture is wide, circular.

Measurements in μm. Cephalic diameter, 75; length of basal feet, more than 150.

Comparison. *P. costatus* differs from *P. transitus* Kozur et Mostler in the development of branching ridges on the cephalic surface.

Occurrence. Upper Triassic, Lower Carnian of Austria and Kotel'nyi Island.

Material. Three specimens from one locality.

Family Ultranaporidae Pessagno, 1977

Ultranaporidae: Pessagno, 1977b, p. 38.

Diagnosis. Double-chambered Nassellaria with small hemispherical cephalis and large open thorax, having three basal feet continuing elements D and L. Apical horn developed from spine A.

Generic composition. Middle Triassic–Upper Cretaceous. In the Triassic, the family is represented by the genera *Silicarmiger* Dumitrica, Kozur et Mostler, 1980, *Spongosilicarmiger* Kozur, 1984, and *Trialatus* Yeh, 1990.

Comparison. The family Ultranaporidae differs from Hinedorcidae Kozur et Mostler in the absence of a vertical horn.

Genus *Eonapora* Kozur et Mostler, 1979

Eonapora: Kozur and Mostler, 1979, p. 89.

Type species. *Eonapora pulchra* Kozur et Mostler, 1979; Austria; Upper Triassic, Lower Carnian.

Diagnosis. Double-chambered forms with simple apical horn, Y-shaped in cross section over entire extent, with porous wall of cephalis and thorax; thorax lacking transverse ridges.

Species composition. Several species from the Middle and Upper Triassic of the Mediterranean Region and New Siberian Islands.

Comparison. *Eonapora* differs from *Trialatus* in the simpler apical horn with Y-shaped cross section over the entire extent and from *Silicarmiger* in the simpler thorax, which lacks transverse ridges.

Eonapora stiriaca **Bragin, sp. nov.**

Plate 14, figs. 6 and 7

E t y m o l o g y. From the Latin *stiriacus* (frozen).

H o l o t y p e. GIN, no. 7438-06-132; Kotel'nyi Island; Middle Triassic, Upper Ladinian.

D e s c r i p t i o n. The test is subconical, small. The cephalis is subconical, with large, straight, smooth apical horn having a pointed end. The cephalis is covered with small irregularly arranged pores. The cephalis is separated from the thorax by a poorly pronounced constriction. The thorax is in the shape of a truncated three-bladed pyramid, slightly longer than the cephalis; the thoracic wall is pierced by circular, irregularly arranged pores, which are slightly larger than in the cephalis. The aperture is wide, open. Three basal feet are smooth, triangular in cross section, with pointed ends; their bases are widened and fused with each other, forming an apertural skirt, which lacks pores.

M e a s u r e m e n t s in μm. Shell length with the apical horn up to the apertural skirt inclusive, 80–95; apical horn length, 30–40; length of the cephalis without the apical horn, 15–20; length of the basal feet, 30–35.

C o m p a r i s o n. The new species differs from *E. robusta* Kozur et Mostler, 1981 in the subconical cephalis without ridges.

O c c u r r e n c e. Middle and Upper Triassic, Upper Ladinian–Lower Carnian of Kotel'nyi Island.

M a t e r i a l. Seven specimens from one locality.

Eonapora robusta **Kozur et Mostler, 1981**

Plate 14, fig. 8

Eonapora robusta: Kozur and Mostler, 1981, p. 82, pl. 29, fig. 1.

H o l o t y p e. Hungary; Middle Triassic, Upper Anisian (Kozur and Mostler, 1981, pl. 29, fig. 1); collection number and depository are not indicated.

D e s c r i p t i o n. The test is monocyrtid, the cephalis is inflated, dome-shaped, with a large massive apical horn, which is Y-shaped in cross section, gradually narrowing to the pointed end. The cephalic surface has small, widely spaced, irregularly arranged pores and ridges continuing the ridges of the apical horn. The basal feet are massive, Y-shaped in cross section, slightly curved towards the aperture; neighboring ridges of neighboring spines are fused to form a narrow smooth apertural skirt. The aperture is wide, subtriangular.

M e a s u r e m e n t s in μm. Apical horn length, 75; cephalis length, 80–90; length of the basal feet, up to 110–115.

C o m p a r i s o n. *E. robusta* differs from *E. mesotriassica* Kozur et Mostler, 1981 in the inflated dome-shaped cephalis, the surface of which has continuations of ridges of the apical horn.

O c c u r r e n c e. Middle Triassic, Upper Anisian of Hungary; Upper Triassic, Lower Carnian, of Kotel'nyi Island.

M a t e r i a l. Two specimens from one locality.

Family Planispinocyrtiidae Kozur et Mostler, 1981

Planispinocyrtiidae: Kozur and Mostler, 1981, p. 111.

D i a g n o s i s. Multicyrtid Nassellaria with cephalic spicule without element D, with apical horn and horns derived from other elements of spicule, or with columella formed by element V.

G e n e r i c c o m p o s i t i o n. *Planispinocyrtis* Kozur et Mostler, 1981, *Ladinocampe* Kozur, 1984, and *Spinotriassocampe* Kozur, 1984 from the Middle and Upper Triassic.

C o m p a r i s o n. This family differs from Tetraspinocyrtiidae Kozur et Mostler, 1994 in the absence of element D in the cephalic spicule.

Genus *Ladinocampe* Kozur, 1984

Ladinocampe: Kozur, 1984, p. 73.

T y p e s p e c i e s. *Ladinocampe multiperforata* Kozur, 1984; Italy; Middle Triassic, Lower Ladinian, Buchenstein Formation.

D i a g n o s i s. Shell multicyrtid, with apical horn, without lateral horns in apical part of shell, and with alar (wing-shaped) columella in upper half of shell formed by element V.

S p e c i e s c o m p o s i t i o n. Four species occur in the Middle Triassic of the Mediterranean–Alpine Region and New Siberian Islands.

C o m p a r i s o n. *Ladinocampe* differs from *Planispinocyrtis* and *Spinotriassocampe* in the absence of lateral horns and in the development of an alar columella.

Ladinocampe vicentinensis **Kozur et Mostler, 1994**

Plate 14, fig. 9

Ladinocampe vicentinensis: Kozur and Mostler, 1994, p. 93, pl. 23, figs. 3–5.

H o l o t y p e. Italy; Middle Triassic, Lower Ladinian (Kozur and Mostler, 1994, pl. 23, fig. 5); collection number and depository are not indicated.

D e s c r i p t i o n. The test is multicyrtid, composed of 12 or 13 segments, with a conical apical part; further, it becomes subcylindrical, slightly narrowing towards the apertural part. The cephalis is small, conical, without pores, with a large apical horn, which is Y-shaped in cross section. The thorax is wide, hemispherical, without pores. The columella extends from the base of the thorax to the middle of the shell, reaching the third postabdominal segment. The abdomen is wide, truncated conical, with small pores arranged in indistinct transverse rows. The postabdominal segments are subcylindrical up to the end of the columella, with transverse rows of pores; after the end of the columella, they are trapezoid in section, with transverse ridges in the upper part of each segment.

M e a s u r e m e n t s in μm. Shell length, 270–280; apical horn length, 50; columella length, 90; maximum shell width, 85.

C o m p a r i s o n. *L. vicentinensis* differs from *L. annuloperforata* Kozur et Mostler, 1994 in the presence of proximal ridges on the postabdominal segments beginning from the end of the columella.

O c c u r r e n c e. Middle Triassic, Upper Anisian of Kotel'nyi Island; Lower Ladinian of Italy.

M a t e r i a l. Five specimens from two localities.

Genus *Planispinocyrtis* Kozur et Mostler, 1981

Planispinocyrtis: Kozur and Mostler, 1981, p. 111.

T y p e s p e c i e s. *Planispinocyrtis baloghi* Kozur et Mostler; Hungary, Balaton Highland; Middle Triassic, Upper Anisian.

D i a g n o s i s. Shell multicyrtid, with three postabdominal segments. Cephalis rounded, with apical horn; thorax large, porous, with three lateral horns on formed by elements V and 2l.

S p e c i e s c o m p o s i t i o n. Up to 20 species occur in the Middle Triassic and Lower Carnian of the Mediterranean Region and New Siberian Islands.

C o m p a r i s o n. *Planispinocyrtis* differs from *Ladinocampe* and *Spinotriassocampe* in the presence of three lateral horns.

Planispinocyrtis kotelnyensis Bragin, sp. nov.

Plate 15, figs. 1 and 2

E t y m o l o g y. From Kotel'nyi Island.

H o l o t y p e. GIN, no. 7438-06-137; Kotel'nyi Island; Upper Triassic, Lower Carnian.

D e s c r i p t i o n. The test is multicyrtid, composed of six or seven segments. The cephalis is small, conical, smooth, without pores, with a long apical horn, Y-shaped in cross section. The constriction between the cephalis and thorax is indistinct. The thorax is large, smooth, hemispherical, with many small isolated pores. Three lateral horns, with Y-shaped cross section, deviate laterally from the lower part of the thorax at an angle of 60° to the apical horn; they are longer than the apical horn. The constriction between the thorax and abdomen is hardly discernible. The abdomen is inflated, slightly wider than the thorax; it has small irregularly arranged pores and is separated from the succeeding segment by a distinct constriction. The postabdominal segments are inflated, approximately as wide as and as high as the abdomen, with larger pores arranged in six or seven transverse rows.

M e a s u r e m e n t s in μm. Shell length, 260–280; maximum shell width, 100–110; apical horn length, 45–50; length of lateral horns, 90.

C o m p a r i s o n. The new species differs from *P. pelsoensis* Kozur et Mostler, 1994 in the narrower apical horn, longer lateral horns, and in the absence of proximal ridges on the postabdominal segments.

O c c u r r e n c e. Upper Triassic, Lower Carnian; Kotel'nyi Island.

M a t e r i a l. Twelve specimens from two localities.

Family Triassocampidae Kozur et Mostler, 1981

Triassocampidae: Kozur et Mostler, 1981, p. 97.

D i a g n o s i s. Multicyrtid Nassellaria with or without apical horn. Shell wall single-layered, with transverse ridges at boundaries between segments and with transverse rows of pores.

G e n e r i c c o m p o s i t i o n. *Triassocampe* Dumitrica, Kozur et Mostler, 1980, *Paratriassocampe* Kozur et Mostler, 1994, *Pseudotriassocampe* Kozur et Mostler, 1994, *Striatotriassocampe* Kozur et Mostler, 1994, *Yeharaia* Nakaseko et Nishimura, 1979, *Annulotriassocampe* Kozur, 1994, and *Papiliocampe* Tekin, 1999 in the Anisian–Norian.

C o m p a r i s o n. The family Triassocampidae differs from Parvicingulidae Pessagno in the single-layered wall of the shell.

Genus *Annulotriassocampe* Kozur, 1994

Annulotriassocampe: Kozur and Mostler, 1994, p. 249.

T y p e s p e c i e s. *Annulotriassocampe baldii* Kozur, 1994; Hungary; Carnian.

D i a g n o s i s. Shell multicyrtid, narrow conical, without apical horn. Postabdominal chambers with one central row of pores bordered two smooth transverse ridges. In primitive forms, lower transverse ridge undeveloped.

S p e c i e s c o m p o s i t i o n. Eight species occur in the Middle Anisian–Lower Norian of the Mediterranean and Pacific regions.

C o m p a r i s o n. *Annulotriassocampe* differs from *Triassocampe* Dumitrica, Kozur et Mostler, 1980 in the presence of only one row of pores on the postabdominal chambers.

Annulotriassocampe baldii (Kozur, 1994)

Plate 15, figs. 3–5

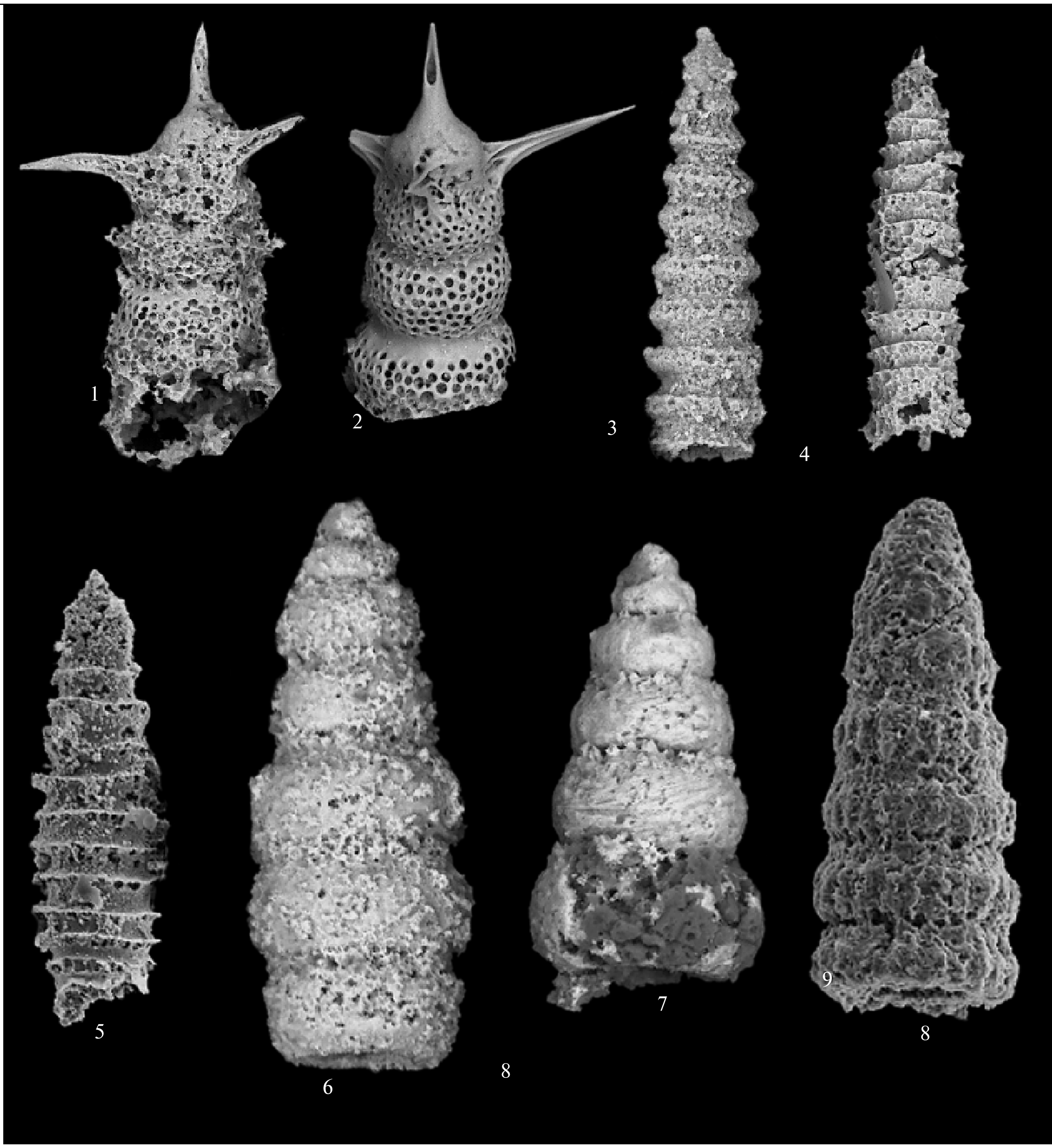
Annulotriassocampe baldii: Kozur and Mostler, 1994, p. 249, pl. 1A, fig. 13; Tekin, 1999, p. 169, pl. 41, figs. 1 and 2; Wang et al., 2002, p. 331, pl. 2, figs. 11–13, Tekin and Goncuoglu, 2007, pl. 3, figs. 25 and 26; Bragin, 2007, p. 1017, pl. 15, fig. 8.

Triassocampe baldii: Sugiyama, 1997, fig. 49.6.

H o l o t y p e. Hungary, Balaton Highland, borehole Inke-1; Middle–Upper Carnian (Kozur and Mostler, 1994, pl. 1A, fig. 13); collection number and depository are not indicated.

D e s c r i p t i o n. The test is multicyrtid, consisting of 7–10 segments. The cephalothorax is dome-shaped, smooth, almost lacking pores. The abdomen is subcylindrical, smooth, without pores, separated from the cephalothorax by a narrow constriction. The postabdominal segments are subcylindrical, each has a smooth transverse ridge and, under it, a transverse row of small pores. The first two postabdominal segments have an additional smooth transverse ridge below the row of pores; in other segments, it is absent. The last segment has two transverse rows of pores and a short smooth terminal tube.

Plate 15



E x p l a n a t i o n o f P l a t e 1 5

Figs. 1 and 2. *Planispinocyrtis kotelnyensis* Bragin, sp. nov., sample 06-10-8r, Pryamaya River; Upper Triassic, Lower Carnian, ×250: (1) paratype GIN, no. 7438-06-136, (2) holotype GIN, no. 7438-06-137.

Figs. 3–5. *Annulotriassocampe baldii* (Kozur, 1994): (3, 4) sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×180: (3) GIN, no. 7438-06-138, (4) GIN, no. 7438-06-139; (5) GIN, no. 7438-06-140, sample 06-10-8r, Upper Triassic, Lower Carnian, ×220.

Figs. 6 and 7. *Canoptum zetangense* Wang et Yang, 2002: (6) GIN, no. 7438-06-141, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×220; (7) GIN, no. 7438-06-142, sample 06-17-12r, Sukhoi Creek, Upper Triassic, boundary beds of the Lower and Upper Carnian, ×220.

Fig. 8. *Whalenella speciosa* (Blome, 1984), GIN, no. 7438-06-143, sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×200.

M e a s u r e m e n t s in μm. Shell length, 255; maximum width (fifth postabdominal segment), 70; cephalis height, 25.

C o m p a r i s o n. *A. baldii* differs from *A. sulovensis* (Kozur et Mock, 1981) in the reduction of the second ridge in the last postabdominal segments.

O c c u r r e n c e. Carnian–Lower Norian of Hungary, Japan, Turkey, Sikhote Alin, Tibet, Cyprus, and the New Siberian Islands.

M a t e r i a l. Eighteen specimens from four localities.

Family Parvicingulidae Pessagno, 1977

Parvicingulidae: Pessagno, 1977a, p. 83.

D i a g n o s i s. Multicyrtid Nassellaria with very small cephalis; apical horn occasionally present. Postthoracic segments separated by transverse external ridges, which or spaced between which containing transverse rows of pores enclosed in polygonal pore frameworks. Transverse rows of pores separated from each other by additional transverse ridges. Shell wall double- or multilayered.

C o m p o s i t i o n. Two subfamilies, Parvicingulinae Pessagno, 1977 and Canoptinae Pessagno, 1979, from the Middle Triassic (Ladinian)–Lower Cretaceous.

C o m p a r i s o n. Parvicingulidae differs from other families with a multicyrtid shell in the wall structure, i.e., transverse rows of pores alternating with transverse ridges.

R e m a r k s. This is undoubtedly an artificial family that possibly comprises unrelated taxa. The cephalic structure of many taxa remains an open question.

Subfamily Canoptinae Pessagno, 1979

Canoptidae: Pessagno et al., 1979, p. 180.

D i a g n o s i s. Parvicingulidae with porous external layer of shell and latticed internal layer.

G e n e r i c c o m p o s i t i o n. Upper Triassic–Lower Cretaceous. In the Triassic, the subfamily is represented by the genus *Canoptum* Pessagno, 1979. The genera *Japonocampe* Kozur, 1984, *Pachus* Blome, 1984, and *Whalenella* Kozur, 1984 are tentatively referred to this subfamily.

C o m p a r i s o n. The subfamily Canoptinae differs from the Parvicingulinae in the porous external layer of the shell.

Genus *Canoptum* Pessagno, 1979

T y p e s p e c i e s. *Canoptum poissoni* Pessagno, 1979; Turkey; Lower Jurassic, Pliensbachian Stage, Gumuslu.

D i a g n o s i s. Shell multicyrtid, conical. Cephalis and thorax lacking pores. Succeeding chambers covered by external microgranular layer, sometimes pierced by a few irregularly arranged pores or very small, densely spaced pores accumulated on transverse ridges of shell. Internal layer of shell typical for family.

S p e c i e s c o m p o s i t i o n. About 30 species from the Upper Triassic–Jurassic (beginning from the Upper Norian) throughout the world.

C o m p a r i s o n. *Canoptum* differ from *Whalenella* Kozur, 1984 in the absence of longitudinal ridges, considerable development of the external microgranular layer of the shell, and in the very small pores.

***Canoptum zetangense* Wang et Yang, 2002**

Plate 15, figs. 6 and 7

Canoptum zetangense: Wang and Yang, (in Wang et al., 2002, pl. II, figs. 24–27).

H o l o t y p e. Tibet; Upper Triassic, Carnian (Wang et al., 2002, pl. II, fig. 24); collection number and depository are not indicated.

D e s c r i p t i o n. The test is multicyrtid, conical or spindle-shaped, composed of seven segments. The cephalis is small, dome-shaped, without pores and without an apical horn. The thorax is smooth, lacking pores, as high as and twice as wide as the cephalis. The abdomen and postabdominal segments are at least twice as high as the thorax and gradually increase in width in a series of segments. The last segment is slightly narrower than the penultimate segment. The abdomen and postabdominal segments are separated by deep constrictions, which are pierced by many small, irregularly arranged pores.

M e a s u r e m e n t s in μm. Maximum shell length, 220; maximum width, 90.

C o m p a r i s o n. *C. zetangense* differs from *C. cucurbita* Sugiyama, 1997 in the fact that the pores are accumulated on the constrictions of the shell.

O c c u r r e n c e. Upper Triassic, Carnian, of Tibet and Kotel'nyi Island

M a t e r i a l. Eighteen specimens from two localities.

Genus *Whalenella* Kozur, 1984

Whalenella: Kozur, 1984, p. 71.

Corum: Blome, 1984, p. 50.

T y p e s p e c i e s. *Dictyomitra arrecta* Hinde, 1908; Indonesia; Jurassic?.

D i a g n o s i s. Shell multicyrtid, with double-layered wall. Internal layer coarse-porous, external layer pierced by transverse rows of pores only on constrictions between chambers. Postthoracic segments with longitudinal ridges interrupted at interchamber constrictions.

S p e c i e s c o m p o s i t i o n. About ten species occur in the Upper Carnian–Norian of Japan, Oregon, Sikhote Alin, Cyprus, and Turkey.

C o m p a r i s o n. *Whalenella* differs from the genera *Japonocampe* Kozur, 1984 and *Canoptum* Pessagno, 1979 in the presence of longitudinal ridges.

***Whalenella speciosa* (Blome, 1984)**

Plate 15, fig. 8

Corum speciosum: Blome, 1984, p. 51, pl. 13, figs. 4, 13, 14, and 17; Blome and Reed, 1995, p. 61, pl. 2, fig. 14; Tekin, 1999, p. 153, pl. 35, fig. 12.

H o l o t y p e. USNM (Natural History Museum, United States), no. 305919; Oregon; Upper Triassic, Upper Carnian–Middle Norian.

D e s c r i p t i o n. The test is multicyrtid, composed of ten segments. The cephalis is very small, dome-shaped, without an apical horn. The thorax is smooth, trapezoid in cross section. The abdomen and postabdominal segments are truncated conical, almost cylindrical, separated by distinct constrictions. The surface of these segments has well-pronounced longitudinal ridges, up to 20 ridges on the entire surface of the segment. In the last segments of the shell, some ridges bifurcate.

M e a s u r e m e n t s in μm. Maximum shell length, 160–170; maximum width, 60–70.

C o m p a r i s o n. *W. speciosa* differs from *W. robusta* Bragin, 2007 in the greater number of ridges on segments and in the bifurcation of ridges in the last segments.

O c c u r r e n c e. Upper Triassic, Upper Carnian–Middle Norian of Oregon, Nevada, Turkey, and Kotel'nyi Island.

M a t e r i a l. Three specimens from one locality.

Family Syringocapsidae Foreman, 1973

Syringocapsinae: Foreman, 1973, p. 265.
Syringocapsidae: Baumgartner et al., 1995, p. 31.

D i a g n o s i s. Multicyrtid Nassellaria, with inflated subspherical middle part of shell. Segments of proximal part very small and numerous, distal part formed of one segment considerably extended to form tube.

G e n e r i c c o m p o s i t i o n. Upper Triassic–Cretaceous. In the Triassic, the family is represented by the genera *Syringocapsa* Neviani, 1900, *Katroma* Pessagno et Poisson, 1981, *Globolaxtorum* Carter, 1993, and *Podobursa* Wisniowski, 1889.

C o m p a r i s o n. Syringocapsidae differs from other multicyrtid families in the inflated subspherical middle part of the shell.

Genus *Syringocapsa* Neviani, 1900

Syringocapsa: Neviani, 1900, p. 662.

T y p e s p e c i e s. *Theosyringium robustum* Vinassa de Regny, 1901; Greece; Lower Cretaceous.

D i a g n o s i s. Apical horn absent, surface of inflated part of shell smooth, without spines.

S p e c i e s c o m p o s i t i o n. More than 15 species are known from the Upper Triassic–Cretaceous throughout the world, except for boreal and notal regions. In the Triassic, the genus is represented by five species.

C o m p a r i s o n. *Syringocapsa* differs from *Podobursa* Wisniowski in the absence of apical horn.

***Syringocapsa turgida* Blome, 1984**

Plate 16, figs. 1–3

Syringocapsa turgida: Blome, 1984, p. 53, pl. 14, figs. 2, 6, 7, and 16; Tekin, 1999, p. 168, pl. 40, figs. 7 and 8.

H o l o t y p e. USNM, no. 305939; Oregon; Upper Triassic, Upper Carnian–Middle Norian.

D e s c r i p t i o n. The cephalis is smooth, dome-shaped. The thorax and abdomen are inflated, with massive tubercles; the abdomen is twice as large as the thorax. The first postabdominal segment is large (thrice as large as the abdomen), subspherical; its shell is latticed; the pores are circular, enclosed in massive pentagonal porous frameworks. A short narrow terminal tube is developed, although they are frequently lost.

M e a s u r e m e n t s in μm. Maximum shell length, 190–210; maximum shell width, 110–120.

C o m p a r i s o n. *Syringocapsa turgida* differs from *S. extansa* Tekin, 1999 in the latticed structure of the wall of the postabdominal segment.

O c c u r r e n c e. Upper Triassic, Upper Carnian–Middle Norian of Oregon, Turkey, and Kotel'nyi Island.

M a t e r i a l. Seventeen specimens from five localities.

Nassellaria incertae familiae

Genus *Droltus* Pessagno et Whalen, 1982

Droltus: Pessagno, Whalen, 1982, p. 120.

T y p e s p e c i e s. *Droltus lyellensis* Pessagno et Whalen, 1982; British Columbia; Lower Jurassic.

D i a g n o s i s. Shell multicyrtid, with apical horn, without constrictions, with spongy structure in apical part of shell, with structure composed of longitudinal ridges separated by singular rows of pores, beginning from middle part of shell up to its end. Terminal tube absent.

S p e c i e s c o m p o s i t i o n. Seven species from the Upper Triassic and Lower Jurassic.

C o m p a r i s o n. *Droltus* differs from *Parahsuum* Yao, 1982 in the spongy structure of the apical part of the shell.

***Droltus gelidus* Bragin, sp. nov.**

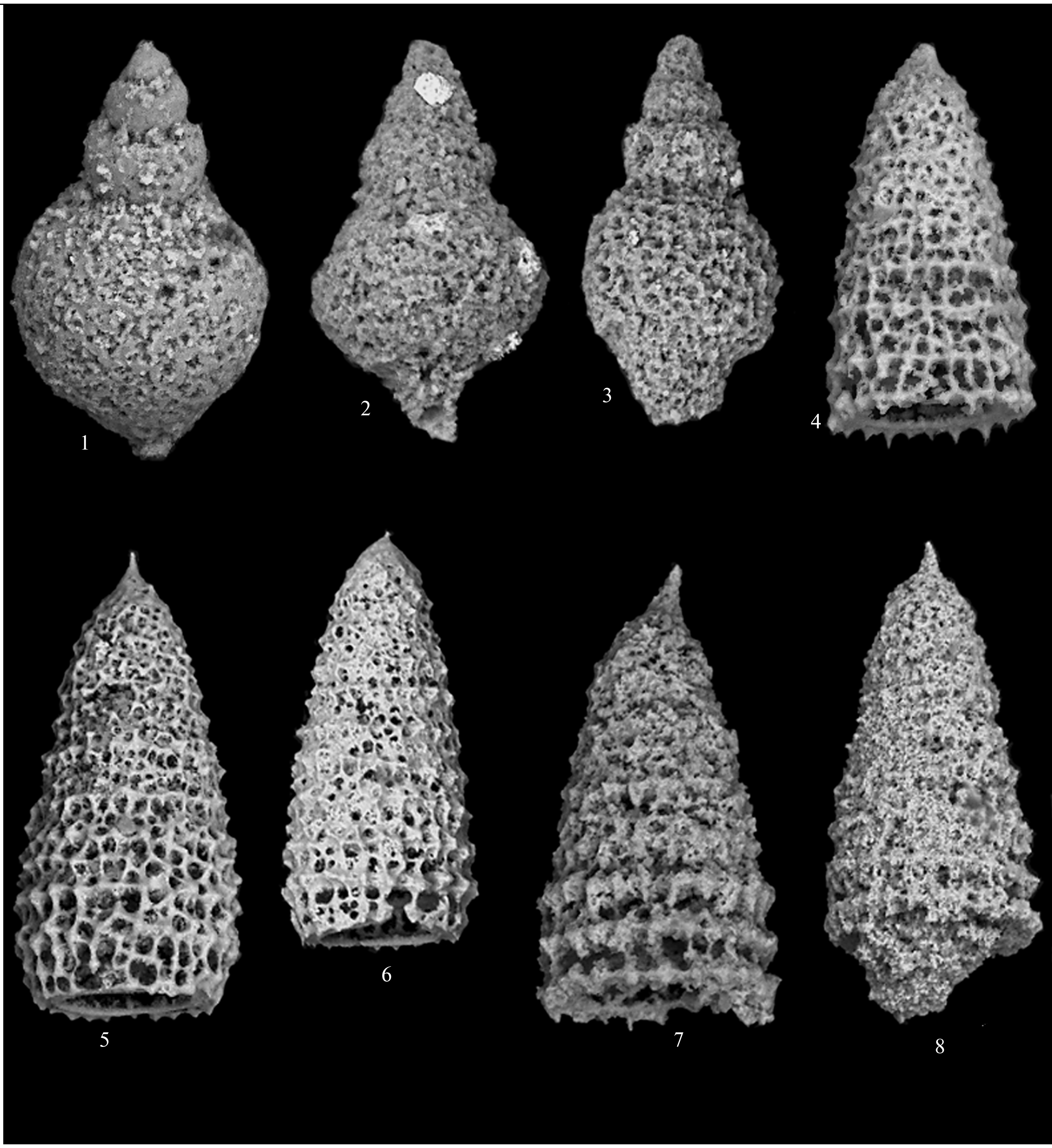
Plate 16, figs. 4–8

E t y m o l o g y. From the Latin *gelidus* (cold, ice).

H o l o t y p e. GIN, no. 7438-06-148; Kotel'nyi Island; Upper Triassic, Upper Carnian

D e s c r i p t i o n. The test is multicyrtid, composed of 11 or 12 segments, with a dome-shaped apical part, conical middle part, and slightly narrowing apertural part. The cephalis is small, conical, without pores, with a small smooth apical horn. The thorax is

Plate 16



Explanation of Plate 16

Figs. 1–3. *Syringocapsa turgida* Blome, 1984, (1) GIN, no. 7438-06-144, sample 06-30-1r, Tikhaya River, Upper Triassic, Lower Norian, ×220; (2, 3) sample 06-22r, Balyktakh River, Upper Triassic, Middle Norian, ×220: (2) GIN, no. 7438-06-145, (3) GIN, no. 7438-06-146.

Figs. 4–8. *Droltus gelidus* Bragin, sp. nov.: (4–6) sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian, ×220: (4) paratype GIN, no. 7438-06-147, (5) holotype GIN, no. 7438-06-148, (6) GIN, no. 7438-06-149; (7, 8) sample 06-30-1r, Tikhaya River, Upper Triassic, Lower Norian, ×220: (7) GIN, no. 7438-06-150; (8) GIN, no. 7438-06-151.

truncate conical, with small densely spaced pores. The abdomen and first three postabdominal segments gradually expand; their wall is spongy, fine-porous. Succeeding segments acquire longitudinal ridges separated by singular rows of pores, frequently interrupted and bifurcating. The penultimate and last segments are narrower than the preceding segments. Articulations between segments of the postabdominal region have thin and narrow transverse ridges.

M e a s u r e m e n t s in μm. Maximum shell length, 280–290; maximum shell width, 140.

C o m p a r i s o n. The new species differs from *D. hecatensis* Pessagno et Whalen, 1982 in the greater number of segments in the shell and in the less distinct, branching longitudinal ridges on the shell surface.

O c c u r r e n c e. Upper Triassic, Upper Carnian and Lower Norian; Kotel'nyi Island.

M a t e r i a l. Twenty-five specimens from three localities.

Droltus niveus **Bragin, sp. nov.**

Plate 17, figs. 1 and 2

E t y m o l o g y. From the Latin *niveus* (snowy, from snow).

H o l o t y p e. GIN, no. 7438-06-152; Kotel'nyi Island; Upper Triassic, Upper Carnian.

D e s c r i p t i o n. The test is multicyrtid, narrow, spindle-shaped, composed of eight or nine segments. The cephalis is small, dome-shaped, without pores, with a small smooth apical horn. The thorax, abdomen, and first postabdominal segment are truncated conical, with a spongy wall pierced by circular, irregularly arranged pores, varying in size. The other segments are subcylindrical, with narrow, frequently branching longitudinal ridges, separated by singular rows of pores, without transverse ridges. The last two segments are gradually narrow.

M e a s u r e m e n t s in μm. Maximum shell length, 210–220; maximum shell width, 80.

C o m p a r i s o n. The new species differs from *D. gelidus* in the narrower and thinner shell with fewer segments, without transverse ridges on the articulations.

O c c u r r e n c e. Upper Triassic, Upper Carnian; Kotel'nyi Island.

M a t e r i a l. Twelve specimens from two localities.

Genus *Pseudoeucyrtis* Pessagno, 1977

Pseudoeucyrtis: Pessagno, 1977b, p. 58.

T y p e s p e c i e s. *Eucyrtis* (*?*) *zhamoidai* Foreman, 1973.

D i a g n o s i s. Shell multicyrtid, long, spindle-shaped, with weak constrictions between segments. Shell wall porous; pores arranged in longitudinal rows, transverse rows, or randomly. Aperture relatively small, located at end of terminal tube.

S p e c i e s c o m p o s i t i o n. At most ten species occur in the Upper Triassic, Jurassic, and Cretaceous.

C o m p a r i s o n. *Pseudoeucyrtis* differs from *Eucyrtis* Haeckel in the spindle-shaped shell.

Pseudoeucyrtis annosus **Bragin, sp. nov.**

Plate 17, figs. 3–8

E t y m o l o g y. From the Latin *annosus* (long-standing, old, ancient).

H o l o t y p e. GIN, no. 7438-06-154; Kotel'nyi Island; Upper Triassic, Lower Carnian.

D e s c r i p t i o n. The test is long, narrow, spindle-shaped. The cephalis is small, dome-shaped, without pores, with a small apical horn. The thorax and abdomen are truncated conical. The thorax is wider and higher than the abdomen, separated from the cephalis and abdomen by hardly discernible constrictions, pierced by small irregularly arranged pores. The postabdominal segments are subcylindrical; beginning from the fourth segment, they gradually narrow and are pierced by small circular pores, arranged in transverse rows. The apertural part of some specimens extends to form a short terminal tube.

M e a s u r e m e n t s in μm. Maximum shell length, 310–330; maximum shell width, 75.

C o m p a r i s o n. The new species differs from *P. angusta* Whalen et Carter, 1998 in the poorly developed terminal tube, poorly pronounced constrictions in the middle part of the shell, and in the arrangement of pores of the postabdominal part in transverse rows.

O c c u r r e n c e. Upper Triassic, Lower Carnian of Kotel'nyi Island.

M a t e r i a l. Twenty-two specimens from three localities.

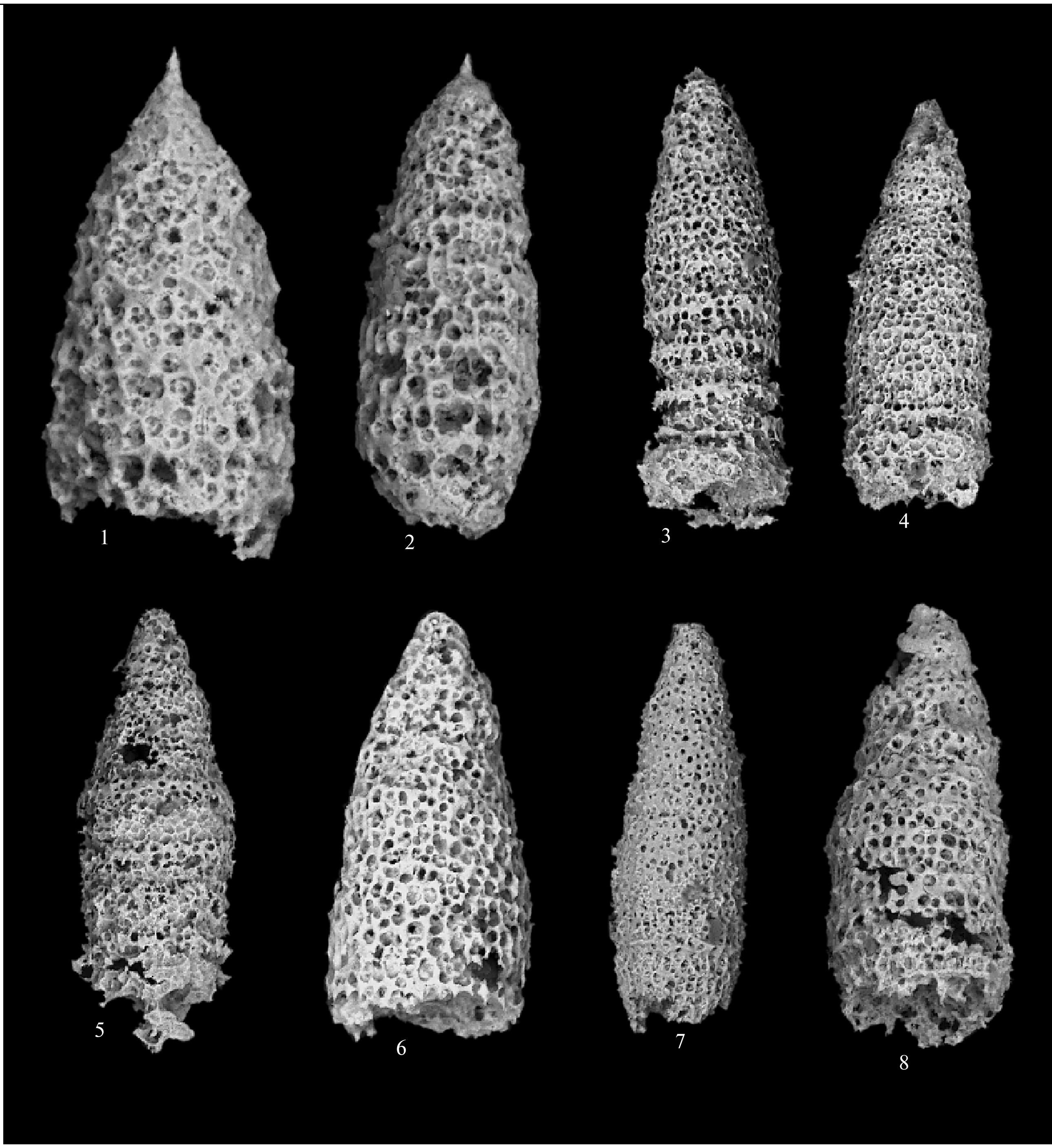
CONCLUSIONS

Thus, Middle and Upper Triassic radiolarians from Kotel'nyi Island are studied in detail for the first time. The following conclusions are drawn:

(1) Representative radiolarian assemblages, along with other fossils (cephalopods and bivalves), occur in the Triassic beds of Kotel'nyi Island; this allows a detailed study of stratigraphic distribution of radiolarian species.

(2) Radiolarians are recorded at many stratigraphic levels of the Middle Triassic (Upper Anisian and Upper Ladinian) and Upper Triassic (Carnian–Lower Norian), which are represented by clays with interbeds of limestone and combustible schist and phosphatic, calciferous, and sideritic concretions. From the bottom upwards, the following associations are recognized: an assemblage with *Glomeropyle clavatum* dated Late Anisian and including *Glomeropyle clavatum* Bragin, sp. nov., *G. boreale* Bragin, *G. manihepuaensis* Aita, *G. insulanum* Bragin, sp. nov., *Triassospongosphaera multispinosa* (Kozur et Mostler), *Tetraspongodiscus*

Plate 17



Explanation of Plate 17

Figs. 1 and 2. *Droltus niveus* Bragin, sp. nov., sample 06-31-2r, Tikhaya River, Upper Triassic, Upper Carnian: (1) holotype GIN, no. 7438-06-152, ×270; (2) paratype GIN, no. 7438-06-153, ×210.

Figs. 3–8. *Pseudoeucyrtis annosus* Bragin, sp. nov.: (3) holotype GIN, no. 7438-06-154, sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×220; (4, 5) sample 06-10-8r, Pryamaya River, Upper Triassic, Lower Carnian, ×220: (4) paratype GIN, no. 7438-06-155, (5) GIN, no. 7438-06-156; (6) GIN, no. 7438-06-157, sample 06-8-2r, Tikhaya River, Upper Triassic, Lower Carnian, ×250; (7) GIN, no. 7438-06-158, sample 06-10-3r, Pryamaya River, Upper Triassic, Lower Carnian, ×180; (8) GIN, no. 7438-06-159, sample 06-10-8, Pryamaya River; Upper Triassic, Lower Carnian, ×250.

hibernus Bragin, sp. nov., *T. borealis* Bragin, sp. nov., *Eptingium abditum* Bragin, sp. nov., *E. manfredi* Dumitrica, *Spongostephanidium japonicum* (Nakaseko et Nishimura), and *Ladinocampe vicentinensis* Kozur et Mostler; a *Muelleritortis kotelnyensis* assemblage of the Late Ladinian age, with *Muelleritortis firma* (Gorican), *M. kotelnyensis* Bragin, sp. nov., *Tiborella nivea* Bragin, sp. nov., *Pseudostylosphaera goestlingensis* (Kozur et Mostler), *P. omolonica* Bragin, *Triassospongosphaera multispinosa* (Kozur et Mostler), *Sarla cincinnata* Bragin, sp. nov., *S. obscura* Bragin, sp. nov., *S. prava* Bragin, sp. nov., and *Eonapora stiriaca* Bragin, sp. nov.; *Glomeropyle cuneum* assemblage of the Early Carnian age, with *Pentactinocarpus colum* Bragin, sp. nov., *Glomeropyle cuneum* Bragin, sp. nov., *G. algidum* Bragin, sp. nov., *G. aculeatum* Bragin, sp. nov., *Kahlerosphaera isopleura* Bragin, sp. nov., *Stauracanthocircus folium* Bragin, sp. nov., *Tetraspongodiscus uncatus* Bragin, sp. nov., *Poulpus costatus* (Kozur et Mostler), *Eonapora robusta* Kozur et Mostler, *Planispinocyrtis kotelnyensis* Bragin, sp. nov., *Annulotriassocampe baldii* (Kozur), and *Pseudoeucyrtis annosus* Bragin, sp. nov.; *Capnuchosphaera triassica* assemblage of the Late Carnian age, with *Pseudostylosphaera glabella* Bragin, sp. nov., *P. gracilis* Kozur et Mock, *P. voluta* Bragin, sp. nov., *P. gelida* Bragin, sp. nov., *Kahlerosphaera unca* Bragin, sp. nov., *K. aspinosa* Kozur et Mock, *K. fuscinula* Bragin, sp. nov., *K. acris* Bragin, sp. nov., *Capnuchosphaera kuzmichevi* Bragin, sp. nov., *C. triassica* De Wever, *C. angusta* Bragin, sp. nov., *Sarla intorta* Bragin, sp. nov., *S. compressa* Bragin, sp. nov., *S. aequipeda* Bragin, sp. nov., *Betraccium irregulare* Bragin, *B. kotelnyensis* Bragin, sp. nov., *Spongotortilispinus carnicus* (Kozur et Mostler), *S. subtilis* Bragin, sp. nov., *Dumitricasphaera simplex* Tekin, *D. aberrata* Bragin, sp. nov., *D. arbustiva* Bragin, sp. nov., *Zhamojdasphaera epipeda* Bragin, sp. nov., *Z. proceruspinosa* Kozur et Mostler, *Vinassaspongus subsphaericus* Kozur et Mostler, *Palaeosaturnalis triassicus* Kozur et Mostler, *Paronaella concreta* Bragin, sp. nov., *P. aquilonia* Bragin, sp. nov., *Tetraspongodiscus cincinnalis* Bragin, sp. nov., *Annulotriassocampe baldii* (Kozur), *Canoptum zetangense* Wang et Yang, *Whalenella speciosa* (Blome), *Syringocapsa turgida* Blome, *Droltus gelidus* Bragin, sp. nov., and *D. niveus* Bragin, sp. nov.; *Palaeosaturnalis mocki* assemblage of the Early Norian age, with *Pseudostylosphaera glabella* Bragin, sp. nov., *P. gelida* Bragin, sp. nov., *P. voluta* Bragin, sp. nov., *Kahlerosphaera retunsa* Bragin, sp. nov., *Capnuchosphaera deweveri* Kozur et Mostler, *Sarla globosa* Bragin, sp. nov., *Palaeosaturnalis mocki* Kozur et Mostler, *Paronaella aquilonia* Bragin, sp. nov., *Syringocapsa turgida* Blome, and *Droltus gelidus* Bragin, sp. nov.; and an impoverished Middle Norian assemblage, with *Sarla globosa* Bragin, sp. nov., *Sarla* sp., *Paronaella aquilonia* Bragin, sp. nov., *Syringocapsa turgida* Blome, *Canoptum* sp., and *Laxtorum?* sp.

(3) Due to the presence of a number of geographically widespread species, the above assemblages are compared with certainty to associations of the same age from southerly regions. The similarity in taxonomic composition with southern associations increases in the Upper Carnian, which is probably accounted for by migration of southern taxa. The radiolarian fauna from the Upper Triassic of Kotel'nyi Island is distinguished by the mixed composition, including species characteristic of boreal and southern regions. The latter include both cosmopolitans and true Tethyan elements. These features of the taxonomic composition are useful for direct boreal–Tethyan correlation of sections and improvement of Triassic stratigraphy of Kotel'nyi Island.

(4) A total of 69 radiolarian species of 3 orders, 18 families, and 29 genera are described; 44 new species are described. The stratigraphic and geographical ranges of the majority of taxa are specified.

ACKNOWLEDGMENTS

I am grateful to Yu.B. Gladenkov, V.A. Zakharov, and V.S. Vishnevskaya (Geological Institute, Russian Academy of Sciences) for their interest and valuable remarks during the preparation of this publication. I am indebted to A.B. Kuz'michev (Geological Institute, Russian Academy of Sciences) for help in the organization of field work in Kotel'nyi Island. I am grateful to paleontologists who identified macrofossils. Ammonoids were determined by A.G. Konstantinov (Institute of Geology, Siberian Branch, Russian Academy of Sciences, Novosibirsk); nautiloids and coleoids, by E.S. Sobolev (Institute of Geology, Siberian Branch, Russian Academy of Sciences, Novosibirsk); and bivalves, by I.V. Polubotko (VSEGEI). I am sincerely thankful to N.V. Gor'kova (Geological Institute, Russian Academy of Sciences) for producing photographs of microfossils under an electron microscope.

This study was supported by the Program ONZ-14.

REFERENCES

1. Y. Aita and K. B. Sporli, "Late Triassic Radiolaria from the Torlesse Terrane, Rimutaka Range, North Island, New Zealand," New Zeal. J. Geol. Geofiz. **37**, 155–162 (1994).
2. Y. Aita and N.Yu. Bragin, "Non-Tethyan Triassic Radiolaria from New Zealand and Northeastern Siberia," Geodiversitas **21** (4), 503–526 (1999).
3. P. O. Baumgartner, L. O'Dogherty, S. Gorican, E. Urquhart, A. Pillevuit, P. De Wever, et al., "Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, Systematics, Biochronology," Mem. Geol. Lausanne, **23**, 1–1172 (1995).
4. C. D. Blome, "Upper Triassic Capnuchosphaeridae and Capnodocinae (Radiolaria) from East–Central Oregon," Micropaleontology **29** (1), 11–49 (1983).

5. C. D. Blome, "Upper Triassic Radiolaria and Radiolarian Zonation from Western North America," Bull. Am. Paleontol. **85** (1), 1–88 (1984).

6. C. D. Blome and K. M. Reed, "Radiolarian Biostratigraphy of the Quinn River Formation, Black Rock Terrane, North–Central Nevada: Correlations with Eastern Klamath Terrane Geology," Micropaleontology **41** (1), 49–68 (1995).

1 7. V. Bortolotti, M. Chiari, A. Kodra, et al., "Triassic MORB Magmatism in the Southern Mirdita Zone (Albania)," Ofioliti **31** (1), 1–9 (2006).

8. N. Yu. Bragin, "Radiolarians and Lower Mesozoic Strata of the Eastern USSR" Tr. Geol. Inst. Akad. Nauk SSSR **469**, 1–125 (1991).

9. N. Yu. Bragin, "Radiolarians As Indicators of Climate of Northeastern Asia in the Triassic Period," Stratigr. Geol. Korrelyastiya **2** (1), 81–85 (1994).

10. N. Yu. Bragin, "Radiolarian Zones in the Triassic of the Far East of Russia," Stratigr. Geol. Korrelyastiya **8** (6), 59–73 (2000).

11. N. Yu. Bragin, "Late Triassic Radiolarians of Southern Cyprus," Paleontol. J. **41** (10), 951–1029 (2007).

12. N. Yu. Bragin and A. Yu. Egorov, "Middle and Late Triassic Radiolarians from the Dzhugadzhak Section (Omolon Massif)," Stratigr. Geol. Korrelyastiya **8** (4), 49–58 (2000).

13. N. Yu. Bragin and K. A. Krylov, "Early Norian Radiolaria from Cyprus," Geodiversitas **21** (4), 539–569 (1999).

14. E. S. Carter, "Biochronology and Paleontology of Uppermost Triassic (Rhaetian) Radiolarians, Queen Charlotte Islands, British Columbia, Canada," Mem. Geol. Lausanne, No. 11, 1–175 (1993).

15. E. S. Carter, M .J. Orchard, and E. T. Tozer, "Integrated Ammonoid–Conodont–Radiolarian Biostratigraphy Late Triassic Kunga Group, Queen Charlotte Islands, British Columbia," Geol. Surv. Canada Curr. Res. **89** (1), 23–30 (1989).

16. Y.-H. Cheng, "Upper Paleozoic and Lower Mesozoic Radiolarian Assemblages from the Busuanga Island, North Palavan Block, Philippines," Bull. Nat. Mus. Natur. Sci. **1**, 129–175 (1989).

17. A. S. Dagys, Yu. V. Arkhipov, and Yu. M. Bychkov, *Stratigraphy of the Triassic System of Northeastern Asia* (Nauka, Moscow, 1979) [in Russian].

18. T. Danelian, S. Lekkas, and A. Alexopoulos, "Decouverte de radiolarites triasiques dans un complexe ophiolitique a l'Extreme-Sud du Peloponnese (Agelona, Lakonie, Grece)," CR Acad. Sci. Paris. Sci. Terre Plan. **330**, 639–644 (2000).

19. G. Deflandre, "Radiolaires fossiles" in *Traite de Zoologie*, Ed. by P. P. Grasse (Masson, Paris), Vol. 1, No. 2, pp. 389–436 (1953).

20. P. De Wever, *Radiolaries polycystines du Trias et du Lias de Tethys* (Soc. Geol. Nord, Paris, 1982) [in Russian].

21. P. De Wever, A. Sanfilippo, W. R. Riedel, and B. Gruber, "Triassic Radiolaria from Greece, Sicily and Turkey," Micropaleontology **25** (1), 75–110 (1979).

22. D. A. Donofrio and H. Mostler, "Zur Verbreitung der Saturnalidae (Radiolaria) im Mesozoikum der Nordlichen Kalkalpen und Sudalpen," Geol. Paläont. Mitt. Inn. **7** (5), 1–55 (1978).

23. L. Dozstaly, "Geochronological Evaluation of Mesozoic Formations of Darno Hill at Recsk on the Basis of Radiolarians and K–Ar Age Data," Acta Geol. Hung. **35** (4), 371–393 (1993).

24. P. Dumitrica, "Family Eptingiidae, n. fam., Extinct Nassellaria (Radiolaria) with Sagittal Ring," Dari Seama. Inst. Geol. Geofiz. Bucharest **64**, 27–38 (1978a).

25. P. Dumitrica, "Triassic Palaeoscenidiidae and Entactiniidae from the Vicentinian Alps (Italy) and Eastern Carpathians (Romania)," Dari Seama. Inst. Geol. Geofiz. Bucharest **64**, 39–59 (1978b).

26. P. Dumitrica, H. Kozur, and H. Mostler, "Contribution to the Radiolarian Fauna of the Middle Triassic of the Southern Alps," Geol. Paläont. Mitt. Inns. **10** (1), 1–46 (1980).

27. A. Yu. Egorov, Yu. A. Bogomolov, A. G. Konstantinov, and N. I. Kurushin, "Stratigraphy of Triassic Deposits of Kotel'nyi Island (New Siberian Islands)," in *Boreal Triassic* (Nauka, Moscow, 1987), pp. 66–80 [in Russian].

28. A. Yu. Egorov and N. Yu. Bragin, "The First Finds of Radiolarians in Triassic Deposits of Northern Siberia," Dokl. Akad. Nauk. **340** (5), 649–652 (1995).

29. C. G. Ehrenberg, "Fortsetzung der mikrogeologischen Studien als Gesammt-Uebersichtder mikroskopisschen Paläontologie gleichartig analysirter Gebirgsarten der Erde, mit specieller Rucksicht auf den Polycystinen-Mergel von Barbados," (Abhand. Koniglishe Preussichen Acad. Wissens., Berlin, 1875).

30. H. P. Foreman, "Radiolaria from DSDP Leg 20" in *Initial Reports of the Deep Sea Drilling Project*, Ed. by B. C. Heezen, J. D. MacGregor, et al. (US Gov. Print. Off., Washington DC, 1973), Vol. 20, pp. 249–305.

31. J. Fujii, I. Hattori, and T. Nakajima, "A Study of Radiolarian Biostratigraphy and Magnetostratigraphy of Early Mesozoic Red Bedded Chert, Central Japan," News Osaka Micropaleont., Spec. **9**, 71–89 (1993).

32. S. Gorican and S. Buser, "Middle Triassic Radiolarians from Slovenia (Yugoslavia)," Geol. Ljubljana **31–32**, 133–197 (1990).

33. S. Gorican, J. Halamic, T. Grgasovic, and T. Kolar-Jurkovsek, "Stratigraphic Evolution of Triassic Arc–Backarc System in Northwestern Croatia," Bull. Soc. Geol. Fr. **176** (1), 3–22 (2005).

34. R. H. Grapes, S. H. Lamb, H. L. Campbell, B. Sporli, and J. E. Simes, "Geology of the Red Rocks—Turbidite Association, Wellington Peninsula, New Zealand," New Zeal. J. Geol. Geoph. **33**, 377–391 (1990).

35. E. Haeckel, *Die Radiolarien (Rhizopoda Radiaria): Eine monographie* (Reimer, Berlin, 1862).

36. E. Haeckel, "Entwurf eines Radiolarian-Systems auf Grund von Studien der Challenger-Radiolarien," Jen. Zeits. Naterwissens. **15**, 418–472 (1881).

37. E. Haeckel, "Report on the Radiolaria Collected by H.M.S. *Challenger* during the Years 1873–1876," Rep. Sci. Res. Voy. Challenger, Edinburgh Zool. **18**, 1–1803 (1887)

38. J. Halamic and S. Gorican, "Triassic Radiolarites from Mts. Kalnik and Medvednica (Northwestern Croatia)," Geol. Croat. **48** (2), 129–146 (1995).

39. R. S. Hori, J. D.Campbell, and J. A. Grant-Mackie, "Triassic Radiolaria from Kaka Point Structural Belt, Otago, New Zealand," J. R. Soc. New Zeal. **33** (1), 39–55 (2003).

40. S. Kido, "Occurrence of Triassic Chert and Jurassic Siliceous Shale at Kamiaso, Gifu Prefecture, Central Japan," Micropaleontology **5** (Spec. Vol.: Proceedings of the First Japanese Radiolarian Symposium, News of Osaka), 135–152 (1982).

41. A. L. Knipper, M. A. Satian, and N. Yu. Bragin, "Upper Triassic–Lower Jurassic Volcanogenic–Sedimentary Deposits of the Staryi Zodskii Pass (Transcaucasia)," Stratigr. Geol. Korrelyastiya **5** (3), 58–65 (1997).

42. A. G. Konstantinov and E. S. Sobolev, "Biostratigraphic Scheme of the Carnian and Lower Norian of Northeastern Russia: 2. New Zonal Scales and Correlation," Tikhookean. Geol. **18** (4), 48–60 (1999).

43. A. G. Konstantinov, E. S. Sobolev, and T. V. Klets, "New Data on the Fauna and Biostratigraphy of Norian Deposits of Kotel'nyi Island (New Siberian Islands)," Stratigr. Geol. Korrelyastiya **11** (3), 27–39 (2003).

44. M. V. Korchinskaya, "On Biostratigraphy of Triassic Deposits of Kotel'nyi Island (New Siberian Islands)," in *Mesozoic Deposits of the Northeastern USSR* (Leningrad, 1977), pp. 43–49 [in Russian].

45. H. Kozur, "New Radiolarian Taxa from the Triassic and Jurassic," Geol. Paläont. Mitt. Inns. **13** (2), 49–88 (1984).

46. H. Kozur, "Muelleritortiidae n. fam., eine characteristishe longobardische (oberladinische) Radiolarienfamilie: T. I," Freiberger Forch.-H. **49**, 51–61 (1988).

47. H. Kozur, K. Krainer, and H. Mostler, "Radiolarians and Facies of the Middle Triassic Loibl Formation, South Alpine Karawanken Mountains (Carinthia, Austria)," Geol. Paläont. Mitt. Inns. Sonderband **4**, 195–269 (1996).

48. H. Kozur and H. Mostler, "Beitrage zur Erforschung der Mesozoischen Radiolaria: T. 1," Geol. Paläontol. Mitt. Inns. **2** (8–9), 1–60 (1972).

49. H. Kozur and H. Mostler, "Beitrage zur Erforschung der Mesozoichen Radiolaria: T. 3," Geol. Paläontol. Mitt. Inns. **9** (1–2), 1–132 (1979).

50. H. Kozur and H. Mostler, "Beitrage zur Erforschung der mesozoichen Radiolarien: T. 4," Geol. Paläontol. Mitt. Inns. Sonderbd. **1**, 208 (1981).

51. H. Kozur and H. Mostler, "Entactinaria subordo nov., a New Radiolarian Suborder," Geol. Paläont. Mitt. Inns. **11** (12), 399–414 (1982).

52. H. Kozur and H. Mostler, "The Polyphyletic Origin and the Classification of the Mesozoic Saturnalids (Radiolaria)," Geol. Paläont. Mitt. Inns. **13** (1), 1–47 (1983).

53. H. Kozur and H. Mostler, "Anisian to Middle Carnian Radiolarian Zonation and Description of Some Stratigraphically Important Radiolarians," Geol. Paläont. Mitt. Inns. Sonderband. **3**, 39–255 (1994).

54. H. Kozur and H. Mostler, "Longobardian (late Ladinian) Muelleritortiidae (Radiolaria) from the republic of Bosnia-Hercegovina," Geol. Paläont. Mitt. Inns. Sonderband 4, 83–103 (1996).

55. B. Lahm, "Spumellarienfaunen (Radiolaria) aus den mitteltriassischen Buchensteiner Schichten von Recoaro (Norditalien) und den obertriassischen Reiflingerkalken von Grossreifling (Osterreich). Systematik. Stratigraphie," Mun. Geowiss. Abh. Reihe A. Geol. Paläontol. **1**, 1–161 (1984).

56. P. Moix, H. Kozur, G. Stampfli and H. Mostler, "New paleontological, biostratigraphic and paleogeographic results from the Triassic of the Mersin Melange, SE Turkey" in Lucas S.G & Spielman J.A. (Eds), The Global Triassic. Bulletin of the New Mexico Museum of Natural History and Science, New Mexico. **41**, 282–305 (2007).

57. K. Nakaseko and A. Nishimura, "Upper Triassic Radiolaria from Southwest Japan," Sci. Rep. Coll. Gen. Educ. Osaka Univ. **28** (2), 61–109 (1979).

58. A. Neviani, "Supplemento alla fauna a Radiolari delle rocce mesozoichen del Bolognese," Boll. Sic. Geol. Ital. **19**, 645–671 (1900).

59. Y. Nishizono, A. Ohishi, T. Sato, and M. Murata, "Radiolarian Fauna from the Paleozoic and Mesozoic Formations Distributed along the Mid-stream of Kuma River, Kyushu, Japan," Micropaleontology **5** (Spec Vol.: Proceedings of the First Japanese Radiolarian Symposium, News of Osaka), 311–326 (1982).

60. M. Ohtaka, Y. Aita, and T. Sakai, "Middle Triassic Radiolarian Biostratigraphy of the Bedde Chert in the Minowa Quarry, Kuzuu Town, Ashio Mountains," News Osaka Micropaleontol. **11** (Spec. Vol.), 95–113 (1998).

61. T. Otsuka, M. Kajima, and R. Hori, "The Batinah Olistostrome of the Oman Mountains and Mesozoic Radiolarians," Micropaleontology **8** (Spec. Vol.: Proceedings of the Third Radiolarian Symposium, News of Osaka), 21–34 (1992).

62. E. A. Pessagno, jr., "Jurassic and Cretaceous Hagiastridae from the Blake-Bahama Basin (Site 5A, JOIDES Leg 1) and the Great Valley Sequence, California Coast Ranges", Bull. Am. Paleontol. **60** (264), 5–83 (1971).

63. E. A. Pessagno, jr., "Upper Jurassic Radiolaria and Radiolarian Biostratigraphy of the California Coast Ranges," Micropaleontology **23** (1), 56–113 (1977a).

64. E. A. Pessagno, jr., "Lower Cretaceous Radiolarian Biostratigraphy of the Great Valley Sequence and Franciscan Complex, California Coast Ranges," Contrib. Cushman Found. Foramin. Res., No. 15 (Special Publ.), 1–87 (1977b).

65. E. A. Pessagno, jr., W. Finch, and P. L. Abbott, "Upper Triassic Radiolaria from the San Hipolito Formation, Baja California," Micropaleontology **25** (1), 160–197 (1979).

66. E. A. Pessagno, jr. and P. A. Whalen, "Lower and Middle Jurassic Radiolaria from California, East–Central Oregon and the Queen Charlotte Islands," Micropaleontology **28** (2), 111–169. (1982).

67. M. G. Petrushevskaya, "A New Variant of the Polycystina System," in *Extinct and Extant Radiolarians* (Zool.

Inst. Akad. Nauk SSSR, Leningrad, 1979), pp. 101–118 [in Russian].

68. E. N. Preobrazhenskaya, G. V. Trufanov, D. A. Vol'nov, et al., "Mesozoic Deposits of Kotel'nyi Island," in *Geology and Minerals of the New Siberian Islands and Wrangel Island* (Leningrad, 1975), pp. 28–37 [in Russian].
69. A. Ramovs and S. Gorican, "Late Anisian–Early Ladinian Radiolarians and Conodonts from Smarna Gora near Ljubljana, Slovenia," Razpr. IV. Razr. SAZU **36** (9), 179–221 (1995).
70. T. Sato, M. Murata, and H. Yoshida, "Triassic to Jurassic Radiolarian Biostratigraphy in the Southern Part of the Chichibu Terrane of Kyushu, Japan," News Osaka Micropaleont. **7** (Spec. Vol.), 9–23 (1986).
71. J. P. Smith, "Upper Triassic Marine Invertebrate Faunas of North America," USGS Prof. Pap., No. 141, 1–262 (1927).
72. K. Sugiyama, "Triassic and Lower Jurassic Radiolarian Biostratigraphy in the Siliceous Claystone and Bedded Chert Units of the Southeastern Mino Terrane, Central Japan," Bull. Mizunami Fos. Mus. **24**, 79–153 (1997).
73. U. K. Tekin, "Biostratigraphy and Systematics of Late Middle to Late Triassic Radiolarians from the Taurus Mountains and Ankara Region, Turkey," Geol. Paläont. Mitt. Inns. Sdb. **5**, 1–296 (1999).
74. U. K. Tekin and M. C.Goncuoglu, "Discovery of the Oldest (Upper Ladinian to Middle Carnian) Radiolarian Assemblages from the Bornova Flysh Zone in Western Turkey: Implications for the Evolution of the Neotethyan Izmir–Ankara Ocean," Ofioliti **32** (2), 131–150 (2007).
75. U. K. Tekin and H. Mostler, "Longobardian (Middle Triassic) Entactinarian and Nassellarian Radiolaria from the Dinarides of Bosnia and Herzegovina," J. Paleontol. **79** (1), 1–20 (2005a).
76. U. K. Tekin and H. Mostler, "Late Ladinian (Middle Triassic) Spumellaria (Radiolaria) from the Dinarides of Bosnia and Herzegovina," Riv. Ital. Paleontol. Strat. **111** (1), 21–43 (2005b).
77. U. K. Tekin, A. Mørk, and W. R. Weitschat, "Radiolarians from the Ladinian–Early Carnian Successions of Svalbard," NGF Abstr. Proc. **3**, 131–134 (2006).
78. E. T. Tozer, "Canadian Triassic Ammonoid Faunas," Bull., Geol. Surv. Canada **467**, 1–663 (1994).
79. Y. Wang, Q. Yang, A. Matsuoka, et al., "Triassic Radiolarians from the Yarlung–Zangbo Suture Zone in the Jinlu Area, Zetang County, Southern Tibet," Acta Micropaleontol. Sin. **19** (3), 215–227 (2002).
80. K.-Y. Yeh, "Studies of Radiolaria from Fields Creek Formation, East–Central Oregon, USA," Bull. Nat. Mus. Natur. Sci. **1**, 43–109 (1989).
81. K.-Y. Yeh, "Taxonomic Studies of Radiolaria from Busuanga Island, Philippines," Bull. Nat. Mus. Natur. Sci. **2**, 1–63 (1990).
82. K.-Y. Yeh, "Triassic Radiolaria from Uson Island, Philippines," Bull. Nat. Mus. Natur. Sci. **3**, 51–91 (1992).

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