

# New Early Ordovician Calcareous Foraminifers of the Middle Tien Shan

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**Abstract**—Twelve new species of calcareous foraminifers of the genera *Parathurammina*, *Parathuramminites*, *Bisphaera*, *Archaesphaera*, and *Vicinesphaera* from the Lower Ordovician of the Middle Tien Shan are described.

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**Key words:** Foraminifera, new taxa, Ordovician, Tien Shan.

## INTRODUCTION

Primitive calcareous secreting foraminifers, which are widespread in the Silurian and, particularly, in the Devonian, are extremely scarce in earlier strata; thus, such records are of great interest.

Published data on Ordovician and Cambrian foraminifers were reviewed by Reitlinger (1948), Bykova (1956), and Lipina (1959). More detailed information was provided by Loeblich and Tappan (1964) and Pojarkov (1979). The analysis of published data shows that, outside the former Soviet Union, the Cambrian and Ordovician beds yielded only agglutinating arenaceous and chitinoïd taxa, which were mostly examined after extraction from the matrix. These foraminifers are phylogenetically remote from secreting calcareous foraminifers. Subsequently, some of these genera and species were removed from foraminifers. To date, 14 genera of arenaceous foraminifers have been recorded in the Cambrian and Ordovician beds of the United States, Greenland, Norway, Sweden, Poland, Belgium, and China, four of which occur in the Cambrian. Arenaceous foraminifers from the Ordovician of the former Soviet Union were described for the first time by Bykova (1956) from the Baltic Region. Chitinoïd foraminifers resembling those from the Silurian of the Baltic Region were described from Upper Caradocian claystones of northern Kazakhstan (Bykova, 1958), while calcareous tubular tests of the genera *Parasiniella* and *Turbianta*, along with arenaceous and chitinoïd taxa, were described from the Caradocian beds of eastern Kazakhstan (Bykova, 1961).

From the Cambrian beds of Yakutia, Reitlinger (1948) described unusual small spiral tubular formations with a dark calcareous wall (in sections), which were presumably referred to as foraminifers of the genera *Obruchevella*, *Glomovertella*, *Cavifera*, and *Syn-*

*iella*. Vologdin (1958) described similar calcareous tubular formations from the Lower Cambrian of Tuva and assigned them to new foraminifer genera, *Reitlingerella*, *Bostrychosaria*, *Flexurella*, *Kordella*, *Lebedevella*, *Lukashevella*, and *Tuvaellina*. Subsequently, Reitlinger (1959) assigned the genera established by her in 1948 to tubular formations of uncertain taxonomic position and described single-chamber calcareous foraminifers, including *Archaesphaera cambrica*, *A. cambrica* var. *crafta*, *Vicinesphaera eosqualida*, *Vicinesphaera* sp.; at present, these taxa are considered to be problematic formations of vegetative nature, *Calcisphaera tjungensis* and *C. mundruchensis* (Luchina, 1975). In the same year, Lipina (1959) described one specimen from the Ordovician of Siberia, *Hyperammina sibirica* forma *grandis*, along with Silurian calcareous foraminifers. Pronina (1960) described *Parathurammina serginensis* from the Middle and Upper Ordovician of the western slope of the Ural Mountains. Loeblich and Tappan (1964) placed all tubular formations described by Reitlinger (1948) and Vologdin (1958), the genera *Parasyniella* and *Turbianta* described by Bykova (1961), and *Chabakovia* (Vologdin, 1939) to the foraminiferal order Reitlingerellida Vologdin, 1958. Riding and Brasier (1975) established a new family (Renalcidae) of the superfamily Parathuramminacea, which comprised six genera assigned by most of the researchers to calcareous algae: *Renalcis* Vologdin, *Nubecularites* Maslov, *Chabakovia* Vologdin, *Shuguria* Antropov, *Izhella* Antropov, and *Nephelostroma* Dangeard et Dore. Riding and Brasier regarded these taxa as the earliest foraminifers, which developed from the Early Cambrian. Two genera from this list (*Renalcis* and *Chabakovia*) were for the first time assigned to foraminifers by Elias (1950). Pojarkov (1979) excluded some genera from the order Reitlingerellida, such that only the genera *Reitlingerella*, *Obruchevella*, *Lebedevella*, *Glomovertella*, *Cavifera*,

and *Syniella* were still referred to foraminifers. However, a present, algologists usually assign these formations, along with six genera of the family Renalciidae Riding and Brasier, to the blue-green algae (Luchinina, 1975; Chuvashov *et al.*, 1985). The authors adhere to this point of view.

Saltovskaia (1989) described seven new species of calcareous foraminifers from the Upper Ordovician beds of the Zeravshan–Hissar mountain region: *Parathuramina antiqua*, *Eoirregularina magnifica*, *Vulgarella crassa*, *V. sabirovi*, *Quasiserginella oblonga*, *Cribrosphaeroides praeturcmenica*, and *Bisphaera eoelegans*. Thus, of all presently known Cambrian and Ordovician calcareous secreting taxa, only the following forms should be assigned to foraminifers: *Archaesphaera cambrica* Reitlinger, *A. cambrica* var. *crafta* Reitlinger, *Vicinesphaera eosqualida* Reitlinger, *Vicinesphaera* sp. (Cambrian of Siberia), *Earlandia sibirica* (Lipina) forma *grandis* (Ordovician of Siberia), *Parathuramina sergiensis* Pronina (Middle–Upper Ordovician of the Ural Mountains), and seven species from the Upper Ordovician of Uzbekistan described by Saltovskaia (1989). The Lower Ordovician has not yielded any taxa.

Thus, the numerous calcareous secreting foraminifers found in the Lower Ordovician beds of the Tien Shan are of great interest. These foraminifers were found by S.B. Gushchin in carbonate rocks of the Upper Cambrian–Middle Ordovician of the Beshtash Formation in the Kainar–Karagain interfluvium (southern slope of the Talass Mountains). Gushchin described this section in detail and performed a layer-by-layer sampling of microfauna along with accompanying macrofauna. All the taxa described come from the Lower Ordovician, although individual specimens of inferior preservation occur in the overlying Middle Ordovician beds. These strata were dated based on nautiloids, brachiopods, gastropods, conodonts, and corals.

To date, it has been impossible to extract calcareous secreting foraminifers from dense carbonate matrix by physical or chemical methods. Our attempts at solving this problem using an ultrasonic disintegrator have been unsuccessful, because specimens split at the boundaries of calcareous grains composing both walls of foraminifers and enclosing matrix rather than at the boundaries of calcareous foraminifer walls and the carbonate matrix. Therefore, the morphology of foraminifers and microstructure of their walls were examined in transparent sections using standard transmitted or polarized light, under a 50- to 1200-power microscope. The objects recognized are referred to primitive foraminifers, because they are similar in morphology to members of the order Parathuramminida, which are widespread in the Silurian and Devonian; the microscopic study of the wall has shown that it corresponds in structure to this order, is organic in nature, calcareous, secreting, granular, and dark in transmitted light, or, according to the modern terminology (*Reference Book...*, 1993), it is microgranular. The walls of younger parathuramminids, in particular, those of

Devonian taxa, consist of small randomly oriented calcite crystals tightly adjoining each other. In contrast, the foraminifers considered in the present study, belonging to the genera *Parathuramina*, *Parathuramminites*, *Vicinesphaera*, *Archaesphaera*, and *Bisphaera*, which are widespread in the younger Middle Paleozoic strata, are more primitive in appearance, which is primarily manifested in the wall structure. It is more friable, lighter in color, more coarse-grained, with isolated inclusions of large transparent calcite grains, frequently with indistinct, uneven internal and external outlines, with constrictions and pockets on the surface of the internal cavity. In addition, they are more variable and usually less regular in shape.

The systematics accepted in the present study follows that proposed by Sabirov (1987) and in *Reference Book on the Systematics of Paleozoic Smaller Foraminifers* (1993).

In addition to the species described, some specimens were identified as *Parathuramina* sp., *Earlandia* sp., *Bituberitina* sp., *Parastegnammina* sp., etc.; they are not described because of limited material or poor preservation. Members of the genus *Vicinesphaera* prevail in the assemblage with reference to both taxonomic diversity and abundance.

The data obtained do not corroborate the stepwise character of foraminifer development, which was established based on material from the Ural Mountains (Pronina, 1978), giving evidence for the evolution from primitive thick-walled parathuramminids lacking apertural necks (Silurian, Lower Ludlovian) to better organized taxa with a medium-thick wall (Upper Ludlovian) and, then, to thin-walled taxa possessing apertural necks (transitive layers between the Silurian and Devonian); our data do not agree with the statement that thick-walled tests mostly occur in the second half of the existence of parathuramminids (Pojarokov, 1969), i.e., beginning approximately from the Givetian. As early as the Early Ordovician or, possibly, even earlier, both branches existed simultaneously and evolved in parallel up to their extinction in the Carboniferous; this is evident from the original data on their development in the Ordovician, Silurian, Devonian, and Early Carboniferous of the Tien Shan.

The foraminifers described are housed in the Institute of Geology of the Academy of Sciences of the Republic of Tajikistan, Dushanbe (IG AS RT); collection no. 13.

## SYSTEMATIC PALEONTOLOGY

Superfamily Parathuramminacea E. Bykova, 1955

Family Parathuramminidae E. Bykova, 1955

Genus *Parathuramina* Suleimanov, 1945

*Parathuramina talassica* Sabirov et Gushchin, sp. nov.

Plate 1, fig. 1

Etymology. From the Talass Mountains.

Holotype. IG AS RT, no. 13/1; Talass Mountains, Kainar–Karagain interfluvium; Lower Ordovician.

**Description.** The test is rounded or angular round in shape, with projecting conical apertural eminences varying in diameter. The wall is dark, single-layered, calcareous, granular, rough, and nonuniform in thickness.

**Measurements, mm:**

	Holotype	Range of variation
Test diameter (without apertural eminences)	0.31	0.29–0.33
Length of apertural eminences	0.03–0.08	0.03–0.09
Diameters of apertural openings	0.01–0.037	0.008–0.04
Wall thickness	0.02	0.018–0.02
Number of apertures in section	4	3–4

**Comparison.** *P. talassica* differs from the previously known thin-walled *Parathuramina*, which occur in younger beds, in the apertural eminences and apertural openings varying in size within the same test and in the nonuniformly thick and rough wall.

**Material.** Three specimens from the type locality.

### Genus *Parathuramminites* Antropov, 1970

*Parathuramminites kainaricus* Sabirov et Gushchin, sp. nov.

Plate 1, fig. 5

**Etymology.** From the Kainar River.

**Holotype.** IG AS RT, no. 13/2; Talass Mountains, Kainar–Karagain interfluve; Lower Ordovician.

**Description.** The test is irregularly rounded in shape, with an irregular internal cavity. The wall is thick, nonuniform in thickness, pierced by narrow cylindrical apertural canals, which are frequently curved. Apertural eminences are absent. The wall is dark gray, single-layered, calcareous, and rough on both surfaces.

**Measurements, mm:**

	Holotype	Range of variation
Test diameter	0.31	0.26–0.31
Diameter of internal cavity	0.168	0.14–0.168
Diameter of apertural canals	0.009	0.008–0.01
Wall thickness	0.038–0.09	0.032–0.1
Number of canals in section	5	4–7

**Comparison.** The new species differs from *P. eosuleimanovi* sp. nov. in the absence of apertural eminences, in the curved apertural canals, smaller dimensions, less regular shape, and widely varying wall thickness within the same test. A comparison with *P. sphaericus* sp. nov. is given in its description.

**Material.** Four variously preserved specimens from the type locality.

*Parathuramminites sphaericus* Sabirov et Gushchin, sp. nov.

Plate 1, fig. 3

**Etymology.** From the Latin *sphaericus* (spherical).

**Holotype.** IG AS RT, no. 13/3; Talass Mountains, Kainar–Karagain interfluve; Lower Ordovician.

**Description.** The test is large, spherical or subspherical, with a rounded internal cavity. The wall is thick, more or less smooth, pierced by large cylindrical apertural canals; it is single-layered, calcareous, fine- or medium-grained, with inclusions of transparent calcite.

**Measurements, mm:**

	Holotype	Range of variation
Test diameter	0.53	0.5–0.57
Diameter of internal cavity	0.28	0.22–0.31
Diameter of apertural canals	0.046	0.038–0.046
Number of apertures in section	2	2–4

**Comparison.** The new species differs from *P. kainaricus* sp. nov. in the more regular shape, large size, thicker and uniform wall, and in the greater diameter of the apertural canals.

**Material.** Four specimens from the type locality.

*Parathuramminites eosuleimanovi* Sabirov et Gushchin, sp. nov.

Plate 1, figs. 2 and 4

**Etymology.** From the Greek *eos* (dawn) and the closely related species *P. suleimanovi* Lipina.

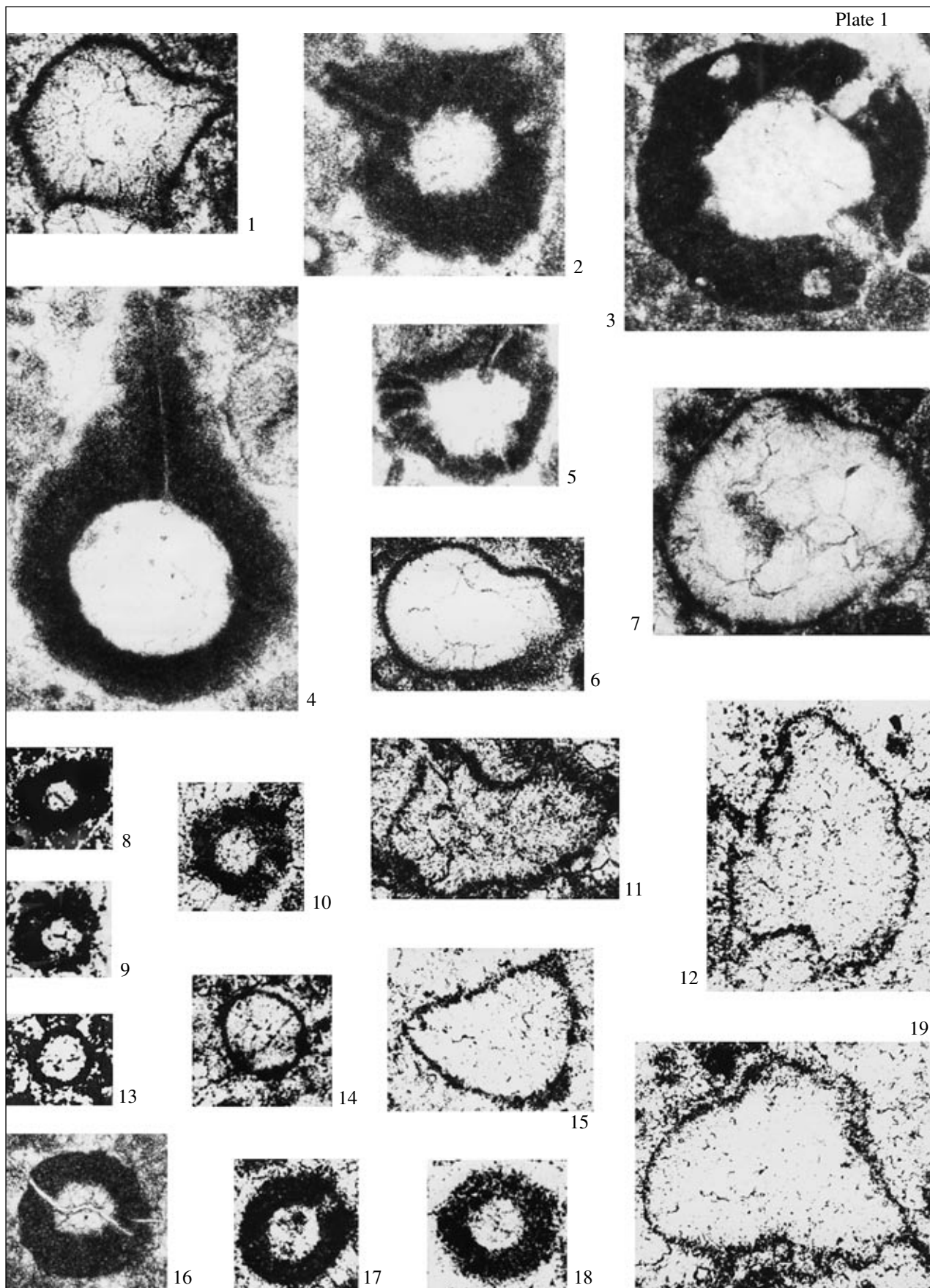
**Holotype.** IG AS RT, no. 13/4; Talass Mountains, Kainar–Karagain interfluve, lower Ordovician.

**Description.** The test is large, rounded externally, with a spherical internal cavity and widely spaced conical eminences enclosing the apertural canal. The eminences are up to half as long as the test diameter. The external surface is relatively rough and uneven. The wall is dark, fine- or medium-grained, single-layered, calcareous, more or less uniform in thickness, except for the sites with eminences, where it is sharply thickened. Occasionally, it contains large transparent calcite grains. The sections further from the center have smaller test and internal cavity, but have thicker walls.

**Measurements, mm:**

	Holotype	Range of variation
Test diameter (without eminences)	0.48	0.35–0.49
Diameter of internal cavity	0.3	0.12–0.32
Height of projections (eminences)	0.24	0.08–0.24
Length of apertural canal	0.36	0.17–0.36
Diameter of apertural canal	0.0085	0.008–0.01
Number of apertures in section	1	1–2

**Comparison.** The new species differs from *P. kainaricus* sp. nov. and *P. sphaericus* sp. nov. in the presence of projections at the sites of the apertural



canals. It differs from the Upper Devonian–Lower Carboniferous *P. suleimanovi* Lipina, 1950, which is similar in general structure, in the larger size (0.35–0.49 mm versus 0.12–0.26 mm), less dense wall, and the presence of individual large calcite grains in the wall.

**Material.** Five specimens from the type locality.

### Family Bisphaeridae Sabirov, 1987

#### Genus *Bisphaera* Birina, 1948

*Bisphaera eomalevkensis* Sabirov et Gushchin, sp. nov.

Plate 1, figs. 6 and 7

**Etymology.** From the Greek *eos* (dawn) and the closely related species *B. malevkensis* Birina, 1948.

**Holotype.** IG AS RT, no. 13/6; Talass Mountains, Kainar–Karagain interfluvium; Lower Ordovician.

**Description.** The test is medium- or large-sized, rounded oval in shape, with gently sloping convexities and gentle constrictions. Some limited areas are uneven due to small irregularly shaped projections or concave sites. The wall is dark, single-layered, calcareous, fine-grained, thin, and, in places, nonuniform in thickness.

**Measurements, mm:**

	Holotype	Range of variation
Test length	0.49	0.34–0.52
Test width	0.40	0.24–0.4
Wall thickness	0.012	0.01–0.013

**Comparison.** The new species resembles *B. malevkensis* Birina, 1948 in the rounded oval shape, gentle constrictions, and weakly sloping convexities and differs in the presence of small sites of irregular shape and in the less dense wall varying in thickness.

**Material.** Eight specimens from the type locality.

*Bisphaera primitiva* Sabirov et Gushchin, sp. nov.

Plate 1, figs. 11, 12, 15, and 19

**Etymology.** From the Latin *primitivus* (primitive).

**Holotype.** IG AS RT, no. 13/8; Talass Mountains, Kainar–Karagain interfluvium; Lower Ordovician.

**Description.** The test is irregularly rounded angular in shape, with abrupt constrictions and bends of the wall and angular projections. The wall is single-layered, calcareous, nonuniform in thickness, rough, loose, granular.

**Measurements, mm:**

	Holotype	Range of variation
Test length	0.47	0.3–0.49
Test width	0.33	0.19–0.35
Wall thickness	0.01–0.017	0.01–0.035

**Comparison.** The new species differs from *B. eomalevkensis* sp. nov. in the irregularly shaped test and the strongly rough wall varying in thickness to a greater extent. It differs from *B. irregularis* Birina, 1948 in the wall structure.

**Material.** Eighteen variously preserved specimens from the type locality.

### Family Archaesphaeridae Antropov, 1970

#### Genus *Archaesphaera* Suleimanov, 1945

*Archaesphaera postcambrica* Sabirov et Gushchin, sp. nov.

Plate 1, figs. 13 and 14

**Etymology.** From the Latin *post* (behind, after, later) and the species name *A. cambrica* Reitlinger, 1959.

**Holotype.** IG AS RT, no. 13/12; Talass Mountains, Kainar–Karagain interfluvium; Lower Ordovician.

**Description.** The test is small, spherical or spherical in shape. The wall is dark, rough, calcareous, single-layered, nonuniform in thickness, fine-grained.

**Measurements, mm:**

	Holotype	Range of variation
Diameter	0.11	0.10–0.16
Wall thickness	0.011–0.013	0.007–0.015

### Explanation of Plate 1

All specimens come from the Lower Ordovician of the Talass Mountains, at 100-fold magnification.

**Fig. 1.** *Parathuramina talassica* sp. nov., holotype IG AS RT, no. 13/1.

**Figs. 2 and 4.** *Parathuramminites eosuleimanovi* sp. nov.: (2) IG AS RT, no. 13/7 and (4) Holotype. IG AS RT, no. 13/4.

**Fig. 3.** *Parathuramminites sphaericus* sp. nov., holotype IG AS RT, no. 13/3.

**Fig. 5.** *Parathuramminites kainaricus* sp. nov., holotype IG AS RT, no. 13/2.

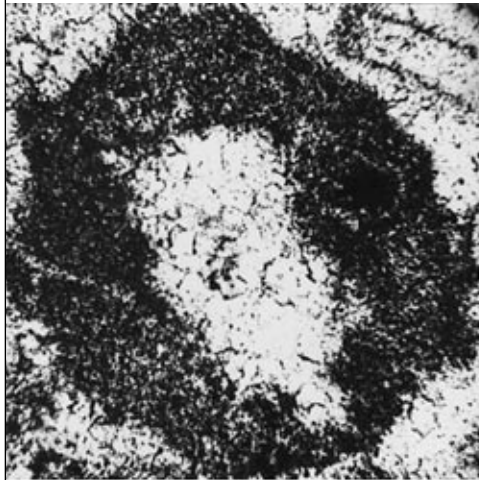
**Figs. 6 and 7.** *Bisphaera eomalevkensis* sp. nov.: (6) IG AS RT, no. 13/7 and (7) holotype, IG AS RT, no. 13/6.

**Figs. 8–10.** *Vicinesphaera parva* sp. nov.: (8) holotype, IG AS RT, no. 13/17; (9) IG AS RT, no. 13/18; and (10) IG AS RT, no. 13/36.

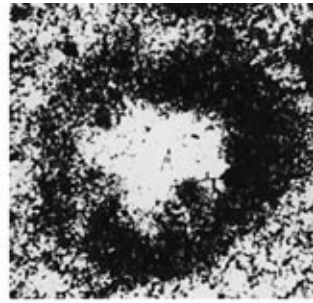
**Figs. 11, 12, 15, and 19.** *Bisphaera primitiva* sp. nov.: (11) IG AS RT, no. 13/11; (12) IG AS RT, no. 13/10; (15) IG AS RT, no. 13/9; and (19) holotype, IG AS RT, no. 13/8.

**Figs. 13 and 14.** *Archaesphaera postcambrica* sp. nov.: (13) holotype, IG AS RT, no. 13/12 and (14) IG AS RT, no. 13/13.

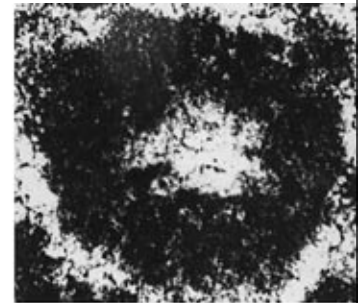
**Figs. 16–18.** *Vicinesphaera globosa* sp. nov. (16) IG AS RT, no. 13/16; (17) IG AS RT, no. 13/15; and (18) holotype, IG AS RT, no. 13/14.



1



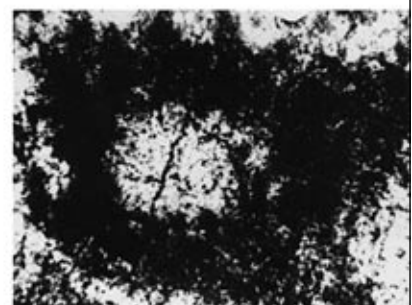
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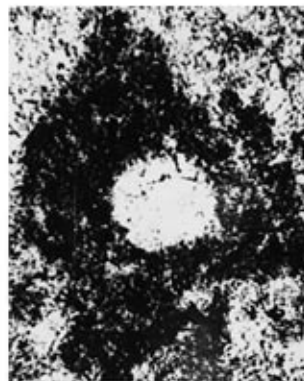
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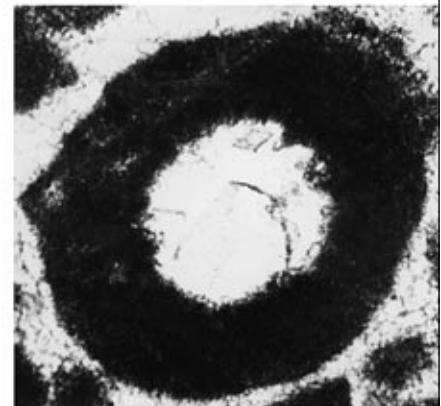
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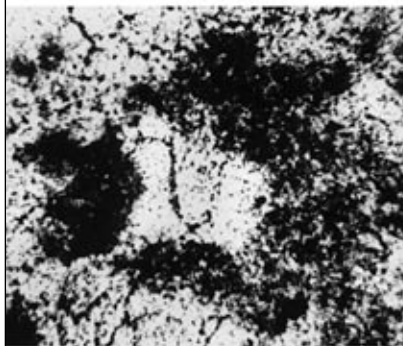
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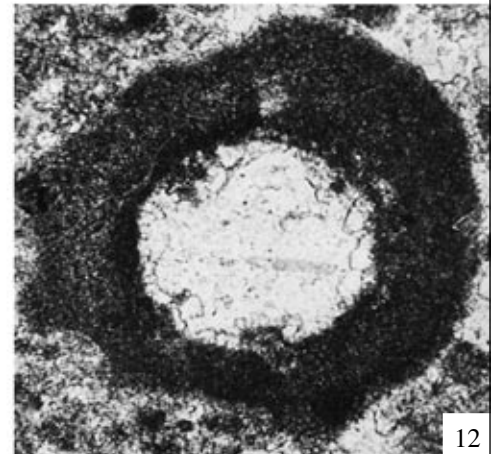
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10



11



12

**Comparison.** The new species differs from *A. cambrica* Reitlinger, 1959 in the larger dimensions and in the wall structure. In *A. cambrica*, the wall is smooth and uniform in thickness. *A. postcambrica* differs from *A. cambrica* var. *crafta* Reitlinger, 1959 in the rough and thinner wall (0.007–0.015 mm versus 0.02–0.023 mm) and in its smaller dimensions. It differs from *A. minima* Suleimanov, 1945 in the less regular shape and in the rough wall of nonuniform thickness.

**Material.** Eight specimens from the type locality.

### Genus *Vicinesphaera* Antropov, 1950

*Vicinesphaera globosa* Sabirov et Gushchin, sp. nov.

Plate 1, figs. 16–18

**Etyymology.** From the Latin *globosus* (globular).

**Holotype.** IG AS RT, no. 13/14; Talass Mountains, Kainar–Karagain interfluve; Lower Ordovician.

**Description.** The test and its internal cavity are spherical or subspherical. The wall is single-layered, thick, calcareous, medium-grained, usually uniform in thickness, usually rough, or, occasionally with inclusions of relatively large calcite grains.

**Measurements, mm:**

	Holotype	Range of variation
Test diameter	0.2	0.2–0.27
Diameter of internal cavity	0.09	0.08–0.11
Wall thickness	0.055	0.04–0.07

**Comparison.** The new species differs from *V. squalida* Antropov, 1950 and *V. eosqualida* Reitlinger, 1959 in the uniform thickness and general structure of the wall and regular outlines, without projections. In addition, it differs from *V. eosqualida* in the smaller dimensions of the internal cavity combined with the relatively larger test diameter. It differs from *V. parva* sp. nov. in the regular outlines, the larger dimensions of the internal cavity (0.08–0.11 mm versus 0.045–0.065 mm), and the uniform thickness of the wall.

**Material.** Seven specimens from the type locality.

*Vicinesphaera parva* Sabirov et Gushchin, sp. nov.

Plate 1, figs. 8–10

**Etyymology.** From the Latin *parvus* (small).

**Holotype.** IG AS RT, no. 13/17; Talass Mountains, Kainar–Karagain interfluve; Lower Ordovician.

**Description.** The test is irregularly angular, with a more regular spherical internal cavity. The wall is single-layered, calcareous, thick, nonuniform in thickness because of various projections, medium or fine-grained, with inclusions of larger calcite grains, somewhat loose and rough.

**Measurements, mm:**

	Holotype	Range of variation
Greatest diameter	0.17	0.11–0.17
Diameter of internal cavity	0.065	0.045–0.065
Wall thickness	0.02–0.065	0.02–0.07

**Comparison.** The new species differs from the most closely related *V. squalida* Antropov, 1950 in the wall structure, i.e., its looseness and roughness. It additionally differs from *V. eosqualida* Reitlinger, 1959 in the smaller dimensions; the diameter of the internal cavity is 0.045–0.065 mm (versus 0.13 mm), while the test diameter is 0.11–0.17 mm (versus 0.19 mm).

**Material.** Eight specimens from the type locality.

*Vicinesphaera mutabilis* Sabirov et Gushchin, sp. nov.

Plate 2, figs. 1–3, 6, 7, and 11

**Etyymology.** From the Latin *mutabilis* (changeable).

**Holotype.** IG AS RT, no. 13/19; Talass Mountains, Kainar–Karagain interfluve; Lower Ordovician.

**Description.** The test is irregular and changeable in shape, with an irregularly shaped internal cavity. The external surface is uneven and vague in outline, with various projections and depressions. The internal cavity has various depressions, pockets, and constrictions, sometimes, star-shaped. The wall is dark, calcareous, fine- or medium-grained, rough, nonuniform in thickness, frequently, with larger calcareous inclusions.

**Measurements, mm:**

	Holotype	Range of variation
Test length	0.55	0.33–0.61
Test width	0.38	0.29–0.39
Length of internal cavity	0.36	0.18–0.36
Width of internal cavity	0.22	0.10–0.22
Wall thickness	0.03–0.13	0.02–0.21

### Explanation of Plate 2

All specimens come from the Lower Ordovician of the Talass Mountains, at 100-fold magnification.

**Figs. 1–3, 6, 7, and 11.** *Vicinesphaera mutabilis* sp. nov.: (1) IG AS RT, no. 13/21; (2) IG AS RT, no. 13/22; (3) IG AS RT, no. 13/23; (6) IG AS RT, no. 13/24; (7) IG AS RT, 13/20; and (11) holotype, IG AS RT, no. 13/19.

**Figs. 4, 5, and 8.** *Vicinesphaera laxa* sp. nov.: (4) IG AS RT, no. 13/26; (5) IG AS RT, no. 13/27; and (8) holotype, IG AS RT, no. 13/25.

**Figs. 9, 10, and 12.** *Vicinesphaera karagainica* sp. nov.: (9) holotype, IG AS RT, no. 13/28; (10) IG AS RT, no. 13/29; and (12) IG AS RT, no. 13/30.

**Comparison.** *V. mutabilis* differs from the species described above in the more variable shape, irregular internal cavity, larger dimensions, greater wall thickness, which abruptly changes within the test.

**Material.** Seventeen specimens from the type locality.

*Vicinesphaera laxa* Sabirov et Gushchin, sp. nov.

Plate 2, figs. 4, 5, and 8

**Etymology.** From the Latin *laxus* (friable).

**Holotype.** IG AS RT, no. 13/25; Talass Mountains, Kainar–Karagain interfluve; Lower Ordovician.

**Description.** The test is irregularly rounded in outline, with an uneven surface because of the presence of various projections, and with a regularly spherical internal cavity. The wall is single-layered, calcareous, thick, friable, nonuniform in thickness, rough, fine- or medium-grained, with individual relatively light sites formed by somewhat larger calcite crystals.

**Measurements, mm:**

	Holotype	Range of variation
Greatest length	0.47	0.35–0.49
Diameter of internal cavity	0.12	0.11–0.18
Wall thickness	0.057–0.2	0.028–0.2

**Comparison.** The new species is similar to *V. parva* sp. nov., *V. squalida* Antropov, 1950, and *V. eosqualida* Reitlinger, 1959 in the general appearance and the shape of the internal cavity and differs in the larger dimensions of the test and internal cavity, the thicker wall (the external dimension is 0.35–0.49 mm versus 0.11–0.17, 0.12–0.25, and 0.19 mm, respectively; the internal cavity is 0.11–0.18 mm in diameter versus 0.045–0.065, 0.033–0.080, and 0.13 mm, respectively; the greatest wall thickness is 0.2 mm versus 0.07, 0.074, and 0.059 mm, respectively), and in the more friable structure of the wall.

**Material.** Eight specimens from the type locality.

*Vicinesphaera karagainica* Sabirov et Gushchin, sp. nov.

Plate 2, figs. 9, 10, 12

**Etymology.** From the Karagain River.

**Holotype.** IG AS RT, no. 13/28; Talass Mountains, Kainar–Karagain interfluve; Lower Ordovician.

**Description.** The test is large, almost regularly spherical in shape, occasionally, with small regular conical projections, and with a spherical internal cavity. The wall is single-layered, calcareous, thick, smooth, medium-grained, gray or dark gray, with inclusions of isolated larger calcite grains.

**Measurements, mm:**

	Holotype	Range of variation
Test diameter	0.55	0.46–0.69
Diameter of internal cavity	0.25	0.21–0.35
Wall thickness	0.12	0.08–0.18

**Comparison.** The new species is most similar in general test structure to *V. globosa* sp. nov. and differs from it in the larger dimensions (0.46–0.69 mm versus 0.2–0.27 mm), thicker wall (0.08–0.18 mm versus 0.04–0.07 mm). It additionally differs from other species in the more regular outline.

**Material.** Nine specimens from the type locality.

## REFERENCES

1. E. V. Bykova, "Foraminifers from the Ordovician and Silurian of the Soviet Baltic Region," in *Microfauna of the USSR* (1956), pp. 6–38 [in Russian].
2. E. V. Bykova, "On the Find of Chitinoïd Foraminifers in the Ordovician Beds of Northern Kazakhstan," *Dokl. Akad. Nauk SSSR* **120** (4), 879–881 (1958).
3. E. V. Bykova, *Foraminifers from the Caradocian of Eastern Kazakhstan* (Akad. Nauk Kazakh. SSR, Alma-Ata, 1961) [in Russian].
4. B. I. Chuvashov, O. V. Yuferev, and V. A. Luchinina, "Algae from the Middle and Upper Devonian of Western Siberia and the Ural Mountains," in *Biostratigraphy of the Paleozoic of Western Siberia* (Nauka, Novosibirsk, 1985), pp. 72–99 [in Russian].
5. M. K. Elias, "Paleozoic Ptychocladia and Related Foraminifera," *J. Paleontol.* **24**, 287–306 (1950).
6. O. A. Lipina, "A Find of Foraminifers in the Silurian and Ordovician of Siberia," *Dokl. Akad. Nauk SSSR* **128** (4), 823–826 (1959).
7. A. Loeblich and H. Tappan, *Treatise on Invertebrate Paleontology: Part C: Protista 2* (Univ. Kansas Press, Lawrence, 1964), pp. C1–C900.
8. V. A. Luchinina, *Paleoalgalogical Characteristics of the Early Cambrian of the Siberian Platform* (Nauka, Novosibirsk, 1975) [in Russian].
9. B. V. Pojarkov, *Stratigraphy and Foraminifers from the Devonian of the Tien Shan* (Ilim, Frunze, 1969) [in Russian].
10. B. V. Pojarkov, *Development and Distribution of Devonian Foraminifers* (Nauka, Moscow, 1979) [in Russian].
11. T. V. Pronina, "New Parathuramminidae from the Ordovician and Silurian of the Ural Mountains," in *New Species of Early Plants and Invertebrates of the USSR* (Gostekhizdat, Moscow, 1960), Part 1, pp. 138–139 [in Russian].
12. T. V. Pronina, "On the Stepwise Pattern of the Evolution of Foraminifers in Connection with the Problem of the Silurian–Devonian Boundary," *Ezhegodn. Vsesoyu. Paleontol. O–va* **21**, 3–11 (1978).

13. *Reference Book on the Systematics of Paleozoic Smaller Foraminifers* (Nauka, Moscow, 1993) [in Russian].
14. E. A. Reitlinger, "Cambrian Foraminifers of Yakutia," *Byull. Mosk. O-va Ispyt. Prir., Otd. Geol.* **23** (2), 77–81 (1948).
15. E. A. Reitlinger, "Atlas of Microscopic Fossils and Problematics from the Ancient Strata of Siberia," *Tr. Geol. Inst. Akad. Nauk SSSR*, No. 25, 1–62 (1959).
16. R. Riding and M. Brasier, "Earliest Calcareous Foraminifera," *Nature* **257** (5523), 208–210 (1975).
17. A. A. Sabirov, "On the Systematics and Taxonomic Rank of the Parathuramminoideans (Foraminifers)," *Vopr. Mikropaleontol.*, No. 29, 60–70 (1987).
18. V. D. Saltovskaya, "Foraminifers from the Ordovician of the Zeravshan and Hissar Mountain Region," in *New Species of the Phanerozoic Fauna and Flora of Tajikistan* (Irfon, Dushanbe, 1989), pp. 203–210 [in Russian].
19. A. G. Vologdin, "Archaeocyatha and Algae from the Middle Cambrian of the Southern Ural Mountains," *Probl. Paleontol.* **5**, 209–245 (1939).
20. A. G. Vologdin, "Lower Cambrian Foraminifers of Tuva," *Dokl. Akad. Nauk SSSR* **120** (2), 405–408 (1958).