TÜBİTAK

Turkish Journal of Earth Sciences

http://journals.tubitak.gov.tr/earth/

Research Article

Turkish J Earth Sci
(2022) 31: 495-519

doi:10.55730/1300-0985.1817

Devonian parathuramminids from Taurides, southern Turkey

Recep ÖZKAN*
Turkish Petroleum Corporation, Research and Development Center, Ankara, Turkey

Received: 14.12.2021 • **Accepted/Published Online:** 23.10.2022 • **Final Version:** 16.11.2022

Abstract: Devonian shallow marine carbonate rocks of the Taurides (southern Turkey) host rich and diverse faunal assemblages of foraminifera including unilocular organisms of the family Parathuramminidae. This study allowed investigating the calcareous unilocular parathuramminid fauna obtained from three measured stratigraphic sections Halevikdere, Kocadere and Eceli in addition to one detailed, shorter section measured along the Halevikdere section. The investigation revealed that the parathuramminid species, which commonly occur in lagoonal environments, are widely distributed throughout the studied sections. They mostly exist in limestone beds deposited in a time interval from Middle Devonian (Eifelian) to Late Devonian (Frasnian). However, their richness and diversity increased in Givetian period. The systematics of the family Parathuramminidae in the region is here provided. The family consists of 25 species belonging to two subfamilies Parathuramininae and Parathuramminitinae including *Proninellites*, new genus, and *Sabirovellites altineri*, new genus, new species. A practical identification key for the parathuramminid genera is introduced.

Key words: Devonian, foraminifer, parathuramminidae, systematics, classification, Taurides

1. Introduction

Suleimanov (1945) described the Devonian globular, unilocular fossils with numerous apertures at the end of papilliform protuberances and a uniform calcareous wall, and attributed them to the foraminiferal family Saccamminidae. Bykova in Bykova and Polenova (1955), later, placed these organisms within the family Parathuramminidae. These unilocular organisms are principally considered foraminifera because tests of them are only known among foraminifers with an indisputable extant genus *Thurammina* (Vachard et al., 2018). However, a controversy remains over the higher rank of these organisms. They have been interpreted as volvocacean algae (Kazmierczak, 1976), postmortem calcified acritarchs (Kazmierczak and Kremer, 2005), dasycladacean cysts (Mamet, 2006), microproblematica (Mamet and Préat, 2009), radiolarians (Vishnevskaya and Sedaeva, 2002), or incertae sedis (Schlagintweit et al., 2013).

The Devonian calcareous parathuramminids, which are principally determined in thin sections, have been mostly studied by Russian researchers (e.g., Antropov, 1950; Vissarionova, 1950; Lipina, 1950; Bykova in Bykova and Polenova, 1955; Pronina, 1960; Chuvashov, 1965; Poyarkov, 1969; Petrova, 1981; Zadorozhnyi, 1985, 1987). They are poorly known in North America (e.g., Toomey et al., 1970; Armstrong and Mamet, 1976) and Australia (e.g., Edgell, 2004). They have been recently studied in Europe (e.g., Vachard, 1994; Vachard et al., 2018; Özkan, 2018).

The Devonian deposits in the Taurides have been studied within the framework of two successive multidisciplinary projects, measuring three representative stratigraphic sections in addition to some detailed shorter sections in the eastern and central Taurides. As a result, the stratigraphic subdivision of the Devonian succession of the Taurides was established at the stage level based on foraminifers, ostracods, conodonts, juvenile brachiopods, and palynomorphs (Wehrmann et al., 2010). The limestone samples collected from all studied sections revealed a rich and diversified calcareous foraminiferal assemblage consisting of both multi- and unilocular species. The multilocular foraminifers have been previously documented (Özkan, 2011; Özkan and Vachard, 2015; Özkan, 2018; Özkan et al., 2019). The unilocular foraminifers referred to as parathuramminids are here presented.

The main objectives of this study are: (1) to describe the Devonian unilocular parathuramminids in the carbonate rocks of the Taurides; (2) to present a detailed systematic identification of these organisms; (3) to introduce the newly described taxa; (4) to provide insight into the taxonomy of the Devonian parathuramminoids.

* Correspondence: recozkan@tpao.gov.tr

2. Geologic setting

The Tauride Orogenic Belt developed on the Northern Gondwana border lies along the coast of the Mediterranean Sea and extends to eastern Turkey. Two strike-slip faults, the Kırkkavak Fault in the west and the Ecemiş Fault in the east subdivide geographically the Tauride Belt into the eastern, central, and western Taurides (Figure 1). Based on litho-tectono-stratigraphical characteristics and depositional conditions, Özgül (1976) classified the rocks of the Taurides into six tectono-stratigraphic units: parautochthonous Geyikdağı Unit, and the allochthonous Bozkır, Bolkar, Aladağ, Alanya, and Antalya units. The Devonian sequence, as a part of the Geyikdağı Unit, is widely distributed in the eastern and central Taurides. The Devonian rocks formed by carbonates and siliciclastics were mainly deposited in shallow marine environments (Demirtaşlı, 1967; Özgül, 1976; Wehrmann et al., 2010; Yalçın and Yılmaz, 2010).

In the eastern Taurides, the Devonian sequence, conformably overlying the Silurian deposits, consists of three lithostratigraphic formations, from bottom to top, the Ayıtepesi, Şafaktepe, and Gümüşali (Figure 1). Özgül et al. (1973), to include clastic rocks with some carbonate beds, first defined the Ayıtepesi Formation. Demirtaşlı (1967) originally named the Şafaktepe and Gümüşali formations. The former is mostly composed of carbonate rocks interbedded with clastic deposits, and latter predominates in clastic deposits.

In the central Taurides, Demirtaşlı (1984) subdivided the Devonian sequence, conformably overlying the Silurian deposits, into three lithostratigraphic formations, which are, in ascending order, the Sığırcık, Büyükeceli, and Akdere (Figure 1). The basal Sığırcık Formation comprises a succession of siliciclastic and carbonate deposits. The overlying Büyükeceli Formation is composed predominately of carbonate rocks. The Akdere Formation, the top unit of the Devonian sequence in the central Taurides, consists of carbonates rocks with intercalations of siliciclastic deposits.

3. Materials and methods

The samples of this study are from four stratigraphic sections: Halevikdere, Kocadere, Eceli and Halevikdere detail (HD) sections. The Halevikdere and Kocadere sections are located in the eastern Taurides, and the Eceli section is in the central Taurides (see section locations in Figure 1). The thicknesses of these main profiles are 1197 m, 1077 m, and 933 m, respectively. The detailed shorter section, which is a part of the Halevikdere section, is 9.3 m thick. Nearly 1000 thin sections from 243 field samples were prepared and examined under a microscope to determine the parathuramminid assemblages. The studies by Antropov (1950), Lipina (1950), Bykova and Polenova (1955), Pronina (1960), Chuvashov (1965), Poyarkov (1969), Petrova (1981), Zadorozhnyi (1985, 1987), Vachard (1994), and Vachard et al. (2018) were used for the identification of the parathuramminid fauna. Thin sections are housed in the collection of Turkish Petroleum Corporation, Ankara, Turkey.

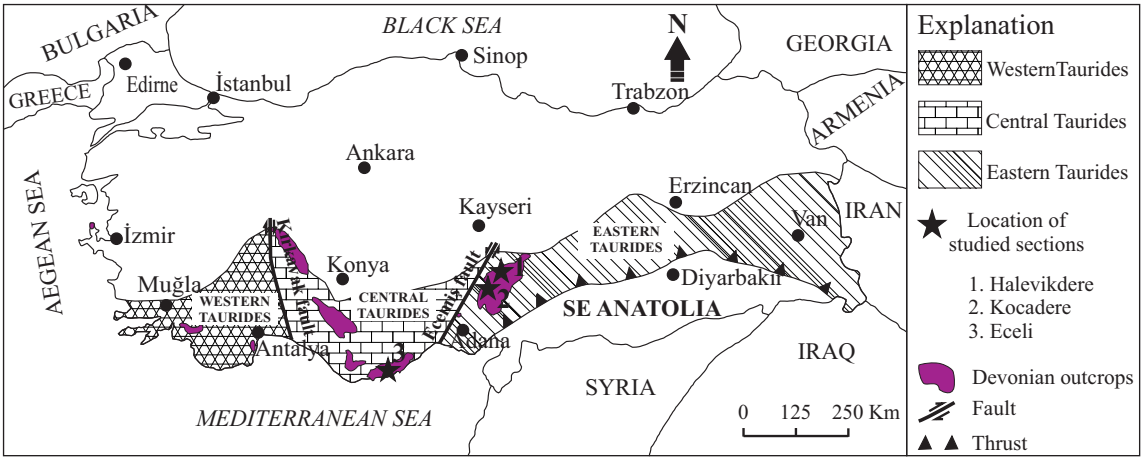
4. Results and discussion

4.1. Practical identification of the Devonian parathuramminid genera with phylogenetic implications

In this study, a practical identification key for the Devonian parathuramminid foraminifers at genera level is proposed (Figure 2). These globular organisms have evolved from ivanovellids in pre-Devonian time (Vachard et al., 2018). According to recent classifications (e.g., Zadorozhnyi, 1987; Vachard et al., 2018), the family Parathuramminidae, mainly based wall thickness, was subdivided into two subfamilies: Parathuramminae and Parathuramminitinae. The species with thin wall of single, double, or three layers were assigned to the subfamily Parathuramminae, and those with a medium-to-thick, uniform, single-layered wall structure were placed within the subfamily Parathuramminitinae.

Bykova in Bykova and Polenova (1955) first named the subfamily Parathuramminae as a subdivision of the family Parathuramminidae. Genera *Parathurammina* and *Bykovaella* represent the single-layered forms of this subdivision. While the former is characterized by papillate apertural protuberances, the latter represents the species with tubular apertural spines. The second subdivision of this subfamily encompasses the species with double-layered wall structure with short, tubular apertural spines. Here, the newly described genus *Proninellites* n. gen. is placed in this subdivision. It is supposed to have evolved from *Bykovaella* with the appearance of a two-layered wall during the Givetian age. On the other hand, the three-layered species of the subfamily Parathuramminae are categorized into two subgroups according to the character of the middle layer, which is either light or dark. Accordingly, the species with a light middle layer are assigned to the genera *Marginara* and *Saltovskajina*. Where the papillate apertural protuberances define the former, the long tubular apertural spines characterize the latter. However, a dark-middle layer as well as short, tubular apertural spines differentiate the newly described genus *Sabirovellites* n. gen. During the Givetian stage, *Proninellites* n. gen. is supposed to have evolved into *Marginara*, which in turn gave rise to *Saltovskajina*. Similarly, the *Proninellites* n. gen. gave rise to *Sabirovellites* n. gen.

Antropov (1970) first introduced the subfamily Parathuramminitinae into the family Parathuramminidae. Zadorozhnyi (1987) placed the genera *Parathuramminites*,



GENERALIZED STRATIGRAPHIC COLUMNAR SECTIONS

CENTRAL TAURIDES

System	Series	Formation	Thickness (m)	Lithology	Explanations
Permian	Upper	Kırtıldağı	325		Limestone with *Mizzia*, sandstone with cross bedding and clayey limestone
Devonian	Upper	Akdere	250		Limestone with coral, sandstone with iron-oxide, shale and siltstone
	Middle	Büyükeceli	630		Limestone with megabreccia, dolomitic limestone, dolomite, shale and sandstone with cross bedding and ripple marks
					Conglomerate
	Lower	Sığırcık	250		Quartzite, sandy limestone, dolomite and shale
Silurian	Upper	Karayar	350		Sandy limestone, clayey limestone and shale
	Lower	Hırmanlı	100		Limestone with *Orthoceras* Black shale
		Eğripınar	125		Shale and sandstone
Ordovician	Upper	Ovacık	400		Shale with sandstone interbeds
	Lower				
Cambrian	Upper				Shale and siltstone with nodular limestone interbeds
	Middle	Ovacık Işıklı	75		Dolomitic limestone

EASTERN TAURIDES

System	Series	Formation	Thickness (m)	Lithology	Explanations
Permian	Upper	Yığıltepe	500		Limestone with algae and foraminifera
					Quartzite
Carboniferous	Lower	Ziyaretteppe	350		Shale and limestone
Devonian	Upper	Gümüşali	500		Quartzite, shale and reefal limestone
	Middle	Şafaktepe	1250		Limestone
					Limestone *with Amphipora*
					Dolomite
	Lower	Ayıtepesi	400		Quartzite, shale and limestone
Silurian	Upper	Yukarıyayla	150		Shale and limestone
	Lower	Puşcutepe	100		Black shale
Ordovician	Upper	Halıtyaylası	100		Conglomerate and sandstone (Glacio-marine deposits)
	Lower	Sabova	50		Shale and limestone
		Armutludere	1500		Shale, siltstone and sandstone
Cambrian	Upper - Middle	Değirmentaş	125		Nodular limestone,
					Limestone and dolomite
	Lower	Koçyazı	400		Quartzite with cross bedding and ripple marks
					Conglomerate

Figure 1. Geographical subdivision of the Tauride Belt (Özgül, 1984) and generalized columnar sections of the central Taurides (Demirtaşlı, 1984) and the eastern Taurides (Özgül and Kozlu, 2002).

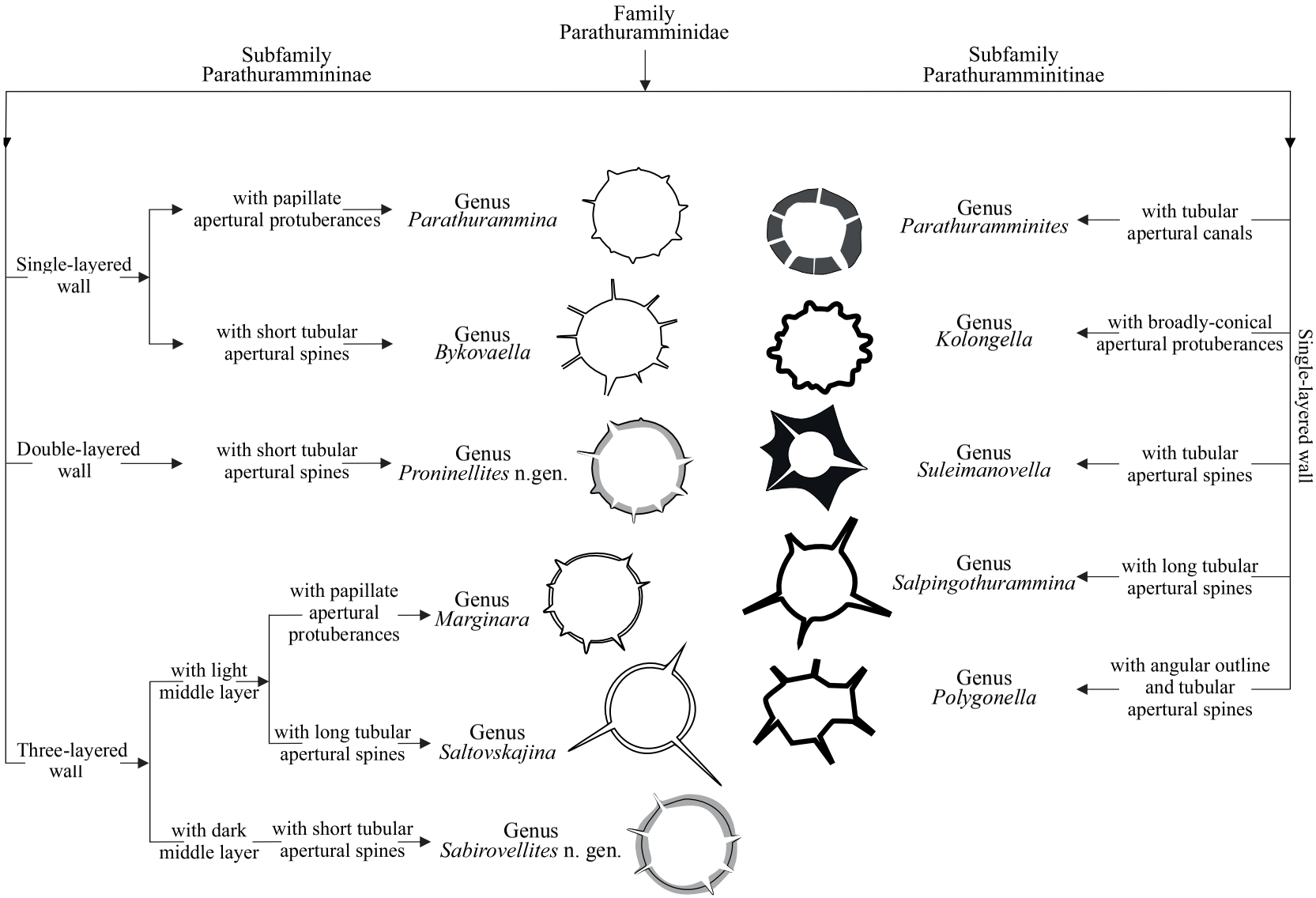


Figure 2. Identification scheme of the parathuramminid genera with representative drawings.

Kolongella, *Suleimanovella* and *Salpingothurammina* in this subfamily. Vachard et al. (2018), later, considered the genus *Polygonella* as a member of this group. Tubular apertural canals characterize *Parathuramminites*, among them, and *Kolongella* is defined by broadly conical apertural protuberances. While the tubular apertural spines describe *Suleimanovella*, the long tubular spines distinguish the genus *Salpingothurammina*. An angular outline and tubular apertural spines characterize the genus *Polygonella*. The first representatives of this subfamily appear in the Eifelian deposits of the Taurides although they are known to have evolved before the Devonian Period (Poyarkov, 1969; Sabirov, 2017; Vachard et al., 2018).

4.2. Diversification of the parathuramminid genera in the Devonian units of Taurides.

In the Halevikdere section, thin limestone beds of the basal Ayıtepesi Formation revealed a few parathuramminid species of *Bykovaella*. However, the same unit, in the Kocadere section and its time equivalent Sığırcık Formation in the Eceli section, is devoid of foraminifers. The overlying Şafaktepe Formation, which dominates in carbonate deposition, includes abundant unilocular foraminiferal associations in the Halevikdere section (Figure 3). The limestone beds in the lower part of the unit witnesses the first appearance of parathuramminid species of *Salpingothurammina*, *Kolongella*, *Bykovaella*, *Parathuramminites*, and *Suleimanovella*. On the other hand, the limestone beds corresponding to the upper part of the unit in both Halevikdere and Halevikdere Detail (HD) sections contain a rich and diversified parathuramminid assemblage. Here, a large number of newly appeared specimens of *Bykovaella*, *Polygonella*, *Proninellites* n. gen., *Marginara*, *Saltovskajina*, and *Sabirovellites* n. gen. characterize this assemblage. Although the parathuramminid species of the Şafaktepe Formation in the Kocadere section are barely preserved due to dolomitization, a distinct limestone bed at 590 m of the section comprises a rich and diversified fauna (Figure 4). However, the Büyükeceli Formation in the Eceli section, a time equivalent unit of the Şafaktepe Formation reveals a poor parathuramminid association (Figure 4). The Gümüşali Formation in the Halevikdere and Kocadere sections in addition to the Akdere Formation in the Eceli section that represent the upper part of the Devonian sequence in the Taurides are marked by a decrease in diversity and abundance of parathuramminid fauna. Nevertheless, the occurrence of few representatives of *Parathurammina*, *Kolongella*, *Bykovaella*, *Polygonella*, *Parathuramminites*, *Salpingothurammina*, and *Suleimanovella* are still notable.

Overall, the parathuramminid species are abundant at certain intervals throughout the studied sections. At most levels, however, they are absent or rare. Their absence, preservation or decrease in diversity and abundance may be due to changes in depositional environment and facies as well as pervasive dolomitization.

4.3. Systematic paleontology

Phylum Foraminifera d'Orbigny 1826 emend. Cavalier-Smith, 2003

Class Fusulinata Gaillot and Vachard, 2007 emend. Vachard, 2016

Subclass Afusulinana Vachard, Pille and Gaillot, 2010

Order Parathuramminida Mikhalevich, 1980 emend. Vachard, 2016

Superfamily Parathuramminoidea Fursenko in Rauzer-Chernousova and Fursenko, 1959 emend. Vachard, 2016

Family Parathuramminidae Bykova in Bykova and Polenova, 1955 emend. Vachard, 1994

Subfamily Parathuramminae Bykova in Bykova and Polenova; 1955 emend. Vachard, 1994

Genus *Parathurammina* Suleimanov, 1945

Type species: *Parathurammina dagmarae* Suleimanov, 1945.

Parathurammina dagmarae Suleimanov, 1945

Figures 5(1–8)

1945 *Parathurammina dagmarae* Suleimanov, p. 132, figure 3.

1954 *Parathurammina dagmarae*; Grozdilova and Lebedeva, p. 23, pl. 1, figures 1-2.

1962 *Parathurammina dagmarae*; Bogush and Yuferev, p. 76, pl. 1, figure 7.

1965 *Parathurammina dagmarae*; Chuvashov, p. 18, pl. 1, figures 1-2.

1969 *Parathurammina* (*Parathuramminites*) *dagmarae*; Poyarkov, p. 79, pl. 1, figure 10.

1977 *Parathurammina dagmarae*; Vachard, pl. 8, figure 3.

1984 *Parathurammina dagmarae*; Kotlyar, p. 8, pl. 1, figures 3-6.

1991 *Parathurammina dagmarae*; Vachard, p. 261, pl. 1, figure 26.

1999 *Parathurammina* du groupe *P. dagmarae* (= *Salpingothurammina breviradiosa*); Mamet et al., pl. 5, figures 13-14.

2017 *Parathurammina dagmarae*; Sabirov, pl. 1, figures 1-3.

***Diagnosis*:** Test unilocular, large, and globular with numerous short papilliform protuberances. Wall unilayered, thin, dark-microgranular. Apertures numerous and rounded. Characterized by the large size and short protuberances.

***Measurements*:** Test outer diameter = 0.25–0.28 mm; test inner diameter = 0.24–0.27 mm; number of apertural necks: 2–8; length of apertural necks = 0.006–0.04 mm; test wall thickness = 0.01–0.012 mm.

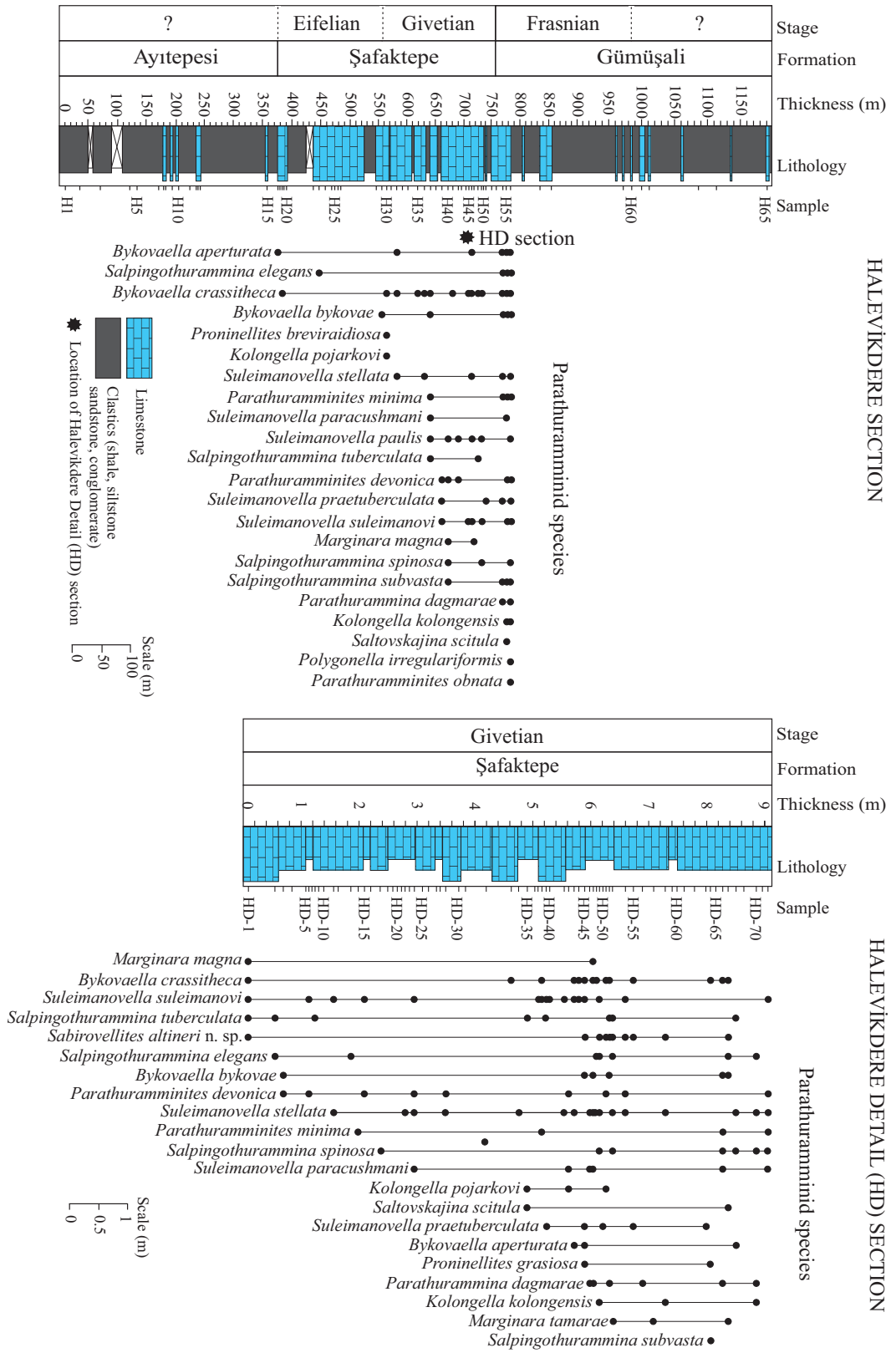


Figure 3. Stratigraphic distributions of parathuramminids in the Halevikdere and Halevikdere Detail sections (Age and formation boundaries are from Wehrmann et al. (2010) and Özkan (2018)).

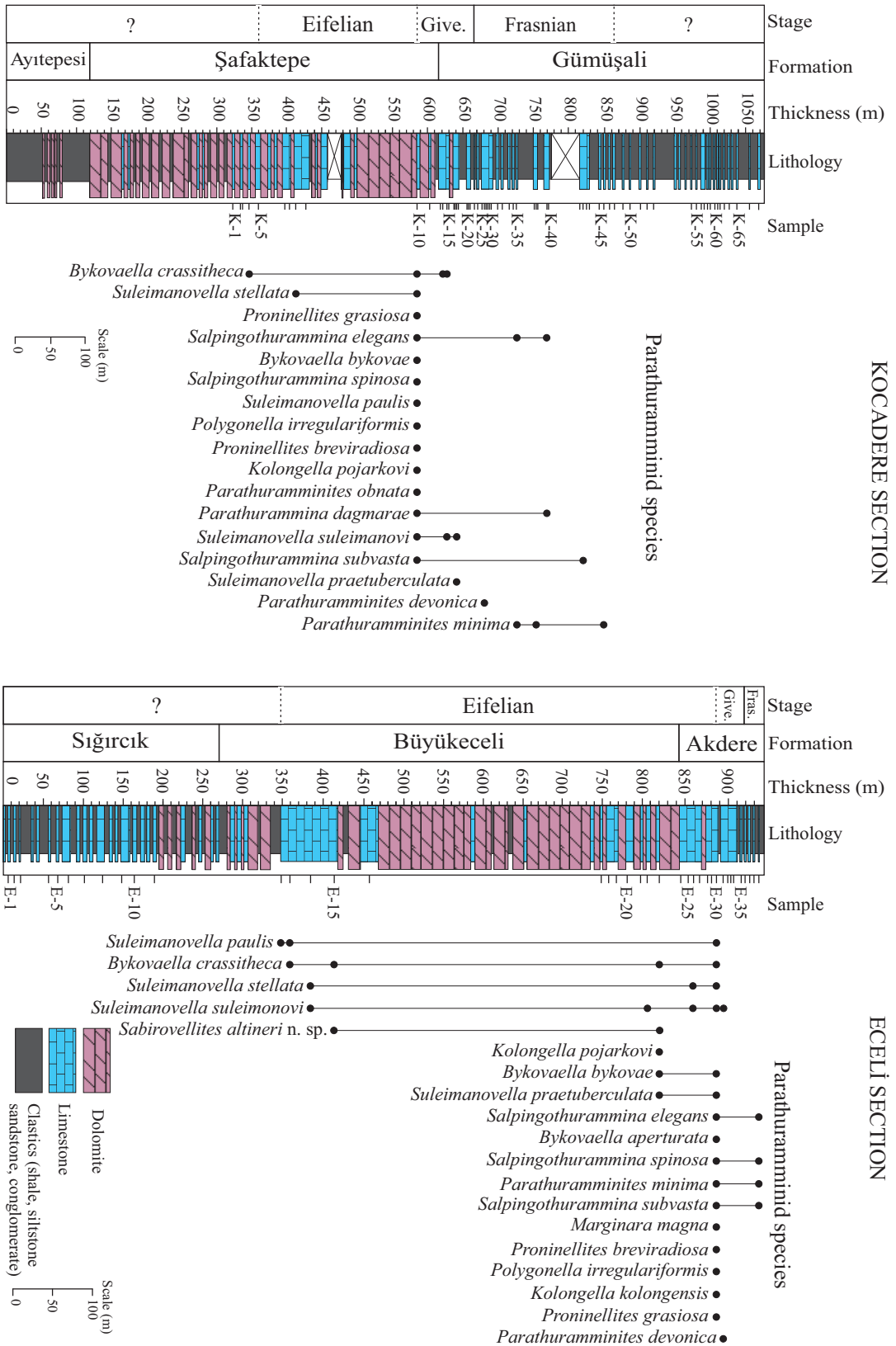


Figure 4. Stratigraphic distributions of parathuramminids in the Kocadere and Eceli sections (Age and formation boundaries are from Wehrmann et al. (2010), Özkan (2018), and Özkan et al. (2019)).

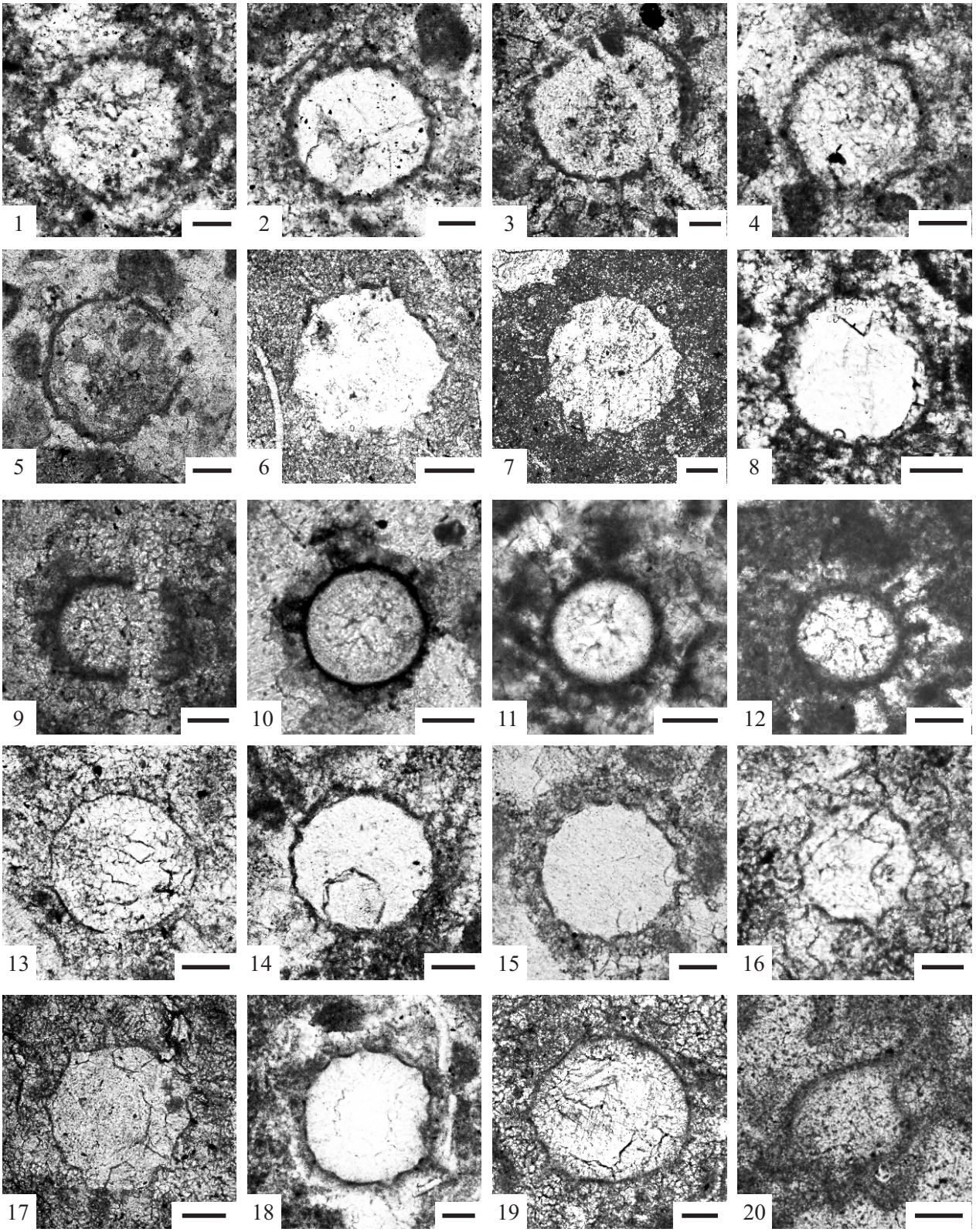


Figure 5. **1-8.** *Parathurammina dagmarae* Suleimanov, 1-2. HD-46, 3. HD-47, 4. HD-56, 5. HD-70, 6. K10, 7-8. K40; **9-12**. *Bykovaella aperturata* (Pronina), 9. H56, 10. HD-45, 11. HD-68, 12. E30. **13-19**. *Bykovaella crassitheca* (Antropov), 13. H32, 14. H46, 15. HD-33, 16. E23, 17-19. E30; **20**. *Bykovaella bykovae* (Poyarkov in Purkin et al.), H55. Scale bars = 0.05 mm.

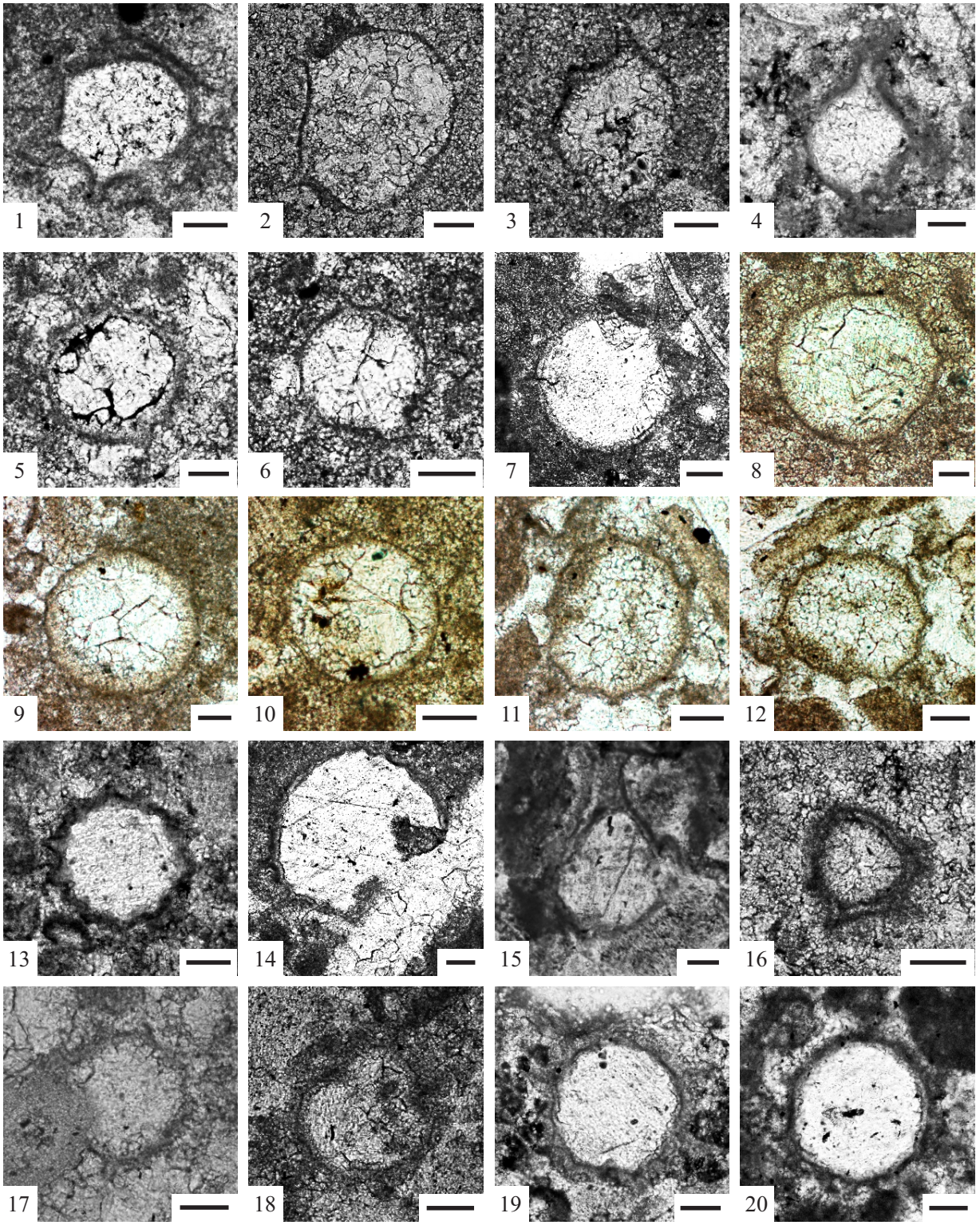


Figure 6. **1-4**. *Bykovaella bykovae* (Poyarkov in Purkin et al.), 1-2. H55, 3. H56, 4. HD-67; **5-10**. *Proninellites graciosa* (Pronina), 5-6. HD-45, 7. HD-64, 8. K10, 9-10. E30; **11-12**. *Proninellites breviradiosa* (Reitlinger in Varsanofieva and Reitlinger), 11. H30, 12. E30; **13.** *Marginara tamarae* (Petrova), HD-57; **14**. *Marginara magna* (Antropov), E30; **15-16**. *Saltovskajina scitula* (Chuvashov), 15. HD-35, 16. HD-67. **17-20** *Sabirovellites altineri* n. gen. n. sp., 17. Paratype, HD-1, 18. Paratype, HD-53, 19. Paratype, HD-58, 20. Paratype, HD-67. Scale bars = 0.05 mm.

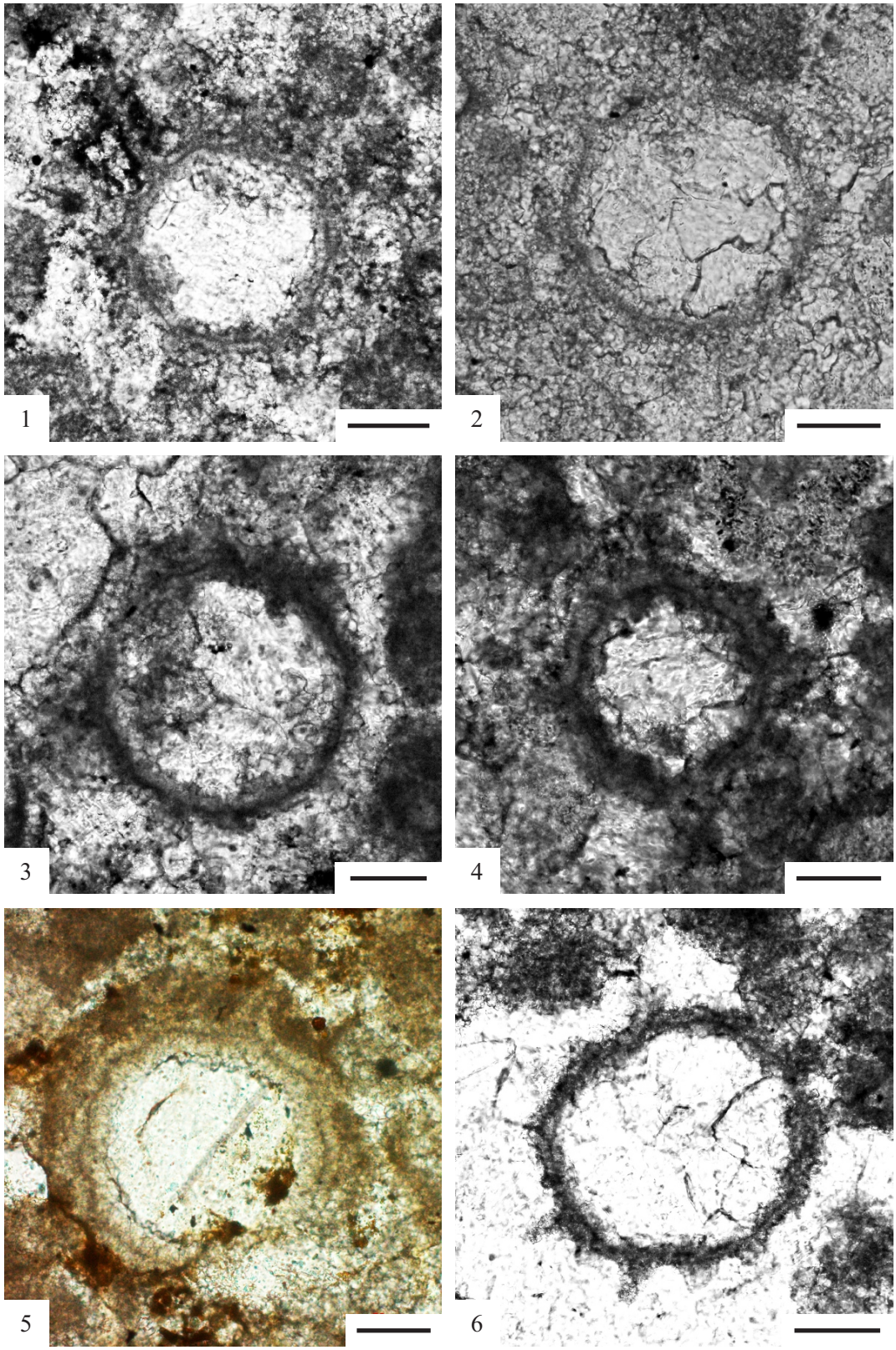


Figure 7. **1-6**. *Sabirovellites altineri* n. gen. n. sp., 1. Holotype, HD-52, 2. Paratype, HD-1, 3. Paratype, HD-45, 4. Paratype, HD-54, 5. E15, 6. E23. Scale bars = 0.05 mm.

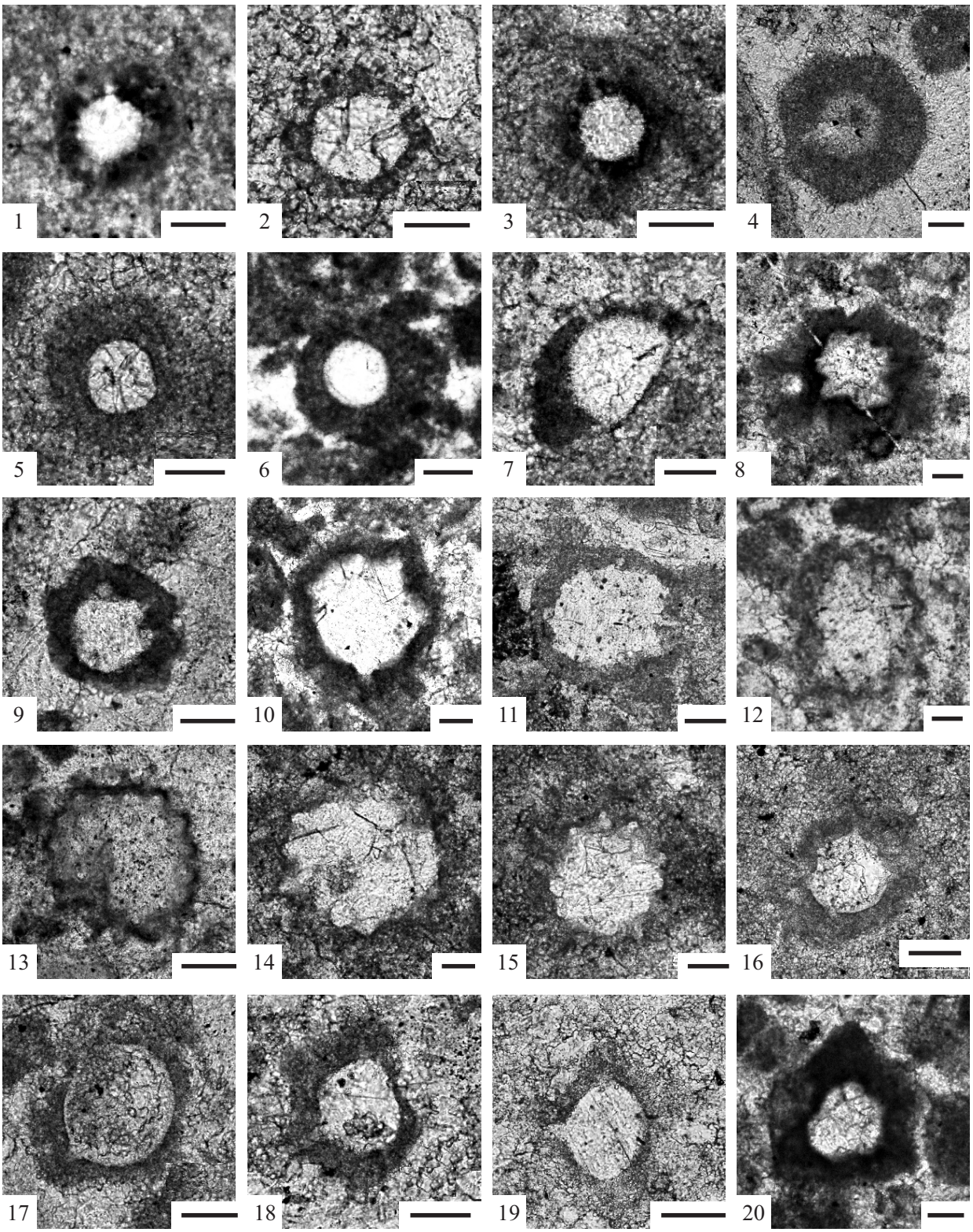


Figure 8. **1-3**. *Parathuramminites minima* (Antropov), 1. H54, 2. H55, 3. H56; **4-6**. *Parathuramminites devonica* (Vissarionova), 4. H55, 5-6. E31; **7**. *Parathuramminites obnata* (Chuvashov), H56; **8-11**. *Kolongella kolongensis* (Pronina), 8. HD-58, 9-10. HD-70, 11. E30; **12-15**. *Kolongella pojarkovi* (Zadorozhnyi and Yuferev), 12. HD-35, 13. HD-42, 14. HD-51, 15. E23; **16-19**. *Suleimanovella paracushmani* (Reitlinger), 16. H37, 17. HD-42, 18. HD-46, 19. HD-66; **20**. *Suleimanovella suleimanovi* (Lipina), H45. Scale bars = 0.05 mm.

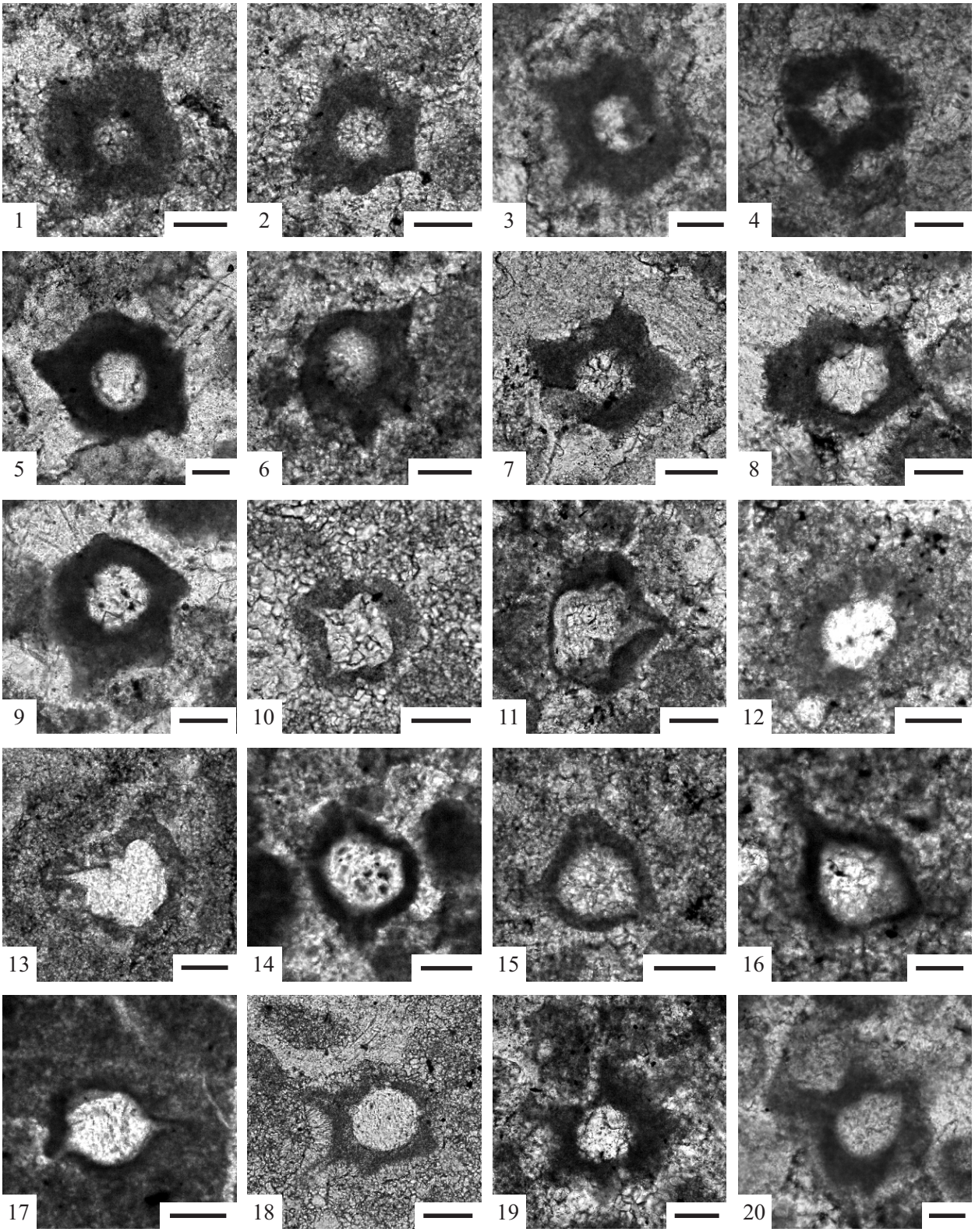


Figure 9. 1-9. *Suleimanovella suleimanovi* (Lipina), 1. H45, 2. H49, 3-4. HD-24, 5. HD-43, 6. HD-45, 7. HD-54, 8-9. HD-72; **10-13**. *Suleimanovella praetuberculata* (Reitlinger), 10. H39, 11. HD-45, 12. K18, 13. E23; **14-17**. *Suleimanovella paulis* (Bykova in Bykova and Polenova), 14. H46, 15. H49, 16. H56, 17. K10; **18-20**. *Suleimanovella stellata* (Lipina), 18. H32, 19. HD-11, 20. HD-41. Scale bars = 0.05 mm.

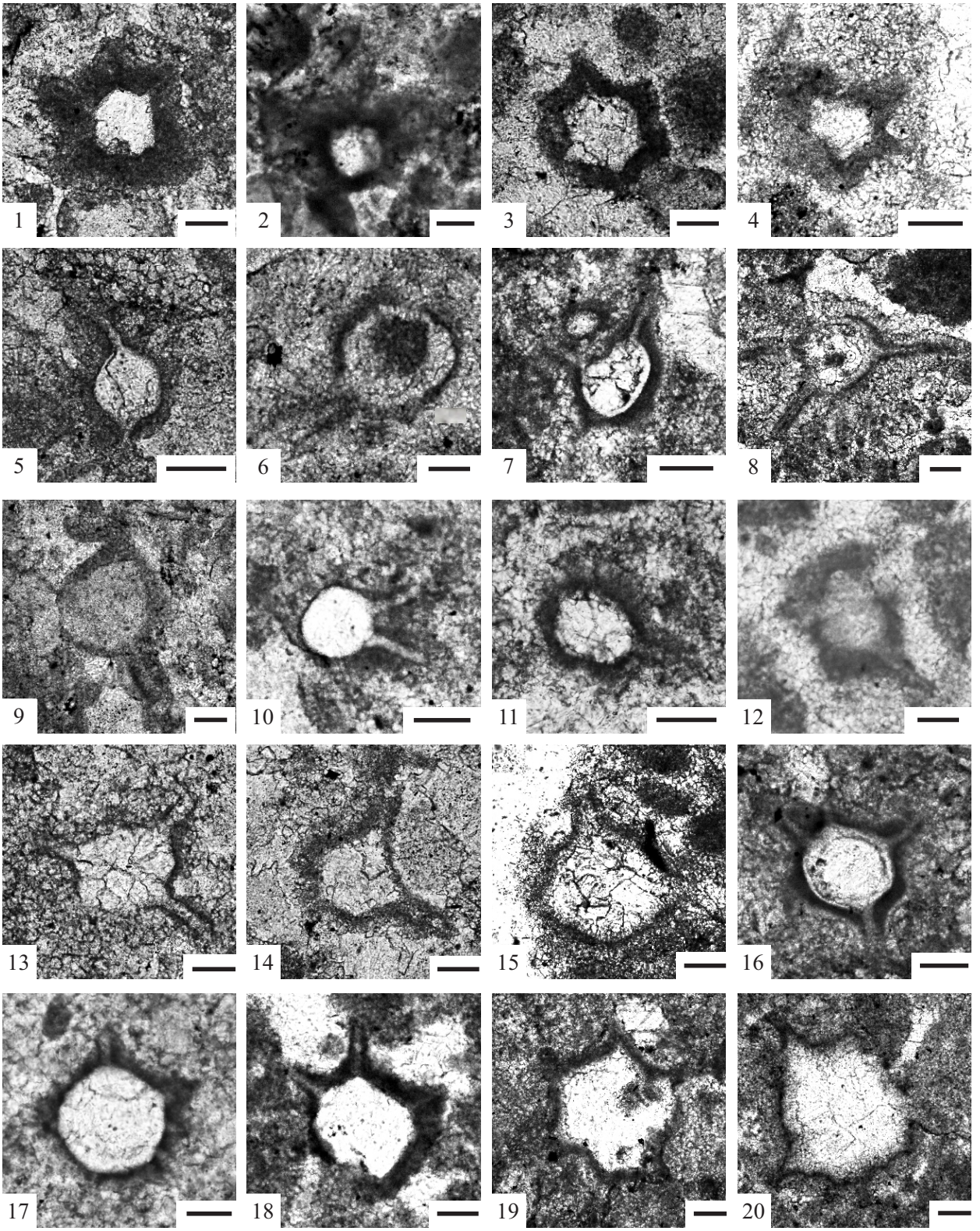


Figure 10. 1-4. *Suleimanovella stellata* (Lipina), 1-2. HD-43, 3. HD-58, 4. K10. **5-10**. *Salpingothurammina spinosa* (Lipina), 5. H49, 6. H56, 7. HD-70, 8. K10, 9. E30, 10. E39; **11-12**. *Salpingothurammina tuberculata* (Lipina), 11. HD-1, 12. HD-8; **13-15**. *Salpingothurammina subvasta* (Bykova in Bykova and Polenova), 13. H40, 14. HD-64, 15. E30; **16-18**. *Salpingothurammina elegans* (Poyarkov), 16. H22, 17. H56, 18. E30; **19-20**. *Polygonella irregulariformis* Zadorozhnyi and Yuferev, E30. Scale bars = 0.05 mm.

***Range and occurrence*:** Tournaisian of Bashkortostan, Russia (Suleimanov, 1945); Late Devonian of Kolvo-Visher region, Russia (Grozdilova and Lebedeva, 1954); Famennian and Tournaisian of the central and southern Urals, Russia (Chuvashov, 1965); Tournaisian of Karatau, Kazakhstan (Bogush and Yuferev, 1962); Famennian of Tian-Shan, Kyrgyzstan (Poyarkov, 1969); Visean of Montagne Noire, France (Vachard, 1977); Famennian of Ukraine (Kotlyar, 1984); Emsian of Oviedo region, Spain (Vachard, 1991); Givetian of Morocco (Mamet et al., 1999); early Famennian of Zeravshan, Tajikistan (Sabirov, 2017); Givetian and Frasnian of Taurides, Turkey (in this study).

***Materials*:** Over 20 specimens from the samples H54 and H56 of the Helevikdere section; HD-46, HD-47, HD-52, HD-56, HD-66, and HD-70 of the Halevikdere Detail section; K10 and K40 of the Kocadere section.

Genus *Bykovaella* Zadorozhnyi in Zadorozhnyi and Yuferev, 1984

Type species: *Parathurammina aperturata* Pronina, 1960.

Bykovaella aperturata (Pronina, 1960)

Figures 5(9–12)

1960 *Parathurammina aperturata* Pronina, p. 47, pl. 1, figure 3.

1969 *Parathurammina* (*Salpingothurammina*) *aperturata*; Poyarkov, p. 87, pl. 1, figures 2, 5.

1979 *Parathurammina* (*Salpingothurammina*) *aperturata*; Poyarkov, p. 44, pl. 5, figure 2.

1981 *Parathurammina* (*Salpingothurammina*) *aperturata*; Petrova, pl. 6, figures 4, 7.

1984 *Bykovaella aperturata*; Zadorozhnyi and Yuferev, p. 79, pl. 1, figures 3-5.

1985 *Bykovaella aperturata*; Zadorozhnyi, pl. 17, figure 2, pl. 18, figure 3.

1987 *Bykovaella aperturata*; Zadorozhnyi, p. 16, pl. 1, figures 4-7.

2017 *Salpingothurammina aperturata*; Sabirov, pl. 3, figures 47-48.

2018 *Bykovaella aperturata*; Vachard et al., p. 16, figures 9.16-17, 9.24-25.

***Diagnosis*:** Test unilocular, spherical with numerous short tubular apertural spines. Apertural necks thin. Wall single-layered, thin, and dark-microgranular. Apertures at the end of apertural spines.

***Measurements*:** Test outer diameter = 0.11–0.2 mm; test inner diameter = 0.008–0.016 mm; number of apertural necks: 6–14; length of apertural necks = 0.01–0.024 mm; test wall thickness = 0.006–0.009 mm.

***Range and occurrence*:** Early Eifelian of the western part of the central Urals, Russia (Pronina, 1960); Givetian of Tian-Shan, Kyrgyzstan (Poyarkov, 1969, 1979; Givetian of the southern Urals, Russia (Petrova, 1981); Eifelian and Givetian of the western Siberia and Kuznets Basin (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1985, 1987); Frasnian of Zeravshan, Tajikistan (Sabirov, 2017); Givetian of Mount Polinik, Carnic Alps, Austria (Vachard et al., 2018); Eifelian, Givetian and Frasnian of Taurides, Turkey (in this study).

***Materials*:** Over 20 specimens from the samples H16, H32, H46, H54, H55, and H56 of the Helevikdere section; HD-43, HD-45, and HD-68 of the Halevikdere Detail section; E30 of the Eceli section.

Bykovaella crassitheca (Antropov, 1950)

Figures 5(13–19)

1950 *Parathurammina dagmarae* var. *crassitheca* Antropov, p. 23, pl. 1, figures 7-8.

1962 *Parathurammina crassitheca*; Bogush and Yuferev, p. 80, pl. 1, figure 12.

1965 *Parathurammina crassitheca*; Chuvashov, p. 20, pl. 1, figure 9.

1984 *Bykovaella crassitheca*; Zadorozhnyi and Yuferev, p. 80, pl. 1, figures 7-8.

1987 *Bykovaella crassitheca*; Zadorozhnyi, p. 18, pl. 1, figures 10-12.

1991 *Parathurammina crassitheca*; Vachard, p. 261, pl. 1, figure 25.

1994 *Parathurammina crassitheca*; Vachard, p. 20, pl. 1, figures 2, 12-23, pl. 2, figures 1, 7.

2012 *Parathurammina crassitheca*; Zaytseva, pl. 1, figure 11.

2017 *Salpingothurammina crassitheca*; Sabirov, pl. 4, figures 49-50.

***Diagnosis*:** Test unilocular, globular, and large. Numerous short tubular apertural spines on the surface of the test. Wall single-layered, thin, and dark-microgranular. Apertures numerous at the end of apertural necks. This species is similar to *B. aperturata*, but differs in having thicker apertural spines and larger test dimensions.

***Measurements*:** Test outer diameter = 0.12–0.21 mm; test inner diameter = 0.11–0.2 mm; number of apertural necks: 4–15; length of apertural necks = 0.01–0.03 mm; test wall thickness = 0.008–0.012 mm.

***Range and occurrence*:** Frasnian of the Shugurovsky region, Tatarstan (Antropov, 1950); Tournaisian of Karatau, Kazakhstan (Bogush and Yuferev, 1962); Famennian of the central and southern Urals, Russia (Chuvashov, 1965); Famennian of the western Siberia and Kuznets Basin, Russia (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1987); Emsian of Oviedo region, Spain (Vachard, 1991); Givetian of Ancenis Basin, France (Vachard, 1994); Famennian of Melekesskian depression, western Tatarstan, Russia (Zaytseva, 2012); late Emsian of Zeravshan, Tajikistan (Sabirov, 2017); Eifelian, Givetian and Frasnian of Taurides, Turkey (in this study).

***Materials*:** Over 50 specimens from the samples H18, H30, H32, H35, H36, H37, H41, H45, H46, H47, H49,

H54, H55, and H56 of the Helevikdere section; HD-1, HD-33, HD-38, HD-43, HD-44, HD-45, HD-47, HD-48, HD-51, HD-52, HD-55, HD-64, HD-66, and HD-67 of the Halevikdere Detail section; K4, K10, K13, and K14 of the Kocadere section; E13, E15, E23, and E30 of the Eceli section.

Bykovaella bykovae (Poyarkov in Purkin et al., 1961)

Figures 5(20), 6(1–4)

1955 *Parathurammina magna*; Bykova in Bykova and Polenova, p. 17, pl. 2, figures 4-5; pl. 4, figure 5

1961 *Thurammina* (*Salpingothurammina*) *bykovae* Poyarkov in Purkin et al., p. 31, pl. 1, figures 1, 6.

1969 *Parathurammina* (*Salpingothurammina*) *bykovae*; Poyarkov, p. 86, pl. 1, figures 3, 6, 11.

1981 *Parathurammina* (*Salpingothurammina*) *bykovae*; Petrova, pl. 6, figures 1-2.

1984 *Bykovaella bykovae*; Zadorozhnyi and Yuferev, p. 80, pl. 1, figure 6.

1987 *Bykovaella bykovae*; Zadorozhnyi, p. 17, pl. 1, figures 8-9.

1994 *Parathurammina bykovae*; Vachard, p. 22, pl. 2, figures 1-3.

2017 *Salpingothurammina bykovae*; Sabirov, pl. 4, figures 52, 55.

2018 *Bykovaella bykovae*; Vachard et al., p. 18, figures 10.4-6, 10.7, 10.8

***Diagnosis*:** Test unilocular, spherical and large with numerous tubular apertural spines. Wall single-layered and dark-microgranular with thin or medium thickness. Apertures at the end of apertural spines and apertural canals wide. Characterized by expansion of the wall near apertural canals outward. This species is close to *B. crassitheca*, but it has larger test size and larger apertural canals.

***Measurements*:** Test outer diameter = 0.14–0.26 mm; test inner diameter = 0.12–0.22 mm; number of apertural necks: 2–8; length of apertural necks = 0.016–0.038 mm; test wall thickness = 0.009–0.012 mm.

***Range and occurrence*:** Givetian of the eastern Urals, Russia (Poyarkov in Purkin et al., 1961); Givetian of Tian-Shan, Kyrgyzstan (Poyarkov, 1969); Givetian of the western Urals (Petrova, 1981); Givetian and Frasnian of the southeast of the western Siberia (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1987); Givetian of Ancenis Basin, France (Vachard, 1994); early Frasnian of Zeravshan, Tajikistan (Sabirov, 2017); Givetian of Mount Polinik, Carnic Alps, Austria (Vachard et al., 2018); Givetian and Frasnian of Taurides, Turkey (in this study).

***Materials*:** Over 20 specimens from the samples H29, H37, H-54, H55, and H56 of the Helevikdere section; HD-3, HD-45, HD-47, HD-52, HD-66, and HD-67 of the Halevikdere Detail section; K10 of the Kocadere section; E23 and E30 of the Eceli section.

Proninellites new genus

Type species: *Parathurammna graciosa* Pronina, 1960.

***Diagnosis*:** Test is unilocular, small, globular, and subglobular or angularly rounded with numerous tubular apertural spines. The wall is two-layered with very thin to thin, dark-microgranular outer layer and thick light radial-pseudofibrous inner layer. Apertures are situated at the end of apertural necks.

***Range and occurrence*:** Early Givetian of the eastern part of the central Urals, Russia (Pronina, 1960); Frasnian of Pechora, Russia (Reitlinger in Varsanofieva and Reitlinger, 1962); Frasnian and Famennian of the central and southern Urals, Russia (Chuvashov, 1965); Eifelian and Givetian of the western Urals, Russia (Petrova, 1981); Frasnian and Famennian of western Siberia, Russia (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1987); Eifelian and Givetian of western Siberia, Russia (Zadorozhnyi, 1985); Givetian of Mount Polinik (Carnic Alps, Austria; Vachard et al., 2018); Pragian, Emsian, Eifelian, Givetian, Frasnian and early Famennian of Turkestan, Zeravshan and Gissar, Tajikistan (Sabirov, 2017); Givetian of Taurides, Turkey (this study).

***Etymology*:** Named in honor of T. V. Pronina from Russia for her contributions to Devonian foraminifers.

***Remarks*:** *Proninellites* n. gen. is defined to represent parathuramminid species characterized by a two-layered wall structure with short and tubular apertural spines.

Proninellites graciosa (Pronina, 1960)

Figures 6(5–10)

1960 *Parathurammina graciosa* Pronina, p. 3, pl. 1, figures 1-2.

1981 *Parathurammina* (*Parathurammina*) *graciosa*; Petrova, pl. 8, figures 4-5, 8.

1985 *Parathurammina graciosa*; Zadorozhnyi, p. 127, pl. 17, figure 1; pl. 18, figures 1-2.

2017 *Parathurammina graciosa*; Sabirov, Sabirov, pl. 1, figure 13.

2018 *Parathurammina graciosa*; Vachard, p. 14, figures 9.4, 9.6-7, 9.19-23, 9.27, 9.28?, 10.2.

***Diagnosis*:** Test unilocular and small, globular with numerous short tubular apertural spines. Wall thin and double-layered. The outer layer thin and dark-microgranular. The inner layer light and radial-fibrous. Apertures at the end of apertural necks.

***Measurements*:** Test outer diameter = 0.16–0.2 mm; test inner diameter = 0.13–0.18 mm; number of apertural necks: 8–12; length of apertural necks = 0.01–0.019 mm; outer wall thickness = 0.006–0.009 mm; inner wall thickness = 0.008–0.017 mm.

***Range and occurrence*:** Early Givetian of the eastern part of the central Urals, Russia (Pronina, 1960); Eifelian of the western Urals, Russia (Petrova, 1981); Eifelian and Givetian of the western Siberia, Russia (Zadorozhnyi, 1985); Givetian of Turkestan, Tajikistan (Sabirov, 2017);

Givetian of Mount Polinik (Carnic Alps, Austria; Vachard et al., 2018); Givetian of Taurides, Turkey (this study).

***Materials*:** Six specimens from the samples HD-45 and HD-64 of the Halevikdere Detail section; K10 of the Kocadere section; E30 of the Eceli section.

Proninellites breviradiosa (Reitlinger in Varsanofieva and Reitlinger, 1962)

Figures 6(11–12)

1962 *Parathurammina breviradiosa* Reitlinger in Varsanofieva and Reitlinger, p. 52, pl. 1, figures 1–2.

1965 *Parathurammina breviradiosa*; Chuvashov, p. 19, pl. 1, figures 4-6.

1979 *Parathurammina breviradiosa*; Poyarkov, pl. 3, figure 4.

1981 *Parathurammina breviradiosa*; Petrova, pl. 8, figure 19.

1984 *Parathurammina breviradiosa*; Zadorozhnyi and Yuferev, p. 77, pl. 1, figures 1-2.

1987 *Parathurammina breviradiosa*; Zadorozhnyi, p. 14-15, pl. 1, figures 1-3.

2012 *Parathurammina breviradiosa*; Zaytseva, pl. 1, figure 18.

2017 *Parathurammina breviradiosa*; Sabirov, pl. 1, figures 4-5.

2018 *Bykovaella breviradiosa*; Vachard et al., p. 17, figures 9.7, 10.3.

***Diagnosis*:** Test unilocular, subglobular, or angularly rounded with numerous short tubular apertural spines. Wall double-layered. The outer layer very thin and dark-microgranular. The inner layer thick and light radial. Distinguished by subglobular test and double-layered wall. This species is very similar to *P. graciosa*, but its test is larger and subglobular.

***Measurements*:** Test outer diameter = 0.16–0.2 mm; test inner diameter = 0.15–0.18 mm; number of apertural necks: 4–12; length of apertural necks = 0.013–0.02 mm; outer wall thickness = 0.003–0.005 mm; inner wall thickness = 0.007–0.012 mm.

***Range and occurrence*:** Frasnian of Pechora, Russia (Reitlinger in Varsanofeva and Reitlinger, 1962); Frasnian and Famennian of the central and southern Urals, Russia (Chuvashov, 1965); Givetian of the western Urals, Russia (Petrova, 1981); Frasnian and Famennian of the western Siberia, Russia (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1987); Famennian of Melekesskian depression, western Tatarstan, Russia (Zaytseva, 2012); Pragian, Emsian, Eifelian, Givetian, Frasnian and early Famennian of Turkestan, Zeravshan and Gissar, Tajikistan (Sabirov, 2017); Givetian of Mount Polinik, Carnic Alps, Austria (Vachard et al., 2018); Givetian of Taurides, Turkey (this study).

***Materials*:** Three specimens from the samples H30 of the Helevikdere section; K10 of the Kocadere section; E30 of the Eceli section.

Marginara Petrova in Zarodzhonyi and Yuferev, 1984

Type species: *Parathurammina tamarae* Petrova, 1981.

Marginara tamarae (Petrova, 1981)

Figure 6.13

1981 *Parathurammina tamarae* Petrova, p. 88, pl. 8, figures 1-3.

1984 *Cordatella* (*Marginarae*) *tamarae*; Zadorozhnyi and Yuferev, p. 83, pl. 1, figures 11-13.

1987 *Cordatella* (*Marginarae*) *tamarae*; Zadorozhnyi, p. 21, pl. 2, figures 1-3.

***Diagnosis*:** Test unilocular, globular, and large with numerous conical papillate apertural protuberances. Wall three-layered with dark-microgranular inner and outer layers and light unequal inner layer. Apertural canals conical and wide. Characterized by elevated, triangular and conical protuberances, which are tapering outwards.

***Measurements*:** Test outer diameter = 0.15–0.2 mm; test inner diameter = 0.13–0.18 mm; number of apertural necks: 6–9; length of apertural necks = 0.01–0.03 mm); test wall thickness = 0.011–0.014 mm.

***Range and occurrence*:** Givetian of the central Urals, Russia (Petrova, 1981); Eifelian and Givetian of the western Siberia, Russia (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1987); Givetian of Taurides, Turkey (this study).

***Materials*:** Six specimens from the samples HD-53, HD-57, and HD-67 of the Halevikdere Detail section.

Marginara magna (Antropov, 1950)

Figures 6(14)

1950 *Parathurammina magna* Antropov, p. 24, pl. 1, figures 11-12.

1955 *Parathurammina magna*; Bykova in Bykova and Polenova, p. 17, pl. 2, figures 4-5; pl. 4, figure 5.

1981 *Parathurammina* (*Parathurammina*) *magna*, Petrova, pl. 7, figure 12.

***Diagnosis*:** Test large, unilocular, and globular with numerous papillate apertural protuberances. Wall dark gray and finely granular; sometimes with a light layer on the inner side of the wall. Numerous apertures rounded at the end of papillate apertural protuberances. Characterized by large tests and light layers in the wall.

***Measurements*:** Test outer diameter = 0.47–0.65 mm; test inner diameter = 0.41–0.59 mm; number of apertural necks: 10–18; length of apertural necks = 0.018–0.04 mm; test wall thickness = 0.013–0.021 mm; thickness of light layer: 0.004–0.008 mm.

***Range and occurrence*:** Frasnian of Shugurovsky region, Tatarstan, Russia (Antropov, 1950); Givetian of Volga-Ural region, Russia (Bykova and Polenova, 1955); Eifelian of the western Urals, Russia (Petrova, 1981); Givetian of Taurides, Turkey (this study).

***Materials*:** Eight specimens from the samples H40 and H47 of the Helevikdere section; HD-1 and HD-47 of the Halevikdere Detail section; E30 of the Eceli section.

Genus Saltovskajina Sabirov, 1982

Type species: *Parathurammina scitula* Chuvashov, 1965.

Saltovskajina scitula (Chuvashov, 1965)

Figures 6(15–16)

1965 *Parathurammina scitula* Chuvashov, p. 20, pl. 1, figures 10-12.

1984 *Cordatella* (*Cordatella*) *scitula*; Zadorozhnyi and Yuferev, p. 82, pl. 1, figures 9-10.

1987 *Parathurammina scitula*; Zadorozhnyi, p. 19, pl. 1, figures 13-14.

2017 *Saltovskajina scitula*; Sabirov, pl. 5, figure 77.

***Diagnosis*:** Test unilocular, small and globular with long tubular apertural spines. Wall three-layered with dark-microgranular inner and outer layers and light middle layer. Apertures at the end of apertural necks.

***Measurements*:** Test outer diameter = 0.1–0.2 mm; test inner diameter = 0.08–0.15 mm; number of apertural necks: 2–3; length of apertural necks = 0.025–0.09 mm; outer wall thickness = 0.0044–0.0046 mm; middle wall thickness = 0.005–0.007 mm; inner wall thickness = 0.0025–0.0034 mm.

***Range and occurrence*:** Early Famennian of the central and southern Urals, Russia (Chuvashov, 1965); Frasnian and Famennian of the western Siberia, Russia (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1987); early Famennian of Zeravshan, Tajikistan (Sabirov, 2017); Givetian and Frasnian of Taurides, Turkey (this study).

***Materials*:** Six specimens from the samples H55 of the Helevikdere Section; HD-35 and HD-67 of the Halevikdere Detail Section.

Genus *Sabirovellites* new genus

Type species: *Sabirovellites altineri* n. sp.

***Diagnosis*:** Test is small, single-chambered, nearly spherical, spherical and unattached. The test surface is covered with several short apertural spines. The wall is calcareous, consisting of three layers. The middle layer is thin and dark-microgranular with uniform thickness. The inner and outer layers are thick, light, and hyaline-fibrous with more or less equal thickness.

***Range and occurrence*:** Givetian of Taurides, Turkey.

***Etymology*:** Named in honor of A. A. Sabirov from Tajikistan for his contribution to Devonian foraminifers.

***Remarks*:** Characterized by a three-layered wall structure with a dark-microgranular middle layer. Similar to the other three-layered parathuramminid genera *Marginara* and *Saltovskajina*, but these genera have a light middle layer.

Sabirovellites altineri new species

Figures 6(17–20), 7(1–6)

***Holotype*:** Figure 7.1 (No. HD-52 (thin section), Turkish Petroleum Corporation, Research and Development Center, Ankara) from Givetian of Şafaktepe Formation, Taurides, Turkey.

***Diagnosis*:** Test is unilocular, small, spherical and unattached with several short spine-like apertural protuberances on the surface of the test. Wall is calcareous, consisting of three-layers. The middle layer is thin and dark-microgranular with uniform thickness. The inner and outer layers are thick, light and hyaline-fibrous with more or less equal thickness.

***Range and occurrence*:** Givetian of Taurides, Turkey.

***Measurements*:** Holotype: Test outer diameter = 0.13 mm; test inner diameter = 0.11 mm; number of necks = 9; length of necks = 0.001–0.027 mm; test wall thickness (inner layer = 0.005 mm; middle layer = 0.003 mm; outer layer = 0.006 mm). Paratypes: Test outer diameter = 0.11–0.25 mm; test inner diameter = 0.1–0.2 mm; number of necks = 4–10; length of necks = 0.001–0.033 mm; test wall thickness (inner layer = 0.005–0.011 mm; middle layer = 0.002–0.005 mm; outer layer = 0.005–0.01 mm).

***Etymology*:** Dedicated to D. Altiner for his contribution to Turkish micropalaeontology.

***Materials*:** Nineteen specimens from the samples HD-1, HD-45, HD-49, HD-51, HD-52, HD-53, HD-54, HD-55, HD-58, and HD-67 of the Halevikdere Detail section; E15 and E23 of the Eceli section.

***Remarks*:** *S. altineri* n. sp. is the only species of *Sabirovellites* n. gen. It is very similar to *P. graciosa* in having a globular test, and short tubular apertural spines, but differs in having a three-layered wall structure.

Subfamily Parathuramminitinae Antropov, 1970

Genus *Parathuramminites* Antropov, 1970

Type species: *Parathurammina cushmani* Suleimanov, 1945.

Parathuramminites minima (Antropov, 1950)

Figures 8(1–3)

1950 *Parathurammina cushmani* var. *minima* Antropov, p. 23, pl. 1, figures 7-8.

2004 *Parathurammina* cf. *P. cushmani* var. *minima*; Edgell, p. 6, pl. 1, figure 5.

***Diagnosis*:** Test unilocular and irregularly globular with numerous apertural canals. Wall single-layered, thick, not uniform and dark-microgranular. Numerous apertures at the end of apertural canals passing through the wall.

***Measurements*:** Test outer diameter = 0.08–0.13 mm; test inner diameter = 0.05–0.07 mm; test wall thickness = 0.017–0.021 mm.

***Range and occurrence*:** Famennian of Shugurovsky region, Tatarstan (Antropov, 1950); Late Devonian of Canning Basin, Australia (Edgell, 2004); Givetian and Frasnian of Taurides, Turkey (this study).

***Materials*:** Over 10 specimens from the samples H37, H54, H55 and H56 of the Helevikdere section; HD-14, HD-38, HD-66, and HD-72 of the Halevikdere Detail section; E30 and E39 of the Eceli section.

Parathuramminites devonica (Vissarionova, 1950)

Figures 8(4–6)

1950 *Parathurammina devonica* Vissarionova, p. 35, pl. 1, figure 5.

1965 *Parathurammina devonica*; Chuvashov, p. 25, pl. 2, figures 14-15.

1991 *Parathurammina devonica*; Vachard, p. 261, pl. 1, figures 16-21.

2017 *Parathuramminites devonica*; Sabirov, pl. 3, figure 43.

***Diagnosis*:** Test irregularly globular with regularly rounded inner cavity. Wall very thick and dark-microgranular. Numerous thin apertural canals passing through the wall.

***Measurements*:** Test outer diameter = 0.14–0.22 mm; test inner diameter = 0.07–0.1 mm; test wall thickness = 0.036–0.1 mm.

Range and occurrence: Devonian of Bashkortostan, Russia (Vissarionova, 1950); Frasnian and Famennian of the central and southern Urals, Russia (Chuvashov, 1965); Frasnian and Famennian of Oviedo region, Spain (Vachard, 1991); early Famennian of Zeravshan, Tajikistan (Sabirov, 2017); Givetian and Frasnian of Taurides, Turkey (this study).

Materials: Over 20 specimens from the samples H39, H40, H42, H55 and H56 of the Helevikdere section; HD-3, HD-6, HD-15, HD-24, HD-29, HD-42, HD-51, HD-54, and HD-72 the Halevikdere Detail section; K26 of the Kocadere section; E31 of the Eceli section.

Parathuramminites obnata (Chuvashov, 1965)

Figure 8.7

1965 *Parathurammina obnata* Chuvashov, p. 26, pl. 2, figures 17-19.

1984 *Parathuramminites obnatus*; Kotlyar, p. 13, pl. 3, figures 6-10.

1984 *Cushmanella obnata*; Zadorozhnyi and Yuferev, p. 85, pl. 2, figures 1-3.

1987 *Parathuramminites obnata*; Zadorozhnyi, p. 22, pl. 2, figures 4-6.

***Diagnosis*:** Test small, unilocular, subspherical, and attached. Wall single-layered, thick and dark-microgranular but thin at the attachment part. Apertural canals numerous reaching the outer surface of the chamber. This species is characterized by unequal wall thickness, thin apertural canals, and the presence of the attachment part.

***Measurements*:** Test outer diameter = 0.09–0.16 mm; test inner diameter = 0.07–0.1 mm; test wall thickness = 0.016–0.04 mm.

***Range and occurrence*:** Famennian of the western part of the central Urals, Russia (Chuvashov, 1965); Famennian of Ukraine (Kotlyar, 1984); Middle Devonian of the southeast of the western Siberia and the eastern Urals, Russia (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1987); Givetian and Frasnian of Taurides, Turkey (this study).

***Materials*:** Two specimens from the samples H56 of the Helevikdere section; K10 of the Kocadere section.

Genus *Kolongella* Zadorozhnyi in Zadorozhnyi and Yuferev, 1984

Type species: *Parathurammina kolongensis* Pronina, 1969.

Kolongella kolongensis (Pronina, 1969)

Figures 8(8–11)

1969 *Parathurammina kolongensis* Pronina, p. 25, pl. 5, figures 1-2.

***Diagnosis*:** Test unilocular with uneven outer surface and star-shaped inner surface. Numerous papilliform elevations on the outer wall surface. Wall calcareous, thin but varying in thickness, dark-microgranular. Numerous broad canals perforating the wall. Apertures at the end of papilliform elevations. The specimens are very close to type materials of Pronina (1969) although they were determined in the Silurian rocks.

***Measurements*:** Test outer diameter = 0.12–0.19 mm; test inner diameter = 0.07–0.13 mm; number of apertural necks: 3–6; length of apertural necks = 0.014–0.024 mm; test wall thickness = 0.024–0.026 mm.

***Range and occurrence*:** Late Ludlovian (Middle Silurian) of the eastern part of the central Urals, Russia (Pronina, 1969); Givetian and Frasnian of Taurides, Turkey (in this study).

***Materials*:** Over 10 specimens from the samples H55 and H56 of the Helevikdere section; HD-49, HD-58, and HD-70 of the Halevikdere Detail section; E30 of the Eceli section.

Kolongella pojarkovi (Zadorozhnyi and Yuferev, 1984)

Figures 8(12–15)

1984 *Suleimanovella* (*Kolongella*) *pojarkovi* Zadorozhnyi and Yuferev, p. 89, pl. 2, figures 6, 7.

1985 *Suleimanovella* (*Kolongella*) *pojarkovi*; Zadorozhnyi, pl. 17, figure 4.

1987 *Suleimanovella* (*Kolongella*) *pojarkovi*; Zadorozhnyi, p. 27, pl. 2, figures 9-11.

2018 *Kolongella* cf. *pojarkovi*; Vachard et al., p. 20, figures 10.11.

***Diagnosis*:** Test unilocular, irregularly globular with numerous, massive, low, broadly rounded, triangular and papilliform elevations. Wall calcareous, dark-microgranular, thin and uniform. Apertures at the end of papilliform elevations. It is close to *K. kolongensis*, but differs in having a thinner wall and more elevated and triangular papillae.

***Measurements*:** Test outer diameter = 0.16–0.25 mm; test inner diameter = 0.13–0.23 mm; number of apertural necks: 12–16; length of apertural necks = 0.014–0.023 mm; test wall thickness = 0.008–0.018 mm.

***Range and occurrence*:** Givetian of the southeast of the western Siberia, Russia (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1985); Givetian of the western Urals, Russia (Zadorozhnyi, 1987); Givetian of Mount Polinik, Carnic Alps, Austria (Vachard et al., 2018); Eifelian and Givetian of Taurides, Turkey (in this study).

***Materials*:** Over 10 specimens from the samples H30 of the Helevikdere section; HD-35, HD-42 and HD-51 of the Halevikdere Detail section; K10 of the Kocadere section; E23 of the Eceli section.

Genus *Suleimanovella* Yuferev in Zadorozhnyi and Yuferev, 1984

Type species: *Parathurammina suleimanovi* Lipina, 1950.

Suleimanovella paracushmani (Reitlinger, 1954)

Figures 8(16–19)

1954 *Parathurammina paracushmani* Reitlinger, p. 68, pl. 21, figures 4-6.

1965 *Parathurammina paracushmani*; Chuvashov, p. 24, pl. 2, figures 10-11.

1969 *Parathurammina* (*Parathuramminites*) *paracushmani oshiensis*; Poyarkov, p. 83, pl. 2, figures 1, 10, pl. 3, figures 2, 5.

1984 *Parathuramminites* aff. *paracushmani*; Kotlyar, p. 12, pl. 2, figures 13-18.

1994 *Parathurammina paracushmani*; Vachard, p. 24, pl. 1, figure 1; pl. 2, figures 13-15; pl. 7, figure 17.

2002 *Suleimanovella paracushmani*; Timokhina and Klets, pl. 1, figure 1.

2017 *Suleimanovella paracushmani*; Sabirov, pl. 3, figures 36, 40.

***Diagnosis*:** Test massive and nearly spherical with few spines like apertural canals. Wall thick and dark-microgranular with unequal thickness. Apertural canals thick. Characterized by the massive test with few and broader apertural canals.

***Measurements*:** Test outer diameter = 0.091–0.16 mm; test inner diameter = 0.06–0.13 mm; test wall thickness = 0.012–0.041 mm.

***Range and occurrence*:** Frasnian of Kirov Oblast, Russia (Reitlinger, 1954); Frasnian of the central and southern Urals, Russia (Chuvashov, 1965); Frasnian of Tian-Shan, Kyrgyzstan (Poyarkov, 1969); Late Devonian of Ukraine (Kotlyar, 1984); Frasnian of Ancenis Basin, France (Vachard, 1994); late Frasnian of the western Siberia (Timokhina and Klets, 2002); Frasnian of Zeravshan, Tajikistan (Sabirov, 2017); Givetian and Frasnian of Taurides, Turkey (this study).

***Materials*:** Over 10 specimens from the samples H37 and H55 of the Helevikdere section; HD-24, HD-42, HD-46, HD-47, HD-66, and HD-72 of the Halevikdere Detail section.

Suleimanovella suleimanovi (Lipina, 1950)

Figures 8(20), 9(1–9)

1950 *Parathurammina suleimanovi*; Lipina, p. 104, pl. 1, figures 3-4.

1954 *Parathurammina suleimanovi*; Grozdilova and Lebedeva, p. 26, pl. 1, figures 6-8.

1962 *Parathurammina suleimanovi*; Bogush and Yuferev, p. 82, pl. 1, figure 16.

1964 *Parathurammina suleimanovi*; Conil and Lys, p. 30, pl. 4, figures 15-16.

1975 *Parathurammina suleimanovi*; Neumann et al., pl. 2, figure 10.

1976 *Parathurammina* of the group *P. suleimanovi*; Armstrong and Mamet, p. 22, pl. 26, figures 9-12.

1977 *Parathurammina suleimanovi*; Vachard, pl. 8, figure 2.

1980 *Parathurammina suleimanovi*; Malakhova, pl. 1, figure 12.

1981 *Parathurammina suleimanovi*; Petrova, pl. 8, figures 17-18.

1984 *Suleimanovella* (*Suleimanovella*) *suleimanovi*; Zadorozhnyi and Yuferev, p. 87, pl. 1, figures 14-15.

1987 *Suleimanovella* (*Suleimanovella*) *suleimanovi*; Zadorozhnyi, p. 24, pl. 1, figures 15-17.

2012 *Parathurammina suleimanovi*; Zaytseva, pl. 1, figure 10.

2017 *Suleimanovella suleimanovi*; Sabirov, pl. 5, figures 76, 79.

***Diagnosis*:** Test unilocular with irregular chamber surface; often angular with a few apertural canals making small conical elevations. Inner cavity globular. Wall dark-microgranular and very thick with unequal thickness. Apertures at the end of apertural canals. Characterized by irregular, star shaped outline and presence of the spines.

***Measurements*:** Test outer diameter = 0.103–0.21 mm; test inner diameter = 0.045–0.108 mm; test wall thickness = 0.03–0.06 mm.

***Range and occurrence*:** Famennian and Tournaisian of the south of the central Siberia, Russia (Lipina, 1950); Late Devonian of Kuznets Basin, Russia (Grozdilova and Lebedeva, 1954); Famennian and Tournaisian of Karatau, Kazakhstan (Bogush and Yuferev, 1962); Tournaisian and Visean of Belgium and France (Conil and Lys, 1964); Frasnian of Lublin, Poland (Neumann et al., 1975); Early Carboniferous of Alaska, America (Armstrong and Mamet, 1976); Visean of Montagne Noire, France (Vachard, 1977); early Moscovian of the southern Urals, Russia (Malakhova, 1980); Eifelian of the southern Urals, Russia (Petrova, 1981); Eifelian of the western Siberia, Russia (Zadorozhnyi and Yuferev, 1984); Frasnian of the western Siberia and Kuznets Basin, Russia (Zadorozhnyi, 1987); Famennian of Melekesskian depression, western Tatarstan, Russia (Zaytseva, 2012); late Famennian of Zeravshan, Tajikistan

(Sabirov, 2017); Givetian and Frasnian of Taurides, Turkey (this study).

***Materials*:** Over 50 specimens from the samples H39, H45, H46, H49, H55 and H56 of the Helevikdere section; HD-1, HD-6, HD-11, HD-15, HD-24, HD-37, HD-38, HD-39, HD-40, HD-41, HD-43, HD-44, HD-45, HD-49, HD-54, and HD-72 of the Halevikdere Detail section; K10, K14 and K18 of the Kocadere section; E14, E22, E26, E30, and E31 of the Eceli section.

Suleimanovella praetuberculata (Reitlinger, 1954)

Figures 9(10–13)

1954 *Parathurammina praetuberculata* Reitlinger, p. 68, pl. 19, figure 4.

2004 *Parathurammina* sp. aff. *P. praetuberculata*; Edgell, p. 6, pl. 1, figure 4.

***Diagnosis*:** Test irregularly spherical with a rough outer surface and subspherical inner cavity. Wall thick and unequal. A few thick tapering apertural necks in the form of spines. Characterized by irregular form and wide apertural necks tapering outwards.

***Measurements*:** Test outer diameter = 0.09–0.117 mm; test inner diameter = 0.05–0.09 mm; test wall thickness = 0.023–0.044 mm.

***Range and occurrence*:** Frasnian of Kirov Oblast, Russia (Reitlinger, 1954); Famennian of Canning Basin, Australia (Edgell, 2004); Eifelian, Givetian and Frasnian of Taurides, Turkey (this study).

***Materials*:** Over 20 specimens from the samples H39, H47, H54, and H56 of the Helevikdere section; HD-39, HD-45, HD-50, HD-55, and HD-63 of the Halevikdere Detail section; K18 of the Kocadere section; E23 and E30 of the Eceli section.

Suleimanovella paulis (Bykova in Bykova and Polenova, 1955)

Figures 9(14–17)

1952 *Parathurammina paulis* Bykova, 17, pl. 1, figures 4-5

1969 *Parathurammina* (*Salpingothurammina*) *paulis*; Poyarkov, p. 93, pl. 2, figures 3, 7.

1981 *Parathurammina* (*Salpingothurammina*) *paulis*; Petrova, pl. 7, figures 7-8, 18.

1985 *Suleimanovella* (*Suleimanovella*) *paulis*; Zadorozhnyi, pl. 16, figures 9-10; pl. 17, figure 16; pl. 18, figures 17-18.

2017 *Spinosella paulis*; Sabirov, pl. 4, figures 60-62.

***Diagnosis*:** Test small with a rounded or slightly angular outline with short and thick apertural necks. Wall thick, uniform and dark-microgranular. Apertures at the end of necks. This species is similar to *S. praetuberculata*, but it has a smaller test and more rounded inner cavity.

***Measurements*:** Test outer diameter = 0.053–0.13 mm; test inner diameter = 0.04–0.094 mm; number of apertural necks: 2–3; length of apertural necks = 0.023–0.06 mm; test wall thickness = 0.02–0.03 mm.

***Range and occurrence*:** Famennian of Bashkortostan, Russia (Bykova, 1952); Givetian, Frasnian and Famennian of Tian-Shan, Kyrgyzstan (Poyarkov, 1969); Middle Devonian of the central Urals, Russia (Petrova, 1981); Middle Devonian of the western Siberia, Russia (Zadorozhnyi, 1985); late Frasnian of Zeravshan, Tajikistan (Sabirov, 2017); Givetian and Frasnian of Taurides, Turkey (this study).

***Materials*:** Over 10 specimens from the samples H37, H40, H42, H46, H49, and H56 of the Helevikdere section; K10 of the Kocadere section; E12, E13, and E30 of the Eceli section.

Suleimanovella stellata (Lipina, 1950)

Figures 9(18–20), 10(1–4)

1950 *Parathurammina suleimanovi* var. *stellata* Lipina, p. 120, pl. 1, figures 15-16.

1962 *Parathurammina stellata*; Bogush and Yuferev, p. 79, pl. 1, figure 11.

1965 *Parathurammina stellata*; Chuvashov, p. 25, pl. 2, figure 16.

1984 *Parathurammina stellatus*; Kotlyar, p.10, pl. 2, figures 1-8.

1994 *Parathurammina stellata*; Vachard, p. 25, pl. 2, figures 3-5, 8, 11.

***Diagnosis*:** Test unilocular with irregular or star shaped outline. Inner cavity irregular or star shaped drawing outside to apertures. Wall calcareous, dark-microgranular and thick but varying in thickness. Apertures at the end of apertural canals. Characterized by irregular, star shaped outline and presence of tubular apertural spines. This species is similar to *S. suleimanovi*, but differs in having longer tubular spines.

***Measurements*:** Test outer diameter = 0.086–0.17 mm; test inner diameter = 0.06–0.11 mm; number of apertural necks: 5–6; length of apertural necks = 0.04–0.09 mm; test wall thickness = 0.016–0.032 mm.

***Range and occurrence*:** Late Devonian and early Tournaisian of the southern and central Urals, Russia (Lipina, 1950); Tournaisian of Karatau, Kazakhstan (Bogush and Yuferev, 1962); Frasnian, Famennian and early Tournaisian of the western Urals (Chuvashov, 1965); Frasnian of Ukraine (Kotlyar, 1984); Givetian and Frasnian of Ancenis Basin, France (Vachard, 1994); Eifelian, Givetian and Frasnian of Taurides, Turkey (this study).

***Materials*:** Over 50 specimens from the samples H32, H36, H46, H54, and H56 of the Helevikdere section; HD-11, HD-22, HD-24, HD-29, HD-34, HD-41, HD-43, HD-46, HD-47, HD-48, HD-49, HD-53, HD-54, HD-58, HD-68, HD-70, and HD-72 of the Halevikdere Detail section; K8 and K10 of the Kocadere section; E14, E26 and E30 of the Eceli section.

Genus *Salpingothurammina* Poyarkov in Purkin et al., 1961

Type species: *Parathurammina tuberculata* Lipina, 1950.

Salpingothurammina spinosa (Lipina, 1950)

Figures 10(5–10)

1950 *Parathurammina spinosa* Lipina, p. 117, pl. 1, figures 1-2.

1954 *Parathurammina spinosa*; Grozdilova and Lebedeva, p. 25, pl. 2, figures 1-3.

1955 *Parathurammina spinosa*; Bykova in Bykova and Polenova, p. 18, pl. 2, figures 6-8; pl. 4, figure 4.

1962 *Parathurammina spinosa*; Bogush and Yuferev, p. 78, pl. 1, figure 10.

1965 *Parathurammina* sp. cf. *P. spinosa*; Toomey, p. 257, pl. 2, figures 4-9; pl. 4, figure 1.

1970 *Parathurammina* sp. cf. *P. spinosa*; Toomey et al., p. 968, pl. 4, figures 24-31.

1976 *Parathurammina* of the group *P. spinosa*; Armstrong and Mamet, p. 22, pl. 26,

figures 2-4, 6-8.

1999 *Parathurammina spinosa* (Williamson) (= *Parathurammina spinosa* Lipina) (sic); Mamet et al., pl. 5, figure 11.

2017 *Spinosella spinosa*; Sabirov, pl. 4, figures 53, 56-59, 63-64.

***Diagnosis*:** Test unilocular and irregularly rounded with numerous long tubular spines, the inner cavity more rounded than outer surface. Wall single-layered, not uniform and dark-microgranular. Apertures at the end of apertural spines.

***Measurements*:** Test outer diameter = 0.09–0.18 mm; test inner diameter = 0.07–0.014 mm; number of apertural necks: 2–3; length of apertural necks = 0.04–0.11; test wall thickness = 0.005–0.012 mm.

***Range and occurrence*:** Late Famennian of the southern part of Moscow Basin, Russia (Lipina, 1950); Tournaisian of Karatau, Kazakhstan (Bogush and Yuferev, 1962); Late Devonian of Kuznets Basin, Russia (Grozdilova and Lebedeva, 1954); Tournaisian of Alaska, America (Armstrong and Mamet, 1976); Famennian of Volga-Ural Oblast, Russia (Bykova and Polenova, 1955); Late Devonian of Alberta, Canada (Toomey, 1965; Toomey et al., 1970); Givetian of Morocco (Mamet et al., 1999); Frasnian of Zeravshan, Tajikistan (Sabirov, 2017); Givetian and Frasnian of Taurides, Turkey (in this study).

***Materials*:** Over 20 specimens from the samples H40, H49, and H56 of the Helevikdere section; HD-17, HD-49, HD-53, HD-66, HD-68, HD-70, and HD-72 of the Halevikdere Detail section; K10 of the Kocadere section; E30 and E39 of the Eceli section.

Salpingothurammina tuberculata (Lipina, 1950)

Figures 10(11–12)

1950 *Parathurammina tuberculata* Lipina, p. 118, pl. 1, figures 3-4.

1962 *Parathurammina tuberculata*; Bogush and Yuferev, p. 77, pl. 1, figure 9.

1969 *Parathurammina* (*Salpingothurammina*) *tuberculata*; Poyarkov, p. 94, pl. 2, figure 4.

1984 *Parathurammina tuberculata*; Kotlyar, p. 9, pl. 1, figure 9.

1985 *Polygonella tuberculata*; Zadorozhnyi, pl. 16, figure 11; pl. 18, figure 9.

2004 *Parathurammina tuberculata*; Edgell, p. 5, pl. 1, figure 3.

2017 *Salpingothurammina tuberculata*; Sabirov, pl. 3, figures 44-46.

***Diagnosis*:** Test unilocular, small, and irregularly globular with several long apertural spines. Wall thin, single-layered, dark-microgranular, and uniform. Apertures at the end of apertural spines. It is close to *S. spinosa*, but differs in having irregular inner cavity of the test.

***Measurements*:** Test outer diameter = 0.08–0.12 mm; test inner diameter = 0.062–0.11 mm; number of apertural necks: 2–3; length of apertural necks = 0.04–0.07 mm; test wall thickness = 0.007–0.012 mm.

***Range and occurrence*:** Late Famennian of the southern part of Moscow Basin, Russia (Lipina, 1950); Famennian and Tournaisian of Karatau, Kazakhstan (Bogush and Yuferev, 1962); Famennian of Tian-Shan, Kyrgyzstan (Poyarkov, 1969); Late Devonian of Ukraine (Kotlyar, 1984); Famennian of Canning Basin, Australia (Edgell, 2004); Eifelian and Frasnian of the western Siberia, Russia (Zadorozhnyi, 1987); Frasnian of Zeravshan, Tajikistan (Sabirov, 2017); Givetian of Taurides, Turkey (in this study).

***Materials*:** Over 10 specimens from the samples H37 and H49 of the Helevikdere section; HD-1, HD-2, HD-8, HD-35, HD-39, HD-52, HD-53 and HD-67 of the Halevikdere Detail section.

Salpingothurammina subvasta (Bykova in Bykova and Polenova, 1955)

Figures 10(13–15)

1955 *Parathurammina subvasta* Bykova in Bykova and Polenova, p. 18, pl. 5, figures 7-8.

1965 *Parathurammina subvasta*; Chuvashov, p. 23, pl. 2, figures 7-8.

1975 *Parathurammina subvasta*; Neumann et al., pl. 2, figure 9.

1984 *Parathuramminites* aff. *subvastus*; Kotlyar, p. 15, pl. 3, figures 24-27.

1984 *Polygonella subvasta*; Zadorozhnyi and Yuferev, p. 92, pl. 2, figures 13-14.

1987 *Salpingothurammina subvasta*; Zadorozhnyi, p. 30, pl. 2, figures 14-15.

***Diagnosis*:** Test unilocular and angularly rounded outline of the test with long and rather massive apertural

spines. Wall single-layered and dark-microgranular. Apertures at the end of apertural spines. It is close to *S.* cf. *tuberculata*, but differs in having more angular outline and larger size of the test.

***Measurements*:** Test outer diameter = 0.16–0.17 mm; test inner diameter = 0.09–0.14 mm; number of apertural necks: 3–4; length of apertural necks = 0.06–0.1; test wall thickness = 0.01–0.02 mm.

***Range and occurrence*:** Frasnian of Shugurovsky region, Tatarstan and the western Urals, Russia (Bykova and Polenova, 1955); Givetian of the central and southern Urals, Russia (Chuvashov, 1965); Frasnian of Lublin, Poland (Neumann et al., 1975); Late Devonian of Ukraine (Kotlyar, 1984); Givetian, Frasnian and Famennian of the southeast of the western Siberia, Russia (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1987); Givetian and Frasnian of Taurides, Turkey (in this study).

***Materials*:** Over 10 specimens from the samples H40, H54, H55, and H56 of the Helevikdere section; HD-64 of the Halevikdere Detail section; K10 and K42 of the Kocadere section; E30 and E39 of the Eceli section.

Salpingothurammina elegans (Poyarkov, 1969)

Figures 10(16–18)

1969 *Parathurammina* (*Salpingothurammina*) *elegans* Poyarkov, p. 92, pl. 2, figures 2, 6, 8.

1981 *Parathurammina* (*Salpingothurammina*) *elegans*; Petrova, pl. 7, figures 1-4.

1984 *Suleimanovella* (*Suleimanovella*) *elegans*; Zadorozhnyi and Yuferev, p. 88, pl. 2, figures 4-5.

1987 *Suleimanovella* (*Suleimanovella*) *elegans*; Zadorozhnyi, p. 25, pl. 2, figures 7-8.

1994 *Parathurammina elegans*; Vachard, p. 23, pl. 2, figures 6-7, 9-10, 12; pl. 7, figure 20.

2017 *Spinosella elegans*; Sabirov, pl. 4, figures 67-68.

***Diagnosis*:** Test unilocular and spherical with a few tubular apertural spines. Apertures at the end of apertural spines. Apertural canals in medium to large size. Wall single-layered and dark-microgranular. It is well-differentiated by large apertural canals.

***Measurements*:** Test outer diameter = 0.16–0.21 mm; test inner diameter = 0.09–0.17 mm; number of apertural necks: 3–5; length of apertural necks = 0.03–0.08 mm; test wall thickness = 0.01–0.026 mm.

***Range and occurrence*:** Givetian and Frasnian of the southern Fergana, Tian-Shan, Kyrgyzstan (Poyarkov, 1969); Eifelian and Givetian of the western Urals, Russia (Petrova, 1981); Givetian and Frasnian of the southeast of the western Siberia, Russia (Zadorozhnyi and Yuferev, 1984; Zadorozhnyi, 1987); Givetian of Ancenis Basin, France (Vachard, 1994); early Tournaisian of Zeravshan, Tajikistan (Sabirov, 2017); Eifelian, Givetian and Frasnian of Taurides, Turkey (in this study).

***Materials*:** Over 20 specimens from the samples H22, H54, H55, and H56 of the Helevikdere section; HD-2, HD-14, HD-48, HD-49, HD-53, HD-67, and HD-70 of the Halevikdere Detail section; K10, K35, and K39 of the Kocadere section; E30 and E39 of the Eceli section.

Polygonella Yuferev in Zadorozhnyi and Yuferev, 1984

Type species: *Polygonella irregulariformis* Zadorozhnyi and Yuferev, 1984.

Polygonella irregulariformis Zadorozhnyi and Yuferev, 1984

Figures 10(19–20)

1984 *Polygonella irregulariformis* Zadorozhnyi and Yuferev, p. 91, pl. 2, figures 10-12.

1987 *Salpingothurammina irregulariformis*; Zadorozhnyi, p. 29, pl. 2, figures 16-18.

***Diagnosis*:** Test unilocular and irregular-angularly globular with several tubular protuberances. Wall thin, dark-micrograunlar and uniform. Apertures at the end of tubular protuberances.

***Measurements*:** Test outer diameter = 0.2–0.24 mm; test inner diameter = 0.15–0.22 mm; number of apertural necks: 3–6; length of apertural necks = 0.034–0.09 mm; test wall thickness = 0.007–0.015 mm.

***Range and occurrence*:** Givetian of the southeast of the western Siberia, Russia (Zadorozhnyi and Yuferev, 1984); late Eifelian of the eastern part of the central Urals and Givetian of the southeast of the western Siberia, Russia (Zadorozhnyi, 1987); Givetian and Frasnian of Taurides, Turkey (this study).

***Materials*:** Four specimens from the samples H56 of the Helevikdere section; K10 of the Kocadere section; E30 of the Eceli section.

5. Conclusions

The detailed investigations of the unilocular foraminifers from the Devonian carbonate rocks of the eastern and central Taurides have led to the following conclusions: The stratigraphic sections Halevikdere, Halevikdere Detail (HD), Kocadere and Eceli revealed rich and diversified parathuramminid assemblages. In total, 25 parathuramminid species were identified, and the systematic descriptions of these species were provided. The descriptions include new taxa *Proninellites* n. gen. and *Sabirovellites altineri* n. gen. n. sp. The parathuramminids are mostly distributed in a time interval from Eifelian to Frasnian in the Taurides. This distribution relates to that the carbonate sedimentation prevails in this period. Although the parathuramminid species are limited in the Lower Devonian sediments, they show a significant radiation during the Givetian stage, during which the double- and three-layered parathuramminid species are dominated. Their abundance and diversity decrease in the Upper Devonian deposits of the Taurides.

The parathurammid species of the Taurides show a close morphology with those found in the deposits of the Urals, Siberia (Russia), and Central Asia (Kyrgyzstan, Kazakhstan, and Tajikistan).

A detailed study on morphological features of the parathuramminid species allowed proposing a practical identification schema.

Acknowledgments

This paper contributes to the projects "Devonian Ecosystems and Climate of Turkey (DEVEC-TR)" and "Sedimentary cycles and signatures of global events in the Devonian at the Northern margin of Gondwana, Southern Turkey (DECENT)", supported by The Scientific and Technological Research Council of Turkey (TÜBİTAK) (projects DEVEC-TR 104Y218; DECENT 111Y179), the International Bureau of the BMBF (projects DEVEC-TR: TUR 04/009; DECENT: 01DL12036) and Turkish Petroleum Corporation. This paper is also a part of the PhD thesis of the author who expresses his sincere gratitude to his advisor A. Nazik in Çukurova University for her support and motivation. Thanks are extended to D. Vachard for naming new taxa. The anonymous reviewers are acknowledged for their comments and suggestions.

References

Armstrong AK, Mamet BL (1976). Carboniferous microfacies, microfossils and corals, Lisburne Group, Arctic Alaska. Geological Survey Professional Paper 849: 1-129.

Antropov CA (1950). Novye vidy foraminifer verkhnego devona nekotorykh rayonov vostoka russkoi platform. Rossiiskaya Akademiya Nauk, Izvestiya Kazanskogo Filiala, Geologicheskii Institut 1: 21-33 (in Russian).

Antropov CA (1970). K vaprosam sistematiki, filogenii i stratigraficheskogo rasproctraneniya paraturamminid. Akademiya, Izvestiya Kazanskogo Filiala, Geologicheskii Institut 26: 138-150 (in Russian).

Bogush OI, Yuferev OV (1962). Foraminifery i stratigrafiya kamennoygolnykh otlozhenii Karatay i Talasskogo Alatay. Moskva, Russiya: Rossiiskaya Akademiya Nauk, Sibirskoe Otdelenie, Trudy Instituta Geologii i Geofiziki (in Russian).

Bykova EV (1952). Foraminifery devona Russkoi Platformy i Priuralya. Trudy Vsesoyuznogo Neftyanogo Nauchno-Issledovatelskogo Geologo-razvedochnogo Instituta, Microfauna 5: 5-64 (in Russian).

Bykova EV, Polenova EN (1955). Foraminifery, radiolarii i ostrakody devona Volgo-Uralskoi oblasti i tsentralnovo devonskovo polya i ikh znachenie dlya stratigrafii. Trudy Vsesoyuznogo Neftyanogo Nauchno-Issledovatelskogo Geologo-razvedochnogo Instituta 87: 1-141 (in Russian).

Cavalier-Smith T (2003). Protists phylogeny and the high-level classification of Protozoa. European Journal of Protistology 39: 338-348.

Chuvashov BI (1965). Foraminifery i vodorosly iz verkhnedevonskikh otlojenii zapadnogo sklona srednego i juznogo Urala. Rossiiskaya Akademiya Nauk, Trudy Instituta Geologii, Uralskiy Filial 74: 1-153 (in Russian).

Conil R., Lys M (1964). Matériaux pour l'étude micropaléontologique du Dinantien de la Belgique et de la France (Avesnois), Part 1, Algues et Foraminiféres; Part 2, Foraminiféres. Mémoire de l'Insitut de Géologie, Université de Louvain 23: 1-372 (in French).

Demirtaşlı E (1967). Pınarbaşı-Sarız-Mağara ilçeleri arasındaki sahanın litostratigrafi birimleri ve petrol olanakları. Maden Tetkik ve Arama Enstitüsü, Rapor No: 3489. Ankara, Turkiye: Maden Tetkik ve Arama Enstitüsü (in Turkish).

Demirtaşlı E (1984). Stratigraphy and tectonics of the area between Silifke and Anamur. In: Tekeli O, Göncuoğlu MC (editors). Geology of the Taurus Belt Proceedings. Ankara, Turkey: Mineral Research and Exploration Institute, pp. 101-141.

d'Orbigny A (1826). Tableau méthodique de la classe des Céphalopodes: Annales des Sciences Naturelles 7: 245-314.

Edgell HS (2004). Upper Devonian and Lower Carboniferous foraminifera from the Canning Basin, Western Australia. Micropaleontology 50 (1): 1-26.

Gaillot J, Vachard D (2007). The Khuff Formation (Middle East) and time equivalents in Turkey and South China: biostratigraphy from Capitanian to Changhsingian times (Permian), new foraminiferal taxa, and palaeogeographical implications. Coloquios de Paleontología 57: 37-223.

Grozdilova LP, Lebedeva NS (1954). Foraminifery nixhnego karbona i bashkirkogo yarusa sresnego karbona Kolvo-Visherskogo Kraya. Trudy Vsesoyuznogo Neftyanogo Nauchno-Issledovatelskogo Geologo-razvedochnogo Instituta, Mikrofauna, Sbornik 7: 4-203 (in Russian).

Kaźmierczak J (1976). Volvocacean nature of Paleozoic non-radiosphaerid calcispheres and parathuramminid "Foraminifera". Acta Palaeontologica Polonica 21 (3): 245-258.

Kaźmierczak J, Kremer B (2005). Early post-mortem calcified Devonian acritarchs as a source of calcispheric structures. Facies 51 (1): 554-565.

Kotlyar OE (1984). Foraminifery verkhnego devona USSR. Rossiiskaya Akademiya Nauk, Ukrainskoy Filiala, Institut Geologicheskikh Nauk 4: 1-53 (in Russian).

Lipina OA (1950). Foraminifery verkhnego devona Russkoi Platformy. Rossiiskaya Akademiya Nauk, Trudy Instituta Geologicheskikh Nauk 119, Geologiskaya Seriya 43: 110-133 (in Russian).

Malakhova NP (1980). Kompleks melkikh foraminifer srednego karbona yugo-vostochnogo Urala. Akademiya Nauk SSSR, Ural'skiy Nauchnyy Tsentr, Trudy Instituta Geologii i Geokhimii, pp. 1-54 (in Russian).

Mamet B (2006). Taxonomy of Visean marine calcareous algae, Fernie, British Columbia (Canada). Rivista Italiana di Paleontologia e Stratigrafia 112 (3): 323-357.

Mamet B, Préat A (2009). Algues et microfossiles problématiques du Dévonien moyen du "Fondry des Chiens" (bord sud du synclinorium de Dinant, Belgique): implications paléobathymétriques. Revue de Micropaléontologie 52 (3): 249-263 (in French).

Mamet B, Préat A, Lehmami M (1999). Algues calcaires marines du Dévonien marocain (Meseta). Revue de Micropaléontologie 42 (4): 301-314 (in French).

Mikhalevich VI (1980). Sistematica I evolyuyuciya foraminifer v svete novyikh dannyikh po ih citologii I ultrastrukture. Trudy Zoologicheskogo Instituta 94: 42–61 (in Russian).

Neumann M, Pozaryska K, Vachard D (1975). Remarques sur les microfaciès du Dévonien de Lublin (Pologne). Revue de Micropaléontologie 18 (1): 38-52 (in French).

Özgül N (1976). Toroslar'ın bazı temel jeoloji özellikleri. Türkiye Jeoloji Kurumu Bülteni 19 (1): 65-78 (in Turkish).

Özgül N (1984). Stratigraphy and tectonic evolution of the Central Taurides. In: Tekeli O, Göncuoğlu MC (editors). Geology of the Taurus Belt Proceedings. Ankara, Turkey: Mineral Research and Exploration Institute, pp. 77-90.

Özgül N, Metih S, Göğer E, Bingöl İ, Baydar O et al. (1973). Tufanbeyli (Doğu Toroslar, Adana) Kambriyen-Tersiyer kayaları. Türkiye Jeoloji Kurumu Bülteni 16 (1): 82-100 (in Turkish).

Özgül N, Kozlu H (2002). Kozan-Feke (Doğu Toroslar) yöresinin stratigrafisi ve yapısal konumu ile ilgili bulgular. Türkiye Petrol Jeologları Derneği Bülteni 14 (1): 1-36 (in Turkish).

Özkan R (2011). Frasnian (Late Devonian) foraminiferal biostratigraphy from Taurides, southern Turkey. Stratigraphy 8 (4): 281-292.

Özkan, R (2018). Doğu ve Orta Toroslar Devoniyen istifinin stratigrafik, mikropaleontolojik (bentik foraminifer) ve sedimantolojik özellikleri. Ph.D Tezi, Çukurova Üniversitesi, 300 s (in Turkish with English abstract).

Özkan R, Vachard D (2015). A new early Frasnian (Late Devonian) foraminifer from eastern Taurides (Turkey): Evolutionary and paleobiogeographic implications. Revue de Micropaléontologie 58 (3): 267-282. https://doi.org/10.1016/j.revmic.2015.07.005

Özkan R, Nazik A, Munnecke A, Saydam-Demiray DG, Schindler E et al. (2019). Givetian/Frasnian (Middle/Upper Devonian) transition in the eastern Taurides, Turkey. Turkish Journal of Earth Sciences 28 (2): 207-231. https://doi.org/10.3906/yer-1804-20.

Petrova LG (1981). Foraminifery srednego Devona vostochnovo sklona Urala. Rossiiskaya Akademiya Nauk, Sibirskoe Otdelenie, Trudy Instituta Geologii i Geofiziki 482: 81-101 (in Russian).

Poyarkov BV (1969). Stratigrafiya i foraminifery devonskikh otlozhenii Tyan-Shanya. Bishkek, Kyrgyzstan: Izdateltsvo "Frunze, Ilim" (in Russian).

Poyarkov BV (1979). Razvitie i rasprostranenie devonskikh foraminifer. Moskva, Russiya: Dalnevostochnyi Geologicheskii Insitut, Izdateltsvo "Nauka" (in Russian).

Pronina TV (1960). Novye vidy foraminifer iz nizhnezhivetskikh otlozhenii srednogo i yuzhnogo Urala. Paleontologicheskii Zhurnal 1: 45-52 (in Russian).

Pronina TV (1969). Novie siluriiskie i devonskie foraminiferi Urala. Paleontological Journal 2: 21-33 (in Russian).

Purkin MM, Poyarkov BV, Rozhanets VM (1961). Stratigrafiya i novye vidi foraminifer turneyskih otlozhenii khrebta Borkoldoy (Tyan-Shan). Rossiiskaya Akademiya Nauk, Kirgizskoi Otdelenie, Seriya Estestvvennykh i Tekhnicheskikh Nauk 3 (4): 15-36 (in Russian).

Rauzer-Chernousova DM, Fursenko AV (1959). Osnovy Paleontologii, Obshchaya chast Prosteishie. Moskva, Russiya: Rossiiskaya Akademiya Nauk, Izdatelstvo (in Russian).

Reitlinger EA (1954). Devonskie foraminiferi nekotoryh razrezov vostochnoy chasti Russkoy Platformy. Trudy Vsesoyuznogo Neftyanogo Nauchno-Issledovatelskogo Geologo-razvedochnogo Instituta 1: 52-81 (in Russian).

Sabirov AA (2017). Paleozoickie primitivnyi izvestkovyi foraminifery: Morfologiya i sistematika, filogeniya i stratigraficheskoe znachenie. Dushanbe Tadzhikistan: Institut Geologii, Seysmostoykogo Stroitel'stva i Seysmologii (in Russian).

Schlagintweit F, Hladil J, Nose M, Salerno C (2013). Palaeozoic record of *Thaumatoporella* Pia, 1927 (incertae sedis?). Geologica Croatica 66 (3): 155-182. https://doi.org/10.4154/GC.2013.14

Suleimanov IS (1945). Novie vidy melkikh foraminifer iz Tureyskogo yarusa Ishimbaebskogo neftenosnogo rayona. Comptes Rendus Doklady, Rossiiskaya Akademiya Nauk 48 (2): 130-134 (in Russian).

Timokhina IG, Klets AG (2002). Novyye dannie o raspredelenii verkhnedevonskikh foraminifer v tsentralnykh karbonatnykh rayonakh Zapadno-Sibirskoy ravniny. Novosti Paleontologii i Stratigrafii 5: 137-143 (in Russian).

Toomey DF (1965). Upper Devonian (Frasnian) foraminifera from Redwater and south Sturgeon lake reefs, Alberta, Canada. Bulletin of Canadian Petroleum Geology 13: 252-270.

Toomey DF, Mountjoy EW, MacKenzie WS (1970). Upper Devonian (Frasnian) algae and foraminifera from the Ancient Wall carbonate complex, Jasper National Park, Alberta, Canada. Canadian Journal of Earth Sciences 7 (3): 946-981.

Vachard D (1977). Etude stratigraphique et micropaléontologique (algues et foraminiferes) du Viséen de la Montagne Noire (Hérault, France). Mémoires de l'Institut géologique de l'Université de Louvain 29: 111-195 (in French).

Vachard D (1991). Parathuramminides et moravamminides (Microproblematica) de l'Emsien supérieur de la Formation Moniello (Cordillères Cantabriques, Espagne). Revue de Paléobiologie 10 (2): 255-299 (in French).

Vachard D (1994). Foraminifères et moravamminides du Givétien et du Frasnien du domaine Ligérien (Massif Armoricain, France). Palaeontographica A 231: 1-92 (in French).

Vachard D (2016). Macroevolution and biostratigraphy of the Paleozoic foraminifers. In: Montenari M (editor). Stratigraphy and Timescales. Amsterdam, the Netherlands: Elsevier, pp. 257-323.

Vachard D, Pille L, Gaillot J (2010). Palaeozoic Foraminifera: systematics, palaeoecology and responses to the global changes. Revue de Micropaléontologie 53(4): 209-254. https://doi.org/10.1016/j.revmic.2010.10.001.

Vachard D, Krainer K, Mörtl A (2018). Middle Devonian parathuramminid and earlandiid foraminifers from shallow marine carbonates of the Carnic Alps (Austria). Journal of Paleontology 92 (3): 336-372. https://doi.org/10.1017/jpa.2017.127

Varsanofieva VA, Reitlinger EA (1962). K kharakteristike verkhnedevonskikh I Turneiskikh otlozhenii Maloi Pechory. Moskovskogo Obshchestva, Ispytatelei, Prirody, Otdelenie Geologii, Byulleten 37 (5): 36-60 (in Russian).

Vishnevskaya VS, Sedaeva KM (2002). O zonalnykh deleniyakh otlozheniy granitsy devona - kamennougolnogo perioda na osnove paraturaminov (foraminifera ili foraminifera - radiolyarnyy masshtab. In: Chuvashov BI, Amon EO (editors). Stratigrafiya i paleogeografiya kamennougolnogo perioda Yevrazii. Moskva, Russiya: Rossiiskaya Akademiya Nauk, Mezhvedomstvennyi Stratigrafichevskii Komitet Rossii, Institut Geologii i Geokhimii, pp. 53-60 (in Russian).

Vissarionova AYa (1950). Fauna foraminifer v devonskikh otlozheniyakh Bashkiri. Bashkirskaya Neft, Ufa 1: 33-36 (in Russian).

Wehrmann A, Yılmaz I, Yalçın MN, Wilde V, Schindler E et al. (2010). Devonian shallow-water sequences from the north Gondwana coastal margin (central and eastern Taurides, Turkey. Gondwana Research 17 (2): 546-560. https://doi.org/10.1016/j.gr.2009.09.011

Yalçın MN, Yılmaz I (2010). Devonian in Turkey - a review. Geologica Carpathica 61 (3): 235-253. https://doi.org/10.2478/v10096-0014-3

Zadorozhnyi VM (1985). Rasprostranenie foraminifer v tipovikh razrezakh devona okranii Kuznetskogo basseyna. In: Dubatolov VN, Kanygin AV (editors). Biostratigrafiya Paleozoya Zapadnoi Sibiri. Moskva, Russiya: Rossiiskaya Akademiya Nauk, Sibirskoe Otdelenie, Trudy Instituta Geologii i Geofiziki, pp. 119-141 (in Russian).

Zadorozhnyi VM (1987). Foraminifery i biostratigrafiya devona zapadno-Sibirskoe plity i yego skladchatogo obramleniya. Rossiiskaya Akademiya Nauk, Trudy Instituta Geologii i Geofiziki, Sibirskoe Otdelenie 680: 1-126 (in Russian).

Zadorozhnyi VM, Yuferev OV (1984). Foraminifera. In: Kanygin AV (editor). Paleozoy yugo-vostochnoy chasti Zapadno-Sibirskoy plity. Moskva, Russiya: Rossiiskaya Akademiya Nauk, Sibirskoe Otdelenie, Trudy Instituta Geologii i Geofiziki, pp. 70-113 (in Russian).

Zaytseva EL (2012). Devonskiye foraminifery vostochnoy chasti Melekesskoy vpadiny. Sovremennaya Mikropaleontologiya 15: 64-67 (in Russian).