Available online at www.sciencedirect.com
ScienceDirect
Palaeogeography, Palaeoclimatology, Palaeoecology 252 (2007) 82–92
PALAEO
www.elsevier.com/locate/palaeo

Olenekian (Early Triassic) foraminifers of the Gorny Mangyshlak, Eastern Precaucasus and Western Caucasus

Valery J. Vuks

All Russian Geological Research Institute (VSEGEI), Sredny pr., 74, 199106, St. Petersburg, Russia

Accepted 30 November 2006

Abstract

A new Early Triassic (Olenekian) foraminiferal assemblage has recently been discovered in the Gorny Mangyshlak in the Caspian Sea region. The Triassic foraminiferal assemblages of the Western Caucasus and Eastern Precaucasus are similar to those present in the Gorny Mangyshlak. Widely distributed species of foraminifers, conodonts, and ammonoids occur in the Lower Triassic of all three of those regions. Therefore, it is possible to correlate the Olenekian foraminiferal assemblage of the Gorny Mangyshlak to the *Meandrospira pusilla* assemblage in other parts of the world, and to the global stratigraphic scale.

The Olenekian foraminiferal assemblage of the Gorny Mangyshlak mainly consists of primitive attached foraminifers and diverse nodosariids. Such a foraminiferal assemblage usually indicates adverse paleoenvironmental conditions for benthic fauna. The taxonomic composition of the Olenekian foraminiferal assemblages from the Gorny Mangyshlak and Caucasus regions allows us to conclude that these faunas are similar to the foraminiferal assemblages from the Carpathians and Balkans. It is possible that the paleobasins of these regions had good connections and foraminifers migrated between these regions. The late Olenekian transgression provided conditions for the existence of different groups of macrofaunas and foraminifers to develop in these basins. The late Olenekian transgression allowed the biota from the Caucasus paleobasin to move into the paleobasin of Central Asia (Mangyshlak). Similarities of the Early Triassic biotic assemblages of the Caucasus and Gorny Mangyshlak to coeval strata in Europe are demonstrated.

Keywords: Triassic; Olenekian; Foraminifers; Stratigraphy; Gorny Mangyshlak; Western Caucasus; Eastern Precaucasus

1. Introduction

Triassic foraminiferal assemblages of the Western Caucasus and Eastern Precaucasus (south part of Russia) may be used as a standard reference succession for correlating coeval assemblages throughout the Caucasus and adjacent regions, because there are foraminifers and other faunas through almost the whole of the Triassic. The discovery of an Early Triassic (Olenekian) foraminiferal assemblage in the Gorny Mangyshlak allows us to correlate the Early Triassic foraminiferal assemblages of these Caucasus regions. The foraminiferal assemblage of the Gorny Mangyshlak is similar to the coeval assemblages in the Caucasus region (Fig. 1), but the Gorny Mangyshlak assemblage contains fewer species. Furthemore, the abovementioned assemblages of Caucasus (Efimova, 1991) include some widely distributed species that occur in coeval microfaunal assemblages in the European (from Slovakia to Greece) and Asian territories (Trifonova, 1984) that are useful in interregional correlation. The late Olenekian ammonoid assemblages from the

E-mail address: Valery_Vuks@vsegei.ru.

0031-0182/$ - see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.palaeo.2006.11.035

Fig. 1. Studied areas with Olenekian foraminifers: 1. Western Caucasus, 2. Eastern Precaucasus, and 3. Gorny Mangyshlak.

Columbites local zone of the Eastern Precaucasus and Gorny Mangyshlak are diverse and well correlated (Gavrilova, 1994). The correlation of the Olenekian foraminiferal assemblages of the Gorny Mangyshlak and Eastern Precaucasus is important because it is supported by ammonoids.

The main aim of this research is to study the distribution of the Olenekian foraminifers from carbonate–siliciclastic successions of the Mangyshlak and Caucasus, and to compare the assemblage with others in coeval deposits of the world. Special attention is given to the research and correlation of the foraminiferal assemblage of the Mangyshlak to coeval assemblages of Russia and adjacent regions (Western Caucasus, Eastern Precaucasus, Crimea, and other). The Triassic strata of the Caucasus and Mangyshlak have been studied for years, but most results have been published only in Russian and rarely in English. This work contributes to investigations of the Olenekian Stage, the boundaries of which are a focus of the International Subcommission on Triassic Stratigraphy (IUGS) and the International Geological Correlation Programme Project 467 ("Triassic time").

2. Previous works and material

A foraminiferal zonation of the Triassic deposits from the Western Caucasus and Eastern Precaucasus was proposed by Efimova (1991). In the Mangyshlak and Crimea areas there were no zonal schemes. No data on Early Triassic foraminifers from the Southern Mangyshlak are known, and there are only two papers about foraminifers from the Lower Triassic of the Crimea (Spasov et al., 1977, 1978), which considered the compositions of the foraminiferal assemblages and their correlation. The first Early Triassic foraminifers from the Gorny Mangyshlak were discovered as a result of the Peri-Tethys Program (Vuks, 1997, 2000; Gaetani et al., 1998). These studies were the first attempts to establish a foraminiferal zonation and correlate coeval deposits according to foraminifers. Samples were collected from various lithotypes (limestones, shales,

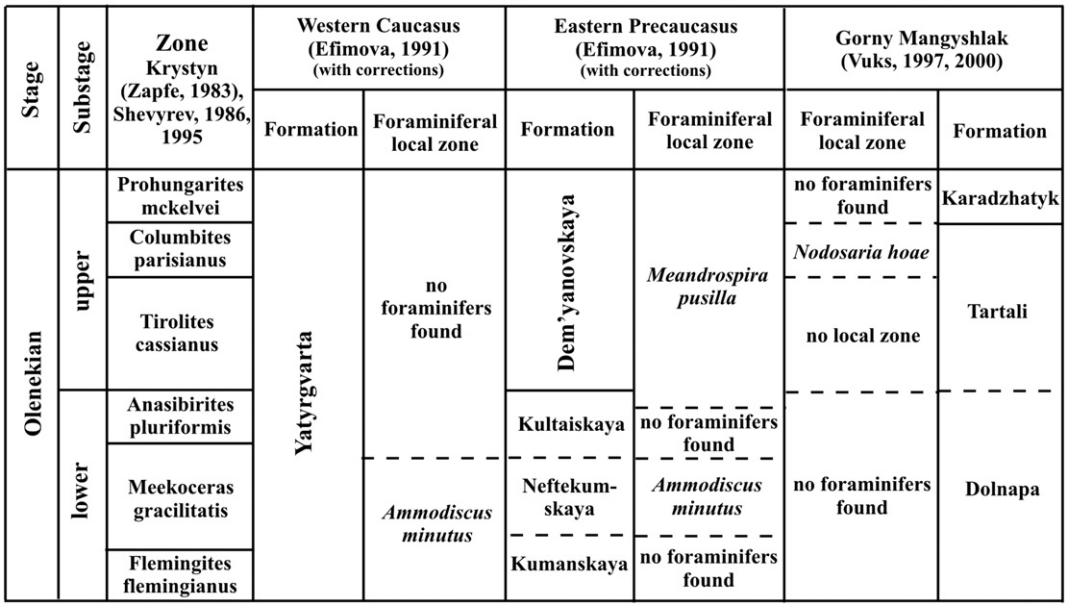

Fig. 2. Foraminiferal zonation of the Olenekian of the Western Caucasus, Eastern Precaucasus, and Gorny Mangyshlak.

and argillites) of the Lower Triassic formations (Dolnapa, Tartali, and Karadzhatyk formations) and correlated with ammonoids. Sixty thin-sections from the Lower Triassic limestones of the Gorny Mangyshlak were studied.

Finally, a large number of the thin-sections from the Lower Triassic of the Eastern Precaucasus and Gorny Mangyshlak were studied at Pavia University in 2005, thanks to a fellowship obtained from the Cariplo Foundation for Scientific Research and Landau Network–Centro Volta. New material consisted of 130 thin-sections of Triassic limestones (mainly of Early Triassic age) from several boreholes of the Eastern Precaucasus, most of which are located in the Mirnensko–Arzgirskaya and Prekumskaya areas. Foraminiferal species were found in 8 thin-sections, generally from the strata of the Dem'yanovskaya Formation (upper Olenekian). Besides, data on the Olenekian foraminifers of the Eastern Precaucasus and Western Caucasus result from publications of Efimova (1974, 1991) and Hoffman (Oleynikov and Rostovtsev, 1979). All studied thin-sections are deposited in All Russian Geological Research Institute (VSEGEI), St. Petersburg, Russia.

3. Geological setting and results

3.1. Gorny Mangyshlak

Gorny Mangyshlak (Western Kazakhstan) is located on the eastern side of the Caspian Sea (Fig. 1) in the western part of Central Asia, and consists of three areas named from west to east, Karatauchik, West Karatau, and East Karatau. The Triassic strata of the Gorny Mangyshlak conformably rest on the Permian and are unconformably overlain by Jurassic rocks. The Lower Triassic succession is subdivided in an ascending order into the Dolnapa Formation (Induan?–lower Olenekian), the Tartali Formation (lower part of the upper Olenekian), and Karadzhatyk Formation (upper part of the upper Olenekian; Fig. 2; Alferov et al., 1977). The Tartali Formation consists of intercalation of grey shales, siltstones, and limestones. The thickness of this unit is about 500 m. Tartali Formation includes four ammonoid beds. They are, in ascending order, the *Dorikranites*, *Kiparisovites*, *Tirolites*, and *Columbites* bed, which correlate to the *Tirolites cassianus* and *Columbites parisianus* zones of the upper Olenekian (Gavrilova, 1994) (Fig. 2). Moreover, the *Columbites* beds contain abundant recrystallized fossil fragments, microgastropods, ostracods, bivalves, and foraminifers, part as endemic forms.

Several sections of Triassic deposits from the Gorny Mangyshlak were studied, but foraminifers were mainly found in a limestone bed in the upper part (*Columbites* beds) of the Tartali Formation (Dolnapa section, Karatauchik) (Figs. 2 and 3) near layers with several species of ammonoids that indicate a late Olenekian age (*Columbites* beds) (Gaetani et al., 1998; Gavrilova, 1999). It is very important to note this age because it permits the correlation of the foraminiferal assemblage to the global stratigraphic

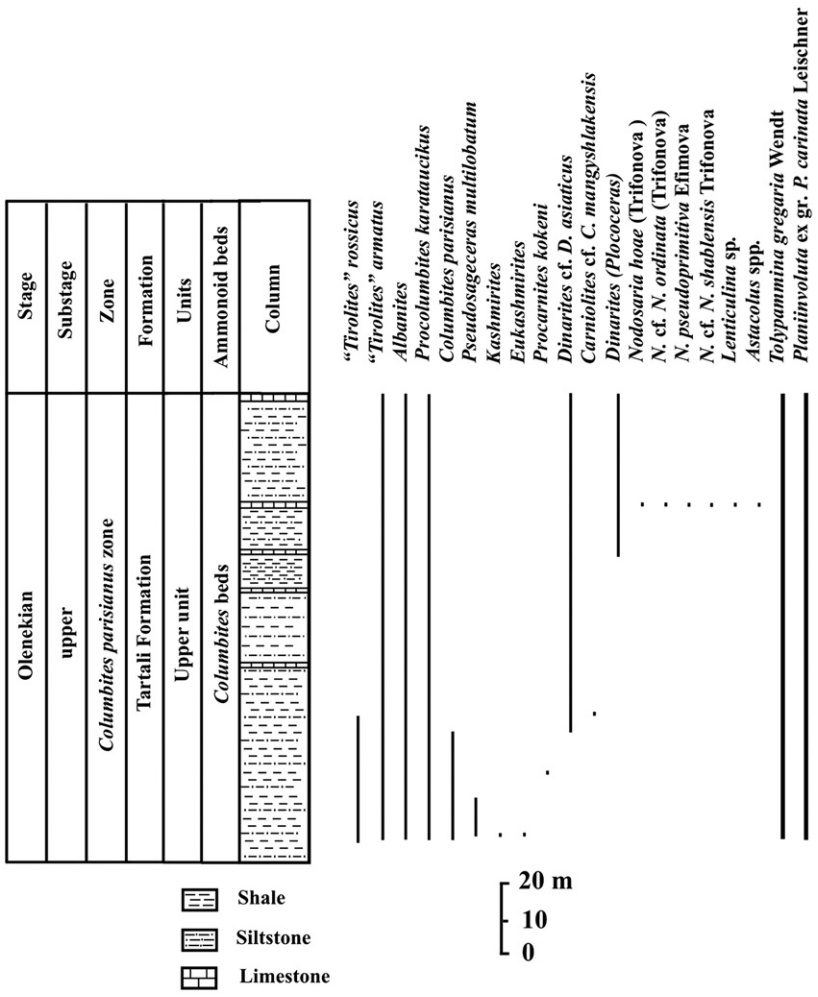

Fig. 3. Distribution of ammonites and foraminifers in the *Columbites* beds of the Tartali Formation, upper Olenekian (Dolnapa section, Karatauchik, Gorny Mangyshlak, Kazakhstan) (modified after Gaetani et al., 1998).

scale. In slightly older *Tirolites* beds, *Tolypammina gregaria* Wendt and *Nodosaria* sp. were discovered from the Tartali Formation (Vuks, 1997; Gaetani et al., 1998; Vuks, 2000). In several thin-sections from the *Columbites* beds there are the foraminifers *T. gregaria* Wendt, *Planiinvoluta* ex gr. *P. carinata* Leischner, ?*Calcitornella* sp., *Nodosaria hoae* (Trifonova), *N.* cf. *N. ordinata* (Trifonova), *N. pseudoprimitiva* Efimova, *N.* cf. *N. shablensis* Trifonova, *N.* spp., *Lenticulina* sp., *Astacolus* sp. A, *A.* sp. B, and *A.* sp. C (Figs. 3–6). In particular, representatives of *Tolypammina* and *Planiinvoluta* were found in several levels of the *Columbites* beds. Based on this total assemblage, the *N. hoae* local zone was tentatively proposed only for the stratigraphic interval of the *Columbites* local zone (Vuks, 1997, 2000). The foraminifers are very small and are not well preserved. This assemblage consists of nodosariids and primitive attached foraminifers, both of which reflect adverse paleoenvironmental conditions for the development of the benthic faunal communities in this paleobasin. The assemblage is similar to the Early Triassic (Olenekian) assemblages of the Western Caucasus and Eastern Precaucasus, particularly the *Meandrospira pusilla* assemblage of the Eastern Precaucasus (Efimova, 1991), which shows various nodosariids and some common species with the *N. hoae* assemblage of the Gorny Mangyshlak. However, *M. pusilla* Ho is absent in the latter region.

3.2. Eastern Precaucasus

The Eastern Precaucasus is located between the city of Stavropol and the Caspian Sea (Fig. 1). The Lower Triassic strata of this area are represented (from bottom to top) by the Kumanskaya, Neftekumskaya, Kultaiskaya, and

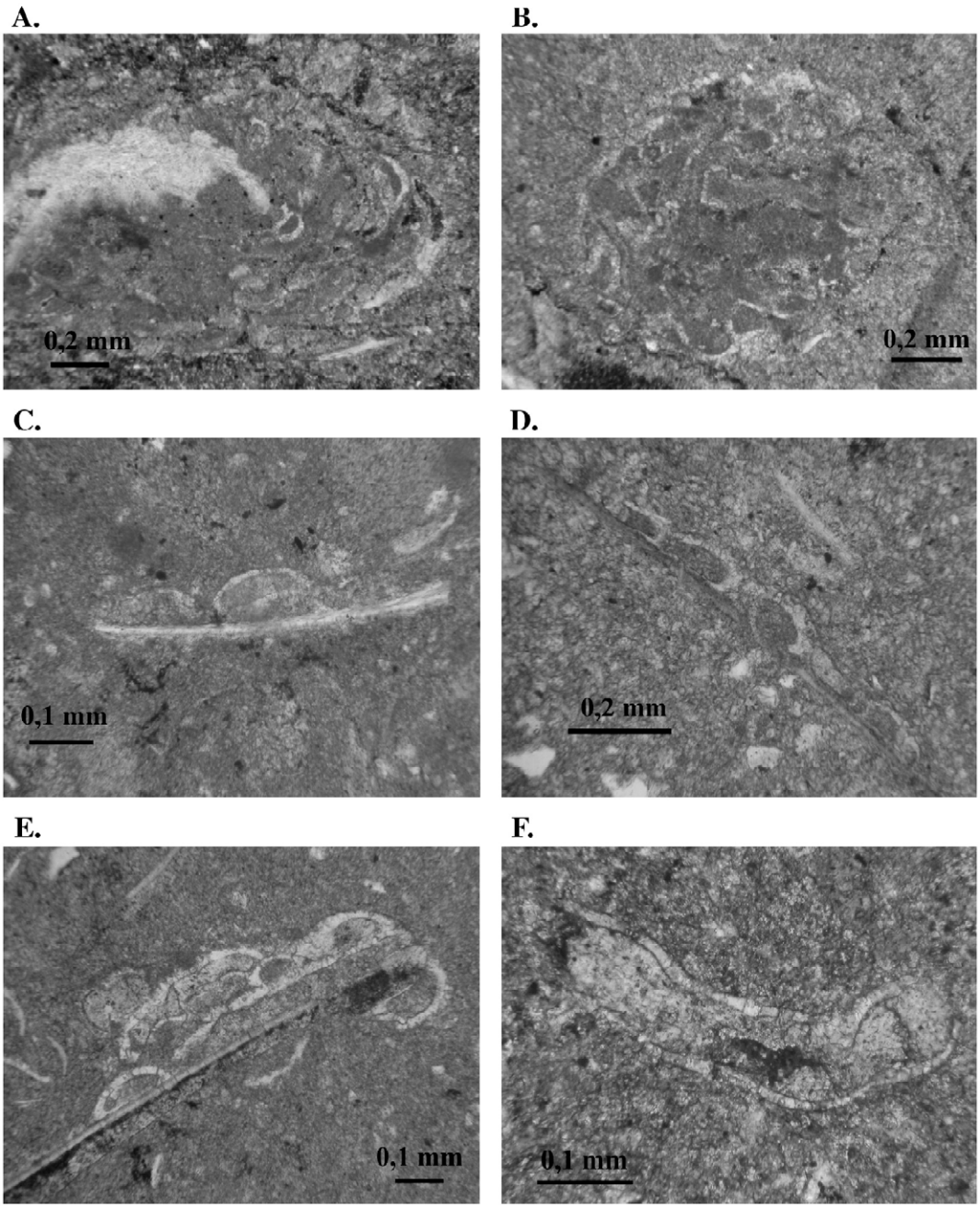

Fig. 4. Primitive attached foraminifers from the *Columbites* beds of the Tartali Formation (Dolnapa section, Karatauchik, Gorny Mangyshlak): (A, B) *Tolypammina gregaria* Wendt. (C, D) *Planiinvoluta* ex gr. *P. carinata* Leisch. (E, F) ?*Calcitornella* sp.

Dem'yanovskaya formations (Fig. 2). The Neftekumskaya Formation (Lower Triassic, lower Olenekian) conformably overlies the Kumanskaya Formation (Induan?–lower Olenekian), and consists of grey and dark grey limestones with subordinate grey organic–clastic limestone and argillite beds. In the upper part of this formation there are grey massive biohermal limestones and tuffs. The thickness of the Neftekumskaya Formation is estimated at about 900 m (Oleynikov and Rostovtsev, 1979). The early Olenekian age of this formation is supported by conodonts (upper part of the *Pachycladina–Furnishius* Zone and lower part of the *Neospathodus conservativus* Zone) that can be correlated to the *Meekoceras gracilitatis* ammonoid zone of the lower Olenekian (Gavrilova, 1994). In the Neftekumskaya Formation there is a foraminiferal assemblage that corresponds to the assemblage of the

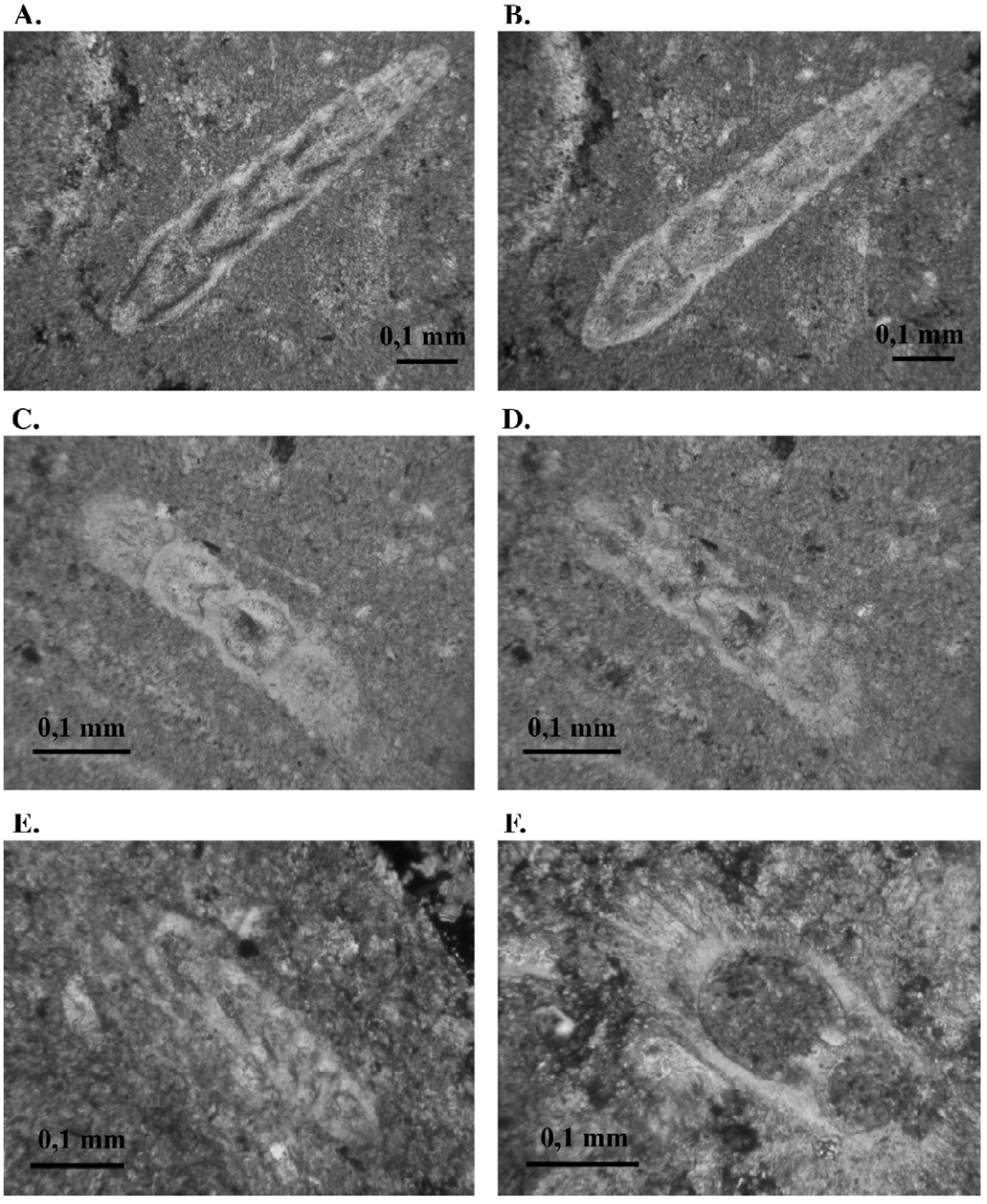

Fig. 5. Foraminifers (nodosariids) from the *Columbites* beds of the Tartali Formation (Dolnapa section, Karatauchik, Gorny Mangyshlak): (A, B) *Nodosaria hoae* (Trifonova); (A) specimen in cross nicol. (C, D) *Nodosaria* cf. *N. ordinata* (Trifonova); (D) specimen in cross nicol. (E) *Nodosaria* sp. (F) *Nodosaria* cf. *N. shablensis* Trifonova.

Ammodiscus minutus local zone of the Western Caucasus (Efimova, 1991) based on a lot of common species of nodosariids. The typical species of the assemblage are *Hoyenella sinensis* (Ho), *Glomospirella facilis* Ho, *Nodosaria orbicamerata* Efimova, *N.* cf. *N. ordinata* Trifonova, *N.* aff. *N. piricamerata* Efimova, *N. shablensis* Trifonova, *N. skyphica* Efimova, *Dentalina splendida* Schleifer, and others (Efimova, 1991). The generic composition of this assemblage is also similar to those from the Lower Triassic (Olenekian) of China (Ho, 1959; He, 1993), Gorny Mangyshlak (Vuks, 1997, 2000), Crimea (Spasov et al., 1977, 1978), Bulgaria (Trifonova and Chatalov, 1975), and Hungary (Broglio Loriga et al., 1990). The main feature of the taxonomic assemblage

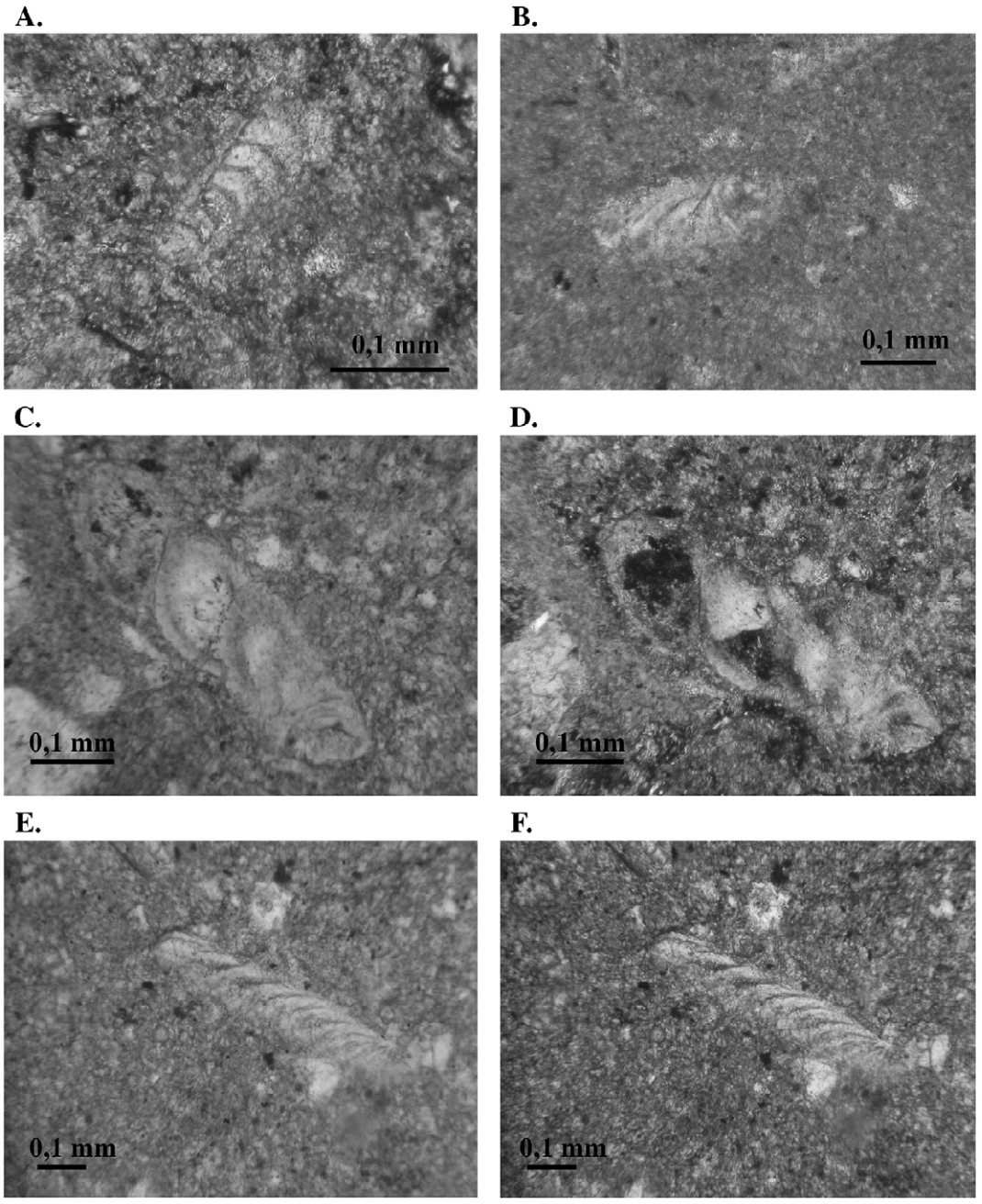

Fig. 6. Foraminifers (nodosariids) from the *Columbites* beds of the Tartali Formation (Dolnapa section, Karatauchik, Gorny Mangyshlak): (A) *Nodosaria* sp. (B) *Lenticulina* sp. (C, D) *Astacolus* sp. A; (D) Specimen in cross nicol. (E, F) *Astacolus* sp. B; (F) Specimen in cross nicol.

from the Neftekumskaya Formation is the presence of varying representatives of the nodosariids and some primitive agglutinated foraminifers. The composition of this assemblage is very specific and mostly consists of forms that can exist in adverse paleoenvironmental conditions.

The Kultaiskaya Formation (Lower Triassic, lower Olenekian) conformably overlies the Neftekumskaya Formation and is composed of grey and brown clayey limestones with a thickness of about 300 m (Oleynikov and Rostovtsev, 1979). The ammonoids *Owenites* sp., *Juvenites sinuosus* Kiparisova, *Paranannites* cf. *gracilis* Kiparisova, and *Parussuria* sp. occur in the lower part of Kultaiskaya Formation and, in common with the underlying formation, this part has been correlated to the *M. gracilitatis* Zone of the lower Olenekian (Gavrilova,

1994). Moreover, there is a conodont assemblage in the upper part of the formation that is considered to be equivalent to the upper part of the *N. conservativus* Zone, and to the early Olenekian *Anasibirites pluriformis* Zone (Gavrilova, 1994).

The Dem'yanovskaya Formation (Lower Triassic, upper Olenekian) conformably overlies the Kultaiskaya Formation and it is represented by dark grey argillites with limestone and siltstone beds. The thickness is about 450 m (Oleynikov and Rostovtsev, 1979). A conodont assemblage, which corresponds to the *Neogondolella jubata* Zone (Gavrilova, 1994), occurs in the lower part of the Dem'yanovskaya Formation. This conodont zone is correlated with the *T. cassianus* zone of the upper Olenekian (Gavrilova, 1994). In the upper part of this formation there are two ammonoid levels, one with *C. parisianus–Procolumbites karataucikus* and the other with *Stacheites undatus* (Gavrilova, 1994). These ammonoid beds can be correlated to the *C. parisianus* and *Prohungarites crasseplicatus* zones of the Tethyan scale (upper Olenekian).

In the upper part of the Kultaiskaya Formation and in the Dem'yanovskaya Formation there is a foraminiferal assemblage yielding these characteristic species: *H. sinensis* (Ho), *Verneuilinoides edwardi* Schroeder, *M. pusilla* (Ho), *Nodosaria angulocamerata* Efimova, *N.* cf. *N. hoae* Trifonova, *N. ordinata* Trifonova, *N. piricamerata* Efimova, *N. pseudoprimitiva* Efimova, *N. skyphica* Efimova, and, *Dentalina luperti* Efimova (1991). Efimova (1991) proposed the *M. pusilla* local zone for this fauna and correlated this local zone to the upper Olenekian. However, the zones represented in the Kultaiskaya Formation belong to the upper part of the lower Olenekian (Gavrilova, 1994). The foraminifers of this zone are very small and not well preserved. Besides the name giver, the main taxonomic feature of this assemblage is the presence of various species of nodosariids, and some primitive agglutinated foraminifers. This assemblage is more diverse than other assemblages of the considered regions and indicates less stressed paleoenvironmental conditions for this fauna.

The assemblage from the *M. pusilla* local zone can be correlated with coeval foraminiferal assemblages in eastern Bulgaria (Trifonova, 1984), Dinarides (Pantic and Pampnoux, 1972), Hungary (North Bakony; Broglio Loriga et al., 1990), Western Carpathians (Salaj et al., 1983), Gorny Mangyshlak (Vuks, 1997, 2000), and China (Ho, 1959; He, 1993). Efimova (1991) correlated it to the zone with same name from Western Carpathians (Salaj et al., 1988) and Bulgaria (Trifonova, 1993). The revision of the range charts of *M. pusilla* and *Meandrospira cheni* (Rettori, 1995) gives possibility to change the foraminiferal zonation of the Lower Triassic of Bulgaria and stratigraphical position of the *M. pusilla* Zone in particular. In the Olenekian assemblages from the abovementioned regions (Bulgaria, Hungary, Western Carpathians, Caucasus, Gorny Mangyshlak, and China) primitive agglutinated foraminifers (*Hoyenella*, *Glomospirella*, and *Ammodiscus*) and a representative of the genus *Meandrospira* are dominant, and most of them have various representatives of the nodosariids. In the studied collection from the *M. pusilla* local zone of the Eastern Precaucasus, the foraminiferal assemblage consists of *H. sinensis* (Ho), *Meandrospira*? ex gr. *M. pusilla* (Ho), *Nodosaria* cf. *N. piricamerata* Efimova, *Nodosaria*? sp., and *Dentalina* cf. *D. luperti* Efimova. In general, these foraminifers are not well preserved. The taxonomic composition of this Olenekian foraminiferal assemblage is mainly similar to the composition of the coeval assemblages of these deposits studied from the Eastern Precaucasus by Efimova (1991).

3.3. Western Caucasus

The Triassic deposits of the Western Caucasus are located in the Peredovoy Range, in the Laba and Belaya River basins (Fig. 1). The Triassic strata unconformably rest on different Paleozoic rocks, and in turn are unconformably overlain by the Jurassic. The lower part of the Triassic deposits in the Western Caucasus is represented by the Tkhach Group. The Tkhach Group is assigned to the Lower–Middle Triassic and consists (in ascending order) of the Yatyrgvarta, Maly Tkhach, and Acheshbok formations. The Yatyrgvarta Formation is mainly represented by thin-bedded limestones and a basal horizon that consists of thick-bedded limestones, sandstones, and conglomerates (Figs. 2 and 7). The thickness of this unit is about 200–300 m and belongs to the upper part of the Induan and Olenekian (Oleynikov and Rostovtsev, 1979; Shevyrev, 1995). The Maly Tkhach Formation (Lower Anisian) conformably overlies the Yatyrgvarta Formation with local erosion in some sections.

Efimova (1991) placed the *A. minutus* local zone in the middle part of the Yatyrgvarta Formation and correlated it to the *Meekoceras gracilitatis* Zone of the lower Olenekian. The typical species of this local zone are *A. minutus* Efimova, *N. orbicamerata* Efimova, *N. shablensis* Trifonova, *N. skyphica* Efimova, *D. luperti* Efimova, *D. splendida* Schleifer, and others (Efimova, 1991). Bivalves and ammonoids support an early Olenekian age assignment (Oleynikov and Rostovtsev, 1979). In an older paper, Efimova (1974) showed a lot of the characteristic foraminifers of the *A. minutus* assemblage in the several levels below the ammonoid zone. On

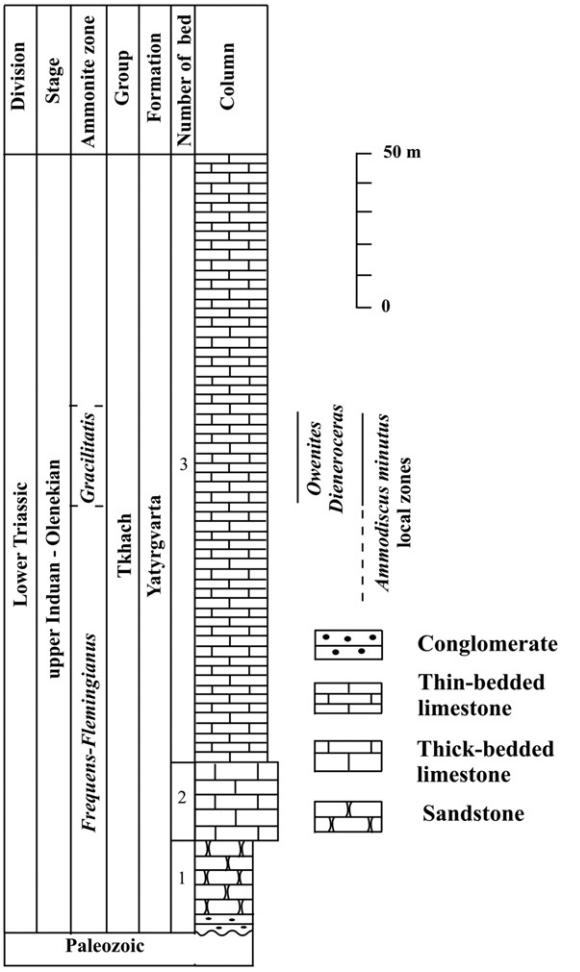

Fig. 7. Section of the Yatyrgvarta Formation of the Yatyrgvarta Mountain, Laba River basin, Western Caucasus, Russia (modified after Schevyrev, 1995).

consideration of the investigation of the Triassic ammonoids by Shevyrev (1995) I propose to correlate the *A. minutus* local zone with the *M. gracilitatis* and *Flemengites flemingianus* zones of the lower part of the lower Olenekian.

The *A. minutus* assemblage can be correlated to the Olenekian assemblage from Eastern Precaucasus (Efimova, 1991), eastern Bulgaria (Trifonova and Chatalov, 1975), the Western Carpathians (Salaj et al., 1983), Dinarides (Pantic and Pampnoux, 1972), and Hungary (Broglio Loriga et al., 1990). The main taxonomic feature of this foraminiferal assemblage is the dominance of diverse representatives of nodosariids — the foraminifers are very small and not well preserved. Radiolarians and ammonoids (pelagic fauna) are more common and diverse than foraminifers and bivalves, possibly because of anoxic bottom conditions of this paleobasin.

4. Conclusions

Foraminiferal assemblages with *M. pusilla* (Ho) are known from various regions of the world, from the Carpathians and Alps to China and Malaysia (Zaninetti, 1976; Salaj et al., 1988; Vachard and Fontaine, 1988; Rettori, 1995) (Fig. 8). This research supports results of previous investigators about the presence of *M. pusilla* (Ho) in late Olenekian foraminiferal assemblages from Eastern Precaucasus.

The present research demonstrates that the late Olenekian foraminiferal assemblage of the *N. hoae* local zone from the Gorny Mangyshlak can be correlated to the coeval assemblage from the *M. pusilla* local zone of the Eastern Precaucasus. The main feature of the taxonomic composition of the Olenekian foraminiferal assemblages of the Gorny Mangyshlak and Caucasus regions (i.e., the *A. minutus* and *M. pusilla* assemblages) is the dominance of diverse nodosariids. The last mentioned assemblage of the Eastern Precaucasus corresponds to other Olenekian assemblages found in Bulgaria, Hungary, the Western Carpathians, and China, where nodosariids are recorded. The correlation of the Olenekian strata of the studied regions is also supported by other faunas (ammonoids, bivalves, and conodonts). Consequently, a connection between these foraminiferal assemblages and the global stratigraphic scale appears plausible.

The primitive agglutinated foraminifers and diverse representatives of the nodosariids usually dominate the Olenekian foraminiferal assemblages of the Gorny Mangyshlak, Western Caucasus, and Eastern Precaucasus. The abovementioned foraminifers generally indicate adverse paleoenvironmental conditions because assemblages are poor, foraminifers have very thin walls, generic diversity is very low, each species has few specimens, and generic composition is typical for eurybiontic foraminiferal assemblages. As is known, the ammonoid assemblages in the upper Olenekian of the Gorny Mangyshlak are varied and richer than the bivalve assemblages. The benthic fauna of bivalves and foraminifers is poorly represented. All groups of biota (especially macrofauna) include some endemic forms. So, the paleobasin of the Gorny Mangyshlak in Olenekian time had adverse paleoenvironmental conditions for the development of the benthic fauna. In contrast, in the Eastern Precaucasus and Western Caucasus paleobasins these conditions and the possibility of a migration of this benthic fauna were more favourable. This interpretation is also supported by the similar picture of the distribution of ammonoids, conodonts, and bivalves in Caucasus, where faunal assemblages are more diverse (Gavrilova, 1994).

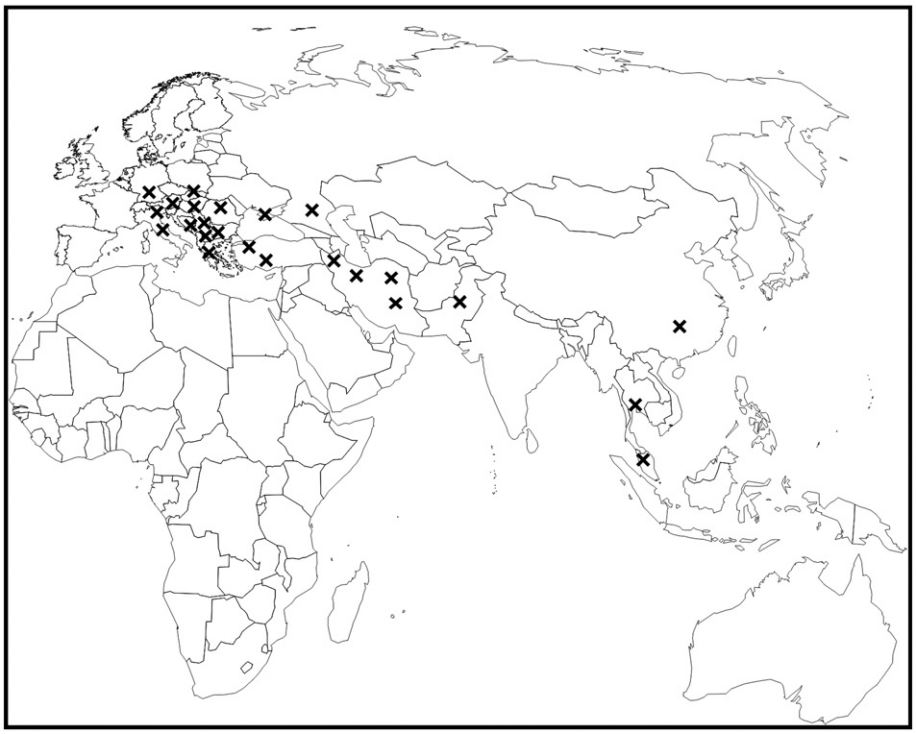

Fig. 8. Geographical distribution of *Meandrospira pusilla* (Ho) (x) in the world.

Olenekian foraminifers of the Gorny Mangyshlak and Caucasus are known from the Triassic deposits of several areas of Europe and China, but most listed species (especially nodosariids) are found primarily in the Olenekian and Anisian of the Carpathians and Bulgaria. About one third of the representatives of the genus *Nodosaria* noted in this paper are also typical for the Triassic deposits of Hungary, Greece, and China. A few species are typical only for the Triassic deposits of the Caucasus (e.g., *A. minutus* Efimova and *N. anguloca-merata* Efimova). The similarity of the taxonomic composition of the Olenekian foraminiferal assemblages of the Gorny Mangyshlak and Caucasus to those from regions of Europe and China permits us to suppose that the paleobasins of these regions were connected in Olenekian time and the foraminifers could migrate from one region to another (Fig. 9).

The findings of marine fauna through the whole of the Olenekian deposits of the Eastern Precaucasus indicate the marine conditions in this paleobasin and a good connection with European paleobasins during the Olenekian. The distribution of marine fauna in the Gorny Mangyshlak paleobasin allows us to suppose that transgression started in the middle of the Olenekian and that this paleobasin was most united with another paleobasins in the middle part of the upper Olenekian. The upper Olenekian deposits of the Gorny Mangyshlak and Eastern Precaucasus demonstrate a maximum diversity of marine fauna and a minimum number of the endemic forms. Therefore, we can suggest that the maximum sea transgression observed in these areas probably developed in middle part of the late Olenekian and that this transgression allowed the biota from the

Fig. 9. Geographical distribution of the Olenekian foraminiferal assemblages (∗) in the study area and adjacent areas.

Caucasus paleobasin to move to the paleobasin located in Gorny Mangyshlak.

Acknowledgements

This research was supported, at different times, by the Peri-Tethys Program, the Cariplo Foundation for Scientific Research and Landau Network–Centro Volta, and IGCP 467. The author warmly thanks these organizations and Prof. M. Gaetani, Prof. G. Cassinis, Dr. M. J. Orchard, and Dr. G. Warrington for their support. The author also thanks Prof. G. Cassinis, Prof. M. K. Nestell, Prof. G. P. Nestell, Dr. G. W. Hughes, Dr. D. K. Ivanova, Dr. G. Warrington, and an anonymous reviewer for their valuable remarks, important suggestions, and for helping me improve the English of this paper.

References

Alferov, G.Y., Beznosov, N.V., Bogdanova, T.N., Gar'kovez, V.G., Zhamoida, A.I., Il'in, V.D., Kiparisova, L.D., Krymholtz, G.Y., Lobacheva, S.V., Luppov, N.P., Prozorovskii, V.A., Romanovskaya, G.M., Tulyaganov, K.T. (Eds.), 1977. Decision of the Interdepartmental Stratigraphic Conference on Mesozoic of the Central Asia (Samarkand, 1971). VSEGEI, Leningrad, pp. 1–48 (in Russian).

Broglio Loriga, C., Goczan, F., Haas, J., Lenner, K., Neri, C., Oravecz-Scheffer, A., Posenato, R., Szabo, I., Makk, A.T., 1990. The Lower Triassic sequences of the Dolomites (Italy) and Transdanubian Mid-Mountains (Hungary) and their correlation. Memorie degli Instituti di Geologia e Mineralogia dell'Universita di Padova XLII, 41–103.

Efimova, N.A., 1974. Triassic foraminifers of the North-West Caucasus and Precaucasus. Questions of Micropaleontology 17, 54–83 (in Russian).

Efimova, N.A., 1991. Triassic system. In: Azbel, A.Y., Grigelis, A.A. (Eds.), Practical Manual on Microfauna of the USSR. Mesozoic Foraminifers, vol. 5. Nedra, Leningrad, pp. 16–25 (in Russian).

Gaetani, M., Balini, M., Vuks, V.Ja., Gavrilova, V.A., Garzanti, E., Nicora, A., Erba, E., Cariou, E., Cecca, F., Premoli-Silva, I., Petrizzo, M.R., Cirilli, S., Palliani, R.B., 1998. The Mesozoic of Mangyshlak (West Kazakhstan). In: Crasquin-Soleau, S., Barrier, E. (Eds.), Peri-Tethys Memoir 4. Epicratonic Basins of Peri-Tethyan Platform. Mém. Mus. Natn. Hist. Nat. 179, pp. 35–74.

Gavrilova, V.A., 1994. Correlation of the marine Triassic deposits of the Central, Eastern Precaucasus and Mangyshlak. In: Oleynikov, A.N. (Ed.), Zonal Units and Interregional Correlation of Paleozoic and Mesozoic Deposits of Russia and Adjacent Territories. Book 2. Mesozoic. VSEGEI, St.-Petersburg, pp. 7–29 (in Russian).

Gavrilova, V.A., 1999. Typical species of ammonoids from Columbites zone of the Mangyshlak. In: Stepanov, D.L., Kiselev, G.N. (Eds.), Questions of Paleontology. Interinstitution Collection, vol. XI. St.-Petersburg University, St.-Petersburg, pp. 88–96 (in Russian).

He, Y., 1993. Triassic foraminifera from northeast Sichuan and south Shaanxi, China. Acta Paleontologica Sinica 32 (2), 170–187 (in Chinese, with English Abstr.).

Ho, Y., 1959. Triassic foraminifera from the Chialingkiang Limestone of South Szechuan. Acta Paleontologica Sinica 7 (5), 387–418 (in Chinese, with English Abstr.).

Oleynikov, A.N., Rostovtsev, K.O. (Eds.), 1979. Decision of the Second Interdepartmental Regional Stratigraphic Conference on Mesozoic of the Caucasus (Triassic) 1977. VSEGEI, Leningrad, pp. 1–36 (in Russian).

Pantic, S., Pampnoux, J.P., 1972. Concerning the Triassic in the Jugoslavian Inner Dinarides (Southern Serbia, Eastern Montenegro): microfacies, microfauna, an attempt to give a paleogeographic reconstitution. Mitteilungen der Gesellschaft der Geologie– und Bergbaustudenten 21, 311–326.

Rettori, R., 1995. Foraminiferi del Trias Inferiore e Medio della Tetide: revisione tassonomica, stratigrafia ed interpretazione filogenetica. Publications du Département de Géologie et Paléontologie, vol. 18. Université de Genève, pp. 1–150.

Salaj, J., Borza, K., Samuel, O., 1983. Triassic foraminifers of the West Carpathians. Geologicky Ustav Dionyza Stura, Bratislava.

Salaj, J., Trifonova, E., Gheorghian, D., Coroneou, V., 1988. The Triassic foraminifera microbiostratigraphy of the Carpathian–Balkan and Helenic realm. Mineralia Slovaca 20 (5), 387–415.

Shevyrev, A.A., 1995. Triassic ammonoids of the North-Western Caucasus. Nauka, Moscow. (in Russian).

Spasov, K., Budurov, K., Trifonova, E., 1977. Lower Triassic limestone in bore hole N 10 of Evpatoriya town (Crimea, USSR). Review Bulgarian Geological Society 38 (3), 171–178 (in Russian, with English Abstr.).

Spasov, K., Budurov, K., Trifonova, E., 1978. Lower Triassic conodonts and foraminifers from Crimea. Review Bulgarian Geological Society 39 (2), 193–200 (in Bulgarian).

Trifonova, E., 1984. Correlation of Triassic foraminifers from Bulgaria and some localities in Europe, Caucasus, and Turkey. Geologica Balcanica 13 (6), 3–24.

Trifonova, E., 1993. Taxonomy of Bulgarian Triassic foraminifera: II. Families Endothyriidae to Ophthalmiidae. Geologica Balcanica 23 (2), 19–66.

Trifonova, E., Chatalov, G., 1975. Microfacies in the Triassic calcareous rocks from the Teteven Anticlinorium: I. Campilian–Anisian. Paleontology, Stratigraphy and Lithology 2, 3–16 (in Bulgarian, with English Abstr.).

Vachard, D., Fontaine, H., 1988. Biostratigraphic importance of Triassic Foraminifera and Algae from South-East Asia. Revue de Paléobiologie 7 (1), 87–98.

Vuks, V.Ja., 1997. Triassic foraminifers of Russia and adjacent countries (Caucasus, Mangyshlak, Pamirs). In: Ross, C.A., Ross, J.R.P., Brenckle, P.L. (Eds.), Late Paleozoic Foraminifera; Their Biostratigraphy, Evolution, and Paleoecology; and Mid-Carboniferous Boundary. Cushman Foundation for Foraminiferal Research, Special Publication, vol. 36, pp. 159–162.

Vuks, V.Ja., 2000. Triassic foraminifers of the Crimea, Caucasus, Mangyshlak and Pamirs (biostratigraphy and correlation). Zentralblatt fuer Geology und Paleontology 1 (11–12), 1353–1365.

Zaninetti, L., 1976. Les Foraminifères du Trias. Essai de synthèse et corrlation entre les domains mésogéens européen et asiatique. Rivista Italiana di Paleontologia e Stratigrafia 82 (1), 1–258.