Zbl. Geol. Paläont. Teil I	1998	Heft 11–12	1353–1365	Stuttgart, Februar 2000

Triassic foraminifers of the Crimea, Caucasus, Mangyshlak and Pamirs (biostratigraphy and correlation)

EPICONTINENTAL TRIASSIC INTERNATIONAL SYMPOSIUM
Halle/S. Germany
September 21 – 23, 1998

V.J. Vuks

with 5 figures

Abstract: The richest foraminifera assemblages were found in Triassic of the North-West Caucasus and Precaucasus for the southern part of the former USSR. Triassic deposits of the North-West Caucasus and Precaucasus include complete and diverse assemblages of foraminifers through almost the whole Triassic succession, therefore the foraminiferal zonation of these regions is rather complete. This zonation includes stratigraphic intervals from the Olenekian to Rhaetian stages: beds with Ammodiscus minutus (the lower part of the Lower Olenekian), the Meandrospira pusilla zone (the lower part of the Upper Olenekian), the Meandrospira insolita zone (the Lower Anisian), the Hemigordius chialingchiangensis zone (the lower part of the Middle Anisian), the Cornuloculina tricki zone (the upper part of the Middle Anisian), beds with Pseudonodosaria obconica-Lenticulina muensteri (the Upper Ladinian), beds with Pachyphloides klebelsbergi (the Lower Carnian), the Aulotortus friedli zone (the lower part of the Upper Norian) and the beds with Involutina liassica (the upper part of the Upper Norian and the lower part of the Rhaetian).

In limestone blocks within the Jurassic Eskiordin Formation of the Alma River basin of the Crimea a rich foraminifera assemblage was found. The analysis of this association allows us to consider this assemblage as Late Norian-Rhaetian. This foraminifera association is similar to the Norian-Rhaetian assemblages of the North-West Caucasus and Precaucasus (the beds with Involutina liassica), the Carpathians-Balkan, the Hellenic Realm, Turkey, and Indonesia.

There are foraminifera assemblages in the Tartaly and Karaduan Formations of the Gorny Mangyshlak. This provides reason enough to establish the beds with foraminfers for each formation accordingly: the beds with Nodosaria hoae (the middle part of the Upper Olenekian) and beds with Tolypammina gregaria-Planiinvoluta carinata (Anisian). The foraminifera association from the first formation corresponds to simultaneous foraminifera assemblages of the North-West Caucasus and Precaucasus. The second foraminifera assemblage is very poor and consists of two primitive foraminifers.

In some Upper Norian-Rhaetian formations in the South-East Pamirs there are poor and very diverse foraminifera assemblages, which allowed us to present the foraminiferal zonation: beds with Miliolipora cuvillieri-Semiinvoluta clari (the lower part of the Upper Norian), the beds with Angulodiscus friedli (the upper part of the Upper Norian) and beds with Involutina cf. turgida (Rhaetian). The associations of these beds with foraminifers are similar with simultaneous assemblages of the North-West Caucasus and Crimea.

The North-West Caucasus and Precaucasus have a unique geographic position at the juncture of several distinctive paleogeographic area. Foraminifera assemblages may be used

0340–5109/00/1998–1353 $ 3.25

as a standard reference succession for correlating simultaneous foraminifera associations between the Caucasus and other regions of the former USSR. In addition, the foraminiferal zonations of the North-West Caucasus and Precaucasus have several zones which are well correlated with coeval zones of the Carpathians and the Balkans. The Triassic foraminifera assemblages of the South-East Pamirs, Gorny Mangyshlak, Crimea, North-West Caucasus and Precaucasus have an essential likeness based on taxonomical composition, allowing a reliable correlation between the above mentioned Triassic deposits and suggesting the migration of foraminifers between paleobasins of the territories.

Thus, these data on the Triassic foraminifers give grounds to subdivide the Triassic deposits in more detail, to carry out interregional correlation from the Pamirs to the Alps, and to create more complete paleobiogeographic reconstructions.

1. Introduction

Triassic deposits of the North-West Caucasus and Precaucasus (southern part of Russia) include diverse assemblages of foraminifera through almost the whole of the Triassic succession (Fig. 1). These faunas may be used as a standard reference succession for correlating coeval foraminiferal associations in the entire Caucasus and other regions of the former USSR because the North-West Caucasus and Precaucasus are at the juncture of several distinctive paleobiogeographic areas. In addition, the foraminiferal assemblages of the North-West Caucasus and Precaucasus include a number of widely distributed species in coeval foraminiferal assemblages in European and Asiatic regions that allows their use in the interregional correlation.

Efimova (1991) proposed a foraminiferal zonation for dividing the Triassic deposits of the North-West Caucasus and Precaucasus. Other southern regions of the former USSR had no such zonal schemes. There is only one article about the

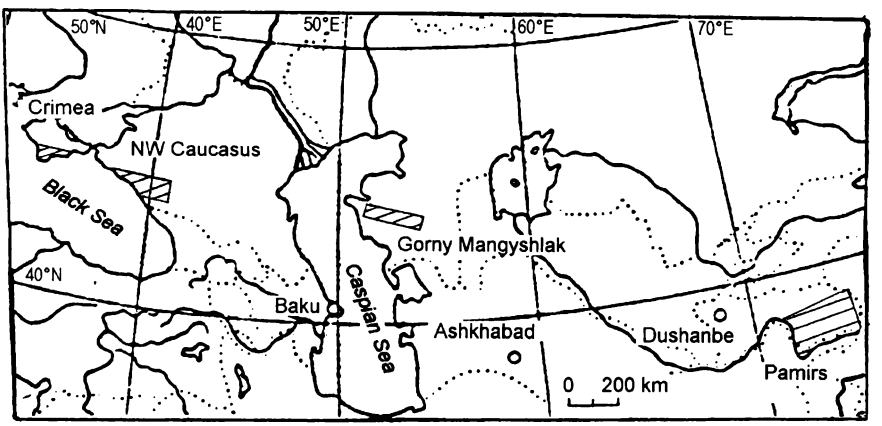

Fig. 1. Map of the south part of the former USSR showing the regions of study (the Crimea, NW Caucasus, Gorny Mangyshlak, Pamirs).

Triassic foraminifers of the Pamirs (Dronov et al. 1982): one article about the Triassic foraminifers of the Southern Mangyshlak (Aliev et al. 1976): and three papers about the Triassic foraminifers of the Crimea (Voloshina 1974, Spasov et al. 1977, 1978), which only consider the compositions of the foraminifera assemblages and their correlation. There have been no papers about the Triassic foraminifers of the Gorny Mangyshlak. Since 1990 there have been several attempts to establish the foraminiferal zonation and correlation between the coeval deposits according to foraminifers (Pronina and Vuks 1996, Vuks 1996, 1997). These papers first describe the Triassic foraminifers of the Gorny Mangyshlak and from limestone blocks of the Eskiordin Formation of the Crimea. The present paper is one of first works dealing with this subject which summarizes more data on the foraminiferal zonation and correlation.

2. Foraminifers and stratigraphy

2.1 North-West Caucasus and Precaucasus

The Triassic deposits of the North-West Caucasus occur in the area of North-Western subsidence of the Fore-range in the Laba and Belaya River basins. Total thickness of the Triassic is about 1000 m–1500 m. The Triassic occurs with deep erosion on different Paleozoic horizon, and is overlain by the Jurassic with erosion.

The Triassic deposits in the North-West Caucasus are composed of the Tkhach, Sakhray and Khodz (or Khodzhokh) Groups (Fig. 2). The Tkhach Group is assigned to the Lower-Middle Triassic and is composed of the Yatyrgvarta, Maly Tkhach and Acheshbok Formations. The Yatyrgvarta Formation is mainly represented by thin-bedded limestones and a basal horizon, which consists of thick-bedded limestones, sandstones and conglomerates. This Formation correlates with the upper part of the Indian-Olenekian. The thickness is about 200–300 m. Beds with *Ammodiscus minutus* are present in the Yatyrgvarta Formation and indicate a correlation to the Lower Olenekian interval; bivalves and ammonoids support this age assignment. The typical species of these beds are *Ammodiscus minutus* Efimova, *Dentalina splendida* Schleifer, *Nodosaria hoae skyphica* Efimova, *N. orbicamerata* Efimova, *N. shablensis* Trifonova and others (Oleynikov and Rostovtsev 1979, Efimova 1991). In the East Precaucasus, in the same stratigraphic interval in the Neftekumsk Formation, Efimova (1991) tentatively identified the same beds with foraminifers which probably correspond to this Upper Permian-Lower Triassic interval.

The *Meandrospira pusilla* zone occurs in the upper part of the Kultayiskaya Formation and in the Dem'yanovskaya Formation of the East Precaucasus and correlates to the Lower Olenekian (Fig. 2). Characteristic species of this zone are *Verneuilinoides edwardi* Schroeder, *Meandrospira pusilla* (Ho), *Dentalina luperti* Efimova, *Nodosaria hoae skyphica* Efimova, *N. ordinata* Trifonova, and *N. pseudoprimitiva* Efimova.

Stage	Substage	Zone (Koren et al. 1991)	North-West Caucasus and Precaucasus (Efimova, 1991)		Gorny Mangyshlak (Vuks, 1997)	
			Group	Foraminifera zones and beds	Foraminifera beds	Formation
1	2	3	4	5	6	7
Carnian	Lower	*Austrotrachyceras austriacum*	Sakhray	?	?	Akmysh
		Trachyceras aon		*Pachyphloides klebelsbergi* beds		
		Trachyceras aonoides				
Ladinian	Upper	*Frankites ? regoledanus*		*Pseudonodosaria obconica - Lenticulina muensteri* beds		
		Protrachyceras archelaus				
	Lower	*Protrachyceras gredleri*		?		
		Eoprotrachyceras curionii				
Anisian	Upper	*Nevadites*	Tkhach	?	*Tolypammina gregaria - Planiinvoluta carinata* beds	Karaduan
		Parakellnerites				
		Paraceratites trinodosus				
	Middle	*Balatonites balatonicus*		*Cornuloculina tricki* zone		
		Anagymnotoceras ismidicum				
		Nicomedites osmani		*Arenovidalina chialingchiangensis* zone		
	Lower	*Aegeiceras ugra*		*Meandrospira insolita* zone		
Olenekian	Upper	*Prohungarites crasseplicatus*		?	?	Karadzhatyk
		Columbites parisianus		*Meandrospira pusilla* zone	*Nodosaria hoae* beds	Tartala
		Tirolites cassianus			?	
	Lower	*Anasibirites pluriformis*		?		Dolnapa
		Meekoceras gracilitatis		*Ammodiscus minutus* beds		

Gray, massive limestone of the Maly Tkhach Formation conformably overlies the Yatyrgvarta Formation with local erosion (Fig. 2). The thickness of this formation is about 150 m. The *Meandrospira insolita* zone occurs in the Maly Tkhach Formation and indicates early Anisian age. The typical species of this zone are *Glomospira sinensis* Ho, *Ammobaculites corpulentus* Efimova, *Arenovidalina labaensis* Efimova, *Meandrospira deformata* Salaj, *M. insolita* (Ho), and *"Diplotremmina" pulchra* Efimova (Efimova 1991). Brachiopods and ammonoids confirm this age assignment.

The Acheshbok Formation, which conformably overlies the Maly Tkhach Formation, consists of gray thin-bedded limestones, but in the upper part of this formation there is alternation of limestones with clay and in the middle part there is an horizon of massive-concretion limestones (Fig. 2). The thickness of this formation is about 300 m. The *Arenovidalina chialingchiangensis* zone in the lower part of the Acheshbok Formation correlates with the lower part of the Middle Anisian and is mainly represented by *Ammobaculites radstadtensis* Kristan-Tollmann, *Trochammina almtalensis* Koehn-Zaninetti, *Arenovidalina chialingchiangensis* (Ho), *A. fragilis* (Liem), *Dentalina* aff. *bicornis* Terquem, and *Pseudonodosaria simpsonensis* (Tappan). The *Cornuloculina tricki* zone in the upper part of the Acheshbok Formation correlates with the upper part of the Middle Anisian, as also evidenced by brachiopods and ammonoids (Oleynikov and Rostovtsev 1979). The typical species of this zone are *Spiroplectammina* aff. *dobrudzhiana* Trifonova, *Cornuloculina tricki* (Langer), *Dentalina* aff. *bicornis* Terquem, *Pseudonodosaria* aff. *irregularis* (Franke), *Lingulina borealis* Tappan, and *Duostomina* cf. *rotundata* Kristan (Efimova 1991).

Gray and green argillites of the Sakhray Group overlie the Acheshbok Formation with an erosional contact (Fig. 2). In the lower part of this group there are beds of sandstones and gravelstones and a basal horizon, which consists of massive sandstones and conglomerates. The thickness of this group is about 480 m. The Sakhray Group corresponds to the Ladinian-Carnian interval. Beds with *Pseudonodosaria obconica-Lenticulina muensteri* in the lower part of the Sakhray Group confirm the Upper Ladinian age. The typical species of these beds are *Ammodiscus glumaceus* Gerke et Sossipatrova, *Dentalina praenuda* Gerke, *Pseudonodosaria densa* (Tappan), *P. obconica* (Reuss), *Lingulina* aff. *aghdabandi* Oberhauser, and *Lenticulina* aff. *gottingensis* (Bornemann). Bivalves and ammonoids in this group are also Upper Ladinian. The beds with *Pachyphloides klebelsbergi*, which occur in the upper part of this group, correlate with the lower part of the Lower Carnian. The characteristic species of these beds are *Cornuloculina exiguum* Zaninetti, *Labalina tkhachensis* (Antonova), *Pachyphloides klebelsbergi* (Oberhauser), *P. oberhauseri* Sellier de Civrieux et Dessauvagie, *Ichtyolaria sulcata* Oberhauser, *Astacolus carnicus* (Oberhauser), and *A. connudatus* Tappan. Bivalves, brachiopods and ammonoids confirm this correlation (Oleynikov and Rostovtsev 1979).

Fig.2. Correlation of the Triassic deposits of the North-West Caucasus, Precaucasus and Gorny Mangyshlak according to foraminifers.

The Khodz Group, represented by diverse types of limestone (for instance – massive reef limestones and bioclastic limestones), overlies the Sakhray Group with an erosional contact (Fig. 3). The basal horizon consists of conglomerates, sandstones and sandy limestones. The thickness is about 600 m. The Khodz Group corresponds to the Norian-Lower Rhaetian(?). The *Aulotortus friedli* zone occurs in the lower part of the Khodz Group and corresponds to the lower part of the Upper Norian (*Sagenites quinquepunctatus* zone). Typical species of this zone are *Trochammina alpina* Kristan, *"Tetrataxis" inflata* Kristan, *Aulotortus friedli* (Kristan-Tollmann), *A. sinuosus* (Weynschenk), *"Trocholina" crassa* Kristan, *"T." multispira* Oberhauser, and *Agathammina austroalpina* Kristan-Tollmann. In addition to foraminifers, this age is defined by bivalves (*Monotis salinaria* Schlother) and brachiopods. Beds with *Involutina liassica* were determined in the upper part of this group and conform to the upper part of the Upper Norian-Rhaetian (*Sagenites reticulatus* zone and *Vandaites sturzenbaumi* zone). Characteristic species of these beds are *Auloconus permodiscoides* (Oberhauser), *Coronipora austriaca* (Kristan), *Involutina liassica* (Jones), *"Trocholina" turris* Frentzen, *Galeanella panticae* Zaninetti et Broennimann, *Miliolipora cuvillieri* Broennimann et Zaninetti and others. Besides foraminifers, this age is defined by brachiopods and ammonoids (Oleynikov and Rostovtsev 1979, Efimova 1991, Vuks 1996).

<table>
<tr><th rowspan="2">Stage</th><th rowspan="2">Substage</th><th rowspan="2">Zone (Krystyn, 1987; Koren et al. 1991)</th><th colspan="2">North-West Caucasus (Efimova, 1991)</th><th colspan="2">Crimea (Vuks)</th></tr>
<tr><th>Group</th><th>Foraminifera assemblages of zones and beds</th><th>Foraminifera assemblage of blocks</th><th>Blocks of the formation</th></tr>
<tr><td rowspan="2">Rhaetian</td><td rowspan="2">-</td><td>Choristoceras marshi</td><td>?</td><td>?</td><td>?</td><td rowspan="4">Eskiordin</td></tr>
<tr><td>Vandaites stuerzenbaumi</td><td rowspan="3">Khodz</td><td rowspan="2">Involutina liassica beds</td><td rowspan="3">Miliolipora cuvillieri-Semiinvoluta clari</td></tr>
<tr><td rowspan="2">Norian</td><td rowspan="2">Upper</td><td>Sagenites reticulatus</td></tr>
<tr><td>Sagenites quinquepunctatus</td><td>Angulodiscus friedli zone</td></tr>
</table>

Fig. 3. Correlation of the Upper Triassic foraminifera assemblages of the North-West Caucasus and Crimea.

2.2 Mangyshlak

In the Triassic of Southern Mangyshlak there are only two foraminifera assemblages from drill hole sediments in the North Rakushechnaya area (Aliev et al. 1976). One was established in the argillite beds of the upper part of the Yuzhno-Zhatybayiskaya Formation and the age of these deposits corresponds to the upper part of the Middle Triassic. The other was determined in the terrigenous deposits from the Severo-Rakushechnaya Formation; the age of these rocks conforms to the Upper Triassic.

The Triassic of the Gorny Mangyshlak forms the major part of the Karatauchik, West and East Karatau Ranges, conformably overlying Permian and overlain by the Jurassic with erosion.

The study of thin sections from the Triassic of the Gorny Mangyshlak provided the first findings of foraminifers (Fig. 2). The Tartaly Formation overlies the Dolnapa Formation conformably and consists of grey argillites with limestone beds. The thickness is about 500 m. The Tartaly Formation contains microfossils and fossil fragments of macrofossils. In the Tartaly Formation there are four beds with ammonoids: *Dorikranites* beds, *Kiparisovites* beds, *Tirolites* beds, *Columbites* beds (Gavrilova 1994). The *Dorikranites* beds have abundant recrystallized fossils fragments, microgastropods, and single primitive species of foraminifers – *Lituotuba?* sp. The upper part of the *Tirolites* beds contain rare agglutinated and calcareous foraminifers – *Tolypammina gregaria* Wendt, *Nodosaria* sp., but the *Columbites* beds contain abundant recrystallized fossil fragments, microgastropods, ostracods and a diverse foraminiferal assemblage. Therefore, in this interval the beds with *Nodosaria hoae* have been established (Fig. 2) and are represented by *Tolypammina gregaria* Wendt, *Planiinvoluta* ex gr. *carinata* Leischner, *Nodosaria hoae* (Trifonova), *N.* aff. *hoae* (Trifonova), *N.* cf. *ordinata* (Trifonova), *N. pseudoprimitiva* Efimova, *N.* cf. *shablensis* Trifonova, *N.* sp., *"Frondicularia"* ex gr. *elegantula* K.M.-Maclay, *Lenticulina* ex gr. *goettingensis* (Franke), and *Astacolus* spp. (Vuks 1997). This foraminiferal assemblage is very similar to associations from the Lower Triassic (Olenekian) of the North-West Caucasus and Precaucasus (for instance -foraminifera association of *Meandrospira pusilla* beds). Upper Olenekian age is dated by ammonoids (Gavrilova 1994).

The Karadzhatyk Formation, which conformably overlies the Tartaly Formation, is composed of argillites, siltstones, sandstones, and some limestone beds (Fig. 2). The thickness is about 400 m. This formation corresponds to the upper part of the Upper Olenekian and contains no foraminifers. The Karaduan Formation conformably overlies the Karadzhatyk Formation and consists of sandstones and argillites with conglomerate beds. The thickness is about 500 m. The Karaduan Formation has abundant recrystallized fossil fragments, microgastropods, ostracods, and an assemblage of primitive species of foraminifers – beds with *Tolypammina gregaria-Planiinvoluta carinata*. These beds contain only the two species of foraminifers *Tolypammina gregaria* Wendt and *Planiinvoluta carinata* (Leischner), but there are many specimens of these species (Vuks 1997). These foraminifera species are common in the Middle and Upper Triassic. Bivalves date the formation as Anisian (Gavrilova 1994).

The Akmysh Formation overlies the Karaduan Formation with an erosional contact and contains mainly limestone (Fig. 2). The thickness is about 550 m. This formation has oolites, algae, abundant fossil fragments, and rare calcareous foraminifers – *Ophthalmidium?* spp. The formation age is Lower Carnian (Alferov et al. 1977).

2.3 Crimea

The Triassic-Jurassic Taurida Group of the Crimea is divided into two parts, the upper part of this group is the Eskiordin Formation (Fig. 3). The upper part of the Jurassic Eskiordin Formation is mainly represented by quartzite sandstones and conglomerates with Permian, Triassic, Liassic blocks of limestone. All outcrops of Late Triassic limestone blocks were found in the fluvial part of the Izvestnyakovy Creek in the Alma River basins. One of these blocks is represented by pink crystalline limestone. Its dimensions are: length 1.5 m and height 5 m. The richest foraminifera assemblage is found in this block and consists of the typical species *Trochammina almtalensis* Koehn-Zaninetti, *Duotaxis inflatus* (Kristan-Tollmann), *Lamelliconus turris* (Frentzen), *Sigmoilina bystrickyi* Salaj, Borza et Samuel, *Galeanella panticae* Zaninetti et Broennimann, and *Miliolipora cuvillieri* Broennimann et Zaninetti (Fig. 4) (Pronina and Vuks 1996).

The foraminifera assemblages of the blocks studied are similar in generic and specific composition, which allows them to be considered as coeval. They are characterized by the presence of miliolids and involutinids, the most important foraminifers for dating the Triassic deposits. In this assemblage there are many species known in Norian – Rhaetian deposits, some occur in deposits not older than the Rhaetian, and sometimes even in younger deposits.

This foraminifera assemblage of the Crimea is named *Miliolipora cuvillieri-Semiinvoluta clari* (Fig. 3) and is very similar to the Late Norian (Sevatian)-Rhaetian foraminifera associations of the Khodz Group of the North-West Caucasus (Efimova 1991). It also resembles the Late Norian (Lacian-Sevatian) assemblage from the *Miliolipora cuvillieri* standard zone of the Carpathian-Balkan and Hellenic Realm, the Upper Norian association from the Kocagedik unit of Turkey, and the Norian-Rhaetian assemblage from the Asinepe Limestone of Seram, Indonesia (Pronina and Vuks 1996).

Therefore, there is reason enough to consider that the age of the foraminifera assemblages of the Crimea can be either Late Norian or Rhaetian, but most likely is of Sevatian-early Rhaetian age (Fig. 3).

2.4 South-East Pamirs

In some Upper Norian-Rhaetian formations in the South-East Pamirs, some formations have either poor or very diverse foraminifera assemblages (Dronov et al. 1982, Vuks, 1996, 1997). Vuks (1996, 1997) proposed to subdivide the Upper

Norian-Rhaetian succession of this region based on foraminifers (Fig. 5). These deposits include the Naizatash, Kamarutek, Bostanak, Bortepa, and Chichkautek Formations and their equivalent beds. However, beds with foraminifers have been established only in the Naizatash, Bortepa and Chichkautek Formations. The Naizatash Formation is mainly represented by clay detrital limestones with thin beds and lenses of chert. The maximum thickness of this formation is 80 m. In the Naizatash Formation, beds with *Miliolipora cuvillieri-Semiinvoluta clari* are established and correlated with foraminiferal assemblages of the Upper Triassic (Upper Norian) of the Austrian Alps, the Dinarides, the West Carpathians, and the North-West Caucasus (Vuks 1996). Typical species of these beds are *Ammobaculites zlambachensis* Kristan-Tollmann, *Trochammina almtalensis* Koehn-Zaninetti, *Duotaxis inflatus* (Kristan-Tollmann), *Lamelliconus turris* (Frentzen), *Aulotortus sinuosus* (Weynschenk),and *Miliolipora cuvillieri* Broennimann et Zaninetti (Fig. 4). The most similar foraminifera associations are described from the beds with *Involutina liassica* of the Norian-Rhaetian of the North-West Caucasus and assemblage with *Miliolipora cuvillieri-Semiinvoluta clari* of the Crimea. These foraminiferal assemblages are found in organic-detrital and biomorphic water-shallow limestones, formed in the reef development zone. The age analysis of the foraminifera assemblage of the Naizatash Formation allows us to consider this association as the Late Norian (Sevatian-Early Rhaetian). The Bortepa Formation consists of siltestones, mudstones and sandstones with thin beds of organic-clastic limestones. The maximum thickness of this formation is 150 m. The species of the poor foraminifera assemblage of the Bortepa Formation are numerous and occur in most of the sections, but the species *Angulodiscus friedli* (Kristan-Tollmann) is the most typical. Therefore, it is proposed to establish the beds with *Angulodiscus friedli* in the stratigraphical interval for the whole formation. The Chichkautek Formation is represented by organic-clastic bioherm and reef limestones. The maximum thickness of this formation is 150 m. In many sections of the Chichkautek Formation a poor foraminifera association with many specimens has been found. *Involutina* cf. *turgida* Kristan is the most characteristic and numerous species, therefore it is proposed to establish beds with *Involutina* cf. *turgida* in the Chichkautek Formation (Fig. 5).

3. Conclusions

This paper reviews published and new data. Recent investigations of the foraminifera assemblages supplement our general understanding of the development of Triassic foraminifera associations in the Crimea, Mangyshlak and Central Asia and help to bring to light the microfaunal features in the Triassic Formations of the Gorny Mangyshlak. The Columbites beds (Upper Olenekian) of the Tartaly Formation include beds with foraminifers, which correspond to simultaneous foraminifera beds or a zone in the Early Triassic (Olenekian) of the North-West Caucasus and Precaucasus. The discovery of foraminifers from the Triassic of the Gorny Mangyshlak confirms the usefulness of the zonal division of these Triassic

N	Foraminifers	Pamirs	Crimea
		Naizatash Formation	Blocks from Eskiordin Formation
1	2	3	4
1	*Tolypammina gregaria* Wendt	+	+
2	*Gandinella falsofriedli* Salaj, Borza et Samuel	+	-
3	*Ammobaculites zlambachensis* Kristan-Tollmann	+	-
4	*A.* sp.	-	+
5	*Trochammina almtalensis* Koehn-Zaninetti	+	+
6	*T. jaunensis* Broennimann et Page	+	+
7	*Duotaxis humilis* (Kristan)	+	-
8	*D. inflatus* (Kristan)	+	+
9	*D. metula* (Kristan)	+	+
10	*Gaudryina triadica* Kristan-Tollmann	+	+
11	*G. triassica* Trifonova	-	+
12	*Palaeolituonella meridionalis* (Luperto)	-	+
13	*Permodiscus eomesozoicus* (Oberhauser)	+	-
14	*"Endoteba" austrotriadica* (Oberhauser)	-	+
15	*"E". kuepperi* (Oberhauser)	-	+
16	*"E". sp.* 1	+	-
17	*Malayspirina bicamerata* (Salaj)	+	+
18	*M. wirtzi* (Koehn-Zaninetti)	-	+
19	*Lamelliconus turris* (Frentzen)	+	+
20	*L. multispirus* (Oberhauser)	+	+
21	*Angulodiscus friedli* (Kristan- Tollmann)	+	-
22	*Arenovidalina chialingchiangensis* Ho	-	+
23	*Auloconus permodiscoides* (Oberhauser)	+	-
24	*Aulotortus sinuosus* (Weynschenk)	+	-
25	*Coronipora etrusca* (Pirini)	-	+
26	*Semiinvoluta bicarinata* Blau	-	+
27	*S. clari* Kristan	+	+
28	*Trochonella granosa* (Frentzen)	-	+
29	*"Calcitornella" gebzeensis* Dager	-	+
30	*Planiinvoluta carinata* Leischner	+	+
31	*Agathammina austroalpina* Kristan-Tollmann et Tollmann	+	-
32	*Gsollbergella spiroloculiformis* Oravecz-Scheffer	+	-

deposits, which has been accepted in Samarkand (Alferov et al. 1977). The foraminifera assemblage of the beds with *Miliolipora cuvillieri-Semiinvoluta clari* in the Naizatash Formation of the Pamirs is similar to the foraminifera association from blocks in the Eskiordin Formation of the Crimea. The Upper Triassic foraminifera assemblages of the Pamirs and Crimea are very similar to the coeval associations of the North-West Caucasus. In addition, foraminiferal zonation of the North-West Caucasus and Precaucasus have several zones which are well correlated with coeval zones of the Carpathians and Balkans. Thus the North-West

(continued fig. 4)

1	2	3	4
33	*Ophthalmidium exiguum* Koehn-Zaninetti	-	+
34	*O. fusiformis* (Trifonova)	-	+
35	*O. lucidum* (Trifonova)	+	+
36	*O. triadicum* (Kristan)	+	+
37	*Quinqeloculina nucleiformis* Kristan-Tollmann	+	+
38	*Sigmoilina bystrickyi* Salaj, Borza et Samuel	+	+
39	*S. plectospira* (Oravecz-Scheffer)	-	+
40	*S. schaeferae* Zaninetti, Altiner, Dager et Ducret	+	+
41	*Galeanella panticae* Zaninetti et Broennimann	+	+
42	*Miliolipora cuvillieri* Broennimann et Zaninetti	+	+
43	*Austrocolomia* ex gr. *canaliculata* (Kristan-Tollmann)	+	+
44	*A. marshalli* Oberhauser	+	+
45	*Nodosaria ordinata* Trifonova	+	-
46	*Septalingulina* cf. *tetrasepta* He et Norling	-	+
47	*"Frondicularia woodwardi"* Howchin	+	+
48	*Lenticulina rectangula* Kristan-Tollmann	-	+
49	*Diplotremmina astrofimbriata* Kristan-Tollmann	+	-
50	*Duostomina* sp.	+	+
51	*Variostoma cataliforme* Kristan-Tollmann	+	-

Fig. 4. Correlation of the Upper Triassic foraminifera assemblages of the South-east Pamirs and Crimea.

Caucasus is the key region for correlation of the Triassic deposits according to foraminifera between the regions and for comparison with others regions of Europe and Asia. This paper is the first attempt to compare Triassic foraminiferal zones between the Caucasus, Crimea, Mangyshlak and Pamirs. The Triassic foraminiferal associations of these regions have many species and genera in common.

The Triassic foraminifera assemblages of the South-East Pamirs, Gorny Mangyshlak, Crimea, North-West Caucasus and Precaucasus have a very similar likeness based on taxonomical composition, thus allowing a reliable correlation between the Triassic deposits and suggesting the migration of foraminifers between paleobasins of the territories.

The described foraminifera assemblages of Russia and adjacent countries enable us to supplement the common picture of development of the Triassic foraminifers and will be useful for further paleoecological and biogeographical reconstructions.

Stage	Substage	Zone (Krystyn, 1987; Koren et al. 1991)	North-West Caucasus (Efimova, 1991)		South-East Pamirs (Vuks, 1996)	
			Group	Foraminifera zones and beds	Foraminifera beds	Formation
Rhaetian	-	*Choristoceras marchi*	?	?	*Involutina* cf. *turgida* beds	Chich-kautek
		Vandaites stuer-zenbaumi	Khodz	*Involutina liassica* beds		
Norian	Upper	*Sagenites re-ticulatus*			*Angulodiscus friedli* beds	Bortepa
					Not studied	Bostanak
		Sagenites quin-quepunctatus		*Angulodiscus friedli* beds	Un-named beds	Kamarutek
					Miliolipora cuvil-lieri-Semiinvoluta clari beds	Naizatash

Fig. 5. Correlation of the Norian-Rhaetian deposits of the North-West Caucasus and South-East Pamirs according to foraminifers.

Acknowledgements: This work is made within the framework of the IGCP Project N 359 "Tethyan, Circum-Pacific and Marginal Gondwanan Late Paleozoic and Early Mesozoic Correlation" and Peri-Tethys Programme. The author is grateful to the leaders of these programmes: Acad. Yin Hongfu, Prof. M. Gaetani and Prof. J. Dercourt. One of the foraminifera collections was sampled and studied in the framework of the Project N 95–56 "The Mesozoic of Mangyshlak (West Kazakhstan): stratigraphic and structural evolution" of the Peri-Tethys Programme. The author is particularly grateful to the leader of this project Prof. M.Gaetani. I would like to express my appreciation to Dr. V.I. Dronov for his valuable advice and thin-sections presented from the Naizatash Formation of the South-East Pamirs.

References

Alferov GY, Beznosov NV, Bogdanova TN, Gar'kovez VG, Zhamoida AI, Il'in VD, Kiparisova LD, Krymholtz GY, Lobacheva SV, Luppov NP, Prozorovskii VA, Romanovskaya GM, Tulyaganov KT (eds) (1977) Decision of the Interdepartmental Stratigraphic Conference on Mesozoic of the Central Asia (Samarkand 1971). Leningrad, 48 pp (in Russian)

Aliev MM, Alekseeva LV, Hoffman EA (1976) Foraminifers of the Triassic of the South Mangyshlak. Izvestiya AN SSSR, Seriya geologicheskaya, 10:140–141 (in Russian)

Dronov VI, Gazdzicki A, Melnikova GK (1982) Upper Triassic Reefs in the Southeastern Pamir Range. Facies 6:107–128

Efimova NA (1991) Triassic system. In: Azbel AY and Grigelis AA (eds) Practical manual on microfauna of the USSR. v.5. Mesozoic foraminifers. Nedra, Leningrad, pp 16–25 (in Russian)

Gavrilova VA (1994) Correlation of the marine Triassic deposits of the Central, Eastern Precaucasus and Mangyshlak. In: Oleynikov AN (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)

Koren TN, Bugrova EM, Gavrilova VA, Kotlyar GV, Kropacheva GS, Modzalevskaya TL, Moiseeva AI, Rostovtsev KO (eds) (1991) Zonal Stratigraphy of the Phanerozoic of the USSR. Nedra, Moscow, 160 p (in Russian)

Krystyn L (1987) Zur Rhaet-Stratigraphie in den Zlambach-Schichten (vorläufiger Bericht). Sitzungsb Oesterr Akad Wiss, Math.-naturw Kl, 1(196):21–36

Oleynikov AN, Rostovtsev KO (eds) (1979) Decision of the Second Interdepartmental Regional Stratigraphic Conference on Mesozoic of the Caucasus (Triassic) 1977. Leningrad, 36 p (in Russian)

Pronina GP, Vuks VJ (1996) New data on the Triassic Foraminifers of Crimea. Supplemento agli Annali dei Musei Civici di Rovereto. Sezione Archeologia, Storia e Scienze Naturali 11 (1995):215–227

Spasov K, Budurov K, Trifonova E (1977) Lower Triassic limestone in bore hole N 10 of Evpatoriya town (Crimea, USSR). Rev Bulg Geol Soc, 38(3):171–178

Spasov K, Budurov K, Trifonova E (1978) Lower Triassic conodonts and foraminifers from Crimea. Rev Bulg Geol Soc 39(2):193–200

Voloshina AM (1974) Triassic microfacies with ammodiscids (Foraminifera) in bore hole of flat Crimea. Paleont coll, issue 2(11):10–13 (in Russian)

Vuks VJ (1996) Late Triassic Foraminifers of Caucasus and Pamirs. Supplemento agli Annali dei Musei Civici di Rovereto. Sezione Archeologia, Storia e Scienze Naturali 11 (1995):199–206

Vuks VJ (1997) Triassic foraminifers of Russia and adjacent countries (Caucasus, Mangyshlak, Pamirs). In: Ross CA, Ross JRP, Brenckle PL (eds) Late Paleozoic Foraminifera; their biostratigraphy, evolution, and paleoecology; and Mid-Carboniferous boundary. Cushman Foundation for Foraminiferal Research, Special Publication 36, pp 159–162

Author's address:
V.J. Vuks, All-Russian Geological Research Institute (VSEGEI), Sredny pr., 74, 199026 St. Petersburg, Russia, E-mail: vsegei@mail.wplus.net