

*Palaeobiology*

## Palaeoecological Issues of Tarkhanian-Chokrakian Basins of Western Georgia according to Microfauna (Foraminifers, Ostracodes)

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**ABSTRACT.** Stratigraphic sections of Tarkhanian-Chokrakian sediments were compiled in Western Georgia (the river Chanistskali, village Bardnala, the river Namkashuri, vil. Ghvirishi) and at different levels complexes of foraminifers and ostracodes were established. Most of microfauna species are of the Mediterranean type. Tarkhanian-Chokrakian sediments are represented by dark clays and marls, slightly sandy clays of dark color (deep water basin), grey argillaceous sandstones (transitional) and coarse-grained sandstones, loose sandstones (shallow water basin). In the Early Tarkhanian salinity of the basin was normal. From the Late Tarkhanian salinity decreases. The temperature at different depth of the basin slightly differs by that time. At the end of the Tarkhanian number of emigrant species decreases and endemic species dominate. There occur microfauna that is spread in the Chokrakian sediments as well: foraminifers - *Quinqueloculina selene* (Karrer), *Q. ungeriana* d'Orb., *Sigmoilina mediterraneensis* Bogd., ostracodes - *Loxococoncha carinata* (Lnkls.), *Loxococoncha carinata alata* (Schn.), *Cytheridea mulleri* (Munst.). At the beginning of the Chokrakian, when there is a short-term connection with the open sea, the salinity of the basin is normal. After the Middle Chokrakian the salinity decreases, the basin gradually desalinized and eurybiotic species prevail. Greater part of the Chokrakian microfauna species (foraminifers – genera *Quinqueloculina*, *Tschokrakiella*, *Sigmoilina*, *Tschokrakensis*; ostracodes – genera *Bairdia*, *Leptocythere*, *Cytherura*, *Loxococoncha*) occur in the Lower and Middle Chokrakian sediments. In the Middle Chokrakian numerous species are recorded. The Upper Chokrakian is represented by the numerous species of foraminifer (*Articulina*, *Pseudopolymorphina*, *Nonion*) and ostracode (*Candona*, *Cytheridea*, *Cyprideis*) genera. In microfauna composition often weakened and pathological forms are observed. Microfauna of Chokrakian deep-water basin sediments of Western Georgia is distinguished in abundance and diversity. Temperature is high in the Chocrakian, as evidenced by numerous miliolids, which prefer warm water habitat. © 2016 Bull. Georg. Natl. Acad. Sci.

**Key words:** ostracodes, foraminifers, Tarkhanian, Chokrakian

The Miocene in Georgia mainly consists of terrigene deposits. They often undergo facial changes conditioned by fluctuations taking place in the

Pontian-Caspian region in the second half of the pre-Alpine folding (Styrian phase). Development of Miocene basins directly depended upon the inten-

sity of these processes. As a result of tectonic processes repeatedly changed basins volume, shape, depth, temperature, gas regime, water salinity and hydrodynamic activity.

During the formation of Early Miocene basins connection between the east and west Paratethys was rather extensive. As a result of the above geological processes the basins were isolated from the open sea periodically, thus promoting the formation of desalinated and fresh water conditions. As a result, the inhabitants composition changed from stenohaline to extremely euryhaline. Due to special conditions endemic forms and different fauna evolved. Bionomic conditions directly affected the distribution of microfauna and promoted separate genus and species flourishing, as well as their weakening and extinction.

Lower Miocene sediments of Georgia in the eastern subsidence zone [1] starts with the Aquitanian (Uplistsikhe) regional stage.

Stratigraphic sections of Tarkhanian-Chokrakian sediments were compiled in Western Georgia (the river Chanistskali, village Bardnala, the river Namkashuri, vil. Ghvirishi), where foraminifers and ostracodes (Table 1) were revealed. Kotsakhuri layers and its analog the upper clayey facies of the Maikop series are conformably covered by Tarkhanian sediments.

At the beginning of the Tarkhanian age orogenic movements were not simultaneous and of the same intensity everywhere. Such situation affected the relief of the basin floor and formed submarine uplifts and isolated depressions. Water movement in horizontal direction did not extend to the deepened areas that complicated vertical circulation of the basin. These processes affected the development and distribution of microfauna. Different species of Tarkhanian sediments of the study region are not distributed in equal amounts. Some species are met sporadically. In the Tarkhanian sediments the following Mediterranean species are spread: *Quinqueloculina boueana* d'Orb., *Q. selene* (Karrer),

*Q. ungeriana* d'Orb., *Q. circularis* (Born.), *Triloculina austriaca* d'Orb., *Sigmoilina tenuis* (Czjzek). Foraminifers genetically connected with the West European ones differ in smaller size. According to A. Bogdanovich [2] it is probable that Tarkhanian foraminifers passed into the Euxino-Caspian basin from the Tethys already during the Gori horizon formation. As it is known, numerous Mediterranean mollusks and foraminifers [3] are recorded in the Gori horizon established in Georgia. Endemic species found in Tarkhanian sediments are widely spread in the Crimean-North Caucasian synchronous sediments. There also are recorded the species established known only in the Tarkhanian sediments of Georgia. At the end of the Tarkhanian number of emigrant species decreases and local species dominate. Such distribution of microfauna has been associated with the beginning of isolation of Euxino-Caspian basin. By that time salinity of the basin decreased and amount of stenohaline species reduced. In Tarkhanian sediments of Western Georgia the ostracodes of the following genera are found: *Loxococoncha*, *Trachyleberis*, *Cythereis*, *Cytheridea*. The ostracodes are represented by species living both in marine and desalinated basins. By the origin of ostracodes the following main groups are distinguished: species of Mediterranean type – of West European Vienna basin and species of Northern Germany (*Trachyleberis elegantissima* (Lnkls.), *Loxococoncha carinata* (Lnkls.), also *Cytheridea mulleri* (Munst.), *Cythereis dentata* (Müll.) spread in the Oligocene and Miocene of West Europe. In facies distribution of microfauna certain regularity is observed. In the Tarkhanian three bathymetric areas of distribution appear: deep, transitional and shallow. Tarkhanian sediments are homogeneous and are represented by dark clays and marls, slightly sandy clays of dark color (deep water basin), grey argillaceous sandstones (transitional) and coarse-grained sandstones, loose sandstones (shallow water basin). In the lower part of the Tarkhanian regional stage, where Maikopian clays and calcareous

clays occur, hydrological regime periodically was violated. In particular, oxygen supply was disturbed and sometimes hydrogen sulfide poisoning of the basin took place. This is confirmed by the character of sediments and fauna disappearance as well. After resumption of aeration and deposition of calcareous clays a variety of fauna developed. The Fauna of this period is characterized by small size, thin-walled and non-sculptured species. Already in the late Tarkhanian normal marine conditions with rich and diverse fauna were formed. Almost all recorded miliolid species are connected with clays, clayey sandstones and sandy clays. Among them abundance of *Quinqueloculina selene* (Karrer), *Sigmoilina mediterraneensis* Bogd. is noted. In the Upper Tarkhanian sediments besides the endemic species, microfauna that also extends to the Chokrakian sediments is widespread (foraminifers - *Quinqueloculina selene* (Karrer), *Q. ungeriana* d'Orb., *Sigmoilina mediterraneensis* Bogd., ostracodes - *Loxococoncha carinata* Lnkls, *L. carinata alata* Schn., *Cytheridea mulleri* (Munst.)). Thus, microfauna recorded in the Tarkhanian sediments points to the normal salinity of the basin and its connection to the open sea. Species of the Mediterranean type that almost do not differ from the West European Miocene forms occur in the Tarkhanian microfauna association. Along with the salinity, also other environmental conditions were considered to be normal for the development of microfauna except for some deep areas, where the gas conditions were disturbed. By that time, the temperature slightly differs at different depth in the basin. Thermophile and psychrophile species variability is not observed. At the end of the Tarkhanian with the decrease of salinity amount of stenohaline species also reduced.

At the beginning of the Chokrakian in the study region hydrological conditions changed that led to the extinction of typical Tarkhanian species. At the same time, there developed association of peculiar fauna indicative of independent evolution induced by complicated connection between the Chokrakian

basin and the ocean. It is noteworthy that the Tarkhanian and Chokrakian fauna were genetically related to each other. Ostracodes of Chokrakian sediments comprise species characteristic of properly Chokrakian and also the Mediterranean type species that passed from the Tarkhanian. It should be noted that some of the Mediterranean type ostracodes, which are found in the Chokrakian sediments of Georgia and slightly vary from typical forms are not known in the Tarkhanian (*Loxococoncha* aff. *bairdi* Müll., *Cythereis spinulosa* (Reuss), *Xestoleberis* aff. *fuscomaculata* Müll.). According to composition and origin of foraminifers in the Chokrakian sediments the Mediterranean species migrating from the Tarkhanian and the endemic ones are observed [4]. A. Bogdanovich [5] denies migration of foraminifers from West Europe and points out that in the Chokrakian independent formation of fauna took place and that was conditioned by isolation of the Chokrakian basin from the Mediterranean and its gradual desalination. According to the author, some species deviate from the Mediterranean forms, which allows Chokrakian microfauna to be considered in conditions of isolation. As to ostracodes [6], they have species in common with the Tarkhanian and the author does not reject the connection with West European basins at the beginning of the Chokrakian. We share the above authors' opinion and suppose that Mediterranean type species of Chokrakian microfauna migrated without changes from the Tarkhanian at the beginning of the Chokrakian, when the connection with the open sea was restricted. At the same time some species that migrated from the Mediterranean and got adapted to the post-Tarkhanian reduced salinity, underwent insignificant changes and continued evolution. At the beginning of the Chokrakian, when there is a short-term connection with the open sea, the salinity of the basin is normal. Then the connection gradually comes to an end, hydrological conditions change, salinity decreases. The basin undergoes gradual freshening and eurybiotic species adaptable to different conditions

prevail. By that time temperature at different depth changes. Such development of the Chokrakian is well expressed in the microfauna complexes that allows to divide the Chokrakian regional stage into three parts: the lower, middle and upper. However, it should be noted that in a number of areas in Eastern Paratethys due to similarity of Lower and Upper Chokrakian microfauna, it is impossible to separate them [6]. Some foraminifer species - *Quinqueloculina akneriana* d'Orb., *Q. selene* (Karrer), *Spiroloculina irma* Bogd., *Sigmoilina tschokrakensis plana* O. Djan., *Florilus boueanus* d'Orb. - are traced everywhere. Most of the species occur in the Lower and Middle Chokrakian – *Quinqueloculina orbignuana* Bogd., *Q. akneriana* d'Orb., *Q. akneriana rotunda* Gerke, *Q. akneriana argunica* Gerke, *Q. akneriana longa* Gerke, *Q. aff. laevigata* d'Orb., *Q. ungeriana* d'Orb., *Q. elongata – carinata* Bogd., *Q. ex gr. circularis* (Born), *Tschokrakiella caucasica* Bogd., *Sigmoilina haidingerii tschokrakensis* Bogd., *Caudina linter* O. Djan, etc. There are also ostracods – *Bairdia ex gr. elliptica* Schn., *Leptocythere rugosa* Schn., *L. ex gr. cellula* Livent., *Cytherura magna* Schn., *C. filicata* Schn., *Loxoconcha carinata* Lnkls., *L. carinata alata* Schn. The foraminifer and ostracode genera spread in the lower part of the Chokrakian sediments are represented by more numerous species in the Middle Chokrakian. Upper Chokrakian sediments comprise foraminifers - *Articulina tschokrakensis* Bogd., *Pseudopolymorphina tschokrakensis* O. Djan., *Nonion bogdanowiczi* Vol. etc. and ostracodes - *Candona ex gr. candida* Müll., *Cytheridea mulleri* (Munst.), *Cyprideis littoralis* (Brady). The Upper Chokrakian is strongly impoverished. Some species are represented by a single specimen and weakened and pathological species are frequent. Along with the Chokrakian microfauna the bryozoans, otoliths, spiralis, gastropods, worms traced all over the clay facies. In Chokrakian sediments different types of facies are distinguished. More thick deep water facies that contains numerous *Spiralis* lithologically are represented by dark-colored clays

and marls. In stratigraphic sections they belong to the lower part of the Chokrakian. There prevail species in common for the Tarkhanian and Chokrakian. Transitional facies – argillaceous sandstones, sandy clays, where diverse and rich fauna occur. Two complexes are distinguished: the lower rich in microfauna and the upper impoverished. Facies characteristic of shallow water, finegrained sandstones with clay partings and loose sandstones was deposited near the coast. From view point of abundance, most of Chokrakian ostracodes of Western Georgia occur in deep and transitional facies of the basin. From ostracodes in deep basin facies the following species are frequent: *Leptocythere stabilis* Schn., *Loxoconcha carinata* Lnkls., *L. carinata alata* Lnkls., *Trachyleberis elegantissima* (Lnkls.), *Cythereis spinulosa* (Reuss), *C. dromas* Schn., *Cytheridia mulleri* (Munst.). In the transitional facies often occur the species of genus *Loxoconcha* and *Leptocythere distincta* Schn. Other species are rarely found. Other species occur sporadically in shallow basin sediments, but *Cytherideis littoralis* (Brady) is often met.

Sediments (dark-coloured clays, slightly sandy clays) of stratigraphic section of the river Chanistskali belong to the Chokrakian deep water basin. In transitional sediments in sandy clays and slightly argillaceous sandstones diversity of microfauna is recorded and in shallow water laminated sandstones and sandstones single species of microfauna is observed. In the stratigraphic section of the village Bardnala in lower Chokrakian deep water dark-coloured clays and slightly sandy clays microfauna is represented by species common for the Tarkhanian-Chokrakian. In above-mentioned sediments some species forms are small in size. The fauna occurs also in Middle Chokrakian dark-grey clays belonging to deep water basin. Transitional sediments are rich in diverse fauna. In shallow-water sediments where clay facies also occur, microfauna is recorded as well. Upper part of the Chokrakian lithologically is represented by sediments characteristic of deep-water and

Table. Distribution of Tarkhanian-Chokrakian microfauna in Stratigraphic Sections

Sections Species 1	The river Chanistskali		Village Bardnala		The river Namkashuri		Village Ghvirishi	
	tr 2	č 3	tr 4	č 5	tr 6	č 7	tr 8	č 9
Foraminifera								
<i>Textularia tarchanensis</i> Bogd.	+		+		+		+	
<i>Quinqueloculina</i> aff. <i>boueana</i> d'Orb.	+				+			
<i>Q. boueana</i> d'Orb.	+							
<i>Q. orbignuana</i> Bogd.			+					+
<i>Q. longiuscula</i> Bogd.		+						+
<i>Q. akneriana</i> d'Orb.		+		+		+		+
<i>Q. akneriana rotunda</i> Gerke		+		+		+		+
<i>Q. akneriana argunica</i> Gerke		+		+		+		+
<i>Q. selene</i> (Karrer)	+	+	+	+	+	+	+	+
<i>Q. dmitrievae</i> (Bogd.)		+						+
<i>Q. aff. laevigata</i> d'Orb.		+		+		+		+
<i>Q. caucasica</i> (Bogd.)		+						+
<i>Q. ungeriana</i> d'Orb.	+	+	+	+	+	+	+	+
<i>Q. akneriana longa</i> Gerke		+		+		+		+
<i>Q. elongata-carinata</i> Bogd.		+		+		+		+
<i>Q. pyrula</i> Karrer								+
<i>Q. ex gr. circularis</i> (Bogd.)		+		+		+		+
<i>Flintina</i> sp.			+					
<i>Tschokrakiella caucasica</i> (Bogd.)		+		+				
<i>Triloculina austriaca</i> d'Orb.				+		+		+
<i>T. subfoliacea</i> Bogd.				+				
<i>T. tricarinata georgiana</i> O. Djan.								+
<i>Sigmoilina irma</i> Bogd.				+		+		+
<i>S. mediterranensis</i> Bogd.	+	+		+	+	+	+	+
<i>S. tenuis tarchanensis</i> Bogd.	+					+		+
<i>S. tenuis</i> (Gzizek)	+		+		+		+	
<i>S. tschokrakensis</i> Gerke		+		+				+
<i>S. tschokrakensis plana</i> O.Djan.				+				+
<i>S. haidingerii</i> (d'Orb.)		+		+				+
<i>S. haidingerii tschokrakensis</i> Bogd.		+		+		+		+
<i>Articulina</i> aff. <i>tschokrakensis</i> Bogd.				+		+		+
<i>Pseudopolymorphina tschokrakensis</i> O.Djan.		+				+		
<i>Caudina linter</i> O. Djan.		+	+	+	+	+		
<i>Discrobia</i> sp.				+				
<i>D. ex gr. tarchanensis</i> O.Djan.					+			
<i>Nonlon bogdanowiczi</i> Vol.				+		+		+
<i>N. granosus</i> d'Orb.	+							
<i>Nonionella pulchella</i> O.Djan.	+							
<i>Florilus boueanus</i> (d'Orb.)	+			+	+			+
<i>Ammonia beccarii</i> (Linné)	+	+	+	+	+	+	+	+
<i>Globigerina</i> sp.	+							+
<i>G. tarchanensis</i> Subb.et Chutz.	+				+		+	+
Ostracoda								
<i>Bairdia</i> ex gr. <i>explicata</i> Schn.				+				
<i>Pontocypris suzini</i> Schn.				+				
<i>Pontocypris</i> sp.				+				
<i>Candona</i> ex gr. <i>candida</i> Müll.				+				
<i>Pseudocythere caudata</i> Sars.						+		
<i>Potamocypris</i> sp.								+
<i>Leptocythere</i> aff. <i>ukrainica</i> Schn.				+				
<i>L. stabilis</i> Schn.		+		+				+

Table 1.

Sections Species	The river Chanistskali		Village Bardnala		The river Namkashuri		Village Ghvirishi	
	tr	č	tr	č	tr	č	tr	č
1	2	3	4	5	6	7	8	9
<i>L. rugosa</i> schn.		+						+
<i>L. distincta</i> Schn.				+				+
<i>L. ex. gr. cellula</i> Livent.				+				
<i>L. bardnalensis</i> Popch. sp. nov.				+				
<i>Cytherura magna</i> Schn.				+				+
<i>C. filicata</i> Schn.				+				
<i>Paracytheridea</i> aff. <i>reussi</i> Schn.								+
<i>Loxoconcha carinata</i> Lnkls.	+	+	+	+	+	+	+	+
<i>L. carinata alata</i> Schn.	+	+	+	+	+	+	+	+
<i>L. aff. bairdi</i> Müll.				+				
<i>Loxoconcha</i> sp.				+				
<i>Cytheretta</i> sp.								+
<i>C. korobkovi</i> Schn.								+
<i>Trachyleberis</i> sp.				+		+		
<i>T. elegantissima</i> (Lnkls.)				+				+
<i>Cythereis</i> aff. <i>dentata</i> Müll.	+				+		+	
<i>C. aff. denudata</i> (Reuss.)								+
<i>Cythereis caucasica</i> Schn.	+		+		+		+	
<i>C. dromas</i> Schn.		+						+
<i>C. spinulosa</i> (Reuss.)								+
<i>Cytheridea mulleri</i> (Münst.)	+	+	+	+	+	+	+	+
<i>Cyprideis littoralis</i> (Brady)		+		+		+		+
<i>Xestoleberis</i> sp.				+				
<i>X. aff. fuscomaculata</i> Müll.				+				+
<i>X. aff. lutrae</i> Schn.				+				+

transitional basins that contain fauna. In stratigraphic section of the river Namkashuri, Chokrakian deep-water sediments contain fauna. Transitional ones are rich in species. Dark-colored sandstones represent a shallow-water basin. In the mentioned stratigraphic section in argillaceous sandstones and grey sandstones fauna mainly is not observed. In some sandstones only fragments of microfauna occur. Chokrakian deep- and shallow water basins established in the vicinity of village of Ghvirishi are rich in microfauna. In transitional sediments poorly preserved forms occur. In the upper part of the Chokrakian unitary and fragmentary fauna species are deposited. Shallow sea coarse-grained sandstones miss microfauna.

Basin floor with silt up to 18-45% is most favourable for the existence of ostracodes. The reduction and the increase of silt percentage caused species impoverishment or extinction. Ostracodes live on the

layer surface or under the surface layer. Subsurface ostracodes are better preserved due to their fast fossilization. It should be noted that ostracode shells occurring in sandstones are found with open valves. In clays more often intact shells occur. The existence of separate shells corroborates more intensive water movement in shallow water basin. According to microfauna genera and species of Chokrakian sediments in the early and middle Chokrakian marine conditions were normal. Salinity is lower compared to the Tarkhanian. The salinity decreases after the Middle Chokrakian. Basin depth and temperature along with salinity were of great importance for microfauna evolution and distribution, its qualitative and quantitative composition. Temperature is high in the Chocrakian, as evidenced by numerous miliolids. In composition of microfauna of Chokrakian sediments abundance of anomalously developed forms is revealed. Some ostracodes are deformed, as

if crushed. Definite part of foraminifers has a misdeveloped last chamber, therefore the form is distorted and tooth is atrophied. Such pathological species exist when bionomical conditions change. It is

manifested especially under the reduction of salinity. Along with pathological forms there were also normally developed species adapted to the existing environment.

## პალეობიოლოგია

# დასავლეთ საქართველოს თარხნულ-ჩოკრაკული აუზების პალეოეკოლოგიური საკითხები მიკროფაუნის (ფორამინიფერები, ოსტრაკოდები) მიხედვით

## ლ. ფოფხაძე

თბანე ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტი, ა. ჯანელიძის გეოლოგიის ინსტიტუტი, თბილისი, საქართველო

თარხნულ-ჩოკრაკული ნალექების სტრატეგრაფიული ჭრილები შედგენილია დასავლეთ საქართველოში (მდ. ჭანისწყალი, ნამკაშური, სოფ. დვირიში, ბარდნალა) და სხვადასხვა დონეზე გამოვლენილია ფორამინიფერებისა და ოსტრაკოდების კომპლექსები. მიკროფაუნის სახეობათა უმრავლესობა ხმელთაშუაზღვიურია. თარხნულ-ჩოკრაკული ნალექები წარმოდგენილია მუქი ფერის თიხებით და მერგელებით, მუქი ფერის სუსტად ქვიშიანი თიხებით (დრმა წყლის აუზი), ნაცრისფერი თიხიანი ქვიშაქვებით (გარდამაგალი), მსხვილმარცვლოვანი და ფხვიერი ქვიშაქვებით (მარჩხი წყლის აუზი). ადრე თარხნულში აუზის მარილიანობა იყო ნორმალური. გვიან თარხნულიდან იკლებს მარილიანობა. ტემპერატურა ამ დროისათვის აუზის სხვადასხვა სიღრმეებზე უმნიშვნელოდ განსხვავებულია. თარხნულის ბოლოს ემიგრანტი სახეობების რიცხვი კლებულობს და ჭარბობს ენდემური სახეობები. აღინიშნება მიკროფაუნა, რომელიც ვრცელდება ჩოკრაკულ ნალექებშიც. ჩოკრაკული საუკუნის დასაწყისში, მოკლევადიანი კავშირია გაშლილ ზღვასთან და აუზის მარილიანობა არის ნორმალური. შუა ჩოკრაკულის შემდეგ მარილიანობა მცირდება, აუზი თანდათან მტკნარდება და ჭარბობს ევრიბიოტური სახეობები. ჩოკრაკული მიკროფაუნის სახეობათა უმრავლესობა (ფორამინიფერები – გვარები *Quinqueloculina*, *Tschokrakiella*, *Sigmoilina*, *Tschokrakensis*; ოსტრაკოდები – გვარები *Bairdia*, *Leptocythere*, *Cytherura*, *Loxococonch*) გვხვდება ქვედა და შუა ჩოკრაკულ ნალექებში. მრავალრიცხოვანი სახეობებით აღინიშნება შუა ჩოკრაკული. ზედა ჩოკრაკული ასევე წარმოდგენილია ფორამინიფერებისა და ოსტრაკოდების მრავალფეროვნებით. მიკროფაუნის შემადგენლობაში ხშირია დაკინებული და პათოლოგიური ფორმები. ტემპერატურა ჩოკრაკულ დროს მაღალია, რასაც ადასტურებს ჭარბი რაოდენობის მილიოლიდები.

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