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Paleobiology

Paleoecological Data of the Sarmatian Basin on Microfauna of East Georgia

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ABSTRACT. Biocenosis of the Early Satmatian (Volhynian) basin is homogenous. Microfauna is characterized by saline forms. Due to the developed conditions the amount of stenohaline species reduced or disappeared. In the Middle Sarmatian (Bessarabian) the microfauna is distinguished in its diversity. Endemic species appeared. Desalination and freshening of the Late Bessarabian basin led to the sharp impoverishment or extinction of microfauna. In stratigraphic sections, compiled in Eastern Georgia (the rivers Aragvi, Ksani, Lekhura, Noriostskali), the species of the following genera are recorded: foraminifera – *Quinqueloculina, Nubecularia, Wiesnerella, Dogielina, Nonion, Porosononion, Elphidium, Globigerina*; ostracods – *Pontocypris, Leptocythere, Loxoconcha, Aurila, Cyprideis*. In the complex of ostracods with the exception of the species that passed from the Konkian typical Sarmatian species occur. They considerably differ from the Mediterranean ones. But in the complex of foraminifera the Mediterranean forms are established. In the Upper Sarmatian (Khersonian) of Eastern Georgia thick mute continental sediments are recorded. Late Sarmatian marine conditions are preserved in the vicinity of the river Iorispiri. In Georgia in the Late Sarmatian due to short term transgression the connection with the norm salinity seas restored and in marine sediments the ostracods of atypical Sarmatian appearance occured – *Leptocythere maeotica* (Suzin) and *Xestoleberis maeotica* (Suzin). *© 2017 Bull. Georg. Natl. Acad. Sci.*

Key words: ostracodes, foraminifera, Sarmatian

During the development of the early Miocene basins the connection between the Central and Eastern Tethys was very extensive. As a result of the geological events, the basins were periodically isolated from the open seas causing desalination and freshening of their waters. In the semi-closed basins, norm-marine sediments were deposited; they alternated with saline-water and freshwater marine sediments. The closed basins were freshened as a result of the river water influx, which led to the replacement of marine fauna complexes by typical of the saline-water and freshwater basins. The composition of the sea inhabitants varied from stenohaline to euryhaline species. Due to specific conditions the endemic forms occurred and peculiar fauna differing from the previous one was formed. Bionomic condi-

tions had a direct influence on the occurrence of microfauna and promoted both its flourishing and "suppression" and disappearance of some genera. In the Sarmatian the connection with the Mediterranean ended finally and the Sarmatian Sea stretching from the Vienna Basin to Central Asia was formed. There is a close phylogenetic link between the Sarmatian and Konkian foraminifera. Most of the Sarmatian foraminifera originate from the Konkian forms that survived the seawater desalination, which began at the end of the Konkian Age and adapted to the progressive desalination during the Sarmatian. At this stage gradual adaptation of forms to the new conditions took place. At the beginning of the early Sarmatian (Volhynian), the biocoenosis of the basin was uniform and the microfauna was represented by more brackish forms. Unlike the foraminifera, ostracods are more sensitive organisms and at this stage of desalination of the reservoir, the number of ostracod species is being reduced. In addition to the species that have survived from the Konkian, typical Sarmatian forms *Aurila Sarmatica* (Zalanyi), *Loxoconcha subcsrassula* (Suzin) are noted in the complex of ostracods. There are also *Aurila levis* (Schn.), *Leptocythere mironovi* (Suzin), *L. stabiles* (Schn.), *L. plana* (Schn.). In the complex of foraminifer fauna belonging to genera *Nonion, Porosononion* and *Elphidium*, the Mediterranean type species were identified. The microfauna of this period is characterized by even smaller dimensions in comparison with the forms found in the Konkian deposits. The Lower Sarmatian fauna is mainly euryhaline and eurythermal. It is noteworthy that the conditions created at that time caused gradual reduction and disappearance of stenohaline species. In the carbonate laminated clays (with a blue tint) and in fine-grained sandstones dated according to microfauna, exposed in the Aragvi river valley, *Nonion bogdanowiczi* Vol., *Porosononion subgranosum* (Egger), *Elphidium maccellum* (F. et M.) were found. Further to the west, the sediments of the same age are recorded in the Ksani (village Kanchaveti, river Kanchaura) and Lekhura river gorges. Eastwards of the river Aragvi, Lower Sarmatian deposits stretched as a narrow strip up to the Norio-Patardzeuli anticline, where they are exposed on its northern limb, near the village Nazrevi. In the southeast, these deposits are quite common in Outer Kakheti (the Iori strip). According to the foraminifera from natural outcrops and borehole material [1], the Sarmatian deposits were identified in different regions of East Georgia. The Lower Sarmatian deposits are conformably followed by the Middle Sarmatian (Bessarabian) ones that are divided into 3 parts. In the upper part of the Lower Sarmatian and at the beginning of the Middle Sarmatian bionomic conditions were normal, except for the decreased water salinity. At that time, stenohaline fauna is missing, pointing to progressive desalination of the reservoir. This period is associated with the development and diversity of microfauna species. In terms of almost closed basin various forms of Sarmatian type foraminifera and ostracods are observed. Endemic forms occur, the origin of which is associated with the Konkian and Early Sarmatian microfauna, though they differ from their congenial species. At that stage, the main complexes well adapted to the changing environmental conditions are formed. Similar situation is observed at the beginning of the Middle Sarmatian in both, East and West Georgia. In East Georgia, in the stratigraphic sections of Sarmatian deposits (Bebris-Tsikhe, the Kanchaura River valley) studied by us, the microfauna (the foraminifera and ostracods as well) is extremely impoverished. Similar situation is observed in the North Caucasus. According to A.Suzin [2], in this region the Lower Sarmatian species composition and number are very few. In the western part of the North Caucasus, various species from Middle Sarmatian ostracod genera are found almost everywhere, but sporadically. In the eastern part, both in the Lower and Middle Sarmatian, the microfauna is very rare. The territorial proximity of Georgia and the North Caucasus gives possibility to believe that the same geological processes occurred in the eastern parts of the mentioned

regions; respectively, the same environmental conditions occurred for the habitation and existence of microfauna. In the Norio-Martkopi zone, the Middle Sarmatian foraminifera - *Articulina kalickii* (Bogd.), *Meandroloculina bogatschovi* (Bogd.), *Spiroloculina okrajantzi* (Bogd.) were found by A.K. Bogdanovich [3]. Ostracods of the same age - *Aurila Sarmatica* (Zalanyi), *A. kolesnikovi* (Schn.), *Leptocythere multicristata* Suzin, *Loxoconcha* aff. *viridis* (Mull.), collected in Kakheti (unspecified location) were identified by G.F. Schneider [4]. As a result of desalination and even greater freshening of the Upper Bessarabian basin, the fauna abruptly depleted and completely disappeared. By this time, miliolids got extinct. It is noteworthy that the existence of miliolids depended on the character of the sea floor, depth and salinity of water. Some miliolids cannot survive in shallow waters. The Sarmatian microfauna from the studied stratigraphic sections is represented by the euryhaline complex of foraminifera and ostracods. The species from the following genera were identified: foraminifera - *Quinqueloculina, Nubecularia, Wiesnerella, Dogielina, Nonion, Porosononion, Elphidium, Globigerina* and ostracods - *Pontocypris, Leptocythere Loxoconcha, Aurila.* Microfauna is represented by benthic forms; there are no representatives of planktonic foraminifera within the complexes, only few *Globigerina* sp. are recorded. The microfauna complex contains typical Middle Sarmatian species: F - *Porosononion hyalinum* (Bogd.,), *Elphidiella antifex* (Serova), O - *Loxoconcha* aff. *quadrituberculata* (Schn.), *Leptocythere plana* (Schn.), *Aurila kolesnikovi* (Schn.), etc. This period of the Sarmatian is characterized by the reproduction of the representatives of genus *Aurila*. Among the other species, the forms of genera *Nonion, Porosononion, Elphidium* are more numerous. They are characterized by medium size and slightly sculptured shell surfaces. A pinkish-brownish and dark colour is seen. The species do not show obvious intraspecific changes, if not taken into account some individual cases of increased shells or increased number of chambers on the last whorl. Following the general appearance of microfauna, we believe that during this period of the Sarmatian, suitable conditions for favourable development of microfauna (salinity, food, warmth) were restricted. In the Bebris-Tsikhe section, the Middle Sarmatian is represented by coastal facies represented by massive sandstones alternating with thin-layered sandy clays, yellowish medium-grained sandstones, occasionally with the interlayers of grayish-gray clays. It should be noted that, in contrast to the section near the river Kanchaura, in the microfauna complex the ostracod species of the genus *Leptocythere* are missing. Generally, they live in deeper parts of the basin, in conditions with no active movement of water masses. In the vicinity of the village Naniani, the sediments of the studied section (dark gray clayey sandstones) can be considered as transitional, i.e. more distant from the shore. The deposits are mostly "mute", induced by a temporal contamination of the basin with hydrogen sulfide.

It should be noted that species of the genus *Elphidium* are more resistant to changes of their environmental conditions; however, as is known, the progressive water desalination from the end of the Bessarabian time resulted in the disappearance of this group. *Elphidium macellum* (F. et M.), according to the paleoecologic data, are widely spread in the Miocene sediments. This species lives in desalinated basins, but its number is limited. The species is adapted to the salinity of 4-13‰. Although this species is thermophilic, it can survive at 5°C as well. Along with *E. macellum* (F. et M.), fossilized *E. crispum* (Linne) is identified as an ecological-specific variety. This species also occurs at a depth of 880 m, but is best developed at 20 m. It withstands water salinity of 2.5‰ and temperature of -15.5-16°C. As for habitats, this species prefers places with clean water, muddy, shelly and sandy ground. It is also noteworthy that the species of genera *Porosonion* and *Nonion* that inhabit the coastal zone of the shallow sea usually have large sizes and additional skel-

etal formations; but, the discovered foraminifera are changed – they are small and the number of skeletal formations is limited. The unfavourable conditions of living habitat are also evidenced by the ostracods found by us. Species of genus *Aurila*, inhabiting the off-shore areas, have the shells of medium thickness and size. Besides, in the ostracod complex numerous broken forms are observed. The presence of shell fragments points either to a long-lasting movement of the shells, or to shallow coastal conditions, where, under the influence of intensive wave action, the thin-walled shells got damaged. The proximity to the coastal zone by the presence of a large number of algae is also evidenced. It should be noted that the sculptures of the ostracod shells are significantly altered. In this respect, the greenish-gray striated clays with the admixture of sand exposed in the Kanchaura River valley deserve special attention. Species of genus *Leptocythere* are found here. Both valves of the shells are preserved, and brownish colouring can be seen. Here, bi-valve mollusks of a black colour with micro-dimensions were found. The representatives of genus *Leptocythere* are stunted, as if compressed. There are also pathological species noted among foraminifera that is important for the reconstruction of environmental conditions. Sometimes, the pathology of forms may be induced by a local damage of the shell. A living organism restores its damaged section by the excretion of a new skeletal matter to its damaged shell. In this case, the shell seems to acquire a different shape. This phenomenon is observed both, in foraminifera (especially in case of an improperly developed body chamber) and in ostracods, when the contours change, the shape is deformed and the tooth is atrophied. Similar forms were also found in the material collected by us. Anomalies occur in case when the bionomic conditions change in the basin. As the stratigraphic sections studied by us evidence, during the sedimentation of the Middle Sarmatian deposits, relatively deep sections of the water reservoir were contaminated with hydrogen sulphide in a certain period. The salinity of the water was sufficient for subsistence, but other conditions, such as food, oxygen supply and temperature were disturbed. The microfauna from other coastal and off-shore parts of the basin is not stunted, but the limited development of shell formation is still obvious; there is missimg lustre typical to the forms that live in the clear water. It is noteworthy that warm waters stimulate the evolution of the organisms, while the normal conditions contribute to the intensive development of species. We assume that at this stage of the Mid-Sarmatian, the areas studied by us were characterized by relatively low temperatures. The shallow water basin significantly depended upon the climate changes and air temperature. An important factor for the development of microfauna, alongside with the salinity of water, was also the temperature regime of the basin. All these circumstances resulted in the scarcity and imperfect development of the fauna. Thus, the thickness of the studied sediments, their lithological composition and insignificant amount of marine fauna allow to conclude that they were formed in the desalinated basin of a vast shallow sea. This is confirmed by fossilized microfauna represented mainly by euryhaline forms. The sedimentation took place within the mid-upper sublittoral zone, where the temperature, apparently, was low and subjected to seasonal fluctuations. As a result of the analysis of the facial development of the microfauna, the following regularity was identified: 1. The coastal facies represented by yellowish-gray coarse-grained and medium-layered, as well as fine-grained sandstones. Foraminifera with pendant sculptures of *Elphidium regina* (d'Orb.), *E. aculeatum* (d'Orb.) dominate here. Abundance of ostracod fragments and algae (representatives of the family Characea) remnants points to shallow coastal zone conditions with low salinity and active movement of water masses. The depth reaches H" 20 m; 2. Transitional facies - with deepened areas: clays with low sand content and sandstones with interlayers of gray thin-layered clays. Foraminifera and ostracods with a changed general appearance are common here. The

foraminifera of genera *Nonion, Porosononion, Elphidium*, confined to dark rusty leaf clays, as well as to the clays with low sand content that deposited in the deeper parts of the basin, have a markedly brownish-pink and black colour. Species of ostracods of genus *Leptocythere* have a suppressed appearance, although both valves are maintained. Among the mollusks *Spirialis* sp., *Acteocyna* sp. are present here. During this period of the Sarmatian, the movement of the water masses was stable, but other environmental conditions, such as salinity, food, oxygen supply regime and temperature, were disturbed.

Transition of the Middle Sarmatian to the Upper Sarmatian (Khersonian) is gradual. The lower limit of the Upper Sarmatian passes along the area where the layers with the Middle Sarmatian fauna end. In East Georgia the Middle Sarmatian upwards is followed by thick continental "mute" strata and molasses are accumulated. By this time, the area and depth of the basin sharply decreased. The sea was divided into semi-closed separate basins (the lakes). These events were induced by the maximum intensity of tectonic movements in the Late Sarmatian (Attic phase). The Upper Sarmatian sandy-argillaceous continental deposits are known as a Natskhori suite. The Natskhori suite southeast of Kakheti Ridge, passes into the Eldari Suite. Upper Sarmatian marine conditions are preserved in the area of the Iori River, where they are gradually replaced by continental formations. Marine sediments ("marine stratum") of the sandy-clay facies contain impoverished microfauna characteristic of the Upper Sarmatian [5, 6]. The upper part of the Upper Sarmatian sediments is represented by a continental "variegated" suite.

According to many literary data, Upper Sarmatian marine sediments were deposited in the basins with a low level of salinity, i.e. in desalinated marine basins. It is also probable that these sediments were deposited in a reservoir contaminated with hydrogen sulfide. During this period, foraminifera almost disappeared, only "suppressed" *Ammonia* and *Porosononion* survived here. Numerous *Cyprideis torosa*, (Jones) and few species of genera *Candona* and *Eucypris* of the ostracods occur. According to G. Schneider [4], as a result of a short-term transgression, the connections with norm saline seas are restored and ostracods with atypical Sarmatian appearance emerge - Meotian *Leptocythere maeotica* Suzin and *Xestoleberis maeotica* Suzin. These conditions undoubtedly were, associated with tectonic processes manifested in the Late Sarmatian and Early Meotian. This period is characterized by the invasion of the Mediterranean Sea and migration of stenohaline forms.

პალეობიოლოგია

სარმატული აუზის პალეოეკოლოგიური მონაცემები მიკროფაუნის მიხედვით (აღმოსავლეთ საქართველო)

ლ. ფოფხაძე

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

(წარმოდგენილია აკადემიის წევრის მ. კაკაბაძის მიერ)

სარმატულის დასაწყისში მთლიანად შეწყდა კავშირი ხმელთაშუაზღვასთან და ჩამოყალიბდა მომარილიანო და მტკნარი აუზი. ადრე სარმატული (ვოლინური) აუზის ბიოცენოზი ერთგვაროვანია. მიკროფაუნა მომარილიანო ფორმებით არის დახასიათებული. შექმნილმა პირობებმა გამოიწვია სტენოჰალური სახეობების შემცირება, გაქრობა. შუა სარმატულში (ბესარაბიული) მიკროფაუნა მრავალფეროვანია. ჩნდება ენდემური სახეობები. გვიან ბესარაბიული აუზის კიდევ უფრო განმარილიანებისა და გამტკნარების შედეგად მიკროფაუნა მკვეთრად ღარიბდება ან სრულიად ქრება. აღმოსავლეთ საქართველოში შედგენილ სტრატიგრაფიულ ჭრილებში (მდ.მდ. არაგვი, ქსანი, ლეხურა, ნორიოს წყალი) გამოვლენილია სახეობები შემდეგი გვარებიდან: ფორამინიფერები – *Quinqueloculina, Nubecularia, Wiesnerella, Dogielina, Nonion, Porosononion, Elphidium, Globigerina* ოსტრაკოდები – *Pontocypris, Leptocythere, Loxoconcha, Aurila, Cyprideis*. ოსტრაკოდების კომპლექსში გარდა კონკურიდან გადმოსული სახეობებისა, არის ტიპიური სარმატული სახეობები, რომლებიც მნიშვნელოვნად განსხვავდებიან ხმელთაშუაზღვიური სახეობებისგან. ფორამინიფერების კომპლექსში კი დადგენილია ხმელთაშუაზღვიური ფორმები. აღმოსავლეთ საქართველოს გვიან სარმატულში (ხერსონული) ძირითადად აღინიშნება მძლავრი კონტინენტური მუნჯი ნალექები, თუმცა გვიან სარმატულის ზღვიური პირობები შენარჩუნებულია მდ. იორისპირას რაიონში. საქართველოში გვიან სარმატულში მოკლევადიანი ტრანსგრესიის შედეგად იწყება კავშირის აღდგენა ნორმული მარილიანობის ზღვებთან და ზღვიურ ნალექებში ჩნდება ოსტრაკოდები ძირითადად არატიპიური სარმატული იერით – *Leptocythere maeotica* (Suzin) და *Xestoleberis maeotica* (Suzin).

REFERENCES

1. Koiava K.P. (2006) Biostratigrafia Sarmatskikh otlozhenii Vostochnoi Gruzii po foraminiferam. Doctoral Thesis. Tbilisi, 3-42 (in Russian).
2. Suzin A.B. (1956) Ostrakody tretichnykh otlozhenii Severnogo Predkavkaziia. Groznenski Ordena trudovogo znameni neftianoi institut. M., 183 (in Russian).
3. Bogdanovich A.K. (1947) O rezultatakh izucheniia foraminifer miotsena Krymsko-kavkazskoi oblasti. V Knige: Mikrofauna neftyannykh mestorozhdenii Kavkaza, Embi i Srednei Azii. 5-35 (in Russian).
4. Schneider G. F. (1949) Miocenovaia fauna ostrakod Kavkaza i Kryma. V Knige: Mikrofauna neftiannykh mestorozhdenii SSSR, sb. II: 89-182 (in Russian).
5. Buleisvili D.A. (1960) Geologia i neftegazonosnost' mezhgornoi vpadiny Vostochnoi Gruzii. Leningrad, 239 (in Russian).
6. Gruzinskaia K.F. (1974) K stratigrafii verkhnego miotsena Gruzii. Materiali po geologii i neftegazonosnosti Gruzii. Tbilisi, 96-114 (in Russian).

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