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Palaeobiology

The Comparison of the Results of Palynological and Microfaunistical Investigations of the Sarmatian Deposits of Eastern Georgia

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ABSTRACT. The results of palynological and microfaunistical investigations of the Sarmatian deposits of Eastern Georgia are given. The similarity in dynamics of terrestrial and marine biocenosis is established. *© 2012 Bull. Georg. Natl. Acad. Sci.*

Key words: *Eastern Georgia, Sarmatian, flora, microfauna, stages of development.*

Sarmatian deposits are widely distributed on the territory of Eastern Georgia. By faunistical data they are divided into three substages: Volhinian, Bessarabian and Khersonian (Fig.1). In most cases the Lower Sarmatian is conformably bedded on the Konkian deposits and is represented by coastal-shallow and deep-sea sediments. The thickness of Lower Sarmatian is 50-90 m in coastal regions and 250-350 m in the central part of the basin. The sections are dated by micro-macrofauna *(Quenqueloculina, Nonion, Elphidium, Porosononion, Donax, Mactra, Ervilia)* [1-3].

By data of Koiava [3], the thickness of Lower Sarmatian deposits, poorness of fauna indicate the existence of a large, shallow, brackish basin. Northsouthward of this basin mountain ranges of latitudinal direction were situated.

At the beginning of the Middle Sarmatian the paleogeographical situation was unchanged. Only the retreat of the sea northwards had taken place, that found reflection in the transgressive bedding of Middle Sarmatian deposits of the south wing of the Kakhetian range. The deposits of Middle Sarmatian mainly are represented by blue-grayish clays with rich fauna. The thickness of the Middle Sarmatian is changed from 100 to 1000 m [1,3].

In Kartli to the Upper Sarmatian belongs the thick series of continental deposits of the so-called Natskhorian suite, whose thickness changes from 300 to 2500 m. This suite is widely distributed on

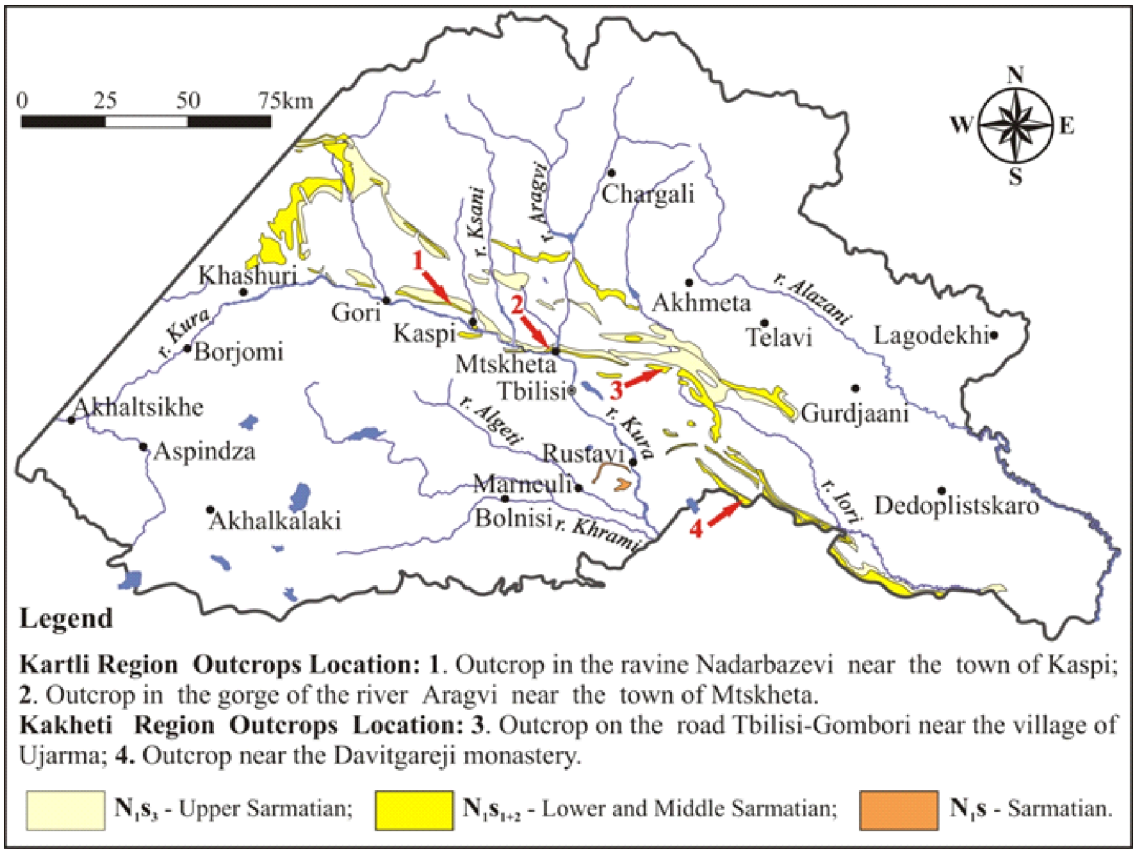

Fig. 1. Map of distribution of Sarmatian deposits of Eastern Georgia together with outcrops location (according to Gudjabidze, 2003).

slopes of Kartli depression, where it takes part in the building of most anticline and syncline folds. In some sections it is divided into two parts: lower - clayey - sandstone and the upper built by the sandy clay deposits [1].

In Kakheti the Upper Sarmatian is somewhat different. Here in north-eastern part of the region it is represented by continental sediments of Eldarian suite with tests of freshwater and terrestrial gastropods. To the south-eastwards the character of deposits is changed and clays of the lower part of Eldarian suite are replaced by marine deposits with fauna of *Mactra*. The presence of the "marine series" in the area of the Iori river is confirmed by micropaleontological investigations of core material from boreholes of Taribani and Eldari [4].

Until recently the knowledge about the Sarmatian flora and vegetation was based on macrobotanical remains from deposits of Lower and Middle substages [5,6]. Palynologically Sarmatian deposits were not studied. There was only one work devoted to study of core material from boreholes of the central part of Kartli depression [7]. In spite of poorness of palynoflora (28 forms) the assemblages of three stages of Sarmatian were distinguished. Now we possess rich palynological material [8-10] from outcrops on the territory of Kartli (Aragvi, Nadarbazevi) and Kakheti (Davidgareji, Gombori). In the composition of flora about 200 forms belonging to 130 genera and 88 families are determined. Besides, palynomorphs were seen in deposits of the entire Sarmatian. So, the use of palynological method broadens the outlook both about the composition of flora and dynamics of the vegetation cover. On the basis of this material a palynological diagram was built, which reflects the changes of percentage contents of separate groups of plants, joined according to their ecological - climatic requirements.

The analysis of the diagram allows to trace the dynamics of vegetation directed mainly to the reduction of forests and the expansion of woodless areas. These changes were connected with the decrease of humidity. This process acquired the most distinct character in Late Sarmatian, especially in Kartli. In Kakheti (area of Gombori) it was not so drastic.

The changes in composition of pollen assemblages allow to distinguish 5 phases in dynamics of vegetation, which are represented completely in Aragvi section [9].

Phase I corresponds to the upper part of the Early Sarmatian. It is represented in Aragvi and Nadarbazevi sections and probably in Gombori. In this time on the territory of Eastern Georgia the polydominant forest predominated. In its composition were pine, thermophilic conifers and leaf-bearing trees, among which the subtropical plants and plants of warm-temperate climate had an equal part. In comparison with the following stretch of time the humidity was somewhat lower, being indicated by high percentage contents of pollen grains of pine and grasses.

Phase II corresponds to the lower part of the Middle Sarmatian and is represented in all outcrops studied. Most completely it is reflected by pollen assemblages of the Nadarbazevi section. In the II phase the area of subtropical ferns and trees expanded noticeably, whose systematical composition was very rich. The role of pine and xerophytes was decreased. The II phase can be considered as climatic optimum, with comparable high humidity.

Phase III, which in the sections of Aragvi and Davidgareji corresponds to the middle part of the Middle Sarmatian significantly differed from the previous one. The composition of thermophilic conifers, leaf-bearing trees and ferns was impoverished; the territory of their distribution was also reduced. The role of pine and the area of xerophytic vegetation were increased. These changes were probably connected with the process of xerophytisation, which had oscillating character. This is confirmed by the composition of the vegetation of the next phase.

Phase IV of development of flora and vegetation was distinguished in the sections of Aragvi, Nadarbazevi and Davidgareji, where it corresponds to the uppermost part of the Middle Sarmatian. During this time the role of thermophilic trees rose again but on the whole the flora was impoverished.

Phase V corresponds to the lower part of the Late Sarmatian when, by the data of Buleishvili [1], on the territory of Eastern Georgia continued to preserve water basins. The sea divided into separate small lakes, poorly connected with each other. Such supposition is confirmed by data of palynology. The Upper Sarmatian deposits of the sections studied contain a great enough number of palynomorphs, whose accumulation was possible only in water conditions. Phase V is characterized: by a sharp increase of the role of xerophytes in the composition of vegetation; by reduction of leaf-bearing plants and conifers, among which the pine predominated. We suppose that the subtropical plants whose pollen grains occur in palynological assemblages of Upper Sarmatian deposits were represented by shrub forms. *Disanthus cercidifolius* Maxim. var. minor Shat. et Mched. [11] can be cited as an example. The pollen grains of this form are of much smaller sizes than those of the species *Disanthus cercidifolius* Maxim. Probably, it was a shrub that developed under the influence of dry climate, unfavorable for this plant.

The Sarmatian deposits of Eastern Georgia were studied by the micropaleontological method [2,3, 12,13]. In the lower part of Early Sarmatian the foraminiferal assemblages are characterized by *Quingueloculina, Sinuloculina, Varidentella, Affinetrina, Nonion, Elphidium, Porosononion* and *Ammonia. Bolivina, Discorbis, Bulimina, Cibicides* and *Fissurina* are relatively rare. Their morphology does not differ noticeably from that displayed by their Middle Miocene ancestors. These forms are also characterized by small sizes, and sometimes, transparent walls. The lower part of Early Sarmatian is distinguished as the layers with *Varidentella reussi*. They reflect the first phase of development of foraminifera.

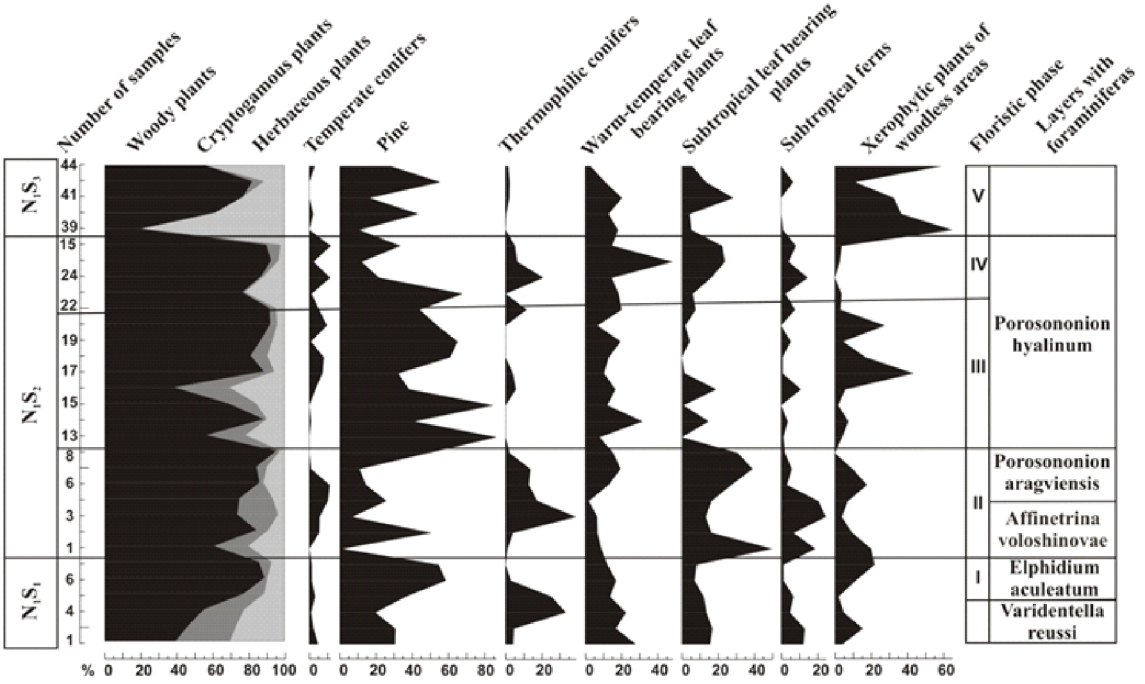

Fig. 2. Comparison of flora and microfauna development phases during the Sarmatian on the territory of Eastern Georgia.

Assemblages from the upper part of Early Sarmatian are characterized by reduced diversity because of the disappearance of *Bolivina, Discorbis, Cibicides*. Nevertheless, a large number of genera survived and adapted to the new environment. They are characterized by strong intraspecific variability and a potential for a speciation. The upper part of Early Sarmatian is distinguished as the layers with *Elphidium aculeatum*. They reflect the second phase of development of Early Sarmatian foraminifera.

By the data on microfauna the Middle Sarmatian is divided into three parts. The first is characterized by foraminiferal assemblages very different from those observed in the Early Sarmatian. The new genera, such as *Dogielina, Meandroloculina, Sarmatiella*, contributed a considerable number of species. Foraminifers of these assemblages are characterized by comparatively large sizes.

The richest assemblages of endemic foraminifera characterize the second part of the Middle Sarmatian, with the number of individuals and new species and their size reaching the maximum.

The third part of the Middle Sarmatian is distinguished for a decrease in the abundance of foraminiferal genera, species and individuals. Because of the worsening of bionomic conditions only very few representatives of most euryhaline families survived: *Elphidium, Porosononion, Ammonia* and very seldom *Affinetrina* and *Varidentella*. Among them *Porosononion* is characterized by large size and additional ornamentations on very coarse walls of tests. The lower part of the Middle Sarmatian is identified as layers with *Affinetrina voloshinovae*; the middle part - as layers with *Porosononion aragviensis* and the upper - as layers with *Porosononion hyalinum.*

Some species of genera *(Elphidium, Nonion, Porosononion, Ammonia)* of Middle Sarmatian assemblages also occur in Upper Sarmatian. These forms show deformation, irregular cameras or immature shell development and are presented only in some parts of the Late Sarmatian basin. The above-mentioned anomalies of shells point to the existence of nonoptimal conditions for foraminifera.

The phase of development of flora and vegetation of Eastern Georgia during the Sarmatian were

compared with those of foraminifera (Fig.2). In sections Nadarbazevi and Aragvi the I - floristic phase corresponds to the deposits directly underlying the Middle Sarmatian. On the basis of this we correlate it with the second phase of development of Early Sarmatian foraminifera. The conditions of this time were not optimal, either for flora, or for foraminifera.

In the development of flora and foraminifera during the Middle Sarmatian three phases are distinguished but in terms of time they do not coincide completely. The appearance of new taxa and increase of test sizes served as the common sign of the first and second phases of development of foraminifera. In the second phase these phenomena were more distinct, indicating the existence of optimal conditions. We correlated both microfaunistic phases with phase II of development of flora and vegetation, which reflects the conditions of climatic optimum.

Phases III-IV, when the impoverishment of Middle Sarmatian flora took place, can be correlated with the third phase of development of Middle Sarmatian foraminifera. It was characterized by a decrease of the number of genera, species and individuals.

The V - floristic phase, in our opinion, corresponds to the lower part of the Upper Sarmatian. It was characterized by sharp changes in the composition of marine and terrstrial biocenoses and in the conditions of their existence. Similar phenomena happened also in other regions of Eastern Paratethys. The sections of Azerbaijan, South Ukraine, the Crimea and some other regions of the Pre-Caucasus are characterized only by euryhaline forms: *Ammonia, Elphidium, Nonion* indicate the brackish conditions of Late Sarmatian basins [2].

The paleofloristic data also indicate changes of environmental complex in Upper Sarmatian on the territory of South-western Ukraine. Here began the formation of steppes, which periodically gave way to forest landscape [14]. The flora of South-eastern Ukraine and of the south part of the Russian plain was also impoverished. In the opinion of Ananova [15] here in Late Sarmatian and Meotian began the phase of "borealization~ of Miocene flora but the main time of disappearance of most of thermophilous and hygrophilous plants was the Middle Sarmatian.

Thus, the use of the palynological method allows to trace the history of the flora, vegetation and climate of Eastern Georgia during the Sarmatian and distinguish the phases of their development. The main signs, used by us as the basis were: the reduction of forest areas; the decrease of the part of hygrophilous subtropical plants in the composition of the flora; the expansion of woodless areas. The climate was the main factor influencing the development of flora and vegetation. Xerophytisation, which began in the Middle Sarmatian, acquired a more drastic character in the Late Sarmatian, when the predominance of xerophytic vegetation began in the larger part of Eastern Georgia.

The comparison of floristic phases with phases of development of foraminifera revealed a definite similarity in the dynamics of terrestrial and marine biocenoses, connected, mainly with the deterioration of habitation conditions both for thermophilous and hygrophilous plants and foraminifera. Probably, the main reason was the changes in the paleogeographical situation. As a result of tectonical movements on the boundary of the Middle and Late Sarmatian the Transcaucasus depression transformed into dry land with two great regions, divided by the Dzirulian Block. On the West, in the Colchis refugium, the humid and warm climate, favorable for development of subtropical flora was preserved. In the East began the process of xerophytisation, connected with common phenomenon that took place beyond the boundaries of the Caucasus. The decrease of sea and the appearance of freshwater basins was fatal for foraminifera, the main part of which became extinct on the boundary of the Middle and Upper Sarmatian nearly in the whole Eastern Paratethys.

The identified phases of development of flora and foraminifera can be used for division of the Sarmatian deposits of Eastern Georgia into small stratigraphic units.

პალეობიოლოგია

აღმოსავლეთ საქართველოს სარმატული ნალექების პალინოლოგიური და მიკროფაუნისტური კვლევის შედეგების შეპირისპირება

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(წარმოდგენილია აკადემიის წევრის ა. ვეკუას მიერ)

აღმოსავლეთ საქართველოს სარმატული ნალექების პალინოლოგიური მეთოდით შესწავლამ შესაძლებელი გახადა თვალი გავადევნოთ ფლორის მცენარეულობისა და კლიმატის ცვალებადობის ისტორიას და გამოვყოთ მათი განვითარების ეტაპები სარმატული საუკუნის განმავლობაში. ეტაპების დასადგენად ძირითად კრიტერიუმად გამოყენებულია მცენარეულობის შემადგენლობაში ტყის ფორმაციების და ტენიანობის მოყვარული სახეობების რაოდენობის შემცირება, რაც უტყეო სივრცის არეალის გაფართოებას იწვევდა.

ფლორისა და მცენარეულობის განვითარებაზე გავლენის ძირითად ფაქტორად ითვლება კლიმატური პირობები. დადგინდა, რომ შუასარმატულის ბოლოს იწყება ქსეროფიტიზაციის პროცესი, რომელმაც შედარებით მკვეთრი ხასიათი მიიღო გვიანსარმატულში. ამ პერიოდში აღმოსავლეთ საქართველოს ტერიტორიის დიდ ფართობზე ქსეროფიტული მცენარეულობა გაბატონდა.

ფლორისტული ეტაპების შეპირისპირებამ ფორამინიფერების განვითარების ეტაპებთან გამოავლინა გარკვეული მსგავსება ხმელეთისა და ზღვის ბიოცენოზების დინამიკაში, განსაკუთრებით გარემოს გაუარესების პირობებში. ცნობილია, რომ შუა და ზედასარმატულის საზღვარზე განვითარებულმა ოროგენეტურმა პროცესებმა შეცვალა პალეოგეოგრაფიული გარემო ამიერკავკასიაში. საქართველოს ტერიტორია ძირულის მასივით ორ დიდ რეგიონად გაიყო. დასავლეთით (კოლხეთის რეფუგიუმი) შენარჩუნდა თბილი და ტენიანი ჰავა, რამაც განაპირობა სუბტროპიკული მცენარეულობის გადარჩენა. აღმოსავლეთით კი დაიწყო ქსეროფიტიზაციის პროცესი (რომელმაც მოიცვა კავკასიის ჩრდილოეთით მდებარე ტერიტორიები). ზღვის ფართობის შემცირებამ და ცალკეული განმარილიანებული დაბშული აუზების გაჩენამ დამღუპველი პირობები შეუქმნა ფორამინიფერებს, რამაც შუა და ზედასარმატულის საზღვარზე ფორამინიფერების დიდი უმრავლესობის ამოწყდომა გამოიწვია.

ხმელეთისა და ზღვის ბიოცენოზების დადგენილი ეტაპები შეიძლება გამოყენებული იყოს აღმოსავლეთ საქართველოს სარმატული ნალექების უფრო დეტალურ სტრატიგრაფიულ ერთეულებად დანაწილებისათვის.

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