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Palaeobiology

Palynological Investigations of Sarmatian Deposits of Mtskheta District (Kartli, Eastern Georgia)

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ABSTRACT. The Sarmatian deposits in the vicinity of the town of Mtskheta were studied by palynological method. All layers of the section contain pollen and spores. Of great interest is the presence of palynomorphs in Upper Sarmatian deposits, a large part of which on the territory of Kartli is represented by continental sediments.

Key words: *Kartli, Sarmatian, palynomorphs, vegetation, climate.*

Sarmatian deposits are widely distributed on the territory of Eastern Georgia (Fig.1). By faunistical and lithological data they are divided into three substages: Volhinian, Bessarabian and Khersonian.

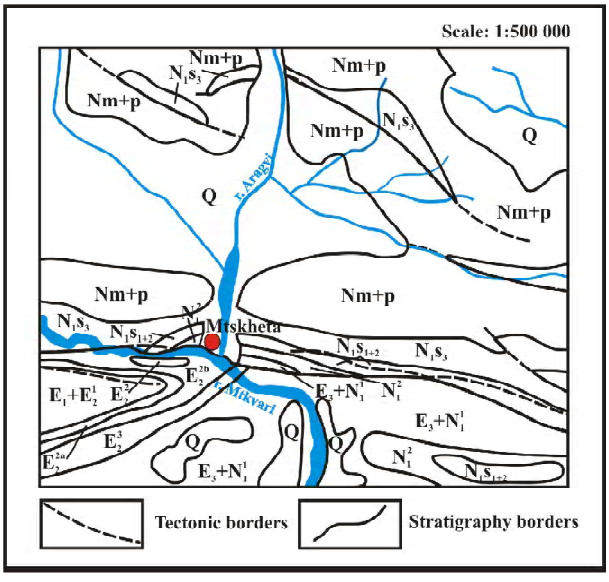

Fig. 1. Geological map of Mtskheta region [2].

On the territory of Kartli the Lower Sarmatian is conformably bedding on the Konkian deposits and is represented by clayey sediments with intercalations of limestones and sandstones. Lower Sarmatian is characterized well by fauna [1].

The deposits of Middle Sarmatian are comfortably bedding on Lower Sarmatian. They are represented by blue-grayish or green-grayish clays with rich fauna of mollusks [1].

In the Kartli depression the Upper Sarmatian is represented by fresh-water continental deposits of so-called Natskhorian suite. In some sections it is divided into two parts: lower – clayey sandstone and upper, built of sandy clay deposits [1].

On the territory of Kartli one of the full sections of Sarmatian deposits is situated in the vicinity of the town of Mtskheta. Recently it was studied by Koiava [3]. He began the description of layers from the Aragvi valley, where the Lower Sarmatian is represented by clayey sandstone deposits with remains of macrofauna [1, 4].

The Middle Sarmatian deposits are cropped out on the left bank of the Aragvi in the vicinity of Bebristsikhe. From this locality the rich assemblage of foraminifers

was described by Koiava [3]. By the data of this author, different layers of Middle Sarmatian are represented here. The big sizes of shells of *Porosononion subgranosus hyalinus* (Bogd.), the number of individuals and absence of other representatives of this genus, point to the presence in the Bebristsikhe section of the upper layers of Middle Sarmatian. The boundary between Middle and Upper Sarmatian in this section presumably is drawn according to the appearance of the lenses of conglomerates, pointing to the change in the cycle of sedimentation [3].

The same Aragvi-Bebristsikhe section was described by us and samples for palynological analysis were collected. Below is given the list of plants whose spores and pollen grains were found in the deposits of Lower, Middle and Upper Sarmatian (Table 1).

The Sarmatian deposits of Mtskheta region are characterized by rich spore-pollen assemblages. In its composition 113 forms belonging to 10 classses, 72 families and 79 genera were determined. Between Lower and Middle Sarmatian there are no differences. In both parts the composition of flora is nearly the same. Much poorer is the flora of Late Sarmatian, in which the total number of components decreases. The impoverishment of flora occurred at the expense of thermophilous plants - ferns, conifers and angiosperms (Tables 1, 2).

Table 1.

Common list of the Sarmatian flora.

Class	Family	Species	Lower	Middle	Upper
Bryopsida	Sphagnaceae	Sphagnum sp.		p	
Lycopodiopsida	Lycopodiaceae	Lycopodium sp.	p	p	
Isoëtopsida	Selaginellaceae	Selaginella sp.	p		
Ophioglossopsida	Ophioglossaceae	Botrychium sp.		p	
		Ophioglossum sp.		p	
Polypodiaceae	Schizaeaceae	Schizaeaceae gen.indet.	p	p	
	Anemiaceae	Anemia sp.	p	p	
		Mohria sp.		p	
	Lygodiaceae	Lygodium multivalatum (W.Kr.) Ram.		p	
		Lygodium sp.	p	p	p
	Pteridaceae	Pteridacidites verus (Mtchedl.) Shat., Stuch.		p	
		Pteridacidites vittatoides Shat., Stuch.	p		
		Pteris sp.	p	p	p
	Adianthaceae	Onychium sp.	p		
	Gleicheniaceae	Clavifera sp.		p	
		Gleichenia sp.	p	p	p
		Gleicheniaceae gen.indet.		p	
	Polypodiaceae	Polypodium verrucatum Ram.	p	p	
		Polypodium sp.	p	p	p
		Polypodiaceae gen.indet.	p	p	p
	Hymenophyllaceae	Hymenophyllum sp.	p		
	Dicksoniaceae	Dicksonia sp.	p		p
	Cyatheaceae	Cyathea sp.	p	p	p
	Aspidiaceae	Dryopteris sp.	p		
Ginkgoopsida	Ginkgoaceae	Ginkgo sp.	p	p	
Pinopsida	Podocarpaceae	Dacrydium sp.	p	p	
		Podocarpus sp.	p	p	
	Pinaceae	Abies sp.	p	p	
		Cedrus sp.	p	p	p
		Keteleeria caucasica Ram.	p		
		Picea sp.	p	p	p
		Pinus sp.	p	p	p
		Tsuga sp.	p	p	p
	Sciadopityaceae	Sciadopitys sp.		p	
	Taxodiaceae	Taxodiaceae gen.indet.	p	p	p
	Cupressaceae	Cupressaceae gen.indet.	p	p	p
Ephedropsida	Ephedraceae	Ephedra sp.	p		

Dycotyledoneae	Myricaceae	Comptonia sp.	p	p	p
		Myrica sp.	p	p	p
	Juglandaceae	Carya sp.	p	p	p
		Engelhardia sp.	p	p	
		Juglans cinerea L.		p	
		Juglans regia L.		p	
		Juglans sp.	p	p	p
		Platycarya sp.	p	p	
		Pterocarya sp.	p	p	p
	Betulaceae	Alnus sp.	p	p	p
		Betula sp.	p	p	p
		Carpinus betulus L.	p		
		Carpinus caucasica Grossh.	p	p	p
		Carpinus orientalis Mill.	p	p	p
		Carpinus sp.	p	p	p
		Corylus sp.	p	p	p
	Fagaceae	Castanea sp.	p	p	p
		Castanopsis sp.	p	p	p
		Fagus sp.	p	p	p
		Quercus sp.	p	p	p
	Ulmaceae	Celtis sp.		p	p
		Ulmus sp.	p	p	p
	Eucommiaceae	Eucommia sp.	p		
	Moraceae	Moraceae gen.indet	p	p	p
	Caryophyllaceae	Caryophyllaceae gen.indet.		p	
	Chenopodiaceae	Chenopodiaceae gen.indet.	p	p	p
	Tamaricaceae	Tamarix sp.		p	p
	Magnoliaceae	Magnolia sp.	p	p	p
	Saxifragaceae	Saxifragaceae gen.indet.			p
	Berberidaceae	Berberidaceae gen.indet			p
	Ranunculaceae	Ranunculus sp.	p	p	
	Platanaceae	Platanus sp.		p	p
	Hamamelidaceae	Corylopsis sp.		p	
		Disanthus sp.	p	p	
		Fothergilla sp.	p	p	
	Rosaceae	Rosaceae gen.indet.	p	p	p
	Geraniaceae	Geranium sp.			p
	Fabaceae	Fabaceae gen.indet.	p		
	Anacardiaceae	Rhus sp.		p	p
	Aceraceae	Acer sp.	p	p	
	Hippocastanaceae	Aesculus sp.		p	
	Aquifoliaceae	Ilex sp.		p	p
	Rhamnaceae	Rhamnus sp.			p
	Vitaceae	Vitis sp.		p	
	Celastraceae	Euonymus sp.			p
	Tiliaceae	Tilia sp.	p	p	p
	Elaeagnaceae	Elaeagnus sp.	p		
	Violaceae	Viola sp.		p	
	Myrtaceae	Eucalyptus sp.	p	p	
		Myrtaceae gen.indet.	p	p	
	Nyssaceae	Nyssa sp.	p	p	p
	Cornaceae	Cornaceae gen.indet.	p	p	p
	Araliaceae	Acanthopanax sp.	p		
		Brassaiopsis sp.		p	
		Araliaceae gen.indet.	p	p	p

Dycotyledoneae	Apiaceae	Apiaceae gen.indet.	p	p	p
	Ericaceae	Ericaceae gen.indet.	p	p	
	Sapotaceae	Sapotaceae gen.indet.	p		
	Symplocaceae	Symplocos sp.		p	
	Apocynaceae	Apocynaceae gen.indet.		p	
	Oleaceae	Fraxinus sp.	p		
	Convolvulaceae	Convolvulus sp.			p
	Caprifoliaceae	Viburnum sp.			p
	Lamiaceae	Lamiaceae gen.indet.	p		
	Plantaginaceae	Plantago sp.	p	p	p
	Valerianaceae	Valeriana sp.		p	
	Campanulaceae	Campanulaceae gen.indet.		p	
	Dipsacaceae	Knautia sp.		p	
	Asteraceae	Artemisia sp.		p	p
		Cichorium sp.	p	p	p
		Asteraceae gen.indet.	p	p	p
Monocotyledoneae	Poaceae	Poaceae gen.indet.	p	p	p
	Arecaceae	Arecaceae gen.indet.	p	p	
	Sparganiaceae	Sparganium sp.	p		
Artificial taxa		Fupingopollenites wackersdorfensis (Thiele-Pfeiffer) Liu Geng-wu		p	p
		Tricolporopollenites edmundi (R.Pot.) Th. et Pf.		p	

The percentage contents of pollen and spores is given in the diagram (Fig.2), in which separate plants are grouped according to their ecology and distribution at different levels of relief, excepting the pine which is an azonal plant. Judging by the diagram, forest was the main formation of vegetation cover. Among conifers the predominant tree was the pine, which was distributed on all levels of relief. The dark conifers (*Picea, Abies, Tsuga*) occupied a rather small territory, probably far from the basin of accumulation.

Vast territories were covered by polydominant forests of subtropical and warm-temperate plants. Their distribution depended on the character of relief and distance from the marine basin. The dominants of forests were the representatives of the families *Taxodiaceae, Podocarpaceae, Juglandaceae, Myricaceae, Betulaceae, Moraceae, Fagaceae, Araliaceae.* The lower layers of forests were composed of subtropical ferns: *Anemia, Mohria, Gleichenia, Polypodium, Dicksonia, Cibotium.* Among ferns there were forms determined by artificial system.

The Lower Sarmatian deposits on the Aragvi river (Fig.2, samples 1-7) are characterized by rich spore-pollen assemblages, reflecting the existence of forests in conditions of warm climate, close to subtropical. At the beginning of Lower Sarmatian the area of pine was small. Vast territories were covered with thermophilic conifers, especially representatives of the family *Podocarpaceae.* Large, almost equal areas were held by subtropical and thermophilic broad-leaved trees. The generic composition of subtropical ferns was very rich.

The character of spore-pollen assemblages differed in the overlying deposits of Middle Sarmatian (Fig.2, samples 8-12), in which the quantity of grasses decreases and the number of thermophilic plants – trees and ferns – is comparable high.

Table 2.

Number of taxa in the composition of Sarmatian flora.

Systematic units	The total number			Number of Cryptogams			Number of Gymnosperms			Number of Angiosperms		
	Low.	Mid.	Up.	Low.	Mid.	Up.	Low.	Mid.	Up.	Low.	Mid.	Up.
Form (species)	76	89	56	16	18	7	12	11	6	48	60	43
Genus	54	64	41	13	13	6	10	9	4	31	42	31
Family	49	54	38	13	10	6	6	6	3	30	38	29
Class	8	8	4	3	4	1	3	2	1	2	2	2

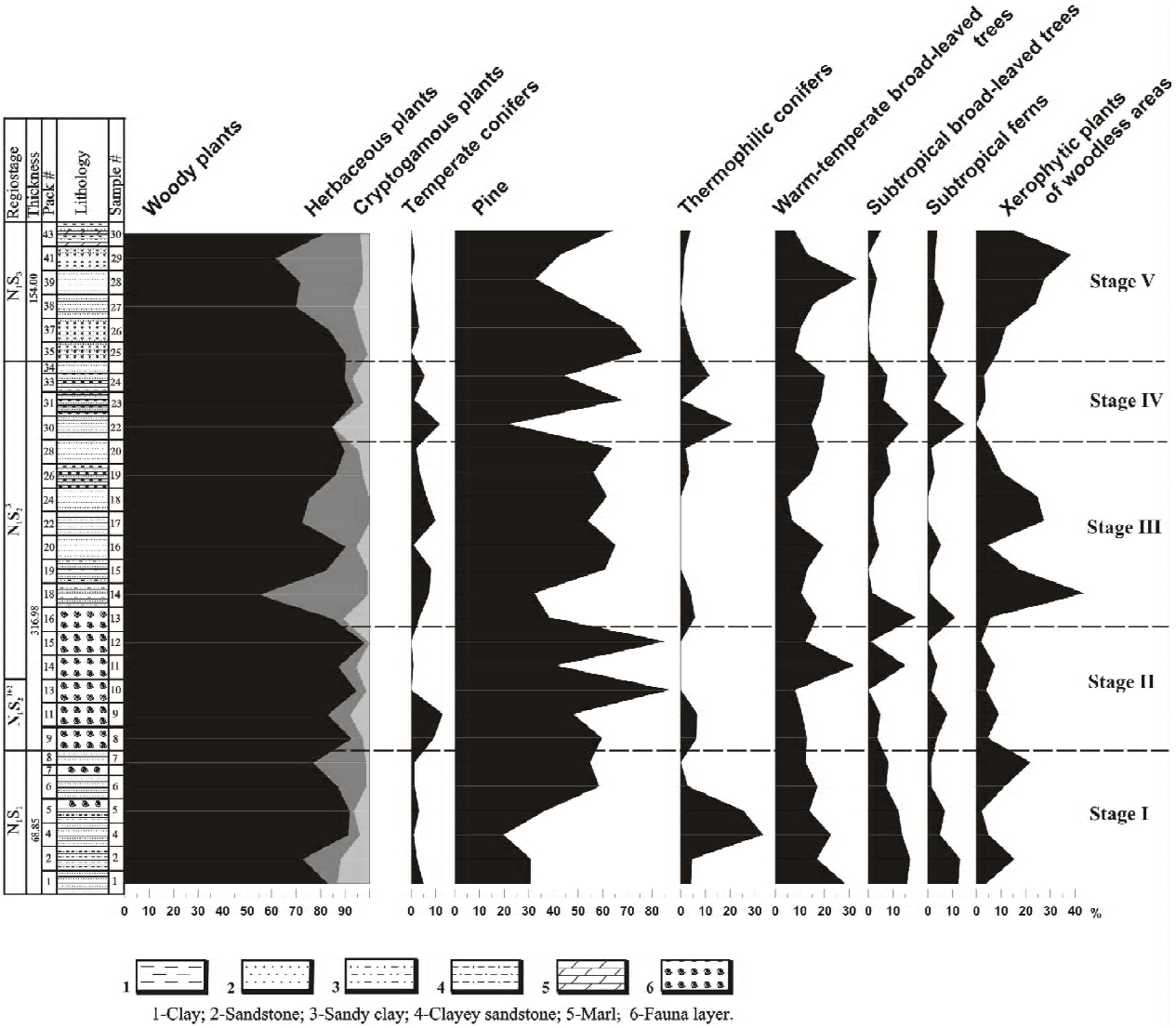

Fig. 2. The fluctuation of percentage contents of pollen grains in the composition of spore-pollen assemblages of Sarmatian deposits on the territory of Mtskheta district. The age of layers is determined by Siradze [4], Buleishvili [1] and Koiava [3].

The spore-pollen assemblages of the middle part of Middle Sarmatian (Fig.2, samples 13-20) reflect the increase of grasses and decrease of subtropical trees and ferns.

The upper part of Middle Sarmatian (Fig.2, samples 22-24) differs by full predominance of rich polydominant forests with subtropical and temperately thermophilic components.

According to the character of palynoflora in Late Sarmatian (Fig.2, samples 25-30) the area of forest diminished. The part of subtropical plants was minimal in its composition. The area of herbs significantly increased, especially of representatives of families of *Poaceae, Chenopodiaceae* and *Asteraceae* (genus *Artemisia*).

On the whole, the analysis of spore-pollen assemblages of Aragvi-Bebristsikhe sections allows to trace the dynamics of vegetation and climate and establish five stages of development.

On the basis of palynological data, it is possible to conclude that the main climatic factor that influenced the development of vegetation on the territory of Kartli was the regime of humidity. As is known, the end of Middle Sarmatian was the turning-point in the Neogene history of the Caucasus, when intensive orogenic movements led to significant paleogeographical changes [5, 6]. The area of the marine basin decreased and the territory of Eastern Georgia transformed into dry land. Fresh-water basins survived only here or there, where the near-shore deposits with poor fauna of mollusks were accumulated.

According to our data, the process of xerophytisation on the territory of Kartli began in the Middle Sarmatian

and was of oscillating character, expressed in the alternation of stages with different humidity. During stage III, characterized by low humidity, the area of forest formation shrank and the expansion of herbs began. This phenomenon assumed a more drastic character in Late Sarmatian (stage V) expressed in the composition of flora and peculiarities of vegetation. The area of herbs extended. The main components of forest were the pine and deciduous plants, their majority presumably being shrubs. These data confirm the conclusion on the existence of steppes and semi-deserts on the territory of Kartli in Late Sarmatian and subsequent stages of the Pliocene [7, 8].

Thus, the use of the palynological method allowed us to trace the process of consistent replacement of forest vegetation with xerophilous vegetation, which began to predominate on the territory of Eastern Georgia after the Middle Sarmatian. During this process five stages of development of vegetation and climate took shape, differing mainly in the regime of humidity. The climate of stages I, II and IV was warm, humid, close to subtropical. The climate of stage III and, especially, of stage V was characterized by low humidity, being the main reason of radical change of vegetation on the territory of Eastern Georgia.

The identified stages of development of vegetation and climate can be considered as the basis for the subdivision of Sarmatian deposits of Kartli into small stratigraphical units – palynozones.

პალეობიოლოგია

მცხეთის რეგიონის (აღმოსავლეთ საქართველო, ქართლი) სარმატული ნალექების პალინოლოგიური კვლევა

ი. შატილოვა*, ნ. მჭედლიშვილი*, ი. კოკოლაშვილი**

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(წარმოდგენილია აკადემიის წევრის ა. ვეკუას მიერ)

სარმატული ნალექები ფართოდაა გავრცელებული აღმოსავლეთ საქართველოს ტერიტორიაზე. ერთ-ერთი სრული ჭრილი, რომელიც ქ. მცხეთის მიდამოებში მდებარეობს, იწყება მდ. არაგვის ზეობიდან, სადაც ქვედა სარმატული წარმოდგენილია მაკროფაუნის ნაშთების შემცველი თიხიან-ქვიშაქვიანი ნალექებით. შუასარმატული ნალექები შიშვლდება მდ. არაგვის მარცხენა ნაპირზე, ბებრისციხის მიდამოებში, და დახასიათებულია ფორამინიფერების მდიდარი კომპლექსით. საზღვარი შუა და ზედა სარმატულს შორის ამ ჭრილში, სავარაუდოდ, გატარებულია კონგლომერატების ლინზების გამოჩენის მიხედვით, რაც სედიმენტაციის ციკლის ცვლილებაზე მიუთითებს.

აღნიშნული ჭრილი შესწავლილ იქნა პალინოლოგიური მეთოდით. პალინოკომპლექსის შემადგენლობაში განსაზღვრულია 113 ფორმა, რომლებიც 10 კლასს, 72 გვარსა და 79 ოჯახს მიეკუთვნება. ქვედა და შუა სარმატულს შორის დიდი სხვაობა არ არის; ორივე ნაწილში ფლორის შემადგენლობა დაახლოებით ერთნაირია. გაცილებით ღარიბია ზედა სარმატულის ფლორა, რომელშიც კომპონენტთა საერთო რაოდენობა მცირდება. ფლორის გაღარიბება მოხდა თერმოფილური მცენარეების ხარჯზე. პალინოლოგიური კვლევის შედეგები დატანილ იქნა დიაგრამაზე. დიაგრამის ანალიზი საშუალებას გვაძლევს თვალი გავადევნოთ ტყის მცენარეულობის თანმიმდევრულ შეცვლას ქსეროფიტული მცენარეულობით, რომლის გაბატონება აღმოსავლეთ საქართველოს ტერიტორიაზე შუა სარმატულის შემდეგ დაიწყო. ამ პროცესის განმავლობაში დადგენილ

იქნა ჰავისა და მცენარეულობის განვითარების ოთხი ეტაპი, რომლებიც ერთმანეთისგან ტენიანობის რეჟიმით განსხვავდება. I და III ეტაპების ჰავა თბილი, ნოტიო, სუბტროპიკულთან მიახლოებული იყო. II და, განსაკუთრებით, IV ეტაპების ჰავა დაბალი ტენიანობით ხასიათდებოდა, რაც აღმოსავლეთ საქართველოს ტერიტორიაზე მცენარეულობის რადიკალური შეცვლის ძირითად მიზეზს წარმოადგენდა.

ჰავისა და მცენარეულობის განვითარების გამოყოფილი ეტაპები შეიძლება განვიხილოთ როგორც ქართლის სარმატული ნალექების წვრილ სტრატიგრაფიულ ერთეულებად – პალინოზონებად – დანაწილების საფუძველი.

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