საქართველოს მეცნიერებათა ეროვნული აკადემიის მოამბე, ტ. 13, №1, 2019
BULLETIN OF THE GEORGIAN NATIONAL ACADEMY OF SCIENCES, vol. 13, no. 1, 2019

Palaeobiology

The Palaeobiological Basis of the Stratigraphical Subdivision of Meotian Deposits of Abkhazia (Pollen and Foraminifera)

Ira Shatilova[*], Lamara Maissuradze[*], Irma Kokolashvili[**], Angela A. Bruch[§]

[*] *Institute of Palaeobiology, Georgian National Museum, Tbilisi, Georgia*
[**] *Georgian Technical University, Tbilisi, Georgia*
[§] *ROCEEH Research Centre, Senckenberg Research Institute, Frankfurt/M, Germany*

(Presented by Academy Member David Lordkipanidze)

ABSTRACT. The pollen and foraminifera of Meotian deposits of Abkhazia were studied with the samples taken from the sections Gedjiri, Galidzga, Otapi and Gudou dated by molluska and microfauna. The Meotian flora of Abkhazia consists of nearly 190 elements, belonging to 82 families and 124 genera. Their distribution was connected with a vertical zonality of relief, which in the Meotian was already well developed. The climate of Abkhazia on the coastal plains and in the lower mountain belt was subtropical. With higher altitudes it changed to warm and warm-temperate conditions. In the development of vegetation during the Meotian two main staged can be distinguished. In Early Meotian the predominant components of forest were subtropical conifers and angiosperms. In the Late Meotian subtropical and warm-temperate plants had a nearly equal share in the composition of forest communities. Also, in the development of foraminifera assemblages two stages are distinguished. In Early Meotian the species that have a broad tolerance of salinity giving them the possibility to live in basins with different conditions were more abundant. Due to the interruption of oceanic connection the salinity of the Late Meotian Sea decreased and as a result, a large number of marine foraminifera became extinct and euryhaline species and Ostracoda became predominant. *© 2019 Bull. Georg. Natl. Acad. Sci.*

Key words: Meotian, Abkhazia, pollen assemblages, flora, vegetation, foraminifera

The boundary between Sarmatian and Meotian was a turning-point in the geological history of the Caucasus. As a result of crustal movements, the Transcaucasian intermountain depression, which during the Early and Middle Miocene was covered by sea, transformed into dry land, split into two parts by the Dzirula Massif. In the Late Sarmatian, in the East the Kura Bay formed and the adjoining territory of Georgia became dry land, on the most part of which the accumulation of continental deposits began. In the West the Rioni Bay developed, where marine deposits continued to accumulate until the end of the Pleistocene. Today this is a stratotypical region of Eastern Parathetys,

where the Black Sea Upper Cenozoic is represented by full series of deposits.

The boundary between Sarmatian and Meotian also was a turning-point in the history of the vegetation of Georgia. The territory adjoining the Rioni Bay surrounded by high mountains, became isolated from the rest of the Caucasus. A warm and humid climate prevailed here, supporting the preservation of rich forest vegetation. Thus, from the end of the Middle Sarmatian, the Colchis Refuge took shape with many Tertiary plants, surviving until present.

On the territory of Georgia marine deposits of Meotian stage are mainly known from Western Georgia. The Meotian is divided by faunistic data into two substages: Bagerovian and Akmanaian [1]. These Lower and Upper Meotian deposits were studied from four sections in Abkhazia. Samples were taken from outcrops Gedjiri (Lower Meotian), Galidzga (Lower and Upper Meotian), Gudou and Otapi (Upper Meotian), dated by molluska and foraminifera.In section Otapi the Upper Meotian is overlay by lower Pontian, the Eupatorian horizon [2].

The Characteristic of Pollen Assemblages

The Meotian flora from Abkhazia at first was described by Uznadze [3]. The fossil material came from two localities, near the village Agubedia and in the vicinity of the village Meore-Atara, on the left bank of river Kodori. Later the Kodorian locality was studied by Kolakovsky [4]. Further data about the Meotian flora of Abkhazia was published also by Chelidze and Kvavadze [5].

In spite of their rich systematical composition, spores of ferns compose only a small part of the total pollen assemblages. Relatively more frequent are the genera *Pteridacidites, Polypodium, Cryptogramma,* taxa which flourished up to Kimmerian on the territory of Western Georgia. The genera *Lygodium, Cibotium, Gleichenia,* typical representatives of Sarmatian and Middle Miocene floras are less abundant in the palynological assemblages.

Pollen of conifer plants are characterized by a high diversity, with a predominance of *Podocarpus, Dacrydium, Araucaria,Cedrus, Keteleeria,* representatives of the family Taxodiaceae (Fig.1).

The pollen assemblages of Meotian deposits of Abkhazia are characterized by high abundances of pollen grains of the family Hamamelidaceae. In the history of this family on the territory of Georgia three main stages can be distinguished. The first stage embraced the Eocene, Oligocene and Middle Miocene, when the flora included 4 genera: *Hamamelis,*

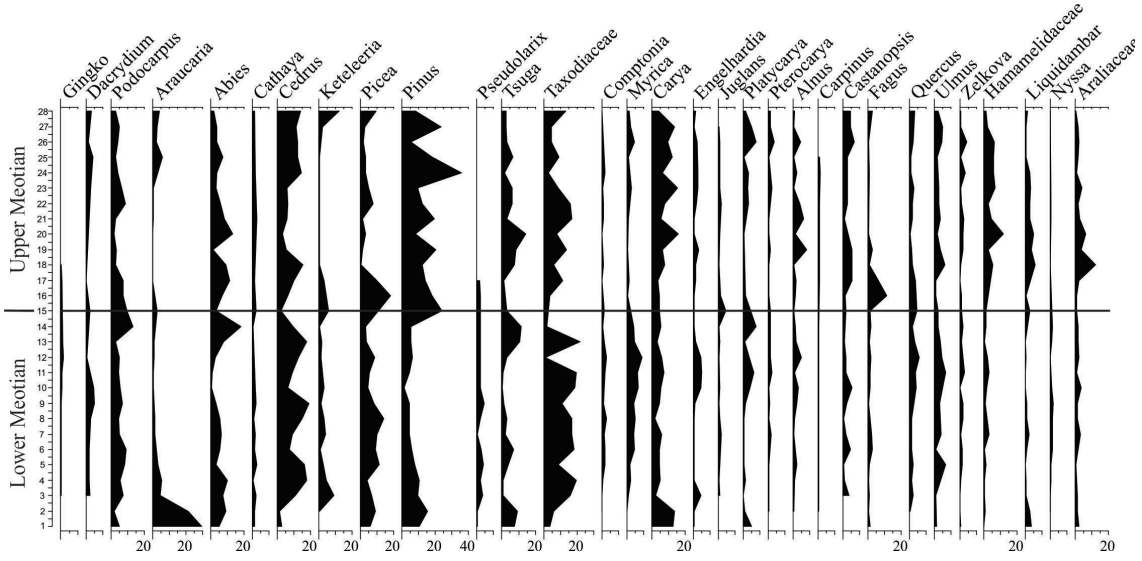

Fig. 1. The pollen diagram of Meotian deposits of Abkhazia.

Corylopsis, Sycopsis and *Liquidambar*. The second stage, Sarmatian and Meotian, may be considered as the peak of flourishing of the family, represented by 16 genera belonging to 3 subfamilies: Hamamelidoideae, Exbucklandioideae, Altingioideae. The third stage was the time of stepwise extinction. It extended throughout the whole Pliocene [6].

Also the presence of the species *Fupingopollenites wackersdorfensis* (Thiele-Pfeiffer) Liu Geng-wu is necessary to note. This unknown angiosperm plant, described only by pollen grains, was widely distributed on territory of Eurasia in Cenozoic and was connected to regions of humid, subtropical climate [7]. On the territory of Western Georgia *Fupingopollenites wackersdorfensis* is known until the end of the Meotian [8].

Judging by habitat conditions of recent plant-equivalents, we try to restore the vegetation cover on the territory of Abkhazia during the Meotian. Probably big areas were occupied by communities analogous to recent swamp forests, distributed today in regions with subtropical humid climate in the south-eastern part of North America. In the fossil composition occur *Taxodium, Carya, Nyssa, Liquidambar, Fothergilla* and other plants. At the same time, the assemblages comprise *Glytostrobus, Lauraceae, Dalbergia, Diospyros, Eugenia*, which are characteristic for coastal swamp forests of south-eastern China and Vietnam. The valleys of rivers were occupied by *Pterocarya, Ulmus* and *Alnus*, which also spread up the mountain slopes.

The lower belt of mountains was occupied by subtropical forests composed of evergreen and deciduous plants, representatives of families Lauraceae, Fagaceae, Araliaceae, Hamamelidaceae, Juglandaceae and others. In the middle belt the communities of warm-temperate conifers (*Araucaria*, *Cedrus, Cryptomeria, Cathaya, Keteleeria, Podocarpus, Dacrydium*) and broad-leaved plants (*Quercus, Carpinus, Juglans, Fagus, Zelkova, Tilia*) were distributed. Numerous ferns, *Dicksonia, Cibotium, Cyathea, Pteris, Polypodium, Cryptogramma, Gleichenia*, were part of both formations. But at whole the fern layer in Abkhazia was not as rich as in Guria.

The upper mountain belt was occupied by *Abies, Picea, Tsuga*. In the Sarmatian the distribution area of these plants was smaller than in the Meotian, when the conifer forest became a zonal type of vegetation. The main reasons of this phenomenon probably were orogenic movements at the end of the Middle Sarmatian, when the territory of Georgia turned into high mountain country.

On the basis of these data we attempt to restore the climatic conditions of the northern part of Colchis in Meotian. The whole composition of pollen assemblages was divided into groups according the climatic requirements of the plants. These are: temperate and warm-temperate conifers, subtropical and warm temperate broad-leaved plants, ferns and herbs.

During the Early Meotian the main part of flora is composed of subtropical broad-leaved plants and warm-temperate conifers, among which were the taxa with tropical roots passing in subtropical zone. Beside, among the conifers one of the main trees was *Podocarpus*, which now is a component of mountain forests in the tropical zone. Not less significant in the composition of assemblages is the presence of the pollen of *Araucaria*, which now is a component of subtropical rain forests in America, Australia and on Pacific islands [9]. In Late Meotian the picture somewhat changed and abundances of subtropical and warm-temperate plants became nearly equal (Fig.2).

Thus, in Meotian the climate of the northern part of Colchis was subtropical, humid in lower and middle mountain belts, with temperate conditions in the upper mountain zone. Judging by the low abundances of ferns the humidity was not as high as in the southern Colchis (Guria). Probably, this was connected with the process of xerophytization, which during the Sarmatian embraced the whole southern part of Russian plain [10] and may had some influence on the climatic conditions of Abkhazia due to its geographical position.

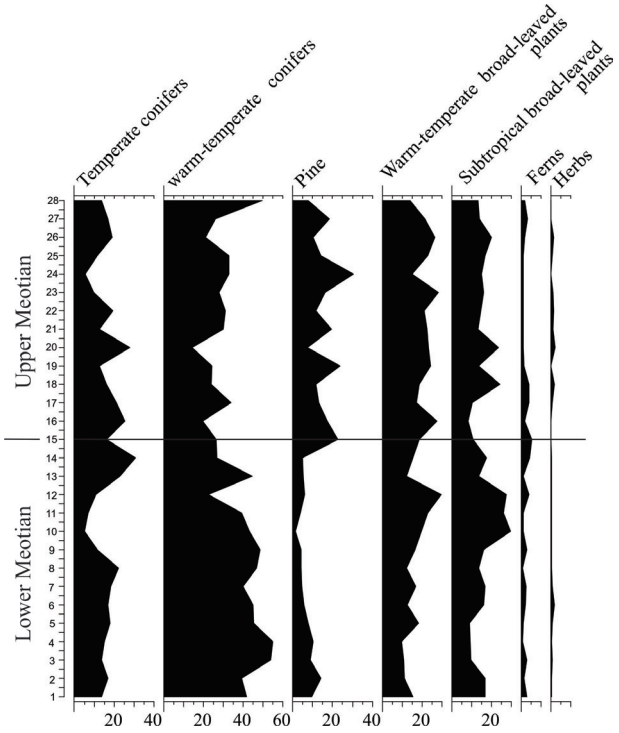

Fig. 2. Diagram of abundance of ecological groups of plants indicating changes in the major forest formations of Abkhazia during the Early and Upper Meotian.

The Microfaunistical Characteristic of Meotian Deposits

In the limits of the Black Sea-Caspian basin, Lower Meotian deposits of Western Georgia are distinguished by the composition of rich foraminifera assemblages. There are several works devoted to foraminifers of Meotian deposits of Abkhazia. Among them it is necessary to note the work of Bogdanowicz [11], who described some species of family Miliolidae from the Lower Meotian deposits of section Galidzga. Data about foraminifera from Meotian deposits of Abkhazia are also in the work of Imnadze [12]. The first monographic descriptions of foraminifera from Meotian deposits of Western Georgia belonging to 52 species, 8 families and 16 genera were published by Maissuradze [13].

The Early Meotian assemblages of foraminifera are composed of marine species of Mediterranean origin, which however already somewhat evolved from the initial Sarmatian taxa. Among them both widely and narrowly distributed species are present. A wide distribution have *Quinqueloculina seminulum maeotica, Cycloforina* aff. *gracilis*, *Sinoloculina* ex gr. *consobrina, Affinetrina* aff. *guriana, Porosononion* aff. *martkobi*, *P. subgranosus*, *Elphidium macellum, E. feodorovi*, *Ammonia* ex gr. *beccarii.* Species with narrow distribution are *Quinqueloculina akneriana*, *Q. vermicularis, Triloculina* aff. *intermedia*, and *Miliolinella circularis* [14].

Due to the interruption of oceanic connection the salinity of the Late Meotian Sea decreased and subsequently a large number of marine foraminifera disappeared. They were replaced by euryhaline species, predominantly *Ammonia beccarii-liliae* and Ostracoda.

The gradual extinction of foraminifera in the late Meotian led to their nearly total disappearance, with only a few species preserved in Pontian [2].

The stratigraphic distribution of foraminifera in Meotian deposits of Abkhazia is given below.

Table. The stratigraphic distribution of foraminifera in Meotian deposits of Abkhazia

Age of layers	Lower MeotIan			Upp er MeotIa n		
Name of sections	Otapi	Gedjiri	Galidzga	Otapi	Galidzga	Gudou
1	2	3	4	5	6	7
Cyclogyra atapica Maissuradze	X					
Hauerina iljinae Bogdanowicz	X	X	X			
H.tchelidzei Popchadze	X		X			
H. ex gr. *confusa* Serova	X	X				
Quinqueloculina iberiae Bogdanowicz	X	X	X			
Q. disparilis d'Orb.*galidzganensis* Bogd.	X	X	X			
Q. similiakneriana Didkowski	X	X	X			
Q. aff.*brauni* (Reuss)	X					
Q. lachesis Karrer	X					
Q. vermicularis Karrer	X	X	X			
Q. akneriana d'Orb.*maeotica* Maiss.	X					
Q. djanelidzeae Maissuradze	X					
Q. seminulum (Linné)*ukrainica* Didkow.	X			X		
Q. seminulum (Linné)*maeotica* Gerke.	X					
Q. aff. *postbadensis* Venglinski	X	X	X			
Flintina sp.	X					
Sinuloculina ex gr. *consobrina* (d'Orb.)	X	X	X			
S. consobrina (d'Orb.)*maeotica* Maiss.	X	X	X	X	X	X
Varidentella bogatschovi (Bogdanowicz)	X					
Cycloforina aff. *gracilis* Karrer	X	X				X
Affinetrina aff. *guriana* (O.Djanelidze)	X					
Triloculina aff. *inflata* (d'Orb.)		X				
T. aff. *intermedia* Karrer	X					
Pyrgo clypeata (d'Orb.) maeotica Maiss.	X					
Spirolina aff. *stelligera* Didkowski	X					
S. elegans (d'Orb.)*maeotica* Didkowski	X					
Miliolinella circularis(Bornemann)Maiss.	X					
*M.*aff.*majuscula* Popchadze	X					
Articulina tenella (Eich.)*maeotica* Bogd.	X					
Nonion aff. *matagordanus* Kornfeld	X	X				
Porosononion aff. *martcobi* (Bogd.)	X					X
*P.*aff.*subgranosus* (Egger)	X					
Ammonia beccarii-liliae Popch.	X	X	X	X	X	X
A.novoeuxinica Janko	X	X	X	X	X	X
A. ex gr. *beccarii* (L.)	X	X	X	X	X	X
Haynesina maeotica Maissuradze	X		X			
Elphidium feodorovi Bogd.	X					X

1	2	3	4	5	6	7
E.mirandum Krash.*maeotica* Maiss.	X					
E.macellum (Fich. et Moll)*maeotica* Gerke				X		x
E. ex gr.*ponticum* Dogopolskaya et Pauli	X			X		
Cribroelphidium maeotica Maissuradze	X					
Cribroelphidium sp.						X
C. ex gr. *poeyanum* (d'Orbigny)	X					
Bolivina atapica Maissuradze				X		
B. aff. *nisporenica* Didkowski				X		
B. ex.gr.*variabilis* (Williamson)				X		X
B. ex gr. *moldawica* Didkiwski				X		
B. ex gr.*tumida* Cushman				X		
B. iae Maissuradze				X		

Conclusion

The pollen and foraminifera of Meotian deposits of Abkhazia were studied with samples taken from the sections Gedjiri, Otapi, Galidzga and Gudou dated by mollusks and foraminifera.

On the basis of pollen data it is possible to restore the following picture. The main components of flora were subtropical and warm-temperate plants, conifers and angiosperms. Their distribution depended on the vertical zonality of the mountain relief. Coastal plains were covered by swamp forests. On higher levels the vegetation was dominated by evergreen laurel communities, which were distributed up to the foothills. Subtropical mountain forest of conifer and broad-leaved plants grew in the lower and middle belts. The upper mountain belt was occupied by conifer communities of temperate climate.

On coastal plains and in the lower belt the climate was subtropical. With higher altitudes it changed to warm-temperate conditions. Based on the number of spores in the palynological assemblages, it is possible to suppose that the humidity of climate in the territory of Abkhazia was not as high as in Guria. Probably, in spite of the existence of the Colchis Refuge, the process of xerophytization, which during the Miocene embraced the southern regions of the Russian plains, had some influence on the vegetation of Abkhazia.

Two types of diagrams are presented here. The first one show the changes of pollen abundance of selected taxa in layers of Lower and Upper Meotian. It reflects mainly the composition of flora. The second type of diagram depicts the fluctuation in the composition of pollen assemblages with respect to different ecological groups of plants, reflecting the changes of area covered by the main forest communities.

In general, on basis of pollen data two main stages are distinguished in the history of vegetation of Abkhazia during the Meotian. The Early Meotian was the time of predominance of subtropical forests, whereas in the Late Meotian warm-temperate communities spread and covered nearly the same amount of space. These stages correspond to the two substages of Meotian: Bagerovian and Akmanaian, which were established by macrofauna (mollusks) and are confirmed by data of microfauna (foraminifera).

პალეობიოლოგია

აფხაზეთის მეოტური ნალექების სტრატიგრაფიული დაყოფის პალეობიოლოგიური დასაბუთება (პალინოლოგიური მონაცემებით და ფორამინიფერებით)

ი. შატილოვა*, ლ. მაისურაძე*, ი.კოკოლაშვილი**, ა. ბრუხი§

*საქართველოს ეროვნული მუზეუმი, პალეობიოლოგიის ინსტიტუტი, თბილისი, საქართველო
**საქართველოს ტექნიკური უნივერსიტეტი, თბილისი, საქართველო
§ROCEEH კვლევითი ცენტრი, სენკენბერგის კვლევითი ინსტიტუტი, ფრანკფურტი/მ, გერმანია

(წარმოდგენილია აკადემიის წევრის დ. ლორთქიფანიძის მიერ)

შრომაში მოცემულია აფხაზეთის მეოტური ნელექების პალინოლოგიური და მიკროფაუნისტური კვლევის შედეგები. ნიმუშები აღებულია ზედა და ქვედა მეოტურის შემდეგი ჭრილებიდან: ღეჯირი, ღალიძგა, ოტაპი და გუდოუ. არსებული პალეობოტანიკური მონაცემების მიხედვით აფხაზეთის მეოტური ფლორის შემადგენლობაში 190 ელემენტია, რომლებიც მიეკუთვნება 82 ოჯახს და 124 გვარს. ფლორის ძირითად ნაწილს შეადგენს სუბტროპიკული და სითბოზომიერი წიწვოვანი და ფოთლოვანი მცენარეები, რომლებიც გავრცელებული იყო მთიანი რელიეფის სხვადასხვა დონეზე. მცენარეულობის განვითარებაში გამოიყოფა ორი ეტაპი. ქვედა მეოტურში ტყის მთავარი კომპონენტი იყო სუბტროპიკული მცენარეები. სურათი შეიცვალა ზედა მეოტურში, როცა სუბტროპიკულ და სითბოზომიერ მცენარეებს ეკავათ თითქმის თანაბარი როლი ტყის შემადგენლობაში. მეოტურის განმავლობაში ფორამინიფერების განვითარებაში ასევე გამოიყოფა ორი ეტაპი. ქვედა მეოტურში ჭარბობდა მარილიანობის ფართო დიაპაზონის მქონე სახეობები. ღია ზღვასთან კონტაქტის შეწყვეტამ გამოიწვია ზღვიური ფორმების მასიური გადაშენება. ზედა მეოტურ ზღვაში მიკროფაუნა წარმოდგენილი იყო ფორამინიფერების რამდენიმე ევრიჰალური ფორმით და ოსტრაკოდით.

REFERENCES

1. Badzoshvili Ts.I. (1979) Molluski meoticheskikh otlozhenii Zapadnoi Gruzii, p. 144. Tbilisi (in Russian).
2. Taktakishvili I.G., Vekua M.L.,Maissurade L.S., Shatilova I.I (2018) The palaeobiological characteristic of the Late Neogene of Western Georgia, p. 93. Tbilisi.
3. Uznadze M. D (1965) Neogenovaia flora Gruzii, p.180, Tbilisi (in Russian).
4. Kolakovsky A.A., Rukhadze L.P., Shakryl A.K. (1970) Meoticheskaia flora Kodori. *Transec. of Sukhumian Bot. Gard.* XVI : 89-119 (in Russian).
5. Chelidze L.T., Kvavadze E.V. (1986) Iskopaemye rasteniia meoticheskikh otlozhenii Abkhazii. *Bull. Georg. Acad. Sci.* **122**, 1 :177-180 (in Russian).
6. Shatilova I., Rukhadze L., Kokolashvili I. (2016) Representatives of the family Hamamelidaceae in Neogene of Georgia, p. 79. Tbilisi.
7. Liu Geng-wu (1985) *Fupingopollenites* gen. nov. and its distribution. *Acta Paleontologica Sinica* **24**(1): 64-70.
8. Shatilova I.I. Mchedlishvili N.Sh. (2009) The pollen of genus *Fupingopollenits* in the Cenozoic deposits of Georgia. *Bull.Georgian Acad. Sci.,* **3**, 3:153-157. Tbilisi.
9. Walter G. (1974) Rastitelnost' zemnogo shara, p. 574, Moscow (in Russian).
10. Ananova E.N. (1974) Pyl'tsa v neogenovykh otlozheniiakh iuga Russkoii ravniny, p.196, Leningrad (in Russian).
11. Bogdanowicz A.K. (1974) Novye miliolidy iz meotisa Zapadnoi Gruzii. The materials on Geology and Oil-Gas bearing of Georgia, 136-140, Tbilisi (in Russian).
12. Imnadze Z.A. (1974) Etapy razvitiia Ostracoda v pliocenovykh otlozheniakh Zapadnoy Gruzii. The Materials on Geology and Oil-Gas bearing of Georgia, 126-132, Tbilisi (in Russian).
13. Maissuradze L.S. (1988) Foraminifery meoticheskikh otlozhenii Zapadnoi Gruzii. 73 p. Tbilisi (in Russian).
14. Maissuradze L.S., Koiava K.P. (2011) Biodiversity of the Sarmatian Foraminifera of the Easter Paratethys. *Bull. Georgian Acad. Sci.*, **5**, 1:143-150, Tbilisi.

Received December, 2018