საქართველოს მეცნიერებათა ეროვნული აკადემიის მოამბე, ტ. 13, №3, 2019
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Palaeobotany

New Species of the Fossil Flora in the Tuffs of the Goderdzi Suite (Goderdzi Pass Area)

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ABSTRACT. The region under study is the administrative part of the municipalities of Khulo and Adigeni. It is located on the Arsiani ridge, the watershed of the rivers Dzindza (to the east) and Acharistskali (to the west), at the height of 2025 meters. The region was distinguished by strong volcanic activity during the Mio-Pliocene, the products of eruption of which are referred in geological literature as the Goderdzi suite. As a result of field work, in the sub suite of the Goderdzi suite, several new locations of the fossil floristic complex were discovered uniquely preserved and represented by species diversity. The present paper reports on the results of the identification of the well-preserved remnants of fossil flora of different sizes and morphologies and their importance for the reconstruction of palaeoclimatic regime. It was found that out of 12 samples of the fossil flora only the representatives of Lauraceae were recorded and the rest were not found until today. It could be said that by discovering the new species of fossil flora in the tuffogenic subsuite of the Goderdzi suite, a new stage in the study of the Miocene fossil flora of Goderdzi suite started. *© 2019 Bull. Georg. Natl. Acad. Sci.*

Key words: fossil flora, tuff breccias, tuffs, Goderdzi suite

Geological Settings

The suite is rather thick (about 1 km) and lithologically diverse in the boundaries of the Goderdzi pass. The suite is subdivided into volcanogenic-sedimentary (pyroclastic) and volcanogenic (lava) subsuites [1-3]; the pyroclastic subsuite is represented by volcanic conglomerates, tuff-breccias, tuffs and tuff-sandstones. They are conformably covered by andesite (mainly) and rhyodacite lava flows. Fossil flora preserved in volcanogenic-sedimentary formations, the first description of which belongs to M. Uznadze [4-6], attractted the attention of researchers for a long time, as one of the main factors for determining the age of a suite containing them, and for reconstruction of palaeoclimatic conditions.

Description of the fossil flora

Family: Platanaceae. Genus: *Platanus*. Species: *Platanus aceroides*

Platanus aceroides is represented by the fragments of three-lobed leaf (Fig. 1A, 1; 1E, 6a). On a well-preserved sample (Fig. 1A, 1), the length of the central part is 8 cm, width – 2-6 cm. Most of the left lobe is damaged and makes up the third of the entire length. A part of the right lobe is relatively well-preserved (length – 5.5.-6 cm); the base of the leaf is rounded or wedge-shaped; leaves with fragmentarily toothed contours are rare; venation is radial; three central basal veins outgoing from the base and symmetrically going along the central part of the lobes are well observed. The thickest vein is the middle one, from which lateral veins come out parallel to each other at an angle of 25° and reach the edges of the leaf (Fig. 1A, 1). In contrast to the previous sample, only central and left lobes are preserved on samples (Fig. 1B, 1; 1E, 6a) (the length of the central lobe is 8.5 cm, width – 1.5-1.7 cm). These samples show similarity by existence of well-expressed basal veins which pass over the entire length of the central lobe and are distinguished by branches of the lateral veins. In addition, basal vein of the central lobe is less pronounced, though it is clearly seen at the beginning, at the distance of 1.5 cm from the leaf base. Polygonal network of venation is also preserved on the leaf prints. Forms, similar to the described fossil flora are found in the North American Pleistocene, German Pliocene [7], Outer Kakhetian Tertiary [8] Abkhazian (Kodori valley) Pliocene sediments etc.

Family: Myrtaceae. Genus: *Myrtus*. Species: *Myrtus melastomoides* F. Muell

Fossil forms of this species are represented in our collection both in the form of intact leaves and fragments (Fig. 2A, 7a; 2B, 9a; 2D, 14, 14a). The length and width of the preserved parts of prints of elongated lanceolate leaf vary according to samples and change correspondingly: from 3-3.5 cm to 5-6 cm, from 0.5 to 2 cm. Their edges are smooth, are not toothed, texture is leathery. The central vein is strong and straight. Basal veins which come out of the middle one to the left and right, go to the tip of the leaf and occupy positions parallel to each other, are clearly visible. The maximal distance between the central vein and basal veins is in the central part of the leaf and is 0.5 mm. And the distance between basal vein and the edge of the leaf is 2-3 mm. *Myrtus melastomoides* F.Muell shows a strong resemblance with modern *Rhodamnia rubescens* growing in the tropical forests of Australia, in shape, texture and venation [9].

Family: Myrtaceae. Genus: *Myrtus sp.*

Samples of *Myrtus sp.* are represented in our collection in the form of several prints of elongated lanceolate leaves (Fig. 1B, 2a, 3; Fig. 2B, 9). The length and width of the prints are 4-6 cm and 1.5-3 cm, respectively. On the leaves, only the central vein, which extends from the base to the acute tip, is clearly visible. Edges are smooth. The general appearance and morphology make it possible to identify it only up to a genus. Myrtus-like fossil flora is described on the territory of Georgia in the Late Miocene sediments of the village Metekhi, Kartli [8], and Mio-Pliocene sediments of South-West Europe; it shows a great similarity with modern flora of South Europe, North Africa, West Asia and India.

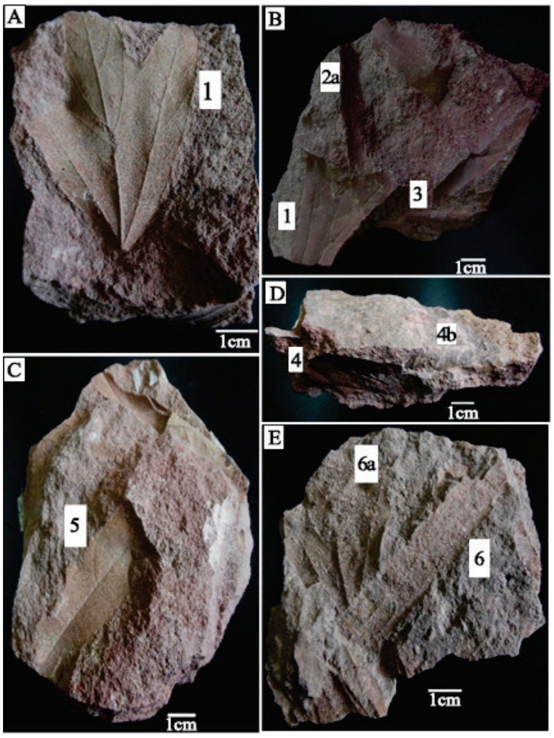

Fig. 1. Photos of Goderdzi flora specimens: Platanus aceroides: 1, 6a. Myrtus sp.: 2a, 3, 9. Sapindus sp.: 5. Corylus insignis Heer: 4. Sapindus cupanoides ett. or Avicennia officinalis 4b. Thevetia peruviana (Pero) Merr. or Meliosma glaziovii Urb. 6.

Family: Lauraceae. Genus: *Cinnamomum*. Species: *Cinnamomum lanceolatum* Heer.

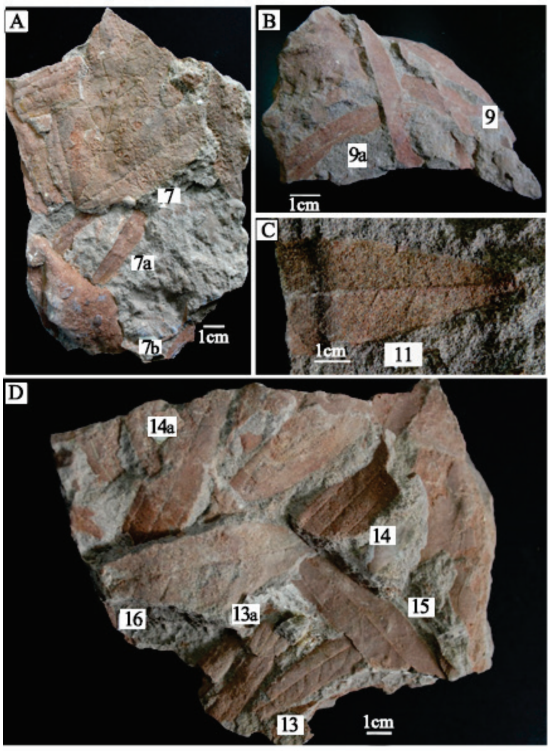

Fig. 2. Photos of Goderdzi flora specimens: Acer sp.: 7. Myrtus melastomoides F.Muell: 7a, 9a. 14, 14a. Cinnamomum lanceolatum(ung) Heer: 7b. Myrtus sp.: 9. Alstonia parvifolia Merr.: 11. Cinnamomum sp.: 13a. Quercus neriifolia A, Br.: 13,15,16.

Elongated lanceolate-elliptical forms of *Cinnamomum lanceolatum* Heer occur in our collection (Fig. 2D, 13a; 2A, 7b). Samples are mainly fragmentary, which complicates determination of complete parameters; only the definition of their width is possible (1.2-1.8 cm). The bases of leaves are wedge-shaped, texture is leathery. The central veins are more pronounced than basal veins. These veins go to the tip of the leaf in parallel where they connect to lateral veins, coming out of the central vein at an angle of 35-40^{o}, and form the network of loops. The distance between the central and basal veins reaches its maximum (0.5 cm) in the central part of the leaf, and decreases towards the edge down to 0.2 cm. The edges are smooth, are not toothed. The elongated lanceolate shape and characteristic venation of the leaves make it easy to identify them as *Cinnamomum lanceolatum* Heer. A plant, analogous to Cinnamomum lanceolatum Heer, *Cinnamomum camphora* L. is described in South China and South Japan [4]; above listed forms are also common in the Tertiary – Oligocene and lower Miocene – sediments on the territory of Europe [4], and are described in Sarmatian sediments of Georgia as well [10].

Family: Betulaceae. Genus: *Corylus.* Species: *Corylus insignis* Heer.

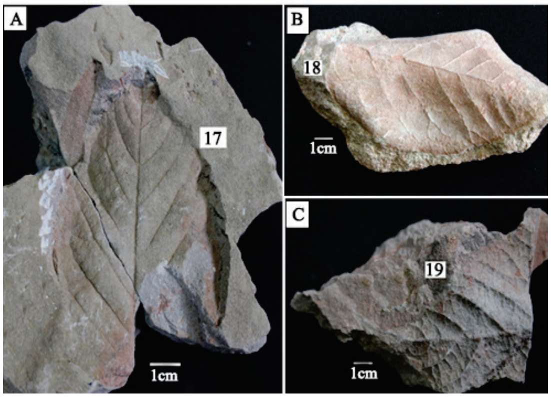

Fig. 3. Photos of Goderdzi flora specimens: Corylus insignis Heer.: 17,18. 19.

Samples identified as *Corylus insignis* Heer are mainly represented in our collection in the form of fragments (Fig. 1D, 4; Fig. 3A, 17; 3B, 18; 3C, 19). The length of the entire leaf is supposedly 10 cm, and the width might be 3-6.5 cm. The central vein extends from the base of the leaf up to its tip and creates bilateral symmetry. 7-8 pairs of lateral veins coming out from the central one at an angle of 45^{o} are well observed. The distance between each pair of lateral veins is 0.5-1 cm; at the edge of the leaf they are branched into two parts by an angle of 40^{o}. First three lateral veins outgoing from the leaf base are branched 2-3 times before they reach the edge; the right branch of the vein, divided into two, continues branching, while the left one reaches directly the edge of the leaf. On one of the samples of the leaf (Fig. 3B, 17), a stripe of the main vein bulges like a crest due to deformation, and the lateral veins, area among which is filled with polygonal checkered network, are branched from it. The edge of the leaf if slightly toothed. Despite poor preservation of the samples, they are identified as *Corylus insignis* Heer. according to their general morphology and venation. Similar flora is found in the Paleocene sediments of Rocky Mountains (US), Middle Eocene sediments on the territory of Canada, Tertiary sediments of Europe and Pliocene sediments of Great Britain. In general, species of *Corylus* show similarity to some species of *Alnus* and *Betula*. The latter differs from *Corylus* by a lesser venation of secondary basal formation compared to tertiary veins and serration of numerous thin edges.

Family: Fagaceae. Genus: *Quercus*. Species: *Quercus neriifolia* A, Br.

This species is represented in the samples of our collection by fragmentary prints of an elongated, lanceolate leaf of a lenticular shape. The prints are 70-80% of the entire leaf (length 3.5-5 cm, width 08.-1.5 cm) (Fig. 2D, 13; 15; 16). Texture is leathery. The main vein passes the central part of the leaf and 4-5 pairs of relatively weak lateral veins emerge from it at an angle of 40^{o}. The latter ones, after coming out from the central vein, go to the smooth edges of the leaf subparallel, in a weakly pronounced arc-shaped form. Tertiary venation is not detected because of poor preservation. Similar flora is found in late Miocene sediments of the Metekhi village, Kartli (Eastern Georgia) [8]. Described samples were identified as Quercus neriifolia A, Br. according to their morphological appearance and peculiarities of venation. Similar fossil flora is found in late Cainozoic sediments of Iceland [11]. Modern *Quercus imbricaria* Michx and *Quercus phellos* L., which belong to mesophytic and hygromesophytic plants, are close to the flora under discussion. They represent the genus *Quercus* of the family Fagaceae and are common in the South-Eastern states of the United States.

Family: Apocynaceae. Genus: *Alstonia*. Species: *Alstonia parvifolia* Merr.

This species is represented in our collection by only one fragmentary sample (Fig. 2C, 11). Only the lower half of the leaf is preserved. The leaf has an elongated elliptical shape. The central vein is clearly visible. It comes out from the wedge-shaped base of the leaf, goes towards its central part and divides it into two symmetrical halves. The length of the fragment is 4.5 cm, width – 3 cm. 6 pairs of relatively weak lateral veins come out from the central vein at an angle of 40^{o}, go parallel to each other to the tip of the leaf, but do not reach it. Texture is leathery, edges are even. The sample was identified as *Alstonia parvifolia* Merr. According to its general features (character of venation, morphology, texture etc.); it should be noted that forms similar to this species are common in the Philippine islands, in the subequatorial belt.

Family: Apocynaceae or Sabiaceae. Genus: *Thevetia* or *Meliosma*. Species: *Thevetia peruviana* (Pero) Merr. or *Meliosma glaziovii* Urb.

In the only fragmentary sample, represented in the collection (Fig. 1E, 6), only the middle part of the leaf is preserved. The base and tip are not detected. The length of the fragment is 5.5. cm and the width of its widest part is 1.8 cm. The leaf has an elliptically elongated form. The strong, central vein, dividing it into two halves, is clearly visible. The texture is leathery, edges are even. Other details of the sample are not detected due to poor preservation, so it was presumably identified as *Thevetia peruviana* (Pero) Merr. or *Meliosma glaziovii* Urb. It should be noted that today *Thevetia peruviana* (Pero) Merr. is found in the tropical and subtropical belts of Mexico and Central America, and *Meliosma glaziovii* Urb. is mainly common in South America, subequatorial belt of Brazil.

Family: Aceracea. Genus: *Acer* sp.

The sample is poorly preserved (Fig. 2A, 7). There is a central vein in the central part of three-lobed, bilateral leaf; the central part of right and left lobes is divided in the middle by the basal veins. The base of leaf is supposedly wedge-shaped or slightly rounded. Edges of the sample are even, and there are only rare small teeth similar to tubercles. Texture is leathery. Venation is radial. Each lobe of the three-lobed leaf corresponds to each basal vein. 5-6 pairs of lateral veins flow out from the central vein in turn at an angle of 40-45°, go towards the edge and are divided into two parts above the 2/3 part of the leaf. Initial 2 pairs of lateral veins join to lateral veins coming out from neighbor basal veins, and form the network of loops. Tertiary veins are weakly pronounced and create polygonal network, crossing almost at right angle. Similar forms are described in the works of Palibin I. and Uznadze M., though with only one difference – they emphasize the asymmetry of those forms [4] which is not found in our case. Moreover, fragmentary nature of the sample does not allow us to make such a conclusion. In any case, identification of the genus as Acer sp. according to morphology, three-lobed form, character of venation and other parameters, should not raise doubts. Prints of Acer are widespread in Oligocene-Pliocene sediments of Europe [4].

Family: Sapindaceae. Genus: *Sapindus* sp.

We have fragmentary sample (Fig. 1D, 5) in our collection. Its length along the central vein is 5 cm, width – 2.5-2 cm. Morphologically, it might be of elongated lanceolate shape (Fig. 1D, 5). The strong central vein divide the leaf in two symmetrical halves. Secondary lateral veins come out from the central vein in opposite directions at an angle of 37° and reach the edge of the leaf symmetrically. Tertiary veins come out from the lateral ones almost at right angle and form network of polygonal loops. Texture of the leaf is leathery. Edges are smooth. Because of the fragmentary nature of the sample, its identification as a species is not possible, although it could be identified as *Sapindus* sp. according to its morphology.

Family: Sapindaceae or Verbenaceae. Genus: *Sapindus* or *Avicennia*. Species: *Sapindus cupanoides* Ett. or *Avicennia officinalis*.

Because of the fragmentary nature of the sample (Fig. 1D, 4b), its precise identification is not possible. It shows a similarity with the fossil species *Sapindus cupanoides* Ett.- and Avicennia officinalis, widespread in India.

Conclusion

The complex of fossil flora, obtained by us in the tuffaceous sediments of the Goderdzi suite is distinguished by unique preservation and species diversity. Results of description of obtained fossil plants enable us to divide them in three ecological groups: subtropical flora (Apocynaceae, Lauraceae, Myrtaceae, Sapindaceae, Verbenaceae, Sabiaceae) is the most widespread of them, followed by the group of plants of moderate warm climate (Fagaceae, Platanaceae), which is 17-20% of the whole flora, and the floristic group of moderate climate (Platanaceae, Betulaceae), making 15-17%.

Goderdzi fossil flora indicates to the existence of hygrophilous evergreen and deciduous forests and relief of levels sharply differing from each other by microclimatic conditions.

Several genera of fossil plants found and identified by us are found in modern floristic complex of the area under study even today. Proceeding from the hypsometric peculiarities of the spread of modern forest, they might have been represented at the various levels.

The obtained and described species confirm the considerations of previous researchers on the subtropical nature of the Goderdzi fossil flora; the Goderdzi suite does not contain boreal components, instead there are presented a lot of warm-moderate deciduous plants, and the subtropical species should mainly be represented by shrubs [12]. A particularly large number of fossil leaves of the Lauraceae family indicate the wided distribution of laurel forests in the past.

It should be noted that modern analogues of the Goderdzi flora are common in South-West Asia, North-East India, North America, in the Antilles and the Canary Islands, the Mediterranean region and the Caucasus [6].

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პალეობოტანიკა

ნამარხი ფლორის ახალი სახეობები გოდერძის წყების ტუფებში (გოდერძის უღელტეხილის არეალი)

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**ივანე ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტი, გეოლოგიის დეპარტამენტი, თბილისი, საქართველო*

(წარმოდგენილია აკადემიის წევრის დ. ლორთქიფანიძის მიერ)

სტატიაში განხილულია მიო-პლიოცენურ გოდერძის წყების ტუფოგენურ ქვეწყებაში, საველე სამუშაოების შედეგად აღმოჩენილი უნიკალური დაცულობისა და სახეობრივი სხვადასხვაგვარობით წარმოდგენილი ნამარხი ფლორისტული კომპლექსის რიგი ახალი ადგილსამყოფელი, აქ მოპოვებული ნამარხი ფლორის ნაშთების განსაზღვის შედეგები და მათი მნიშვნელობა პალეოკლიმატური რეჟიმის რეკონსტრუქციისათვის. ნამარხი ფლორის აღწერა ჩატარდა საქართველოს ეროვნული მუზეუმის პალეობიოლოგიის ინსტიტუტის პალეობოტანიკის განყოფილებაში. დადგინდა, რომ 12 აღწერილი ნამარხი ფლორის ნიმუშებიდან მხოლოდ Lauraceae-ს წარმომადგენლებია აღწერილი, დანარჩენი დღემდე ცნობილი არ იყო. გოდერძის წყების ტუფოგენურ ქვეწყებაში ნამარხი ფლორის ახალი ადგილსამყოფლების აღმოჩენით და ახალი სახესხვაობების აღწერით შეიძლება ითქვას, რომ გოდერძის მიოცენური ნამარხი ფლორის შესწავლის კიდევ ერთი ახალი ეტაპი დაიწყო.

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