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The Pollen of Genus *Alangium* in Cenozoic Deposits of Georgia

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ABSTRACT. In geological records the genus *Alangium* is known from the Paleogene. Morphologically different pollen grains were determined in the Eocene deposits of both hemispheres: the pollen of Alangium sp. A in North America, *Alangiopollis eocaenicus* Krutzsch in Europe and *Alangium sibiricum* Lubomirova in the Western Siberia. The species *A. barhoornianum* Traverse was described from the Upper Oligocene Brandon lignite of Vermond (North America). The same pollen grains were revealed in Europe. The European pollen remains were similar to Traverse's *Alangium barhoornianum* and only the generic name was changed. On the territory of Europe the species *Alangiopollis barhoornianum* (Traverse) Krutzch is known mainly from the Paleogene till the Middle Miocene. Approximately in the same interval of time the species *A. simplex* Nagy and *A. rarus* Cernjavska were determined. On the territory of Georgia the genus *Alangium* is also known from Paleogene. The species *Alangiopollis eocaenicus* was described from the Middle Oligocene deposits of Southern Georgia. In Sarmatian the genus was represented by two species *A. eocaenicus* and *A. barhoornianum.* After Sarmatian the history of *Alangium* was connected only with the area adjoining the Black Sea, where the accumulation of marine deposits continued during the whole Pliocene and Pleistocene. In Meotian the pollen grains of two species were determined - the extinct taxon *A. simplex* and the recent *Alangium kurzii* Craib, which were preserved in composition of flora during Pliocene and Lower Pleistocene (Gurian). After Gurian the genus *Alangium* fully became extinct on the territory of Georgia. © *2014 Bull. Georg. Natl. Acad. Sci.*

***Key words**: Georgia, Cenozoic, pollen grains, genus Alangium.*

At present *Alangium* is the single genus of the family *Alangiaceae.* In its composition there are about 20 species, united in 4 sections: Conostigma, Alangium, Marlea and Rhytidandra. There are evergreen trees, shrubs and lianas, whose area is connected to south-eastern part of Asia (India, China and Japan), Africa and the islands of Pacific. *Alangium platanifolium* is the only deciduous species and its range includes regions of temperate to cold-temperate, continental climatic conditions [1].

Alangium pollen grains are characterized by great diversity. The morphology of 13 species was studied by Eramian [2]. Two types of grains were distinguished on the basis of pollen shape and character

Fig. 1. Comparison of *Alangium sibiricum* (a, collection of Lubomirova) with pollen of *Fupingopollenites wackersdorfensis* (b) from Upper Miocene deposits of Georgia.

of colpi: type Alangium and type Marlea. The latter was divided into two subtypes: *Alangium ridleyi* and *A. vitiense*. According to some scientists, in connection with great variation of pollen grains and overlapping characters found in four sections, the pollen of *Alangium* cannot be sharply separated into "types" and "subtypes" [1].

In Europe the most ancient pollen grains of *Alangium* are described from Eocene deposits of Germany under the name *Alangiopollis eocaenicus* Krutzsch [3]. The author compared it with *Alangium griselloides* Capuron, whose recent area is limited by Madagascar. *A. eocaenicus* possesses signs characteristic of some pollen types and its pollen can only approximately be compared with *Alangium chinense* type A [4]. The pollen grains of *Alangium* sp. from London Clays are also referred by this author to *A. eocaenicus*. According to Eyde [5], "Reitsma's claim that the London Clay pollen conspecific with *A. eocaenicus* from various German localities is not based on a direct comparison of specimens and therefore should be treated cautiously; photos show that British fossil is quite similar to German fossils, but there appears to be a substantial difference in size". At the same time Eyde recognizes that both *A. eocaenicus* and London Clay pollen have coarse reticulation.

The species *Alangium sibiricum* Lubomirova was described from the Eocene deposits of Western Siberia [6]. The author compared it with *A. javanicoides* Cookson [7] from the Upper Pliocene deposits of New Guinea or with its modern analogue *A. javanicum* (Blume) Wangerin.

In 1992 Nagy referred pollen grains of *Alangium sibiricum* to the unidentified plant, known in literature as *Tricolporopollenites wackersdorfensis* Thiele-Pfeiffer [8] or *Fupingopollenites wackersdorfensis* (Thiele-Pfeiffer) Liu Geng-wu [9]. A new taxon was described under the name *Tricolporopollenites sibiricum* (Lubomirova) Nagy et n.comb. [10], which now is used by palynologists of Europe [11].

The question about renaming of *A. sibiricum* was discussed in the articles, devoted to the history of genus *Fupingopollenites* on the territory of Georgia [12, 13]. There are two main differences between pollen grains of *A. sibiricum* and *Fupingopollenites*. The first is the absence of exine thickening around the pores on the pollen grains of *Fupingopollenites*. According to Lubomirova it is the main feature of *A. sibiricum,* which differs it from other species of this genus and bring it near to *A. javanicoides.* The second difference is the absence of "concave plate-like thinning areas of exine" typical for *Fupingopollenites* on the pollen grains of *A. sibiricum* (Fig.1).

From the Upper Eocene deposits of North America the species *Alangiopollis* sp. A was determined [14]. The second species *Alangium barghoornianum* Traverse was described from the Upper Oligocene Brandon lignite, a small brown coal deposit in Central Vermont [15].

Two opposite opinions were expressed about the age of Brandon deposit [1]. The first is based on the

Tab. 1. Stratigraphical division of the Black Sea Upper Cenozoic deposits [26]

Cenozoic	Quaternary			0.50Ma
				Chaudian 0.73Ma
				Gurian 1.67 Ma
	Neogene	Pliocene	Upper	Kuyalnician 3.40 Ma
			lower	Kimmerian 5.2 Ma
		Miocene	Upper	Pontian 7.0 Ma
				Meotian 9.3 Ma
			Middle	Sarmatian 13.7 Ma

similarity of Brandon fossil fruits *Alangium vermontanum* Eyde & Barghoorn to Miocene fruits of Salzhausen (Germany) that allows thinking about the Miocene age of the Brandon deposit. The second opinion about the upper Oligocene age suggested for Brandon flore is based on pollen remains.

Traverse compared the pollen grains of *A. barghoornianum* to recent *A. chinense* (Lourielo) Harms. At the same time, another opinion exists that there are other species in section Marlea, to which the fossil can be compared [1]. At first it was compared to *A. platanifolium* because of the striate surface pattern common to both. But a more careful comparison of the second *Alangium* grain in Brandon material revealed that the resemblance is only superficial. The ridged surface pattern in the exine of *A. platanifolium* is underlain by a reticulum, independent of the overlying ridges, which is completely absent in Brandon fossils. On the basis of this difference the conclusion was made that the nearest modern counterpart to the Brandon grains is the species *Alangium kurzii* Craib, a palynologically variable species. According to Reitsma [4], *Alangium barghoornianum* was the parent taxon, divided into two recent species *A. kurzii* and *A. platanifolium*.

In Europe the pollen grains similar to *A. barghoornianum* were discovered in the Tertiary deposits of Germany. The five localities were listed by Krutzsch [16]. Two of them belong to the Lower Miocene and the others - to the Middle Oligocene. The European remains were so similar to Traverse's *A. barghoornianum* that only the generic name was changed and pollen grains were described as *Alangiopollis barghoornianum* (Traverse) Krutzsch. Krutzsch also noticed the resemblance of his German fossils to pollen of *Alangium kurzii*.

On the territory of Central Europe the pollen grains of *Alangiopollis barghoornianum* are presented mainly in deposits beginning from the Middle Oligocene till the Middle Miocene [17-20]. Besides, from the Helvetian deposits of Hungary the pollen

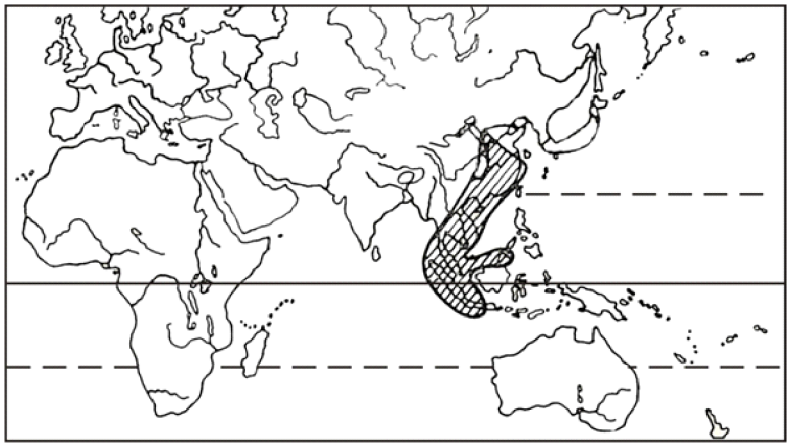

Fig. 2. The species of *Alangium kurzii* recent area [4].

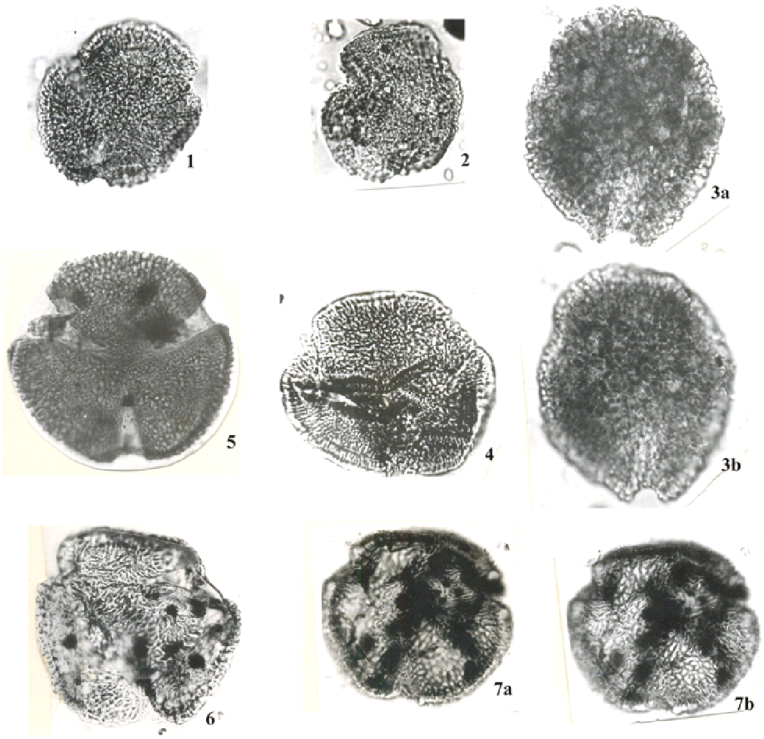

Plate I. 1- *Alangiopollis eocaenicus*, Middle Oligocene deposits of Southern Georgia; 2-*A. eocaenicus*, Sarmatian deposits of Eastern Georgia; 3a, b-*A. barghoornianum*, Sarmatian deposits of Eastern Georgia; 4-*A. simplex,* Meotian deposits of Western Georgia; 5-*Alangium kurzii*, Meotian deposits of Western Georgia; 6, 7a,b-*A. kurzii,* Kimmerian deposits of Western Georgia .

grain of *A. (Alangiopollenites) simplex* Nagy was described [18,19]. According to the author, this species morphologically reminds recent *Alangium chinense* (Lour.) Harms. *Alangiopollis rarus* Cernjavska from the coalbearing Paleogene deposits of Bulgaria is the other species, which distinctly stands out from *A. barghoornianum* [21].

The species *Alangium barghoornianum* (Trav.) Tarasevicz was described from the Miocene deposits of Russian Plain [22]. According to the author, morphologically and biometrically pollen grains are similar to *Alangiopollis barghoornianum.*

The fossil pollen grains close to recent species *Alangium chinense*, *A*. cf. *javanicum* and *A*. cf. *scandens* Bloumb. were described from the Pliocene deposits of VietNam [23].

Most of the fossil pollen grains belong to section Marlea, which occupied Europe and North America in the Tertiery. The plants of sections Conostigma, Alangium and Rhytidandra never extended very far beyond their present ranges [1]. But the presence in Eocene deposits of Siberia the pollen grains of *Alangium subiricum* similar to *A. javanicum* somewhat changes this hypothesis.

In Georgia's fossil floras the genus *Alangium* is known only by pollen data [24]. The first finds are connected to location of the Middle Oligocene macroflora of Tori (Southern Georgia). The pollen grains were determined as *Alangiopollis eocaenicus*.

Sarmatian is the following stretch of time, whose deposits contain the remains of *Alangium.* In composition of flora the genus was represented by two species: *Alangiopollis eocaenicus* and *A. barghoornianum*. The single pollen grain of this taxon was first determined as *Alangium* aff. *kurzii* [25]. But after more detailed study of new material from Sarmatian deposits of Eastern and Western Georgia it was renamed as *Alangiopollis barghoornianum.* Morphologically the pollen grains are more similar to those from the deposits of Southern part of Europe, Hungary and Slovakia [18, 21].

The end of the Middle Sarmatian was the turning

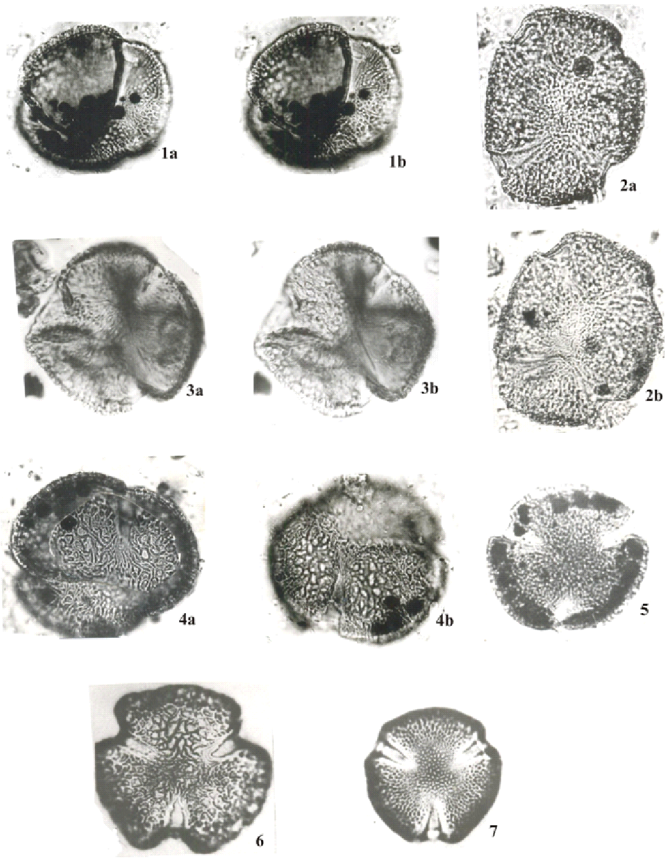

Plate II.1a, b- *Alangium kurzii* Kimmerian deposits of Western Georgia; 2a,b-*A. kurzii*, Kuyalnician deposits of Western Georgia; 3 -5-*A. kurzii*, Lower Gurian deposits of Western Georgia; 6,7-recent pollen grains of *A. kurzii* [1].

point in the Neogene history of Georgia. As a result of orogenic movements the Transcaucasian intermountain depression transformed into dry land, divided into two parts by the Dzirula massif. To the east of the Dzirula massif the Kura bay was formed. In the Late Sarmatian the territory of Georgia adjoined this bay became dray land with the landscape typical to the continental climate. In the west the Rionian Bay originated, where marine deposits continued to accumulate till the end of the Pleistocene. Now the Western Georgia is the stratotypical region where the Black Sea Upper Cenozoic is represented in full series of deposits (Tab.1). So, after the Sarmatian the comparative complete history of Georgia's flora can be reconstructed only on the basis of fossil material from the Western Georgia.

In the Meotian the genus *Alangium* was represented by extinct species *Alangiopollis simplex* and the recent *Alangium kurzii*. In deposits of the following stages the pollen grains of *Alangiopollis simplex* were not seen. In the Pliocene on the territory of Western Georgia only one species *A. kurzii* was preserved. Especially great number of grains was seen in Duabi layers, to which the famous Duabian macroflora is connected [27]. It was the last stretch of time, when on the territory of Western Georgia in lower mountain belt the subtropical vegetation existed as the independent community.

In the Kuyalnician and Lower Gurian on the territory of Western Georgia the predominance of rich polydominant deciduous forest began, which occupied the lower and middle mountain belts. The Pliocene relicts had rather big part in its composition.

The following Late Gurian time was the transitional period, when the vegetation of Western Georgia began to lose the features, typical for the

Neogene, and obtained the signs, characteristic of the Quaternary. The polydominant forest divided into some communities, which distributed along the separate mountain zones. In middle mountain belt the formation of oligomonodominant beach communities began. The lower mountain belt was occupied by mixed forest, where the bulk of thermophilous plants were concentrated. In Upper Gurian there were also big changes in the character of flora, where a great number of Pliocene relicts became exinct including the species *Alangium kurzii*, whose recent area ranges from Java to China (Fig.2).

პალეობიოლოგია

გვარ *Alangium*-ის მტვრის მარცვლები საქართველოს კაინოზოურ ნალექებში

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დღეისათვის ოჯახ *Alangiaceae*-ის შემადგენლობაში *Alangium*-ი ერთადერთი გვარია. გვარში 20 სახეობაა, რომლებიც გაერთიანებულია 4 სექციაში: **Conostigma, Alangium, Marlea, Rhytidandra**. ძირითადად ეს მარადმწვანე ხემცენარეები, ბუჩქები და ლიანებია, რომლებიც გავრცელებულია აფრიკისა და სამხრეთ-აღმოსავლეთ აზიის ტროპიკულ და სუბტროპიკულ ზონებში. მათ შორის მხოლოდ ერთი ფოთოლმცვენი სახეობაა ***A. platantifolium***-ი, რომელიც იზრდება სითბოზომიერიდან ზომიერში გარდამავალი ჰავის პირობებში. გვარ *Alangium*-ის განვითარების ისტორია საქართველოს ტერიტორიაზე ეფუძნება მხოლოდ პალინოლოგიურ მონაცემებს. უძველესი მონაპოვარი დაკავშირებულია შუაოლიგოცენურ თორის ფლორასთან, რომლის შემადგენლობაში განსაზღვრულია ***Alangiopollis eocaenicus* Krutzsch**-ის მტვრის მარცვლები. იგივე ტაქსონი ნაპოვნი იყო აღმოსავლეთ საქართველოს სარმატულ ნალექებში, რაც იმაზე მეტყველებს, რომ ეს სახეობა არსებობდა საქართველოს ტერიტორიაზე ზედამიოცენურამდე. სარმატულ ნალექებში აგრეთვე განსაზღვრული იყო სახეობა ***Alangiopollis barghoornianum* (Traverse) Krutzsch**-ი. სარმატულის შემდეგ ეს ორი ტაქსონი გადაშენდა საქართველოს ტერიტორიაზე. შუა სარმატული დრო იყო გარდატეხის პერიოდი საქართველოს გეოლოგიურ ისტორიაში, როდესაც ორგანული მოვლენების შედეგად ამიერკავკასიის მთათაშუა დეპრესია ხმელეთად გადაიქცა. ეს ხმელეთი ძირულის მასივით გაიყო დასავლეთისა და აღმოსავლეთის რეგიონებად. აღმოსავლეთით ჩამოყალიბდა კონტინენტური რეჟიმი, დასავლეთით კი გაგრძელდა ზღვიური ნალექების აკუმულაცია. აქედან ცხადია, რომ საქართველოს ფლორის ისტორიის შედარებით სრული სურათის აღდგენა შეიძლება მხოლოდ დასავლეთ საქართველოს ტერიტორიაზე ნაპოვნი პალეობოტანიკური მასალის საფუძველზე. სარმატულის შემდგომ მეოტურ დროში გვარი *Alangium*-ი წარმოდგენილი იყო გადაშენებული ტაქსონით ***Alangiopollis simplex* Nagy**, რომელიც ახალგაზრდა ნალექებში აღარ გვხვდება და თანამედროვე სახეობით ***Alangium kurzii* Craib**. პლიოცენურში ამ სახეობის მტვრის მარცვლები განსაკუთრებით დიდი რაოდენობითაა ზედაკიმერიულ ნალექებში, დუაბის შრეებში. დასავლეთ საქართველოს ტერიტორიაზე

ეს იყო სუბტროპიკული ფორმაციის არსებობის, როგორც დამოუკიდებული ერთეულის, ბოლო პერიოდი. ამის შემდეგ კუიალნიკურში და ადრეულ გურიულში იწყება პოლიდომინანტური ფოთოლმცვენი ტყის გაბატონება, რომლის შემადგენლობაში სუბტროპიკულ რელიქტებს ეკავა ჯერ კიდევ საკმაოდ დიდი როლი. გვიან გურიული იყო გარდამავალი პერიოდი, როცა დასავლეთ საქართველოს მცენარეულობა კარგავდა ნეოგენისთვის დამახასიათებელ თვისებებს და იძენდა ახალს, ტიპურს მეოთხეული დროისათვის. პოლიდომინანტურმა ტყემ დაიწყო დაშლა ცალკეულ ფორმაციებად, რომლებიც განაწილდნენ ვერტიკალური ზონების მიხედვით. შუა სარტყელში გავრცელდა ოლიგომონოდომინანტური ტყე, რომლის მთავარი კომპონენტი იყო წიფელი. ქვედა სარტყელი დაიკავა შერეულმა ტყემ, სადაც მოხდა თერმოფილური მცენარეების კონცენტრაცია. გვიან გურიულში ფლორამ ასევე განიცადა დიდი ცვლილებები. მის შემადგენლობიდან გაქრა პლიოცენური რელიქტების დიდი რაოდენობა, მათ შორის ***Alangium kurzii***.

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