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Paleobiogeographic Zoning of the Basins of the Caucasus in the Early Jurassic-Bajocian by Ammonites

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ABSTRACT. On the basis of study of the ecology and evolution of Early Jurassic-Bajocian ammonites of the Caucasus, the routes of migration of these organisms and areas of their dispersal were established. The paleobiogeographic boundaries were specified and the existence of 4 palaeobiogeographic regions on the territory of the Caucasus in the Early Jurassic-Aalenian time was verified: 1. The Lesser Caucasian, in its southern part; 2. The Southern Caucasus intermountain area including the Dzirula massif; 3. The Southern slope of the Greater Caucasus including the territories of Georgia and Azerbaijan; 4. The Northern Caucasus. At the end of the Bajocian age considerable differentiation of ammonite fauna took place. It led to the appearance of new families and genera. Ranking of the earlier distinguished palaeobiogeographic areas to the subprovinces and also the existence of the Nakhichevan subprovince are justified. *© 2012 Bull. Georg. Natl. Acad. Sci.*

Key words: *palaeobiogeography, Early Jurassic, Bajocian, Caucasus, ammonites.*

Over the past few decades our knowledge of Jurassic ammonites has increased considerably. Due to numerous studies of this important group of fauna, the possibility of solving the problems of biostratigraphy and paleobiogeography appeared. The changes in ammonite fauna in space and time were traced on the basis of extensive material.

Numerous researches were dedicated to Lower Jurassic-Bajocian palaeobiogeographical structures. However, information on the palaeobiogeography of this geological time interval in the Caucasus can be found only in [1, 2].

Recently new data on the Early and Middle Jurassic ammonites of the South Caucasus were received. They are of major importance in revealing general patterns of their geographic differentiation.

Taxa of palaeobiogeographical subdivisions used in this study are determined by the rank of groups of ammonites characteristic of them. In particular, biogeographic unit of the highest rank, i.e. an area covering an extensive territory of land or sea that differs from the adjacent one by the presence or disappearance of superfamilies and genera. Biogeographical unit of the second rank is a province, which is a part of the area characterized by species and subspecies and more fractionated subdivisions belonging to the provinces, such as subprovinces and districts.

Based on the study of ammonite fauna and biofacies analysis, in the Caucasus in the Early Jurassic and Aalenian 4 regions are distinguished: 1) the Lesser Caucasian, located in its southern part; 2) the South Caucasian intermountain area including the salient of the Dzirula crystalline basement; 3) the Southern slope of the Greater Caucasus including the territories of Georgia and Azerbaijan; 4) the Northern Caucasus. These paleobiogeographical units are considered in this paper (Fig. 1).

Geographic differentiation of ammonite fauna in the Early Jurassic and Aalenian was not sufficiently expressed and manifested mainly at the species level. At that time mainly the same genera were widespread. This, of course, complicates the distinguishing of a palaeobiogeographical unit that is larger than a province. The Caucasian marine basin in the Early Jurassic and Aalenian was a part of the Mediterranean province and was located in its northeastern part. Marine basins of North-Western Europe were identified as the Middle European province [2].

The complex of Early Jurassic and Aalenian ammonite fauna of the Caucasus is fairly abundant. Its members are distributed unevenly. A great number of ammonite genera of the Sinemurian age of the Early Jurassic epoch are recorded in the marine basin situated in the northern part of the Lesser Caucasus region. Here, in the Sinemurian age shallow marine conditions with normal water temperature and salinity favorable for intensive development of vital processes were established. In the organic world the ammonites of the following genera play an important role: the Mediterranean- *Partshiceras, Eoderoceras* and *Epideroceras,* the Middle European - *Canavarites, Arietites Coroniceras, Paracoroniceras* and *Metophioceras,* as well as *Vermiceras, Arnioceras, Oxynoticeras, Echioceras, Microderoceras,* found both in the Middle European and Mediterranean provinces and predominantly the Middle European - *Gleviceras* and *Paltechioceras* [3-5].

Ammonites of the Pliensbachian age are more exhausted and represented by the Mediterranean *Arieticeras, Liparoceras,* the Middle European *Tropidoceras*, mainly by the Mediterranean *Pleuroceras* and by widely spread *Amaltheus*.

The ammonite complexes of the Toarcian and Aalenian differ in a restricted amount of ammonites, belonging mainly to the Mediterranean *Callirhylloceras, Peronoceras, Harpoceras, Phymatoceras* and to the Middle European *Grammoceras, Pseudogrammoceras, Dumortieria, Leioceras, Costileioceras* and *Ludwigia*.

It is clear from the above list that the ratio of ammonite genera in some epochs changes. Apparently, in the Sinemurian and Toarcian ages, marine conditions on the territory of the Lesser Caucasus region were favorable for ammonite fauna habitat.

Species composition of genera is typical of the Mediterranean and Middle European provinces. The penetration of Middle European ammonites into the territory of the Lesser Caucasus probably took place from Central Europe along the northern margin of the Tethys, via North Anatolia.

In the Sinemurian age, the sea invading from the Lesser Caucasus basin through a wide strait on the territory of the South Caucasian intermountain area reached the Dzirula massif. During the Early Jurassic and Aalenian, the land on both sides of the strait was highly elevated [6].

The Sinemurian ammonite fauna of the Dzirula massif is considerably poorer than that of the Lesser Caucasus. It is represented by only three genera - *Vermiceras, Arnioceras* and *Microderoceras*.

The biocenosis of the Pliensbachian of the Dzirula massif is composed mainly of brachiopods and ammonites. An overwhelming majority of this fauna developed in the shallow part of the marine basin. As a part of taphocoenosis, the ammonites belong to the Mediterranean *Juraphyllites, Calliphylloceras, Arieticeras, Pleurocerass, Fuciniceras* and to the Middle European *Crucilobiceras, Phricodoceras, Uptonia, Polymorphites, Acanthopleuroceras, Tropidoceras* and *Pseudogrammoceras* [7, 8].

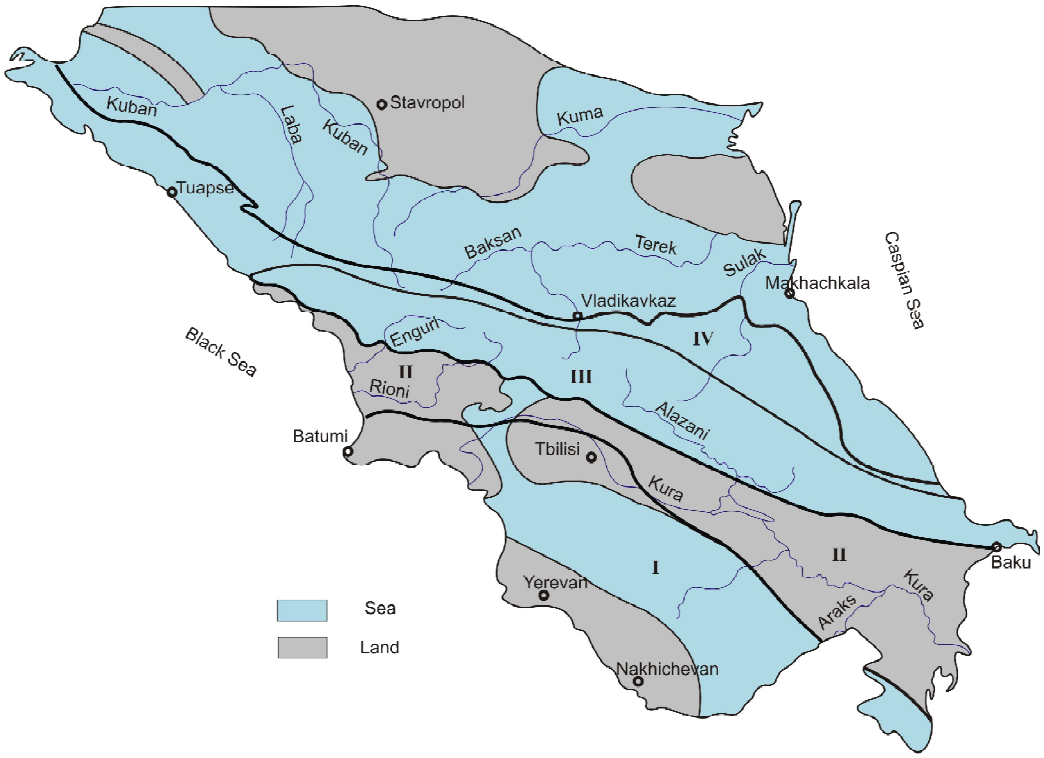

Fig. 1. Scheme of palaeobiogeographic zoning of the Caucasus in the Early Jurassic-Bajocian. The regions: I.The Lesser Caucasus; II.The Southern Caucasus intermountain area; III. The Southern slope of the Greater Caucasus; IV.The Northern Caucasus

In the Toarcian- Early Aalenian the sedimentary environments inherited from the Late Pliensbachian dominate. The abundance of fauna, represented by different groups, indicates optimal conditions for their existence.

The ammonite complex of these epochs in the South Caucasian intermountain area, within the limits of the Dzirula massif basin, is rather rich and diverse in genera and species composition. In the Toarcian age the Mediterranean genera *Calliphylloceras, Lytoceras, Harpoceras, Phymatoceras, Hammatoceras, Peronoceras, Catacoeloceras, Pseudolioceras, Polyplectus, Praehaploceras* prevail and the Middle European *Hildoceras, Grammoceras, Pleydellia* also occur.

The Aalenian age is represented predominantly by the Mediterranean *Tatrophylloceras, Lytoceras, Hudlestonia, Planammatoceras, Erycites* and the Middle European *Costileioceras* and *Leioceras*.

Thus, in the given ammonite complex the genera of the Middle European and Mediterranean provinces as well as the genera common for both biogeographic units were spread. Migration routes and dispersal of ammonites passed through Northern Anatolia by the strait located in the territory of the South Caucasian intermountain area**.**

In the Sinemurian, water penetrated into the territory of the region of the Southern slope of the Greater Caucasus. At that time a normal hydrochemical regime favorable for the dispersal of a rich complex of ammonites (42 species) was established in the basin. The complex is represented by the ammonite genera found in the Mediterranean and Middle European provinces - *Phylloceras, Partschiceras, Juaphyllites, Arietites, Coroniceras, Vermiceras, Arnioceras, Euasteroceras, Oxynoticeras, Gleviceras , Radstockiceras, Echioceras, Paltechioceras, Leptechioceras* [9, 3, 5, 10].

In the Pliensbachian age the Mediterranean *Partshiceras* and *Audaxlytoceras, Arieticeras,* the

Middle European *Zetoceras, Tropidoceras, Uptonia* and a cosmopolitan *Amaltheus* occur.

In the Toarcian age the ammonites reached their bloom. The number of genera and species (27 genera and 80 species) increased. Apparently, the bionomic conditions were most favorable for the prosperity of ammonite fauna. Among the discovered genera *Calliphylloceras, Partshiceras, Harpoceras, Hammatoceras, Planammatoceras* are Mediterranean and *Hildoceras, Polyplectus, Grammoceras, Pseudogrammoceras, Dumortieria, Pleydellia* are Central European.

In the Aalenian the number of genera reduced to 16. Among them *Tatrophylloceras, Brediya*, *Erycites* are Mediterranean and *Leioceras, Costileioceras, Staufenia, Ludwigia, Brasilia* and *Graphoceras* are Middle European.

Thus, in the area of the Southern slope of the Greater Caucasus both Mediterranean and Middle European ammonites were found. Apparently, the migration routes of the Mediterranean ammonite fauna passed across Italy and Anatolia, where analogous forms were recorded [1]. As to the Middle European representatives, they infiltrated into the region of the Southern slope of the Greater Caucasus through the Carpathians and the Crimea.

In the Northern Caucasus region, the complex of Sinemurian ammonites consists of the genera (*Arietites, Oxynoticeras Echioceras* and *Microderoceras)* characteristic of the Middle European and Mediterranean provinces [11].

In the Pliensbachian, the number of genera increased slightly. They are represented by *Pleuroceras, Arieticeras* and the Central European *Tragophylloceras, Androgunoceras* and a cosmopolitan *Amaltheus* [11].

The number of Toarcian genera and species increased compared to the Pliensbachian age. The Middle European *Hildoceras, Grammoceras, Pseudogrammoceras, Dumortieria, Pleydellia* and predominantly the Mediterranean *Peronoceras, Dactylioceras, Harpoceras, Phymatoceras, Haugia* and *Brodieia* were found.

For the Aalenian age the Middle European *Leioceras, Costileioceras, Staufenia, Ludwigia, Brasilia, Graphoceras* and predominantly the Mediterranean *Tmetoceras, Erycites, Planammatoceras* and *Hammatoceras* are characteristic [11].

The ways of migration and settlement of the Middle European Early Jurassic-Aalenian ammonoidea to the Northern Caucasus bypassed the sea of Southern Europe, directly across the Danish-Polish and pre-Dobrogea troughs [2]. And the Mediterranean fauna migrated through the Balkans, the Carpathians and the Crimea.

In addition, in the Early Jurassic-Aalenian time also a direct exchange with fauna between the seas of the Northern and Southern slopes of the Greater Caucasus took place.

In the Bajocian, differentiation of ammonite fauna significantly intensified. It led to the appearance of new families and genera that allowed to establish the Mediterranean and Middle European provinces and to raise the palaeobiogeographical areas, distinguished by us, to the rank of subprovinces.

The complex of ammonoidea of the Lesser Caucasian subprovince consists of the Mediterranean *Calliphylloceras, Phylloceras, Partschiceras, Pseudophylloceras, Thysanolytoceras, Nannolytoceras, Dinolutoceras, Eurystomiceras, Vermisphinctes* and the Middle European *Oppelia, Stephanoceras, Parkinsonia, Cadomites* [4, 12].

To the south, the Nakhichevan subprovince is distinguished [2]. It contains a rich ammonite fauna [13]. Here, together with Phylloceras and Lytoceras the Mediterranean *Spiroceras, Dorsetensia, Lissoceras, Otoites, Sphaeroceras, Leptosphinctes* and the Middle European *Chondroceras, Strigoceras, Oppelia, Oecotraustes, Cadomites, Stephanoceras, Strenoceras, Garantiana, Pseudogarantiana* and *Parkinsonia* are recorded. Apparently, the penetration and settlement of ammonite fauna in the Nakhichevan subprovince went on across the system of depressions of the southern

branch of the Tethys, via Iran [2].

In the Bajocian age, the subprovince of the South Caucasian intermountain area was involved in the downward movements. The width of the strait located here since the Early Jurassic and Aalenian considerably reduced. The Bajocian transgression completely blocked the southern periphery of the Dzirula massif, although with some delay, as the base of the Bajocian verified with ammonite fauna starts here from its second zone [9]. Westward, in Okriba and Khreiti, marine regime was established. In spite of the intense manifestation of volcanic activity in this area, from time to time the ecological environment was favorable for the development of numerous mollusk fauna. The presence of cephalopods with prevalent representatives of *Lytoceras* and *Phylloceras* shows the close connection between the subprovince of the South Caucasian intermountain area and the Tethys Ocean.

In the Bajocian ammonite complexes of Okriba, Khreiti and of the Dzirula massif *Phylloceras, Calliphylloceras, Thysanoceras, Thysanolytoceras, Eurystomiceras, Nannolytoceras, Okribites, Oppelia, Sphaeroceras, Stephanoceras, Strenoceras, Parkinsonia, Emileia, Garantiana, Vermisphinctes* and the Middle European *Orthogarantiana* were recorded [12,14,15].

Further to the north, in the subprovince of the Southern slope of the Greater Caucasus in the ammonite fauna, together with phylloceras and lytoceras (*Pseudophylloceras, Thysanolytoceras, Eurystomiceras, Nannolytoceras, Dinolytoceras* and *Lytoceras*) *Hyperlioceras, Toxolioceras, Sonninia, Otoites, Spaeroceras, Garantiana, Parkinsonia* were discovered [12].

The marine basin existing in the Northern Caucasus in the Bajocian age, raised to the rank of subprovince, is characterized by rich generic and species composition. In the complex of ammonites, as already mentioned, representatives of *Phyloceras* and *Lytoceras* take a significant place. Below, a list of genera that allowed to specify certain issues of palaeobiogeography is given. They include the genera inhabiting the Middle European region - *Toxolioceras, Sonninia, Witchellia, Stephanoceras, Strenoceras, Pseudogarantiana, Garantiana, Parkinsonia, Praebigotites, Prorsisphinctes*, as well as the genera predominantly occurring in the Mediterranean region – *Spiroceras, Reynesella, Hyperlioceras, Dorsetensia, Lissoceras, Emileia, Otoites, Normannites, Stemmatoceras, Cadomites, Sphaeroceras* and *Leptosphinctes* [16, 17, 18]. Migration routes and the dispersal of ammonites in the North Caucasian subprovince were the same as in the Aalenian age, i.e. across the Danish-Polish and pre-Dobrogea troughs and the Mediterranean fauna migrated across the Balkans, Carpathians and the Crimea.

From the foregoing we can draw the following conclusions: Quantitatively the richest Sinemurian complex of ammonites occurs in the regions of the Lesser Caucasus and the Southern slope of the Greater Caucasus. In the South Caucasus, in comparison with the North Caucasus, in the composition of Sinemurian-Pliensbachian ammonite fauna the Mediterranean genera prevail. Toarcian-Aalenian ammonite complexes of the Southern Caucasus are poorer to some extent than those of the North Caucasus. The composition of ammonites is mixed. It is represented by the Mediterranean and Middle European forms, as well as by the forms common to both biogeographic units. In the formation of ammonite complexes of the Caucasus a major role is played by their exchange with other basins, particularly with the seas of South and North-Western Europe.

Thus, on the basis of palaeobiogeographical analysis of the Early Jurassic-Bajocian ammonite fauna of the Caucasus, the routes of migration and areas of their dispersal can be specified and therefore, the boundaries of paleobiogeographical basins of the considered region be determined.

გეოლოგია

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** ი.ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტის ა. ჯანელიძის გეოლოგიის ინსტიტუტი, თბილისი*
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კავკასიის ადრეიურულ-ბაიოსური ამონიტების ეკოლოგიისა და ევოლუციური განვითარების შესწავლის საფუძველზე დადგინდა ამ ცხოველთა მიგრაციის გზები და განსახლების ადგილები. დაზუსტდა პალეობიოგეოგრაფიული საზღვრები და დასაბუთებულია ადრეიურულ-აალენურ დროს კავკასიის ტერიტორიაზე 4 პალეობიოგეოგრაფიული რაიონის არსებობა: 1. მცირე კავკასიონის; 2. სამხრეთ კავკასიის მთათაშუა არე; 3. კავკასიონის სამხრეთი ფერდობის და 4. ჩრდილოეთ კავკასიის. ბაიოსური საუკუნის ბოლოს მოხდა ამონიტური ფაუნის საგრძნობი დიფერენციაცია და ახალი ოჯახებისა და გვარების წარმოშობა. დასაბუთებულია არსებული პალეობიოგეოგრაფიული რაიონების უფრო მაღალ, ქვეპროვინციის რანგში აყვანა და ნახიჭევანის ქვეპროვინციის არსებობა.

REFERENCES

1. *A.L.Tsagareli* (1960), MGC XXI sessiya, Dokl. Sov. Geol., M.: 130-137 (in Russian).
2. *K.O. Rostovtsev* (1978), Voprosy paleobiogeografii, Ufa: 97-102 (in Russian).
3. K.*Sh. Nutsubidze* (1966), Tr. GIN AN GSSR, nov. ser., **8**, Tbilisi: 212 s. (in Russian).
4. *T.A. Gasanov* (1997_1), Geol. Azerbaijana. Stratigrafiya, **1**, Baku: 55-57 (in Russian).
5. *M.V. Topchishvili* (1996), Tr. GIN AN GSSR, nov. ser., **108,** Tbilisi: 216 s. (in Russian).
6. *M.V.Topchishvili*, *G.Sh. Nadareishvili* (2004), Tr. GIN AN Gruzii, nov. ser., **119**: 150-178 (in Russian).
7. *M.V.Topchishvili* (1969), Tr. GIN AN GSSR, nov. ser., **21**: 132 s. (in Russian).
8. *K.O. Rostovtsev, E.A. Prozorovskaya, M.V. Topchishvili* (1992), Tr. Mezhved. Stratigraf. Kom., **22,** Sankt-Peterburg: 63-66 (in Russian).
9. *I.R. Kakhadze* (1947), Tr. GIN AN GSSR. Ser. Geol., **3** (8), Tbilisi: 371 s. (in Russian).
10. *V.B. Agayev* (1997), Geol. Azerbaijana. Stratigrafiya, **1**, Baku: 42-51 (in Russian).
11. N.V. Sakharov, Editor (1973),Ob'yasnitel'naya zapiska k stratigraficheskoy skheme yurskikh otlozheniy Severnogo Kavkaza, M.: 194s. (in Russian).
12. *M.V.Topchishvili,et al.* (2006), Tr. GIN Nats. Akad. Nauk Gruzii, nov ser., **122:** 450s. (in Russian).
13. *T.A. Gasanov* (1997_2), Geologiya Azerbaijana. Stratigrafiya, **1**, Baku: 72-73 (in Russian).
14. *I.R. Kakhadze* (1942), In: Sak. SSR Geol. Inst. Shromebi [Proc. Geol. Inst. Georg. SSR], ser. geol., **1** (6), 3: 208-333, Tbilisi (in Georgian).
15. *E.K. Vakhania* (1976), Yurskie otlozhenia Gruzii (v sviazi s neftegazonosnostyu), Tr. VNIGNI, **207**, Tbilisi: 413s. (in Russian).
16. *K.O. Rostovtsev* (1992), Tr. Mezhved. Stratigraf. Kom., **22,** Sankt-Peterburg: 16-19 (in Russian).
17. K.O. Rostovtsev, D.I. Panov, N.V. Beznosov (1992), Tr. Mezhved. Stratigraf. Kom., **22**, Sankt-Peterburg: 19-25 (in Russian).
18. *D.I. Panov, N.V. Beznosov, K.O. Rostovtsev* (1992), Tr. Mezhved. Stratigraf. Kom., **22**, Sankt-Peterburg: 38-42 (in Russian).

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