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SOME FEATURES OF THE HISTORY OF FLORA FORMATION IN THE CHU RIVER VALLEY

The article describes the history of the formation of vegetation and flora of the Chu river valley, its floristic composition and structure by geological periods. According to the results of many years of floristic research, today on the territory of the Chu River valley within Kazakhstan, there are 730 species of vascular plants belonging to 350 genera and 70 families. According to the species composition, the division Magnoliophyta dominates in the studied territory of the Chu River valley, which accounts for 99.3% and 17.6% belongs to Liliophyta. The largest number of species is concentrated in the subclasses Rosidae, Caryophyllidae, Lamiidae, Dilieniidae and Ranunculidae, each of which has families of 1-2 families, abundant genera and species, the rest of the families are represented by a small number. The history of the development of vegetation and flora of the river valley. Chu is only a part of the history of vegetation in Central Asia and Kazakhstan as a single region of major rank. Analysis of paleobotanical spore-pollen spectra of Tertiary and Quaternary deposits showed that the most ancient types of vegetation in the Chu River valley are xerophytic steppe and desert vegetation.

Key words: biodiversity, flora, vegetation, valley, Chu river.

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Чу өзенінің алқабының флорасының қалыптасу тарихының кейбір ерекшеліктері

Мақалада Шу өзенінің алқабындағы өсімдіктер мен флораның қалыптасу тарихы, оның флористикалық құрамы және геологиялық кезеңдер құрылымы келтірілген. Жүргізілген көп жылдық флористикалық зерттеулердің нәтижелері бойынша бүгінгі күні Шу өзенінің алқабы аумағында Қазақстан шегінде 350 ұрпаққа және 70 тұқымдасқа жататын тамырлы өсімдіктердің 730 түрі бар. Түрлер құрамы бойынша Шу өзенінің алқабының зерттелген аумағында Magnoliophyta бөлімі басым, оның үлесі 99,3% және 17,6% Liliophyta-ға жатады. Түрлердің ең көп саны rosidae, Caryophyllidae, Lamiidae, Dilieniidae және Ranunculidae кіші сыныптарында шоғырланған, олардың әрқайсысында 1-2 отбасы, мол ұрпақтар мен түрлер бар, қалған отбасылар аз мөлшерде ұсынылған. Шу өзені алқабының өсімдіктері мен флорасының даму тарихы ірі дәрежедегі бірыңғай өңір ретінде Орта Азия мен Қазақстанның өсімдіктер тарихының бір бөлігі ғана болып табылады. Үшінші және төртінші шөгінділердің палеоботаникалық спора-тозаң спектрлерін талдау Шу өзенінің алқабындағы өсімдіктердің ең көне түрлері ксерофитті дала және шөлді өсімдіктер екенін көрсетті.

Түйін сөздер: Биоәртүрлілік, флора, өсімдіктер, алқап, Чу өзені.

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Некоторые особенности истории формирования флоры долины реки Чу

В статье приводится история формирования растительности и флоры долины реки Чу, ее флористический состав и структура по геологическим периодам. По результатам проведенных многолетних флористических исследований на сегодняшний день на территории долины реки Чу в пределах Казахстана насчитывается 730 видов сосудистых растений, относящихся к 350 родам и 70 семействам. По видовому составу, на исследуемой территории долины реки Чу доминирует отдел Magnoliophyta, на долю которого приходится 99,3 % и 17,6 % относится к Liliophyta. Наибольшее количество видов сосредоточено в подклассах Rosidae, Caryophyllidae, Lamiidae, Dilieniidae и Ranunculidae в каждом из которых имеются семейства по 1-2 семейства, обильными родами и видами, остальные семейства представлены небольшим количеством. История развития растительности и флоры долины р. Чу является лишь частью истории растительности Средней Азии и Казахстана как единого региона крупного ранга. Анализ палеоботанических споро-пыльцевых спектров третичных и четвертичных отложений показал, что самыми древними типами растительности долины реки Чу, являются ксерофитная степная и пустынная растительность.

Ключевые слова: Биоразнообразие, флора, растительность, долина, река Чу.

Introduction

The aim of this work was to study the history of the formation of the flora of the Chu river valley. The study of the history of the formation of the flora of desert territories in recent years is of great scientific interest [1,2,3,4,5]. It is especially important to study the flora of individual, poorly studied regions located in the desert zone, where the flora and vegetation of the floodplains of rivers, terraces, coastal strip are most vulnerable, which in turn is expressed in a significant change in pristine biocenoses, a decrease in the areas and stocks of species populations and even their destruction. One of these regions is the river valley. Chu, which has long been experiencing significant anthropogenic pressure associated with increased economic activity.The Chu River originates from the glaciers and snowfields of the Terskey Alatau and the Kirghiz ridge, formed by the confluence of the Dzhuanaryk and Kochkar rivers (in the northern spurs of the Tien Shan) (42º41′ N, 75º55′ E) slightly west of the lake. Issyk-Kul through the Boam gorge, it enters the plain and, describing a giant arc, carries its waters into the desert [6,7].

Valley of the r. Chu is located in the south of Kazakhstan between the Betpak-Dala desert and the Chu-Ili mountains in the north and the Moyinkum sands in the south. The length of the Chu river valley is about 1186 m (Figure 1).

The headwaters and part of the middle reaches of the Chu River, with almost the entire catchment area, are located in Kyrgyzstan. Within Kazakhstan, the valley stretches for 800 km, part of the middle reaches and the lower reaches of the river. The Chu River below the Furmanovka village splits into a number of channels and forms several extensive floods. Administratively, the lower reaches of the Chu river valley (Furmanov, Ulanbel and Kamkaly) lie in Kazakhstan within two regions – Zhambyl and South Kazakhstan. The territory of the river. Chu with the adjoining Betpak-Dala and the Moyinkum sands belongs to the dry hot zone of deserts, and only the southern and southeastern part (the territory of the Tas-Utkelsky massif) is located in the arid hot zone of the foothills and flattened low mountains. On the territory of the river valley. Chu, there is a contrast in climatic conditions, significant fluctuations in the hydrothermal coefficient, the values of average annual precipitation. The average annual temperature is positive 8-9 ° C. The coldest month is January (- 9 – 10), especially hot – July-August (from +22 to +29). In the spring, the temperature rises rapidly. In the second decade of February and the first decade of March, the snow melts ends [8]. Frosts in the air in the northern part cease on 21. IV, in the southern part 29. IV. The frost-free period lasts 161 days. The average annual precipitation varies from 265-268 mm (Chu-Tolebi) to 170-167-140 mm (Furmanov, Ulanbel, Kamkaly). In summer, the amount of precipitation decreases significantly. In spring, precipitation is 30-42% of

the annual amount, in summer – 12-16%, the rest falls in autumn and winter. The territory of the river Chu is subject to systematic winds throughout the year (Figure 2). The strongest winds are observed in winter and spring, the speed reaches 2.5-7.6 m / s [8].

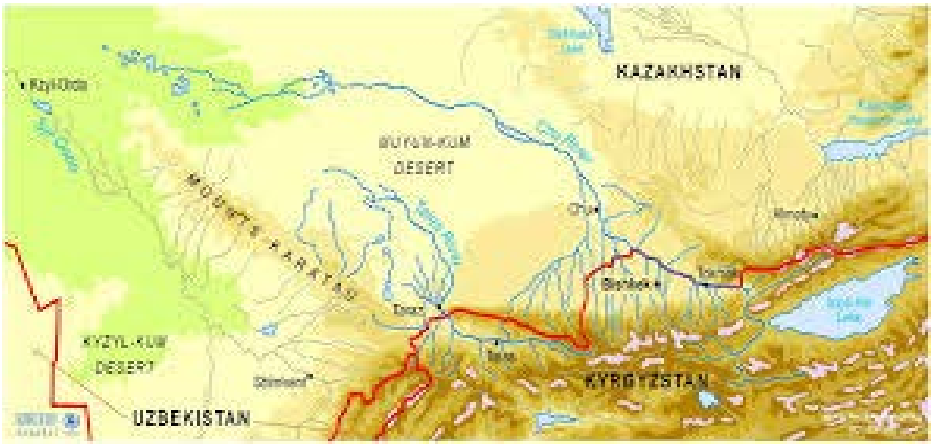

Figure 1 – Shu River

Figure 2 – Chu river

Materials and research methods

In the process of writing the history of the formation of the flora of the Chu river valley, there were sources:, "Flora of the USSR" [9], "Trees and bushes of the USSR" [10], "Flora of Kazakhstan" [11], "Trees and bushes of Kazakhstan" [12], "Plants of Central Asia" [13], "Key to Plants of Central Asia" [14], "Illustrated Key to Plants of Kazakhstan" [15], as well as the works of L.Ya. Kurochkina [16, 17, 18], E.P. Korovin [19, 20, 21], B.A. Fedorovich [6], V.I. Eliseev [22], K.V. Nikiforova [23], L.S. Berg [24], E.F. Wulf [25], V.M. Sinitsyn [26], M.M. Ilyin [27], E.D. Zaklinskaya [28, 29], B.A. Bykov [30, 31], M.G. Popov [32], A.N. Krishtofovich [33], V.S. Kornilova [34, 35, 36], E.F. Kutuzkina [37], P.Ya. Abuzyarova [38], Z.A. Svarichevskaya [39], N.N. Kostenko [40]. To clarify the specific and generic names, the latest reports by S.K. Cherepanov [41], S.A. Abdulina [42], A.L. Takhtadzhyan [43].

Research results and their discussion

As a result of long-term studies of the flora of the Chu river valley, we have identified 730 species belonging to 350 genera and 70 families. Angiosperms form the basis of the flora of the Chu river valley. Flora of angiosperms according to the system of A.L. Takhtadzhyana is represented by 7 subclasses from Magnoliopsida (dicotyledonous) and 3 subclasses from Liliopsida (monocotyledonous). The largest number of species is concentrated in the subclasses Rosidae, Caryophyllidae, Lamiidae, Dilieniidae and Ranunculidae, each of which has families of 1-2 families, abundant genera and species, the rest of the families are represented by a small number. The subclass Asteridae is represented by one polymorphic family, Asteraceae. The smallest number of species is represented in one subclass of dicotyledons (Magnoliidae), and in two subclasses of monocotyledons (Alismidae and Arecidae). In monocotyledonous the majority of species are concentrated in the subclasses Liliidae, in particular in the families *Poaceae, Cyperaceae, Juncaceae* and *Liliaceae*.

Valley of the r. Chu occupies the eastern part of the vast Chuya depression, the formation of the ancient relief of which is reflected in the works of B.A. Petrushevsky [44], S.S. Shultz [45], V.I. Eliseev [46], K.V. Nikiforova [47] and others. Their brief position is as follows. The formation of the depression belongs to the lower cretaceous [47, 48]. However, the main landforms were laid down in the Paleozoic, when the areas of depression of the Chuya depression, the large southeastern and small northwestern ones, were mainly determined [49]. The depression is filled mainly with loose mesozoic-cenozoic sediments. Cretaceous deposits are strongly eroded and kept only in the form of a weathering crust on the remnant uplands of the Paleozoic. To a large extent, the depression is filled with paleogene sediments, among which the Upper oligocene red-colored gypsum clays of the Kendyrlyk Formation (according to K.V. Nikiforova) are the most widespread. In the neogen, due to the dominance of denudation and removal processes, deposits are enriched with pebbles, gravel, and debris. These deposits, which received the most widespread development, were united by K.V. Nikiforova [47] into the Andassai formation. Towards the end of the pliocen, in connection with climate change towards cooling and humidification, there is an accumulation of pale-chocolate lacustrine sediments, identified by the same author, in the Kendyrlyk formation. On the border of the neogen and anthropogen, intense tectonic movements begin, the Tien Shan grows, the climate becomes humid, and erosional phenomena intensify.

The alluvial-proluvial deposits of the Kirghiz ridge overlapped with a thick layer from the south a significant part of the ancient surface of the Furmanov (Gulyaev) depression before the penetration of the river. Chu. From the north and north-east, a stratum of coarse proluvial deposits of the Chu-Ili and Kendyktas mountains descended here. The alluvial-proluvial deposits of the northern and southern mountain framing converged at an oblique angle, forming a giant depression from the Ulan-Tumsuk scarp in the southeast to a remnant plateau called Tas-Suek-Oba in the west, which was used by the Chu River, forming its first large intravalley delta. The geomorphological structure and relief of the Chu river valley largely determines the direction of soil formation processes, which contributes to the distribution of river runoff, which is closely related to the history of the development of the valley, which is a series of deltaic expansions of different ages connected by narrow necks. Its formation was carried out by sequential filling with alluvium of the Furmanov, Ulanbel, Kamkaly depressions and took place in several stages. The first area of accumulation of the Chu sediments (stage 1) was the Furmanov depression, vast and deep, which by the time of the penetration of the Chu River was largely filled with alluvial-proluvial drifts from this mountain frame. With a small thickness of the river, lateral

and bottom erosion was insignificant, here the river deposited material brought from the upper reaches. In the middle course, due to the large slopes, the river had greater strength; it cut off the proluvial plain of the Chu-Ili and Kendyktass mountains. The erosion was based on the area of the Karabugut expansion. The bulk of the Chu water flowed into the Furmanov depression, forming the shallow Karabugut lakes. Most of the water was spent on evaporation and transpiration, since the climate did not undergo sharp changes in the Quaternary period [49]. Thus, at the first stage of development, the vast area of the Furmanov spills was an intravalley delta, the head part of which can be traced somewhat below the settlement of Berlik, where the first fork begins – the dried up right-bank channel of the Saksaul-Dala. As the mountains rose, the runoff increased. Due to regressive erosion, the size of the valley increased both in length and in the volume of annual water flow. The increasing mass of water of solid suspensions could no longer fit in the Furmanov delta and two branches of the Saroi and Kazykty branches, penetrated into the Ulanbel depression (2nd stage), where it formed a new Ulanbel delta. The river outburst caused geomorphological restructuring above the formed valley.

Due to the lowering of the groundwater level, significant areas were prone to drying out and desertification, the right-bank alluvial plain of Saksaul-Dala got lost. The next third stage of the formation of the valley is associated with the penetration of the river. Chu into the Kamkaly depression and the formation of the next Kamkaly delta. The new basis of erosion caused the formation of another terrace above the floodplain in the previously formed valley. This terrace (1 above the floodplain) is narrow and fragmentary; it is compressed on the Tas-Utkel massif and in the head of the Ulanbel spills, at the exit from the Kazykty mouth. The penetration of the Chu into the area of the final runoff (stage 4), after filling the shallow Kamkaly depression, proceeded smoothly almost simultaneously with the Kamkaly depression, without causing changes in the relief above the formed valley; therefore, no terraces are observed in the Kamkaly floods. Large remnant islands, composed of paleogene rocks, rise above the flat surface of the scattered floodplain of channel channels [49]. M.A. Orlova [49], summarizing all available information on paleogeology and calculating the time of filling the depressions, concludes that the Chu river penetrated into the Furmanov basin in the neopleistocen (1st stage) about 130 thousand years ago, that is 96% of the entire time, the activity of the river was aimed at filling the Furmanov (the old name of the Gulyaev) hollow with alluvium. After filling the Furmanov depression, the river with two branches – the Saroi and Kazykty, skirting the Tas-Suek-Oba plateau, broke through into the Ulanbel and then into the Kamkaly shallow depressions. Having reached the territory of the modern final flow (the area of Lake Ashchikol), the river, according to M.A. Orlova turned out to be dammed by the keltiminar deposits of the Syr-Darya, which had formed long before the Chu river penetrated here and had a slope of about 0.000022 from the Syr -Darya towards the lower reaches of the Chu river and the Sarysu alluvium. Thus, the most ancient sediments of the Chu River valley in the lower reaches were formed in the Furmanov spills. Modern landforms are mainly formed by the activity of the river, which branches into a mass of branches in the areas of wide parts of the floodplain and merges into one or two channels in places of its narrowing.

The history of the formation of the flora of the Chu river valley is associated with the uplift of the Buruntau mountains and adjacent parts of the Eastern Betpak-Dala upland, as well as with the uplift of the Kirghiz and Karatau ranges. The uplift of these mountains in the Paleogene epoch led to a reduction in the water surface of the Tethys Sea and, consequently, increased climate aridization [47]. According to geologists [48], the northern arcs of the Tien Shan are characterized by continental deposits, which indicates the long existence of land in this region. As noted by V.M. Sinitsyn [26], in the paleogene era, the Tien-Shan was already a highland with clearly marked blocky ridges and intermontane depressions. However, the general hypsometric level of the country in the paleogene was 2-3 times lower than the present one. At the same time, peripheral depressions open to the Turan plains (Fergana, Angren, Chui and others) were flooded by the sea.

The history of the development of vegetation in the valley of the river. Chu is only a part of the history of vegetation in Central Asia and Kazakhstan as a single region of major rank. Paleobotanical remains of that time from the territory of the Northern Tien-Shan and the Chu river valley are absent, and the complex of flora can be judged from the burials found in a number of places in Central Asia and Northern Kazakhstan, including both plant remains and data from spore-pollen complexes. Thus, according to the numerous data on the Late Cretaceous floras [15, 45], as well as according to the spore-pollen analysis of the Cretaceous strata [23], it can be assumed that in the upper cretaceous, up to the

paleogene borders, the territory of Central Kazakhstan, including the Betpak-Dala desert and the adjacent valley of the river. Chu was still in the zone of influence of the vast Tethys Sea. In this area with a humid and warm climate, rich subtropical flora was developed, which contained a large number of ferns, conifers and ancient angiosperms. As noted by V.M. Sinitsyn [22] the upper cretaceous dinosaurs were accompanied by crocodiles and aquatic turtles, whose remains in places form whole layers of bone-bearing breccias. The earliest mammals, dinocerates and creodonts, appeared on the border with the paleogene. Already at the end of the cretaceous, when the temperature began to drop to 8-6, at which reptiles lose their activity and even stop moving, giant representatives of this class, most characteristic of the mesozoic fauna, begin to die out quickly, in the paleogene they are replaced by warm-blooded mammals, able to withstand significant fluctuations in ambient temperature. In the early paleogene, on the territory of Betpak-Dala and adjacent regions of Central Asia, the subtropical Poltava flora of the savanna type dominated in upland areas and of the type of island forests in depressions. This is confirmed by the data of the analysis of the spore-pollen spectrum of the lower sediments [28] which indicate that a rich subtropical flora of the xerophytic type existed in the oligocene. According to paleobotanical data the first desert elements – *Chenopodiceae, Fabaceae, CaryophylIaceae, Limoniaceae, Rosaceae, Ephedra, Haloxylon, Artemisia* and others – appeared on the territory of South Kazakhstan by the end of the eocen, where their role increased even more in the oligocene [28]. In our opinion, according to the studies of E.P. Korovin [19], B.A. Bykov [30], E.M. Lavrenko [50] on the territory of the river valley. Chu species of the following genera could have survived as relicts: *Calligonum, Artrophytum, Ephedra, Ijinia, Zygophyllum* and others. At the same time, at the end of the cretaceous and at the beginning of the Tertiary period, the penetration of northern Turgai type settlers into the territory of Kazakhstan begins. One of the first waves of boreal flora took place in the first half of the Tertiary. As noted by V. M. Sinitsyn [22], the change of floras took place in connection with the cooling and the manifestation of sharper zoning. The composition of the Turgai flora was more or less uniform throughout the warm temperate zone. In the historical development of the faunas of the Paleogene, the transition of the leading role from the forest fauna at the beginning of the period to the fauna of open spaces at the end of the period is noted. According to the data of M.G. Popov [32], M.M. Ilyin [27], E.M. Lavrenko [47] in the middle of the Tertiary period, due to the reduction of the ancient Tethys sea, climate aridization occurs, where the deserts of Turan, Western Asia, partly Mongolia and Kashgaria. At the beginning of the neogen, on the basis of mesophilic elements and the modernization of the Poltava flora preserved in the composition of the oligocene flora, the ancient Mediterranean flora was formed. In the course of the miocene, the ancient Mediterranean flora gradually acquired a xerophilous appearance, where the xerophilic desert flora then developed. Hence, it can be assumed that from the deserts of Turan and Central Asia there was a settlement on the territory of the valley of the river. Chu Turanian and Central Asian species. In the upper paleogene-oligocene, there are also no plant remains directly related to the region of the Northern Tien Shan [51]. In relation to the valley of the river. Chu there are materials on the fossil fauna mainly related to the territory of the river valley. Chu from the northwest and northeast. Spore-pollen spectra are known for vegetation of the upper oligocene and lower miocene in the regions of the southeastern Betpak-Dala. Thus, in the flora of the Chu-Sarysu depression and Betpak-Dala, the remains of which were collected in the Aquitanian deposits of the Askazansor suite (upper oligocene) south of the Ak-oi depression in the southeastern part of Betpak-Dala, wood remains, spores and pollen were found: Abies – 1, Picea -16, Pinus -33, Betula – 11, Alnus -1, Artemisia – 1, other forbs – 1 grain [46]. According to E.D. Zaklinskaya [28,29] the pollen of woody species is 90,9%, non-woody species – 9,1%. Judging by the list of pollen and spores given in the work, it can be seen that the upper oligocen is characterized by a predominance of angiosperms of the Turgai broad-leaved flora, but still with a rather large participation of rigid-leaved evergreen flora. Summing up the results of the study of the oligocene flora E.P. Korovin [20] comes to the conclusion that on the same territory, side by side, there were various flora with their heredity and in their own way adapted to the habitat conditions: Turgai forest and Turkmen (Poltava) xerophilous. For a long time these floras were the sources from which nature drew material for the autochthonous development of Central Asia. The composition of the fauna, according to V.I. Eliseev [22] combines elements of the middle and upper oligocen, and partly the miocene (Askazansor) fauna. So, along the right bank of the Chu, on the highlands of the eastern Betpak-Dala, in pebble and cross-bedded sands, remains of bones and teeth were collected, among

which E.I. Belyaeva [22] identified: *Indricotheriidae, Allaceropinae, Enteldonidae, Anthracotheriidae* and *Hyaenodontidae.* As noted by V.I. Eliseev: "the structure of the skeleton of the listed animals allows the assumption that they ate the leaves of trees, from which we can conclude that there were forests in the territory under consideration in the upper oligocene. However, the forests, apparently, did not cover the investigated territory with a continuous cover, among them there were also open spaces necessary for the habitation of Allaceropinae, the structure of the skeleton of which suggests that they were good runners" [22]. The spore-pollen complex of the Tortonian deposits in the middle miocene, according to E.D. Zaklinskaya [28,29] is characterized by the presence of a steppe complex of vegetation with a predominance of pollen from non-wood species. Herbaceous species include pollen *Artemisia, Ephedra, Poaceae, Apiaceae, Chenopodiaceae, Asteraceae* and a group of forbs. The pollen of tree species is no more than 10-15%, and contains the genera *Pinus, Picea, Taxodium*, single *Betula, Alnus, Ulmus*.

Thus, the above spore pollen analysis of Tortonian deposits showed that mesophilic tree species begin to disappear in the middle of the miocene, and instead of forest formations, herbaceous cenoses appear, which consist of grasses, wormwood, and others. The territory of Betpak-Dala and the adjacent valley of the Chu river during the miocene is a treeless space, with a predominance of vegetation of the steppe and semi-desert type, with separate island forests along the river banks. And, as noted by E.P. Korovin [21] treeless plains continue to exist in the pliocene. Starting from the middle of the miocene, the climate shifted towards cooling, which resulted in the ancient glaciation of the quaternary period. Until that time, most of Europe was occupied by the Poltava flora of deciduous elements [25,33]. However, by the time of glaciation, the Turgai cold-resistant species displaced the Poltava flora to the west and southwest, and a uniform type of flora was established throughout Northern Eurasia. In the second half of the tertiary – neogen, an intensive uplift of the Tien Shan takes place. Not only its geomorphological appearance is changing, but also the climate. The fossil flora of the Tien Shan is of great interest, since it is a direct witness, allowing one to imagine the ways of the formation of the modern flora and vegetation of the Chu river valley. Plant remains of this time are known from various intermontane depressions of the Central and Eastern Tien-Shan (Kochkor, Issykul, Karkarinsk, Tekes). Thus, in the generalized list of V.S. Kornilova [35] from the Middle Miocene occurrences of the Kochkor depression along the banks of the Chon-Tuz and Kichik-Tuz rivers, E.F. Kutuzkina [37] established the following species for this locality: Gramineae gen. et. sp. indet., Potamogeton miralibis Kutuz., Potamogeton sp., Phragmites oeningensis A. Br, Populus nigra L., P. praeeuphratica Kutuz., P. pruinoza Schrenk, Salix of. argyraceae Wolf, S. densinervis Kutuz., Ulmus carpinoides Goepp., Ulmus sp., Trap asp., Fraxinus sp., Lonicera sp., Acer of. turkestanicum pax. In the same deposits of R. Ya. Abuzyarova [143] a spore-pollen complex was isolated (in%): Lycopodiaceae, Polypodiaceae, Filicales no more than 0.3; Abies sibirica – 3,5; Picea sect. Eupicea – 1-2; Pinus s/g, Hap1oxyIon – 14-40; Diploxilon – 0,5-1; Ephedra sp. – 0,5, Salix sp. – 1, Alnus sp. – 0,5, Betula sp. – 15, Carpinus sp. – 0,5-1, Ulmus sp. – 4-12, Ulmaceae – 0,5-1,5, Celtis – 0,5, Magnolia sp. – 0,5-1,5, Acer sp. – 0,3, Tilia sp. – 1-3, Quercus sp. – 0,5 -1, Jug1ans sp. – 0,5-6,5, Ericaceae – 1 -2,5; Rododendron sp. – 0,4; Lonicera sp. – 0,5; Gramineae – 0,5; Caprifoliaceae – 0,5, Typha sp. – 0,5; Phragmites sp. – 0,3; Chenopodiaceae – 0,5; Sparganium sp. – 0,5-3,0.

By the end of the Pliocene, in connection with climate changes towards cooling, intensive tectonic movements began on the border of the neogen and the anthropogen. The Tien-Shan grows, and apparently, at this time, as a result of endogenous forces, a number of second-order depressions are formed: Furmanov (vast and deep), Ulanbel (narrow and shallow), Kamkaly with large differences in relief [52]. According to the data of Z. A. Svarichevskaya [39], at the border of the pliocen and the quaternary time, the Saroi depression (area of subsidence) is formed, which, as will be seen later, was used by the r. Chu on a breakout. Towards the end of the pliocene (at the border with the quaternary), along with the growth, the Tien-Shan glaciation occurs [36,40]. The climate became so humid that the lake basins began to overflow and overflow their waters one into another, which further contributed to the formation of the river network. There was an increase in erosional phenomena. Friable material accumulates, especially along the mountains. The spore-pollen spectrum of the Akchagyl and Apsheron deposits, dating back to the upper pliocene age, indicates that at the end of the neogen, xerophilic forms prevailed in the vegetation, but some relics of more moisture-loving plants were preserved. Thus, E.D. Zaklinskaya [28] spore-pollen analysis of Akchagyl deposits showed the

predominance of steppe herbaceous vegetation and forbs, constituting 98%, while the pollen of tree species is 2% and is represented by single grains. As a result of the spore-pollen analysis of the Quaternary and Upper Miocene sediments in the area of the lake. Kamkaly-Kol and Bural-kenyntuz in the north of the southeastern part of the Chu-Sarysu depression, it was found that, starting from the Middle Absheron, throughout the entire period of accumulation of sediments, the spore-pollen spectra repeatedly change their character, which is a reflection of rhythmic changes in natural conditions in the northern parts of Eurasia. It should be noted that the structure of the earth's surface and all the main elements of its reliefs in the quaternary period begin to approach modern ones, and, therefore, the conditions of the continental climate prevail everywhere. With the glacial epoch, writes I.M. Krasheninnikov [54], a lake-river regime arises and, accordingly, forest vegetation develops. Xerophytic vegetation retreats to the south, spreading interglacial dry ages.

Thus, as a result of tectonic processes of postglacial accumulation by the Neopleistocen, a surface was formed, the modeling of which determined the direction of the R. Chu and the outline of its valley. Obeying the general law of the dynamics of the earth's surface, the river has done a great job of leveling the ancient relief. Destroying the rocks of mountain structures, it carried out the material and filled them with the most lowered areas of the ancient plains [53]. The influence of the floodplain-alluvial regime, as well as the vegetation of the watersheds of the Moyinkum sands and the Betpak-Dala desert, created conditions for the formation of the flora of the Chu river valley.

As for the history of the development of flora in the Quaternary period on the territory of the Chu river valley, there are materials of palebotanical studies of the intermontane depressions of the northern Tien-Shan. V.S. Kornilova [35] two localities were established, where one of the localities of the fossil flora was found in the Boam Gorge of anthropogenic age, and the second location, this burial of plant remains was found on the southern bank of the Issyk-Kul near the mouth of the Akterek river. Thus, in the upper section of the Boam gorge, on both banks of the Chu river, quaternary astracodes and gastropods, the jaw of a large deer – Megaloceras and a fern imprint – Onoclea sensibilis L, as well as imprints of bog plants were found. From plant residues: Monocotyledoneae – 12.6%; Sparganium sp. – 3%, Potamogeton pliocenicum – 6%, Myriophyllum boamicum Korn. – 44%. As can be seen from the spore-pollen spectrum, the flora from the Boam gorge from the middle anthropogenic deposits is represented by the remains of coastal water and submerged herbaceous plants, composed of fossil forms of modern species. Hence, it can be assumed that the meadow-bog vegetation of the river valley. Chu descended from the mountains of the Northern Tien Shan. V.I. Zauer [23] isolated the pollen of taxa *Chenopodiaceae, CaryophylIaceae, Cruciferae, Umbelliferae, Artemisia* from the sediments of the upper anthropogen in the Saroi depression and the lower reaches of the Chu river, of which haze pollen prevailed. Pollen analysis of the Saroi formation from the Saroi Basin, according to the data of Z.I. Gurieva [23] showed the presence of steppe semi-desert vegetation. As noted by V.S. Kornilova [36] tree species were not found, since in the era of the upper anthropogen here, as well as on a larger area of flat Kazakhstan, apparently, treeless spaces were already undividedly dominated.

Conclusion

Thus, paleobotanical spore-pollen spectra of tertiary and quaternary deposits showed that the most ancient types of vegetation in the valley of the river. Chu, are xerophytic steppe and desert vegetation. Their roots go back to the Paleogen, where, with the reduction of the Tethys Sea, the deserts of Turan, Iran and Central Asia arise, from where the Turanian and Central Asian species began to settle. Found remains of *Populus, Tamarix, Haloxylon, Callygonum* and others indicate that in the valley of the river. Chu, at the end of the Tertiary period, tugai forests already existed. As noted by B.A. Bykov [31] tugai forests and light forests, especially along the rivers of South Kazakhstan, are associated with the former savannah. Turanga forests are formed by special poplars from the Turanga desert section (*Populis diversifolia, P. pruinosa*), oak tree (*Elaeagnus oxycarpa*), silver shengil shrubs (*Halimodendron halodendron*), comb beetles (*Tamarix ramosissima, T. laxcium*), lyceum, clematis (*Clematis orientalis*) and others. In addition to the physical and geographical factors of the environment, human activities influenced the formation of the flora of the Chu river valley. It is known that the valley of the Chu river stood in the way of the movement of caravan routes, which connected the southern cities with settlements of Central Kazakhstan, where cultural and trade relations between Central Asia and Siberia were carried out. Also, the activity of farmers,

plowing the most fertile areas of the middle part of the Chu river valley, had no less influence on the impoverished flora of the valley, in addition, the Chu river valley has long been a pasture for winter grazing, which explains the significant presence of weed species in the flora.

References

1 Peter B. Heenan, Matt S. McGlone. (2019) Cenozoic formation and colonisation history of the New Zealand vascular flora based on molecular clock dating of the plastid rbcL gene (New Zealand Journal of Botany). Vol. 57. Issue 4 pp. 204-226.

2 Robert W. Gess & Cyrille Prestianni. (2021) An early Devonian flora from the Baviaanskloof Formation (Table Mountain Group) of South Africa. (Sci Rep) vol. 11, 11859. https://doi.org/10.1038/s41598-021-90180-z.

3 Edwards, D., Morris, J. L., Richardson, J. B. & Kenrick, P. (2014) Cryptospores and cryptophytes reveal hidden diversity in early land floras. (New Phytol.) vol. 202. pp. 50–78.

4 Gerrienne, P., Bergamaschi, S., Pereira, E., Rodrigues, M.-A.C. & Steemans, P. (2001). An Early Devonian flora, including Cooksonia from the Paraná Basin (Brazil). (Rev. Palaeoboty Palynol.) vol. 116, pp. 19-38.

5 Kraft, P., Psenicka, J., Sakal, J. & Fryda, J. (2019). Initial plant diversification and dispersal event in upper Silurian of the Prague Basin. (Palaeogeogr. Palaeoclimatol. Palaeoecol.) vol. 514, – pp. 144–155.

6 Fedorovich B.A. (1952). Drevniye reki v pustynyakh Turana [Ancient rivers in the deserts of Turan]. Materialy po chetvertichnomu periodu SSSR. V. 3: 69-102.

7 Shchukin I.S. (1964). Obshchaya geomorfologiya. [General geomorphology]. v. 2. -364 p.

8 Pochvy doliny reki Chu (1972) [Soils of the Chu river valley], Alma-Ata, – 327 p.

9 Flora of the USSR (1934 – 1964) [Flora SSSR]. M.:L., vol. 1− 30.

10 Derev'ya i kustarniki SSSR (1966) [Trees and shrubs of the USSR], Moskva, 637 p.

11 Flora Kazakhstana (1956-1966) [Flora of Kazakhstan], Alma-Ata, vol. 1 – 9.

12 Derev'ya i kustarniki Kazakhstana (1966) [Trees and shrubs of Kazakhstan], Alma-Ata, vol. 1-2.9.

13 Rasteniya Tsentral'noy Azii (1963 -1989) [Plants of Central Asia], M.:L., vol. 1 – 9.

14 Opredelitel' rasteniy Sredney Azii (1968 – 1993) [The determinant of plants in Central Asia], Tashkent, vol.1-10.

15 Illyustrirovannyy opredelitel' rasteniy Kazakhstana (1962 – 1975) [Illustrated determinant of plants of Kazakhstan], Alma-Ata, vol. 1 – 2.

16 Kurochkina L. Ya. (1966) Rastitel'nost' peschanykh pustyn' Kazakhstana [Vegetation of sandy deserts of Kazakhstan], Alma-Ata, vol. 1. pp. 191-586.

17 Kurochkina L. Ya., Osmanova L. T. (1973) Pastbishcha peschanykh pustyn' Kazakhstana [Pastures of sandy deserts of Kazakhstan]. Alma-Ata, – 204 p.

18 Kurochkina L. Ya. (1978) Psammofil'naya rastitel'nost' pustyn' Kazakhstana [Psammophilic vegetation of the deserts of Kazakhstan]. A., -.270 p.

19 Korovin E.P. (1961-1962) Rastitel'nost' Sredney Azii Yuzhnogo Kazakhstana [Vegetation of Central Asia in South Kazakhstan]. M.:Tashkent, – 472 p.

20 Korovin E.P. (1934) Ekologicheskiye tipy pustyn' Sredney Azii i Kazakhstana v perspektivakh i ikh khozyaystvennogo osvoyeniya. [Ecological types of deserts of Central Asia and Kazakhstan in the prospects and their economic development]. Economic development of the deserts of Central Asia and Kazakhstan. L, pp. 5-20.

21 Korovin E.P. (1923) Kompleksnaya ekspeditsiya v pustynyu Betpak-Dala Tsentral'nogo Kazakhstana [Complex expedition to the Betpak-Dala desert of Central Kazakhstan]. // National economy of Kazakhstan. № 11-12.

22 Eliseev V.I. (1959) Glavneyshiye osobennosti chetvertichnykh (antropogenovykh) otlozheniy Severo-Vostochnoy pribortovoy chasti Chuyskoy vpadiny [The main features of the Quaternary (Anthropogenic) deposits of the North-Eastern part of the Chuya depression]. Izv. AN Kaz. SSR, seria geol. № 10.

23 Nikiforova K. V. (I960) Kaynozoy golodnoy stepi Tsentral'nogo Kazakhstana [Cenozoic hungry steppe of Central Kazakhstan]. Tr. geol. in-that. Academy of Sciences of the USSR. 45. – 260 p.

24 24. Berg L.S. (1953) O problematichnom usykhanii stepey i pustyn' [On the problematic drying up of steppes and deserts]. // Izv. USSR Academy of Sciences, geographer series. M., 5: pp. 5-13.

25 Wulf E.F. (1944) Istoricheskaya geografiya rasteniy [Historical geography of plants]. Istoriya flor zemnogo shara. M.:L., -545 p.

26 Sinitsyn V.M. (1962) Paleografiya Azii [Paleography of Asia]. M.:L., – 178 p.

27 Ilyin M. M. (1937) K proiskhozhdeniyu flory pustyn' Sredney Azii. [On the origin of the flora of the deserts of Central Asia]. Sovet. Botanika, № 6. pp. 45-86.

28 Zaklinskaya E. D. (1953) Materialy k istorii flory i rastitel'nosti paleogena Severnogo Kazakhstana v rayone Pavlodarskogo Priirtysh'ya [Materials for the history of flora and vegetation of the Paleogene of Northern Kazakhstan in the Pavlodar Priirtysh region]. Trudy inst-ta geol, nauk AN SSR, ser. geol. M., 141 (58).

29 Zaklinskaya E.D. (1958) Tipy sporo-pyl'tsevykh spektrov paleogenovykh otlozheniy razlichnykh fiziko-geograficheskikh provintsiy [Types of spore-pollen spectra of Paleogene deposits of various physical-geographical provinces]. Materials on the history of flora and vegetation of the USSR, M., L., vol. 3.

30 Bykov B.A. (1978) Ocherki rastitel'nogo mira Kazakhstana i Sredney Azii. [Essays on the flora of Kazakhstan and Central Asia]. Alma-Ata, – pp. 5-14.

31 Bykov B.A. (1966) Obshchiy analiz pustyn' Turanskoy nizmennosti [General analysis of the deserts of the Turan lowland]. Structure and productivity of the plant desert zone of Kazakhstan. Nauka, 1:3-36.

32 Popov M.G. (1927) Osnovnyye cherty istorii razvitiya flory Sredney Azii [The main features of the history of the development of the flora of Central Asia]. SAGU. №15.

33 Krishtofovich A.N. (1955) Razvitiye botaniko-geograficheskikh oblastey severnogo polushariya s nachala tretichnogo perioda [Development of botanical-geographical regions of the northern hemisphere since the beginning of the Tertiary period]. Problems of geology of Asia. M., – 278 p.

34 Kornilova V.S. (1961) Ob antropogenovykh florakh iz gornykh oblastey Sredney Azii [Plant remains from the Neogene sediments of the Kungey Alatau]. Materials on the history of fauna and flora of Kazakhstan. 3: 74-83.

35 Kornilova V.S. (1963) Ob antropogenovykh florakh iz gornykh oblastey Sredney Azii [About anthropogenic flora from the mountainous regions of Central Asia] Materials on the history of fauna and flora of Kazakhstan. A., 4:113-135.

36 Kornilova V.S. (1966) Ocherki po istorii flory i rastitel'nosti Kazakhstana [Essays on the history of flora and vegetation of Kazakhstan] Vegetation cover of Kazakhstan. A-Ata., -365p.

37 Kutuzkina E.F. (1957) Materialy po verkhnetretichnoy flore Kirgizii. [Materials on the Upper Tertiary flora of Kyrgyzstan] Collection in memory of A. N. Krishtofovich. M.:L.,- pp. 259-275.

38 Abuzyarova P. Ya. (1966) [Neogene flora of mountainous regions of Central Asia and South Kazakhstan]. Significance of palynological analysis for stratigraphy and paleofloristics. A., – pp. 165-167.

39 Svarichevskaya Z. A. (1961) Drevniy peneplen Kazakhstana i osnovnyye etapy yego preobrazovaniya. [Ancient peneplain of Kazakhstan and the main stages of its transformation]. L., – 275 p.

40 Kostenko N.N. (1956) Kratkaya kharakteristika chetvertichnykh otlozheniy Vostochnogo Kazakhstana [Brief characteristics of the Quaternary deposits of East Kazakhstan] Sovet. geol. 52:141-152.

41 Cherepanov S.K.(1995) Sosudistyye rasteniya Rossii i sopredel'nykh gosudarstv, v predelakh byvshego. SSSR [Vascular plants of Russia and neighboring states, within the former USSR], SPb., 990 p.

42 Abdulina S.A. (1998) Sosudistyye rasteniya Kazakhstana [Vascular plants of Kazakhstan], Almaty, 188 p.

43 Takhtadzhyan A.L. (1987) Sistema magnoliofitov [Magnoliophyte system], L., 439 p.46.

44 Petrushevsky B. A. (1942) Chuyskaya mul'da i zapadnaya chast' Betpak-Daly [Chuiskaya trough and the western part of Betpak-Dala]. Izv. AN. KazSSR. Ser. geol.. 5:53-74.

45 Schultz S.S. (1948) Analiz noveyshey tektoniki i rel'yef Tyan'-Shanya. [Analysis of the latest tectonics and relief of the Tien Shan]. M., 134 p.

46 Eliseev V.I. (1959) Glavneyshiye osobennosti chetvertichnykh (antropogenovykh) otlozheniy Severo-Vostochnoy pribortovoy chasti Chuyskoy vpadiny. [The main features of the Quaternary (Anthropogenic) deposits of the North-Eastern part of the Chuya basin]. Izv. AN Kaz. SSR. seria geol.10: 127-148.

47 Nikiforova K. V. (I960) Kaynozoy golodnoy stepi Tsentral'nogo Kazakhstana [Cenozoic hungry steppe of Central Kazakhstan]. Tr. geol. in-that. Academy of Sciences of the USSR. 45:170-186.

48 Berg L.S. (1953) O problematichnom usykhanii stepey i pustyn' [On the problematic drying up of steppes and deserts] Izv. USSR Academy of Sciences, geographer series. M., 5:5-13.

49 Orlova M.A. (1971) Geomorfologicheskoye rayonirovaniye [Geomorphological zoning]. Soils of the valley of the r. Chu. Alma-Ata,. pp. 23-40.

50 Lavrenko E.M., Nikolskaya N.I. (1963) Arealy nekotorykh tsentral'noaziatskikh i severoturanskikh vidov pustynnykh rasteniy i vopros o botaniko-geograficheskoy granitse mezhdu Sredney Aziyey i Tsentral'noy Aziyey [Areas of some Central Asian and North Turanian species of desert plants and the issue of the botanical-geographical border between Central Asia and Central Asia] Botanical journal. 48 (12):1741 – 1761.

51 Baytenov M.S. (1985) Vysokogornaya flora Severnogo Tyan'-Shanya [Alpine flora of the Northern Tien Shan]. Alma-Ata., -207 p.

52 Orlova M. A. Sokolenko E. A. (1963) Problema osvoyeniya reki Chu. [The problem of the development of the Chu river]. Izv. AN Kaz SSR. series of biol. Issue 2.

53 Orlova M. A., Akhanov Zh. U., Kornienko V. A. (1971) Osobennosti pochvoobrazovaniya v doline reki Chu [Peculiarities of soil formation in the Chu river valley]. // Soils of the Chu river valley. A., pp. 135-167.

54 Krasheninnikov I. M. (1925) Rastitel'nyy pokrov Kirgizskoy Respubliki. [Vegetation cover of the Kyrgyz Republic]. Orenburg, -104 p.