



WAS THERE ANY INLAND ICE AT THE END OF THE CENOZOIC?

V. N. Kalyakin

Research and Scientific Zoological Museum of Lomonosov Moscow State University,
6 Bolshaya Nikitskaya, Moscow, 125009, Russia
E-mail: kalyakiny1939@mail.ru

СУЩЕСТВОВАЛИ ЛИ ПОКРОВНЫЕ ОЛЕДЕНЕНИЯ В КОНЦЕ КАЙНОЗОЯ?

В. Н. Калякин

Научно-исследовательский Зоологический музей Московского государственного университета им. М. В. Ломоносова,
Россия, 125009, г. Москва, ул. Большая Никитская, 6
E-mail: kalyakiny1939@mail.ru

Abstract. The transforming composition of flora and fauna, the change in the structure of natural ecosystems on vast territories (especially of the northern continents) that occurred at the boundary between the Pleistocene and the Holocene require clarification as to their causes, which is impossible without adequate modelling of certain paleogeographical conditions. The natural conditions of that time are reconstructed most often on the basis of the conceptions on catastrophic climate changes and the disappearing giant glaciations, from the formation and decay of which, supposedly, the regressions and transgressions of the ocean depend on. However, since there is no strict synchronization between the processes that are supposedly severely dependent on climate change and, in particular, on the changes of glacial and interglacial, it is quite natural to doubt the very existence of the latter. This doubt is also very significantly enforced by the fact that the activity of glaciers taken as the initial cause of the formation of erratics and their striations is not actually such a cause. Moreover, a rapidly increasing wealth of factual data indicates that no giant glaciations were actually there.

Key words: Pleistocene, Ice-age, glacial covers, glacial threshold, exaration material, ice sheet, interglacial period.

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Аннотация. Трансформация состава флор и фаун, изменение структуры природных экосистем на громадных территориях (особенно северных материков), которые произошли на рубеже плейстоцена и голоцена и в голоцене, требуют выяснения их причин, что невозможно без адекватного моделирования соответствующих палеогеографических условий. Природные обстановки этого времени реконструируются чаще всего на основе представлений о катастрофических изменениях климата и исчезновения гигантских покровных оледенений, от формирования и распада которых в свою очередь якобы зависят регрессии и трансгрессии океана. Однако, поскольку нет жесткой синхронизации между процессами, якобы жестко зависимыми от климатических изменений и, в частности, от смен ледниковий и межледниковий, совершенно естественно возникает сомнение в самом существовании последних. Это сомнение также весьма серьезно усиливается тем обстоятельством, что принимаемая за исходную причину формирования эрратических валунов и их исчерченности деятельность ледников на самом деле таковой не является. Более того, масса фактических данных, к тому же все более нарастающая, свидетельствует о том, что никаких гигантских покровных оледенений на самом деле не было.

Ключевые слова: плейстоцен, ледниковый покров, ледниковый порог, экзарационный материал, ледниковый щит, межледниковье.

Introduction

About 700 thousand years ago (the beginning of the Pleistocene epoch, with which the glacial period is associated), subtropical flora and fauna prevailed over a considerable part of Europe, gradually undergoing various changes. The current composition of the vegetation cover and the animal population was formed quite re-

cently, already in the Holocene during the last 11.7 thousand years. The sudden changes in the composition and structure of flora and fauna began to emerge at the boundary between the Pleistocene and the Holocene. During this short period, the "mammoth fauna" was superseded by a modern one, and this happened on a vast territory of the Northern Hemisphere, and not at the same time.

Most experts believe that the reasons for these changes were the recurrent and sudden fluctuations of the global climate and the glacial and interglacial periods corresponding to them. According to different authors, the number of ice sheets in the Pleistocene varies from one to nineteen. Most adherents of the glacial hypothesis believe that Western Europe was covered by the glacier four times (according to the "Alpine" scheme by Penck and Brückner), and the Russian plain three times. The "Alpine" sequence of glacial epochs (Gunz, Mindel, Riss, Wurm) is extrapolated by many authors to other territories, but with different names. For European Russia, the last three correspond to the Oka, Dnieper, or Don (with the Moscow stage) and Valdai with two or more stages of glaciation.

For the first time the glacial hypothesis was put forward by L. Agassiz in 1837 (according to observation in the Alps) to explain the distant location of puzzling boulders and striations on its' surface. In his report (Neuchatel essay) the scientist claimed that such boulders "represent one of the main evidences of the past glaciation of mountains, and a specific, glacial, period in the history of the Earth."

Somewhat earlier, in 1833, the geologist Ch. Lyell formulated the drift theory, which stated that the main mean of transport for boulders were icebergs, sea, river and lake seasonal ice [1, 2]. In fact, the main ideas of the drift theory were formulated even earlier by our compatriots: M. V. Lomonosov [3] and I. I. Lepyokhin [4]. But these works remained unknown in the West.

The proponents of the glacial hypothesis reconstruct the 20-thousand-year-old atmosphere, the least powerful (according to the views of the vast majority of glacialists, see Figure 1) of the last glaciation, whereas in earlier times the glaciers occupied an even larger area, up to 45 million km² – almost one third of the earth's land.

However, the most diverse data either cannot be explained by the glacial hypothesis, or cause unsolvable contradictions under this hypothesis, as indicated in works by I. G. Pidoplichko [5, 6], G. K. Lindberg [7], M. V. Klovov [8], V. N. Vasilyev [9], V. M. Makeev et al [10], V. G. Chuvarinsky [11–13], I. L. Kuzin [14] and many others, or at all do not stand up to criticism.

The main peculiarities of the Pleistocene (the epoch of the last 700 thousand years) were:

- activating, in comparison with previous periods, processes of mountain formation, oceanization, volcanism, tectonics, the influence of which led to an increase in the contrast of the Earth macrorelief. At the same time, the formation of deep depression in the Arctic Ocean, and the large mountains systems also proceeded;

- a powerful factor was a sharp increase of frequency of transgressions and regressions of the World Ocean – increases and decreases of its level, changes in the ratio of the ocean and the land surfaces;

- a sharp increase in zonal and regional climatic gradients; while studying these processes, the role of inertness during their development was completely ignored, which is practically, probably, inevitable;

- a steady change in the flora and fauna of extratropical areas within the Old World that began in the autonomous natural regime until the end of the Middle Stone Age (about 45–35 thousand years ago or even earlier), and in the Western Hemisphere – from the appearance of a human there (15–12 thousand years ago);

- the interaction of these various natural and anthropogenic factors, as well as the resulting effect of their interaction, were most vividly and finally manifested only in the Holocene [15, 16].

The last two features that interest us are most likely caused by the previous climate changes. Most of the adherents of the glacial hypothesis relate not only the fate of the biota, but also fluctuations in the level of the World Ocean with this very factor. In their opinion, it was the cycles of the cold and warm periods that caused glacials and interglacials and, accordingly, regressions and transgressions of the World Ocean [17–19].

On the main contradictions to glacial hypotheses and their true causes

The last ice age according to multiple reconstructions occurred about the 20 to 18 and 16 to 15 thousand years ago. I. D. Danilov, a geologist, [20] points out reasonably that according to the glaciologists' ideas, great glacial covers appeared, developed, and degraded for very short periods of time, only for 2–5 thousand years ago. In addition, the area of glaciation of the North America has supposed to be super immense, 18 million kilometers². And it, for unknown reasons, should be developed and disappeared many times, while Greenland glacial cover of greatly lower sizes (1,8 million km²), being never enormously degraded existed constantly. Irrationality of this phenomenon is clear.

How glacier covers, capable in addition of moving the boulders to the south up to 48° northern latitude (that is, to the south from Kiev latitude), i.e., for hundreds kilometers, could be formed with that rate? One can find no answer to this important question within the frame of the glacial hypothesis, since the reasons of multiple (in Pleistocene Epoch) and super scale sudden changes of the world climate are unclear.

While solving this problem the adherents of glacial hypothesis base on unproven assumptions or different glacial indicators and the methods of identification of ancient climates, interpretation of which is not uniquely defined, too controversial and contradict many factors. The idea on possible catastrophically sharp climatic oscillations is based on assumption that global climate reached some "glacial threshold" in Pleistocene, wherein it was in greatly unstable state. According to the ideas of the adherents even small changes in temperature (for example, within astronomic Milankovich's rhythms) were sufficient to alter a climate towards next "glacial" or "interglacial period", though the scales of these causes and their consequences were absolutely incomparable, and their rates were incredible along with a complete absence of responses in total global processes. On the one hand, minimal shifts were able to cause maximal and even global consequences, which, however, were ready to change, in accelerated regime, the sign of consequences into the opposite one, but one thing was faith without any evidences, and the other- tangible evidence that are verified via scientific method.

There are mechanisms which contradict these glacialistic scenarios. A certain balance between temperature and moisture, on which the amount and fall of solid precipitations depend, is required to form any glacier. Water vapor in the atmosphere has extremely different concentrations under various conditions. Its content near the Earth surface is variable from 3 % in Tropics up to 2×0.00001 % in Antarctica, with height a quick decrease occurs.

During the formation of the glacier the decreased content of water vapor becomes an important factor of dehydration of an air mass passed over as a result of moisture-induced crystallization. Even the presence of small mountain glaciers is enough for a sharp decrease in the amount of precipitations to the west from them (21). Snow boundary is a contour line in a particular point, above which the amount of solid precipitations exceeds the fall. Under Earth conditions the snow boundary changes from the sea level (some coastal areas of Antarctica) up to 7 thousand meters above (the Himalayas). Under conditions such as the Arctic region the height of the snow line is 280–350 m on Frantz Josef Land, 350 m on Victoria Island, 300–450 m on South-West Land, from 300 up to 600 m on Severnaya Zemlya (North Land) and about 1000 m above the sea level in some regions of Greenland (south and south-west). It is enough for the moisture, that comes from the Indian Ocean Tropical Region – the most powerful vaporizer on Earth – to a piedmont of the Himalaya (here is maximal quantity of annual precipitation: in some places higher than 20000 mm/year), Snow bounda-

ry is a contour line in a particular point, above which the amount of solid precipitations exceeds the fall almost all on the belt of the Himalaya glaciers (average width of this belt is 16 km). However, in Tibet not more than 60mm/year falls. Just due to these reasons formation of the mountain glaciers limited by the area on the islands of Eurasian sector of Arctic was of vividly asynchronous character, since moisture was in deficit in high latitudes for their supply [22]. Hence, in Antarctic, Greenland, and the Himalaya among the surroundings ices are kept nunataks, mountain tops free from ice and snow. That's why formation of giant ice sheet, approaching the latitude of Kiev, was impossible, as ultra Antarctic climate was required for this.

Based on calculations made by A. I. Voeikov, a climatologist, in order that the edge of the Scandinavian glacier could reach the south of the Russian plain, this glacier would have to crawl, for what a cap of 18 km height (only under this condition the necessary pressure reached for the spreading) was necessary. Formation of such glacial cap is impossible, since there is no sufficient moisture at the lower height in the atmosphere.

There is no description which can explain how the ice sheet can transport the boulders by many hundreds of kilometers along the rough terrain: both frontal part of the glacier and its bottom are inevitably the areas of the glacier damage, since hardness of the ice is several times lower the hardness of the rocks underlying the mountain ranges. It is a real example. The boundaries of the so called Don glacial tongue are determined by the presence in loams of Don Moraine of small pebbles of Novozemlsky, Timansky and Ural origin. And these pebbles (but anyway real pebbles are the product of the work of river or coastal waters; nevertheless, according to the shrewd remark of N. G. Zagorskaya [24], a lithologic pattern of moraine has been reliably lost long time ago) are presented ...by coarse sand; meanwhile the volume content in moraine did not exceed 0,01 %. The rocks of this type, as specified by Yu. N. Gribchenko [25] cannot be leading, but, despite this fact he himself and also A. A. Velichko [2] interpret them as the moraine of the Novaya Zemlya glacier. In fact, speaking about glaciation it is impossible to explain the presence of erratic pebbles in the loams of the Don moraine. Much later A. A. Velichko et al. [27], referring to the studies of G. G. Matishov, stated that at the bottom of the south-west part of Barents Sea (Pechora Sea) the moraine of Novaya Zemlya (New Land) ice was supposedly found. But G. G. Matishov himself [28] reported in his article that notwithstanding long-lasting and thorough special studies, unfortu-

nately, no trace of the mentioned moraine was found. On the other hand, in the same work G. G. Matishov gave information that the most part in the east sector of the Barents shelf was covered by the residues of the moraines of the most powerful Dnieper glaciation. Actually, these data additionally provide support for a drift theory of Ch. Lyell. The most part of the catchment area for the Barents Sea is free from seasonal ice and, in the absence of subsequent barriers, the drifting ice islands from the Arctic islands, within many thousand millenniums, had a possibility, detached from fast ices in high Arctic, to drift to the south and discharge at their inevitable thawing. However, within Pechora Sea such possibilities were rather small due to the fact that total glacial cover existed for most of the year and there was no access to the drifting ice islands or it was infinitely lower as compared to the west catchment area. In order that alien sand entered the lower reach of Don annual work of its supply with seasonal river ices, starting from Ural onflows of Kama, running into Volga, is quite enough. The stream flow of Volga jointed the Volga-Don Channel repeatedly in the past.

Based on the glacial theory it is thought that just exaration (i.e. damaging mechanical impact of ice on its foot) caused intense depositions on the bottom of oceans and seas. For the North-East Atlantic it is interpreted as evidence of activity of Lavrentiisky ice sheet. Nevertheless, the same intensification of sediments was marked at subsea cores of Amazonka, Kongo and Niger (29) that could not be associated with the work of any glaciers. Multiple biogeographic data (15; 16) confirmed by many radiocarbon datings [30–32], as well as coniferous trees available in Newfoundland island and endemic *Sorex gaspensis* with tiny area in Labrador (33), deny possible existence of giant Lavrentiisky glaciation. However, the rivers in any region of the Earth work more actively than the glaciers which conserve, in the main, the relief.

1. Some supporters of the glacial hypothesis in order to determine the drifting direction of the last glacier along the Russian Plain use orientation of pebbles (Again! Although the formation of pebbles is not associated with glaciers) being in the layers of allegedly corresponding to it "moraine". Acquaintance with real mountain glaciers, existing in Spitzbergen, Franz Josef Land and Novaya Zemlya islands, gives me ground for the statement that unlike the virtual model glaciers, their moraines consist of gravelist stones which do not have long axes: they have a shape like the intermediate form between a cube and a sphere. Of special interest for us is the glacier spreading out at Archangel Bay in Novaya Zemlya. Unlike many other glaciers of this Archipelago it does not flow into the sea nor stop

abruptly before it, but covers the land surface which extends west as a Lituchin peninsula nowadays (in the beginning of the last century it was an island and V. A. Rusanov rowed a longboat between this island and the coast of Novaya Zemlya in 1909). Its final moraine is an indicator of its maximal movement to the west, since there is not even a trace of the glacier drift to Lituchin peninsula. Column-shaped mountain remains are still found not far than 1 km from the moraine at the coastal side of the former island suggesting that even earlier the glacier has moved to the west only a little further than at present. The same column-shaped mountain remains are known on the vast area allegedly covered by the glacier from Scotland [34] up to the North Urals [35] and Taimyr [36], and U. Holtedal reported about their existence in the North of Norway [37]. No more than 1 km is between moraine and the present edge of the valley glacier, meanwhile almost invisible quantity of moraine material was accumulated between them for Holocene, about 12 thousand centuries, since the height of moraine formed earlier reaches minimum 15–20 meters, and the diameter of its base is at least hundred meters that testify both incomparably longer time of its existence before the Holocene and advanced entry of the river valley covered some time by the glacier. This clearly shows that there was no improbable, by its power, ice cap in Novaya Zemlya [38]). In favor of this conclusion we have gave the evidences of survey of the bottom of Pechora Sea [28] by which no glacial deposits were found.

Recorded in many north regions of the land its current elevations are interpreted by the followers of the glacial hypothesis as glacio-eustatic (raise of the Earth' crust upon release from the ices' load), however vertical movements of lithospereic blocks occur in tropical belt that can not be associated with glaciers' effect. For example, in the area of Madagascar separated from Africa at the boundary of Mesozoic and Neozoic periods or even earlier, approximately at the end of Neozoic epoch two types of hippopotamus and river pig came that could not happen without significant raise of the bottom of the rather deep at present Mozambique Channel. In that case other representatives of rather rich African theriofauna could not use terrestrial joint of the coast and Africa appeared. The analogous connections with South America occurred in Galapagos and the number of Caribbean islands, as well as Indonesian islands and South-East Asia, in Sakhalin, Japanese and the number of other islands with East Asia, and at the number of islands with Europe, North America and Australia, as with formation of Bering bridge not only in late Mesozoic age, but much earlier when along the representa-

tives of mammoth fauna, including a primitive man accompanied by the dog-wolf, it could be used by tropical species like tapir to enter North America. The above said investigations made by U. Holtedal and V. G. Chuvardinsky testify fragmentation of the Scandinavian sheet for many separate blocks. On the works of V. G. Chuvardinsky professor V. Z. Negruzts well said in the article: "Evidences given by V. G. Chuvardinsky on tectonic origin of geological-geomorphologic features traditionally associated with quaternary glaciation are so obvious and reproductive both by in-situ data, and geological modeling, that they seem to be conclusive and undoubted in essence" [cited by 39] and supported in addition by the findings of many mineral deposits.

Since according to the viewpoints of glaciologists the fluctuations of the level of World Ocean are determined by formation (at regressions) and disintegration (at transgressions) of the glaciers, minimal by its power Würm glacier coincided with maximal (for Pleistocene) regression 9 up to 130–140 m) represents within glacial hypothesis absolutely insolvable puzzle. It is known now that at the end of Pleistocene along North-East coast of Asia it was quite large-scale regression during which a number of the Arctic islands due to the shelf drainage became a part of the continent with rather rich mammoth fauna, especially on Novosibirsk islands [40, 41], whereas at the same time transgression was marked at Northern-Eastern part of Europe [20]. And may this regression indicate on the work of the so kind "wave" under the Mokhorovichich boundary caused clear tectonically?

At the same time Late Würm, maximal in Pleistocene regression preceded Late Wurm cooling. Start of the development of the first event was marked about 125 thou. years ago [42], and the second one – 22–16 thou. years ago [43].

But the result can not advance the cause, taking into account approximately 1000 thousand years (!). Sequence of the values, characterizing megastructure of the Erath, is illustrative. Its radius is 6371 km, and the thickness of the Earth's crust is on the average 17,1 km, that is only 0,27 % of the earth radius. The volume of the World Ocean makes up about 0,1 % from the Earth's volume, and the volume of current glaciers are about 0,002 %. These ratios give us reason to believe that fluctuations of the ocean level (even within upper Würm making only about 0,002 % Earth's radius) are controlled by the processes occurred under the boundary of Mokhorovichich. We know not enough on behavior of the Erath mantle. The use, for example, of distant altimetry gave unexpected results. Current zero level of the Ocean turned to be, according to

the data of Harvard Space Centre, averaged abstraction. Maximal positive deviations from it, 66 and 68 m, are in the North Atlantic. And maximal negative deviations (–112 that is not so markedly differ from maximal Late Würm regression to the north from the North-East Asia and the number of other regions) are marked to the south from Ceylon [42] that can not be governed by glacio-eustation. It has been long known on vertical movements of different blocks of the Erath crust asynchronous between each other and independent from the glaciers that agree with the latest data of geophysicists [45; 46]. A lot of data testify that the so called glacial forms of relief have, in fact, completely different genesis: alluvial, littoral-coastal, and tectonic [7, 43, 48–50] that also shatter the base of the so called glacial hypothesis and familiar paleoclimatic reconstructions [17, 43, 48–50]. However, until now glacial concepts are taken on trust, like the gospel's truth, without any discussion of it, for example, Shipman [51], Wade [52] and Harry [53] in the works on the history of mankind.

For glacial epochs (especially for the Late Würm), the climate of which, according to the estimate of A. A. Velichko [26], even at Ukraine met the current Central-Yakutsk, where the average January temperatures did not exceed –40 °C, was typical formation of the power loess strata in the range from 55° up to 24° north latitude. In Würm period loess particles precipitated on the ices of Antarctica ten times higher than now. At the same time it was ascertained that real loess masses, as a rule, were formed in the regions with average January temperature of up to –10°, and never in the regions where it was lower than –20 °C [54].

One of the arguments of the followers of glacial hypothesis for extremely severe Late Würm climate is perennially frozen rocks spread maximally far to the south. Why at the earlier and more powerful glaciations, permafrost did not move to the South at least so far? At the same time the depth of freezing of soil grounds depended not only on winter temperatures, but on stability and the depth of snow cover in winter. Due to the long time work at Yamal and Novaya Zemlya (New Land) I succeeded to ascertain it quite clearly. If on the vast areas of uplands no snow could be in winter or it could be minimum that was followed by the permafrost available even from the depth of 10–15 cm, then under conditions of the river valleys at the sites protected from winds and just due to formation of powerful snow cover on them in winter, there was no permafrost and possibly (up to 68 parallel at Yamal) brown frog (*Rana muta*) and *Neomys fodiens*, *Hunobius keyserlingi* – almost up to the coast of Baidartskaya Bay, Arctic sorex – up to Vaigach, earthworms – up to the South of

Navaya Zemlya, lived. It is necessary to account that at sharply expressed in Late Würm regression, on the vast areas the energy of relief increased sharply, and deepening of erosive cut allowed multiple high sea cliffs to be formed that, in addition, against special extension of hydrographic network increased possible formation of deep cavities and subsidence of soil grounds. Their further development under sharply continental conditions provided appearance of glacial wedges that were usually interpreted as evidence of permafrost up to the South of Ukraine [43]. But even far to the north, in Vladimir region, supposedly permafrost phenomena of the Late Würm age could be determined by seasonal factors as was shown according to the data of Late Pleistocene settlement Sungir' [55, 56]. Besides, the study of bones residues of mammoth fauna [57] from this settlement showed that wild hen inhabited this area simultaneously together with mammoth and collared lemming. The wild hen was found on the rather vast area up to the British Islands, and in the East – up to the Moscow region and survived here up to the Late Neolithic age [58], the species very similar to *Gallus gallus* hen which lived in wild state and many regions in the south-east Asia at present. Along with a number of other species living together with the lemmings (*Myoxus glis*, mice, Vinogradov porcupine, *Ursus thibetanus* and others) its presence in the composition of mammoth or "mixed" fauna indicates that in Late Würm age there was no Atlantic climate to the south up to Kiev, and maintenance of "mixed" fauna was possible due to predominance of the ecosystems of pasture types, and at regressions – by great complication of the relief.

Trying to explain appeared in the previous issue contradiction, A. A. Velichko [26] set the following paradox statement "...there was no direct association between the degree of glaciation development and intensity of the temperature fall. The main peak of cooling falls on the epoch of the latter of the least developed Valdai (Würm) glaciation, again to its second half, when the glacier was in degradation". Further he explains that under sharply continental – Central – Yakutsk – climate there is insufficient moisture to form more powerful Würm glacier that raises questions:

Why just in the Late Würm period at maximal in Pleistocene regression and minimal water and heat exchange between the Arctic basin and the Atlantic, thawing of the latter and activation of evaporation from its surface a special deficit of moisture appeared (as was stressed, there was no problem on drying effect of the glaciers themselves before the glaciologists).

No matter how severe continental climate of Central Yakutiya was, the average temperature was

somewhat higher (+19) there relative to Moscow (+18), and total annual precipitation reached 700 mm. Despite frozen grounds *lignosa* (taiga vegetation) grew there, the continental glacier as is absent as in any area of the Earth. Greenland and Arctic glaciers are exceptions, they are mountain, spreading at high latitudes and having more severe climate relative to Yakutiya. Less precipitations fall on them, up to 50–30 mm/year, but sufficient for ice formation. How could exist the glacier (its Dnieper tongue), reaching 48° north latitude at the less severe climate as compared to the Late Würm one (supposedly according to Velichko the same as Central-Yakutsk one) at this latitude? Ultrantarctic climate was necessary for its existence in such south radiation belt.

Multiple biographic data testify that north elements of flora and fauna on the Russian plain and in the number of other regions, where they are absent now, have been represented to the most extent in Late Würm period. Among them, however, there were no species which demanded conditions for normal life near the great continental glacier. It is indicative that even now very poor in its species high Arctic fauna of some invertebrates is not, really, beyond high Arctic: even in the most northern tundras its relic representatives are absent. According to the views of the most part of the followers of the glacial hypothesis the ecosystems, comprising just every time flora and fauna of the predating Interglacial period, formed rather quickly on the areas released from the continental glaciers. Most part of the glaciologists considers that they restored due to migration of the species from the survived far in the south refugium. In this case two very important circumstances are not taken into account:

Even current (most impoverished for Pleistocene) flora is many hundreds species with rather various biological peculiarities, ecological requirements and possibilities to extend. How such representatives of flora and fauna could every time be restored rather fast, just without any losses and in fact synchronously (that is especially amazing)? What provided succession of their development for the whole Pleistocene? The followers of the glacial hypothesis give data on the rates of distribution of various types of plants not matching to real ones (for example, for oak tree up to 10km/year). At the same time W. Hultedahl [37] knew that in the south of Sweden mixed (with the oak) forests were 9 thousand years ago. At present it has been ascertained that spruces were spread more than 9 thousand years ago even far to the north (see internet).

The fact of existence of dozens of plant species with relic areas (including endemic ones) on the territories of allegedly subjected to total glaciation turns out to be unexplained within a glacial hy-

pothesis. The existence of current rather rich floras on Arctic and Subarctic islands (including, representatives of conifers in the immediate past) can not be associated with the hypothesis of total glaciations of even these areas.

A lot of facts contradict the image of the Panarctic ice sheet that is supposed to exist before the end of the Pleistocene and cover the vast territories of the entire Arctic and the adjacent northern continents: the current spread of glaciation, fauna and flora. This is noted for Spitsbergen, Severnaya Zemlya, Wrangel Island, New Siberian and the adjacent small Islands, Begichev Islands, Taymyr, the mouth of the Lena and the Canadian Arctic and is confirmed by radiocarbon dating [30, 32, 59]. The materials on the New Siberian Islands are of particular interest – with their richest for such a northern region mammoth fauna, which existed around 55 thousand years ago (the oldest date that can be determined by radiocarbon) before the beginning and the Middle Holocene inclusively [41], as well as data on the fauna of the Arctic Ocean and on the paleotemperatures of the bottom water near the coasts of Severnaya Zemlya [60].

The rich and mixed composition of the mammoth fauna, represented with steppe, forest, floodplain and currently tundra species, was determined not by severe, but by very diverse natural conditions of the Wurm (and pre-Wurm) landscapes, including pasture ecosystems, most widespread on plateaus on giant areas of extratropical territories of the Northern Hemisphere, the main edificators of which were mammoths and accompanying species of large phytophages, a number of which were herd animals with very high population density. The mixed type of flora was also emphasized by the proponents of the glacial hypothesis. In the opinion of V. P. Gritschuk [61], around the glaciers of Eastern Europe, there were three landscape zones: 1 – preglacial one with the integrated nature, with elements of the arctic, forest and steppe flora where there were tree species; 2 – forest-steppe; 3 – steppe. A special emphasis is on the first one of these zones, since at the present time on its northern border there are no contacts between tree species and glaciers because they are completely absent. The closest analogue of the latter is the southernmost and southwest of Greenland, where birch forests are noticed between 60 and 61 ° N, and alder, also along the coast, goes to the north to 65 ° N. However, along these shores there is no permanent glacier and even during the winter months they experience the warming effect of the Atlantic. The snow line is situated about 1000 m above sea level. But this is not enough. Zones of tundra (southern, typical and arctic) and polar deserts, the length of which is measured in

hundreds of kilometers along the meridian, are situated currently on the plains between the northern boundary of tree species and the glaciers of the high Arctic. Here tree species are completely absent, and "arctic" vegetation is represented not by "separate elements", but has a zonal expression. Why 20,000 years ago the inland ice sheets during millennia could coexist with "complex vegetation where there were tree species" is completely incomprehensible; the glacialists have no answer to this question. Moreover, in the late Wurm pollen and numerous macrodebris of tree species are found not only at the boundaries of the simulated glaciers, but also on the areas they occupy. But this fact doesn't make the glacialists rethink their ideas.

Much support for the proponents of the glacial hypothesis, while they were creating their respective models of the past, the so-called "elements of the Arctic flora" gave. V. P. Gritschuk [61] intentionally noted that within the periglacial zone not only polar-desert or arctic groupings are absent, but even tundra. Today, for example, the representative of the Arctic flora *Selaginella spinulosa* is spread out to the south up to the Carpathians and to 56 ° N. in the Urals, the dryas reaches the Carpathians and the Brittany Islands, a dwarf birch – Britain, Central Europe, Moscow, Nizhny Novgorod and Bashkiria regions.

Some animals, typical for the Arctic, behave in the same way. The muskox that survived until recent times in the Far North of North America inhabited the southern steppes of Eurasia in the time of the Scythians. This also refers to lemmings. In France, there are known places where their remains (the time of late Wurm) were found together with the remains of not only marmots, ground squirrels and red-backed voles, but also garden dormouse and glis glis, water voles, birch mice and forest mice [62]. Similar data is found in the north of Ukraine, Belarus, the Vladimir region and a number of other regions. Glis glis – an inhabitant of broadleaf and mixed forests, whose basis of nutrition is beechnuts, filbert, fruits of wild fruit trees – is of special interest among the above-mentioned lemmings' companions in a number of areas. Their presence determines not only its modern northern distribution limit, which, by the way, does not differ significantly from the Late Wurm, but also the location of animals and their numbers within the areal. In the Middle Urals, lemmings, along with other common species of the late Paleolithic complex, lived next to the porcupine (that Vinogradov found) and the asian black bear [63]. It must also be taken into account that the climate was completely different (in comparison to the modern one) until the late Pleistocene, when the hippopotamus was spread out to the south of England (64), and in the waters

washed Severnaya Zemlya there was an abundance of cetaceans and pinniped – 120–110 thousand of pinniped, and Bolshiyakov and Makeyev noted that on Severnaya Zemlya "the development of glaciers could happen for no more than 60 thousand years during the last 550 thousand years, which is only about 11 % of this era time" (see page 193) despite the high latitude position of Severnaya Zemlya (!).

Long-term field work in the Far North from the White Sea, Yamal and Gydan to the islands of the high Arctic – Spitsbergen, Franz Josef Land and the north of Novaya Zemlya, gave me an opportunity to make sure of:

1) the correctness of the drift theory to explain the adequate spread of the exaration material, that is supposed to be of glacial origin;

2) as well as to explain a number of biogeographical facts.

Seasonal (and, therefore, annual) river and sea ice, detached in the spring from fast ice, is moving with the current of rivers or along the sea areas moved by current of water or air, and it carries absolutely incomparable even to the glaciers of steep mountain valleys amount of supposedly moraine material during the millennia of constant "work" – from sand to pebbles and boulders (by the way, the presence of the latter indicates that not glaciers "worked" with this material, but water; for example, the presence of glass pebble on the Crimea beaches shows how intense this "work" is. In August 1977 65 km upwards from our station on a fairly steep bank of the Schuchya River (south of Yamal) we found a vertically standing fragment of rock, whose weight was not less than 27 tons according to its measurements. Since we have already been in this place in previous years (and throughout the Schuchya from its mouth, the Great Schuchye lake in the Polar Urals, to the delta), it is quite clear that this fragment of the rock chipped off before the river breaking up of the ice and was moved on an ice floe, which run into a fairly steep bank after it accelerated for not more than one kilometer, where the floe "anchored", until it melted. Next year in the beginning of summer we took a camera and intentionally sailed on a motor boat to this steep river turn, but the mentioned rock fragment crawled into the river, because, in the end, the soil could not stand its weight. The nearest place where this fragment chipped off the rock wall is located not less than 15 km upstream. Downstream the Schuchya there are several spots with more sloping beaches with steep bends, where the river ice formed quite apparent pseudomoraines (by the way, one of them is located straight under our former station, 2.5 km downstream of the "Schuchye" factory, and the other one – opposite the mouth of Hey-Yaha, which flows into Scuchya

from the east side, 50 km upwards from our station). On one of the smaller islands near the northwest of Vaygach at its northern end, which, like the beach, is gradually disappearing into the water, we unexpectedly found a quite vast kurum (not less than a hundred meters in diameter), which could appear here only as a result of its delivery from under some crumbling rock wall by sea floes. By the way, a pair of puffins and a pair of little auks began to nest on it, that is, hundreds of kilometers south of the previously recorded nesting range. V. Y. Wiese [65, 66] describes a huge fast ice floe, which is detached from the western shore of Novaya Zemlya and floating to the north. The presence of soil on it and also the large dwarf birch thicket testified its quite a long period of formation and location at the Novaya Zemlya coast (Fig. 1).

It is clear from the last example that the "work" of sea ice in the Arctic can also have biogeographical consequences. Lemmings and reindeers could reach the Franz Josef Land only on the sea ice (currently they are absent there). J. Payer, who participated in the Austrian expedition, which discovered this archipelago in 1873, reported the presence of lemmings in 1876 [67]. It was found, by using radiocarbon analysis of the found reindeer horns, that this species spread here about 1.5 and 2.5 thousand years ago (S. E. Belikov, personal communication).

For many decades the proponents of the glacial hypothesis believed that under the glaciers of Antarctica and Greenland there are powerful moraines. However, after these glaciers were drilled through, it became clear that there were no moraines beneath them, but there are dusty and fine-grained inclusions throughout their stratum, including volcanic ashes [11–13, 39]. Other fantastic hypotheses or even statements are also known. For example, M. G. Groswald [50] claimed that the Pan-Arctic glacier, which covered the Arctic Ocean, made a series of holes in the mountain ranges located across its way (because there was not enough place for the glacier) and it crawled farther through them to the Eurasian continent (!). A. S. Monin and Y. A. Shishkov [68] believed that the glaciers covered the south of Australia and all of New Zealand. How did it happen that New Zealand managed to preserve the tuatara (the only modern representative of the rhynchocephalia, extinct throughout the rest of the globe in the Mesozoic), leiopelma (one of the two species of the oldest family of frogs, the second representative of which is the tailed frog, the endemic of Northern America), kiwi and also the flightless moa (their closest relatives remained somewhere at the boundary between the Mesozoic and Cenozoic), that were exterminated by Maori already in historical times, as well as the endemic coniferous, the mentioned authors do not explain.



Fig. 1. The part of pseudomorain (Photo Kudryavtsev N. V.)

The contradictions listed above, which have not found any satisfactory solution within the glacial hypothesis, suffice to question the legitimacy of the glacial hypothesis, and what is more, completely abandon it. However, the simple rejection of the glacial theory does not answer the question: what caused such a significant restructuring of the vegetation cover and the animal population in the Pleistocene, especially at its boundary with Holocene, and in the Holocene? I did the research to find an answer to this question, of course beyond the framework of the glacial hypothesis and, since its results are published [15, 16, 38, 69], I will not describe them in details, but just report the main conclusion.

The main cause of degeneration of the mammoth fauna and, as a result, very significant landscape transformations on vast areas is the activity of primitive hunters. In our opinion, a sudden increase in anthropogenic influence on natural ecosystems (first of all on pasture ecosystems) and near completion of global human expansion already within the first thousand years of the Holocene were possible, when domestication of wolf took place, that significantly affected human lives. This is not at all a complete denial of climate changes and their consequences in the late Cenozo-

ic. But simultaneousness of the latter events in extratropical regions of the Northern hemisphere does not correspond the dynamics of expansion of the primitive hunters in different areas not only on Earth's land surface but in the Northern hemisphere, nor the reported natural changes in the same areas, although there is an entirely obvious causal-mediating correlation. Moreover, the analogous consequences of human (together with the dog) expansion occur in tropical regions of Australia, South America and on many islands. The annihilation of the main edificators in the pasture ecosystem by the primitive hunters is just an inevitable cause of a complete extirpation or drastic alterations in such ecosystems and in a number of regions the climate could not remain the same. So called "natural zones" occupying the greater part of the land surface appeared most recently compared to the total Pleistocene duration is an undoubted result from the anthropogenic activity, the intensity of which unfortunately for the Earth's biosphere and mankind increases extensively and without taking proper measures it may lead to self-annihilation.

There are many arguments against that giant glaciers existed either in the Pleistocene or during the last 100–110 thousand years. During this peri-

od the climate was cooling in the high latitudes of the Earth and in the high-mountain regions, and in the end the Pleistocene the cooling covered the middle latitudes as well. The depauperization of fauna of the large herbivores and connected with them carnivores increased in the second part of the late Wurm over the vast territories of Palearctic and Australia. However, in the Nearctic and South America this process took place in the Holocene and in North Africa only by the end of the Holocene, whereas on many islands – in historic time. Identification of the exclusive edificator role of the elephant *Loxodonta africana* in African savannas [71, 72], in "elephant landscape" [73] originated the conception of anthropogenic- biocenotic transformation of the late Wurm pasture ecosystems caused by extirpation of mammoths and a number of other large herbivores [74, 78]. The latter became possible after domestication of wolves by a man, probably in the Mousterian [15, 16, 79–81], that was of a great significance for destiny of a man in the end of the Cenozoic, when finally only

Homo sapiens survived after a number of achievements of our ancestor *Homo erectus*.

Unfortunately, I have to admit that many aspects of geotectonics (among them the aspects that are obviously connected with the issues of this article) have not attracted due attention of the main specialists in this area [45, 70]. So far the real breakthrough in this sphere was made by U. Kholtedal [37] and V. G. Chuvardinsky [11–13].

Conclusion

The main conclusion of this article is that during neither the whole Pleistocene nor its end there were no giant glaciers. The areal of glaciation was limited to the high latitudes and high mountains. The climatic changes didn't reach such rates as it was claimed by the proponents of the glacial hypothesis, and transformation of the ground vegetation on the vast territories took place (and continues to occur) under the influence of still arising anthropogenic factors.

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