# THE DEADLOCK IN PLEISTOCENE PALAEOBOTANY

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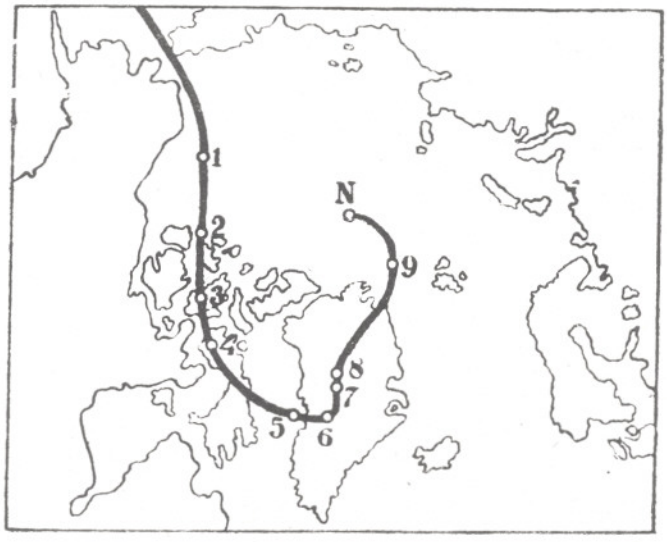
**ABSTRACT**

It seems to me to be necessary to give some remarks as a commentary to my article, since the attitude of some European scientists toward the problem discussed in my paper is (considering the second half of the twentieth century) a rather particular one. I have encountered the following opinions and remarks: " It is known that the diluvial theory of Penck and Brückner is ambiguous, but one cannot agree with the hypotheses given in the article ", . . or " It is true that many scientist tried to find a correlation between the glaciations in Alpes and the remaining part of Europe (A. K. Wells, W. B. Wright, L. J. Wills, J. F. Kirkaldy), and that they have stated many contradictions, nevertheless the explanation of these contradictions given in the article is hardly accepted ". . ., or " The attempts of shaking the diluvial theory of Penck and Brückner are not friendly accepted by the scientists, being not supported by most of them". According to my opinion, such attitudes, luckily not general ones, are anti-scientific. It is up to the science to put hypotheses and theories, provided that it has its disposal the well-grounded facts. But it is also up to the science to shake the hypotheses and to put them to a critical analysis, as the new facts that may be used as necessary arguments become available. The science cannot base its activity upon the faith in infallibility of scientificial authorities. A scientific discussion which admits the facts, the observed phenomena and their logical interpretation is the only basis for any scientificial activity. The scientists who forget this truism are at the same time dooming the domain of science represented by them to decrepitude. I am referring in my article to the papers of Köppen, Wegener, Gams, Bryan, Pflug, Schwarzbach. These papers cannot be ignored, as they faithfully represent the stated facts which every scientist must take under consideration. The diluvial theory of Penck and Brückner cannot stand in its present form, because of the contradictions it contains. Changes which must be introduced into this hypothesis are justified by numerous and new conquests of the science. In such a situation every conception which brings some new elements into the diluvial theory of Penck and Brückner ought to be discussed in a scientific way. If an argument of this new conception is fallacious and not acceptable, the error must be distinctly pointed out. The same critera must be applied if the value of the new hypotheses is to be estimated, and only such a discussion may bring positive results.

FOR a few years one observes among European palaeobotanists a marked embarrassment concerning the pleistocene, and in particular, diluvial interglacials, which is more and more often expressed in scientifical publications. This worry results from the fact, that different fossil evidences which shake the cardinal principles of Penck and Brückner are now more frequently obtained. The question is, that in various interglacial samples from Europe, chiefly from its central part, one often comes across the macroscopic remnants of plants, whose samples tested by pollen analysis method show the presence of fossil sporomorphs of different exotic plants which grew in Europe in lower and upper Tertiary. For macropalaeobotanists, palynologists and geomorphologists the situation gets more troublesome, as more scientific papers concerning this problem are published. Let us give some examples: In 1954 an Austrian botanist from Innsbruck, Gams (1954) published his paper in which he has summarized the results of palaeobotanic research of pleistocene up to 1954, and has drawn the conclusions. He presented the genera of exotic trees and shrubs, whose fossil macroremnants and sporomorphs have been found hitherto in various interglacial sediments. They are the following: *Sciadopitys, Glyptostrobus, Pseudolarix, Pseudotsuga, Cedrus, Keteleeria, Magnolia, Actinidia, Menispermum, Hamamelis, Corylopsis, Nyssa, Liquidambar, Phellodendron, Carya, Engelhardtia,* and so on. As we see from the above list several genera bear a character of subtropical or even tropical floristic elements. The author does not give any acceptable hypothesis to explain where and how the above mentioned plants could survive the greatest glaciation and persist up to interglacial in Europe. If we consider, that the above mentioned trees and shrubs had to live on the areas covered for thousand years almost entirely by continental glacier, (i.e., they had to live a normal vegetation, to flourish, to fructify, and to produce viable seeds to germinate) it will become obvious that in such a situation no reasonable hypothesis can be given. The second example is much more puzzling. In the same year a Danish palynologist M. S. Bryan (1954) obtained from geologists some samples taken from interglacial forma-

tions in central-west Greenland, where those geologists carried out their investigations. Bryan (1954) tested the samples by pollen analysis method and published the results in. He stated that the samples contained fossil sporomorphs of the following plants: *Picea mariana, Alnus crispa, Pinus, Betula, Salix, Juniperus, Empetrum, Dryas, Rubus, Artemisia, Epilobium, Achillea, Filipendula, Plantago maritima, Rumex acetosella, Thalictrum, Sedum, Dryopteris, Lycopodium alpinum, L. annotinum, L. selago, Selaginella selaginoides.* The microphotos of the majority sporomorphs of those plants are given in the above paper. Considering the above list we see that the fossil flora found by Bryan in samples taken from Greenland is characteristic of cool-temperate climate. But this is not a point. The chief assumption of Penck's and Brückner's diluvial theory is a hypothesis on fourfold repetition of the continental glacier in glacial periods and its retreat in interglacials up to arctic regions. On the other hand, from Köppen's and Wegener's geophysical investigations concerning dislocation of the North pole (TEXT-FIG. 1) it follows that in glacial epoch the North Pole was in central-west and central-north Greenland, i.e. just where from the interglacial fossil flora found by Bryan derived. It is clear, that under such a condition this flora cannot be considered as the interglacial one. Three years later a light was thrown on this peculiar situation. In 1957 two palaeobotanists, M. Schwarzbach & H. D. Pflug published their results. The samples tested by pollen analysis method were taken from pliocene layers in the neighbourhood of Tjörnes, north Iceland. In their palynological work they identified fossil sporomorphs of the following plants: *Pinus haploxylon, Pinus silvestris, Picea, Abies, Larix, Fagus, Pseudotsuga, Quercus, Populus, Betula, Corylus, Alnus glutinosa, Alnus viridis, Myrica, Rhamnus, Ilex aquifolium, Salix, Hedera,* Ericaceae, Polypodiaceae and *Sphagnum.* This fossil flora is characteristic for the temperate — Atlantic climate. If we compare fossil flora from Tjörnes with that from central-west Greenland, considering the position of the North Pole given on a graph by Köppen & Wegener (positions 2, 3 and 4), it will be easy to state that fossil flora from Greenland described by Bryan does not belong to the interglacial period, but at least to the middle pliocene. Such examples, as quoted above, can be undoubtledy found in greater quantities in macropalaeobotanic and palynologic literature concerning pleistocene. Most of European palaeobotanists are aware of these discrepancies,

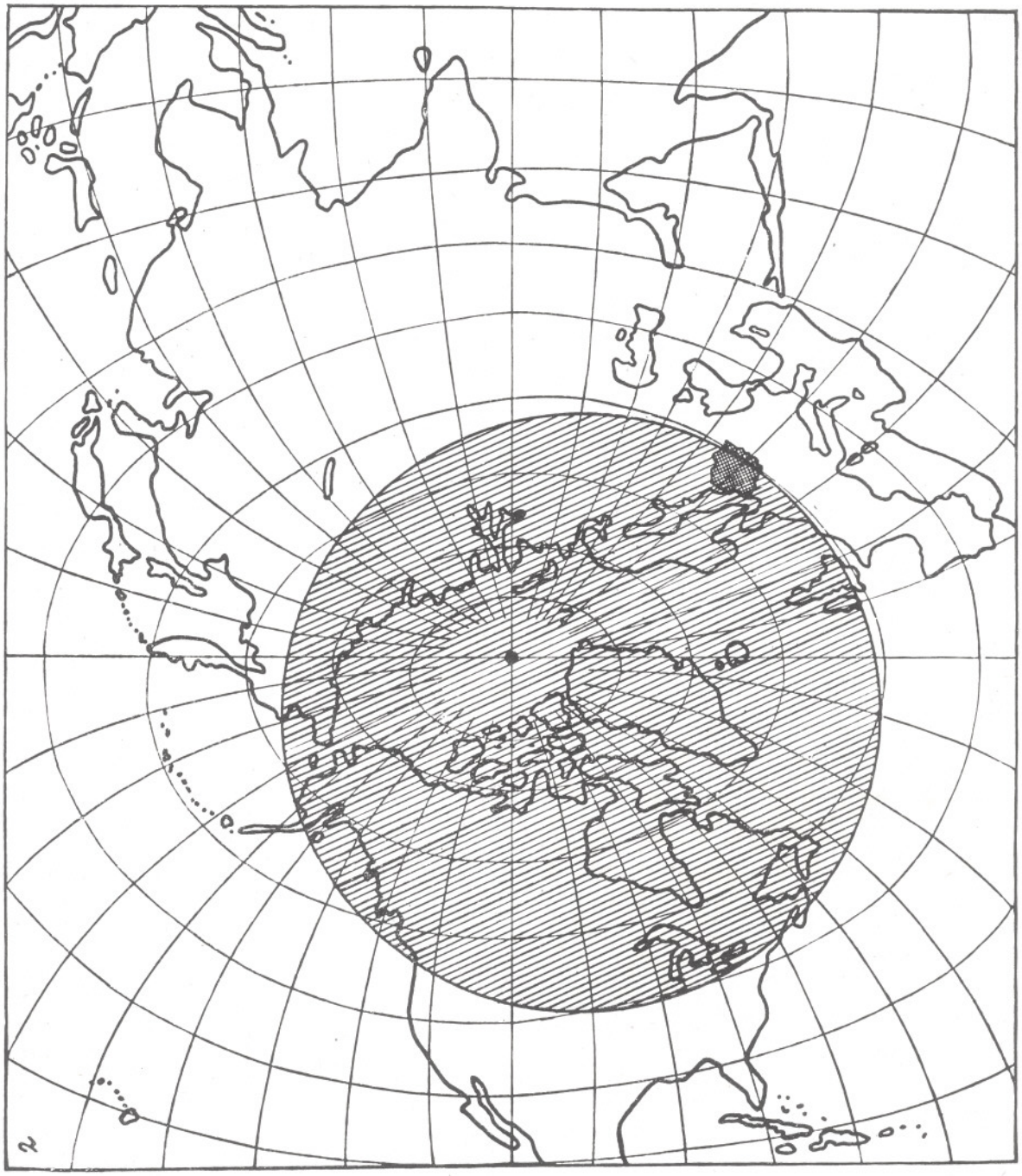



TEXT-FIG. 1 — Displacement of the geographical North Pole, according to Köppen & Wegener (STENZ, 1956). Successive positions of the North Pole: 1–in Miocene, 2-4—in Pliocene, 5-8—in Pleistocene, 9–in Paleolith, N–contemporary position.

but their attitude is rather peculiar from the scientific point of view. They attempt to abolish the contradictions by "arguments", which unfortunately, cannot be seriously treated. According to them both fossil macroremnants and sporomorphs of the exotic plants, found in interglacial layers, are lying in secondary sediments, and this is the reason of the error committed in palynologic research. From this opinion it may be easily concluded that e.g. almost all results concerning interglacials in Polands obtained by pollen analysis method, should be rejected, because of the presence of sporomorphs of exotic plants derived from secondary deposits. It would be perhaps difficult to reject the hypothesis of secondary deposits if the presence of fossil sporomorphs of exotic trees and shrubs in interglacial sediments were not confirmed by analogical investigations carried out all over whole of Europe by means of pollen analysis method (e.g., the paper of GAMS, *l.c.*). Is it thus possible that in interglacials of whole of Europe there were secondary deposits, exclusively? The second argument of the same type is an assumption, that pollen analyses were carried out on impured material. It is clear, that such a situation may happen very seldom and sporadically, since the purity of pollen is considered as elementary technical problem in palynology. Thus the presence of fossil sporomorphs of exotic plants in interglacial deposits cannot be explained by impurity of samples taken for pollen analysis. The increasing discrepancies between the facts obtained from macropalaeological and palynological investigations of interglacial formations, and the chief assumptions of Penck's and Brückner's hypothetical diluvial theory ought to lead finally to a general scientifical discussion, which should deal with the above problem in a way possibly objective. It is a well-known fact that all scientific theories must be compared from time to time with new scientific facts, which would either confirm or reject the assumptions of those theories. From this principle science cannot resign, unless the important problem be misled.

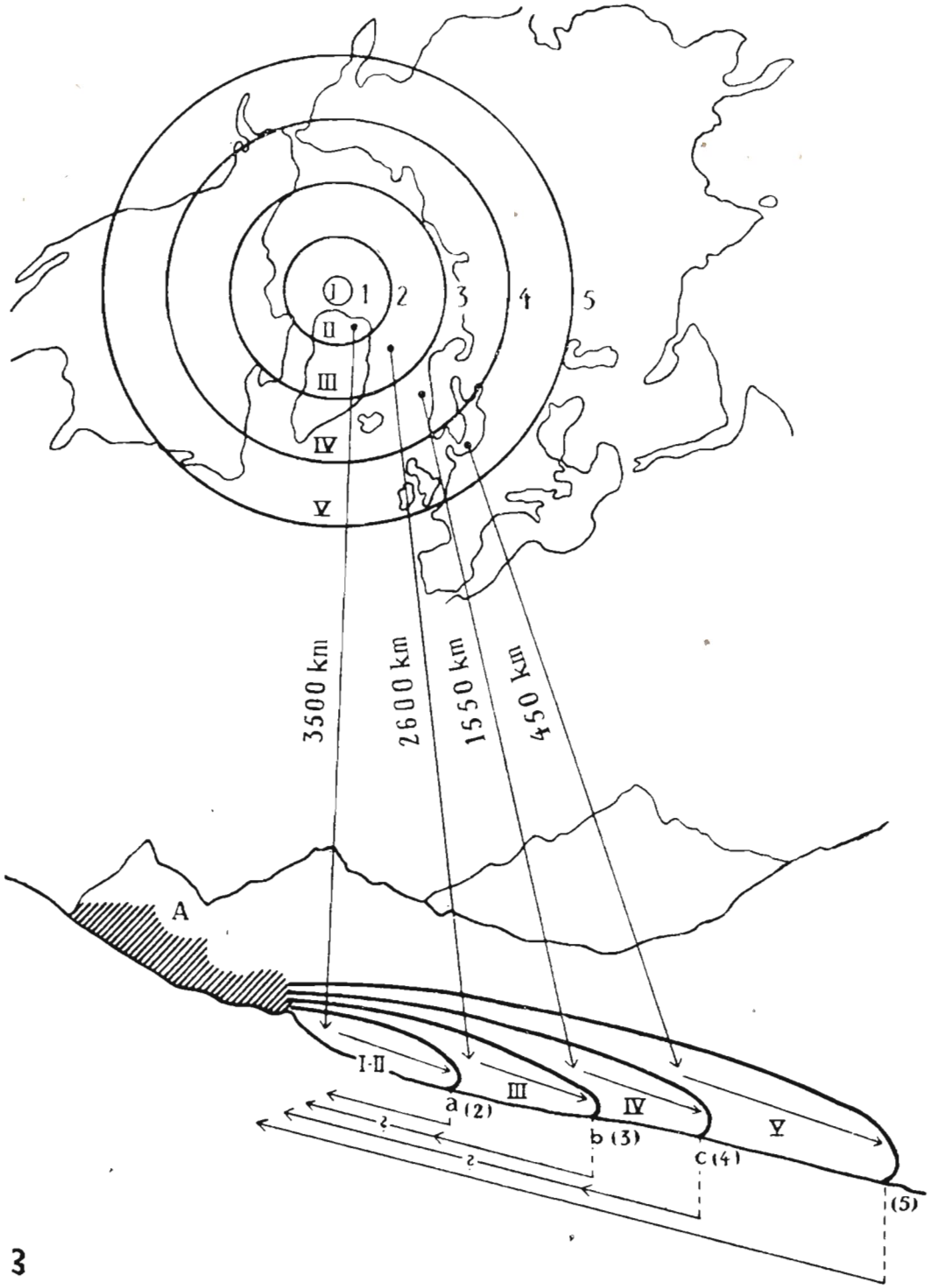
The diluvial theory of Penck and Brückner since its origin (i.e., since about one hundred years) was never critically analysed. In the present paper I want to present some chief assumptions of the discussed diluvial theory which contradict the elementary geophysical phenomena and the elementary mathematical calculations. I hope that my remarks will be clear enough to prove that diluvial theory needs a thorough revision. I hope also, that they will stimulate a scientifical discussion yielding the necessary corrections.

The uniform plateau of continental diluvial glacier had covered in Europe and North America circa 27 per cent of the globe's surface. The maximal range of the continental glacier reached in North America the line running slightly below 40° of the north latitude, and in Central Europe the farthest limit in southern Poland, i.e. 51° of the north latitude. Hence, its range was marked by a line running eastward, at first along the parallel 50°, and then between 50°-60° up to Ural, and in Siberia, between 60°-70° up to Kamchatka, and hence through Alaska to North America, and through Atlantic ocean to Europe (TEXT-FIG. 2). Actually, considering the investigations of Milankowicz, it is assumed, that the glacial epoch lasted for 600,000 years. In this period the continental glacier had been formed in arctic regions from the snowfalls (snow and hoarfrost) which was transformed at first into a firm and afterwards into ice, had produced incessantly new masses of the body of continental glacier. The continental glacier had moved four times from subarctic regions southward, and as many times it had retreated to subarctic regions. This hypothesis may be analysed by help of a simple calculus. The distances from the North Pole zone to the lines indicating the maximal range of diluvial continental glacier in Eurasia and in North America, are more or less equal, and amount to circa 3500 km. The continental glacier had passed from subarctic regions during glacial periods, and retreated or melted during the periods of interglacials. From this it results, that four turns of the transgression of the continental glacier from north to south were performed in the time of 300,000 years, that is, one turn of the continental glacier from the North Pole to the line marking its maximal range covered 75,000 years. The thickness of its plateau changed from 1500 to 3500 m., and here and there it reached 4000 m. Thus we can assume that the average thickness of the continental glacier was 2000 m. During 75,000 years, that is, in course of one turn, the continental glacier had to cover a distance of about 3500 km., i.e. its peripheral velocity was circa 45 m.




TEXT-FIG. 2 — The maximal range of the plateau of the diluvial continental glacier in Eurasia and North America.

per year. The perimeter of the whole plateau in its maximal range amounted to about 32,000 km. Consequently, the very perimeter of the continental glacier plateau had to increase during one year by 1440 m². of ice, 2000 m. thick. Since the ratio of ice density to the density of snow is 1:6, then the production of this icy mass would require an area of 8640 km² of snow 200 m. thick. If this mass of snow was spread in uniform layer 10 m. thick, it would take an area of 17,28,000 km²., whereas a layer 1 m. thick would take 17,28,0000 km². Considering the fact that the winters had lasted as long as the summers [investigations of Schwarzbach (1940) on old diluvial varved clays in Sowie Mountains, Low Silesia, have proved, that in time of one year at least 158 varves per day —" Tageswarwen "— had been formed], these amounts of snow had to be multiplied by 2, giving in result the area 34560000 km.² of snow 1 m. thick per year. Since for one transgression of the continental glacier such amounts of snow had to fall for 75000 years incessantly without any-break, in that period the water should be permanently frozen. We must also take under account, that evaporation of water in winter is equal to 1/3-1/10 of that in summer. The water vapour contained in atmosphere is the source of atmospheric falls. The amount of water vapour in the atmosphere surrounding our globe is proportional to the intensity of evaporation. The total amount of water contained in atmosphere, surrounding the globe, being condensed at once, would cover the whole surface of the globe with a layer of water 24 mm. thick. Considering that its area is 510,000,000 km.², an area equal to 35,000,000 km.² is circa 15 times smaller. A layer of snow 1 m. thick corresponds to a layer of water circa 170 mm. thick. Water obtained from condensed water vapour contained in the whole atmosphere, spread on 350,000,000 km.² would form a layer 360 mm. thick. Hence, the annual increase of diluvial continental glacier's mass derived from snowfalls would require almost one half of water vapour contained in the atmosphere. We know, however, that in pleistocene the so-called pluvial periods which prevailed on subtropical and tropical regions were marked by rainfalls much more abundant than contemporary ones. From this simple calculus it results that the hypothesis on the origin of the continental glacier from snowfalls is not acceptable. Thus the question arises which was the source of water necessary for the increased mass of diluvial continental glacier? There is only one possible source of such enormous amount of water remaining permanently in the plateau of continental glacier in form of ice. At the time of diluvial period the water surface of oceans and seas had been lowered by circa 100 meters. This phenomenon has been confirmed by the facts. Consequently, we may accept only one hypothesis, that just this water was used for the formation of the icy plateau of the continental glacier. We have to explain now the mechanism of this phenomenon, which is connected with sea tides. It is well known that the greatest tides are observed in subtropical zones but in the case of displacement of Axis of the Earth the greatest tides are shifted towards the North Pole. The progressive displacement of the globe's axis, permanent in diluvium, had brought about more and more increasing sea tides, whose lowermost waters got frozen to the bottom of the growing continental glacier. The investigations carried out in 1954 by American and Russian geologists on drifting ice fields showed that the thickness of polar glaciers is increasing from below, due to the freezing water layers adjacent to ice. The contribution of snowfalls in formation of the continental glacier was undoubtedly secondary one. If diluvial continental glacier in Holarctics had four times passed from the North pole southward, and had so many times retreated to subarctic regions (i.e. it had four times melted), then this fourfold change in water level about 100 m. up and down, would have left its trace on the surface of oceans and seas all over the world, we do not have at present any evidence of such enormous oscillations of oceanic littoral waters. If these immense changes in water level occurred recently, it is improbable that they would not have left any evidence. The only explanation of the above phenomena is the following: Diluvial continental glacier had passed from the North pole southward only once. Its transgression was, however, gradual and followed by longer intervals in warm periods. Hence, the interglacials should be considered as great stadials representing in diluvium warm periods of time, in course of these periods the transgression was stopped, and the continental glacier did not retreat northward


I
1
2
3
4
5
II
III
IV
V
3500 km
2600 km
1550 km
450 km
A
I-II
III
IV
V
a (2)
b (3)
c (4)
(5)

3

TEXT-FIG. 3

just its front slightly melted. The conception of a single glaciation of Holarctis in diluvium is not a new one. A large group of scientists, in particular among those of older generation, opposed the theory of fourfold glaciation of Holarctis. Those scientists, however, had not at their disposal a sufficient number of facts to support their thesis. The facts and simple calculations cancelling the chief assumption of fourfold glaciation theory are presented in the present paper. There remains, however, one problem to be discussed: How to explain the fourfold invasion of Alpine glaciers in diluvium, which served Penck and Brückner to construct their theory of fourfold glaciation of Holarctis? The explanation of this phenomenon does not seem to be difficult. If we consider spacial and climatic conditions, it is obvious that mountain glaciations had followed the glaciation of Holarctis, and not vice versa, as it was assumed by Penck and Brückner. Diluvial Alpine glaciers were rather small when compared with the continental glacier of Holarctis. Thus, if a considerable lowering of air temperature in circumpolar regions had resulted in the formation of the plateau of continental glacier, then a corresponding decrease of air temperature should have occurred in the mountains of Holarctis. Clearly, the decrease of air temperature was in the initial phase of glacial period inversely proportionate to the distance of the mountains from the North pole. Though the temperature decreased progressively, with slowly increasing size of the plateau of continental glacier. Therefore, the first and the shortest glacial period during which the smallest area of the plateau of continental glacier was produced, did not cause any more remarkable reduction of air temperature in Alps, since these mountains were too remote from the centre of glaciation, but brought about only slight movements of the Alpine glaciers. Just the second and the third greater glacials are responsible for such a decrease in air temperature in Alps, that their glaciers have flown down to the mountain valleys. This period was followed by warm thermic cycle, in course of which the continental glacier being too huge a massif of ice was neither transgressing southwards nor regressing northwards, whereas the glaciers in Alps regressed far in mountains, because of the melting of their lowermost parts. Such phenomena were occurring with more and more intensity in fourth and fifth glacials and diluvial stadial (TEXT-FIG. 3). Owing to the changes in air temperature in glacial and stadial periods, the Alpine glaciers were either flowing down to the valleys or regressing to the mountains, leaving distinct routes of their migrations, which rechecked by Penck and Brückner suggested them to distinguish in Alps four glacial and three interglacial periods. Diluvial theory of fourfold glaciation undoubtly keen and lustified for Alps, has been applied to build up the diluvial theory of Holarctis, without any detailed analysis. This fundamental error resulting from a false interpretation of the excellent observations of the two German geomorphologists, had a disadvantageous effect consequence to further diluvial investigations carried out some several scores of the last years. I would also like to discuss here still one problem, namely, the so-called Scandinavian glaciation and diluvial chronology of De Geer, based upon the investigations of Scandinavian varve clays. The false interpretation of the previously discussed phenomena, also concerns the above problem. May we start our explanation from Greenland. Topographically, Greenland is in a deeply concave centre, thus it can be compared to a gigantic basin, whose centre is composed of the remnants of the diluvial continental glacier more than

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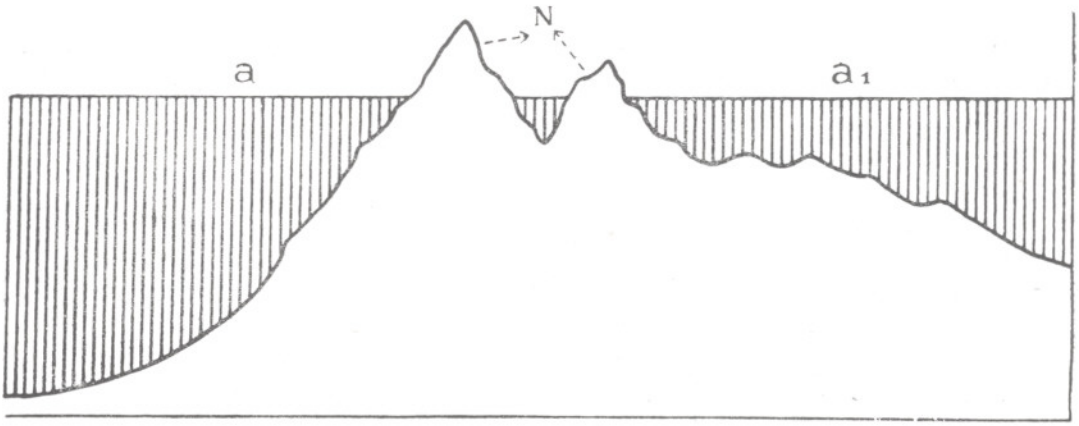
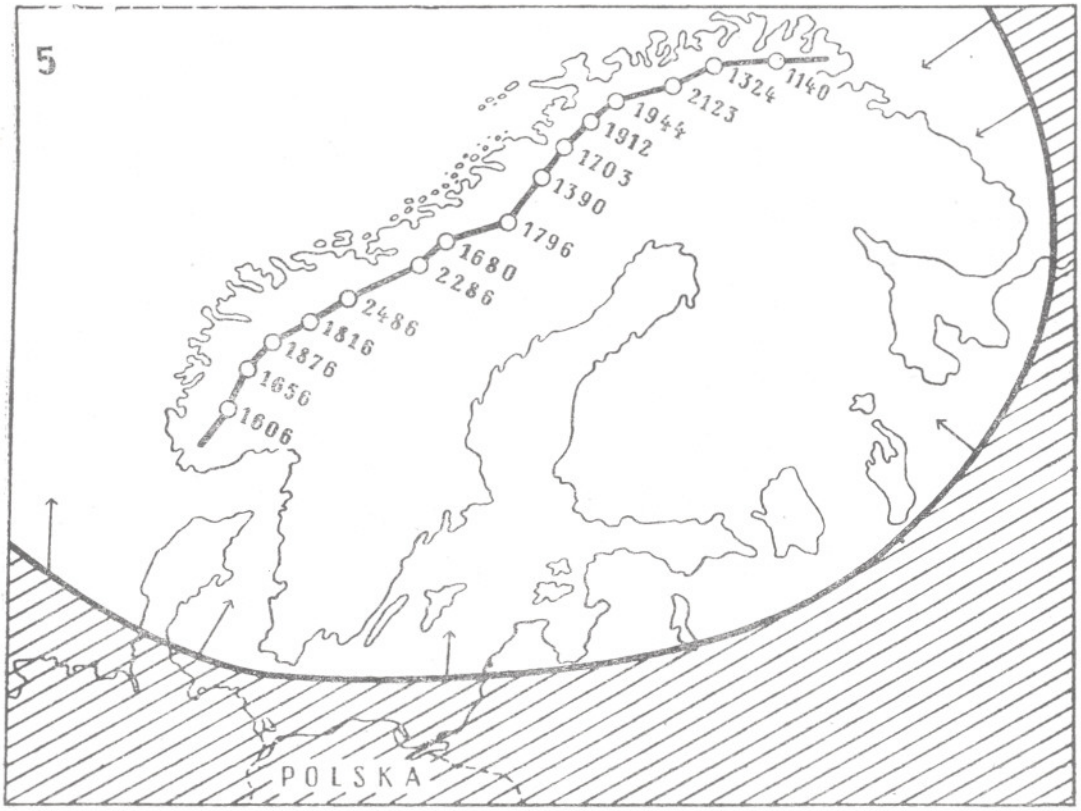
TEXT-FIG. 3 — The diagram representing a supposed effect of the transgressing diluvial continental glacier of the Holarctic territories on the oscillations of the Alpine glaciations.

I, II, III, IV, V = glacials
1, 2, 3, 4, 5 = stadials
A = ferns
——→ = " Flowing down " of the mountain glaciers into valleys
←—— = Retreat of the mountain glaciers

Four interglacials after Penck and Brückner's theory: between I-II Günz, between II-III (a) =Mindel, between III-IV (b) = Riss, between IV-V (c) = Würm.

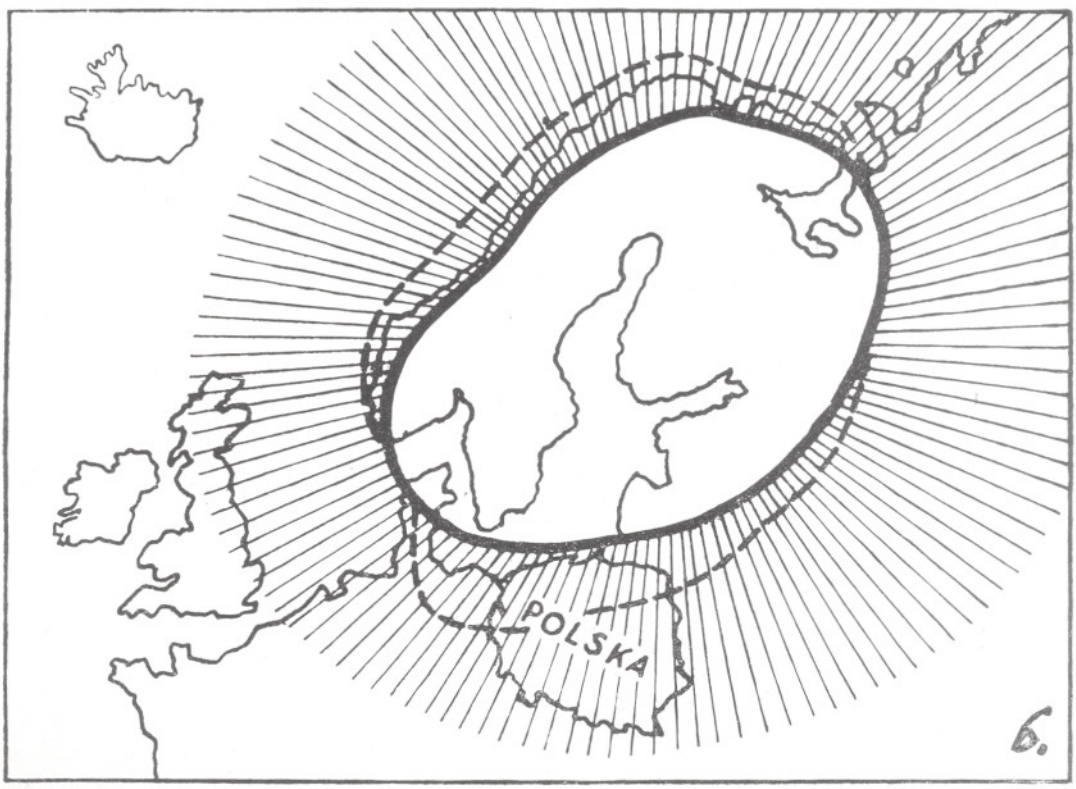



TEXT-FIG. 4 — The scheme of vertical section of the western coast of the Scandinavian Peninsula, and the differences in the thickness of the diluvial glacier's plateau. (a) = from west, ($a_1$) = from east, N = nunataks.

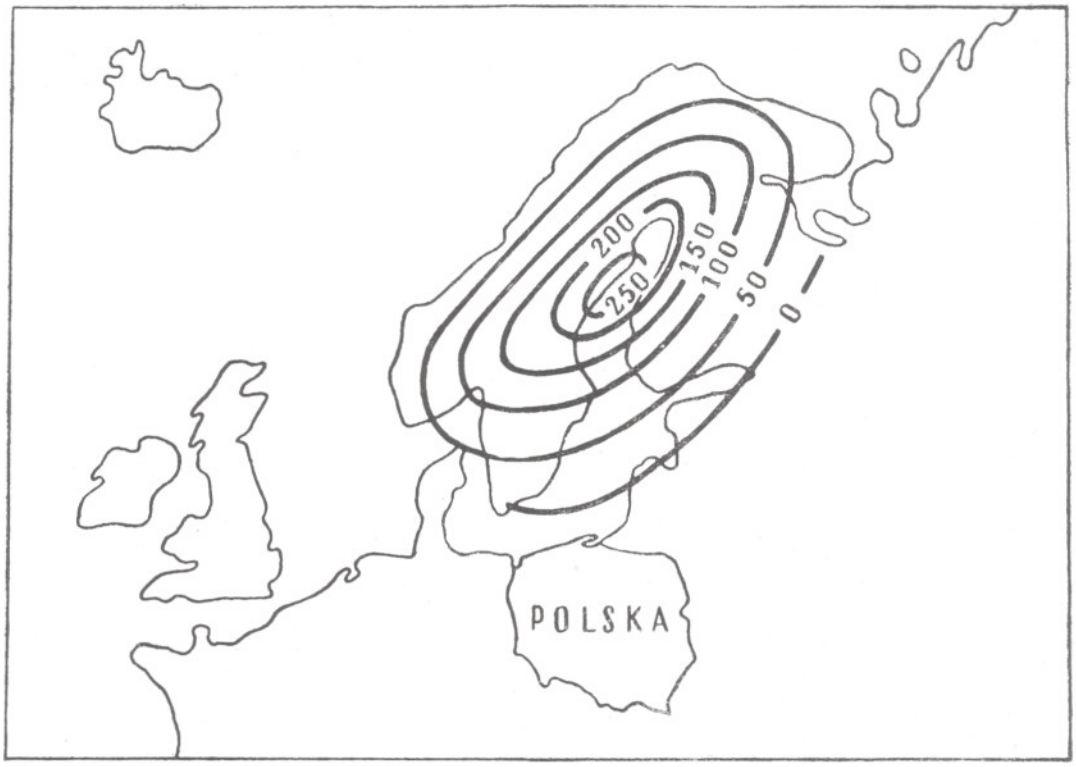



TEXT-FIG. 5 — Mountain tops raising along western coasts of the Scandinavian Peninsula.

3000 m. thick in its deepest part. Why Greenland is up to now covered by the plateau of continental glacier? For two reasons: (1) Greenland lies very closely to the North pole, (2) it is bilaterally surrounded by two big, cold sea currents: from west by the Labradour current, and from east by the north subarctic one. May we now glance at the geophysical map of Fennoscandia. The coasts of the whole Scandinavian Peninsula are from north and west sides surrounded by a continuous chain of mountains cut by deep fiords. The whole interior of the peninsula together with the Gulf of Bothnia is a big and deep basin gently sloping to south-east. The west chains of high mountains of the Scandinavian Peninsula fall in very steep slopes to the fiords and sea, while eastern slopes of the Scandinavian mountains fall gradually along hundred kilometres. Western coasts of Scandinavian Peninsula are rowded with mountains rising up to 1500 m. over sea level, and reaching often the elevation of 2000 m. Owing to such a relief of the terrain, the diluvial plateau of continental glacier in Fennoscandia was very thick in west and comparatively thin in the east (TEXT-FIG. 4), while all the highest mountains projected over the icy mass as nunataks. When the European part of the diluvial plateau of continental glacier had started melting, and when the front of the retreating continental glacier reached Fennoscandia, the continental glacier stuck in the Scandinavian basin, and comparatively quickly broke at the line of nunataks, and laterally retreated towards Atlantic ocean. Briefly the gigantic Scandinavian basin had been at that time in a situation in which its twin land — Greenland — is now (TEXT-FIG. 5). The enormous floe of diluvial continental glacier which had stuck in Scandinavian basin, produced owing to its sizes, a minia-




TEXT-FIG. 6 — Scandinavian ice-sheet of the diluvial continental glacier and a zone of its climatic influence on the countries in Middle Europe. Dotted line=the range of the last glaciation in Europe, according to R. Klebersberg-1949.




TEXT-FIG. 7 — The outcrop of Fennoscandia from the simatic ground, dating from 6800 B.C. (The altitude of the outcrop given in meters. According to SAURANO, 1939).

ture of the glacial period, but only in Fennoscandia (likewise in Labrador). It is clear that this diluvial Scandinavian miniature had an influence on the climate of the neighbouring regions for a rather long period of time (TEXT-FIG. 6). Though in my opinion, this phenomenon should not be correlated directly with the course of general diluvial phenomena in Holarctis. Hence, De Geer's diluvial chronology based on the investigations of varve clays in Sweden, although very precise and really excellent, may be referred only to Fennoscandia. This diluvial chronology applied to the investigation of diluvium carried out in any other place, must lead to false conclusions in the chronological dating of diluvium in Holarctis. The enormous ice-sheet of Scandinavian continental glacier melted from its margins very slowly, but not uniformly; this process being faster in east than in western mountain slopes. In the course of time the melting ice-sheet had formed Ancylus lake stage whose remnants have lasted out our times in form of Gulf of Bothnia. The investigations carried out by a geophysicist Suramo, and published in 1939, concerned the cropping out of Fennoscandia from the simatic ground in the course of 9000 years. They indicated that the melting process of Scandinavian floe of the continental glacier had proceeded centripetally (TEXT-FIG. 7). Sauramo's investigations are consistent with these of De Geer. They prove also that the last traces of the melted Scandinavian floe (ice-sheet) of the continental glacier might have disappeared circa 9000 years ago, according to the dating of De Geer. Because of the above results, we cannot make any stratigraphical parallelism between Scandinavian and Central Europe diluvium, and other parts of Europe and North America (British Islands partially included).

Finally, I wish to explain that the facts given in this paper, and hypothesis based

upon them, are only the fragments of a large paper entitled: "On a regularity of biological processes and phenomena in time and space". In that paper besides other problems an analysis of Penck & Brückner's diluvial theory, with a detailed division into separate glacial and interglacial periods, has been worked out.

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