

The Desiccation of Eur-Asia

By Peter Kropotkin

1. RECENT exploration in Central Asia has yielded a considerable body of evidence, all tending to prove that the whole of that wide region is now, and has been since the beginning of historic record, in a state of rapid desiccation. At the present time, evaporation over the whole of Central Asia is very much in excess of the precipitation, and the consequence is, that from year to year the limits of the deserts are extended, and it is only in the close neighbourhood of mountains, which condense vapours on their summits, that life and agriculture are possible with the aid of irrigation.

Traces of a desiccation which has been going on with great rapidity during historical times abound everywhere in Central Asia. Not only on the borders of the mountains which surround East Turkestan, but even in the interior of the now terrible sandy desert of Takla-makan, explorers, among whom Sven Hedin deserves special mention, have discovered ruins of wealthy cities, monasteries, and irrigated fields, amidst arid deserts where life is now impossible. Further east, all evidence concerning the basin of Lob-nor tends to prove that at times not very remote from our own the whole of the triangular depression between the Tarim in the west, the dry bed of the Concha daria in the north, and the southern shore of Lake Kara-koshun-kul in the south, and now occupied by a terrible desert, was occupied by a great lake, the Lob-nor, which at a later epoch, mentioned by the Chinese historians, was broken up into a number of smaller lakes, of which the Kara-koshun-kul is now the last survivor.

The region at the southern foot of the eastern Tian-shan, including the Lukchun depression, and, further on, the plains of Jungaria, were the seats of populous cities, monasteries, and villages. So, also, very large portions of the Gobi, and, in fact, most of the lower terrace of the high plateau of East Asia.

Altogether it is quite certain that within historical times East Turkestan and Central Mongolia have not been the deserts they are now. They have had a numerous population, advanced in civilisation, which stood in a lively intercourse with different parts of Asia. All this is gone now, and it must have been the rapid desiccation of this region which compelled its inhabitants to rush down to the Jungarian Gate, down to the lowlands of the Balkhash and the Obi, and thence, pushing before them the former inhabitants of the lowlands, to produce those great migrations and invasions of Europe which took place during the first centuries of our era.

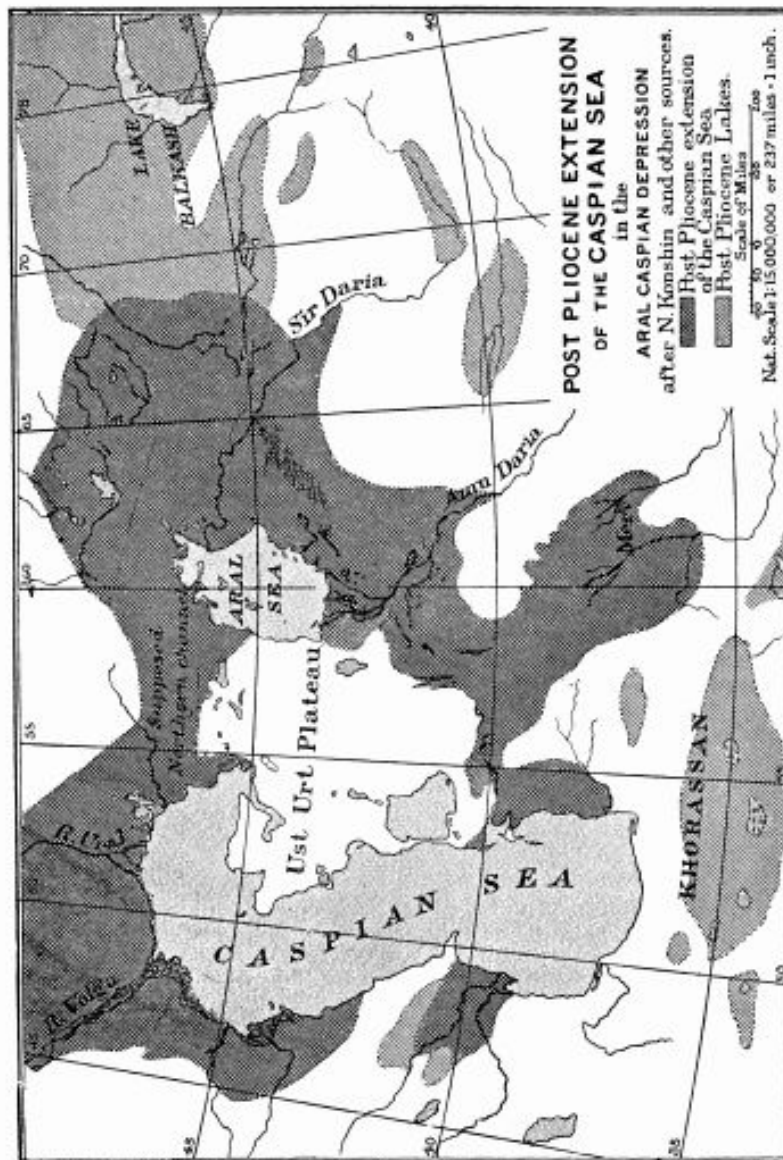
In Western Central Asia we have in the lake Aral and the Caspian sea only small survivals of the immense marine basin which once occupied the place now taken by the Turkoman deserts. The evidence of the ancient Greeks and the Arab geographers, which was brought together some time ago by Prof. Oscar Lenz for the Russian Geographical Society, leaves, in fact, no doubt as to the fact that some two thousand years ago, and maybe much later, the Amu-daria entered the Caspian sea. But it may also be taken as proved by the Russian explorers of the Trans-Caspian region that it was not the Amu which rolled its waters so far westwards as to enter the present Caspian, but that the Caspian sea extended so far eastwards as to join what is now Lake Aral, spreading in its northern portion as far as Perovsk on the Syr (65° 30' E. long.), and receiving the Oxus in its southern part in about 60° E. long.

However, it is not only to Central Asia, i.e. to the region which presently has no outflow to the ocean, that the evidence of recent desiccation is limited. In Southern West Siberia we have a striking evidence in the desiccation of a group of large lakes—Chany, Abyshkan, and Sumy-Chebakly. It so happens that we possess surveys of these lakes, dating from 1786, 1813-24, 1850-60, and 1880; and N. Yadrintseff has published these surveys. The rapidity of desiccation of the shallow lakes of this group is simply striking. Chany has been notably reduced in size during the last hundred years, and will soon be divided into two lakes, while the lakes Sumy, Moloki and Abyshkan have been reduced, in the course of the years 1850 to 1880, to the size of a few small ponds. A dozen villages have been built all along the shores of Chany, upon ground that was under water at the beginning of the nineteenth century, and eight villages now stand upon what was then the bottom of Lakes Abyshkan and Moloki. True, that according to recent information the lakes of this group have slightly increased in size; they apparently have reached once more the sizes they had had in the middle of the last century; but they have not reached, and in all probability will never reach, the size they had at the end of the eighteenth century.

The same is true of Lake Aral. Owing to a period of increased rainfall which we have entered during the last few years, Lake Aral has begun, since 1891, to reconquer parts of the shores which it had lately abandoned. Its waters, rising by nearly 4 feet during the past twelve years, have refilled parts of the gulf of Aibughir; but nobody expects, of course, that the lake should reach and cover once more, let us say, the marshes on the lower Syr, about Perovsk, which formerly belonged to the same Aral-Caspian basin.

Nor is desiccation limited to Asia. Abundant evidence is at hand to prove that in European Russia immense areas, formerly under lakes and marshes, have been laid dry. Thus it is known that when the Mongols invaded the territory of Russia in 1238, they could not reach Novgorod with their horses, because the northern republic was surrounded by impassable marshes, which only could be crossed in winter. The lifting of the land by an additional 16 or more feet during the eight centuries that have passed since the Mongol invasion, and

the improvement of the drainage, which was due to the natural excavation by rivers of their channels, have thus dried to a great extent the marshes in the lake district of Novgorod. The same is true of the whole of Northern Russia. All historical evidence points, indeed, to the fact that seven or eight hundred years ago northern and middle Russia were covered with a far greater number of lakes and marshes than they are now.



The drying up of marshes, lakes, and rivers in Central and especially

South-Eastern European Russia is also a fact that is mentioned everywhere throughout the seventeenth, eighteenth, and nineteenth centuries. It was attributed, of course, to the destruction of the forests; but, without denying that the destruction of the forests has a certain influence in the sense of reducing the amount of precipitation, and especially reducing the quantity of moisture which is retained in the soil after the thawing of the snow, we cannot but accept the conclusions of Boguslavsky concerning the Volga. He has proved by his pluviometric measurements that even the immense destruction of forests which took place for the last two hundred years in Russia, is absolutely inadequate for explaining the considerable reduction in the quantity of water that passes every year through the channel of the Volga, which took place during the nineteenth century.

2. It must thus be recognized that desiccation on a great scale has been going on in Northern Asia and Europe throughout the historical period; but it might be asked whether this desiccation is not merely a temporary fact; whether, in consequence of those fluctuations of which we know so many examples in Nature, the pendulum will not soon begin swinging in the opposite direction, and the regions which have become deserts during the last thousand years will not soon begin once more to receive abundant precipitation and become fertile and flourishing once more. The fact is, however, that the desiccation of which we have testimony in historical documents, is only part of the desiccation which has been going on all over the northern hemisphere during all the geological period which we live in, i.e. the post-Glacial Period. The desiccation of Eurasia is not merely a physico-geographical, modern fact. It is a geological fact, which is entirely dependent upon the character of the geological epoch which preceded it, and must be considered in connection with it.

3. It has been established by the researches of the last fifty years that considerable portions of Eur-Asia were covered during the Ice Age with a mighty ice-sheet. Its southern limits in Central Europe and European Russia are now traced by the geologists approximately along the 50th degree of latitude, with "tongues" of ice which were protruding in Russia along the main valleys (Dnieper, Don) in a south-eastern direction, so as to reach the 47th or the 48th degree of latitude. In France, it has lately been proved that the whole of the Central Plateau and the Vosges were also covered with a thick ice-sheet. The glaciation of the northern portion of the Urals is no more doubted upon, and it is only the glaciation of the middle portions of these mountains which still remains a point of contest. As to the great West Siberian depression, it is now certain that during the Post-Glacial period, and probably also during the Great Ice Age, most of it was under the Arctic ocean, which reached, in West Siberia, roughly speaking, the 52nd degree of latitude, while in Eastern Siberia, which is covered with high plains, this same latitude was reached by narrow gulfs of the Arctic ocean now occupied by the valleys of the main rivers.

The low and broad watershed between the Irtysh-Ob and the Aral-Caspian depression surely must not have been glaciated, the more so, as in the south of that watershed the Aral-Caspian basin was spreading at that time eastwards. But it appears certain, on the other side, that very large portions of what the present writer describes as "the Great Plateau of East Asia" were covered with mighty ice-sheets. In all the border ranges and the Alpine regions which fringe the plateau on the north-west (the Tian-shan system, the Altai system, the western Sayans), traces of a wide glaciation have already been found by most explorers, and still more so in the highlands belonging to the same system further north and north-east of Lake Baikal (Patom Highlands, etc.). But if the border ranges which but little raise above the surface of the plateau have been glaciated, it is more than probable that large portions of the high plateau itself were glaciated as well, as also the high ranges of the Ektagh Altai, the Khangai, the Kentei, and so on, and that traces of this glaciation will be discovered (as they have been discovered on the Central Plateau of France, after having been denied for a long time), as soon as the country is explored by persons competent in that branch of geology. Even now we can already say that to the north of the 50th degree of latitude the high plateau bears doubtless traces of a very extensive glaciation wherever it rises more than 3000 feet above the sea-level. Knowing, as we do now, the wide extension of glaciation in the Himalayas, the Tian-shan highlands, the Karakoram mountains, and the ranges Raskem and Peter the Great, and combining all we know about the structure of the surface deposits and the forms of the mountains on the Tibet plateau, we must presume that, in all probability, extremely wide areas in Tibet, now lying at altitudes of from 10,000 to 16,000 feet, were also under ice-sheets; while the comparatively low parts of East Turkestan and Mongolia ("the Lower Terrace of the East-Asian Plateau," in my classification) were probably at that time (or, at any rate, towards the end of the great glaciation) immense interior lakes, which received the drainage waters from the gigantic glaciers of the border ranges and the high plateau, before these waters found their way to lower levels through the south-eastern gorges of Tibet.

At any rate, remaining in the domain of certitudes, we can say that, with the exception of the lowlands of Siberia, which represented gulfs of the Arctic ocean, *nearly the whole of Eurasia, to the north of the 50th parallel, and a very large portion of the highlands in the south of this line, were buried under ice.*

4. What were the causes of such a glaciation, we don't know yet. All hypotheses, like that of Croll, which attempt to give an astronomical explanation of the Ice Age, on the supposition that periods of intense cold were alternatively experienced in the northern and the southern hemisphere, must be received with the greatest caution, so long as no geological evidence of any sort has been brought forward to support the idea of an alternate glaciation of the two hemispheres. All the geological evidence we possess—that is, the complete similarity of aspect of the glacial deposits in both hemispheres, and the identical

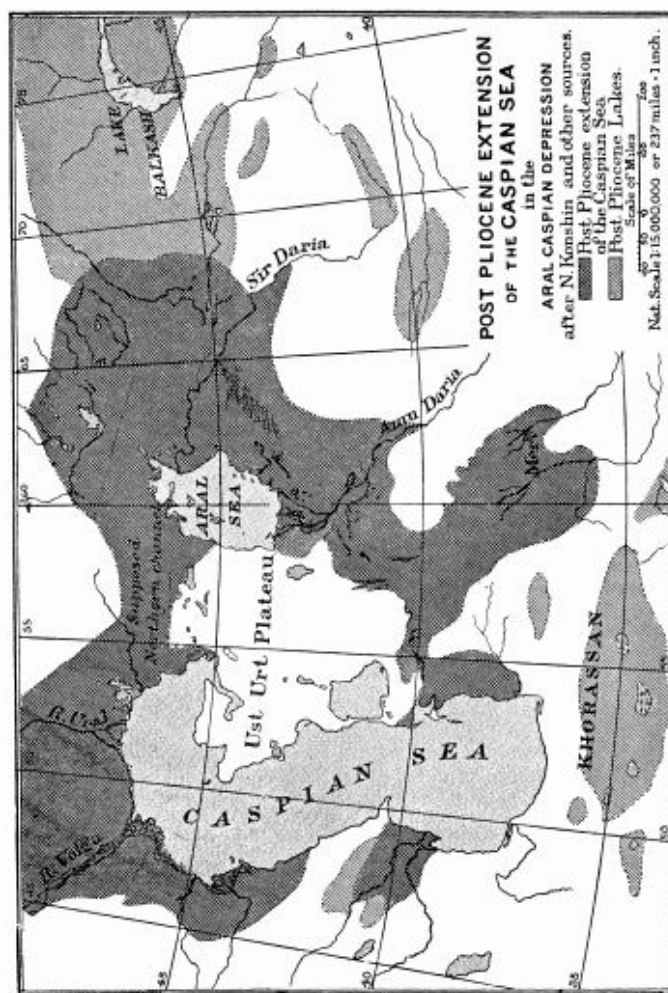
position they occupy with regard to the Tertiary deposits and the Tertiary volcanic eruptions—seems to point out, on the contrary, in favour of a simultaneous glaciation in both hemispheres; and so long, therefore, as the matter has not been gone into from this point of view, and alternation has not been proved, or even rendered probable, by the geologist, all speculation in that direction is misleading and hampering inductive research. Of all hypotheses hitherto proposed for the explanation of the Ice Age, the one which seems, in the present writer's opinion, to offer a possible cause, is the hypothesis of the great Swedish physicist, Prof. Arrhenius, based on the possible fluctuations in the percentage of carbonic acid in our atmosphere. The great volcanic eruptions which, we know, really took place towards the end of the Tertiary period, on a gigantic scale all over the Earth's surface¹, would fully explain why the percentage of carbonic acid in our atmosphere might have been increased; and we have seen ourselves, a few years ago, how one single eruption, that of Krakatau, by throwing out into the atmosphere considerable quantities of dust, was capable of producing a rather considerable effect, indicated by those wonderful pink sunsets which were seen all over the globe. The proper effect of volcanic eruptions going on on a great scale for a certain considerable time is not yet quite settled; and I am inclined to think, with Marchi ('*La cause dell' epoca glaciale*'), that the ejection of considerable quantities of carbonic acid, vapour, and dust into the atmosphere towards the end of the Tertiary period may have been a sufficient cause for the subsequent lowering of temperature and glaciation. Besides, as has been indicated by Eugene Dubois ('*Klimate der geologischen Yergangenheit*,' 1903), who is supported in this case by A. Woeikoff, it is extremely probable that the very quantity of heat radiated from the sun does not remain invariable.

5. Whatever the causes of the Ice Age may have been, it is thus certain that considerable portions of Eurasia were buried under a thick ice-sheet, both in the north of the 50th degree of latitude and in the highlands of both Europe and Asia to the south of this line. It is also certain that towards the end of the Glacial period, and immediately after the retreat of the great ice-sheets, portions of Europe and Asia were under the sea. Leaving aside such doubtful cases as the shells found on Moel Tryfan, and accepting only absolutely doubtless evidence, we may say that all those portions of Western Europe which are now below 300 feet of altitude were under the sea. In Sweden the traces of post-glacial submergence are certain up to nearly the same level, or, at least, up to 250 feet. In Finland and in North Russia now-living shells are found up to the 150-feet and maybe 200-feet level along the Arctic littoral.

The Baltic sea entered, we now know, westwards into Sweden, and covered the region of the great lakes. The Gulf of Finland spread

¹ * In Asia they took place on a tremendous scale. I have found them, with the small craters of eruption still preserved amidst vast sheets of lava, in the West Sayans (Jumbulak-Oka valley), on the Vitim plateau, and to the east of the Great Khingan. Every recent explorer of East Asia has mentioned some new extension of eruptions of apparently the same age

eastwards so as to embody Lake Ladoga, and the head of this gulf must have been separated by a narrow watershed only from the Arctic sea, which spread in Northern Russia as far as the Vychegda and the upper Pechora. In the valley of the Pechora the post- Glacial sea attained a level of 120 or 150 feet, and filled a long gulf stretched southwards. In Western Siberia a wide gulf of the Arctic ocean penetrated almost as far as the line now marked by the Trans- Siberian railway under 50° N., while further east large tracts in the north of the Arctic circle, as well as portions of the main river-valleys, were under the sea, narrow gulfs of the ocean penetrating up the Yenisei and the Lena; and finally, the presence of fossils identical with those molluscs which now live in the Caspian sea testify that during the post-Glacial period the Caspian basin extended eastwards so as to include Lake Aral and large portions of what is now the Transcaspian territory, that it covered at the same time the steppes of the lower Volga, and that a gulf of the sea penetrated northwards up the Volga as far as Kazan and its tributary, the Kama.



6. When the ice-sheets which covered Eurasia began to shrivel and to thaw, immense quantities of water must have been discharged from this mass of thawing ice southwards, and the broad belt of land on the southern fringe of the ice-mass, now occupied in South Russia by Loess, must have been periodically inundated every summer with muddy rivers which covered the land with fine mud, and gave origin to tundras first and to prairies next, or to such urmans, or marshy forests, dotted with countless lakes, as we now see in West Siberia.

As to the space that had been under the ice-sheet itself, immense lakes were formed in its place as it was thawing, and these lakes attained vast sizes. The old drainage systems having been choked by the glacial deposits, immense territories had no drainage, and new channels had to be dug out in order to find an outflow for the waters towards the ocean. Innumerable traces of such post-Glacial lakes are found everywhere in Eurasia, wherever there are traces of glaciation. Consequently, I have proposed to introduce in geology a special term—the Lake Period—to designate the conditions which prevailed over immense portions of the northern hemisphere (in all probability of the southern as well) during the early portion of the post-Glacial period.

The American geologists have long since noticed this feature of the post-Glacial period, and they have tried to delineate the shores of some of the old lakes of that epoch, such as the now disappeared "Lake Agassiz." They are endeavouring, moreover, to reconstitute the drainage systems and the channels of the rivers of that interesting period, very much at variance from the actual systems of drainage. Traces of one such immense lake I have indicated in Europe, namely, in middle Finland—the whole of the area now covered by the countless large and small lakes of Central Finland having been once covered with one large lake with islands in it. Its level stood about 100 feet or more above the present level of the Saima system of lakes, and its southern shore was made by the great front moraine, or as, followed by the Hangoudd to St. Petersburg railway, which runs parallel to the shore of the Gulf of Finland, and is so prominent a feature on the map of the beautiful 'Atlas de Finlande.'²

7. That the whole of the surface which was covered with ice during the Ice Age must have been dotted with countless lakes of all possible

² * I am aware that M. Sederholm is inclined to admit that the level of the Baltic sea rose once to that same level; but I have indicated to him that what he has described as old sea-beaches on the Yviskylä as are parts of the great bottom moraine (krossstensgrus) from which the waves of the old lake have washed out the sand and small gravel, leaving behind the big stones; the deposits which I have described both on the slopes of this as, and in many other places round the lakes, as also the deposits which were pierced by the Hoytiainen lake during the well-known catastrophe, are entirely of a Lacustrine character. They contain, indeed, none of the shells which are found in such quantities as soon as you descend to a level of about 100 feet above the present level of the Baltic. Further inland the same deposits, undoubtedly Lacustrine, are found at a still higher level above the sea than on the Yviiskylä as, thus showing that after the thawing of the ice-sheet all Finland was covered with lakes, disposed terrace-like, up to the highest levels of the Kjollen.

dimensions when the ice-sheet had thawed, is self-evident for any one who has examined the landscapes of Alpine valleys during the retreat of a glacier, or has paid attention to the detailed topography of a formerly ice-bound landscape. Therefore traces of lakes which have existed after the Glacial period, down to relatively quite recent times, are found in countless numbers everywhere in Northern Europe and Asia.

The lowlands which surround the great lakes of Sweden are covered with deposits of lacustrine origin, and on the slopes of the Upsala as and the other asar we see, above the post-Pliocene marine deposits, thick layers of lacustrine deposits. The surface of Schonon is all dotted with smaller lakes, which, like the small high-level lakes of Finland, are only insignificant relics of the countless lakes which existed here in Palaeolithic and Neolithic times. In Northern Russia, the Onega region, the Valdai plateau, the tundras of the Mezen, the Pechora land, the lake district of the western provinces, the marshy lands of the Pripet, the provinces on the upper Volga, vast tracts on the Vetluga, and the lower Kama, etc., are simply dotted with countless lakes, each of which indicates by the flat marshy shores which surround it as a wide fringe, that it only represents the deepest trough of a once much greater basin. I mention, as you see, only Russia and partly Sweden, because these are places of which I have a personal knowledge; but every one here present would be able to name from his own personal knowledge wide portions of these islands (such, for instance, as the immense lake which must have covered the valley between the North Downs and the South Downs), or in France, in Germany (the Seen-Platte of Prussia, etc.), which bear evident testimony of having been covered with lakes for a very long time after the thawing of the ice-sheet.³

It would be most desirable, therefore, that a number of persons interested in this subject should begin to collect the necessary materials, so that we might some time hence prepare correct maps of the lakes of the Great Lake period

In Siberia we should have very large territories literally studded on our maps with lakes if we only possessed detailed surveys of these regions. We have first the immense Urman region, watered by the Irtysh, the Ob, the Vasyugan, etc. Recent surveys represent it as an almost uninterrupted marsh, 1450 English miles wide and 500 miles long (north-west to south-east), intersected only with narrow ridges approximately dry enough to be inhabited. Then we have a territory, 200 miles wide and over 900 miles long (west to east), situated halfway between the above marshes and the Aral-Balkhash basin, which, according to latest surveys, appears literally studded with thousands upon thousands of small lakes. The aspect of this region, dotted with

³ It was always on the rims of such old, now totally disappeared lakes that my friend Polyakoff, who was reputed for his special gift of discovering stone implements by the bushel in so many places of Siberia, usually discovered traces of Neolithic human settlements. "There," he would say, as he looked upon some Siberian valley, "was the shore of the lake which once filled the valley. It's along that shore that they must have lived. There's a nice sheltered place; I am sure they must have liked it. Let us dig there." And in a few hours stone arrows and other implements were invariably dug out, sometimes bushelfuls.

lakes on recent maps (such as Stieler's), is most edifying; but we should have the same aspect in several other places of Siberia if other parts of Northern Asia were mapped with the same details as this portion was lately mapped for the purposes of immigration. Thus, for instance, the Vitim plateau (the basins of the Tsipa, the Amalat) would have exactly the same aspect, so far as I could ascertain along the lines which were followed by Lopatin and myself. The map of North-Western Mongolia, even now, is in the same case; it is covered with a number of large lakes, but there are hundreds of small ones which have not yet been mapped. The high plains of the Vilui are again in the same case; so also the lowlands of the Sungari, the Usuri, and the lower Amur. All these are still in the Lake period.

These are still in the Lake period. In Central Asia we find wide regions bearing distinct traces of having been covered with immense lakes. Such are, the lake-region in Tibet, in the province of Khor, and, in fact, along all the hitherto explored routes; the immense marshes of Tsaidam; the Lob-nor depression, and, in fact, both the depressions which run in Chinese Turkestan along the foot of both the Altyn-tagh and the Ektagh Altai; the marshes and lake regions at the northern foot of the latter, etc.

However, all those now existing lakes are but only indications of the immense areas which were under lakes and marshes during the post-Glacial period. There would be no exaggeration in saying that the whole of the territory invaded by the ice-sheet must have represented, at the beginning of the post-Glacial age or the Lake period, immense marshes, exactly similar to what we now see in the above-mentioned basin of the Ob and the Vasyugan and lake regions, similar to that of Finland.

8. In proportion as the rivers dig out for themselves regular channels, and the drainage becomes more effectual (see, for instance, in my account of the bursting of Lake Hoytyianen, how the upper lakes are gradually emptied in Finland), and in proportion as the northern shores of Europe and Siberia are lifted up at the rate of from 1 to 3 feet per century, the desiccation of the whole of that territory necessarily goes on at a steady accelerated pace. In proportion as the outlets of the lakes dig their channels deeper and deeper, the surfaces of the lakes are diminished; the marshes which surround them are drained; chains of lakes become narrowed, as we often see it in Finland, and gradually a river is formed where formerly there was a chapelet of lakes. Later on, only the inundations which happen in the spring, or after extraordinary rains, will indicate the former position of the lake; but each inundation, owing to the mud it deposits, reduces the limits of the subsequent inundations, and meadows or bush-land spread over what was once the bottom of the lake.

Therefore, when we look at a chart of the soils of European Russia, prepared by Prof. Dokutchaeff and his followers, we see the whole of the once-glaciated surface of European Russia dotted with countless marshes, which, with the exception of a very few of recent origin, are remainders of former lakes. In some places the marshes cover

immense surfaces; such are the marshes of the Polyésie, on the Pripyat and the Berezina, which cover 22,000,000 acres, i.e. a surface larger than that of Ireland. This surface represents, undoubtedly, the not yet quite dried-up bottom of a post-Glacial lake. Such are also the immense marshes of the Meschersk region of Ryazan, those of Vyatka, and of the Novgorod and Pskov lake region—the areas covered with marshes becoming wider and wider as we approach the coasts of the White sea and the Arctic ocean, so that in the provinces of Olonets everything is marsh, except the narrow ridges, or "pigs' backs," which slightly raise above the marshy grounds.

There is not the slightest doubt that where we see these marshes now, there were lakes in a geologically recent past. The finely alternating mud and sand deposits of these lakes are there to prove it, and when we examine a large-scale topographical or a geological map of Central and Northern Russia, we see all the possible gradations in the process of gradual desiccation which transforms lakes into marshes, and marshes into more or less periodically inundated meadows.

9. The deposits of numbers of elongated lakes, which all existed during the early post-Glacial period, but are completely drained by this time, are perfectly well seen on the geological and especially the soil-maps of European Russia. As to Asia, its surface is literally dotted with post-Glacial lakes. On the smoothed surface of the Vitim plateau small lakes are found in countless numbers, and each of them is only the remainder of much larger lakes gone. Every cavity in the plateau, every valley in the surrounding mountains, bears traces of having been filled in post-Glacial times with a lake of large dimensions. The Alpine valleys of the Irkut, the Barguzin, the Muya, the Djida, etc., etc., are desiccated lakes, which now represent prairies, 20 to 30 miles long and from 5 to 15 miles wide, while on the surface of the plateau we see everywhere evidences of recent lacustrine deposits. Nay, even the low and smooth water-partings between the rivers of the plateau are still covered over immense areas with marshes. This is what the high plateau of Mongolia, and at a still more remote epoch the lower terrace of the plateau (Gobi and East Turkestan) must have been at the beginning of the Lacustrine period, and have been in reality, as is attested by the deposits of old lakes with which they are covered.

10. In short, over the whole of the surface of Europe and Asia, and especially over their northern or their more elevated portions, we find traces of a desiccation which is going on now, and has been going on all the time since the end of the great glaciation. It is not with a temporary fact that we have to deal. It is a geological epoch of desiccation that we are living in—an epoch as characterized by desiccation as the Glacial epoch was characterized by the accumulation from year to year of unevaporated and frozen precipitation. More than that, this epoch of desiccation is a necessary outcome of the preceding epoch of glaciation.

Nor is the phenomenon of desiccation limited to small portion of the

continent. It embraces the whole of the region that has once been glaciated. It is not only Central Asia that is desiccating; the same future is in store now for the Caspian steppes of the lower Volga and for South-Eastern Russia altogether. Desiccation in these regions becomes more and more apparent. But it cannot be attributed, as it is often done, to the destruction of forests in Northern Russia. We must see in it a geological fact, independent of the will of man; and while indicating this fact to men of science as an important line of future research, it would be worthwhile, at the same time, to think of the measures which should be taken for combating-at least within the limits of what is possible-the coming drought. Such measures, I mean, as tree-planting on a large scale in the menaced regions, with the aid of artesian wells, which seems to have given good results in North Africa, or any other measures which the knowledge of the danger and further research may suggest.