
On the Desiccation of Eurasia and Some General Aspects of Desiccation

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small allowance of provisions. With dogged determination he held on, stopping once only to make himself a cup of tea, and completed the long and solitary walk within twenty-four hours. He arrived at the ship thoroughly exhausted, but relief was at once despatched, and, as has been testified in a letter to the press by Admiral May (then a lieutenant in the same expedition, and the officer chosen to lead the advance of the relief party) was undoubtedly the means of saving the lives of the northern party, with the exception of one seaman who had already succumbed. Parr afterwards commanded the *Inconstant* in the Egyptian war of 1882, becoming captain in 1887, rear-admiral in 1901, and vice-admiral in 1905. Retiring the year after, he was promoted to admiral in 1908. In his latter years he suffered from serious heart affections, the seeds of which may, it is thought, have been sown by his heroic exertions above referred to. He was only in his 65th year.

CORRESPONDENCE.

On the Desiccation of Eurasia and some General Aspects of Desiccation.

EVERY geographer will surely be thankful to Prof. Gregory for having brought together much valuable information relative to the desiccation of various parts of the Earth, and thus renewed interest in this matter. If he gives us no hints as to the relative value of his data, the copious bibliography appended to his paper will facilitate the study of the subject to those who will intend to go deeper into it.

I certainly will not attempt to discuss the value of Prof. Gregory's authorities, taken so wide apart as the Genesis on the one side and modern geological and archaeological research on the other side. So I shall limit my remarks to the observations made by Prof. Gregory concerning my own contribution to this subject, "The Desiccation of Eurasia," published in the *Geographical Journal* for June, 1904.

First of all, I did not speak of "the desiccation of the world." Not even about the desiccation of *our earthball*. I limited my remarks to the desiccation of *Eurasia*, which I consider as a consequence of the Quaternary Glacial period. And by *Eurasia* I understand—not the continent that existed in Silurian, or Carboniferous, or Jurassic times, but the continent that had acquired approximately its present size and shape since the end of the Tertiary period.

My contention about this continent, as Prof. Gregory correctly words it, is that *the climate of Eurasia is undergoing since the end of the Glacial period "a steady progress towards drought, though there may be fluctuations in the advance."* And, having read now Prof. Gregory's paper, I must say that *if it accentuates the local fluctuations*, it does not contradict my statement; it further confirms it.

It confirms it by direct evidence as regards prehistoric times. As to desiccation in *historical times*, the data brought together by Prof. Gregory concerning Palestine, Egypt, Cyrenaica, Tunis, and Greece cannot be properly interpreted unless we analyze, as physical geographers, some general aspects of desiccation; and this I beg leave to do at some length.

Let us state first, with some precision, the main points of the case. The desiccation I speak of is *not* due to a diminishing rainfall. It is due to the thawing and disappearance of that immense stock of frozen water which had accumulated on the surface of our Eurasian continent during the tens of thousand years that

the Glacial period had been lasting. Diminishing rainfall (where such a diminution took place) is thus *a consequence, not a cause of that desiccation*.

The extension of the ice-sheet in Eurasia is pretty well known. The whole of Northern Europe, nearly down to the 50th degree of latitude, was buried at a certain time under an ice-cap, probably more than 1000 feet thick; while the Pyrenees, the Alps, the Caucasus, and very probably the Carpathians and the Balkans, were also buried under immense masses of ice. As to Asia, it may be taken as proved that not only the border-ridges of the two great plateaux of Asia (the Altai, the Sayan, etc., on the northern border, the Himalayans, the Khingan, the Tian Shan, etc.), but also large portions of the plateaux themselves were covered during the Great Ice Age with immense ice-caps.*

Whatever the causes, atmospherical or cosmical, of such a glaciation may have been, the fact is there; the Earth *has* gone through a period during which over immense portions of the northern hemisphere (possibly also the southern) *the amount of snow received every year from the atmosphere was in excess of the amount of water that was lost during the year by the same surfaces, either by evaporation or by the rivers carrying it to the sea.*

But the appearance and the slow growth of such an ice-cap, until it had covered from 40 to 50 degrees of latitude, was *the building up by Nature of a gigantic ice-cellar*, and this ice-cellar represented an enormous quantity of water withdrawn from the atmosphere *and stored up for future use*; while its subsequent thawing represented a *restitution of that water to the atmospheric circulation*. The gradual exhaustion of that store of water, both evaporated and carried away by rivers from the ice-cap and the glaciers first, then from the lakes to which they gave origin, and finally from the marshes and the *urmans* originating out of the lakes, is what I mean when I speak of the desiccation of the Eurasian continent.

Now, it is self-evident that physical changes of such a magnitude could not have taken place without a series of oscillations and partial reversals. Whichever natural evolution we represent by an ascending or a descending curve, the curve will never be smooth; it will have its undulations. Besides, the gradual melting of these immense masses of ice evidently gave origin to quite a variety of subordinate phenomena. All sorts of new deposits, aerial and aqueous, were accumulated around the fringe of the main mass of the thawing ice-sheet; on the plateaux immense lakes appeared (like the Lake Agassiz of North America), and later on they were broken into myriads of smaller lakes. The old channels of the pre-glacial rivers having been choked by the sub-glacial deposits, new rivers had to dig out new channels in order to find their way to the sea, and so on. *All sorts of landscapes were thus appearing on the territory evacuated by the ice.*

Let us take the Greenland ice-cap. Even now, on the periphery of this relatively small mass of ice, we see how—evidently in consequence of an unequal accumulation of snow over different portions of the ice-cap in different years—the “flowing” of this plastic mass of ice and its discharge through the main valleys differ in different series of years. The result of these changes of pressure is that

* The earlier explorers of Asia who never had studied glacial formations in Europe, denied such an extension of glaciation. Those geologists, on the contrary, who had studied the effects of glaciation in Europe or in the United States easily found in Asia traces of a glaciation as extensive as that of North America. For the sense of the orographical expressions just used see my “Orography of Asia,” with maps, in *Geographical Journal*, vol. 23 (1904), pp. 176, 331; the article “Asia” in *Chambers’ Encyclopædia*; and the articles on Turkestan, Siberia, Russian Empire, etc., in the 9th and 10th editions of the *Encyclopædia Britannica*.

rocks in the sea-coast region, which for centuries had been buried under the ice, are occasionally freed from it ; and immediately the by no means poor vegetation which grows on the seashore in close vicinity with the ice-walls invades them and thrives there for a number of years. Then, again, for the same causes, the discharge of ice through this or that valley is increased, and the moving ice covers with its bottom-moraine, or carries away, the rest of the plants that had invaded the rocks. *In this way inter-glacial deposits of plants are formed even now, under our very eyes.*

Specialist geologist-geographers, like Prof. Penck and several others, have distinguished, it is known, several phases of a more or less extended glaciation in the Alps, and they have subdivided the Quaternary Ice Age in Europe into at least three periods, differing from each other by the extension and thickness of the ice. But they do not mean, so far as I remember (being far from all scientific libraries, I can only speak from memory), that the glaciation of Middle Europe should have come twice to an end, in order to give origin to a sub-arctic vegetation.

Another point of importance is the extreme variety of physiographical features offered by a continent which recovers from the effects of a wide glaciation. Here it is that the collaboration of the geologist and the physical geographer is especially needed. The geologist, when he finds buried in his Post-Glacial records the remainders of a *tundra* vegetation, or of a Steppe flora and fauna, is apt to consider them as traces of different Tundra and Steppe periods, or periods of drought. But the physiographer knows that in a continent which is drying up he finds *side by side* the tundras, the endless marshes, and the steppes, appearing as *contemporary landscapes*. The present steppes of South Russia come quite near to the twenty-million-acres-wide marshes of the Pripyat and Berezina region ; and if one crosses West Russia from Finland or the Novgorod lake district to Odessa, he finds in close succession all the following phases of desiccation : a lake district, the wooded plateaux, the immense marshy region of the Polesie, the black-earth Steppe region, the Loess Steppes, and the dry sun-burnt lands of Bessarabia on the Black sea coast. In Siberia, the terrible marshy woods—the *urmans* of the Ob basin—are close by the dry prairies of Baraba (both in way of desiccation)—the latter, by the way, are an exact counterpart of the prairies of Winnipeg,* which also merge further north into the barren lands, or *tundras*, of Canada. In Transbaikalia we can even see the marshy surface of the Vitim plateau merging gradually into the wide dry valley of the Uda, the gravelly bottom of which represents a dry steppe inhabited by nomad Buryates—as one may see it now along the Trans-Siberian railway between Lake Baikal and Tchita ; and so on.

In all these cases the differences of physical aspect are *not in time* ; all these forms are contemporary. *They are not either in degrees of latitude or longitude ; they are in altitudes and in drainage.* All are in a stage of desiccation, but they represent different phases of it. Consequently there is not the slightest reason for seeing in a similar variety of physiographical characters discovered in Post-Glacial deposits a proof against a steadily progressive desiccation, or a proof of recurrent dry and wet periods. These deposits may be products of the very same period.

The same applies to the Loess deposits. They are not proofs of a special dry period ; they are a necessary local product of Post-Glacial desiccation. The fauna and flora of the Loess-covered regions certainly are now characteristic of moderately dry spaces. But the Loess deposits have also another specific

* See my article on 'Canada,' in *Nineteenth Century*, 1898.

character. Everywhere they fringe the regions covered with the bottom moraines of the ice-caps, or they appear in the large valleys intersecting such regions (the Rhine, the Lena, etc.). Their double origin—æolic in the upper layers and often aqueous in the lower ones—can be taken as proved; and everywhere they are constituted of what is well known to the glacialists as the fine mud, thoroughly mixed in the bottom moraines with the rougher particles of sand and gravel, and carried away out of it either by wind or by rains. Over immense spaces of the East Asian plateaux this mud has been blown out of their surface deposits, or it was carried (on the outskirts) by the surface waters over the grass-covered slopes.

Beginning as deposits in wet prairies and marshes, the Loess soon must have taken, as it grew in thickness, and owing to its great permeability, the dry character it has now in China on the borders of the lower terrace of the high plateau, or in the black-earth regions of South Russia, on the Rhine, and so on. But it certainly is no indication of a dry *period*. This would be a too far-fetching generalization. Thus, for instance, I found on the Lena deposits of typical Loess, containing rests of the extinct rhinoceros (*R. tichorhinus*), together with teeth of small rodents, close by the immense lower red sandstone plateau, covered with marshes. We have here nothing but *two phases of the same portion of the desiccation period*, not two distinct climatic periods.*

This brings us to another important physico-geographical fact—a law, I may say—which can be formulated as follows: *In regions that are desiccating after the thawing of the ice-cap, desiccation in its later phases progresses relatively more rapidly on the higher level plateaux than in the lowlands near the sea-coast. It is retarded in the latter by the water supplied from the higher levels.*†

The following will better explain what I mean. When I explored, in 1871, the Glacial and Post-Glacial deposits of Finland, and slowly moved from south to north, always measuring the altitudes at which I found lacustrine deposits above the levels of the present lakes, I was astonished to find that these altitudes were greater around the lakes of the Kuopio swelling than they had been found to be around the lower lakes of the Saima system. The desiccation of the higher lakes had thus progressed farther than the desiccation of the lower lakes.

An explanation of this fact was given to me, also in Finland, when I studied how the waters of Lake Höytiäinen suddenly found an outflow into a lower-lying lake, digging their channel, in about a week's time, in a thickness of lacustrine deposits between the two lakes. The level of the upper lake was suddenly lowered then by several feet, and its surface reduced. *The water stored up in the higher-level reservoir went to feed the lower reservoir, and to maintain the dampness of the lower terrace.*

What happened here as a catastrophe is going on, however, in a continuous way all over the world, wherever lakes have an outflow to the sea. The channel of this outflow being steadily deepened, the upper lakes decrease in size, and their water goes to maintain a certain degree of moisture in the coast region. *The desiccation of the higher-lying plateaux profits to the lowlands of the coast region.* However, one remark must be made. This law applies only to the later phases of desiccation, when the stores of ice, and later on of water, in the upper lakes

* It is interesting to note that I saw small pits of typical loess formed now in Central Russia, in a river-valley at the foot of a slope covered with boulder clay. I described this feature in a paper on the geology of the district of Meschovsk, in the *Bulletin de la Société des Naturalistes de Moscou* in 1869.

† In the discussion on my paper, in 1904, H. R. Mill had already indicated the possibility of it.

and marshes begin to be exhausted. Where these stores are yet very large, as we see it on the plateaux of the far north, where water remains frozen for the greater part of the year, the process may be in places the reverse. A valley may be dry, while the high plateaux are still ice-bound (Norwegian *fjælds*), or covered with marshes (Vitim plateau, with the valley of the Uda).

This phenomenon—if it be general, as I suppose it is—fully explains the facts of an absence of notable desiccation in the lowlands surrounding the Mediterranean during the historical period, which Prof. Gregory considers as contradicting the desiccation of Eurasia during the same time. What is, in fact, the meaning of the facts he has mustered? Palestine—he writes—is a test case; and in his test case he shows that *in prehistoric times Palestine was much better provided with water than it is now*; but little change has taken place in its climate during the historical times. It is known, indeed, that during the early Post-Glacial period the Dead sea reached a level 250 feet above its present level. And “there is no doubt”—Prof. Gregory writes—“that, in times geologically recent, the climate of Palestine was moister than it is now; but this period was long prehistoric.” He accepts, moreover, the views of Prof. Blanckenhorn, who speaks of three great “Pluvial” periods in Palestine, of which the latest “began 50,000 B.C., lasted to 10,000 years B.C.,” and was contemporary with the last Glacial period of the Alps.

Without endorsing Dr. Blanckenhorn’s classification so long as the so-called “Diluvial” deposits of the Lebanon highlands have not been explored more thoroughly,* we may thus accept Prof. Gregory’s statement to the effect that up to a time which may be placed, roughly speaking, some 12,000 years ago, Palestine, like the rest of Eurasia, lived through periods of considerable wetness (an inland sea reaching the Lake of Galilee, and “Pluvial” periods); but for the last 10,000 or 12,000 years it had already acquired a climate approaching, and finally similar, to the one it has now.

Going now over to other countries, and namely to Egypt, Prof. Gregory mentions the opinions of different explorers who maintain that no change of climate took place in the lower parts of the valley of the Nile during historical times—that is, during the last 8000 years. This is more than probable, and was known long since. But of the changes that may, or may not, have taken place in the highlands of the upper Nile we learn nothing.

Same for Cyrenaica, which Prof. Gregory has explored himself. “There is not,” he writes, “the slightest physiographic evidence of any considerable change in the rainfall or water supply of Cyrenaica since the days of the Greek civilization in the seventh century B.C.” No change, then, for the last 2700 years in the coast region.

Same, again, for Tunis, according to Dr. Partsch: no desiccation since Roman times. Same for the Sahara: Schirmer denies an increased desiccation of the desert in historical times.

And finally, taking Greece, Prof. Gregory writes: “That Greece, like other Mediterranean countries, had a wetter climate during the glaciation of north-western Europe † is indicated by various facts. But through the historical times the climate of Greece seems to have not been altered to a serious extent.”

These are the facts in which Prof. Gregory sees a contradiction to the desic-

* It is known that for a long time geologists described the Glacial deposits as “Diluvial” and attributed them to a “Pluvial” period.

† Why “North-Western Europe” only, when the glaciation of North and Central Germany and Central Russia is recognized by the respective geological surveys?

cation of Eurasia *in historical times*. But all these facts are *relative to the lowlands around the coasts of the Mediterranean*, and if Prof. Gregory will examine *how* the desiccation of a continent is going on, he will certainly himself see that the stationary conditions in the lowlands give not the slightest idea about what was going on at the same time on the plateaux and the highlands, and on the continent altogether. To the geographer and the biologist, the fact that the climate of Egypt has changed but little during the historic times was known long since. I remember even how, nearly half a century ago, in the heat of the discussions raised by Darwin's theory of evolution, the favourite argument of the anti-Darwinians was, that the flora and fauna of Egypt have remained unchanged for the last five thousand years; to which Darwin had already replied that the reason of it was that "*in Egypt, during the last several thousand years, the conditions of life, as far as we know, have remained absolutely uniform.*" *

At the same time we know perfectly well that the climatic conditions have *not* remained uniform on the plateaux of Central Asia, nor in northern Europe and Asia. The gradual upheaval of northern Europe, including northern and north-eastern European Russia (Petchora region), has been going on lately at a rate of about 3 feet per century, and the consequence of it was, of course, the deepening of the river channels, the drying up of the marshes of the Novgorod lake-district of Russia, and the steady diminution of the lakes of Finland. Desiccation was thus going on. The same upheaval having taken place along the Siberian coasts of the Arctic ocean, it has had the same consequence in the drying up of the lakes in the Baraba steppes. It is easy to say that such a desiccation *must* be a temporary desiccation, which *will* be compensated; but not the slightest proof of a reverse process, beyond small temporary fluctuations, has yet been produced to my knowledge, and I find none in Prof. Gregory's paper. Thus, albeit small temporary fluctuations in the lakes of the Chany system,† we have not yet heard that the villages that were built along the shores of Lake Chany, or on the former bottoms of the Lakes Abyshkan and Moloki, *desiccated since the beginning of the nineteenth century*, should have been re-invaded by water. Fluctuations took place, but they are mere ripples on a steady desiccation curve.

As to the Caspian, I know, of course, Prof. Brückner's work on the probable oscillations of its level, and have written about it. But, with all the respect due to every careful empiric investigation, we must not forget how difficult it is to determine the changes of level of an interior sea in times past, when no level observations were made—especially so when we know that local subsidences of its shores have been taking place.‡

Reliable level observations began to be made on the Caspian *only in the nineteenth century*. But even if we allowed that the three figures of Prof. Brückner for the tenth, twelfth, and fourteenth centuries also are correct, they would only prove that, with *one striking exception in the twelfth century* (unexplained

* 'The Origin of Species,' p. 169 of the 6th edition (beginning of Ch. VII.).

† See my first paper in *Geographical Journal*, June, 1904, p. 723.

‡ In 1862 I saw a very instructive case of this sort in the delta of the Selenga, at its entrance into Lake Baikal, when quite a considerable inhabited area sank under the waters of the lake during an earthquake. Remains of houses, now *below* the level of the lake, can easily be taken later on for a proof of a raise of the level of the lake in the year 1862; but there was nothing of the kind: there was only the subsidence of the delta-region. (I gave an account, in French, of this interesting earthquake, probably due to the sinking in the delta of the Selenga, in Prof. Palmieri's *Bulletin* of the Naples Seismological Observatory for 1863 or 1864.)

by Prof. Gregory, and about which I can say nothing, having not the necessary books in this little Italian town), *the sinking of the level of the Caspian has been going on during the last thousand years*. In fact, what is described by Prof. Gregory as "the normal level" of the Caspian is nothing but the level taken by the topographers as a zero, when the first level observations were begun. This zero was found, in 1840, to be 84 feet below the level of the Black sea, and 89 feet in 1860–1870, by the Caucasus triangulation; 86 feet being the figure now accepted. As to the temporary and periodical fluctuations, since 1840, due to winds and rainfall, they do not exceed $3\frac{1}{2}$ feet. Consequently, Brückner's figures reduced to the level of the ocean, would be as follows:—

A.D. 915–921	57	} feet <i>below</i> the level of the ocean.
12th century	...	...	...	...	...	100
1306–7	...	...	...	...	...	49
Five centuries later :—							
1815	...	...	...	...	...	79
1843–6	...	...	...	...	...	88
1847	...	...	...	...	...	85
1856–60	87	}
1876–8	...	...	...	...	...	84

Apart from the single twelfth-century exception (attributed by Woeikoff to exceptional conditions on the plateau, which are *possible*, but still purely hypothetical), we have thus a *pretty regularly accelerated sinking* from –57 to –86 in the last ten centuries. The cyclical fluctuations in the nineteenth century are quite insignificant.

As to the Aral-Caspian basin—so far as I remember Prof. Lenz's paper on the Amu and the Caspian, published some forty-five years ago (it so happened that I was editing the respective volume of the Russian Geographical Society's *Zapiski*), it was a serious study, based on Arabian sources; but I have not here, in this little Italian town, Woeikoff's paper.* At any rate, I prefer to base my conclusions on the geology of the Aral-Caspian region (see the map I gave in my paper in this *Journal*, June, 1904). According to these researches, the Amu never reached the present reduced Caspian. The channel by which Lake Aral was supposed to have once discharged its waters into the Caspian—the Uz Coi—contains no traces of a fluvial bed, but it contains, on the contrary, the same shells which now inhabit the Caspian. It was, then, the Caspian which reached in olden times Lake Aral and received the Amu—great temporary fluctuations taking place in this basin in its steady desiccation. I think that if Prof. Gregory studied this special question, he probably would come to the same conclusion. Mere quotations of divergent opinions prove nothing; they merely create confusion—especially so when the writer leaves entirely to the reader to find out the relative reliability of the different opinions, and even does not give these opinions with sufficient fulness.

The same remark is to be made concerning the Lob-nor basin. With all respect for Sven Hedin's work when he describes the important *facts* he has observed, I cannot follow him in all his physico-geographical *conclusions*; and the reasons for such an attitude, which I take in common with several other explorers of the region, I have explained in the pages of the *Geographical Journal*.

Leaving aside many small remarks, I conclude, therefore, as follows: That the desiccation of Eurasia has been going on during the Post-Glacial period (helped

* Let me express here my best thanks to Mr. C. Bicknell, in whose library I found some of the books I needed, and who has so courteously placed them at my disposal.

by the upheaval of the northern parts of this continent and the consequent retreat of the Post-Glacial ocean); that it has continued in historical times, with a number of *local* oscillations, which were necessary consequences of the general desiccation; *and that it is not yet accomplished*—there is no use to contest. This desiccation was, and still is, a very complicated process offering an immense variety of aspects, while the temporary and local fluctuations in this process have necessarily been and are many; but the general desiccation process continues still.

Let us hope, then, that Prof. Gregory will continue his studies of this subject; and that now, after *having made* the beginning of a symposium of opinions, he and his students will undertake some serious work of exploration of their own. A work that is most desirable and necessary, would be a mapping of all the Post-Glacial lakes and an exploration of their deposits all over Europe and Asia—beginning, let us say, with this country. Such a work would surely yield a solid basis for profitable discussions about desiccation.

P. KROPOTKIN.

Bordighera,
February, 1914.

Prince Kropotkin's interesting restatement of his views on the desiccation problem shows that he does not now hold that there has been a climatic change in the Mediterranean coast lands during historic times. Those countries give the most important evidence because of their written records; but as I pointed out in my paper, Hungary, as a representative of central Europe, the central Sahara, and central Asia, also furnish evidence that their climates have not become appreciably drier in the historic period. Prince Kropotkin's note appears, moreover, to abandon the main evidence in favour of desiccation; for, as he points out, since dry and wet deposits are both being laid down at the present day, the existence of dry deposits does not prove a dry period. Similarly, the existence of deposits laid down under wet conditions does not prove a wet period.

Again, as Prince Kropotkin explains the oscillations of level of the Caspian by earth movements, will he not apply the same explanation to the once greater size of the Dead sea, and thus remove the most striking evidence for the "pluvial period" in Palestine? Prince Kropotkin is no doubt quite correct that northern Eurasia had a moister climate during the passing of the Glacial conditions; but Eurasia appears to have passed so quickly through that stage that, as Dr. Sven Hedin, Dr. Berg, and others assure us, the Post-Glacial desiccation had reached its present stage before the beginning of historic times.

J. W. GREGORY.

On December 4, 1913, I sent you a paper on "Desiccation." When acknowledging my communication you informed me that Prof. J. W. Gregory was dealing with that very question on the Monday following. In later correspondence you were kind enough to forward me a proof of the Professor's paper, and you stated that I would probably agree with you after reading the proof that the subject had been dealt with sufficiently for the present, but you offered me space in the correspondence column for a letter stating briefly any points I desired to bring out. Taking advantage of that offer, I now indicate—

(1) Prof. Gregory's paper was an examination of the question whether the Earth as a whole was drying up. My paper assumed that desiccation *was* proceeding in the centre of great continents, especially in Central Eurasia, and stated the *cause*. On this head I submit that careful examination of Prof. Gregory's paper

will induce the belief that the Professor himself practically admits that, though there is no sufficient proof that the Earth as a whole is drying up, the centres of great continents may be getting drier as an equivalent to greater precipitation elsewhere.

(2) The following is a *précis* of the basis of my paper: "The discharge from a lake having an outlet deepens the outlet, while deposits from the area draining into the lake raise its bed, and thus the lake is converted into a swamp with sluggish rivers draining through it." Prof. Gregory stated the same thing in other words, but he did not follow up the point, which I did thus: "As the outlet continues to deepen, the rivers in the swamp lower their beds and denude their banks till the site of the former lake becomes a rolling plain off which water flows away more or less freely. Analogous to this is the case where a sea bottom is raised above sea-level with so little disturbance that it forms a nearly level plain. With even moderate rainfall such plain tends to be marshy, and if a river drains it the marsh will be denuded precisely as in the case of a lake marsh." Then I added: "Both processes have been proceeding in great degree in Central Eurasia, for the numerous lakes which existed in Neolithic times have nearly all been drained off, while the immense Obi marsh of Western Siberia, which covers about 280,000 square miles, has been steadily undergoing denudation."

(3) Owing to the above-mentioned denudation the evaporation in Central Eurasia is much less than it was, and, as a proportion of the lost evaporation was precipitated within its own area, the precipitation is also less than formerly. This reduction in precipitation is the main factor in the observed desiccation.

The rest of my article was devoted to a mathematical treatment of my theory, and to a suggestion for palliating the desiccation by engineering work.

I have, etc.,

EDMOND COTTER,

Colonel, late Royal Engineers.

MEETINGS OF THE ROYAL GEOGRAPHICAL SOCIETY, SESSION 1913-1914.

Ninth Meeting, February 23, 1914.—The Right Hon. EARL CURZON OF KEDLESTON, G.C.S.I., G.C.I.E., etc., President, in the Chair.

ELECTIONS.—*David Taylor Arnott; Rev. Cyril C. B. Bardsley; C. C. Roslington Boyer; Captain H. Brassey (Royal Horse Guards); Captain Edward Bellasis Cardew, R.E.; Miss A. Murray Campbell Davidson; Frank Debenham; Hon. Walter Fremantle; Gerald Graham-Clarke; Henry Malcolm Hubbard; Miss Mary Meinertzhagen; Rev. Frederick Charles Meredith; William Charles Meyerstein; Harold James Pulein-Thompson; Hon. N. Charles Rothschild; Miss Winifred H. Tweedie; Miss Antonia Williams.*

The paper read was:—

"The Sea Route to Siberia." By Dr. Fridtjof Nansen, G.C.V.O., and Jonas Lied.

Tenth Meeting, March 9, 1914.—Major LEONARD DARWIN, Vice-President, in the Chair.

ELECTIONS.—*Henry D. Boddington, D.Sc.; Cyril Campbell; S. H. Christy, D.S.O.; George Raymund Crowther; Major-General Henry William Duperier (late R.E.); Sherbourne Eardley-Wilmot; Walter William Gibbs; Malcolm Vivian Hay; Lieut. P. Gauntlett Huddleston; Miss Helen E. Ionides; Henry*