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On Snow-Waves and Snow-Drifts in Canada: Discussion

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grooving transverse to the wind are the most conspicuous feature of the resulting structure in the compact, almost homogeneous, fine-grained material. The lines are much freer from minor irregularities than the ripples described above. As the action continues, however, the sinuosities are emphasized, for, the drifting snow not adhering well, the re-entrants are cut back more and more behind the salients. Further, the wind concentrating along the lines of the re-entrants, the general level of the surface there is lowered more quickly by abrasion than is the case along the intermediate lines of the salient angles. Thus is produced an intermediate form in which the transverse ridges are crossed at right angles by alternate ridges and furrows parallel to the wind, the furrows being along the line of the re-entrants.

This action went on until the ridges transverse to the wind were merely a subordinate and scarcely noticeable feature, and the snow was seen to be in great ridges parallel to the wind.

SUN PILLARS.

A letter by the Author in "Nature," April 17, 1902 (vol. 65).

On January 19, 1901, during zero weather at Winnipeg, Manitoba, the fine icy particles which floated over the city as a cloud at 11 a.m. gave a halo round the sun with two mock suns, to the right and left, at the same altitude as the sun, and above the halo an inverted arc of about 120° showing prismatic colours. There was a good deal of wind at the time.

At night the wind dropped and the air became very still. The haze of icy particles descended, and in the middle of the night its illumination by the strong arc lamps of the city gave a column of light, comparable to a sun pillar, extending above each lamp to a height estimated at 300 feet. A striking feature of the phenomenon was the perspective effect, the columns diminishing in apparent height in such precise proportion to the increasing distances of the street lamps that it was evident the upper surface of the cloud of particles was truly horizontal. At this time the vertical columns of light were also visible below the lamps and extended to within a few feet of the ground. A few hours later, viz. at 4 a.m., January 20, the lower ends of the columns were more than 60 feet from the ground, and therefore far above the lamps. They extended to a height of about 300 feet, as judged by the distance of the nearest lamp and my elevation above the ground, which was about 60 feet. A narrow rift extended horizontally through the cloud, breaking each column of light into two parts. The figure is re-drawn from a rough sketch made at this time of the columns above three, only, of the numerous arc lamps.

The slight haze of minute icy particles which is common in zero weather is, I believe, called *poudrette* in Eastern Canada.

Before the reading of the paper, the PRESIDENT said: This evening we are to have a very interesting paper by Dr. Vaughan Cornish, "On the Snow-waves and

Snow-drifts in Canada." I now call upon Dr. Vaughan Cornish to read his paper.

After the reading of the paper, Prof. NORMAN COLLIE said: I am afraid I have very little to say on the subject of waves. But I can say a little about this country of Canada which Mr. Vaughan Cornish has travelled through in the depth of winter. I have not seen it under those conditions; I have only seen it when it has been under the hot sun of summer. Then the prairies were not covered with snow, but with grass, and there was no snow in the valleys, but only on the mountain-tops. Still, I think it says a great deal for the energy and perseverance of the Canadian Pacific Railway to run its trains every day through such a country, where the snow is sometimes 5, 10, 15 or 20 feet deep. The Canadian Rockies, where some of these beautiful photographs were taken, is going to be, I feel certain, the Switzerland of North America. It is a country which abounds in the most beautiful scenery, not only of magnificent rivers and pine woods, but there are glaciers and snow-peaks as well, and there is perfectly healthy air, where the people of the United States and Canada can go for their holidays in the summer-time. The pine woods then are not filled with snow, but with mosquitoes, especially during July and part of August, but in the latter part of August these mosquitoes go. In some respects the Canadian Rockies are very similar to parts of Switzerland, but the magnificent pine woods and splendid rivers are far finer than one gets in Switzerland; there are also beautiful lakes filled with trout, and snow-peaks, glaciers, and mountains. It is a country which, I have no doubt, will very soon be opened out and made into one of the playgrounds of North America. I am afraid I can add nothing on the subject of waves or drifting snow, because in summer-time, when I have been there, even right up on the mountains where there is perpetual snow in the summer-time, the snow is rapidly melting, and so one does not get any of these wave-forms. I am sure you will agree with me that these photographs we have seen to-night are revelations of the different forms snow can take up. One often notices these forms. Last Easter I was in Scotland, and the snow was many feet deep—in fact, about Easter there is more snow on the mountains than at any other time of the year, and in the drifts and on the tops of the hills one often sees these wave-like forms. One looks at them, passes them by and takes no notice, but after what we have seen to-night I think that the next time we see drifted snow we shall look at it with very much more interest, and, seeing the many curious formations, will understand how it is that the many marvellously beautiful curves are formed.

The PRESIDENT: I am sure we have all listened with great interest to this paper, which is one of a series that has been communicated to us by Dr. Vaughan Cornish. I have been struck, and I think we all must have been struck, with the great care and patience with which he has made these researches, and also with the acuteness of his observations. The scientific investigations, purely scientific investigations, he has made are of course of great importance, and as his paper proceeded, and as we listened to his former papers, I am sure we must all have felt that these purely scientific investigations would lead to useful and practical results in various ways. With regard to the snow-ripples, there is the well-known practice described by Baron Wrangell in Siberia, by which travellers in that vast region were able to steer when the sky was overclouded, by knowing the prevailing wind and understanding the forms which its influence caused to be taken on the ripples of the snow. He also relates how, when there have been light falls or drifts of snow in other directions, travellers would get out of their sledges and by sweeping away the upper surface of the snow, would reach the harder or permanent ripples. That is one way in which the knowledge of snow-ripples has been turned to a very practical use. Dr. Vaughan Cornish was showing me in the

other room some of his photographs, which were examples of the way in which, by a knowledge of the formation of ripples in sand, one would be able to tell the direction of currents in mouths of rivers and estuaries. So I think we can congratulate Dr. Vaughan Cornish, not only on the great scientific value of his investigations, but also on the practical use to which many of them may be turned. I now ask the meeting to pass a unanimous vote of thanks to Dr. Vaughan Cornish for his valuable paper and for the beautiful way in which he has illustrated it by his photographs.

THROUGH THE GREAT CAÑON OF THE EUPHRATES RIVER.*

By ELLSWORTH HUNTINGTON.

A REFERENCE to the map of Asia Minor shows that the Euphrates river is formed by the union of two great branches. These for several hundred miles flow west-south-west in nearly parallel longitudinal valleys bounded by high ridges of mountains. The north-western branch, or Kara Su, although it is smaller than the other, is generally called the Frat, or Euphrates. Near Egin the mountains that bound its valley come together, and it is obliged to turn abruptly at right angles toward the south through a tremendous gorge, which it has cut directly across the southern range of the anti-Taurus mountains. Twenty miles below the gorge it empties into the larger branch, the Murad Su. The latter flows from north of Van nearly straight west-south-west to this point, part of the way through an unexplored cañon, said to be longitudinal and impassable. Below the junction of the Murad Su and Kara Su the Euphrates river makes a great bend to the south, and later to the east, and then, again turning south, zigzags through the Taurus mountains in a deep gorge. It is this great bend and the lower part of the two branches which I propose to describe.

Before proceeding to that, however, it will be well to get a general idea of the physical features of the surrounding country. We will examine these in geographical order, beginning on the south with the Taurus range. This rises here to an average height of 7000 feet, the lowest passes, except where the Euphrates and Tigris rivers cut through the range, having an elevation of about 5000 feet. The core of the mountains consists of a very old trap, the oldest formation of the region. This is broken in many places by eruptive granites and porphyries, which are older than the oldest stratified deposits. These crystallines are especially abundant on the north side of the mountains. On the weathered surface of these igneous formations are the remnants of a complex series of strata with several unconformities marking intervals of erosion so extensive that

* Map, p. 177.