MEETING OF NOVEMBER 7th, 1887.

ON GLACIERS IN THE ROCKY MOUNTAINS.

BY S. F. EMMONS.

In passing from a warmer to a colder climate whether it be by ascending from a lower to a higher elevation above the sea, or from a lower to a higher latitude—that is from the equatorial toward the polar region—we come finally to regions where the average warmth of the year is insufficient to entirely remove the snow that has fallen during that year.

This removal is mainly in the form of running water, in part, however, by direct evaporation into the air; the proportion removed by the latter method as compared with the former is of course dependent on the relative saturation of the air at a given point and is much greater in dry regions like the Rocky Mountains, than in moist ones like the Alps, or intensely cold ones like the Arctic regions.

Where more snow falls annually than is removed by the warmth of the atmosphere the accumulation would therefore increase indefinitely, if there were no other means than the heat of the atmosphere to accomplish this removal.

Snow and ice like other substances are subject to the influence of gravity, and experience has shown that when accumulated in sufficiently large bodies, and on an inclined surface, they move under this influence in a manner similar to, though at much more moderate speed than, water under like circumstances. Experience has also shown that under the pressure of a sufficient accumulation of material, and especially where subjected to great changes of temperature, even hard ice becomes partially fluid or viscous, slowly changes its form to fit the rocky bed in which it lies, and,

like water, flows down mountain valleys, not, it is true, in a swift brawling current, but with slow and majestic movement, only perceptible to actual instrumental measurement extended over comparatively long periods of time. Such streams or rivers of ice, which remove this surplus accumulation of congealed water to regions of relatively greater annual warmth of the atmosphere, are called glaciers.

The fact that glaciers have a continuous movement of flow like rivers, and consequently like them have been powerful agents of erosion and taken an important part in mountain sculpture was, as you are well aware, first observed in Switzerland about half a century ago; and it was the great Swiss naturalist, Agassiz, one of the earliest students of glacier movement in the Alps, who first observed the evidence of wide spread glacial erosion throughout the northeastern part of our continent. Under the stimulus of his teachings, which was greatly enhanced by the remarkable personal magnetism of the man, the study of these phenomena made such rapid progress, that America was soon able to repay to Europe the debt she owed her for Agassiz, by showing that glacial action was not confined to the steep slopes of high mountain masses, but might also result from the surplus accumulation of snow and ice in Arctic regions. The evidence of such widespread glacial erosion in America was soon supplemented by similar evidence obtained from northern Europe, which plainly proved that in some earlier period the climatic conditions of the Northern Hemisphere must have been those of far greater cold than obtains at present, and this was further confirmed by the discovery of the remains of animals of Arctic habit in the Temperate zones. This period, from the fact that its discovery originated in the study of the Swiss glaciers, was called the Glacial period. For a long time, however, it remained a warmly contested point whether such a continental glacier or polar ice sheet as was contemplated by the glacialists could have moved over a

region so slightly inclined as is that of the northeastern part of our continent, and whether the striations and erratic boulders found all over New England might not be more reasonably explained as the result of the action of icebergs floating southward through a shallow sea.

It was by the labors of American students that the so-called Iceberg theory was finally set at rest, and the existence of the continental glacier actually proved by the continuous tracing of its terminal moraine from the shores of the Atlantic to the far interior in the Mississippi basin, a distance of over 2,000 miles. As it is not generally known how this investigation originated, I take this opportunity of calling your attention to the fact that it was first suggested by Mr. Clarence King, the importance of whose contributions to the geology of this country, and whose remarkable insight into geological phenomena have not received the recognition at the hands of those who have carried out investigations based upon or suggested by his labors, that they deserved.

It was, I think, in the summer of 1875, during a week's visit at the house of my friend Mr. W. H. Forbes upon the island of Naushon, one of the line of Elizabeth islands, which extends westward from the southern end of Cape Cod, that we became interested in the rather peculiar morainal topography of the island, and upon investigating the structure of the surrounding region, determined that it must form part of a great terminal moraine extending along the south coast of Cape Cod, through the Elizabeth Islands, to Block and Long Islands, thus defining the limit of the old New England glaciers. This suggested a most interesting field of investigation, one which had not yet, as far as we knew, occurred to any of the New England glacialists; as neither of us could at that time undertake such a work, Mr. King wrote a letter upon the subject to Mr. C. E. Wright who was making a study of the Kames or morainal ridges of New England, which was published in full in an article by the latter in the Proc. of the Boston

Nat. History Society, for December, 1876. The suggestions offered by Mr. Wright through Mr. King's letter were soon followed up by New England and Pennsylvania geologists, and the moraine was traced along the line suggested by Mr. King and beyond it through the latter State and across the Appalachians. Prof. T. C. Chamberlin of the U. S. Geological Survey has since followed it in all its ramifications across the Mississippi valley States, and a complete map of it made by him may be found in the third annual report of the Director of the Survey. This year we learn from scientific periodicals that Mr. H. Carvil Lewis, who studied our great terminal moraine in Pennsylvania, has traced a similar one for 550 miles across Great Britain, the existence of which in all their extensive investigations of glacial phenomena does not seem to have been hitherto recognized by English geologists.

While in the eastern United States we have exceptionally favorable conditions for studying the ancient continental glaciers, and on the extreme north-east extremity of our continent, in Greenland, are the only accessible living representatives of this type, a very different set of conditions prevail in the vast mountain regions of the west. As far as we know as yet, no great ice sheet extended from the north over this region, at least within the boundaries of the United States (leaving Alaska out of consideration). Although abundant evidence is found of the existence in former time of an extensive system of local or Alpine glaciers, owing to the peculiar dryness of the climate at the present day there are remarkably few living glaciers at all comparable to the original type in the Swiss Alps.

In early days not even the existence of this earlier system of glaciers was known, and Mr. King, at that time volunteer assistant to Prof. J. D. Whitney, Director of the California Geological Survey, first called the attention of his chief to the morainal ridges along the streams issuing from the Sierra Nevada into the San Joaquin valley, early in the sixties. Up to 1870, however, it was firmly believed

by those best acquainted with the subject that no living glaciers would be found south of Alaska.

In the summer of this year, Mr. King and I discovered active glaciers on Mt. Shasta in Northern California, and later in the same season still more extensive systems of glaciers were discovered by Mr. Arnold Hague and myself on Mts. Hood and Rainier respectively, the glaciers of the latter, which project downwards into the forest region, being quite comparable in size and grandeur with those of the Swiss Alps with which I had become familiar during the excursions of my student days.

Since that time numerous discoveries of glaciers in other parts of the Rocky Mountains have been laid claim to in popular periodicals, notably by a Mr. Muir, a Scotchman who spent several years camping out among the high summits of the Southern Sierras. For these discoveries he claimed particular credit because the region had already been explored by Mr. King. In the latter's opinion, however, Mr. Muir's glaciers were nothing more than relics of the névé-fields of once great glaciers, which, in the climatic changes that have intervened since the Glacial period, had dwindled down to mere shadows of their former selves.

In 1883 Messrs. Gilbert and Russell of the U. S. Geological Survey found similar but somewhat larger snow-masses immediately under the crests of the Sierra Nevada, on their northern or sheltered and colder sides, especially in the vicinity of Mts. Lyell and Dana; as a sequence of this discovery the latter prepared during the following winter an article on the "Existing glaciers of the United States," which appeared in the Fifth Annual Report of the Director of the Survey. In the course of the preparation of this report, doubt having been expressed by some whether these snow-masses were properly entitled to the name glacier, the question naturally suggested itself, what is the true definition of a glacier and how is it to be distinguished from a névé-field? To decide this question

a symposium of the members of the Washington Philos. Society was called together by its then President, Mr. G. K. Gilbert, at which I was present.

The results of this symposium were rather negative, as no definition was offered which met with universal approbation. Naturally the writers upon Swiss glaciers were referred to, and abundant quotations were made from their works, but the conditions found in this country, where so many snow fields are found which are the last relics, and consequently only the very upper portions of once extended glaciers, are so different from any thing occurring in the Alps that they had evidently not been foreseen by these writers. The need of a sharp line of division between névé and glacier, where both were always found in connection, was not so vividly felt there as here where oftentimes only the former remains.

By Swiss glacialists this line was first given as the snow line (or the line of perpetual snow). But this, it was recognized, varied from year to year, and from one slope of a mountain to another. Still more difficult would its use as a line of definition be in this country where in most cases it must of necessity be a purely theoretical line, so thoroughly is the snow in the high mountains removed in the summer by our high dry wind currents. It was next suggested that the dividing line between névé and glacier was the line where névé-snow changes into granular glacier ice, the *firnlinie* of the Germans. This also is one which is difficult to trace, for glacier ice, which is a condition of snow resulting from pressure, may underlie the névé-field, and névé-snow may be found quite low down on the surface of the glacier proper.

Still another suggestion offered was that, as stones falling from the cliffs upon the surface of the névé-snow sink into it to a certain depth, but as the mass moves downward and its surface melts, these blocks gradually come to the surface, and remain there on the harder glacier ice beneath during the rest of the glacier's course, therefore

the glacier might be considered to commence at the point where such stones first appear upon the surface. But this definition could evidently only be applied to such ice masses as are enclosed in steep and comparatively narrowly spaced walls. In the open basins in which the Mt. Dana and Mt. Lyell glaciers of Mr. Russell were found there would be little or no opportunity for such stones to fall upon ice or snow.

The existence of cracks and crevasses as an evidence of movement was also suggested as furnishing evidence that the mass is a glacier. But these are also found at the upper edge of névé-fields, and the névé must evidently move, otherwise it could never become a glacier. Hence movement is not confined to glaciers alone.

An interesting illustration of this fact is found in Science for October 7th in a communication from Mr. W. A. Asche giving his observations, in the Hudson Strait region, of a movement among the particles of the hard snow of that region under the pressure of its own weight, which was even greater than that of glacier ice.

The suggestion which I offered at the time, though it was not accepted by all then present at the symposium, seems to me nevertheless to have a merit in the case of these questionable snow and ice masses in our mountains which the others do not; that, namely, of enabling one to decide in a given case whether to call it a névé-field or a glacier. To some it may seem to be objectionable as offending our national pride in having everything better than any other nation, since it would exclude from the class of glaciers a very large proportion of those masses which their discoverers have hitherto dignified by that name, and restrict the "Existing Glaciers of the United States, outside of Alaska," to a few individuals.

My definition is founded on the conception that the glacier is a river of ice, and that like a river it is confined within and follows all the irregularities of the bed which it fills. That the névé-field is like the mountain lake in

which so many rivers rise; the source of supply in a basin-like receptacle. That, as the river proper commences only when, as it issues from such a receptacle, its water becomes confined within comparatively narrow banks, more or less parallel with each other; so the glacier proper commences only when the snow and ice which has accumulated in the form of névé in the mountain basin has contracted into a relatively narrow channel between two more or less parallel walls.

According to this idea the secular accumulations of ice and snow which are found in the glacial amphitheaters of our great mountain masses, even though giving evidence of a regular downward movement and in many cases crevassed to a considerable extent, would only be considered névé-fields; no glacier proper could exist until they were contracted into a relatively narrow tongue-like mass between two walls.

Since the publication of Mr. Russell's article there has appeared a work by Dr. Albert Heim, of Zurich, entitled "Text-book of Glaciology" *(Handbuch der Gletscherkunde)*, which, from the recognized ability of its author and his life-long experience in the Swiss Alps, undoubtedly the best place in the world for the study of Alpine glaciers, ought to be received as the highest authority upon this subject. I will present briefly some of his views.

He recognizes three types of glaciers: 1st, the Alpine or high mountain type; 2d, the Scandinavian or high plateau type, and 3d, the Greenland or continental type. Of the first he says:* "In the Alps we find as sources of glaciers mostly wide, basin-shaped, elevated valleys, often branching upwards, with a steep, sharp, semi-circular (kettle-shaped) boundary of ridges and peaks. The snow slides downward from the steep walls into the wide basin below, out of which the glacier shoots (or pours) and descends through the only way open to it down the valley, a powerful sluggish ice river (stream).

* P. 41, et seq.

"The source in the snow region, which is filled with coarse granular snow *(firn, nêvé)*, is called *nêvé-field (firn-mulde)* or for short, *névé (firn)*. The ice stream flowing out of it is the *glacier proper (eigentliche Gletscher)*. The greater the névé reservoir, the greater, other things being equal, the resulting glacier."

He then discusses the snow line as a line of division between glacier and névé, and comes to the following conclusion:

"It is therefore entirely impossible to establish a sharp boundary line between *nêvé-field (firnregion)*, i. e., region of accumulation (surplus of snow fall), and glacier-tongue, i. e., region of melting away (predominance of melting)."

He then quotes E. Richter as follows:

"The névé-fields of most great glaciers may be divided into two parts, 1st, the high basins and ravines which receive the surplus snow directly, and 2d, the sort of basin of accumulation into which the névé masses flow together, and from which they first pour out as an actual ice stream."

From the above it seems evident that the general distinction between névé-field and glacier in the mind of Swiss glacialists is that the one (névé) constitutes the material filling the glacier reservoir—the region where the surplus of precipitation over melting and evaporation accumulates—that the glacier, on the other hand, is the tongue or river-like mass which gradually carries away this surplus. That, while they admit the difficulty of drawing a sharp and definite division between these two parts in a given mass, the existence of a névé-field as a source of supply is an essential part of their conception of a glacier. Hence it seems to me a legitimate assumption that whereas they might admit, if the conditions such as occur in this country were presented to them, the possibility of the existence of a névé-field without a glacier flowing out from it, they would not admit that of the existence of a glacier without a névé-field or source of supply. I propose to show later that, in the case of many of the recent

discoveries claimed as glaciers, they want the double character contemplated by Swiss glacialists, and that if we admit that they are glaciers proper, there can be no névé-field.

Let us consider for a moment what are the essential characteristics of Heim's three types of glaciers.

In the Alpine or Swiss type of glacier, which is found in mountain masses consisting of lofty peaks and ridges, separated by a net work of elevated valley-basins, the source of supply is in a névé-basin, or assemblage of névé-basins, which all contribute to form a single glacier outlet. The source of supply has a general concave form, and the characteristic of the type is, as Heim expresses it, the "strong *individualization* of the glacier proper."

In the Norwegian or Scandinavian type, on the other hand, which is found characteristically developed in the high table-lands of Norway, the névé-fields are not divided up by the intervening ridges, but constitute a broad, almost unbroken and continuous sheet of névé-ice, whose general outline is convex rather than concave, from which flow a series of radiating, smaller, and generally steeper glaciers, or the mass ends in an abrupt face from which the ice mass falls down the cliffs in a succession of avalanches to the valleys below. "There is a less strongly marked individualization of the glacier proper."

The continental type, as seen at the present day in Greenland, is a broad ice sheet covering the greater part of the surface, no connected ridges rising above its surface to show the form of the underlying rock surface, but only here and there single detached rocky peaks. It differs from the two other types mainly by its enormously greater mass, and, were it to melt away or shrink together to half its former volume in consequence of some sudden climatic change, the remaining ice masses would probably be found to belong, now to the one, now to the other of the first-mentioned types, according to the varying structure of the underlying mountain mass.

We can form some idea of the immensity of such

glaciers by considering the dimensions of the great glacier that now covers northwestern Greenland. Its estimated area is over 830,000 square kilometers (about 320,000 square miles). From its western side alone 100 glaciers reach the ocean waters and send into them annually 100,000 millions of cubic feet of ice in the form of icebergs. In such a mass it is evident that the distinction between névé and glacier that I have suggested above could hardly be observed, since not only the valleys, but their enclosing walls are buried beneath the accumulation of ice. This by no means proves that it does not exist beneath this cover, and Heim's description of the Norwegian glaciers tacitly admits its validity, for he only characterizes as glaciers the tongue-like masses filling the valleys which radiate out from the great central névé-mass.

My remarks this evening were suggested by a recent paper in "Science" by Mr. G. H. Stone, describing a newly discovered glacier on Mt. Hague near Estes Park in Colorado, and I propose to consider briefly from the evidence given whether this and those described by Mr. Russell should properly be called glaciers or not. This I wish to do in no carping spirit of criticism, nor with any wish to detract from the merit of these gentlemen's discoveries. My object is rather to enable those of you, who may have opportunities in the future of examining such snow-masses, to distinguish critically whether they are more properly névé-fields or glaciers. Surely it is more to our credit to admit freely that we have no true glaciers in the Rocky Mountains, than to show our ignorance by describing as such what are only névé-fields.

In my own pretty wide experience among the higher peaks of the Rocky Mountains, while I have seen many shrunken relics of névé-fields, some of which were crevassed and exhibited undoubted evidence of movement, the only true glaciers I have seen were those upon Mts. Shasta and Rainier. These singular glacier systems belong rather to Heim's Norwegian than to his Alpine type,

though they start from isolated single peaks, and not from a high plateau. Their névé-fields, however, form a broad, practically continuous mantle, almost entirely encircling the upper part of the mountain, with a decided convex outline, from whose lower edge the glaciers radiate out in valleys which diverge more and more as they descend, while the glaciers themselves continually contract between their walls. That these glaciers are still extant is evidently due to the relatively abundant precipitation on these peaks, resulting from their great altitude and proximity to the Pacific Ocean.

The extinct glaciers of the Sierra Nevada, and of the interior ranges of the Cordilleran System which have left such distinct traces of their original form and extent in the U-shaped section of the valleys carved by them, the frequent morainal ridges, abundant striations and *roche-moutonnée* surfaces that we may find to-day amongst any considerable assemblage of high peaks of 13,000 feet elevation or over, were distinctly of the Alpine type. All the above evidences of their existence may not readily be seen; striations rapidly disappear from a rock that is easily weathered; moraines are in many places carried away by later drainage, in others covered by a growth of forest, in which their original character is only to be detected by the existence of frequent oval hollows or depressions without exterior drainage, and sometimes occupied by small ponds. The great glacial amphitheaters which constituted their source of supply, and of which more than one generally contributed to form the original glacier, and the characteristic outlines of the upper part of the valley through which the glacier once flowed, still remain, however, and constitute, to the eye accustomed to study forms and causes of mountain sculpture, the surest means of tracing their original form and extent.

In Mr. Stone's description of the supposed glacier on Mt. Hague, his reasons for considering it such are unfortunately not distinctly stated. As I read his description it

partly fills a semi-circular basin about a quarter of a mile in diameter, the bottom of which is occupied by a small lake. The supposed glacier, which is wider than it is long, slopes down very steeply toward the lake from the north, west, and south, so that the movement from the north and south portions is in nearly opposite directions (a not uncommon phenomenon for a névé, but certainly most unusual in a glacier). It is crevassed generally parallel with the shores of the lake, into which it sends off little icebergs. "The material of the ice-field, though somewhat granular on the surface, is not a mass of snow, but clear and compact ice beneath." From these last remarks I am uncertain whether Mr. Stone is sufficiently familiar with glaciers to be aware that névé looks more like ice than snow, and that, when it has lived through many years of summer's partial melting and winter's freezing, it becomes quite indistinguishable from glacier ice. The other characteristics are decidedly those of a névé-field rather than of a glacier, and an examination of the topographical form of the valley, as shown on the map given in the atlas of the 40th Parallel Exploration, shows me that the original glacier must have been over six miles in length; whence I deduce that the present ice mass is most probably the last remnant of the névé of this old glacier, and could hardly be called a living glacier with strict regard for scientific exactness.

Mr. Russell's article above referred to is profusely illustrated by sketches, by reproductions of photographs and by maps of some of the regions described, and constitutes a most interesting compilation of data in regard to the actual and supposed glaciers of the U. S. and to some of those of Alaska. It is prefaced by a chapter headed "What is a glacier?" containing much useful information in regard to glaciers, but in which I cannot see that any additional light has been thrown upon the question of where to draw the line between névé-field and glacier proper.

There is evident throughout his article a careful avoid-

ance of facts and considerations which might militate against the acceptance of the ice-masses discovered by him in the Sierra Nevada as true glaciers. These masses are of more considerable volume and possess externally greater resemblance to existing glaciers in their complicated systems of crevasses, dirt-bands, perched boulders, etc., than the one described by Mr. Stone, but, if the same critical tests are applied to the one as to the other, the result will be similar.

The topographical map which shows the elevated region of the Sierra Nevada where the "existing" glaciers were found, and upon which they are indicated in blue, is accompanied by a superposed transparent sheet upon which are indicated, also in blue, the supposed outlines of the former glaciers. One's attention is at once attracted by the peculiarity, in many of these older glaciers, that they have no névé-fields at their head. In one case, indeed, the former glacier is represented as stretching continuously across the crest of the range and flowing both ways at once. Such névé as is represented lies mostly on the sides of the valleys in which these former glaciers are represented as flowing. An apparent explanation of this singularity in Mr. Russell's conception of these glaciers is found by comparing their outline with the topographical map beneath the thin covering, where it is seen that the points where these ancient glaciers reached up to the very crest of the range are those where Mr. Russell's "existing" glaciers are now found. In other cases a marginal rim of névé is left between the glacier and the crest of the bounding ridge.

Again these ancient glaciers, as shown on his map, were 15 to 20 miles long, and many of them extended beyond the limits of the map an unknown distance, probably as much more in some cases. Glaciers of such size must necessarily have had correspondingly large sources of supply or névé-fields. The largest of the existing glaciers is, according to Mr. Russell, less than a mile in

length, and most of them are not more than 2,000 feet long, although all seem to have greater width than length. All of them, moreover, extend close up to the crest of the mountain ridge, on the northeastern or most sheltered side of which they invariably lie. It is evident, therefore, that these existing remnants of former glaciers once underlay a névé proper of those glaciers, and the only theory upon which they can be called glaciers now is that, in shrinking and melting away, the ice mass always preserves the two distinctive parts, névé and glacier proper, however diminutive the existing remnant may have become. The line between these two parts of the glacier instead then of being an approximately vertical one, as it seems to be regarded by the Swiss glacialists, would run at a very low angle to the surface of the glacier from near the bottom of the névé-field to some point on the surface of the glacier near the middle of its course, and as the glacier melted this line would rather be a nearly horizontal plane extending from the lower part of the névé-field to some point between the end of the glacier and its head, which would gradually move upward as the glacier melted and shrunk. As far as the features, such as crevasses, dirt bands, etc., are concerned, which are described by Mr. Russell as constituting the essential evidence that his ice-masses are true glaciers, I have no doubt that if one of the great Swiss glaciers—say the Aletsch glacier, which is comparable in size with that which must once have filled the valley of the Tuolumne river—if this glacier were to gradually melt and recede until what the Swiss glacialists consider the glacier proper had entirely disappeared, and only the part they now call névé were left, this part would present conditions entirely comparable with the ice masses which Mr. Russell calls the Mt. Lyell and Mt. Dana glaciers.

If we accept the snow-line, according to the earlier ideas, as the line between névé and glacier, it is evident that masses such as those described above—2,000 feet long—cannot extend across such a line, whose limits could not

be defined within the vertical distance represented by this length, and that in all probability they will be found not to extend below what can be properly considered the lower limit of perpetual snow, that is, where under favoring conditions snow may not lie the year round.

Another evidence that these masses are relics rather of the névé than of the glacier is found in the fact, derived from both Mr. Stone's and Mr. Russell's descriptions, that these so-called glaciers generally end in a little mountain lake. Now a lake necessarily occupies the bottom of a basin, and in these cases I infer from the description that the basins whose bottoms these little lakes occupy were the névé-basins, or accumulating reservoirs of the ancient glaciers. It is true that lakes are found,—like the Twin lakes in the Arkansas valley,—which are formed by the damming up of a valley by a terminal moraine, near the end of the former glacier. Such lakes are a feature of a receding glacier, and could not exist at the end of one which is steadily growing and advancing. Both Mr. Stone and Mr. Russell speak of supposed terminal moraines at the lower end of these lakes, and upon their existence evidently base a portion of their proof that the ice-mass is a glacier. It is evident, however, that where a névé is so situated as to receive rocks and stones from the surrounding cliffs, and where it has no glacier or ice river to carry away its surplus, these must accumulate at its end in a sort of terminal moraine. It is important in such cases to know whether the existence of the lake is due to the configuration of the underlying rock basin, or only to the existence of the gravel dam formed by this apparent terminal moraine. Since such ridges or accumulations of stone would gradually follow back the edge of a retreating ice sheet, up to its very upper edge, there would necessarily come a time when the glaciers, as defined by the existence of the terminal moraine, would exist without any corresponding névé-field. In a retreating glacier, melting and evaporation are greater than secular accumu-

lation; consequently the surplus, which the idea of the glacier (as announced at the commencement of this paper) necessarily involves, does not exist at the time in question, and the only true method of determining the dividing line between névé and glacier proper, is to go back to the time when a surplus did exist, or to that of the original extension of the glacier, and to see what part was then névé, what glacier proper. By the method I suggested above, this reconstruction is rendered unnecessary; it is only required to observe whether the ice-mass has contracted into a relatively narrow channel and become an ice-river. It is evident on its face that, if the ice-mass has greater width than length, such a mass is in no true sense a river; for how can one conceive of a river, even of ice, whose width between its walls or banks at any given point is greater than its aggregate length?

Inasmuch as the névé and the glacier proper are only part of one and the same phenomenon, it may seem to be somewhat like splitting hairs to lay so much stress upon the mere question of a name. It is not uncommon, moreover, to use the word glacier as including both névé and glacier proper, and in that sense these ice-masses are the relics of former glaciers. If, however, we admit the propriety of making any distinction at all between the two parts of the mass, I cannot see the propriety of calling that a glacier now, which in former times unquestionably was part of the névé.