But why, you ásk me, should this tale be told
To men grown old, or who are growing old?
It is too late! Ah, nóthing is too late
Till the tired heart shall cease to palpitate.

6. Cato learned Greek at eighty; Sŏphoclēṣ
Wrote his grand "Œdipus," and Simŏn′idēṣ
Bore ŏff the prize of verse from his compeers,
When each had numbered mōre than fōurscore years;
And Theophrastus, at fourscore and ten,
Had but begun his "Characters of Men";
Chauçer at Woodstock, with the nightingales,
At sixty wrote the "Canterbury Tales";
Goethe[1] at Weïmar, toiling to the lást,
Completed "Faust"[2] when eighty years were pást.
These are indeed exceptions, but they show
How far the gulf-stream of our youth may flow
Into the äretic regions of our lives,
Where little else than life itself survives.

7. As the barometer foretells the storm
While still the skies are clear, the weather warm,
So something in us as old age draws near
Betrays the pressure of the atmosphere.
The nimble mērcury, ere we are aware,
Descends the elastic ladder of the air;
The tell-tale blood from artery or vein
Sinks from its higher levels in the brain;
Whatever poet, ŏrator, or sage
May say of it, old age is still old age;
It is the waning, not the crescent moon,
The dusk of evening, not the blaze of noon;
It is not strength, but weakness; not desire,
But its surcease; not the fierce heat of fire,
The burning and consuming element,
But that of ashes and of embers spent,
In which some living sparks we still discern,
Enough to warm, but not enough to burn.

[1] Goethe (gẽr′tĕ). [2] Faust (foust).

8. What then? Shall we sit idly down and say,
The night hath come; it is no longer day?
The night hath not yet come; we are not quite
Cut ŏff from labor by the failing light;
Something remains for us to do or dare;
Even the oldest trees some fruit may bear;
Not Œdipus Coloneus, or Greek ode,
Or tales of pilgrims that one morning rode
Out of the gateway of the Tabard Inn,
But other something, would we but begin.
For age is opportunity no less
Than youth itself, though in another dress,
And as the evening twilight fades away,
The sky is filled with stars, invisible by day.

Adapted from LONGFELLOW.

SECTION XX.

I.

84. THE GLACIERS OF THE ALPS.

PART FIRST.

THE glăç′iẽrṣ of the Alps have a wide and many-sided interest. While they are objects of fond devotion to those who dwell habitually among them, they attract from distant countries, with a sort of fascination, men of the most opposite pursuits in life. The poet loves to häunt those lonely solitudes of ice, and there, gazing on the wild and changeful face of Nature, "feed on thoughts that voluntarily move harmonious numbers." The dâring mountain climber, lured by the love of adventure, scales their glittering slopes, nor rests till he has reached their highest summits, crowned with a canopy of perpetual snow. The philosopher, again, finds in the glaciers of the Alps a key to the pást hĭstòry of our globe, and recognizes, in those ponderous másses of moving ice, a mighty ĕngīne by which the rough and fŭrrōwed form of many a mountain chain was sculptured out in ages lŏng gŏne by.

2. I shall not now attempt to picture to you the singular and attractive beauty of those păthless regions of ice and snow, lifting up their lŏfty summits against the clear blue sky above, and stretching away to the green mĕadōws and picturesque hamlets of the valleys below. This tȧsk more fitly belŏngs to the artist and the poet. Nēither do I mean to entertain you with a stōry of perilous adventure and hair-breadth escapes. Mine shall be the humbler task of setting before you some account of the ŏrigin and nature of glaciers, and of briefly sketching the functions they fulfil in the physical history of our globe.

3. I need hardly tell you that the higher we ascend in mountain regions the colder the air becomes. But this fact, though familiar, is well deserving of careful consideration, for it is closely bound up with some of the most interesting and important principles of physical science. Why is it that the air gets colder the nearer we go to the sun, the great sōurce of heat? There are two principal reasons, and I trust I shall not weary you if I dwell for a few moments upon each.

4. First, the air is not heated dĭrĕctly by the sun, but by the earth. The bright, luminous rays of the sun pass through our atmosphere without imparting to it any very sensible amount of heat. This you may easily prove for yourselves by a very simple experiment. Stand in the bright sunshine of a clear, cold day, and realize for a few minutes the genial heat which the sun's rays are carrying through the air around you. Then step aside into the shade, a few feet off, and you will at once feel convinced of how little of that heat has been imparted to the air itself, though it has been streaming through it, perhaps, for hours. The earth, however, like your body, is warmed by these same rays; and when the earth grows warm it becomes, in its turn, a source of heat, and sends fōrth rays of its own back into the atmosphere again. Now, these rays that come back from the earth are not luminous like those of the sun: they are dark or obscure rays of heat. And the air, which could imbibe little heat from the bright rays of the sun, imbibes it largely from the dark rays of the earth. Thus it is that while the air is indebted for its warmth to the sun, it receives that warmth not dĭrĕctly from the sun itself, but from the earth, which is heated by the sun.

5. This is a wise and beneficent provision of Nature. Suppose, for a moment, that the atmosphere were so constituted that it could absorb heat from the luminous rays of the sun. The prŏcess would begin when the rays first enter our atmosphere at a height, say, of a hundred miles; it would continue throughout their whōle cōurse; and thus the heat of these rays would be almost wholly exhausted before they could reach the surface of the earth. The consequence would be that the whole earth would be far colder than the arctic regions now are, and would be, thērefore, utterly unfit for human habitation. But in the present dispensation of Nature the atmosphere, in a manner, entraps the sun's heat for our use and benefit, allowing it to pass in freely from without, but not allowing it to pass freely back into space.

6. Bearing in mind, then, that the air receives its heat directly from the earth, let us consider what is the consequence of this fact on its temperature at high altitudes. In the first place, the radiant heat coming from the earth must, as a rule, pass through the lower strātȧ of the atmosphere before it reaches the higher. As it ascends, it suffers lŏss at every moment by absorption, and, therefore, the higher it rises the feebler it becomes. Further, the air of the higher regions being much more rarefied[1] than the air below, its power of absorbing heat is proportionately dĭmĭnished. Thus you see one clear reason why the upper strata of the atmosphere are colder than the lower; the radiant heat that reaches them is less, and their power of absorbing that heat is also less.

7. The second reason will not detain us long. When air expands, heat disappears; when air is compressed, heat is developed. I will ask you to take these statements on trust for the present, because a discussion of them would lead us too far from the subject in hand. But I will ŏffer, in pȧssing, one brief word of explanation, which may, perhaps, serve to stimulate, though it can not quite satisfy, intelligent curiosity. When air expands, heat disappears; because, in fact, heat is the

[1] **Răr′e fied**, made less dense.

agent that produces the effect. It expends its own energy in the act of fŏrcing the particles of âir asunder; and the energy so expended ceases to exist as heat. Hence, âfter expansion has taken place, the total quantity of heat present in the air is less than it was before. On the other hand, when air is compressed, some kind of energy from without must be expended in compressing it. The energy so expended vanishes, and heat appears in its stead. In other words, the energy expended has been converted into heat. Thus, after compression, the total quantity of heat present is greater than before.

8. Now, picture to your minds the great chain of the Alps, with an average height, let us say, of eleven thousand feet; and, to fix our īdē′âs, let us suppose that the wind is blowing from the south. The air, charged with the moisture of the Mediterranean, strikes against the base of this mountain barrier; it is tilted up, and begins to ascend the slopes; as it rises it expands; heat is consumed by the fact of expansion; and long before the highest peaks are reached, the warm atmosphere of Italy has, by its own inhēr′ent action, been reduced to freezing temperature. Meanwhile, the vapor that it bears along has been condensed into water; and when the freezing point is reached, each tiny particle of water passes into the solid form of ice.

9. Then begins that wonderful and mysterious prŏcess by which the infinitesimally minute molecules[1] of ice are built up into tender crystals of snow; and these crystals, clinging together, form flakes; and the flakes fall thick and heavy, covering the slopes and summits of the mountains with a mantle of dazzling white. And now the air, having swept over the towering crests of the mountain rampart, is borne downwards into the valleys of Switzerland. As it descends it is gradually condensed by the increasing pressure of the atmosphere above it; condensation develops heat; and by the time it has reached the cities of the plain, it is genial and pleasant once again. Thus we learn how the same current of air which is warm when it leaves the plains of Italy, and warm again when it reaches the valleys of Switzerland, becomes in the interval so cold, from the very nature of the journey it makes, as to leave a thick covering of snow on the intervening mountain chain.

[1] **Mŏl′e cūle**, a very minute particle of matter, or of a mass or body.

10. We have now, I hope, mâstered one important phenŏm′-enon to which the existence of glăç′ierş is due, and we have traced that phenomenon to its cause. The phenomenon is simple and familiar: that the higher we ascend in mountain regions the colder the air becomes. The cause is twofold: first, the air of the higher regions receives less heat from the earth; and, secondly, the air that comes up from the plains expands as it rises, and is chilled by the fact of expansion.

II.

85. THE GLACIERS OF THE ALPS.

PART SECOND.

BUT a cold atmosphere, though a necessary condition for the production of glaciers, is not in itself sufficient. There must be also an abundant supply of snow, which we may regard as the raw material of which glaciers are made. When the yearly fall of snow is inconsiderable, it is melted away by the summer's sun, and no permanent glacier can be established. But when the snowfall of the year is great and the cold of the air intense, then the snow can bid defiance to the powers of the sun. Hence, in the higher regions of lŏfty mountain chains the ground is covered with snow the whōle year round, except where the projecting crags and peaks are too steep for the snow to lie on them. These are the regions of perpetual snow; and the imaginary line that bounds them is called the limit of perpetual snow, or, more simply, the snowline.

2. The position of this line, that is to say, its height above the level of the sea, is very different in different countries. It depends, as you will easily understand, not on the temperature ōnly, but also on the quantity of snow that falls. In the Alps the snowfall is great owing to the moisture of the climate. The snowline on the southern side is, speaking roughly, about nine thousand feet, and on the northern side about eight thousand feet above the level of the sea. Beyond these limits the snows of winter are piled up from year to year, and constitute, as it were, the vâst storehouse of a system of glaciers which, for number and extent, are unequaled by those of any other country in Europe.

3. Since a new strā′tum of snow is spread out each winter over the whōle surface of the higher Alps, and each succeeding summer melts away but a part of it, you might suppose, perhaps, that the height of the mountains must increase from year to year and from age to age. But it is not so. As the vâst pile grows up, the weight of the mâss above presses down, with enormous force, on the strata underneath, which at length are, in a manner, squeezed out from below, and begin to move slowly down in all dĭrĕctions, over the slopes and valleys of the mountain chain. These moving masses are the glaciers of the Alps. We have sought them out, at their sōurce, in the eternal fields of snow; we have now to follōw them in their downward cōurse, and learn something of their history.

4. As the glā̈çier moves down into the valley it passes from snow into ice by a prŏcess not unlike to that by which a schoolboy makes a snowball. He takes a mass of snow and presses it firmly together, while, at the same time, the surface is partially melted by the heat of his hand. In a few moments the mass becomes much harder and more compact than ordinary snow, but is yet far from having the hardness and density of ice; and with this most schoolboys are content. But, if mĭs′chievoŭsly inclined, these practical philosophers may be seen taking special means to increase the pressure more and more; and, adding fresh snow as the mass is reduced in size, they produce in time a ball which differs little in quality from pure ice. Now, the snow of a glacier is subjected, as we have seen, to enormous pressure; and as it moves on, under the influence of this pressure, it is exposed to the heat of the sun, which melts it at the surface. Thus we find in the glacier, on a colossal scale, the two conditions of the schoolboy's snowball; and accordingly, in the glacier, as in the snowball, the loose, incohēr′ent snow is gradually converted into dense and massive ice.

5. A glacier, then, is a massive stream of ice, which is ever moving slowly down, from the snowfields of the higher Alps to the warmer atmosphere of the valley, where it gradually melts away and disappears. Like a river, it follōws the windings and assumes the form of the channel through which it moves, spreading out into an expansive plain in the wider basins of the valley, and crushing itself between the projecting rocks in the nărrōw pâsses. This unceasing, onward motion is one of the most wonderful phenomena of Nature. To the căș′ual observer the glacier seems not ōnly at rest, but it seems as fixed and immovable as the giant mountains by its side. Nevertheless the poet's words are rigorously true—

> "The glacier's cold and restless mâss
> Moves onward day by day;"

and the proof of this fact is overwhelming.

6. In the year 1788 the famous Swiss naturalist, De Saussure, with a large party of guides, pâssed a fôrtnīght on a lŏfty shoulder of the Alps, called the Col du Géant, just below the summit of Mōnt Blanc. On coming down, they left a ladder fixed in the glacier at a well-known point of the descent. Fragments of this ladder were found by Forbes in the year 1832, about three miles further down the valley. Thus it would seem that this part of the glacier had moved three miles in forty-four years, or at the rate of from three to four hundred feet a year. Again, in 1827, Hugi, another Swiss philosopher, erected for himself a hut on the lower Aar Glacier, near the Grimsel. He came back in 1830, and again in 1836, and on each occasion he found that the hut had moved further down the valley. Finally, at the end of fourteen years, in 1841, it was found to have moved altogether about four thousand nine hundred feet from its first position. This would represent an average yearly motion of three hundred and fifty feet.

7. Still more exact are the observations of Ag′assĭz on the same glacier. In the summer of 1841, having provided himself with iron boring rods, he pierced the ice at six places to a depth of ten feet, in a straight line right across the glacier, and at each boring he drove in a wooden stake. The position of this line of stakes he then determined accurately, in reference to fixed points on the mountains at either side. When he returned, in the month of July of the following year, he found that the whole line of stakes had moved sensibly down from between the two fixed points. Some had moved more, others

less. By careful measurement he ascertained that the greatest advance was two hundred and sixty-nine feet; the least, one hundred and twenty-five.

8. But it is to James David Forbes, formerly professor of natural philosophy in the University of Edinburgh, that we are mainly indebted for the varied and accurate knowledge we now possess regarding the motion of glaciers. He was the first to show, in 1842, that by means of a theŏd′olīte, the motion of a glacier may be made sensible to the eye from day to day, and even from hour to hour. The scene which he chose for his labors, and which still continues a fāvorīte spot for the study of glacier phenomena, was the well-known Mer de Glace, so called from its resemblance to a frozen sea. This is an enormous glacier which descends from a noble amphitheatre of mountains belonging to the group of Mont Blanc, and, after a course of many miles, forces its way through a narrow gorge, close to the beautiful village of Chamouni.[1] Here the professor remained for several weeks, and by accurate mĕasurement determined the exact rate of advânce of evèry part of the glacier, thus placing the question of glacier motion, for the first time, on a sound basis of facts.

9. A theodolite, as I dare say you know, is practically a telescope mounted on a stand; and for the purpose of exact observation the eye-piece of the telescope is provided with two fine spider threads, which crŏss one another at right angles. Planting the instrument on the mountain side, and looking through the telescope, straight acrŏss the glacier, it is not difficult to get some well-defined peak of ice to cōincīde′ with the intersection of these two cross-threads. This done, the instrument may be left fixed in its position for three or four hours. On looking through the telescope at the end of that time, it will be seen that the peak of ice no longer coincides with the intersection of the threads, but has advanced sensibly across the field of view. From careful observations made in this way, and ŏften repeated, it has been shown that the maximum[2] motion of the Mer de Glace, in passing through the gorge, is about three feet a day in summer, and about hälf that distance in winter.

[1] **Chamouni** (shä′mo̤ nē′). [2] **Măx′i mum**, the greatest.

III.

86. THE GLACIERS OF THE ALPS.

PART THIRD.

THOUGH the glăç′iērs of the Alps take their origin from snowfields of dazzling whiteness, they do not lŏng preserve unsullied this spotless purity of color. The fōrces of nature are unceasingly at work on the mountains that flank them at ēither side. Mighty rocks are rent asunder by the frŏst; lŏfty cliffs are shattered by the lightning; loose shingle[1] and mud are wa̤shed down by the tŏrrent; and all this ru̥in is heaped up, from day to day and from year to year, on the surface of the glacier. The lighter materials are scattered about in all directions by the wind, and envelop the glacier in a vesture of dinġy brown. But the larger masses of rock remain, for the most part, near the foot of the mountains, and form, at each side of the glacier, a long and lofty pile, which is bōrne slowly down tōward the plain below. These ramparts of rock are called Lateral Morāineṣ′; and I know hardly any object of more striking interest in the natural history of our globe.

2. Standing in the lonely recess′es of a glacier, the traveler hears, at intervals, the rattle of the loose shingle down the mountain side, and he sees the fragments, sometimes one by one, sometimes in a cluster, like a shower of rockets, leap out upon the ice, to begin their long and tēd′ioŭs, but inevitable journey to the valley below. Now and then a massive rock is let loose which, leaping from crag to crag, comes down at length with a crash to take its place among its fellows on the moraine; or perhaps it is caught on a projecting ledge, and its journey delayed for years. Now, we must realize to our minds that this prŏcess, which we may witness for hälf an hour, once and again, is going on, not for hours only, nor for days, but for years and for centuries; and thus we shall come to form a picture of what Nature is really about in the wild solitudes of the glaciers, unseen and unnoticed, except at rare intervals, by human eye. She is hewing her mountains to pieces, and carrying away the ru̥ins by a machinery of her own, strange and

[1] **Shĭn′gle**, loose gravel and pebbles, worn by the action of water.