with a gas cock at its neck) by immersing it in water, and then filling it with illuminating gas from the city supply. The movement of the bell jar as it descended into the water, and thus forced the gas to the flame, was carefully guided and the weight of the glass jar itself exerted a sufficient pressure. The apparatus is extremely sensitive and must be kept free from vibrations and draughts of air.

The use of the apparatus in the experiments for which it was designed is to determine the minimum change in the amplitude, the nature of which, *i. e.*, whether an increase or decrease of intensity can be detected. A sound of an agreeable intensity (and determined by a constant height of the flame) is taken as a starting point, and the subject informed that this sound will very gradually increase or decrease in loudness; he listens carefully with his head in a fixed position and answers as soon as he is confident of the direction of the change. The operator slowly moves the index in one direction or the other, takes the position when the answer is given and also the time of the experiment.

How far this apparatus will be serviceable for other methods of studying the sensibility to sound intensities is in some measure still to be determined. It may be noted, however, that it lends itself readily to determining absolute sensitiveness to sound; for one has only to note the minimum height of flame giving rise to a just audible sound with the head at a fixed distance from the apparatus. For the method of just observable difference one may have the flame sound, stop it, and sound it again with a slightly modified intensity until the difference between the two sounds becomes perceptible. For the method of right and wrong cases the same mode of use is available, except that the difference between the two sounds in any one series of experiments remains constant. By the method of the average error one should have two singing flames sounding alternately, the subject attempting to set one of them so that the sound it emits equals in intensity the standard sound. To all these applications there are as yet two objections: First, the sound does not begin immediately after the flame is allowed to play, but takes a considerable time to rise to its full intensity. The sound may be stopped instantly by suddenly lowering the flame, or placing a card at the top of the glass tube; but its inertia in starting introduces a disturbing factor. The second objection refers to the difficulty of constructing two such pieces of apparatus exactly alike, so that two flames vibrating with the same amplitude may be regarded as giving out sounds of equal intensity. Neither of these difficulties is insurmountable, and it is to be hoped that they will be solved as occasion demands.

In concluding, it may be well to indicate again that the success of the apparatus is due to the fact that the change in amplitude, and hence in intensity, can be directly observed; secondly, that the sound is fairly pure, of a definite pitch, agreeable and continuous; and thirdly, that it may be most delicately changed. All these advantages result from the use of the singing flame as a source of sound.

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HOW NATURE REGULATES THE RAINS.

WHEN American enterprise invaded with its iron cavalry the mountain regions of the West, many established theories were put to new tests and not all sustained themselves. The relations of plant life to water supply as found on the eastern half of the Continent had led our fathers to believe that the destruction of forests would invariably and inevitably result in the depletion of adjacent streams and to all consequent evils. So potent is the thick shade

which covers the ground in many parts of the Eastern States that no one imagined that conditions existed elsewhere which would produce entirely different results. The building of long lines of railroads and the opening up of mines have led to the cutting off to the very ground, of extensive tracts of timber, and the effect upon local streams has forced observing people upon the spot to the conclusion that nature has surer and wiser methods than she has been given credit for. That she has storage facilities among the mountain tops, capable of resisting the attacks of any human vandals and that the fountains of her rivers will be preserved to send down the precious floods throughout all future time, regardless of what man may say or man may do.

Any discussion of such a question among those who have looked at it from any certain standpoint will be met by the suggestion that close measurements extending over long periods of time and covering widely separated points will be necessary in order to prove anything, but the question whether snow lasts longer before or after the timber is removed can be considered without going into any of the difficult theories as to whether the fall of moisture is or is not affected by trees. In all such things a great many small considerations go to make up the great answer. Scientists point to a whole list of phenomena each one of which, by itself, would hardly have been felt, but each supporting all the rest and all coming together, produced the glacial age, and they say that when they all drop in together again at any future time, the result will be the same and miles of ice will pile up on the surface or the earth. In a small way the same is true in meteorology, and it is with an effort to give to each its due weight that I endeavor to point out some of the reasons why many close observers, after long years of study, have been led to believe that if there is any difference in the flow of streams and the size of springs before and after the trees are cut from above them, the balance is in favor of the open country.

That water which drops on shaded ground which is thickly overspread with spongy leaves and the air so near the dew point that it cannot absorb much more moisture should be held back, while that coming down on open ground should run off quickly, seems very natural, but in high mountain regions there are peculiar combinations which do much to modify the action of the law. The pine and the fir are the only trees found growing at high altitudes in any abundance, and their thin needles do not make the heavy shade when on the tree, nor the thick mat when lying on the ground, that the broad leaves of the oak, beech and maple do. Instead of forming a spongy layer five or six inches thick, they are swept about by the wind and it is not unusual to see the ground bare under the trees and all the needles lodged somewhere in drifts. Even when they lie where they fall the coating is comparatively worthless so far as retaining moisture is concerned.

On the other hand, the foliage on this class of trees being as heavy in winter as in summer, the branches catch an immense amount of the falling snow and hold it up in mid-air for both sun and air to work upon, and only those who have had experience of the absorbing power of the dry mountain air can form any idea of the loss from that source. Such as is melted falls upon that beneath, and breaking the surface sets in operation the forces which are always ready to attack such substances. The theory that the shade protects the moisture laden soil means but little in such places. The law is doubtless in force with more or less strength wherever moisture falls and plants grow, but the class of trees that thrive here require a loose, sandy soil, and are often seen growing

where there is no earth in sight at all clinging to the sides of cliffs, so bare that the roots run along on the surface entirely uncovered until they reach some crevice which they fill, and send tendrils down to draw sustenance from an unseen source. In such places the melting snow disappears quickly from the surface, and, except for their influence in keeping the soil light and porous so that the water can be absorbed readily instead of running off, it matters but little whether trees are there or not. No moisture remains on top of the ground long for shade to protect. It goes either into the air or else into the ground, and it is a well known fact that a very large portion of the water which finds its way down the steep sides of the Sierras disappears near its sources and is found again far below, either in springs, by means of artesian wells, or in the increased flow of the parent stream. Indeed, a number of very respectable rivers, not only in the mountains, but in some of the valleys, seem to owe their existence to such distant and hidden sources. If the trees have any direct power here it seems to be to draw from deep beneath the surface the moisture which has sunk into the earth and exhale gallons and gallons of it hourly. Any good sized tree has been estimated to have a capacity of forty or fifty gallon every twenty-four hours, and a forest of such trees would effect very considerable results. I should like to offer the opinion of Captain J. B. Overton, of Virginia City, Nevada, just here. He has had control of the water supply of that city for many years, and also conducted large operations in the mountains in cutting timber, wood and lumber, for the mines. His experience covers a quarter of a century and extends over several townships of land, from which his men cut the timber. He says "My experience proves to me that the cutting of the timber makes no difference in the amount of snow that falls, but that it drifts more, and for that reason lasts about as late in the summer as it would before the removal of the shade. I do not think the streams get low any sooner or afford any less water. I am of the opinion that the trees absorb from the soil quite as much water as would be evaporated by the action of the sun in the absence of shade. I know two small springs that ran for the whole year for ten years after the land was cut over, but, that since the thrifty growth of young pines have reached a height of from 15 to 25 feet and shade the ground as well, if not better, than the large trees did, have dried up about the last of August for five years past, and I can see no cause for it except that the trees are using the water. The supply of water used by my company in its operations has not decreased with the disappearance of the timber, and I do not find that the freshets are any more frequent or more violent than before the trees were cut off. The trees are coming up in a second growth much more numerously than they were before, and after sixty or seventy years about nine-tenths of them will die off and decay, leaving the timber about as it was when we first came to the country; then I think my springs will flow again. My observation teaches me that the amount of rainfall is not affected by denuding the mountain-side, but that the surface of the ground will be heated more by the sun and will therefore be drier, but that the springs and streams will be more diminished by the water used by the trees than by evaporation in their absence."

In a timber belt the snowfall is comparatively evenly distributed and by the radiation and reflection of heat from its own body each particular tree immediately sets itself to work to clear the ground around it, and long before there is a vacant foot out in the open a space will be bared for several

feet around each trunk. So long as there is no color but pure white for the sun's rays to work upon its heat is largely latent, but let a stick or straw break the surface and it will melt the snow or ice for several times its diameter on every side and stand alone in a few hours. Precisely the same is true upon a larger scale of every stump and tree in a forest. Following the reappearance of the sun after every storm the process begins, slowly or rapidly according to the temperature, clearing up large patches before that beyond shows signs of a break. This is not theory or hearsay, but actual observation covering a score of years spent in daily contact with the subject in all its phases. But it is supported by a theory also. It is a well known fact the temperature in a forest is always several degrees higher than it is on open ground under the same conditions otherwise. A series of observations were made by Cornell University several years ago, and although the belt of woodland was only half a mile long and sixteen rods wide the results were very marked. The trees were oak, maple and chestnut, with some hemlock and pines intermixed with an abundant undergrowth. The thermometers were changed and one put in another's place frequently in order to detect possible errors. The reporter sums up as follows:

"A study of the records will show that the temperature of the wooded belt is somewhat higher than that of the open field, amounting to from 2 to 4 degrees on the average; that fluctuations are less extreme and less rapid, and that gradual changes in the temperature of the field do not affect that of the belt until a day or two later."

Five different stations were kept open for several months; one thermometer being placed against the trunk of a large oak tree, near the center of the woods; one near the same tree, but not touching it; a third on a pole four feet from the ground, ten rods from the edge of the woods, and two others in the trunks of trees. A considerably warmer temperature was shown by the instrument suspended from the oak tree, but not touching it, although on several days the one out in the field was exposed to the sunshine, while the others were in the shade all the time. Of course the higher temperature would have a two-fold effect upon a snow bank. The warmer the air, the greater its capacity for holding moisture and, consequently, the greater evaporation, and at the same time its melting power would be enhanced to that extent and the snow set to running away as water. Too little weight is generally given to the fact that the rays of the sun must be broken up in order to release heat. A good example is given every spring by John Huntington, who is the owner of the toll road extending from Truckee, California, to Lake Tahoe. The snow shuts this road up very early every winter and a deposit of twenty to thirty feet is nothing unusual. As soon as possible, in the spring, Mr. Huntington sprinkles black dirt on the surface of the snow above where his road is known to be and the effect is wonderful. The layer is not heavy enough to shut out the light from striking the surface of the snow, but it is ample to release the heat rays, and there is a long depression that looks like an artificial excavation in a few hours, and days before the ground is clear on either side the stages are running on bare ground.

Trees tend to dissipate the snows in springtime also, by breaking up the steady cold winds which come down from the north at that season, almost invariably. When the current is permitted to flow on in uninterrupted sweep it retains the chill, but let it strike a forest and wind in and out among the trees for a mile or two and there will be a decided change in its temperature. It will be much better prepared to absorb moisture and also to melt the snow banks

in its changed form, as it pursues its southern journey.

But the strongest force at work to save our rivers is the drifting winds which heap up the snow in great banks, and in this the trees are a constant obstacle. There will be miniature drifts, it is true, but nothing to what there are when there is no obstruction. Outside the timber belt, where there is nothing to catch the snow as it falls and nothing to break the force of the wind, one of the most powerful and active agents in preserving the water supply of a country comes into play. By forming solid bodies of snow the most effective means of saving water for summer is reached. Across the bleak summits and down the vast canyons the wind has a well-nigh irresistible force and it not only gathers up the snow after it has ceased to come down, but it usually keeps at work all the time it is falling and carries it in whirling clouds until it strikes a cliff or a canyon set at just the right angle, and there it deposits the whole load. As long as there is any material left outside to work upon this is kept up, and there is no knowing how deep some of the big drifts get to be in the course of a long winter. As the days get warmer, the surface thaws a little and moistens the cake down a few inches, but the cold nights found all the year around at such altitudes soon transform it into ice, making a crust upon which the heat of the sun and the absorbing power of the air find it difficult to make any impression. On open ground the process is aided by the packing power of the wind, and it is not an unusual sight to see a man on horseback traveling comfortably across snow banks high enough to hide both the horse and his rider many times over if they should chance to break through. It is this which has changed the opinion of four settlers out of five along the eastern base of the Sierra Nevadas, where the timber has been cut for the Comstock mines. Over half a billion dollars in treasure have been taken from that one lode, and it is said that for every ton of ore taken out the equivalent of a cord of wood has gone in either in the shape of timber or of fuel. The whole mountain side for a distance of thirty miles has been cut over, covering the heads of such streams as Hunter's Creek, White's Canyon, Thomas Creek, Galena, Steamboat and other small rivers, which have furnished water for irrigation since 1860 to the owners of probably twenty thousand acres of land in valleys below. The concensus of opinion among this class of citizens, intelligent American farmers all of them, is that there is virtually no diminution in the supply of water that reaches them from the hills. James Mayberry had charge of men who cut over 12,000 acres in the early '70s. He is of the opinion that Hunter's Creek, with which he is most familiar, has a more certain flow and somewhat more water than before. John Wright has lived for thirty years on Steamboat Creek. It was dry in 1864, when the timber was standing, but never has been since, and has furnished water for a constantly increasing settlement. Robert Jones lives on low land and says he has had more crops killed by flooding in the ten years after the timber was cut than in the ten before it was touched. G. R. Holcomb says the supply is equally certain if not more so and attributes it entirely to the drifting of the snows. Several made answer that the water melted earlier and ran off sooner and said any one would know that, but failed to convince even themselves that they were lower than in former years.

Hon Ross Lewers, of this county, read a paper before the American Horticultural Society a few years ago in which he said: "There are certain peculiar conditions that prevail in Nevada that I think are worthy of notice. One of them is, that wherever the forest timber has been cut off, a new

growth has sprung up much thicker, and none of the young trees will start until the old ones are gone. Another is that the water supply from the mountains is greater and more permanent now than it was before the timber was cut off. The reason for this is that the wind has a more unimpeded course, and as all the snow storms come from nearly the same point in the south the snow is blown over and lodges on the north sides of the ridges where it is piled deep in drifts, and not being exposed directly to the sun's rays it melts very slowly and thus affords a more permanent supply. Spring floods are less frequent and for the same reason. I do not pretend to decide how much, if any, the presence of trees induce precipitation. They may moisten the air, but the humidity is all taken out of the ground by the roots, and I observe that the undergrowth and grass is more luxuriant since the timber was cut off."

It is hardly necessary to point out the advantage of having the snow supply heaped up in large drifts or buried deep in the canyons rather than to have it spread out, exposing large surfaces to the sun and the dry air, which in such places is almost constantly in motion, thus multiplying its capacity. In drifts the melting is almost all done at the bottom, and far into the summer a little rill will be found running away from the lower side. Good sized caves are often formed in this manner, and sometimes the top crust is so solid that the last seen of a big drift will be an arched shell of frozen snow reaching from one wall of the canyon to the other. The beautiful adaptation of the means to the end seen everywhere in nature is illustrated here. To attempt to hold back an adequate supply of water for a great region like that lying below the Sierra Nevada range in any except a solid state would be utterly useless. Nothing in a liquid form would tarry long on a heavy grade. No shade nor mat of leaves would be strong enough to overcome the law of gravitation to that extent. Nothing could detain it but a short time at the farthest, and if it were not for the vast drifts which hold the snow in an icy grasp until late in the summer, all the horrors prophesied from spring floods and summer droughts would be realized. As it is, I notice that heavy storms continue to visit the places from which the timber has been taken, but when an unfavorable season fails to bank up the drifts there is no water in the streams whether there are trees or stumps on the ground. There are places in Nevada which would give a strong support to the theory that the cutting off of timber brings frequent floods, if any had ever been there, for since the settlement of the country there have been several terrible floods which have been given the name of cloudbursts on account of the suddenness of the rise and subsidence of the water. The town of Austin, Nevada, is a sample. It has been swept several times by sudden floods, and as it lies in a narrow canyon which opens out above and spreads into quite a watershed, it is in constant danger. There never was a forest there and in early days there were no cloudbursts, but the discovery of rich mines led to the whole basin being tramped over and over constantly until the ground was as hard as a pavement. The result was that rains which formerly were taken into the soil ran down the waterways into the main canyon, which soon collected a roaring torrent and swept everything out. In so large a subject there are many things to consider and many unknown quantities to discover and weigh, but it seems to me that it is worthy of more attention than it has received. My observations, while they have extended over a long series of years, have been those of a layman and have not been such as to afford mathematical proof, even that a given

quantity of snow, say a foot, will last as long on open ground as it will among trees. As I have laid much stress upon this matter of evaporation which some may think hardly applies to snow, I will say that a considerable body has been known to disappear from our streets without making a particle of mud, leaving the ground dusty, showing that none of it melted, but that it all went directly into the air. And this will occur any time when the thermometer does not go above 32 degrees within a short time after a storm. The importance of presenting as small a surface to the action of such an air as that is very apparent, and it is in storing up the snow in heaps and packing it away in deep pockets that the economy of nature is manifested. The center of the body will not melt at any time and it requires a very warm day to get at the under side of a snow drift. The grass will be growing all around it before the ground underneath it gets warmed up sufficiently to start a stream from it, but let a tree stick its head up through the crust and it will go quickly. I have yet to see the first body of perpetual snow lying among trees. It will hardly do to say that the timber lies below the line of perpetual snow, for there are many banks which only disappear entirely once in ten years or so, when there comes a long dry summer, which have trees growing higher up on the same mountain side.

In any case I do not wish to be understood as favoring the destruction of the forests of this or any other country. I never cut down a tree in my life and never saw one fall without feeling that I had lost a friend. Whatever is proven there will always be abundant reasons for preserving extensive tracts of woodland everywhere that trees will grow, and it is time the matter became one of public concern.

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CURRENT NOTES ON ANTHROPOLOGY.

THE QUESTION OF THE CELTS.

This question has broken out afresh in Europe, as is the case every few years. The immediate cause was the publication of an essay, by A. Bertrand and Salomon Reinach, entitled, 'Les celtes dans les Vallees du Po et du Danube,' in which the authors claim that the proto-historic culture, the remains of which are found in the valley of the Po, is akin to that of an approximate age in the valley of the Danube, and that both were the products of the 'Celts.'

Prof. Virchow, in a lecture published in the 'Correspondenz-Blatt' of the German Anthropological Society, December, 1895, reviewed their arguments, substantially agreed with them, and further extended the area of this so-called Celtic culture.

By 'Celts' the archæologists understand a series of independent tribes who about 500—1,000 B. C. inhabited central and portions of western Europe. Their language was of that Aryan family which we now know as Celtic, represented to-day by Irish, Highland Scotch and Welsh. In stature they were tall, their skulls narrow (dolichocephalic), their complexion ruddy, eyes blue or gray, hair blonde or reddish. By the Latins they were called Celti, Galli or Galatæ, all three words from the same root *kel*, meaning violent or warlike.

The anthropologists, however, headed by Broca, apply the term 'Celts' to a small dark race in central France, and this leads to wild confusion. A long discussion, aimed to clear up the subject, by Dr. Lefevre, Dr. Collignon, Mortillet and others, has appeared in the Bull. de la Société d' Anthropologie of Paris, 1895. It is worth attentive reading by any one who desires the latest on this vexed question.

DANISH ANTIQUITIES.

Professor Japetus Steenstrup, of Copenhagen, has lately issued two memoirs of