Education and of Charities, in City Councils, city improvement societies and on citizens' committees.

The sooner the fact is recognized in the appointment to municipal offices or boards of public works, that engineering is not politics, the sooner will the reform movement, which has been so happily inaugurated in my own city, spread to other cities and bear good results.

OUR PENNSYLVANIA FORESTS.*

BY DR. J. T. ROTHROCK,

Secretary of the Pennsylvania Forestry Association.

The lecturer was introduced by the Secretary of the Institute and spoke as follows:

MEMBERS OF THE INSTITUTE, LADIES AND GENTLEMEN:

As a nation, our resources have usually been in advance of our needs, or in other words, there never has been a time when our capacity for production has not been in excess of our consumption. When we read of famine in other lands and think that in all our national life no such monster has ever stalked over any considerable portion of our country, we imagine that we are a peculiar people and under a special Divine protection. Anticipating no shortage in the future of any of the necessities of life, we have become reckless in the expenditure of what we have. We have absolutely lost sight of the fact that those who follow may, nay, must inevitably, suffer from our extravagance. Indeed, it is hardly too much to say that most of our legislation is based upon the present and takes almost no account of the future. Hardly a statesman whose name adorns our national records, has fairly looked into the future and shaped a specific policy, to anticipate wants which must press upon us unless we provide in advance for their advent. We have swept the buffalo from the plains, the fish from the streams,

*A lecture delivered before the Franklin Institute, January 4, 1895.

and are, as fast as possible, removing the forests to an extent which older nations have pronounced dangerous.

Before we consummate this last folly it may be well to ask ourselves just what our relations with the trees are. I shall consider this from three standpoints: (1) Forests as holding soil; (2) Forests as making soil; (3) Relation of the forests to the atmosphere; and finally shall draw some general conclusions from the statements previously made.

Forests retain, or hold, soil in its existing position. To illustrate this let me call attention to a hillside in Mifflin County, Pa. When I first knew that ground it was covered with timber. There was not a single gully upon its steep surface; and to this day, upon one end of the same hill, where the timber remains, no sign of wash appears. At present, from one end to the other of the timberless part, the hill is literally seamed and scored by gulches. Its value, as farm land, is absolutely nothing. Nor is this all. The soil, gravel, and even rocks, have been swept like an inundation to overflow and destroy the good soil on the flats below. Thus a two-fold injury has been wrought, one which threatens with each successive year to become worse unless arrested—at a considerable expense to the owner.

Let us take another illustration. Here is a scene in the Valley of Long Run, in Clinton County. The signs of a destructive inundation are everywhere apparent. Huge boulders and massive angular fragments of rocks dot the course of the stream. Fresh landslides show where the retaining soil below has been washed out. If you follow down the course of the stream you will see where the farms have been overflowed, where the original channel has been changed, a new one cut out, and where buildings have been undermined and swept off in the flood, involving a loss of human life which was sickening in its details.

Now return to the head of the stream and what do we find? A principal valley whose steep sides indicate a rapid delivery of water; a number of lateral, smaller valleys, with equally steep sides, and in every one a mountain stream, whose quick flow tells plainly enough with what impetuosity the water is delivered to the main channel.

From almost every part of this valley of Long Run, from even the remotest highlands, whose slopes send their contribution to swell the flood, the surface is as bare as fire and axe can make it; or where the barrenness is not already absolute, the lumberman is at work to complete the naked picture.

Do not misunderstand me. I am waging no war with the lumberman. He has his vocation, and the prosperity of the country demands his product. I am simply considering the facts.

Let us shift the scene, and go over into Rose Valley, in Lycoming County. As I drove through it I was struck by the fact that where the stumps still remained in the fields there were signs of good crops; but when I came to fields which were clear of stumps, and thereby showed that they had been longer under cultivation, generally, the crops appeared to have been smaller. In a word, there was less soil in the old fields than in the newer ones. Then when I came to the foot of the slopes I found what had become of the soil. It was washed out, and the stony surfaces in the older fields showed that it had gone, and explained why the crops were short.

It hardly seems necessary to devote any more space to a discussion of a principle which should be clear enough from the illustrations already given.

Let us now consider the second proposition—*that forests make soil*. First of all, we will note the growth of the mangrove thickets on the coast of Florida. The mangrove is a seaside plant in tropical regions clear around the world. It has its marked peculiarities, and among them is the one that the parent tree holds on to the seed, not only until it is perfectly matured, but until it has well begun its growth. When cast off, the young mangrove is a plantlet, or treelet, about a foot long. Thousands of these are yearly dropped from the older trees on the coast of Florida into the water and carried off by the wind and tide. Perhaps at low tide some of these are stranded on an oyster reef; where the soil is absolutely bare of any sign of what you would consider soil. Nothing but the crevices in a surface which is

covered by the repulsive slime of the ocean exists to offer the young mangrove a foothold. This, however, is sufficient. It is the one plant specially prepared to fill that place, and, once landed, it begins to establish itself and to grow. Nor is this all. No sooner are the roots fairly fastened, and the first trunk two or three feet high, than from the newly formed branches there are sent down hanging "air roots," which attach themselves to the reef as the parent stem had already done. Let us shift the scene and note the vigorous growth of the mangrove on the tropical shores of Jamaica. Near Port Morant one may find forests of this tree possibly seventy feet high. Over the tangled mass of roots one may walk for miles, a foot above the water, without coming in contact with it. This tangle of root and stem is not without its purpose in the general economy of nature. When the tree has attained its growth and fallen, to return by decay to the inorganic condition, it is in the eddies formed by these roots that the matter is retained. By slow degrees, in the course of ages, soil begins to appear above the surface of the water. Slime is buried beneath soil and on the rising earth, forests of a new kind, and possibly of greater utility, may appear.

Or, if we study the bald cypress, a lesson no less impressive is taught. We are quite too apt to think that this tree is specially fitted for bayous and mud-banks and will grow nowhere else. The fact is, the bald cypress is a tree of pliant constitution, well adapted to a wide range of conditions. I have seen it thriving where it grew up out of an asphalt pavement, and also photographed vigorous specimens of it where it stood out in the muddy water of the James River. When we find it in such positions as the one last named, the proper view is that it grows there because it is free from competition by occupying a place in which no other tree of the region will flourish. In the Southern States it forms just such forest masses as the mangrove does in Jamaica, except that it produces no such thickets of "air roots." These trees rise out of the brackish or fresh water, grow, mature, fall, decay, and out of their remains fresh soil is formed to produce dry ground for other crops.

One might be allowed here to call attention to the fact that on the soil formed by the mangrove and the bald cypress some of the most important crops of the world are produced. Indeed, a mangrove thicket strikingly illustrates some of the earlier features of "world-making." Its density, its emergence from the bosom of the ocean, produce an impression which is strikingly at variance with the ordinary course of things in temperate and sub-tropical regions to-day. Furthermore; when we consider the disappearing hemlock forests and recognize the possibilities of modern chemistry, it is hard to estimate what advantages it will place in the hands of the tanning industry, for it contains an enormous percentage of tannin.

No fact of science is better established than that the presence of moisture in the air, over any region, in temperate latitudes, tends to prevent the escape of the earth's heat. Professor Tyndall most forcibly explains that aqueous vapor in the atmosphere of England is as necessary for the vegetable life of that country as clothing is for man. It is equally well attested that plants in a vigorous condition are, during the growing periods, very active in giving off moisture to the air by transpiration, that they even transpire more than is received by the roots, which, of course, indicates another source of supply than the roots. The quantity transpired is very variable for different plants and under different atmospheric conditions; but from known facts, it is well accepted that the volume is enormous. The presence of this enormous body of water in the atmosphere must be accepted, and, if there, its potency must be acknowledged as a factor in climate, if not locally, then generally. It can hardly be doubtful that the change of a country from a wooded to a treeless condition must be accompanied by a change of climate, of moisture in the air, and consequently of temperature.

It appears that in our latitude the result must at least be a climate of greater extremes—extremes which would possibly affect the production of what are now important crops. Strict science has not the whole field to itself, and the observations of intelligent lay observers are at least

worthy of a respectful hearing. Some of these observers, whose remembrance extends back to the time when the country was under more positive woodland conditions, assert, as their opinion, that such changes have already taken place. For example, they assert that the period during which hay may be made has been appreciably reduced during the last half century. Owing to drier atmosphere, they say the grass must be cut at once when ripe, or be damaged as a forage by standing. I neither accept nor deny the statement, but content myself with remarking that the observation is entitled to a hearing, and that it opens the door for a productive line of meteorological research.

From the foregoing it would appear as if the relations between the surface of the country and the forests were most intimate and important. The natural sequence to this conclusion would be the inquiry: What proportion of the State should remain under forest cover? For Pennsylvania, with which we are most concerned, it would be safe to say that forests should be retained wherever they would be the most remunerative crop. This at once divests the subject of all sentiment, and places it under the same common-sense management which we accord to our crops, and it also places forestry where it should be, under agriculture. The mountain axes of the Commonwealth, the steeper ridges, the lowest swamps, where drainage is difficult, worn-out fields, where, owing to steep slopes and natural poverty of soil, it is impossible to retain enough of fertility in the soil to produce remunerative crops of the cereal grains, or even to maintain grass for dairy purposes—all these should be covered again with trees.

To this proposition there would be two natural inquiries. The first, "Is it possible?" The second, "Would it pay?" One may dismiss the first inquiry with the statement that forests may always be produced as a crop when accorded the care of a crop. It seems ridiculous to be obliged to reiterate that in Germany, France, Switzerland, Scandinavia and other European countries, forestry is as firmly established as any other branch of agriculture; but it appears to

be necessary, for to the average American the idea of producing forests is still little less than absurd. The idea is growing; but it will require years to firmly establish it *just where it is most needed*. The remaining inquiry, "Would it pay?" may be answered in two ways: first, does it pay to farm such land as we have indicated should be devoted to growth of forests; second, "Is there any other known way of utilizing these lands, unless they happen to have some mineral deposits?" It will not pay in one year, in five or in ten years; but it will pay, in the longer run, interest and principal on capital invested.

It is well, in this connection, to call attention to the following, which is part of a law now standing on our statute books:

"AN ACT

"For the encouragement of forest culture, and providing penalties for the injury and destruction of forests.

"SECTION 1. Be it enacted, etc., That in consideration of the public benefit to be derived from the planting and cultivation of forest or timber trees, the owner or owners of any land in this Commonwealth planted with forest or timber trees in number not less than 1,200 to the acre, shall, on making due proof thereof, be entitled to receive annually from the commissioners of their respective counties, during the period that the said trees are maintained in sound condition upon the said land, the following sums of money:

"For a period of ten years after the land has been so planted, a sum equal to ninety per centum of all the taxes annually assessed and paid upon the said land, or so much of the said ninety per centum as shall not exceed the sum of forty-five cents per acre;

"For a second period of ten years, a sum equal to eighty per centum of the said taxes, or so much of the said eighty per centum as shall not exceed the sum of forty cents per acre;

"For a third and final period of ten years, a sum equal to fifty per centum of the said taxes, or so much of the said fifty per centum as shall not exceed the sum of twenty-five cents per acre:

“ Provided, That it shall be lawful for the owner or owners of the said land, after the same has been so planted for at least ten years, to thin out and reduce the number of trees growing thereon to not less than 600 to the acre, so long as no portion of the said land shall be absolutely cleared of the said trees;

“ And provided also, That the benefits of this act shall not be extended to nurserymen or others growing trees for sale for future planting.

“SEC. 2. The owner or owners of forest or timber land in this Commonwealth, which has been cleared of merchantable timber, who shall, within one year after the said land has been so cleared, have given notice to the commissioners of their respective counties that the said land is to be maintained in timber, and who shall maintain upon the said land young forest or timber trees in sound condition, in number at least 1,200 to the acre, shall, on making due proof thereof, be entitled to receive annually from the commissioners of their respective counties the sums of money mentioned in the first section of this act. *Provided, That the first period of ten years shall be counted from the time that the said land has been cleared of merchantable timber, and that after the said first period of ten years, the number of trees upon the said land may be reduced as in the said first section is provided.*”

It is a striking example of the folly of men that they will pay taxes on unproductive land, maintain fences, and bestow their labor upon it, render it each year more and more impoverished and continue to do this in spite of the fact that it will yield them nothing in the end. This folly is the more striking when it has been shown, all over the State, that such a law as the above exists for the sole purpose of ameliorating the condition of those “small land owners” who need it most. But how shall one characterise the stupidity of a farmer who owns a few acres of half-grown oak on a barren, steep, hillside, with a slaty surface and a northern exposure, and who cuts it off to sell in a market which is on the very lowest round?

It is an old, threadbare argument, that substitutes for

wood will be found. The statement is doubtless true, and might have some weight were it not for the fact that new uses are also being found for it much more rapidly than the substitutes for it are. The plain undeniable fact is, that wood will always remain almost as much an article of prime necessity as water.

There is another aspect of the problem which may well be considered: rates of interest tend to become lower as countries become better settled and business reaches a condition approaching an equilibrium. Contrast, for example, the interest on capital invested in England, and in Oregon and Washington. The 8 per cent. almost invariably comes from the lands to the west of us, and the undoubted tendency is for good securities to command lower rates. There is an evident exception to this general rule. Our population is becoming more dense, our timber-land areas are becoming more and more depleted, until it requires no prophetic eye to see the practical obliteration of important lines of business in this Commonwealth. In other words, the demand is continually increasing, and the supply as certainly decreasing. The inevitable tendency must be to increase the value of standing timber.

Thus far no allusion has been made to the spontaneous restoration of our forests. It is probably safe to say that in no temperate region is this tendency more marked. I might even go further, and say that the quantity of wood which an acre will produce spontaneously each year is a perpetual marvel to the European forester. It seems to be equally a marvel to our own people that when once a forest is removed it is not succeeded promptly by another of the same kind. As a matter of fact, there is no more reason to expect a perpetual succession of the same kind of timber than there is to expect that, from a single sowing, men should reap a perpetual succession of the same kind of grain; and there is no more reason why the existing tendency should be used, as it often is, as an argument against tree planting than there is why it should be used as an argument against grain sowing. The very same methods which ensure the crop we desire in the one case, will ensure

it in the other, the chief difference being the time of maturing. It is vastly important that the widespread error in regard to our most important tree, or what was our most important tree, the white pine, should be corrected. There is no species in which the tendency to restoration by seed is more marked. Over the State, here and there, in numberless places, one may see thriving groves of this tree coming on; nor does there seem to be any acceptable reason why the coming crop should not be as good as the first, if sufficient time be allowed for the wood to fully mature. It is well known to experts that the white pine does not select the richest soil for its favorite place of growth. This only makes it the more valuable. The one great foe to the young white pine is the unrestrained forest fires. It seems to be a wretched public policy which permits land to lie for half a century unproductive after its white pine crop had been removed. What shall be said of the policy which declines even to protect the spontaneous bounty which nature offers, but allows fires, year after year, to destroy the coming timber crop?

I do not draw upon my imagination when I propose this question, but at this moment can point out extensive areas in this State, which are now a picture of desolation, but which, under a wise State policy, should have been on the verge of reaping a harvest worth millions of dollars for its second growth of timber. One of the shortcomings which will be hard for the next generation to excuse, will be that we have stolidly ignored their interests, so far as protection of our timber resources are concerned. Yet it must not be forgotten that the present generation is the first one, of civilised men, born on American soil, to whom a possible scarcity of timber, or an unfortunate train of circumstances growing out of that scarcity, has presented itself as a present pressing problem. To those who preceded us, the problem was what to do with the excess. Scarcity faces us, however, squarely.

We recognize clearly enough two aspects of forestry—individual and State forestry. Let us briefly consider each.

State forestry may be said to concern itself with tree restoration and removal on soil which belongs to the State, or on soil which it is for the general interest that the State should control. Properly conducted, State forestry should consider ultimate consequences, and shape a perpetual policy which should extend forward indefinitely. It considers measures in the light of State perpetuity. It raises and solves the question as to what will be the ultimate effect on the proper conservation of water in the soil. How will stream beds be affected if this or that body of timber is destroyed, and what kind of timber can be grown most advantageously to the Commonwealth on any given area? Individual interests are, by it, wholly submerged in the general consideration: what will longest preserve and most benefit the community?

Of course, it is an open secret that State forestry has hitherto flourished most under the protection of a monarchical government. Perhaps it always will. With the recurring cries of "turn the rascals out," marking the change from one administration to another, it would be folly to expect a permanent policy, which could calmly contemplate any plan looking into the next century for its completion, however worthy that plan might be. The temptation to meddlesome interference is too great to be successfully resisted.

It follows, then, that the next best plan must be substituted for a general system of State forestry, and the latter appealed to only when it must be.

We believe that the highest function of the State is to allow every man the fullest chance to work out the best that is in him. Greater help than this becomes a doting paternalism, and is more likely to weaken than to strengthen the recipient. Now, to apply this principle, what is required? First, that each person should know how to act. Our public school system has this idea for its basis. It is more a public than a private benefit that we should know how to stamp out contagious disease, or to utilize present resources so as not to entail want upon the children we have begotten. In rational treatment of our forests, as a people, we are wholly

ignorant, and this public admission for the mass of the people is good for the national soul. But we are not hopelessly stupid. On the contrary, no people pick up a new idea with greater avidity, or comprehend it more promptly, if the moving motive is properly appealed to. To convey this instruction the State should own forest reservations where approved methods of tree culture could be illustrated, and where, at the same time, the State could have under its own absolute control such areas, as, if allowed to remain the property of the individual, would become a menace to the peace and prosperity of the community, by the frequent unrestricted deluges which would pour down from the steep and naked slopes. Ignorance of forestry to-day will cost this Commonwealth not less than \$37,000,000 annually, in the near future, and will leave us with a great gap in the list of our most productive industries.

Furthermore, individual forestry should be encouraged, because the surface of the State must, to a certain extent, be covered with trees. The interest of the people demands their *presence*, as well as their *products*. It is merely a question whether the State shall, at a great cost, imperfectly preserve this equilibrium, or make it the interest of the individual to accomplish the same result for it, not only cheaper, but better. We may lay down the general proposition that a tree pays the State, in instant benefit, for the privilege of growing, every hour that it stands. Yet with this incontestable truth in plain view, our laws are actually placing a premium upon a system of forest destruction, which is as unnecessary as it is wasteful. As things now are, there is practically a prohibitory tax upon maintaining tracts of timber, which the future will need vastly more than we do. Or to put the facts in another shape, we may say that there are vast areas of woodland in this State which, in the last thirty years, have been confiscated by taxes, because these have aggregated more than the land can be sold for to-day. To make matters worse, during all this time, in spite of taxes being paid, the owner has received for the same property no protection whatever. The very same county commissioners who expend his money

refuse to accord the protection against forest fires which the law makes it their specific duty to furnish.

The time will come, and can come none too quickly, when not only will this gross injustice be abated, but when the true relation of the forests will be so plainly recognized that the individual will find the State encouragement which he needs to enable him to serve himself in serving the community.

INTERSTITIAL SPACE.

BY T. DUNKIN PARET.

London *Engineering*, for February 22, 1895, contains an abstract of a paper by Mr. Spencer R. Newberry read before the Ohio State Engineers' Society. This paper refers to the manufacturing of concrete. The abstract begins by stating that "it is well known that the voids in a mass of particles, all of nearly uniform size, are greater than when the dimensions of the particles vary largely, and hence in cement testing, the voids in standard sand, carefully ground to be uniform as possible, are much greater than in ordinary gravel." The abstract then states that "in making a concrete the materials should be mixed so as to fill the voids as full as possible, the amount of cement required for this being increased by ten to fifteen per cent. for safety." It also says "that a suitable addition of gravel to sand may strengthen the concrete," and gives a tabulation showing various proportions of cement, sand and gravel, with the crushing strength in pounds per square inch duly tabulated.

While this abstract may do injustice to Mr. Newberry's paper, its general effect is that produced by nearly all formulæ for the manufacture of concrete and by all articles in reference to such manufacture. In other words, there are certain facts and figures given, which are definite and specific, and a general vagueness in reference to that secret of quality which really lies (the cement being assumed as