sharp end forward) into the persons who were mounting, and he said, "Friend, keep on board thine own ship." It is in that sense that I venture to interpret the principle of standing and waiting to which I have referred. I was convinced as firmly as I have ever been convinced of anything in my life that the "Origin of Species" was a ship laden with a cargo of great value, and which, if she were permitted to pursue her course, would reach a veritable scientific Golconda, and I thought it my duty, however naturally averse I might be to fighting, to bid those who would disturb her beneficent operations to keep on board their own ship. If it has pleased the Royal Society to recognise such poor services as I may have rendered in that capacity I am very glad, because I am as much convinced now as I was thirty-four years ago that the theory propounded by Mr. Darwin, I mean that which he propounded —not that which has been reported to be his by too many ill-instructed, both friends and foes—has never yet been shown to be inconsistent with any positive observations, and if I may use a phrase which I know has been objected to and which I use in a totally different sense from that in which it was first proposed by its first propounder, I do believe that on all grounds of pure science it "holds the field," as the only hypothesis at present before us which has a sound scientific foundation. It is quite possible that you will apply to me the remark that has often been applied to persons in such a position as mine, that we are apt to exaggerate the importance of that to which our lives have been more or less devoted. But I am sincerely of opinion that the views which were propounded by Mr. Darwin thirty-four years ago will be understood hereafter to mark an epoch in the intellectual history of the human race. They will modify the whole system of our thoughts and opinions, and shape our most intimate convictions. I do not know, I do not think anybody knows, whether the particular views which Darwin held will be fortified by the experience of the ages which come after us. But of this thing I am perfectly certain, that the present state of things has resulted from the feeling of the smaller men who have followed him that they are incompetent to bend the bow of Ulysses, and in consequence many of them are preferring to employ the air-gun of mere speculation. Those who wish to attain to some clear and definite solution of the problems which Mr. Darwin was the first person to set before us in later times, must base themselves upon the facts which are stated in his great work, and, still more, must pursue their inquiries by the methods of which he was so brilliant an exemplar throughout the whole of his life. You must have his sagacity, his untiring search after the knowledge of fact, his readiness always to give up a preconceived opinion to that which was demonstrably true, before you can hope to carry his doctrines to their ultimate issue; and whether the particular form in which he has put them before us may be such as is finally destined to survive or not is more, I venture to think, than anybody is capable at this present moment of saying. But this one thing is perfectly certain—that it is only by pursuing his methods, by that wonderful single-mindedness, devotion to truth, readiness to sacrifice all things for the advance of definite knowledge, that we can hope to come any nearer than we are at present to the truths which he struggled to attain.

THE BATTLE OF THE FORESTS.[1]

II.

IN the sand-hills which traverse Nebraska from east to west there are now found in eastern counties the sand-drowned trunks of the western bull pine, and the same pine belonging to the Pacific flora is found associated with the black walnut of the eastern region along the Niobrara River.

We may, however, divide the North American forest, according to its botanical features, into two great forest regions, namely, the Atlantic, which is in the main characterised by broad-leaved trees, and the Pacific, which is made up almost wholly of coniferous species.

In the Atlantic forest we can again discern several floral subdivisions, each of which shows special characteristics. The southernmost coast and keys of Florida, although several degrees north of the geographical limit of the tropics, present a truly tropical forest, rich in species of the West Indian flora, which here finds its most northern extension. There is no good reason for calling this outpost semi-tropical, as is done on Sargent's map. With the mahogany, the mastic, the royal palm, the mangrove, the sea grape, and some sixty more West Indian species represented, it is tropical in all but its geographic position. That the northern flora joins the tropic forest here, and thus brings together on this insignificant spot some hundred species, nearly one quarter of all the species found in the Atlantic forest, does not detract from its tropical character.

On the other hand, the forest north of this region may be called sub-tropical, for here the live and water oak, the magnolia, the bay tree and holly, and many other broad-leaved trees are mixed with the sabal and dwarf palmatto. As they retain their green foliage throughout the winter, this region is truly semi-tropical in character, and under the influence of the Gulf Stream, extends in a narrow belt some twenty or twenty-five miles in width along the coast as far north as North Carolina.

While this ever-green, broad-leaved forest is more or less confined to the rich hammocks and moister situations, the poor sandy soils of this as well as of the more northern region are occupied by pines; and as those, especially the long leaf pine, are celebrated all over the world, and give the great mercantile significance to these forests, this region may well be called the great southern pine belt. North of the evergreen subtropic forest stretches the vast deciduous leaved forest of the Atlantic, nowhere equalled in the temperate regions of the world in extent and perfection of form, and hardly in the number of species. This designation applies to the entire area up to the northern forest belt, for the region segregated on the census map as the northern pine belt is still in the main the dominion of the deciduous-leaved forest trees. On certain areas pines and spruces are intermixed, and on certain soils, especially gravelly drifts and dry sand plains, as on the pine barrens of Northern Michigan, they congregate even to the exclusion of other species. Instead, we can divide this deciduous-leaved forest by a line running somewhere below the fortieth degree of latitude, where with the northern limits of the southern magnolias and other species we may locate in general the northern limit of the southern forest flora. Northward from here, in what may be called the "middle Atlantic forest," the deciduous species rapidly decrease, and the coniferous growth predominates, until we arrive at the broad belt of the northern forest, which, crossing from the Atlantic to the Pacific, and composed of only eight hardy species, takes its stand against the frigid breath and icy hands of Boreas.

Abounding in streams, lakes, and swampy areas, the low divides of this region are occupied by an open stunted forest of black and white spruce, while the bottoms are held by the balsam fir, larch or tamarack, poplar, dwarf birch and willow. The white spruce, paper or canoe birch, balsam poplar and aspen stretch their lines from the Atlantic to the Pacific over the whole continent.

On the Pacific side the subdivisions are rather ranked from west to east. While the northern forest battles against the cold blasts from icy fields, the front of the Pacific interior forest is wrestling with the dry atmosphere of the plains and interior basin. Here, on the driest parts, where the sage brush finds its home, the ponderous bull pine is the foremost fighter, and where even this hardy tree cannot succeed in the interior basin several species of cedar hold the fort, in company with the nut pine, covering with an open growth the mesas and lower mountain slopes. Small and stunted, although of immense age, these valiant outposts show the marks of severe struggles for existence.

On the higher, and therefore moister and cooler elevations, and in the narrow canyons, where evaporation is diminished and the soil is fresher, the sombre Douglas, Engelmann, and blue spruce, and the silver-foliaged white fir, join the pines or take their place.

With few exceptions, the same species, only of better development, are found in the second parallel, which occupies the western slopes of the Sierra Nevada. Additional forces here strengthen the ranks, the great sugar pine, two noble firs, a mighty larch, hemlocks and cedars vie with their leaders, the big sequoias, in showing of what metal they are made. The third parallel, occupied by the forest of the Coast Range, the most wonderfully developed, although far from being the most varied of this continent, is commanded by the redwood, with the tide-land spruce, hemlock, and gigantic arborvitæ joining the ranks.

[1] A lecture delivered by Prof. B. E. Fernow, Chief of the Forestry Department of Agriculture, U.S.A., during the Brooklyn meeting of the American Association for the Advancement of Science. (Continued from page 119.)

Broad-leaved trees are not absent, but so little developed in comparison with the mighty conifers that they play no conspicuous part except along the river bottoms, where the maple, cottonwood, ash, and alder thrive, and in the narrow interior valleys, where an open growth of oak is found. Towards the south and on the lower levels these broad-leaved trees again become evergreen, as on the Atlantic side, but of different tribes, and form a sub-tropic flora.

Along the coast we find several species of true cypress, including the well-known, although rare, Monterey cypress, which clings to the gigantic rocks, and braves the briny ocean winds, and with its branches twisted landward. Finally, flanking the battle order of the Pacific forest, we find another section of the army, composed of the northern extension of the Mexican flora, mingled with which are species from the Pacific forest on the west, and from the Atlantic on the east.

The mesquite and some acacias, the tree yuccas and the giant or tree cactus are perhaps the most characteristic and remarkable species of the deserts of this region, while the high mountains support dense forests of firs and pines.

So far we have considered the forest only from the geographical and botanical point of view, and have watched the history of its struggle for existence against the elements and against the lower vegetation and other forces of nature. A new chapter of its life history, which we shall have time only to scan very briefly, began when man came upon the scene, and the economic point of view had to be considered.

For ages man has taken sides against the forest. Not only has he contested for the occupancy of the soil, in order to cultivate his crops or to make the meadow for his cattle—a most legitimate and justifiable proceeding—and not only has he utilised the vast stores of wood accumulated through centuries, for the ten thousand uses to which this material can be applied, and in the application of which he exhibits his superior intelligence, but he has also shown a woeful lack of intelligence in the wilful or careless destruction of the forest without justifiable cause, and by just so much curtailing the bountiful stores provided by nature for him and his progeny. Not only has he, like a spendthrift, wasted his stores of useful material, but more—he has wasted the work of nature through thousands of years by the foolish destruction of the forest cover, wresting from it the toilsomely achieved victory over the soil. He has destroyed the grasses and even all vestige of vegetation, and has handed over the naked soil to the action of wind and water. As the fertility and agriculture of the plain is dependent upon the regular and equable flow of water from the mountains, such as a forest cover alone can secure, he has by barring the slopes accomplished in many localities utter ruin to himself, and turned them back into inhospitable deserts as they were first before the struggle of the forest had made them inhabitable.

One would hardly believe that certain mountains in France had ever seen a luxuriant forest growth, and could during historic times have been so utterly despoiled of their vegetal cover. Yet axe, fire, and cattle have been most successful, and the consequences have been felt not only in the mountains, but in the valleys below. The waters in torrents have brought down the soil and débris, covering out of sight the fertile fields of thousands of toiling farmers. They themselves have brought this ruin upon them on account of their ignorance of the relation of forest cover to their occupation. Now, with infinite hard work and expenditure of energy and money, the slow work of restoring the forest to its possession has begun. The first work is to take care of the rain-waters, and by artificial breaks turn them from rushing torrents over the bare surface into a succession of gentle runs and falls by fascine and stone works. This work must be begun at the very top of the mountains, at the very source of the evil, where the water receives its first momentum in the descent to the valley. The fascines or wattles, laid across each rivulet at more or less frequent distances from each other, and fastened down by heavy stones, are made of live willows or other readily sprouting species, which in course of time strike root and become living barriers. The pockets behind these breastworks gradually fill up, and the contour of the mountain-side is changed from an even and rapid descent into a series of steps with gentle fall, over which the formerly rushing waters, gradually and without turbulence, find their way to the valley below. Where the incline is too steep, and higher breastworks are necessary, they are made of masonry, sometimes at great expense. At the base of these overflow dams an opening is left for the water to drain through, even after the depression behind the rampart has filled up with débris, and soil has washed down from above. Then, when in this way the soil has come to rest, forest planting begins, and gradually the torrent is "drowned in vegetation." Sometimes, where on a steep mountain-side the naked rock alone has been left, it becomes necessary to carry in baskets the soil to the trenches hewn in the rock, where the little seedlings may take their first hold, until they are strong enough to fight their own battle and make their own soil, gradully restoring the beneficent conditions which nature had provided before the arrival of man and his senseless, improvident, self-destructive greed. By the irrational destruction of the forest, first for the supply of timber, then through the careless use of fire, by the clearing for unsuitable farm use, by excessive grazing of sheep and goat, the mountain-sides themselves are not only devastated and made useless, but fertile farms for two hundred miles from the source of the evil are ruined by the deposits of débris, and the population pauperised and driven from their homes. Many millions of dollars have been and many more will have to be spent before these regions become habitable again.

That we are working in this country towards the same conditions is too well known to need rehearsal. Go to the shores of Lake Michigan, or visit the coast of New England, New Jersey, Pennsylvania, down to the Gulf, and you can see the destructive action of the shifting sands set loose by improvident removal of the plant cover. Go to the Adirondacks, the highlands of Mississippi, or the eastern slopes of the Rocky Mountains, and aspects similar to those derived from France will meet your view.

What the farmer has brought upon himself here by excessive clearing, the lumberer, prospector, miner, or hunter prepares in the farthest West hy reckless and purposeless use of fire. Burnt mountain-sides, where no living thing can subsist in comfort, cover not acres but hundreds of square miles in the western country. While the first fire only deadens the trees or undermines their constitution, the second or third fire usually is sufficient to kill what remain alive, and even to clean up the fallen timber. That these bald spots are not more frequent than they are, is only due to the short period of our endeavours in disturbing the balance of nature.

But as our nation prides itself on the rapidity of its development, exercising to the utmost our constructive energies, so do we excel in destructive and wasteful energies and tendencies, and we shall come to grief with our resources much sooner than some of our happy-go-lucky friends would like to make us believe. While these exhibitions of American vandalism are beyond the proprieties of legitimate warfare, there is not much more propriety or intelligence visible in the manner in which we levy tribute from the forest for our legitimate needs. Forests grow to be used, but there is a great difference between intelligent and unintelligent use. Improvidence and ignorance characterise the present methods of using the forest growth. The value of it is not even known. Of the 425 or more species which are represented in the forests, not more than forty or fifty at the most are found in the markets. Although, to be sure, many of the species are of but little or no economic value, the number of the truly useful trees is probably twice or three times as great as that actually used. Ignorance as to the true value of them keeps many from little more than *simply a strictly local use, or from their most fit employment.* The story of the black walnut used for fence rails or firewood is well known. Six years ago the red gum or liquidambar, now a fashionable finishing material, was despised. Ten years ago large hemlock trees were mouldering in the woods after the bark had been taken for tanning purposes because the value of the wood was unknown. Cypress and Douglas spruce cannot yet overcome the prejudice of the market. On the other hand, cottonwood and tulip poplar, not long ago among the despised or only locally used, can hardly now be furnished in sufficient quantities, and the long leaf pine, which had been bled for turpentine, was considered an inferior material, which, as has lately been shown, is nothing but an unwarranted prejudice.

In a vague empirical way the choice of the useful has been attempted, and only lately have we begun to systematically study our forest resources, to determine the qualities and adaptabilities of our timbers, and to find out the conditions under which they produce not only the largest amount but the best quality of timber.

Yet in another direction do the forest users act unintelligently.

As we have seen, most of our forest trees are of a social character. With few exceptions, they keep company with other kinds than their own; they appear in mixed forests. Hence, where certain species, as the pines and spruces, become gregarious, and form unmixed, pure forests, the axe of the lumberer does not as a rule level the entire forest, but he selects the kinds which he wishes to use—he culls the forest. At first sight this would appear rather an advantage for the existence of the forest. So it is from a botanic, geographic, or landscape point of view, yet from an economic point it is exactly the reverse—it is disastrous.

In the well-managed forests of Germany the undeserving species are exterminated, and the most useful fostered, just as the agriculturist exterminates the weeds and cultivates the crop. Not only is the forest there confined to those soils and locations which cannot be used to better advantage, or which require a forest cover in order to protect the soil against detrimental displacement, but it is so managed as to become a more and more valuable resource, a crop of increasing importance, under the management of skilled foresters, of whom, in a late debate on the floor of the Landtag of Prussia, it was said that "While most other productive business has declined, the forest administration has steadily improved and yielded increasing revenues."

The battle of the forest in this country is now fought by man, the unintelligent and greedy carrying on a war of extermination, without the knowledge that victory may lead eventually to their own destitution; the intelligent and provident trying to defend the forest cover, and endeavouring to prevent its removal from such lands as cannot serve a better purpose, and to restrict the use of the balance to such rational harvest of its material, without injurious effects on soil and water conditions, as will insure an ever reproducing crop and a permanent national resource.

While man may study the geography of the earth as it exists, here is about the only opportunity for him to make geography, to shape the surface conditions of the earth, and even to some extent influence its climatic conditions.

The lecturer then referred to the Adirondacks in particular, showing views of forest destruction by fire, water storage, and lumbering, and claiming that they need especially conservative treatment, because the soil itself there is made by the forest, the duff covering the native rock formed at the rate of one foot in 300 to 500 years by the decay of foliage and litter, and hence its loss by washing of the rains is practically irremediable.

He showed the paramount interest which the State has in maintaining favourable forest conditions, and claimed that the private owners, being naturally interested mostly in the timber only, and not caring for the future generations or distant and indirect benefits to others, could not be expected to manage conservatively.

Let it not be overlooked, that the State is not only the representative of communal interests as against individual interests, but also of future interest as against the present; the private interest is not sufficient to protect this class of lands; that State ownership or, what is more objectionable and less effective, State supervision of private forest lands is indispensable in those regions where the forest subserves other functions than that of mere material supply.

Grant for once that the community is interested in the preservation of the forest cover and its rational use with proper regard to the maintenance of permanently beneficial conditions, that the community would suffer from a destructive policy in those watersheds, and you must come to the logical conclusion that the community alone can be expected to guard its interests, that the community, the State, must own and manage these woods.

This does not mean that the same should be kept in virgin condition and unused, that the timber should be left to rot, and the productive capacity of nature's forces be allowed to go to waste, but that a conservative management be instituted, keeping in view both the indirect and the direct benefits of the forest cover, utilising the crop without detriment to the forest conditions.

This, to be sure, is not done by such rules of thumb as a restriction to cutting trees of given diameter, nor can the legislator prescribe to the forest how to grow. He cannot be expected to legislate how many trees to cut, how many to leave, or to lay down rules of technical forest management, any more than he would attempt to prescribe the size of the pillars supporting the roof of the Capitol, or to legislate on the proportions of an arch. It requires the knowledge, the experience, the skill of a professional, technically educated engineer, just as an effective management of the forest requires the knowledge, the experience, the skill of professional foresters, and may not be left to the ignorance and carelessness of the wood-chopper.

May the wisdom of the people of New York, of their legislators and executive officers, be equal to the difficulties of solving the problem as a business proposition, and settling it in a common-sense, business-like manner. May their intelligence and business capacity at least equal that of other States and nations, and forestall the disastrous consequences that follow unavoidably from neutrality or improper partisanship in this battle of the forest.

THE RELATION OF ENERGY OF COMBINATION TO ELECTRICAL ENERGY.

THE problem of directly converting the stored-up energy of coal into available electrical energy is one of great importance; and as a first attempt to perform this operation, the experiments made by Dr. W. Borchers, of Duisburg, and which he described before the first annual meeting of the Deutsche Elektrochemische Gesellschaft, possess great interest. The author in the first place produced an electric current by the "combustion" of carbonic oxide gas. The original form of the apparatus used consisted of a glass vessel divided into three compartments by two glass plates which nearly reached to the bottom of the vessel. In the two exterior compartments copper tubes were placed, which served for the introduction of the carbonic oxide, while the middle compartment contained a bell-shaped mass of carbon. This carbon bell constituted one plate of the cell, and the oxygen was introduced by means of a tube within this bell. As electrolyte the author uses an ammoniacal or acid solution of cuprous chloride; this liquid readily absorbs both oxygen and carbonic oxide, and is therefore particularly well suited to form the electrolyte in a gas battery in which these gases are used. Coal gas which contains 5 per cent. of carbonic oxide was, after the first experiments, used in place of pure carbonic oxide. The copper tubes were weighed before and after each experiment, and no decrease in their weight was ever found. With such a cell working through an external resistance of 0·1 ohm a current of 0·5 ampere was obtained, while with an external resistance of 50 ohms the difference of potential between the terminals was 0·4 volt.

With a cell in which the outer compartments were filled with copper turnings, in order to increase the absorption of carbonic oxide by exposing a greater surface, and by using coal gas in place of pure carbonic oxide, a maximum current of 0·64 ampere was obtained, and by increasing the external resistance a maximum difference of potential of 0·56 volt was maintained. The E.M.F. obtained by calculation from the heat developed in the combination of CO and O is 1·47 volts, so that in the above experiment 27 per cent. of the energy of combination of the fuel is converted into electrical energy. Since a solution of cuprous chloride dissolves hydrocarbons, powdered coal was tried in place of carbonic oxide, when a maximum current of 0·4 ampere and a maximum E.M.F. of 0·3 volt were obtained. The above E.M.F. (0·3) corresponds to about 15 per cent. of the energy corresponding to the oxidation of carbon. In the case of the coal-dust, even when the liquid was kept in motion, there was always a considerable falling off in the current, while the pollution of the electrolyte by the coal would quite prevent its use. With the gases, however, there is no falling off of the E.M.F., and this pollution of the electrolyte does not occur.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. R. D. Roberts has been appointed chief secretary for the University Extension scheme, in the room of Mr. A. Berry, who retires at the beginning of the Lent Term 1895.

The General Board of Studies report in favour of steps being taken to establish a closer connection between Addenbrooke's Hospital and the University teachers in the departments of medicine, surgery, and therapeutics.

The Syndics for State Medicine report that in the past year fifty-six candidates presented themselves for examination in this