SCIENCE

NEW YORK, APRIL 17, 1891.

EUROPE DURING AND AFTER THE ICE AGE.

TEN lectures under this title have been given by Professor James Geikie of the University of Edinburgh, beginning March 13 and ending April 10, as one of the courses of the Lowell Institute, Boston.

Beginning with descriptions of the physiography of Europe and of the present glaciers of the Alps, Professor Geikie afterward described successively the glacial deposits of the Alps and adjacent lower lands, of the British Isles, and of the Scandinavian Peninsula, northern Germany, Finland, and north-western and northern Russia. The accompanying map of Europe at the climax of the glacial period delineated the maximum area of the European ice-sheet nearly as it is mapped in this author's "Prehistoric Europe," but represented it as extending farther north-east, so as to cover the northern part of the Ural Mountains. A very perfect demonstration of the origin of the till or bowlder-clay by the agency of land-ice is supplied by this order of presentation, first considering the development of the till, moraines, and glacial striæ, in the valleys and lowlands bordering the Alps, where glaciers still exist, being evidently the shrunken representatives of their formerly much greater extent during the glacial period or ice age. No theorist has ever claimed a marine origin for these glacial deposits. Thence Professor Geikie proceeds to the similar Scottish till, which in all its characteristics and in its distribution, scanty in the valleys of the mountains and highland districts, but spread thickly on the lowlands, is manifestly the exact analogue of the Swiss ground-moraine. Both, therefore, are attributable to land-ice. And the same argument includes likewise the similar but far more extensive deposits of till and fluvio-glacial detritus which thickly cover the low tracts of Sweden, Denmark, northern Germany, and a large part of Russia. During the final melting of the ice-sheets, much of the finest detritus which had been incorporated with their lower portion was borne far away by rivers, and deposited as loess in the valleys and on flat lands, or in some places in broad shallow lakes.

One interglacial epoch, and perhaps more than one, interrupted the severe cold of the ice age in Europe. For a long time, between two epochs of glaciation and accumulation of till, a mild interglacial climate permitted southern animals and plants to extend into Great Britain and northern Germany; and during this time the ice-sheets were doubtless wholly melted away, or were as much restricted as now, remnants of them lingering only in the Alps and on the mountainous plateau of Scandinavia.

After this mild and even warm interval, which was of long duration, the glaciers of the Alps again spread out to the lowlands, but not so far as before; and ice-sheets were again accumulated upon the British Isles, Scandinavia, Finland, and northern Germany; but they too were less extensive than in the earlier glacial epoch. The British ice-sheet during that earlier epoch had extended south to the Thames; but the ice of the later epoch, according to Professor Geikie, though again wholly enveloping Scotland, reached into England only to Lincolnshire. The earlier British ice-sheet certainly, and the later one probably, were confluent with the ice which deployed from Scandinavia southward in a broad *mer de glace* over the area of the North Sea, bringing Norwegian bowlders to the shores of England. All of Scandinavia, excepting a small tract of southern Sweden, appears to have been covered by the ice-sheet of the latest glacial epoch, which also, as mapped by Professor Geikie, reached east over Lapland to the White Sea, and over Finland nearly to Lakes Onega and Ladoga, but did not cover the Gulfs of Finland and Riga. Toward the south and west, however, the "great Baltic glacier," a lobe of this latest ice-sheet of north-western Europe, filled the basin of the Baltic Sea and overflowed the low northern margin of Germany to Berlin, and the eastern half of Denmark. The extreme limits of the earliest European ice-sheet are not generally marked by terminal morainic accumulations, but rather by extensive stratified deposits of gravel and sand. On the other hand, the later glaciation is bounded in many places by prominent hilly and knolly terminal moraines, with abundant erratic blocks.

Since the ice age, there is evidence, in the fossil faunas and floras of marine deposits and peat bogs, that north-western Europe has experienced for some time a climate considerably warmer than that of the present day; and the speaker compared this with the formerly warmer waters of the Atlantic on the shores of New England and the eastern provinces of Canada, which allowed various species of southern mollusks in the post-glacial or recent epoch to extend northward to the Gulf of St. Lawrence, though now they have become mainly extinct north of Cape Cod, excepting a few colonies that survive in favorable localities. These climatic changes following the glacial period unite the whole quaternary era as characterized from its beginning to the present day by numerous alternations from severity to mildness of climate, and the reverse.

Inquiring what were the causes of the ice age, Professor Geikie pointed out its complex character, with two or more epochs of severe climate and ice accumulation, divided by recession of the ice and long-continued mild conditions; and he especially called attention to the Alpine glaciation and the ice-sheets of north-western Europe as simply the increased and greatly extended development of the glaciers that still are found in Switzerland and Scandinavia. A lowering of the mean temperature of Europe by twelve degrees might gradually restore the ice-sheets. The short estimates of the time (7,000 to 10,000 years) that has passed since the latest glaciation of the northern United States, given by N. H. Winchell, Andrews, Gilbert, and Wright, from their consideration of the recession of waterfalls and erosion of river-gorges, as stated in Wright's "Ice Age in North America," are pronounced by Professor Geikie unreliable; and he maintains the astronomic theory of his friend and colleague, the late Dr. James Croll, which accounts for glacial epochs by eccentricity of the earth's orbit, placing the close of the latest glaciation about 80,000 years ago. But Professor Geikie shows that man, using paleolithic or rough stone implements, was living in France and southern England during this last glacial epoch. When the latest ice departed, permitting men to extend north over Scotland and north-western Europe, they had already reached their neolithic stage, using smoothly ground and polished stone implements.

The alternative theory of the cause of the accumulation of ice-sheets, which is held by Dana, Upham, and LeConte, ascribing the cold climate to elevation of the glaciated areas as high plateaus, so that they would receive snowfall during the greater part of the year, seems to Professor Geikie very improbable, and a large portion of his last lecture was devoted to its refutation. This explanation, however, would accord with the estimates of the length of post-glacial time before noticed, and would seem more consistent with the probable antiquity of man, and with his known rate of development of skill in the manufacture of implements and in all the useful arts.

TREATMENT OF FUNGOUS DISEASES.[1]

THAT many of the most destructive diseases of cultivated plants can be and are every year almost completely controlled, is a fact perfectly well known to those who are familiar with the subject; but it has as yet come to be realized by very few, relatively, of those to whom it is of the greatest importance,—farmers, gardeners, fruit-growers, florists, amateurs, and others.

The practicability and great money value of proper treatment in the case of various plant-diseases, which, in the absence of such treatment, would reduce the yield of important crops to almost nothing, have already become apparent to some cultivators who have been progressive enough to try for themselves, or who live near the experimental fields or orchards of experiment stations, or of progressive neighbors. The vast majority, however, of those who should be most interested have been heretofore too indifferent or too sceptical even to investigate the basis of the very strong and positive statements which have been made concerning the efficacy of preventive treatment for fungous diseases of plants.

From the nature of parasitic fungi, and the fact that they are for the most part parasites within the tissues of their hosts, it is evident that our efforts must be directed toward preventing their attacks. The present state of our knowledge does not enable us to stop the development of a parasite within its host-plant, without injury to the host, after it has once obtained a foothold.

The various forms of preventive treatment for a given disease fall naturally under two heads,—field and orchard hygiene, and individual protection. The former includes the minimizing of all sources of infection by the removal of rubbish, of remains of diseased plants or fruits, or of wild plants which may serve as propagators of the disease. The latter includes the application to the plants to be protected of substances in liquid or solid form which shall fortify them against the attacks of fungi which cause disease. Such substances are known as "fungicides." Since different fungi attack their hosts in very different ways, since their modes of development and the effects which they produce differ widely, it is plain that no all-embracing rule can be laid down for the treatment of fungous diseases. Certain principles of general applicability can, however, be stated, certain general directions can be given, and instructions regarding the preparation and application of those fungicides which have been proved to be most useful and effective can be furnished.

There are definite laws of health for plants as well as for animals; and in one case, as in the other, neglect of those laws invites disease. In the first place, plants which are expected to grow and thrive must be furnished with an abundance of the materials necessary to growth. Weak, poorly nourished plants suffer the attacks of parasites of all sorts, and have no power to resist them. Second, where a crop has suffered from a fungous disease in one season, and a good crop of the same kind is desired in the following season, every tangible trace of the disease must be removed. For example: if a vineyard has suffered from mildew or black rot, all diseased leaves and berries should be collected at the end of the season with scrupulous care, and wholly burned; and the same advice applies to a large list of cases. Thus incalculable numbers of the spores of the fungi of the respective diseases will be prevented from infesting the next season's crop. In some cases where the spores remain in the soil, as in the stump-foot of cabbages or the smut of onions, the attacks of the disease can only be avoided by rotation with crops upon which the fungus in question cannot live. Third, wild plants, which, being nearly related to a given cultivated one, may be subject to the same disease, or which bear a complementary spore-form of a pleomorphic fungus, should be carefully excluded from the neighborhood of cultivated ones. Thus, wild cherries or plums, which are equally subject to the black-knot, should be kept away from plum-orchards, and spinach-fields should be kept free of pig-weed, since both plants are attacked by the same mildew; and again, since red cedars bear one spore form of a fungus whose other form is the rust of apple-leaves, it is plain that they should not be allowed to grow near an apple-orchard.

Now, when the general hygienic conditions have been made as unfavorable as possible to the development of disease, we may resort finally to the special protection afforded by the use of fungicides.

These preparations, when properly prepared and when applied at the right times and in the right way, have been abundantly proved to be of the greatest value, and often to determine the difference between a full crop from plants on which they are used and practically no crop where they are not applied.

But the fact cannot be too strongly emphasized that every thing depends upon how they are prepared, and upon how and when they are applied. The bulletin gives somewhat full instruction how to prepare and apply the most valuable fungicides, and such general hints when to apply them as will be of service. The proper times for their application vary so much with special conditions, however, that instructions on this point must form an important part of the special directions for any particular case.

The protective quality of most of the best fungicides lies in the fact that they contain a certain proportion of copper; and, of the four recommended as applicable to most cases of fungous diseases, three contain it as the essential constituent.

The Bordeaux mixture requires six pounds of sulphate of copper, four pounds of quicklime (fresh), and twenty-two gallons of water.

The sulphate of copper, known to the trade also as blue vitriol or blue-stone, is dissolved in two gallons of water. The solution will be hastened if the water be heated and the sulphate pulverized. After the solution is complete, fourteen gallons of water are added to it. The quicklime is slaked in six gallons of water, and stirred thoroughly until it forms a smooth, even mixture. After standing for a short time, it is again stirred, and added gradually to the sulphate solution, which is thoroughly stirred meanwhile. The mixture is then ready for use, though some experimenters recommend further dilution to twenty-five or thirty gallons for certain uses. It should not be prepared until needed, and should be used fresh, as it deteriorates with keeping. Since the lime remains merely in suspension, and is not dissolved, the mixture should be strained through fine gauze before entering the tank of the spraying-machine, so that all of the larger particles which might clog the sprayer may be removed.

Ammoniacal carbonate of copper, in its improved form, is prepared from three ounces of carbonate of copper, one pound of carbonate of ammonia, and fifty gallons of water.

Mix the carbonate of copper with the carbonate of ammonia, pulverized, and dissolve the mixture in two quarts of hot water. When they are wholly dissolved, add the solution to enough water to make the whole quantity fifty gallons. This preparation has been found to be better and cheaper than that made according to the original formula, which is as follows:—

Dissolve three ounces carbonate of copper in one quart *aqua*

[1] Abstract of Bulletin No. 39 of the Massachusetts State Agricultural Experiment Station, for April, 1891, by James Ellis Humphrey.