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## THE GREEN MOUNTAINS' ANTICLINAL.

BY C. H. HITCHCOCK, HANOVER, N.H.

THE key which is to unlock the intricacies of New England geology is to be found in the discovery of the proper structure of the Green and Hoosac Mountains. Hence in the occupation of this field for careful investigation the United States Geological Survey has acted wisely; and one cannot restrain impatience with the officials of the printing office, who have had the completed manuscripts descriptive of these results in their hands for more than two years, and have not published them.

The pioneers of American geology referred this Green Mountain range to the "Primary" series, chiefly because, in their view, all foliated crystalline rocks belonged there. Of course any sections illustrative of their notions from the theoretical standpoint would exhibit the anticlinal structure. But their actual illustrations, compiled from observation, do not support their theory; as shown by C. T. Jackson's section across the White and Green Mountains, and E. Hitchcock's sections across the Hoosac Mountain. Hence it was that the geological literature of thirty and forty years' standing is pervaded with extreme applications of metamorphism. C. B. Adams, in the second report upon the geology of Vermont, in 1846 (p. 168), raised the query whether the occurrence of the quartz rock, limestone, and talcose schists upon the east side of the Green Mountains, in Plymouth and elsewhere, did not include the repetition of the Taconic rocks over an azoic foundation. He offered this suggestion as something worthy of investigation. His successors in the study of Vermont geology attempted to discover the structure of the mountains, as well as of all parts of the State, by measuring thirteen sections across the territory from east to west. A summary of the results was given by E. Hitchcock in the final report, page 252; from which it would appear that the structure of the Green Mountains was anticlinal. His contemporary, Logan, insisted that this structure was synclinal. The later studies of the writer, in several publications, confirm the first view, which is also held by Selwyn, the successor of Logan as director of the Canadian Geological Survey.

Having had occasion recently to examine the rocks of Hoosac Mountain and the neighborhood, the writer desires to offer the following observations. The excavation of the Hoosac tunnel has afforded us the opportunity of observing the structure of the interior of this mountain compared with what may be seen at the surface; and it was stated in Macfarlane's Railway Guide, 1879, that Hoosac "Mountain is believed to be an inverted and very much crushed anticlinal." Professor R. Pumpelly, in his paper upon secular rock-disintegration in the Bulletin of the Geological Society of America, vol. II., presents a map covering a part of this mountain, which shows the distribution, first, of a central core of granitoid gneiss; second, a coarsely foliated, often white, gneiss, supposed to be the dynamic product of a Cambrian conglomerate; third, the Hoosac schists, which wrap around and over

the gneisses; and, fourth, the quartzite, which is the basal member of the Cambrian, known familiarly as the "granular quartz" of Emmons. The anticlinal fold is therefore easily recognized. The granitoid gneiss in the centre crops out upon the mountain a mile or so south of the tunnel, and the arch dips ten degrees northerly, and the rock is exposed where cut by the excavation. It is made up of blue quartz, large microcline crystals, somewhat elongated and assuming the augen habit, together with the greenish mica, chlorite, and epidote of the foliation. It is said to be the equivalent of the gneiss of Clarksburg Mountain. The Vermont geology described this rock as the Stamford granite (gneiss), and speaks of it at several places farther north also. Our New Hampshire studies enable us to correlate this central granitoid augen gneiss with the "porphyritic granite, or gneiss," said to lie at the foundation of the stratigraphical column. In New Hampshire the mica is commonly biotite, while the greenish micas at the tunnel are more suggestive of the later protogene, called "Bethlehem gneiss." As the chloritic mineral is the result of alteration, its presence is not definitive. But the augen gneiss seems to constitute the foundation upon which the later gneisses were disposed in both localities.

There must be a decided unconformity between the augen and the overlying white conglomerate gneiss. This is shown not so much by a decided divergence in the angle of dip as by the general principle that a conglomerate is necessarily unconformable to the original rock from which the fragments have been derived. Some would say the augen gneiss was of igneous origin; and, if so, the discordance would be equally marked.

This Hoosac gneiss, or its equivalent, must be manifested in the Shelburne Falls anticlinal area, the Halifax-Reading ranges, and others farther east and north. Each range has the anticlinal attitude, while the intervening basins are of newer rocks. Next to the Green Mountains structure, the succession of gneissic waves capped by hornblende schist have aided us in working out the stratigraphy of the New England crystallines.

The proper place for the Hoosac schists may be an open question. E. Hitchcock, in his map of 1844, made the Graylock, Hoosac (west side), and the Charlemont schistose areas equivalents; and perhaps this is the most natural view. We must, however, remember that these hydro-micaceous and chloritic schists are not confined to a single horizon. There are, first, those of the Green Mountain gneiss, described as pre-Cambrian; second, those of the granular quartz, or Lower Cambrian; third, those of the Berkshire and Graylock terranes, as pointed out by Dale, and corresponding to the magnesian slate of Emmons. Hence there may be reason for the reference of the Hoosac schists to any of four different horizons that best explain the dips.

The Stockbridge limestone is evidently repeated on the east side of the anticlinal at Plymouth, Vt. Whether it once extended along the whole range and has been eroded, or is represented by an equivalent terrane, or is wanting, remains to be discovered.

## BOTANY AT THE EXPERIMENT STATIONS.

BY GEORGE F. ATKINSON, BOTANICAL DEPARTMENT, CORNELL UNIVERSITY.

A REMARKABLE stimulus to botanical investigation has been given in the last few years through the opportunities offered by the organization of botanical departments at the various State experiment stations. The acquisition by the States of the congressional fund has afforded means, hitherto possessed only by a few favored institutions, for the purchase of the expensive apparatus and libraries of technical works needed in modern biological research. It also provides for the employment of men who devote part or the whole of their time to original study and the practical application of the results. The fund was designed not only for the purpose of treating economic botany in a practical way, but also for the purpose of pure science study, which in many cases must precede any practical treatment.

Studies of forage plants, of the improvement of sorts by the selection of seed, cross-fertilization, the distribution and harmfulness of weeds, the relations of micro-organisms to the fertility of soils, besides many subjects appertaining more or less to horti-

cultural science, are some of the subjects which engage the earnest efforts of the station botanist.

Perhaps one of the most unique features of the botanist's work at the experiment stations is the study and treatment of plant diseases caused by fungi and bacteria. Nearly all the stations where a botanist is employed give considerable attention to experimentation in various ways for preventing or remedying plant maladies. This is certainly called for, at least the experiment stations should in some way carry on such experimentation, for the prevention of plant diseases is the desired good for which any appropriation for this study is given. There is also a popular demand for results which mean dollars and cents saved for the farm and garden. In some cases, perhaps, this necessitates a sacrifice of the careful study into the cause of the disease. It is gratifying, however, to note that at a number of the stations the importance of original investigation into the cause of plant diseases is recognized. Already important results have been reached. Important in clearing the way for successful treatment, but also important contributions are being annually made to the biology of little-known and obscure forms of plant life. In such a large number of recently organized stations, much chaff will be published, but time will winnow that from the kernel.

In looking over the work of the station botanists, it is interesting to observe the number who are engaged in making use of artificial cultures in studying the life histories of parasitic fungi. The different habits and appearances of the real enemy are brought to light, its plans of attack are studied; proof of its harmfulness can be established by inoculation, and known causes thus supplant supposed ones. No other feature of botanical work at the experiment stations, in my judgment, is doing so much to lay the permanent foundations for a rational economy in the treatment of plant diseases. The best work of this kind can only be successfully carried out with the aid of expensive modern apparatus appertaining to bacteriological laboratories. This provides the trained workman with the tools for proceeding rationally and accurately to the desired end. The stations which at present are provided, more or less completely, with such cultural apparatus are the following:

Alabama, Connecticut (New Haven), Delaware, Illinois, Indiana, Iowa, Kansas, Kentucky, Massachusetts (Amherst), New Jersey, Cornell University Station, N.Y., New York Station (Geneva), North Carolina, North Dakota.

Several workers in other stations feel the need of cultural apparatus in their work. It is to be hoped that another year will find this want provided for.

During the past year the force of botanical workers has been increased by the organization of departments at the following stations: Arizona, Florida, New Mexico, South Dakota, and Texas, the officer at the latter place being horticulturist in charge of botany.

Several changes have been made in the working force. At the Alabama station Atkinson retired Oct. 1, 1892. At the Kansas station Hitchcock was appointed to succeed Kellerman. In Massachusetts, Humphrey retires January 1, 1893. In Michigan the station work has been reorganized and C. F. Wheeler appointed botanist. Craig has been made botanist in Oregon. In New York, at the Cornell University Experiment Station, Dudley retires to accept a position in Leland Stanford, Jr., University, and Atkinson of Alabama has been appointed cryptogamic botanist.

In looking over the report of the chairman of the Section of Botany of the American Association of Agricultural Colleges and Experiment Stations, which met at New Orleans Nov. 16, we note the work of the botanists at the different stations as follows:—

Alabama. Mell (botanist and meteorologist in charge of phanerogamic botany) is engaged upon a study of the economic grasses and weeds of the State, and in crossing varieties of cotton.

Atkinson (biologist in charge of plant pathology) has continued his studies of cotton diseases, has discovered a new "damping-off" fungus, obtained pure cultures of Pammel's *Ozonium* of root-rot of cotton in Texas, is studying the biology of the organisms which cause leguminous tubercles, and the teratological growths caused by *Taphrina*, *Ræstelia*, and root fungi.<sup>1</sup>

<sup>1</sup> For continuation see Cornell University Experiment Station, N.Y.

Arizona. Tuomey (botanist) is making observations on the adaptability of the native grasses, trees, and shrubs for cultivation.

California. Green (botanist) is at work upon the vast native flora of the State.

Connecticut (New Haven). Sturgis (mycologist) is studying the diseases of tobacco, and making experiments in curing tobacco and spraying fruits and garden crops. He is beginning a critical study of the *Cribbriaceae*.

Delaware. Chester (mycologist) is engaged upon studies of *Monilia fructigena*, diseases of watermelons, muskmelons, cucumbers, and the winter killing of blackberries. He has reached promising results in the treatment of peach-rot.

Florida. Rolfs (botanist and entomologist) has recently entered upon his duties, studying plant diseases.

Illinois. Burrill (botanist and horticulturist) is studying bacterial diseases of plants; raspberry rust, *Manilia* of plum, and economic smuts.

Indiana. Arthur (botanist) is investigating the normal growth of the potato, the relation of the number of eyes on a tuber or part of a tuber to the number of stalks produced and to the yield. Is also studying the enzyme in seeds of wheat and oats, the relation of green seed to early maturity, wheat-smuts, and has devised a method of preventing rust and bacterial disease of carnations.

Iowa. Pammel (botanist) is studying life history of *Peziza sclerotiorum*, *Rhizoctonia betæ*, and *Cercospora beticola*. Has experimented on effect of fungicides upon roots and germination of seeds, crossing of cucurbits, treatment of plant diseases, and is at work on the chromogenic bacteria of the Ames flora and anatomy of cucurbits.

Kansas. Hitchcock (botanist) is experimenting with fungicides on seeds, and studying the biology of weeds and economic *Uredineæ*.

Kentucky. Garman (entomologist and botanist) is engaged upon comparative study of forage plants.

Maine. Harvey (botanist and entomologist) is making collections of economic plants.

Massachusetts. Humphrey (vegetable physiologist) has been studying black-knot of plum, a violet disease, a new disease of cucumbers, and is publishing a monograph of N. A. *Saprolegniaceæ*.

Mississippi. Tracy (director and botanist) is making a botanical survey of the State, and working on the *Gramineæ*, southern tomato blight, and a new disease of the grape.

Nebraska. Bessey (botanist) is making an exhaustive study of the native trees and shrubs, and native and cultivated grasses. Is at work on diseases of the sugar-beet.

New Jersey. Halsted (botanist and horticulturist) is working on diseases of cranbury, rose, violet, hazel, and fungi of weeds, and experimenting for treatment of celery and sweet potato diseases.

Cornell University Station, N.Y. Atkinson (cryptogamic botanist) is engaged upon a study of winter blight of tomatoes, a new tomato disease, a *Botrytis* disease of beans, carnation diseases, a new anthracnose of *Ligustrum*, and "damping off" fungi.<sup>2</sup>

New York (Geneva). Beach (horticulturist) is studying the effect of copper compounds in soil on vegetation, has obtained good results from Bordeaux mixture and selection of seed for anthracnose of beans, and from Bordeaux mixture for *Septoria* on chrysanthemums. Has treated also apple and potato scab, raspberry anthracnose, gooseberry mildew, strawberry-leaf blight, and celery diseases.

New Mexico. Wooton (botanist) is collecting plants for an herbarium.

North Carolina. McCarthy (botanist) is engaged in seed-testing, treatment of grape and tomato diseases, and studying bacteria of nitrification.

North Dakota. Bolley (botanist) has found corrosive sublimate effective in preventing potato scab; is studying the fungus of deep scab of potatoes, making attempts at artificial cultures of the *Uredineæ*, and working on the distribution of root tubercles of the *Leguminosææ*.

Ohio. Miss Detmers (botanist) is collecting the *Uredineæ* of the State.

<sup>2</sup> See also Alabama.

Oregon. Craig (botanist) is working on weeds, forage plants, and plant diseases.

Pennsylvania. Buckhout (botanist) is engaged in forestry and hybridization, and working on the practical side of potato-rot and downy mildew of the grape.

Rhode Island. Kinney (horticulturist and acting botanist) has reached important results in the treatment of seed-potatoes with Bordeaux mixture to prevent potato-scab; is also treating seeds.

South Dakota. Williams (botanist) is making observations on forage plants suited to varying conditions in different parts of the State, and studying plum-pockets and a geranium disease.

Tennessee. Scribner (director and botanist) has published a list of the grasses of the State in the form of a popular edition, to be followed by a more technical one.

Texas. Price (horticulturist) is treating cotton and grape diseases.

Utah. The entomologist is acting-botanist.

Virginia. Smythe has charge of phanerogamic botany. Alwood (horticulturist) is studying apple-leaf diseases and experimenting on weak solutions of copper salts for plant diseases.

Vermont. Jones (botanist) has made a test of the comparative value of a number of the standard fungicides on potato-rot (*Phytophthora infestans*).

Wisconsin. Goff (horticulturist) is working on apple-scab and experimenting on the germination of seeds.

Mention should also be made of the work of the Division of Vegetable Pathology, Department of Agriculture, Washington, with its corps of half a dozen workers carrying on important and fruitful investigations, the larger subjects of investigation at present being a mysterious vine disease in California, orange diseases in Florida, and fruit diseases in New York.

A large number of the experiment station botanists do more or less teaching, since most of the stations are connected with, or located near, the State agricultural colleges. This large field of work for specialists offers one of the best openings for young men desirous of becoming either investigators or teachers. New fields are opening each year and changes are being made, so that for some time there will be a demand for young men not only well trained in general botanical science, but those who also have improved the opportunities presented for familiarizing themselves with methods of artificial cultures of micro-organisms and fungi. The call for original investigation at the experiment stations implies with it better equipment than would possibly be supplied under other circumstances at many of the State colleges. This affords, then, the ambitious teacher good facilities for being at the same time an investigator, while it also offers the investigator good opportunities for experience in teaching.

This dual responsibility becomes burdensome if too much of either is required without ample assistance; but, in many cases, teaching duties are lessened in order to give time for the investigation. When the burden is not too great, an ambitious young man with strength and enthusiasm is likely soon to be promoted to greater positions of trust carrying a less number of the more irksome duties.

## THE RETICULATED STRUCTURE OF HUMAN RED BLOOD-CORPUSCLES.

BY DR. ALFRED C. STOKES, TRENTON, N. J.

WHATEVER the histologist may believe in regard to the reticulated structure of the human red blood-corpuscles, whether he accepts it as normal structure or not, he cannot fail to be impressed by the beauty of the minute plexus of fibrils, or to be gratified by the ease with which the net-work structure will explain certain physiological problems. But since Dr. Louis Elsberg, in 1879, first announced his discovery of this structure in the human red corpuscles, the subject seems not to have attracted, among histologists, the attention it deserves. It has been ridiculed by some, just why I have never understood, as the announcement was certainly of sufficient interest to merit further investigation in all seriousness, and while some prominent histologists were disposed to accept Elsberg's observations as

demonstrable, his conclusions were pretty generally waved aside with scant courtesy. Klein, of England, seems to be one of the believers in the existence of the reticulation within the red blood-corpuscles as normal structure, while Ranvier, the learned French histologist and professor in the College of France, dismisses the subject in a single sentence in his treatise on human histology, saying that the reticulum is an illusion produced by wrinkles on the surface of the corpuscle, and letting it go at that. Ranvier's dictum should properly dispose less well-informed students to be cautious in their statements, and especially in their belief in what their own eye sight seems to show them. Yet after the corpuscles have been exposed to the action of a five per cent solution of potassium bichromate, the reticulated appearance is so distinct, it is so constantly present, and the most authoritative investigators are so sure that the bichromate of potassium in solution can have no deleterious effect on the most delicate protoplasmic structure, that in the mind of every microscopist that sees the reticulations in the red corpuscles from his own blood, there must be an unconquerable doubt as to the correctness of Ranvier's opinion and assertion. The net-work, or the corrugated surface, is so exceedingly minute, even when studied with the best high-power objectives, that mere superficial examination can scarcely hope to decide whether the appearances are due to wrinkles on the surface, or to a reticulation below it, although the aspect is certainly much less like a wrinkling than like a reticulum. The net-like collection of fibrils is too regularly and too evenly developed to impress the observer with the belief that it is a collection of wrinkles only or even chiefly.

The action of water on the red corpuscles in such that they soon become inflated and finally invisible. They are not dissolved but are rendered invisible, as a drop of any aniline stain run under the thin glass covering these invisible bodies will demonstrate, by again bringing them into view. The five per cent solution of potassium bichromate also distends the corpuscles, not to the same extent, it is true, as does water alone, yet the distention is conspicuous. It is natural, therefore, to suppose that, although the reticulations and the bodies bearing them are not even microscopically large, yet if the appearances are due to a net-work of surface wrinkles produced by the potassium salt, the absorption of the water carrying the salt, and the consequent distention of the corpuscle, should have a tendency to lessen the number of the wrinkles and likewise to lessen their prominence, but this is not the result.

To investigate the subject for my own personal gratification, I submitted red blood-corpuscles to the action of a five per cent solution of potassium bichromate for an hour, then transferred them to a cell of some depth in which was an exceedingly weak solution of the same salt, hoping that the action of the water would still further distend the corpuscles and, at least to a certain extent, obliterate the surface markings, if they were such. In numerous corpuscles the result was that hoped for, so far as distention was concerned, the bodies in many cases becoming almost globular. A touch of a fine needle-point on the cover-glass rolled over and over beneath the objective, yet, distended as they were, the reticulation was in no way undefined nor uncertain. It surely was not less conspicuous; it actually seemed more prominent, an effect readily explainable by the elongation in all directions of the internal fibrils, if they existed, and the consequent enlarging of the inter-fibrillar spaces.

By pressure on the cover-glass it is not difficult to crush such distended corpuscles, and, although the result is always an indescribable deformity, the reticulation is still to be seen plainly in some specimens, and to show some traces of its existence in all.

Under such circumstances, too, it is not impossible to cut a corpuscle in two by drawing a fine needle across the thin cover-glass. In my experiment the needle cut only a single one of the sub-spherical globules, it is true, but that separation was accidentally accomplished so completely, and the two parts were studied so long and carefully, that there remains no doubt in my mind as to the correctness of the observation or of the interpretation. A single globule had been cut, not entirely into two parts, but so nearly in two that the currents in the medium had lifted