Oregon. Craig (botanist) is working an 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 p ular 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

one portion and thrown it aside, at the same time twisting the little ligature still connecting the parts, the effect being such that the two might be compared to two watch-glasses adherent at one side by the edges, but with the concavity of one directed away from the convexity of the other, the two concavities therefore looking in opposite directions. If there ever was a chance to look into the interior of a distended and sectioned red blood-corpuscle this was it, although the whole was the result of a fortunate accident and of nothing else. It was good luck with no good management, for I could never repeat the experiment with even a similar success. But with an achromatic condenser, N. A. 1.0, and with Reichert's semi-apochromatic, oil-immersion one-twelfth inch objective, N. A. 1.40, each of those two parts of the same red corpuscle was seen to be filled with a distinct and conspicuous reticulum, as a saucer or a watch-glass might be filled with a flat-topped sponge.

The result of this effort at rough-and-ready cutting of the red corpuscles was so pleasing, that the thought of a deliberate sectioning with a microtome was fascinating, and the hope of a still more perfect exhibition of the reticulum within the sections was too great to be long postponed. It is, of course, impossible for the most expert microtomist to select a red corpuscle, put it into position on its narrow edge after having submitted it to the action of the bichromate of potassium solution, to embed it, and then to slice it up in the microtome. A section parallel with the broad surfaces of the corpuscle would not answer the purpose, and indeed, if such a section could be made, the microscope and the microscopist himself might remain blind to the result. It would hardly be possible to know that such a section had been produced, since the microscopical appearances of the entire, uncut corpuscle must be similar to any section possibly made in the direction mentioned. The cutting must therefore be done in a direction transverse to the broad surface of the corpuscle, that is, at right angles to that aspect. Even to cut once across an object only $\frac{1}{3200}$ inch in diameter would be impossible with but a single specimen to work on. The method that occurred to me is one that would naturally occur to any one, and when I suggested it to my correspondents, Mr. Ludwig Reiderer of New York City and Dr. Edward Gray of Santa Cruz, California, they kindly promised to make the experiment and to send me the resultant slides, as they did. The method was simply to submit a large amount of blood to the action of a five per cent solution of potassium bichromate, and to embed a large quantity of the corpuscles without any other preparation, the belief being that some of the numerous corpuscles would place themselves in a position to be sectioned transversely. The tendency of these special objects is to arrange themselves so that the broad surfaces shall be horizontal. If, then, the embedding medium containing them should be turned over, so that the knife should pass through it at right angles to its plane upper surface, the chances were that some of the corpuscles would be sectioned as desired, and at least once across. More than one section of a single corpuscle was not even dreamed of. The results justified the expectation. While not many corpuscles were sectioned, I still found fourteen on one slide, some being admirably cut. These were enough to give an opportunity to look into the interior, and to show that my rough-and-ready method of cutting with a needle-point on the cover-glass, although only an accident, gave as correct a picture of the structure as the more elaborate methods of my correspondents, which, of a truth, were almost equally only an accidental success.

A section of a red corpuscle set up on its narrow uncut edge and looked at from above, that is, with the cut surface upward, is not always panduriform in outline after treatment with the bichromate solution. Whilst some are perfectly pandurate, the majority are variously changed in form by the potassium salt, the outlines being semi-circular, plano-convex, concavo-convex, or "crossed," that is, double convex with the convexities of different curvatures. The specimens panduriform in outline were few in number in these experiments, but they did exist, and were studied with rather more satisfaction than were the other forms, which, although not having the normal outlines, were not altered in structure, if the histologists are correct when they assure us that the bichromate of potassium has no deleterious action on protoplasm.

These as well as all the sections were carefully and repeatedly examined with light passed through blue glass, and with the achromatic condenser and the oil-immersion objective already mentioned. The result justified the conclusion reached by means of the happy accident that I have referred to so repeatedly. The apparent reticulation is a true reticulation and in no way a surface wrinkling. The net-work is made up of minute fibrils that produce an internal reticulum that, at least after the action of the bichromate salt, fill the entire internal part of the human red corpuscle. Upon the thickened, firmer surface that simulates an external membranous cell-wall, even after taking into consideration unavoidable diffraction effects, there is no evidence of a wrinkling. On the surface of certain of the corpuscles that were accidentally set upright, that is, vertically on their narrow edge, but escaped the knife, there were absolutely no signs of any roughness or of any wrinkling. The surface outlines were as smooth and as even as they could possibly be. I am convinced that the reticulation, under the effect of the bichromate of potassium solution, exists, not on the surface but within the body of the human red blood-corpuscle; and if the potassium salt has no deleterious effect on protoplasm, then the reticulation is a normal structure, and the net-work of protoplasmic fibrils is a natural and constant constituent of the red blood-corpuscles. Yet the doubt is great and prominent. How that doubt is to be dispelled I must leave to microscopists that are more expert histologists than am I.

In all the corpuscles lying horizontally on the slide a nucleus-like body was conspicuous, the net-work of fibrils being always connected with it, the nucleus-like body being itself circular in optical section and inconstant in position. In but two corpuscles that had been certainly cut transversely was a nucleus-like body observable. In others, if it existed the section did not happen to pass through it. In one of the two instances referred to, there were two minutely elliptical bodies present, one near each extremity of the section, whilst in the other only a single object of the kind was visible near one end. If a nucleus exists in the red blood-corpuscles, judging from these two examples, it is disciform, as would naturally be supposed. That the appearance should be so prominently visible in most of the corpuscles thus treated, is at least suggestive.

There is in connection with this internal structure a question that should be answered, or at least investigated by those that have access to the murderers in New York State, of whom there are usually several on hand. What is the effect, if any, of the fatal electrical current on the reticulation? That the corpuscles are altered in size and in shape is well known, especially to those that have seen the preparations of the blood from William Kemmler, the first murderer executed in the electrical chair. But nothing was at that time done to learn if there had been any change in the reticulations within the corpuscles, and, so far as I know, nothing of the kind was even thought of. To remove a sufficient quantity of blood that had certainly been under the influence of the electrical current, and to subject it to the action of the bichromate solution, would not be difficult for any competent microscopist that might have access to the criminal's body immediately after the execution. That the reticulations exist within the corpuscles I am convinced; that the electrical current would make a change of any kind in those reticulations is one of the many things that I should like to know. The investigation, too, might go some distance toward deciding as to the normal existence of the net-work. If the killing current alters the corpuscles in form and in size, as it does, it is reasonable to suppose that changes should take place in the internal structure, if there normally is any internal structure. There have been many widely differing kinds of suggestions as to what practical use murderers should be put; there seems to be a desire to make them of some service after death or even before death, for scientific experiments. Some competent microscopist within convenient distance of New York's State Prison at Auburn, may thus make good use of one murderer by investigating this interesting question.

Histologists claim to have proved that a solution of potassium bichromate does not alter the structure of protoplasm. If this be

true, then the reticulation within the red blood-corpuscles is a normal structure; if not true, then the whole body of histological work which has been accepted as correct must be doubted and be revised because about the first thing the histologist does with his specimen is to plunge it into a solution of potassium bichromate. Indeed, he does more, for he not rarely uses Müller's fluid, which is a mixed solution of potassium bichromate and of sodium sulphate. There seem to be two horns to the dilemma, and the microscopist that seizes either is likely to be gored by the other.

LETTERS TO THE EDITOR.

*** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

The Cretaceous at Gay Head, Martha's Vineyard.

IN his article on "Gay Head," published in this journal of Sept. 23, and since supplemented in the Transactions of the Maryland Academy of Sciences (pp 204–212), my friend Professor Uhler furnishes a valuable contribution to the geological literature on that peculiarly interesting promontory, through applying to the task of unravelling the complicated structure of the Vineyard series the knowledge and experience gained in his painstaking and excellent studies of the Lower Cretaceous terranes between New York Bay and the James River. Professor Uhler is the first, in print, to apply, in the interpretation of the disturbed strata in the western portion of Martha's Vineyard, the general principles which he was first to discover in the mode of disposition of the same series in the Middle Atlantic States. To one somewhat familiar with the Middle and Lower Cretaceous of New Jersey and Maryland, the homologies forcibly indicated in the Vineyard series are full of fascinating interest.

While agreeing with Professor Uhler as to the general structure of the original Cretaceous series in Martha's Vineyard, i.e., in the existence of a lower portion, essentially clays, succeeded by deposits of sands, lignitic clays, often somewhat laminated, and alternate clays and sands,—the observations of Professor Shaler and those of us who have viewed the cliffs for several successive seasons have taught the fallibility of indulging in a detailed correlation of the entire section as exposed during a single summer. Each season presents new phases and unsettled local stratigraphic complications, revealed by the winter's storms, as may be noted by consulting Professor Shaler's very valuable memoir, published in the Seventh Annual Report of the U. S. Geological Survey (pp. 297–363, 12 plates), the same author's paper in the Bulletin of the Geological Society of America (Vol. I., pp. 443–452, pl ix.) (neither article is mentioned by Professor Uhler), or in my notes made during 1889, 1890, and 1891. It seems to me, therefore, that Professor Uhler has been a little confident and hasty in naming up the various terranes at Gay Head. In offering some friendly comments on his conclusions, it is not my purpose to discuss several important questions, such as whether the island has been submerged "five times" or only three, or matters of nomenclature, as, for example, whether the underlying clay series should be called "Potomac" or Amboy, or the more arenaceous portion designated as "Raritan," "Albirupean," etc. These questions, as well as those concerning unconformability and the order and relations of the various members of the lower half of the Cretaceous in this region, as well as in other Atlantic coast States will, I trust, soon be considered in full by Professor Lester F. Ward of the U. S Geological Survey, who has made them the subject of special study, and who is far more competent to discuss them than the present writer. The folding, crushing, faulting, and dislocations at Gay Head make a unique example in the Cretaceous and Tertiary of the eastern United States. It is difficult to account for the surprising altitudes of the clays and lignites, as well as extensive elevation and pre-Tertiary erosion, with no other agency than pressure and the encroachment of the sea. In fact, the strata are so disturbed, eroded, mingled with, and masked by, post-Cretaceous deposits that it is, in my opinion, hazardous, in many portions of the section, to attempt more than the application of the general principle of distinction between the lower portion, with more massive clays, and the upper part, embracing variously arranged clays and sands

The greensand toward the north end of the section is much contorted, as described; but my own excavations in search of fossils fail to corroborate my friend's hypothesis that the Tertiary fossils "have settled into the broken surface," the interior of the marl being, in his judgment, equivalent to the lower marl of New Jersey, and carrying Cretaceous fossils only. If such is the explanation of the occurrence of Tertiary fossils on the face of the greensand, it is remarkable that they have not, likewise, settled into the broken surface of the clays and sands on either side. A similar marl was seen well exposed in the season of 1889 at one or two points towards the eastern end of the Weyquosque cliffs in Chilmark, where at one place the materials in the margin of the terrane appear to have been beautifully sorted in Pleistocene or post-Pleistocene time.

With Professor Uhler I agree that the greater portion of the strata below the "ossiferous" conglomerate, which appears to be Miocene, is probably Cretaceous in age. As to whether the more massive clays are equivalent to the plastic clays of the Potomac in the Maryland region, I shall not question in this place, merely mentioning the occurrence of Dicotyledonous remains among the dark clays at high-tide level near that portion of the section which I understand my friend to pronounce Potomac. It is possible, of course, that this terrane had slipped down from the upper part of the cliff, and may be regarded by Professor Uhler as "Raritan." The latter name suggests the remark that, while referring the lower clays to the "Potomac," and explaining that the superimposed series, called "Raritan," is equivalent to the upper part of his "Albirupean," Professor Uhler makes no mention of the presence or absence of the rest of, or the lower portion of, the Albirupean, theoretically intervening between the Raritan and Potomac as defined by him.

So far as I now know, my paper on "Cretaceous Plants from Martha's Vineyard," read at the December meeting of the Geological Society in 1889,[1] was the first in which the opinion was expressed, or evidence adduced to show that a part, at least, of the Vineyard series represents an eastward extension of the Amboy clays to the southward of New England. The opinion expressed by Dr. Newberry, when delivering his judgment on my drawings, that "there can be no doubt that they represent the flora of the Amboy clays," and his view that these clays passed through the entire length of Long Island, have, I think, been fully justified. During the following summer, 1890, evidence was collected which proved the correctness of those views regarding the Gay Head region, while my unpublished notes, made the same season, indicate the extension of the Amboy clays in place as far east as Northport and Fresh Ponds in Long Island, while material probably derived from that series, when not in place, was observed at numerous points, among which are Wyandance, Farmingdale, possibly near Riverhead, and in Gardiner's Island. I anticipate that a careful search among the Pleistocene material between the Firehole and Montauk Point will reveal Amboy elements showing a continuance eastward to the Cretaceous material observed by myself in the north-east and south bluffs of Block Island. On Martha's Vineyard the Amboy clays may be seen in place at several points in the vicinity of Peaked Hill, while its material, perhaps re-deposited, may be traced to Lambert's Cove, or farther. Concretions with Amboy plants have been collected on the shore of Lagoon Pond, above Vineyard Haven, while Professor Thomas Battey of Providence has sent me similar specimens from East Chop and Cottage City, on the east coast, showing the probable extension, in past if not in present, of that important series of clays and sands as far, at least, as the eastern border of the island.

The greater identity of the Amboy (Middle or Lower-Middle Cretaceous) flora with that of the Lower Atane beds of Greenland, instead of with the Dakota group of the United States, is remarkable,[2] and strongly impels one to search for other evidence

[1] Abstract, Bull. G. S. A., I., pp. 554, 555; Printed in full in A. J. S., xxxix., 1890, pp. 93–101, pl. ii.

[2] See A. J. S., l.c., p. 99, and Newberry's remarks, Bull. G. S. A., I., p. 555.