seem, therefore, that *Saccharomyces niger* is to be added to the small list of fungi which are thus capable of assimilating free nitrogen from the air. Mention was also made of certain other of the nutrition phenomena of this fungus.

Dr. George T. Moore gave a very interesting address on a new method of artificially inoculating soils for legumes with the nitrogen-assimilating, tubercle-forming bacteria. The practical application of the method is very simple and was fully described. The paper will be published in full as a bulletin of the Bureau of Plant Industry, U. S. Department of Agriculture. H. J. Webber.

Discussion and Correspondence.

The Grand Gulf Formation.

In Science of December 12, 1902, Professor Dall, in commenting on our note on the Grand Gulf Formation, published in the number for November 21, 1902, calls our attention to two errors, which we now acknowledge and are very glad to correct. We made the statement that Dr. Hilgard had considered the Grand Gulf as of Eocene age. This is a mistake which escaped us both in the manuscript and in the proof-reading. Since Dr. Hilgard's work forms the basis of all our knowledge of the Gulf Coastal Plain, we knew from long-continued study thereof that there was not a line in all his writings which could be interpreted as even suggesting this age for the Grand Gulf. So also we were mistaken in saying that Professor Dall had regarded it as of Eocene age.

It is, furthermore, evident from Professor Dall's criticisms that we have not stated our case with sufficient clearness to prevent misunderstanding of our position. Inasmuch as to us the facts in our possession seem to afford absolute proof of the correctness of our conclusions, we beg to submit the evidence somewhat more fully to the consideration of the geologists interested.

At the outset it seems necessary to define clearly what we mean by Grand Gulf, and we can do no better than to follow Hilgard, who has so well described these beds, and who has correctly mapped them as covering the lower part of the state of Mississippi from the southern limit of the Vicksburg down to within a few miles of the Gulf of Mexico.

The materials of the formation are sandstones, sands and clays, with silicified trunks of trees and beds of lignite, and lignitic clays containing leaf impressions, badly preserved and incapable of determination. Concerning these Grand Gulf beds Dr. Hilgard remarks: "Two points confront us in the discussion of the relations of the formation to the sea; the great rarity of the calcareous feature in the main body of the formation, and the utterly 'unmarine' character of the materials generally, in the constant recurrence of the lignito-gypseous facies." And again, "Of the sweep of 900 miles thus outlined as the known extent of this formation, 400 may be considered as having been examined sufficiently in detail to prove the absence of marine fossils from the formation; the portion so examined embracing, moreover, its widest part and fully two thirds of the area of the outcrop." *

By the characters thus outlined, this great fresh-water formation has been recognized and described by the geologists in Georgia, Florida, Alabama, Mississippi, Louisiana and Texas. No one has had any serious difficulty in distinguishing it in the field; but every one has had difficulty in reconciling the known facts of its surface distribution with any satisfactory assignment of it to a definite place in the stratigraphic column. The only formation with which it is at all likely to be confounded is the Lafayette, which everywhere, according to Hilgard and other geologists, directly overlies it, and of which the materials are often quite similar; and we have conclusive evidence that parts of the Grand Gulf have by several authors been included in the Lafayette.

In their relations also to the underlying older strata, these two formations have much in common; for instance, they both 'blanket' a number of older formations, but the Grand Gulf, so far as yet known, overlaps only Miocene, Oligocene and Eocene as far down as

* *Am. Jour. Sci.*, Vol. XXII., July, 1881.

the Tallahatta Buhrstone, or lower Claiborne.

While, therefore, we appear to be in substantial agreement as to the *characters* of the formation which we call Grand Gulf, we differ radically from Professor Dall as to the *place* which it occupies in the stratigraphic column.

We fully concur in his statement that, "It can not be too often emphasized that no determination of the age of its (southern coastal plain) beds not based on their fauna, or the fauna of beds both above and below those in question, can be regarded as more than tentative; and such determinations in the past have almost invariably proved erroneous."

The sole purpose of our first note was to prove, by the application of these very principles, that the stratigraphic position of the Grand Gulf beds was between the Pascagoula Tertiary and the Lafayette; but since doubt still remains, we wish to offer a few additional considerations.

So far as we have been able to ascertain, the Grand Gulf beds *themselves* do not anywhere contain the fossils which afford incontestable evidence of their age. Dr. Hilgard writes:* "Apart from this [the finding of a few fragments of a turtle shell], my most patient search, in hundreds of localities, has failed to produce any fossil form; even the leaves associated with the lignite seams being so ill-preserved as to be unrecognizable."

And though casts of fresh-water shells have since been found in the formation, no determination of its age from these has been possible,† and we are thus compelled to rely wholly upon the other test, viz., the fauna of the beds below and above the ones in question.

If we consider *first* the formations which are known to *overlie* the Grand Gulf, there is not very much to be said, but it is conclusive.

The case in Texas is thus given by Professor Hill, in a recent letter: 'The so-called Grand Gulf beds of the Texas region *are not overlaid by the Tertiary.*'

In Mississippi we have Hilgard's testimony, as follows: "The latter (stratified drift or Lafayette) is found directly capping almost everywhere, the claystones and sandstones that characterize the highest part of the Grand Gulf group."

In Alabama also the Lafayette is nearly everywhere seen capping the Grand Gulf, and we have no record of anything older than Lafayette in this relation to it. The same thing is certainly true with regard to western Florida, and, we have no doubt, to the rest of Florida and Georgia as well.

In Bulletin 84 of the U. S. Geological Survey, Professor Dall says: "There is no doubt that directly in contact with the Grand Gulf beds in the Gulf states, lies the formation variously recognized under the names of Lafayette or Orange Sand of Hilgard, Lagrange of Safford, or Appomattox of McGee."

So while there are localities by the tens of thousands, in the Gulf states, where the Grand Gulf is directly overlaid by the Lafayette, we have no recorded instance of its being overlaid by any formation older than the Lafayette.

This circumstance alone affords at least presumptive evidence that the true place of the Grand Gulf is high up in the geological scale, and close under the Lafayette.

Secondly, as to the *underlying* formations. In Mississippi Dr. Hilgard found no contact of the Grand Gulf with any underlying formation other than the Vicksburg limestone. In connection with his description of these

* *Loc. cit.*, p. 59.

† Kennedy finds *V. planicosta* in Fayette sandstones, but in basal layers which Veatch considers Jackson; Veatch also, in Frio clays near Binkville, La., finds a fossiliferous (casts) layer in a ferruginous rock; Harris finds *Unio* and *Anodonta* casts at Chalk Hills, La., along with leaves of birch, willow and other dicotyledonous trees; Meyer has mentioned casts of fresh-water shells occurring also at Grand Gulf.

It may easily be imagined that the waters which were active in transporting and depositing the materials of the Grand Gulf might on occasion carry into it fossils of an older formation over which they swept. The finding of a few Eocene Miocene fossils in the Grand Gulf beds should not cause any more surprise than the finding of Sub-Carboniferous fossils, for instance, in the Lafayette, as has often been done.

contacts he points out a very significant fact, viz., "While the Vicksburg rocks show at all long exposures a distinct southward dip of some three to five degrees, the position of the Grand Gulf rocks can rarely be shown to be otherwise than nearly or quite horizontal, on the average; although in many cases faults or subsidences have caused them to dip sometimes quite steeply, in almost any direction."*

And generally in the Gulf states, the landward margin of the Grand Gulf almost invariably rests upon the Vicksburg limestone, and many sections have been published showing this contact. On the principle that, in the absence of evidence to the contrary, a formation follows next in chronological order, that formation upon which it directly rests, the Grand Gulf (or part of it) has usually been placed in the geological column, next above the Vicksburg limestone, *i. e.,* in the Miocene (or, as some now prefer to call it, Oligocene).

The application of this principle in Alabama would cause us to place the Grand Gulf at a number of horizons where we are perfectly certain that it does not belong, for while in most cases it rests upon the Vicksburg limestone, yet we have recently seen it in direct contact with the *Upper Claiborne* and upon the *Lower Claiborne* or *Buhrstone,* on the one hand, and upon the *Chattahoochee Miocene,* and directly upon, as well as far above, the *Pascagoula* (Miocene or Pliocene).

So far as we know, no one has ever placed the Grand Gulf between the lower and upper Claiborne, or between the latter and the Vicksburg. Too many sections have been described showing the contact of these formations without any intercalated Grand Gulf, to permit any such assumption.

But the relations of the Grand Gulf to the Vicksburg and post-Vicksburg Tertiary formations have, perhaps, not heretofore been fully set forth. Conclusive evidence as to these relations is afforded, we think, at the following localities:

1. *Chattahooche and Appalachicola River.*—If any part of the Grand Gulf occupies the position assigned by Professor Dall to his 'typical Grand Gulf,' *i. e.,* between the Vicksburg and the Chattahoochee limetones (or approximately at that horizon), there should be somewhere on the gulf coastal plain a section which would exhibit these beds in that relation to each other. So far as we are aware, no such section has ever yet come under notice.

Certainly we should expect to find such an exposure in that most complete and unbroken section of the later marine Tertiaries afforded by the Chattahoochee and Appalachicola Rivers. This series of the Neozoic rocks, discovered by Langdon in 1887, has been studied by a number of eminent geologists, including Professors Pumpelly and Gilbert Harris, and Messrs. Dall and Stanley-Brown, some of whom have published descriptions.

The most complete and carefully prepared account of this section is that which appears in Volume 5 of the *Bulletin of the Geological Society of America,* 'Cenozoic Geology along the Appalachicola River,' by Messrs. Dall and Stanley-Brown.

From this article we make the following quotations: "At a place on the left bank of Flint River a few miles above the Florida boundary line, known as Willey's Landing, Professor Pumpelly states that the contact between the Vicksburg and undisturbed Chattahoochee Miocene may be observed."

"Beginning at the base of the column, Professor Pumpelly has shown that the Chattahoochee series rests on an erosion surface of the Vicksburg or Orbitoidal limestone which forms the culmination of the Eocene. We have confirmed this by an examination of the fossils submitted by Professor Pumpelly."

In the '18th Annual Report' of the Director of the U. S. Geological Survey, page 330, Professor Dall says: 'There is no marked break in the stratigraphy between the Upper and Lower beds so far as yet observed.' The lower beds here referred to are the Vicksburg

* Many subsequent observations in Mississippi and Alabama confirm this, and show besides that the Grand Gulf beds, having been deposited upon an eroded surface of the Tertiaries, exhibit great variations in both the dip and the thickness.

and Ocala formations, and the upper are the Chattahoochee and Chipola.

Since no mention is made in these sections of any Grand Gulf, we may safely assume that none exists there between the Vicksburg and the Chattahoochee, and yet on the uplands, on both sides of the Chattahoochee River the characteristic Grand Gulf beds may be seen occupying the surface with the usual capping of Lafayette sands.

Mr. Gilbert Harris also publishes a good account of this river section in his 'Bulletin No. 15 of American Paleontology.'

In this article, as well as in that of Messrs. Dall and Brown, it is demonstrated beyond all question that the Chipola overlies the Chattahoochee, apparently conformably and certainly without the intercalation between them of any Grand Gulf beds; and in the same way the Chipola is conformably overlain by the Alum Bluff beds, and these in turn by the Chesapeake marl, followed by what Professor Dall calls an *aluminous clay,* which he considers as belonging probably also to the Chesapeake. "It will be seen on examination" (of the sections and diagrams) "that, while the series is not complete in any single section, taken collectively there is no gap outstanding between the beds and, humanly speaking, no room for misapprehension as to their position and age."*

Let us now trace up the Grand Gulf beds along these rivers. Nobody will deny that they overlie the Vicksburg limestone, both in Alabama and in Georgia, clear up to the Chattahoochee River where the post-Vicksburg series of marine Tertiary beds begins.

Mr. Harris† gives a section of the bluff at the old Chattahoochee Landing, in which, underneath the orange and red sands, presumably Lafayette, at the top of the section, there are some twenty feet of purplish clayey sands, and light sands and clays, which he says 'resemble Grand Gulf.' No doubt they *are* Grand Gulf, and here they overlie the Tertiary beds consisting, according to Professor Dall's determinations, of Chattahoochee and Chipola.

* Dall and Brown, *loc. cit.*, p. 162.

† *Loc. cit.*, p. 52.

Near the top of every section of Professors Dall and Brown there is shown a bed, their No. 2, which has been referred by them to the Lafayette, but which, from the descriptions, appears to include both the Lafayette and the Grand Gulf. For the authors emphasize the facts that these beds are nearly seventy feet thick, and that they are often different in composition, structure and color from the more homogeneous (Lafayette) formation to the northward.

It is safe to say then that in this Appalachicola and Chattahoochee section, from the Vicksburg limestone up to the top of the Chesapeake Miocene as shown at Alum Bluff, none of the beds which take part in the formation of the river bluffs has ever been considered Grand Gulf, unless it be those capping the bluffs, above all the Tertiaries, and covered only by the Lafayette and more recent deposits.

2. *Conecuh River, Escambia County, Ala.*—In the upper part of township 2, range 12, in this county, the bank of Conecuh* River is formed by the Vicksburg limestone, while in the lower part of the same township, some four miles distant, the bank is formed by gray sandy clays holding Miocene fossils. At both localities the Grand Gulf beds, sands, clays and lignites, overlie the Tertiary formations, and form the surface of the country intervening, with the usual capping of Lafayette.

3. *Chickasawhay River, in Greene County, Miss.*—About five miles above the confluence of Leaf and Chickasawhay Rivers on the latter stream, we have recently examined a bluff at the base of which is a shell marl, with innumerable shells of *Rangia Johnsoni,* and a few other forms characteristic of the Pascagoula horizon. Above this and forming the upper half of the bluff are typical Grand Gulf strata, sands and clays with lignite bed and silicified trunks of trees all *in direct contact* with the Pascagoula marl.

4. *Mobile County Artesian Borings.*—These borings have been made at and near Mobile and at Alabama Port. The deepest is the

* By inadvertence this was called Escambia River in our previous note.

Bascomb well near Mobile, to which we have referred in our first note. At this well the Grand Gulf, with its usual capping of Lafayette, forms the surface. The boring reaches the Pascagoula shell bed at about 700 feet, and the bed containing Oak Grove fossils (Chattahoochee) at about 1,500 feet. From the materials brought up we judge that about 180 feet at the top of this boring are in the Grand Gulf; how much, if any, more of the strata belongs to this formation we can not, of course, say, but the main point to be noted is that here the Grand Gulf lies *far above* the Pascagoula, and the latter some seven or eight hundred feet above the Oak Grove beds.

5. *The Coasts in Mobile and Baldwin Counties, Alabama, and in West Florida.*—We have already spoken in our first note of the occurrence of the Grand Gulf down to within a mile or two of the Gulf in Mobile County; of its occurrence in Baldwin County on the shores of Perdido Bay, where it makes a high bluff. Recently we have seen the same formation making the greater part of a bluff, thirty feet or more in height, on the very border of Pensacola Bay in the city of that name.

Now since a formation is bound to be *younger* than the newest formation which it overlies, and *older* than any which overlies it, we are forced by the facts adduced above to conclude that the Grand Gulf occupies a place in the geological column somewhere *between* the uppermost of the Tertiary formations as yet determined by its fossils, viz., the Pascagoula and the Lafayette. We will not even say that the Grand Gulf represents *all* the time and space between these two formations, for the borings near Mobile and the bluffs on Perdido Bay at Pensacola, show that if there are any post-Pascagoula Tertiaries in Alabama and western Florida, the Grand Gulf comes in between *them* and the Lafayette.

If any one should still maintain that the Grand Gulf belongs anywhere in the Tertiary column between the Buhrstone and the top of the Pascagoula, we think the burden of proof rests with him; he should show a single section where Grand Gulf beds, of the character described by Hilgard and accepted by all the geologists of the gulf coastal plain, may be seen intercalated between *any two* of the Tertiary formations.

If we seek to escape the legitimate conclusion from the facts above given of their distribution and stratigraphical relations, by assuming that the *fresh-water* Grand Gulf beds of the west (Mississippi and Alabama) find their *marine equivalents* further east in the Chattahoochee series, we are confronted with this fact, that at the Chattahooche River, and beyond through Georgia, the characteristic fresh-water Grand Gulf beds, such as Hilgard has described them, overspread the country just as they do to the west, showing no signs whatever of any transition into marine deposits. It is needless to seek equivalents when the thing itself is there.

And, moreover, we now know for a certainty that all across Alabama and in the type locality of Dr. Hilgard, on Chickasawhay River in Mississippi, both the *fresh-water Grand Gulf* and the *marine fossiliferous Tertiaries coexist* everywhere, the Grand Gulf above, the Tertiaries below.

The facts which we have presented above may easily be verified by a few days' field work. If they are susceptible of other construction than that which we have placed upon them, or if there are other facts incompatible with the conclusions which we have reached, we stand ready to modify or abandon our views, since we are fully aware of our limitations, and of the difficulty, almost the impossibility, of arriving at the *whole truth*. If we have made a small contribution towards it we ought to be satisfied.

No one can appreciate more than we do the great work which Professor Dall has accomplished in our southern Tertiaries, and we hope he may long continue active in the same work, and bring us finally to a certain and complete knowledge of the sequence of these formations and of their contained fossils. If we differ from him on some of the points presented above, it is because the facts seem to compel us thereto.

Moreover, we think he has hardly given due

weight to the evidence which we brought forward in our first note, and certainly he does not correctly represent our position in some of his comments on that note, as, for instance:

1. He thinks that our assumption of the late, possibly Pliocene, age of the Grand Gulf beds, if it should prove correct, is merely an equivalent of the idea of Dr. Hilgard cited by him, and, therefore, not new.

Dr. Hilgard's idea was that these beds represent *all* the time and space between the Vicksburg and the Lafayette; ours is that they represent *a very small part only* of that time and space, viz., the part between the Lafayette and the uppermost of the known Tertiaries of the Gulf coast—the Pascagoula, and very probably not even all of that. If a part is equal to the whole, then the equivalence is established, and we stand convicted.

2. "The beds which Messrs. Smith and Aldrich call 'Grand Gulf' in their communication to SCIENCE are not the same" (*i. e.*, Professor Dall's 'typical Grand Gulf') "but are the non-fossiliferous upper portion at the other end of Hilgard's Grand Gulf section."

The clays containing lignite and fossil palm leaves, described by Hilgard at Powe's on Chickasawhay River in Mississippi, have been fixed upon by Professor Dall as his 'typical Grand Gulf' beds, and have been classed by him as Oligocene (SCIENCE, December 12, 1902, p. 946). Now from this type locality Dr. Hilgard traveled southward down Chickasawhay and Pascagoula, giving details of exposures of the Grand Gulf as far as Dwyer's ferry, ten or twelve miles from the gulf. Although he then saw no contact of the Grand Gulf with any underlying formation, owing, no doubt, to the stage of the water, yet this formation may be seen, as above described, resting on the Pascagoula shell marl on the Chickasawhay, a few miles above its confluence with Leaf River. And furthermore, the Grand Gulf at this point consists of clays, sands and lignitic clays, with silicified trunks of trees. The same formation is at the surface thence back to the type locality near which it is seen resting upon Vicksburg limestone. Here then the unquestioned Grand Gulf, with Hilgard's hall-mark of genuineness upon it, rests upon the beds of Upper Miocene (or Pliocene) age, called the Pascagoula, just as they rest upon the Eocene Vicksburg limestone twenty miles further north. Both Hilgard and Johnson have given details of numerous other fossiliferous Grand Gulf beds in these parts of Mississippi. These are the beds which we have called Grand Gulf. And furthermore, we find lignites and lignitic clays with leaf impressions in the formation overlying the Miocene at Coal Bluff and Roberts in Escambia County, Alabama; we find the lignitic matters in the same beds down to the water's edge on Mobile Bay, so that certainly all the beds which we have been calling Grand Gulf *are fossiliferous* precisely as are those described by Hilgard which Professor Dall accepts as his typical Grand Gulf. Nor have we been writing about the upper part of the formation only, as the bluffs on Conecuh River demonstrate. If the Grand Gulf beds which there rest on the Vicksburg limestone be counted as the lower beds, then the beds of the same formation resting on Miocene fossiliferous sands, four miles further south, can not be very much higher up, especially in view of the fact that the Grand Gulf beds are everywhere very nearly horizontal. And even upon the assumption of a steeper dip, since the Grand Gulf covers the country down to the gulf, a distance of thirty or forty miles from the Conecuh River localities, those beds which form the surface over only four miles (or one tenth of this area) certainly would not belong to the upper portion.

3. "By means of paleontological data, * * * I have been enabled to fix the age of *different portions* of the original heterogeneous series as uppermost Oligocene (transitional) and Chesapeake Miocene, which is fully confirmed by the facts now cited by your correspondents."

Langdon's discovery along the Chattahoochee in 1887 first showed beyond all question that fossiliferous marine beds occupied a part of the geological column which Hilgard once thought to be covered by his Grand Gulf beds alone. Langdon gave the name Chattahoochee to these deposits, which he

classed as Miocene, and this determination of the age has been very generally accepted by the geologists. Professor Dall's critical studies of the fossils and stratigraphy of this region have since enabled him to give greater exactness and precision to Langdon's first outline by establishing several substages of the original Chattahoochee; by assigning the lower part of the original Miocene to the Oligocene, and the upper to the Chesapeake Miocene, etc.

Now, while the facts given by us certainly confirm the existence of Langdon's Chattahoochee beds, by whatever name now known, below the Grand Gulf in western Florida, and in Alabama and Mississippi, we do not see how they either confirm or contradict the conclusions of Professor Dall as to the true age of the different parts of the Chattahoochee series.

To summarize:

1. The Grand Gulf of 'Messrs. Smith and Aldrich' is the same fossiliferous formation which Hilgard has described by that name, and not merely 'the upper non-fossiliferous portion at the other end of Hilgard's section.' It is the same formation which Professor Dall calls the 'typical Grand Gulf' in his recent communication, and which he considers Oligocene, and a remnant of the heterogeneous Grand Gulf of Hilgard. We are compelled by the facts to believe that this typical Grand Gulf is not Oligocene at all, but that it belongs about a quarter of a mile vertically above the place in the geological scale to which it is assigned by Professor Dall.

2. There is also no Miocene Grand Gulf, as Langdon's discovery has proved and as has been confirmed by other geologists who have studied the Chattahoochee-Appalachicola section. We might perhaps more correctly say there is no Miocene Grand Gulf below the horizon of the Pascagoula, if that be certainly proved to be Miocene.

3. We think our facts prove that the Grand Gulf, all and singular, occupies a place in the geological column *below* the Lafayette and *above* the Pascagoula (which is the uppermost of the Tertiary formations as yet determined along the Gulf coast). This is all we have endeavored to show, and it was the *raison d'être* of our first note. We do not see wherein what we have there said in any way confirms Professor Dall's 'earlier determinations,' and, furthermore, we think that our view of the age of the Grand Gulf is new, and not a mere equivalent of the views of any other geologist.

Eugene A. Smith,
Truman H. Aldrich.

SHORTER ARTICLES.

THE REMAINS OF BEAR AND DEER ON THE SHORES OF ONONDAGA LAKE.

Through the courtesy of the firm of Will & Bauer, of Syracuse, the university received in March parts of the skulls of six bears (*Ursus americanus*); the leg bones of at least three bears (*Ursus Americanus*); and parts of the leg bones of three deer, the Virginia deer. The bones were identified through the kindness of Dr. Ablen, of the Natural History Museum of New York.

The find was made north of Syracuse, about one eighth of a mile east of Onondaga Lake, while the company was excavating for a trench. The land at this place is level, the surface soil is of a mucky character, varying in thickness from three to nine feet. Beneath the muck there is a bed of marl with here and there some quicksand.

The workmen noticed bones when they first began digging, but failed to bring the fact to the attention of the foreman until the work was nearly completed. A careful watch was maintained during the remainder of the excavations, with the above gratifying results. The bones were not taken from one place, but were found scattered over an area of several square rods, a skull being found at one place and the jaws at another.

A brief description of the bones may be of some general interest. The larger skull measured twelve inches from the occipital ridge to the premaxilla; nine and one half inches from the anterior side of the foramen magnum to the premaxilla; three and one half inches from the right zygomatic arch to the sagittal plane of the skull; the left