AGRICULTURAL, GEOLOGICAL, AND DESCRIPTIVE

SKETCHES

OF

LOWER NORTH CAROLINA,

AND THE

SIMILAR ADJACENT LANDS.

BY

EDMUND RUFFIN,
OF VIRGINIA.

RALEIGH:
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RALEIGH, NOVEMBER 8, 1860.

To His Excellency JOHN W. ELLIS,

Governor of North Carolina:

SIR:—The proposition of Mr. EDMUND RUFFIN, the distinguished Agriculturalist and Author, to furnish a communication upon the agriculture of the eastern counties of this State, will, I hope, be accepted by your Excellency.

It will please me especially, if this communication can be published in such a form, that it may be regarded as a report for the Agricultural and Geological Survey now in progress.

The field of investigation in North Carolina is extremely wide, in consequence of a diversity of interest, climate and soil. Aid, therefore, from any quarter is important, especially when proffered by a gentleman of Mr. Ruffin's abilities.

The principles of agriculture are the same everywhere in all countries,—but their application often require special modifications. It is so in this State. The use of our native fertilizers for example, in the various kinds of marls, call for special rules of application. These are to be found out only by close observation and much experience. An immense saving in money depends upon their proper application, as to *time, from composition* and the *condition of the* soil to which they are to be applied.

The subject has been, and is still, receiving all the attention I am able to bestow upon it. We have no fear that we shall receive too much light upon the subject. Agriculture is slow in its advances, and hence, every communication which is calculated to give it an impulse, deserves the patronage of the State.

I am, Sir,

Your Obedient Servant,

E. EMMONS,

State Geologist.

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ERRATA.

[N. B.—The inability of the author to see, for correction, the proof sheets of this work, was the necessary cause of many errors of the press—of which the most important will be here noted, for correction by the reader.]

Page x. line 21, for 'has' read *have*.
" xi. line 11, after 'is' insert *as*.
" 14, after 'North Carolina' insert (as part of heading) *Part I.*
" 13 line 1, for 'scope' read *slope*.
" 25 " 5, for '&c.' read *and*.
" 45 " 16, for 'lower' read *larger*.
" 45 " 28, for 'even' read *over*.
" 49 " 7, for 'such' read *each*.
" 50 " 22, for 'There' read *These*.
" 52 " 16, for 'loose' read *lose*.
" 52 " 25, for 'impossible' read *impassable*.
" 57 " 20, for 'banks and' read *branches of*.
" 57 " 23, for 'or' read *of*.
" 60 " 2, for 'such' read *much*.
" 62 " 10, for 'drouth' read *drought*.
" 62 " 31, for 'important, it' read *important. It*.
" 63 " 9, for 'low-lands, but,' read *low-lands. But*.
" 66 " 13, for 'low' read *close*.
" 68 " 18, for 'ever' read *even*.
" 75 " 30, for 'rivers's' read *river's*.
" 77 " 3, for 'draining' r. *drawing*.
" 79 " 20 " " "
" 80 " 3, for 'summer; while' read *summer. While*.
" 116 " 17, for 'But Core' read *But, as Core*.
" 119 " 5, for 'creek' read *creeks*.
" 124 " 26, for 'preceding' *receding*.
" 126 " 36, for 'course' read *coarse*.
" 129 " 24, for rotted' read *unrotted*.
" 130 " 6, for 'getting' r. *gathering*.
" 132 " 35, for 'seldom' r. *could not*
" 134 " 24, for 'effects' read *effect*.
" 134 " 33 & 34, f. 'extreme' *extensive*.
" 137 " 14, for 'from' read *for*.
" 138 " 10, for 'sickness' r. *sickliness*.
" 138 " 16, after 'the' insert *previous*.
" 141 " 35 & 36, for 'loose' read *lose*.
" 143 " 2, for 'Profitable' r *Probable*.
" 144 " 26, after 'beam' ins. *being*.
" 147 " 14, for 'captan' read *capstan*.
" 148 " 27, for 'loose' read *lose*.
" 154 " 10. for 'loose' read *lose*.
" 158 " 24, for 'knot' read *kind*.
" 165 " 13, after 'are' insert *not*.
" 167 " 19, after 'supplies' insert closing quotation ('') for the preceding passage.
" 169 lowest line, for 'tempature' read *temperature*.
" 171 " 35, for 'This' read *Thus*.
" 172 " 17, for 'on' read *or*.
" 178 " 19, for 'mantle' read *mantel*.
" 181 " 15, for 'leval' read *level*
" 182 " 8, after 'both of' omit *the*.
" 182 " 15, for 'peet' read *peat*.
" 184 " 11, after 'had' insert stop (.)
" 185 " 28, for 'in places' r. *in place*.
" 187 " 18, for 'then' read *there*.
" 188 " 25, for 'favor' read *form*.
" 189 " 33, for 'impregnative' read *impregnation*.
" 196 " 27, f. 'increasing r. *unceasing*.
" 197 " 24, for 'moss' read *mass*.
" 203 " 9, (of text) for 'enumerated' read *enunciated*.
" 204 " 17, for 'further' read *farther*.
" 204 " 27, for 'larger' read *longer*.
" 205 " 2 of note, for 'whenever' read *wherever*.
" 205 " 28, for 'from' read *for*.
" 214 " 33, for 'river' read *ground*.
" 215 " 14, for 'ever' read *even*.
" 216 " 11, for 'dug' read *dry*.
" 231 " 28, for 'prover' read *proper*.
" 251 " 16, (of text) for 'select-part' read *part select*.
" 271 " 1 (heading of table,) for 'Forest | Land never cleared, read *Forest land never cleared*.
" 272 in and throughout the foot-note, for 'Dr. James F. McRae,' read *McRee*.

PREFACE.

MORE than twenty years ago, the writer of these Sketches made several excursions, for personal observation, to different parts of the region to be here treated of. The facts of his then very limited opportunities for examination, were reported in different communications to the *Farmers' Register*.* The extent and the importance of the subjects for investigation, of which only limited and hasty glances could then be taken, left a strong desire for renewing and making more full examinations of this remarkable agricultural region, the important values of which, so far, were but little known even to the most intelligent residents, and the peculiar features of which were almost entirely unknown to all others than its residents. It was not until long after, in 1856, when, by my withdrawal from my previous engrossing business and continued labors as a farmer, I obtained the requisite leisure, and so was enabled to attempt the fulfillment of this wish, which had been suspended for so many years. But when engaged in this investigation—working, as I was, without any official appointment or position—at my own expense—and encountering much toil, and risk to health by exposure—without aid from any quarter—without any definite object, other than my own present gratification, and without any prospect of personal gain, or reimbursement—it cannot be supposed that my labors, or their fruits, could be anything like complete, or to be compared with what they ought to be, and perhaps might have been, if all these disadvantageous

* Among the more important of sundry such articles as are referred to above, reports of earlier personal examinations made by the writer, are the following:

Observations on the Dismal Swamp, in "Farmers' Register," Vol. iv, p.513 to 521.

Descriptions of some of the Swamp Lands, near Plymouth and Lake Scuppernong, &c., and remarks on kindred subjects in North Carolina. Vol. vii, pp. 698 to 703, & 724 to 733.

Observations on Lands of New Hanover.—Vol. viii., p. 245; Calcarious beds of Rocky Point, 246; Savanna Lands, &c., 248; Marl and Limestone, on Neuse and Trent Rivers, 253; Judge Gaston's Pocoson Farm, 251.

Also, in the "Farmers' Register," (Vol. ix, 1841,) was made the first publication of "The History of The Dividing Line," and the other private writings of Colonel William Byrd, of Westover, which curious and interesting memoirs had before remained in manuscript for a century.

conditions had been reversed. But even under the actual disadvantages, I am persuaded that even my very imperfect observations may still indicate important means for very valuable agricultural and other great improvements of the extensive region under consideration. A few other persons, who only have read the reports in manuscript, have formed like favorable opinions of their probable utility. For such favorable opinion, of the Hon. JOHN W. ELLIS, Governor of North Carolina, formed upon his own reading of the whole series, I am indebted for his request to me, to have these reports published at the charge, and for the use of the State of North Carolina, as part of a collection of sundry District Reports, by different writers, on the Agricultural character, Topography, Natural History, &c., of this State. It is under these auspices that most of those reports will now be first published, and a few others re-published, as necessary, or suitable parts of the series. All these reports were mostly written within the year 1856, and no alteration has been made in the substance of what was then written, and no attempt made to bring up occurrences to later, or to the present time. But some later excursions have supplied more material for description, or for illustration—and some such new matters have been since inserted, and which will appear as later additions, whenever that fact, or the later date, is of any importance to the subject.

All my observations of this great and remarkable agricultural region has brought me to believe, that I have not known or heard of any other, comparable in extent or value, which so much unites the several characteristics of (1st.,) its so much needing agricultural improvement, and the increasing of its fertility and production.—(2nd.) of possessing great resources and fertilizers for effecting the needed improvements—and (3rd) of promising great and certain pecuniary profit, and both individual and general benefit, from producing these improvements. All estimates constructed on such imperfect and limited data, as now only are reliable, must necessarily be uncertain. But when trying to make due allowance for the uncertainty of the grounds, I still confidently believe that the new nett agricultural value and wealth so to be produced in lower North Carolina alone, would amount to hundreds of millions of dollars, over the present value, and over any possible value to be secured by the present system of culture and husbandry. And I would count upon acquiring this great profit, and net increase of productive agricultural capital, from three principal sources or modes of improvement only, independent of all other minor, yet important improvements and profits available—and some of which have already been admirably used in Edgecombe county. The three great wants, and also means for improvement in lower North Carolina, and to two of which the following reports will mainly apply, are the following:

1st.—The draining, (where proper and needed, according to the character of the soil.) of the vast area of rich swamp lands.

2nd.—The proper draining (on the principle and theory which will be indicated in Part II. of these Reports.) of most of the other and firm land, which in common parlance is designated as dry, but of which, but little in this low-land region is ever really dry, except during summer and autumn droughts, when their dryness is, indeed, often in full proportion to their excess of wetness during winter and spring.

3rd.—The proper use of marl, from the very extensive, rich, and in many cases very accessible beds which underlie so much of this great region—or, otherwise, of lime brought to places where marl is not available.

On this head, but little will be said in the following articles, because the writer has heretofore published so much on the subject of improvement of soils by calcareous manures, all of which is applicable to lower North Carolina as to lower Virginia, for which his reasoning and instructions were first designed.

The several articles which will here appear, under one general title, and as a series, were at first written as separate reports, on different subjects.—Each one is sufficiently distinct in subject and treatment to be read alone. Still the series will be required for consideration of the general subject of the natural features and agricultural resources of lower North Carolina.

E. R.

Virginia, Oct., 1860.

SKETCHES OF LOWER NORTH CAROLINA, &c.

AGRICULTURAL GEOLOGY; OR REMARKS ON THE DRIFT-FORMED AND THE DENUDED REGIONS OF THE ATLANTIC SLOPE.

Throughout the Atlantic scope of the United States, from Georgia to New York, inclusive, at greater or less distance from the sea shore, a continuous elevation of granite rock forms the long western boundary line and higher border of the lower lands.—The same rock, rising to various higher elevations, and in various conditions of texture, or of progressing disintegration, is seen often at the surface, or at intervals, for many miles more westward. The eastern border of the granite, though mostly hidden by the overlying earth, is exposed to view in all the beds of the rivers, (and in many of the smaller streams,) and serves to constitute the very distinct and high barrier of stone which makes the eastern or lower falls of all the rivers which flow into or toward the Atlantic ocean. Between these most eastern falls and the ocean, the rivers have but slight rates of descent, and therefore are of moderate velocity, and of smooth and placid surface. The flow of the ocean tides, (unless where obstructed by obvious causes,) generally extend through the whole or a large portion of the space between the ocean and the eastern falls of the rivers, (or the first visible granite). Hence the great area, lying between these boundaries, is generally distinguished as the "tide water" region, and that term will be thus used here, for designation, and in conformity with established usage. But the term is not accurate, or descriptive even for all of eastern Virginia; and still less for the like territory much farther North and South. In the Hudson river of New York, the tide flows through and westward of the eastern granite—and in south eastern Virginia, and all further southward, the flow of tide does not nearly approach the granite falls. The most northern rivers of this last description, are those discharged into Albemarle Sound, in North Carolina, from which the entrance of ocean or tide-water is excluded by the long sand bank, or reef, along all that coast, which serves as a barrier. Farther southward, in South Carolina and Georgia, the greater length of the rivers east of the falls, and the greater rate of their descent, prevent the tides rising to the falls, or approaching within many miles of them. With this explanation and admission of inaccuracy, must be understood the ordinary term of the "tide-water region," as including all the space between the ocean and the most eastern falls of the river.

The granite range or falls, the line of which marks the western boundary of this great area, is nearer to the sea-shore at the north, and diverges therefrom, more and more towards the south. My personal observations of this region have been made principally in Virginia, and with less opportunity for examination, in Maryland, North Carolina and South Carolina. Similar characteristics as to the more northern and southern States, are inferred merely from general report of their topography, and other features.

Many years ago, when my personal observations on this subject had been altogether confined within even smaller limits than their later and still very narrow extent, I was forcibly impressed by what seemed to be peculiar and remarkable characteristics of this region, in the configuration of the surface, and the qualities of the soils—and in the supposed great uniformity of general character, (notwithstanding many variations in particulars,) throughout the whole extent, so far as known. The supposed peculiar qualities were studied, so far as my very deficient means permitted, for the purpose of learning thence how to improve and enrich the soil of this great and generally poor region. A young and busily occupied farmer, as I was, almost confined to my farm and its labors, and without any previous knowledge of the sciences necessary for such investigations, it necessarily followed that the results of my enquiries were but small, compared to what might have been obtained by one properly prepared—who, to a competent knowledge of practical agriculture, could have brought to bear on such investigations, the important lights of Botany, Chemistry, Mineralogy and Geology. It is unfortunate for the improvement of agriculture that, almost without exception, the men who have successfully cultivated these scientific pursuits, are as little acquainted with agriculture, as nearly all practical farmers are with the sciences just named, the knowledge of which would so greatly aid the study and improvement of practical agriculture. Until some investigator shall bring both the kinds of knowledge required for such subjects, great deficiencies in all must be expected, and be overlooked and excused. Such allowances, so much needed for all mere scientific investigators and teachers of Agriculture, I trust may not be denied to me, when attempting, as I shall do, to derive something from the lights of science, to aid agricultural researches, and for practical application.

The peculiarities of the tide water regions, which might strike any cursory observer, are these:

1.—Hilly or irregular as many parts are, the general surface of the highest lands, present the numerous points in a very regular plane, gradually declining in elevation from the higher surfaces at and above the falls, towards the sea shore. In and to various depths below this supposed inclined plane, have been grooved or excavated, the numerous valleys and ravines.

2.—The soils are mostly light; but whether light, and of loose or open texture, or close and stiff, are, to a very great extent, composed of silicious sand—coarser in the open, and very fine in the stiff soils.

3.—There is no fixed or extensive rock, or beds of stone, unless of recent formation—but few pebbles, and none over the lower and larger extent of surface.

4.—With all variations of texture and of exposure of soils, there is much uniformity of character—and especially in the natural poverty of the lands generally.

To these more obvious general characteristics, (the few exceptions to which will be passed by for the present,) I have formerly added some others, as deductions from reasoning or experience. Among these were the following:

5.—The naturally poor lands of this region, are incapable of being considerably and durably enriched by putrescent or organic manures alone.

6.—Such soils are greatly deficient in lime, and much more so than soils generally in the higher country.

7.—The proper application of lime, in every case, will be greatly beneficial and improving to the soil, and also will serve to make the subsequent use of putrescent manures of much more durable effect.

8.—Gypsum, as manure, was of no effect on these poor lands, before their being well and sufficiently limed; and generally was efficacious, on leguminous crops afterwards, probably in every case of full previous and needed effect of the lime, on both soil and sub-soil.

These latter positions, with others, were maintained in my "Essay on Calcareous Manures," and therefore will not be discussed again here, but assumed as established and understood.

In all these respects, and as to every natural and artificial quality named, the lands lying higher than, or westward of, the falls, (termed in Virginia, the Piedmont region,) are different, and, in some of the points, of entirely opposite character. They have no such uniformity of surface, or of constitution of soil. They were much richer naturally, and are generally capable of being much and profitably improved by putrescent manures. Lime, as manure, has rarely had there any appreciable effect, while gypsum is generally beneficial as manure. As in the other case (of the tide-water lands,) it is designed here to state general rules and facts, and not to stop to note and explain (or to attempt to explain all) exceptional soils and cases, whether really or apparently only in contradiction. Whether the interesting facts of cases so opposed, can be accounted for satisfactorily, may well be doubted. But it is certain that the manner of the geological formation of the soils and sub-soils ot these two neighboring regions was entirely different: and in tracing these differences of origin, much light may be thrown on the existing differences of physical structure, and chemical constitution of the soils of the different regions; and possibly such imperfect lights may guide future and better prepared inquirers to more useful results. I will now endeavor to trace the former great operations of nature, in producing changes, and bringing about the very different existing conditions of these different regions, and thence attempt to deduce their different agricultural capabilities.

The investigations of Geologists, extended more or less through all the well-known portions of the globe, have served to discover and establish certain great fundamental truths, as to the changes which the earth has undergone since its creation, or its oldest ascertained condition. These doctrines are now of universal acceptation. Therefore, in taking them as bases on which to found my observations and reasoning, it will only be necessary for me to refer to these recognized truths, and assume them as unquestionable premises—and not to argue for their correctness, or to enter into their details. But, speaking as a mere agriculturist, having but little pretensions to science, and addressing hearers of my own class, and not generally better instructed, it will be proper and excusable to be somewhat more explanatory than would otherwise be necessary. When assuming as premises the admitted truths of Geology, I merely use the lights of others, now common to all learners. But in making deductions from these borrowed premises, and especially in applying them to the circumstances and character of the region in question, the observations and the reasoning will be my own, and consequently, the errors and the responsibility.

From the more recent and universally admitted doctrines of Geology, we learn that the oldest (or first existing) known material of the globe is granite, which, in its original place, or position, is the lowest rock from the present surface of the earth, and is supposed to constitute the interior part, and the far greater bulk of the whole globe. The first great agent of change, or of formation of the entire globe, was fire or intense heat; and the early condition of all the parts was that of fusion, or fluidity produced by intense heat. Of this agency and this origin, the interior and older rocks, and the granite in general, offer abundant evidences In after ages, when the outer part of the globe had cooled down to solidity, and water had been deposited in full quantity, aqueous agencies succeeded to the previous igneous, and thereafter most of the changes in the upper beds, or what is termed the "crust" of the globe, were thus produced.

Next followed upon the outer and exposed portions of the globe, the various results of the action of water, when in motion, and also when more or less tranquil, and whether as rain or ice, and in seas and lakes, rivers and rivulets, or in violent and transient torrents and inundations. These agencies were sufficient to produce all the effects ascribed to them, great and marvelous as they are. The highest pinnacles of mountains, (previously raised by igneous or volcanic action,) were gradually disintegrated and washed down, and the ruins thereof, suspended in, or rolled by moving waters, were deposited in, and filled the lowest depths of the ocean, as well as others on the lands—and thus in a sufficient time, of unknown and inconceivable duration, the whole surface and outside material of the globe were changed mainly by aqueous abrasion, removal, transportation, and the mingling and final re-deposition of the parts. The whole of the successive and connected deposits of such earthy matters, by one of these great operations, though sub-divided into different varieties, or beds, are considered as one "formation," and possess peculiar characteristics, distinguishing it from all other formations. All of the many successive formations, and indeed of the several sub-divisions of each, except a few of the oldest, or the primitive rocks (of igneous origin,) have fossil remains of animals and vegetables proving conclusively that species entirely different occupied the surface of the earth and its waters, during the deposition of each such great formation. Also, between the several different, but next adjacent sub-divisions of each formation, there are such general changes and substitutions (though not universal,) of animal life, as to show that the conditions necessary to sustain life were greatly varied, with every such minor change of the earth's surface. Thus many races and kinds of living beings have successively been created, occupied the earth and its waters, and then perished—each of such races having been incapable of existing in the very different conditions of either the next preceding, or the next succeeding period, of the earth's many great changes.

Thus, in succession, and in uniform order of time and position, throughout the known world, have been produced, as secondary and later acts of construction and creation by the All-wise and All-benevolent God, all of the many successive formations, and their several sub-divisions of strata, and the different races and numerous species of animals that successively inhabited each.—In some parts of the world, certain rocks, or strata, or in some cases even whole formations, are wanting. But of such beds or rocks as are present in any one locality, the order of succession in which they occur, is always the same as of the similar beds and rocks found in any other part of the world.

While these sundry formations were successively in progress, by aqueous action and sedimentary deposition of transported materials, the igneous action was still powerful, and unceasing in operation, though irregular and long remitting in numerous localities—and the effects were of the greatest magnitude and importance. During all the successive periods of aqueous formations, internal heat and volcanic forces operated to upheave and lift, to greater elevations, the solid rocks of the overlying formations, (the former soft and loose sedimentary deposits, solidified to stone by time and pressure)—in some cases leaving the upheaved strata nearly horizontal, and in others, and more generally, raising them greatly on one side, and depressing them on the other. In this manner, the mountain ranges of greatest extent and height were upheaved, from beneath the former ocean, and the previously lower beds, or formations, raised and protruded through the former upper and horizontal strata of sedimentary deposition. And the separated edges of the ruptured strata were thus lifted, so as to be greatly inclined, or in some cases, the strata placed nearly or quite perpendicular to their original horizontal position. Such effects, however separated by time, and whether of slow and gradual, or in part of rapid production, have been extended through vast spaces, and at different times, have distinctly marked and changed every known part of the surface of the globe, except in the very recent deposits In most cases the lower strata have been raised and thrust upward in their solid form, and remain unchanged, except in their new position and inclination. In other cases, the granite, from beneath all the later formed and stratified rocks, has been forced through them, (by volcanic action) in a softened or molten and fluid state, raised above what were previously the highest and newest deposits, and so is left on the surface of the latest sedimentary strata.

Thus, by the great and extended effects of internal igneous and volcanic agencies, the before nearly horizontal stratified rocks and beds were all broken through and raised, and inclined, so that the broken and raised edges of all the strata were brought somewhere to the new surface of the earth, and so are exposed to view and examination. Such is the usual present condition of all regions composed of any of the older formations, or indeed of any other than of the latest, and very recent, not yet much altered in position, since their being originally deposited as sediment.

The greatest and most numerous of these effects are of antiquity far beyond, not only the traditions, but even the existence of mankind. But, even if the remaining present appearances did not fully prove and explain the greatest and oldest of these volcanic changes, and upheavals of portions of the earth, there have been enough of such operations and effects, both of upheaval and of subsidence, for examples and proofs, which have occurred within the time of reliable history, and even within very recent times. Every locality of primitive, or of the early formations, exhibits either manifest effects of ancient igneous action, or of subsequent upheavals, which have thrown all the stratified rocks into more or less inclined or other changed and irregular positions.

From these general and received geological doctrines, I will proceed to remark upon the actual and observed Geological features of the country next adjoining to, and both westward and eastward of the granite falls of the rivers flowing into the Atlantic ocean.

Though the eastern falls of the rivers have been heretofore supposed to make the line of separation between two very different agricultural regions, (the differences of which have been adverted to above, and some of which are generally recognized by even slight observers—) and though this belief is not far wrong, still it is not entirely correct. The true line of division, as I now believe, between these regions of very different agricultural characters, is one of irregular and varying course, lying westward from, and something like parallel to, and not far distant from the other line so distinctly marked by the eastern falls of the Atlantic rivers.—This supposed line of division has not been fixed by actual observation at more than a few precise points. It may, however, be easily determined by observation, at any part of its course. And when ascertained throughout, this line, separating, (as now inferred) surfaces and regions of different agricultural characters, will be found to be identical with the line separating the higher and *denuded* region, from the adjacent and lower region covered by the deposited sediment or *drift* of materials washed and transported from the higher levels. These terms and agencies as here applied, will presently be explained, and reasons stated for the supposed operations. And in advance of more full explanation and description, (and even of knowing the actual locality of the dividing line in question,) for convenience of reference and distinction, I will call the upper or north-western, the *denuded* region, and the adjoining lower or south-eastern, the *drift* region.* The precise line of separa-

*This application of the term "drift," is without scientific authority, and therefore would be pronounced illegitimate and improper. It is admitted, (as I believe,) that no geologist who has viewed or written upon this tide-water region, has deemed it of drift formation—and Professor Emmons, the present Geological Surveyor of North Carolina has expressly stated, (in his first Report,) that "there is not a boulder or a drift bed in North Carolina. The masses that have been moved in this and other Southern States, have been by means of rivers and oceanic waves—those means which exist now, and are in operation under our eyes."—(p. 104). The first designation for, and the manner of, the formation of the tide-water region, received and understood by geologists, was that of "alluvial." The formation has also been ascribed to earth being thrown up by the waves and action of the ocean, and the land being thus formed by materials moved from the former bottom of the ocean. While, indeed, both these modes of formation were, and are still, in operation for particular and very narrow spaces, and with very different results, it is manifestly incorrect, and even absurd, to assume either or both of these operations as the producing causes of much the greater part of the tide-water region. The upper beds of the great region in question, have also been referred to by geologists as "sedimentary beds," and tertiary beds." These terms are far from being exact, or even loosely descriptive. The under-lying marl beds (of entirely different oriration between the "denuded" and the "drift" regions, may be fixed by any careful observer, for any locality, by noting the inclination, &c., of the strata of earth, where exposed in deep excavations, or high and steep river bluffs. A well marked point of separation is where the Richmond and Danville railway crosses the Appomatox river. Eastward, and below that point, the strata are horizontal, or nearly so, and present the usual evidences of the materials having been transported and deposited by aqueous action.—On the westward, the strata are variously contorted and greatly inclined, showing changes produced by igneous action. The undetermined line separating these regions, from within Maryland to North Carolina, varies from 5 to more than 25 miles above the line of the falls—and seems generally to diverge more and more from the falls, as proceeding southward. The western limits of this "denuded" region are still more uncertain; and therefore I will not include in my remarks, or the application of my reasoning, the range of the southwest mountains, or their eastern slopes.—With such entire absence of designated western boundaries, so much of the great "denuded" region as will be here under consideration, lies wholly in, and includes much the largest portion of the space between the falls of the rivers and the Blue Ridge mountains, which space, in Virginia, is known as the Piedmont region. The drift region includes the whole of the (so-called) tide-water district, and also the next adjacent (and undetermined) narrow strip of the Piedmont district.

The whole portion under consideration of what is here termed the denuded region, with some partial exceptions of later origin, is of igneous formation or alteration, as exhibited at and near the present surface. Granite, either in boulders, and water-borne from higher surfaces, or in places where upheaved from below, by igneous force, is the prevailing rock, and is to be seen in various stages

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gin,) belong to the tertiary formation, and from them have been taken that name to be applied to the much more recent beds lying above. These recent beds are certainly of "sedimentary" formation: but so are much the greater number of all the different beds, and even of the more ancient rocks, (all of aqueous origin) to the greatest depths known. My application of the term "drift," if illegitimate, or without scientific sanction, will at least, (as here used and defined) be clear and precise. If the *thing* meant is understood, the *name* for it is of little importance.

of disintegration. The strata of all kinds of visible rocks—or of earthy strata, obviously formed by the decomposition of rocks—are greatly inclined—and in some cases, as contorted and irregular as if they had been pressed upward when the material was so heated as to be in a semi-fluid state. There is every appearance of all the visible stratified rocks having been so pressed upward, and tilted so that all were brought obliquely to the surface, and their edges there exposed to all the disintegrating, transporting and commingling agencies of the atmosphere and its changes of temperature, and of water, whether of rains or of floods. Here, as elsewhere, such agencies and influences, operating on such materials and subjects, have served to reduce solid rocks more or less to pebbles, gravel, sand and clay—and thus, by mixture of these materials with lime, magnesia, potash, phosphates, &c., (derived in small quantities from sundry compound igneous rocks,) and with organic matter, have been produced all the various existing surface soils.

Throughout all the tide-water region, (i.e. below the falls of the rivers,) at intervals of greater or less extent, and at greater or less depths below the present surface of the earth, there are to be found beds of what is improperly termed "marl," which were manifestly formed, during long successions of ages on the bottom of the then ocean, partly by continued earthy sediment, and partly by the gradual deposition of the shells of the numerous shell-fish, which lived and died there, and which were of species and of races which are now either generally or wholly extinct. No transient flood or current, however violent, can be supposed to have removed these shells from a distant ocean bottom to their present positions, which are generally elevated far above the level of the surface of the ocean, and very much more above its bottom. Many of these shells are manifestly in the places where the inhabiting animals died.—Some, in their present uniform position, even indicate the habits of the former living animals, agreeing with others of the same genus, (though of different species) now in existence. From these and other satisfactory evidences, which are not required to be adduced here, it is certain that these shells, where mostly whole, are now in what were their native beds. And hence it follows, that the much higher present elevation of these remains, and their entire beds, must have been produced by upheaval from their former lower position. The beds of shells, which afford this ample proof, are now unbroken by the upheaving force, and are little inclined, or remain nearly horizontal, as seen at any one locality, and for so much space as can be included in one view. But still there is a slight and irregular dip of the original beds toward the East and South; and in addition, there is a declining of the plane of the present surface of the marl strata, caused by the early denuding agency which will be explained, and which occurred before this new denuded surface of the marl was again covered by other drift earth, transported from the higher country. There is rarely seen exposed any different stratum below the lowest marine shells. When such inferior beds have been reached, in excavating marl, they have not been carefully noticed, because no importance was attached to their difference of origin. The eocene marl, (or oldest tertiary) on the Pamunkey river, where rising highest in level, (not far below the falls) permits the underlying bed to be seen. It consisted of rounded (or water-worn,) hard silicious pebbles, imbedded in gravel and sand, and showing no appearance of marine remains, or origin. It seemed to my cursory and then careless observation, to be what I would now deem a formation by ancient drift, older, of course, than this oldest of the tertiary marls, and of materials transported from a far distant and much more elevated locality.

In the recent excavation for a new street in Richmond, (on Council Chamber Hill, nearly as high as the site of the Capitol,) the miocene tertiary was exposed, in numerous and perfect casts or impressions of shells—though nothing of the shells, nor even any of their calcareous matter remains. This uncommon elevation shows that the original sea-bottom has been raised more than 150 feet perpendicular above the present ocean surface, to the present elevation. If any observer, having the opportunity, would notice the digging of a well through this miocene bed in Richmond, the lowest depth of the bed could be ascertained, and also what is the character, and the geological origin of the underlying bed.

The marl beds, (or their now existing remains,) rarely extend quite as far westward as the present falls of the rivers. Near Petersburg and the Appomattox, only, is marl found extending some two miles above the lower falls. Therefore, as the position of the marine remains must fix the former extent of the ocean-bottom, we must infer that the former shore of the ocean was nearly identical with the line of the present falls of the rivers. When the granite of the falls, and of the higher country was upheaved, the widely extended movement also raised the neighboring ocean bottom, and laid it bare, throwing back the new shore far eastward of the line of the former shore. This then new land, the raised bottom of the ocean, and largely composed of marine relics, was but slightly altered from its previous slope or level, and then became the general new and dry surface, extending from the line of the falls to the then removed sea-shore. This new sea shore was somewhere midway between the falls, and the present ocean beach, which is still farther removed, by the subsequent deposition of drift materials.*

* Borings for designed Artesian wells have been made (though all were interrupted before completion,) at three different localities, Norfolk, Edenton, and Fortress Monroe, of the low lands, and near the present deep waters. Of the boring at Norfolk, I have learned nothing more than that shell marl, (or a bed containing fossil sea-shells,) was first reached at the depth of about 40 feet. In this connection it may be mentioned that no well in Northampton county, (on the Atlantic, and eastward of the Chesapeeke,) has touched the marl formation—and some of these wells were dug forty feet deep. The boring at Edenton was executed by the direction, and at the expense of Messrs. J. B. Skinner and J. C. Johnson—the former of whom furnished the following notes to Professor Mitchell, who first published them:

ORDER AND THICKNESS OF STRATA UNDER EDENTON, ON ALBEMARLE SOUND.

	Separate Strata,		Total.
Sand, from surface to depth of	8 feet		8
Sand of different kind,	5½		13½
Clay	5½		19
Vegetable matter. [Qu.: Peat ? or Marsh grass ?]	3		22
Sand,	4½		26½
Blue Clay,	2½		29
Vegetable Matter,	4		33
Quick-sand,	9		42
Gravel,	0½		42½
Clay,	4½		47
Sand and Marine Shells,	7½	[Continuous beds of marl or earth with fossil shells, 139½ feet.]	54½
Shell rock,	3		57½
Sand and Marine Shells,	21		78½
Clay and Shells,	68½		146
Sand and Shells,	1½		147½
Clay and Shells,	35		182½
Sand and Marine Substances,	3		185½
Quick-sand.	2½		188
Clay,	2		190

"Left off in the clay, the depth of which is unknown. The shells brought up from 182

All soils were originally formed by the disintegration or decomposition of the different rocks. In the condition of things above supposed, each rock, or bed, of the Geological formation, thus exposed in succession, in the higher country, would be acted on by atmospherical influences and their changes,. &c., according to the fitness of the several rocks to be so acted on, each, or its exposed surface, would be gradually converted to earth or soil. And if there were no transporting agencies, to remove and mingle these separate earths, or soils, each one would continue to be of the same chemical constitution with its parent rocks, until new causes came into operation, to produce mixtures and changes. In such cases, of isolated earths, the sandstones would, by disintegration only, be-

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feet resemble exactly, those found elsewhere at the surface," [i.e. in out-croppings of marl, and of the *miocene* era, as presumed.]

The boring at Fortress Mouroe (Old Point Comfort,) was noted more carefully in a record of the operations, which I was permitted to see in the Engineer's office, and to abstract from it the following notes. Also, specimens of all the various beds, (and of each day's boring,) have been carefully preserved there, nailed up in boxes, which there was not time or opportunity for me to examine throughout. A few of the upper specimens of the shelly earth, showed it to be sandy and poor shell-marl, of the miocene age. It is intended that the boring operations, suspended at the depth of 312 feet, shall be again resumed, and continued as deep as may be necessary to obtain water.

STRATA PASSED THROUGH BY THE BORING, AT OLD POINT COMFORT.

From Surface,			Total.
Marsh soil,	to depth of	[5½]	5 or 6 feet.
Then, fine dark sand, clean,		[12½]	18
Angular and light colored sand, containing coarser sand and rounded pebbles, and mud, &c,,		[10]	28
Sand and mud, in different layers,		[12]	40
Some stone, sand and mud,		[5]	45
Then miocene marl,		[200]	245
The lowest layers of the last showed some "green-sand and shells," and next, hard stone, full of shells.—[Both these last probably in the *eocene* bed].			
Below, little or no change of earth, all being sand and bluish clay, mixed with shells.		[16]	260
The same, but the fragments of shells smaller, and pieces of stone, harder,		[9]	269
Below, earth softer as descending, and of light sky-blue color—[no reference made to shells, and, therefore, I infer that there were none in these,]		[43]	312

The fossil shells, or marine, continuous deposits here, were 224 feet in thickness.

In digging for the canal (16 feet deep and 3 miles long,) through the low peninsula separating Clubfoot and Harlow's creek, (south of the lower Neuse, North Carolina,) the must infer that the former shore of the ocean was nearly identical with the line of the present falls of the rivers. When the granite of the falls, and of the higher country was upheaved, the widely extended movement also raised the neighboring ocean bottom, and laid it bare, throwing back the new shore far eastward of the line of the former shore. This then new land, the raised bottom of the ocean, and largely composed of marine relics, was but slightly altered from its previous slope or level, and then became the general new and dry surface, extending from the line of the falls to the then removed sea-shore. This new sea shore was somewhere midway between the falls, and the present ocean beach, which is still farther removed, by the subsequent deposition of drift materials.*

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But, in point of fact, there cannot long remain any earth, or soil, formed by disintegration of rock, free from foreign admixtures.—Transporting and mixing agencies are never altogether wanting—and earths, thus formed by nature, cannot long remain separate. On a naked surface, (and much more after tillage has been introduced,) the winds have a very powerful agency in removing soil from every exposed space to every other neighboring locality.—

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1.—"Black mould—such as usually found in the eastern swamps, very rich. [Peaty formation ?]

2.—Potter's clay—yellowish brown color.

3.—A thin layer of sand, full of sea-shells, and the remains of land-animals, (mammoth and fossil elephant.) A profusion of shells, principally conch-shells, scallops and clams, such as are found near Cape Lookout, [recent shells]. The clam-shells, however, are frequently of larger size than the recent. (This layer sometimes wanting).

4.—A soft blue clay—said by the inhabitants to correspond in character precisely with the mud of the adjacent ocean.

All the words or figures above within brackets [thus,] are added by the copyist, for more full explanation ; and if, in any case erroneous, the errors should not be charged to the original notes.

Within a few miles of the boring on Old Point Comfort, near Back river, the miocene marl is within 3 or 4 feet of the surface of the arable land.

E. R.

Water is a much more powerful agent, in many cases, for transporting and intermixing soils. It is not necessary here, and for this case, to describe such effects—or of the more moderately acting powers of the atmosphere, rain, and changes of temperature—inasmuch as all such milder agencies and influences were superseded, in this case, by one immeasurably more powerful. This was the great flood which deeply washed away and denuded the surface and especially the higher portions of the upper country, and spread the removed earth, in drift, deeply over all the lower country, and carried off the finer, lighter and richer parts to be partly accumulated under eddying or tranquil water, or more generally wasted in the ocean.

Geologists have ascertained the former existence, and have traced in many localities the course and the effects, of an ancient and mighty flood of water, rushing from the north, and which has left abundent traces of its passage, and results of its transporting violence and power, and the later deposition of its burden of suspended and drifted earth. It is not needed to quote authorities for the former existence of such a flood, or to discuss any of its supposed causes and sources. I do not know whether any competent Geologist has examined,in reference to this flood, the particular regions here under consideration. But nowhere can evidences of the drift operation and formation, (as here understood,) thus produced, be more distinct and more generally manifest, than in the great area which is here termed the drift region.

Over the surfaces which now make the eastern portions of Virginia, Nort Carolina and the neighboring Atlantic States, the course of the flood was from north-west to south-east. In the same direction, or nearly such, also, is the general direction of all the rivers, passing through the tide-water region, or of the broad bottoms through which these rivers there meander. These wide bottoms were marked and cut out by the earlier and more violent currents of this great flood, while its later and less violent and shallower waters yet covered all the intervening spaces or intervals between the lower borders of the present rivers.

What was the height, violence, and duration of this flood can no more be known than its cause or source. It doubtless came from come and remain barren sands. The slates and other aluminous rocks, would be clays, or clayey soils, and the poorer in proportion to the purity, or freedom from all other matters, of the parent rock. The chalk and limestone, if such rocks had been there, would become almost pure calcareous soils. Of these, however, there were almost none, in the Piedmont region. It would have been only the rocks of mixed composition, containing lime, magnesia, or potash, as hornblende, soap-stone, granite, &c., that separately could have made compound soils, of even moderate fertility. The tide-water region would have been very different. Consisting of the upheaved marl, that is of sand and clay with abundant calcareous and some other fertilizing ingredients (phosphate of lime, common salt, and in some cases sulphate of lime,) the disintegration would have produced soils with abundant elements of fertility, and as much superior to those of the Piedmont region, as in later time, and by differently operating causes, the soils of the tide-water region were actually and generally worse than the others.

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What was the height, violence, and duration of this flood can no more be known than its cause or source. It doubtless came from westward of the Blue Ridge mountains, and it may have even overtopped their present height. It probably was more than a thousand feet in depth, when rushing over the now Piedmont region—and during its long eastward passage, swept off some hundred or more feet in depth of earth and rock—depositing the transported earth over the lower lands, and in the ocean. I have had but small opportunity to trace the effects of this flood in the upper country, which is supposed to have been thereby generally denuded; though, in numerous lower places, it received and retained the materials removed from the still higher lands farther westward. If the general fact be true of such a flood having been poured in such a direction, every careful observer, in his own neighborhood, can find enough of facts for confirmation—or for contradiction, if the doctrine is not true. In a hilly part of the upper country, the evidences of such action may be sought for in various results, which would be modified by every different shape of surface. If the loose stones are rounded, it shows that they were water-rolled. If there are no rounded pebbles, except such as are of very hard material, it shows that these had been transported a long distance, in traversing which, all the softer aluminous and calcareous stones had been rubbed to powder, or so as to be suspended in, and floated off by water. If the hill-sides facing the north and west are always steeper than the sides towards the south and west—and still more, if the latter have on their lower slopes and at their bases, accumulations of rolled pebbles and rounded gravel, decreasing in size with increasing distance from the hill, all these would be striking evidences of the action of such a flood, and of its direction.

In the tide-water region, the results now visible, at the surface, are not of denudation, but of universal covering by drifted matter—pebbles, gravel, sand, and more rarely, clay. Yet the denuding agency was in operation here, also, at first, and powerfully, before the abated violence of the flood permitted the deposition of sediment. The early denuding action may be seen in numerous cases. On the upper surface of many beds of higher-lying and firm marl, there are numerous narrow and deep depressions, either funnel-shaped, or cylindrical with nearly perpendicular sides, which were evidently cut out by the whirling currents of rapid water. These hollows in the marl are filled by a fine and loose reddish earth, of subsequent deposition. Such a whirl of water could not have existed at the bottom of the sea—or if existing, and strong enough to thus excavate compact marl, it would have been permanent, and must have prevented shell-fish living there, or the loose and light dead shells, and their small fragments, remaining there. The shells of other marl, and in numerous localities, have been abraded to coarse powder, and removed and deposited elsewhere, according to specific gravity, together with the sand and other materials of the bed. But the most striking illustration of this former denudation of marl may be seen along the Pamunkey river, where, for 20 or 30 miles, I have traced the different (now slightly inclined) layers of the original bed, successively rising to, and "cropping out," or showing higher in the present bed, as the observer proceeds up the river; or otherwise, as going eastward (down the course of the river,) each such layer successively dips and disappears.* After much of the upper and then exposed edges of the different layers of marl had been so washed away, so as to make a new and nearly horizontal surface, then the flood, in after time, and with abated velocity, brought from above and deposited thereon, first its coarser sediment, of rolled pebbles, and then gravel and sand, and finally the lighter and richer earth which now makes the surface soil of the bottom land.

The evidences, in visible exposures, of this early denuding action on the now tide-water region, are rare, because they were subsequently covered and concealed by the now overlying deposits of drift earth. But of the later and general deposition of the drift, abundant evidences are visible, some of which may be seen in almost every excavation, or surface of any exposed perpendicular section of earth. These appearances of the strata, serving as proofs of their origin, will be described hereafter.

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* A description and figured illustration of this, in "Essay on Calcareous Manures" at pages 483–5 of 5th Edition.

time indicated by the geological facts observed, the ocean extended as far westward as the line of the present granite falls, and was of sufficient depth for the production, and successive living and dying of the shell-fish, whose remaining shells and fragments constituted the beds of the now remaining marl. Subsequently this area of tertiary formation, on its western side, was, by volcanic force, upheaved high above the surface of the ocean, and less and less so toward the east, if the eastern side (of former ocean bottom,) was not actually depressed. (Near the present sea-coast the marl lies much lower than the level of the ocean; at Norfolk, as much as 40 feet). Next, of this new raised surface of marl, where highest or otherwise most exposed, the upper portion was washed off by the violent current of the flood from the north-west; and the removed material of shells was again deposited either at short distances, and in new layers of marl, composed of the rubbish and small fragments of shells—or, otherwise, much of the more reduced and lighter calcacareous matter was floated far into the ocean, and lost. Next, by the first abating of the violence of the flood, its currents ceased to denude the lower and flatter surface of the now tide-water region, and then the flood began to leave thereon the earth torn from the higher country.

To trace the operation of the great flood, and the depositing its burden of drift stony and earthy matter, we have only to consider the enormous volume and power of the water, the general direction, and also the many variations of the currents, and then look to the existing condition of the drift region or the results, and also or the explanation of many (at first) embarrassing difficulties in particular facts and matters of observation.

Whatever was the cause or source, and also the duration of so mighty a flood, the violence of the current must have varied much at different times, and under changing conditions, so as to produce various effects, both in removing and depositing the materials of drift. At first, and when the current was most rapid, and its volume greatest, nearly its whole operation was denuding, or removing earth and stone, and below as well as above the present falls. As the first and greatest violence of the flood moderated, it began and continued to drop the transported matters on all the more eastern surface—and also to extend that surface more and more into and above the ocean, and making more and more of what is now the low-land, bordering on the present ocean beach. There was not only the general and gradual lessening of the volume and violence of the flood, serving generally to change the manner and kinds of its deposited earth, but also many changes of the direction and force of particular currents, producing at particular places successive and many changes of their power and effects. Thus, at one place, the covering water was at some times a violent and denuding current, and at other times comparatively tranquil, or eddying. And such fluctuations might return and be re-produced along the same course, as obstructions of hills, or high shoals, in the upper country served to direct and divert the currents, or as the subsequent removal (by washing away) of such obstacles, allowed the current to take a new direction and shorter course, and with renewed violence, to the ocean, and its former channel to be filled by comparatively tranquil water, and raised by its deposited sediment. The channel or passage-way of each of these particular and temporary currents, in the now drift region, would, for the time be deepened, by washing away the still soft and loose deposit of the then very recent soft sediment. In these deepened channels of the more rapid currents, the heaviest drift materials only could be left—either large or small pebbles, gravel or coarse sand, according to the then burden and action of the current—while in the more tranquil water, close on each side, the finer suspended earth only would be let fall, and there raise the bottom by the accumulation, even while the strong current alongside might be still deepening its channel, and bearing off the removed earth. Then, as the direction and positions of particular currents would be changed, the channels previously cut out, and then covered by more tranquil water, would be filled with the finer and lighter suspended earth—and the new currents would cut new and deep channels through the previously formed shoals, sweeping the fine drift much farther, or even into the ocean, and dropping into the new deep channels the drifted stones, or other materials too heavy to be carried far-time indicated by the geological facts observed, the ocean extended as far westward as the line of the present granite falls, and was of sufficient depth for the production, and successive living and dying of the shell-fish, whose remaining shells and fragments constituted the beds of the now remaining marl. Subsequently this area of tertiary formation, on its western side, was, by volcanic force, upheaved high above the surface of the ocean, and less and less so toward the east, if the eastern side (of former ocean bottom,) was not actually depressed. (Near the present sea-coast the marl lies much lower than the level of the ocean; at Norfolk, as much as 40 feet). Next, of this new raised surface of marl, where highest or otherwise most exposed, the upper portion was washed off by the violent current of the flood from the north-west; and the removed material of shells was again deposited either at short distances, and in new layers of marl, composed of the rubbish and small fragments of shells—or, otherwise, much of the more reduced and lighter calcareous matter was floated far into the ocean, and lost. Next, by the first abating of the violence of the flood, its currents ceased to denude the lower and flatter surface of the now tide-water region, and then the flood began to leave thereon the earth torn from the higher country.

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So far, the great flood, however abated in depth and power, has been considered as still covering the whole area of the now drift region. But later, as the water still diminished, its flow would be contracted to the last made channels of the latest partial currents—and the broader intervals between these channels would be gradually left bare, and be no longer subject to changes, either in losses by secondary denudation, or of gains by accession of drift. These high interval lands are now the highest ridge or table land of the drift region—of which the plane of their general outline and highest surface, is remarkably even, and nearly horizontal—but gradually and regularly dipping from the height above the falls of the rivers to the sea shore. The water, now confined to the channels of the last formed currents, within these passages still had great force, which was in part exerted in continuing to deepen the then channels. But the borders of these passage-ways would necessarily be higher, and the covering water, shallow and more tranquil; and on such places, the stiller water would begin to deposit its finer and richer suspended earth, while, where deep and swift, in the middle of the current, it would be still cutting its channel deeper, (into the previously deposited drift,) and bearing off the loosened earth towards the ocean. The water, continuing to decrease in volume, would next be drawn within narrower limits of breadth, and thus

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leave bare the outer and higher margins, after having previously covered these also with a deposit of the lighter and richer earth.—This process would continue to be repeated, until the flood entirely subsided. Then the latest and deepest cut channels, for the latest currents, would be left bare, and to serve as broad bottoms through which the present rivers flow, in meandering beds.

Instead of pursuing and describing the supposed progress of these changes, I will refer to existing facts of the drift region, open to present observation, and will concisely indicate the conformity of these facts with the supposed causes, as above presented.

1.—All the rivers, and also the estuaries and bays, which empty through the tide-water region, from New York to Georgia, have their general courses directing between south and west, and mostly nearer to the middle between these points than to either extreme. Such, or as nearly as could be, must have been the directions of the various separate currents of the great flood, which marked and excavated the bottoms through which these rivers and estuaries flow.

2.—The number and close vicinity of many of these rivers, and also the depths and widths of their channels or beds, have no relation or proportion to the amount of water now requiring channels for their discharge. This last fact, if considered without reference to the cause here supposed, would be a geographical puzzle. It would be incomprehensible, for example, why four great channels should have been provided, and so near together, for the lower waters of the Potomac, Rappahannock, York and James rivers. Still more incomprehensible would it be, why the five large rivers (or rather estuaries) which empty into the north side of Albemarle Sound, should exist, and in so small a space, and their head-springs so near together, nearly all rising in the Dismal Swamp, when all their very scant supplies of water would have ample room for passage through the smallest of these sundry channels. Of these rivers, the Chowan only receives, from the small head tributaries (the Meherrin, Nottoway and Blackwater,) a moderate supply of water from the land, but not enough to need for passage-way, one-twentieth part of the broad Chowan, five miles wide near its mouth. Yet the next river coming from the north-west, the great Roanoke, discharges much more water than all the other five rivers, and yet its lower channel is more contracted than the least and shortest of the other rivers. Here, more marked than in other cases, it is seen that the passage-ways of the rivers bear no proportion to the volumes of water they now convey; and, therefore, the existing rivers could not have been the agents which cut out their valleys and passage-ways.

3.—Another puzzle would be to discover, what has cut out and shaped the several successive broad and flat terraces which, on one or both sides, border all our rivers in the drift region, and which are termed "first," "second" and "third low-grounds," when there are so many as three flats below the highest or table land.—One or more of such terraces are seen on rivers whose highest waters can never approach the lowest surface of such land. Moreover, the breadths of these highest flats are entirely disproportioned to the sizes of their respective rivers, and the amounts of water they convey even at the highest floods. But, narrow as is the Pamunkey, (for example.) and slight the rise of its highest inundations, the size of the ancient current, which cut out this bottom, might, at first, well have required all the very wide space between the first cutting down of the now table land, (thereby shaping the third terrace, or highest "low-ground,") and next, for the lowered and contracted current, the deeper and narrower depression of the second terrace, (usually there from three to five miles broad,) through which broad bottom the present narrow river meanders, among smaller spaces of "first low-ground," which latter only is subject to be covered by the highest freshes of the river.

4.—The strata of the drift region are nearly horizontal everywhere, and usually the divisions between the different strata, as of sand and clay, do not run into each other, by gradual change or intermixture, but alter suddenly, and at a well defined line of separation. Each stratum, separately, may exhibit in itself, and in the manner of its deposition, the operation of specific gravity; that is, in sand and gravel beds especially, the coarser and heavier parts are seen at and near the bottom of the stratum, and the grains are smaller and lighter as lying nearer to the top. But there is no such rule as to different contiguous strata; and the bed of heavier particles is as often above as below one of much lighter material. For example: near Richmond, along the Mechanicsville road, there is exposed to view a high-lying stratum of rounded pebbles, many of large size, compactly imbedded in gravelly sand, resting upon a stratum of clay, and in immediate contact with the clay. At the Tau river landing, at Tauborough, North Carolina, there is a deep gully, perpendicular to the course of the river, which exposes well to view an extensive cross-section of the bank. There a stratum of sand overlies another of clay, the lighter earth, which would be impossible, if both these earths had been suspended together in the same overflowing water, or deposited under the same circumstances. Like examples may be seen in almost every considerable excavation and exposure of different strata. And all such facts go to prove that each separate stratum, in one locality, was deposited under nearly uniform conditions of the flood, and therefore according to specific gravity. But the changes, from one to another of the strata were caused by changes of the conditions of the flood, and perhaps also by different supplies of drift materials, successively broken down and transported.

5.—Large stones, generally of granite, say from 100 to 2,000 pounds of weight, are seen rarely, and only along the margins of rivers, or on their terraces, between the falls and twenty miles below. Other rounded or rolled stones, extremely hard, and usually of smoothly worn surfaces, extend still lower down the country, and especially along the rivers. These latter stones lie mostly in distinct beds, compactly and closely imbedded in gravel and coarse sand; but in other cases, they are thinly scattered. These stones, where washed out by the river banks in quantity, have supplied the best materials for paving the streets of the towns. Rolled pebbles are rarely found, and only of small sizes, lower down the country; and at fifty miles below the falls, scarcely any small pebbles can be seen, and none at one hundred miles, and even gravel is there very rare. Within twenty miles below Augusta, on the Savannah, pebbles are entirely absent. All these facts obviously would be results of the various operations of the supposed great flood, in tearing up and bearing off the rocks of the higher country, rolling and rounding and reducing the harder, and grinding to powder the softer—and leaving the heaviest remains where the velocity of the current began to slacken, and the lighter in succession, in the farther moderated progress of the burdened waters.

6.—While the flood, at its greatest height and power was rolling along and depositing larger or smaller stones and pebbles, the silicious sand, derived from the same stony beds and materials, or otherwise washed out and separated from the previous earthy beds, would be borne along in much greater quantity, and successively deposited, in the order of the specific gravity of its particles, or as permitted by the abating violence of the flood, when over the most level bottom and nearly reaching to the sea. The gravel and coarse sand would stop first, and in least quantity. The finer sand would be suspended by the water longer, carried farther, and afterwards be deposited, more uniformly, and in greatest quantity, and as one of the earliest deposits there, on the then bottom, near to, or even beyond the previous margin of the ocean—and forming the lower bed of newly deposited earth, spread out by the flood into the ocean, and removing still farther eastward its former shore-line. Thus would be formed the existing lower *sand-bed*, which is general, but very irregular in thickness,and of coarse particles, on the higher parts of the drift region, and the sand becoming finer, and the deposit more thick and uniform, as extending farther from its sources, and dropped by more tranquil water, on the lowest and most level bottom. This great, and now underlying bed of pure sand, sloping very gradually downward towards the ocean (in the direction of the course of the former flood,) and subsequently covered more or less deeply by the later and usually more clayey deposits, is the great or universal water-bearing under-bed—and which, both when dry at top, or entirely filled and surcharged with water, (derived from a higher level of the sand-bed, in the higher country,) has most important relations to the natural wetness and the means for artificial drainage of the country. The existence and the remarkable features of this great under-lying sand-bed, are all manifest results of the supposed manner of geological formation, by the action of a great flood from the north-west—and no satisfactory explanation can be afforded in any other hypothesis, or reasoning.*

7.—Besides, in regard to the rounded stones, which have been carried to various distances below the falls, the kinds of earth deposited, and the shape of the present surface of the land, are both much more varied in the country next below the falls, than much nearer to the sea. In the former, there is no obvious depression of level of the table land. Far back from the tide-water rivers, the interval ridges, or table lands, between them, are generally level, and the depressions and beds of streams are shallow. But within a few miles of the larger rivers, the table land is cut down by numerous deep and narrow ravines, obviously formed by the passage of the smaller but yet powerful former currents, though now serving only to convey rivulets. The soils of the higher part of the drift region, next below the falls, are various. The level surface of the high table land, is generally of very fine particles, mostly silicious, but of closer texture, and stiffer than any other neighboring soil, or than most of true clay soils elsewhere. This fine and stiff sandy soil, was the last deposited at that place, by the then shallow and retreating, and nearly tranquil water of the flood, while the deeper and divided currents were still rushing furiously, and deepening the broad bottoms in which the present rivers flow. When the last covering waters left the table land, they, in passing off, cut down, through the previously deposited (and yet soft) drift, the most considerable of the deep and narrow ravines just described. But some, and these the steepest ravines, have been opened, or extended, through high ground, in eastern localities within very recent times, and under the eyes of persons now living, without the aid of more water than was supplied temporarily by rains. To this cause (and mostly in long passed times) may be ascribed the excavation of all the narrow and deep, and very steep-sided ravines which traverse the highest borders of our tide-water rivers, and

* The great importance of understanding the position and operation of this broadly extended under-bed of sand, in aid of drainage, will be again referred to, and more fully treated, in subsequent articles of these Sketches.

empty therein—while the much more extensive and broader valleys with gently sloping hill-sides were still earlier scooped out by the later currents of the great flood, and the sides were subsequently sloped and smoothed over by later operations of natural causes. But in either case, every valley or ravine was cut down through the previously deposited drift, and must have exposed, on each side, a section of all the various strata before deposited, from the surface of the table-land and later deposited drift, to the oldest at the bottom of the ravines. The sloping sides of such valleys must necessarily have soils composed of these several strata intermixed by rains and winds, and subsequently by tillage. Such mixed soils, though far from rich, are usually richer than the surface of the table land, with its one general soil of fine and close silicious sand.

The entire mass of earth, of various strata, excavated by the flood—not only from these narrow ravines, and small valleys, but from the broad valleys cut out by the greater currents, and in which the rivers now flow—intermixed, and transported by the later currents, served as materials to be deposited on the successive terraces, or elsewhere to fill depressions. This mixture of various materials, with other and richer matters from the upper country, served to make the good soils of the lower country, which are called "low-grounds," and usually and improperly designated as "alluvial." If the valleys had been cut through beds of marl, as generally was the case below the falls, then enough of the admixture would certainly have made material for rich soil. But if no such supply of calcareous material was intermixed in the valley of a river, the flat lands, bordering thereon, would probably be comparatively poor.

8.—As proceeding towards the ocean, the present surface of the drift region declines in elevation more and more, and becomes more and more level. These conditions are the necessary results of the out-spreading of the flood, and of the finer sand and the clay being carried farthest. There was no longer enough height of the deposit, above the level of the ocean, to permit the cutting down of any but shallow valleys and ravines. The soil of the higher ground is almost uniformly sandy and poor. The shallow depressions are more external, and level, and by accessions of vegetable matter, became rich swamp soil—a formation of soil later than the drift. Where nearest to the ocean, and to the neighboring estuaries and sounds, the surface of the land is but a few feet above ordinary high tide—and large spaces, even of firm ground, are too low for safe cultivation.

If the differences of agricultural character between the soils of the tide-water region and of most of the Piedmont lands, (as stated in an early part of these remarks,) result from their different geological conditions, as being respectively drift-formed and denuded soils, then it will be important to ascertain precisely the line of separation of these great areas. If sundry points in this line were ascertained and made known, by resident observers, it would be easy, by drawing a line on the map through all these points, to designate the common boundary of both the denuded and drift regions. In the latter, the whole of the tide-water district is included. If the primitive rocks and soil, in place, are to be found eastward of the falls, they are overlapped and concealed by the drift formation. Only one obvious instance of this has been observed by me, at the Halifax ferry, on the south side of the Roanoke, and about seven miles below the falls. There, in the steep river bank, the drift, in horizontal layers, is seen overlying the denuded, stony and greatly inclined strata, and the exact line of separation between the two is distinctly marked. The drift formation may be always known, where sections of earth are exposed to view, by the strata of different earths, as sand, clay, gravel or rounded pebbles, being nearly or apparently quite horizontal, and usually separated from each other by precise lines of demarkation. And in each bed of earthy material, there are manifest evidences of the earth having been suspended in (or rolled by) and then deposited from water. The rocks of the igneous regions either exhibit no stratification, or otherwise strata contorted, or if straight, the lines of separation are greatly inclined. In exposed sections, the earth often shows its origin from disintegrated rock, of which the process is not yet completed. Where the fragments of rocks whether in or lying above the earth, are angular, and none rounded, that will show that they have not been water-borne, or rolled—as is always the case with stones in the drift-region. Still, within the denuded region there are probably many places, which were formerly basin-shaped depressions much lower than the former general surface, and which therefore were filled with drift, and so remain, though with their present surfaces raised to the level of the surrounding denuded lands. It is an interesting question whether these spots exhibit the same agricultural peculiarities as do the lands of the great lower drift region. There must, however, from the nature of the case, be this difference: In these limited spaces of depression and subsequent covering by drift, the transported materials were brought from the adjacent high land, and could not have been much altered by attrition and suspension—whereas, the drift that covers the lower land had been completely changed, chemically as well as in mechanical texture, by its long transportation, attrition or suspension in water.

The differences between the soils of these different regions, in physical and also the more obvious agricultural characteristics, striking as they are, are less important than differences of chemical constitution, which no chemist has yet ascertained by tests or analysis of the different soils, or has otherwise thrown any light on the obscurity of the subject. Though I endeavored to invite the attention of scientific men to these difficulties many years ago, I am no more able now than then, from any such source of information, to supply the still needed explanations.

As stated concisely before, on the whole of the tide-water region, lime, or carbonate of lime, as manure, has never failed to act beneficially and profitably—and in the far greater number of cases, (and on all the high ridge, or table or other naturally poor land,) this manure has produced beneficial effects more speedy and remarkable than have been obtained on any other known lands, in any part of the known world. And on nearly throughout this same tide-water region, and on all these lands where lime and marl have been found most operative, if gypsum is applied before marling or liming the same land, it has no profitable, if any even perceptible effect. Yet on the same land, gypsum, before of no effect, if applied after good marling or liming, has been often found effective—and I suppose, would be generally effective.

In the denuded region, (within that portion of the Piedmont region, in Virginia, embraced in these remarks,) lime is said to be generally of no effect—and in but few of the many experiments of its application is it reported as producing any benefit, either early, or in any after times. Such total failures have been mostly on red soils. The few cases of evident benefit were on gray soils. Gypsum is said to be more or less operative on most of the lands in the denuded region.

If then, as seems probable, the soils of *drift* formation are especially deficient in lime, and will be especially improved by its application, the fact may serve to indicate where lime may be tried, above the falls, with a prospect of success—and on what other soils and localities there might be expected failure.

Besides the sure mode of determining the upper limits of the drift, by noting the appearance of the stratification, I believe that there may be found another test, in the presence, and thrifty growth of the lablolly pine, (*pinus tæda*). One of the most striking of the general differences of the country below the falls, and that above, (but not precisely to that line of division), is the very general growth (and exclusive second growth,) of pine trees in the former, and the general absence of pine in the latter region—and the almost entire absence of pine on the most fertile natural soils. These general facts, led me long ago to infer (erroneously) that the free growth of pine was, in itself, a sure indication of unusual deficiency of lime in the soil. And this I still deem correct, in the main, and as to the particular species of pine, (*p. tæda*) which formed the exclusive and luxuriant second growth of nearly all the lands below the falls, within my then range of observation. I had not then learned that different species of pines, probably indicating different kinds of soils, exclusively occupied different localities, of the same region and climate. Much of the worn land in the upper (or Piedmont) countries,is occupied as exclusively by second-growth pine,(though not so speedily,) as the lands below the falls. And in both the upper and lower country, these trees of second growth are alike designated as "old-field pines;" and the difference of their appearance and growth are supposed by most persons to be the effects of difference of soil on the same species of tree. But these growths, of the lower and upper localities are generally of different species. The almost universal second growth of the lower country being the loblolly pine (*pinus tæda*) and of the upper country, as in the counties of Amelia and Cumberland, &c., in Virginia, and Orange, in North Carolina, as exclusively of the short-leaf pine, (*pinus variabilis*) which is the best and ordinary timber pine, of original forest growth of most of the tide-water region of Virginia. The latter has very short leaves, growing generally two, but often three from one sheath, and very small cones. The former has much longer leaves, growing three from a sheath, except in some rare cases, on luxuriant young trees, on which some leaves grow four from a sheath. This latter tree is a more southern plant, and is not seen generally north of Fredericksburg, nor at all much farther north. As these two species, where equally favored by clim..te, severally and exclusively occupy the abandoned fields of different localities, it would be interesting to observe whether the common pine of the low country, (*p. tæda*) when found occupying land above the falls, does not indicate the presence of drift-formed soil and under-beds—and whether the change to second growth exclusively of the short-leaf pine, (*p. variabilis*) does not indicate a portion of the denuded or primitive formation.

The lands of the Piedmont region, (including all the surface here treated as part of the denuded region,) in their natural state of fertility, as found when first settled by the white race, and subjected to tillage, (or before the lands were subsequently again denuded, superficially and partially, by washing rain-water, acting on the tilled and carelessly ploughed slopes, and were further worn out by exhausting tillage—) were, in general, far more fertile than the great body of the lower drift-formed lands. And further—after most of the lands of both regions had been reduced to their former lowest state or exhaustion, by long continued tillage, and the washing off of all hilly surfaces, the lands of the lower country, in general, were still much the poorest. Again—since the recent course of improvement and resuscitation has been begun, and was extensively in successful progress in both regions, and wherever *no marl or lime has been used*, the lands of the denuded region have been found the most capable of being enriched by putrescent manures alone, and restored to a productive condition. Yet, between a region which had formerly been denuded of its surface earth, and another over which that removed earth had been spread, their comparative conditions as to fertility might be expected to be reversed—and that the formerly denuded lands would have remained the most impoverished, and the lands covered with the transported earth, would have been enriched by the spoils of the higher lands. Such, undoubtedly would have been the results, if the upper region had been merely stripped of its richer surface soil, or, in addition, of no great depth of subsoil—and the removed earth, in mixture, had been equally distributed over all the surface of the lower lands, and whether these had first been also denuded, or not. But this was very far from being the case, as appears from the existing geological indications and evidences. Not only was the soil of the upper lands swept off, but the inferior earth, and stone, to great depths, were torn up and removed from the denuded region. After losing the richer surface soil, it mattered little, for the fertility of all below, whether a greater depth of 2 or 10, or 100 feet, was also removed. Whatever remained as the new surface, after the denuding process had ceased, and at whatever depth below the original surface, was composed of the same rocks, of igneous origin, which had served to form the original upper or surface layer—and which, by the subsequent disintegration, &c., had served as materials for the first formed earth and soil. Now nearly all these igneous rocks contain some lime, magnesia, or potash; and these, and also other of the ingredients, by their intermixture, are well fitted to constitute soils capable of acquiring and retaining fertility. And in sufficient lapse of time, and under Nature's care and operations only, these rocks would become earth and soil, and such soils would have capacity, (from their constitution,) to reach a high grade of fertility. Precisely such results do we find of these soils, after their being again denuded and exhausted by tillage, and afterwards manured and well nursed under good culture. The impoverished soil, and even the former subsoil, washed bare and left at the surface naked and barren, are improved by putrescent manures, aided, at most, only by a little gypsum, to an extent impossible to be be approached, by like means only, on the great body of the exhausted lands of the drift region. In most of the upper country, (and most remarkably on the south-west mountain lands,) the sub-soil, if washed bare, is still improvable, and to profit, by putrescent manures and atmospheric influences. The like naked subsoil, or washed slopes of the lower or drift region, whether of red clay or sandy, is incapable of being thus enriched, without the previous application of calcareous manure, in lime, marl or wood ashes.

Now let us consider whether the addition of the transported drift to the lower lands, was likely to furnish good soils, such as materials were left for in the new surface of the denuded region.

If *all* of the materials removed from the higher lands had been deposited, in mixture, on the lower, and no matter of what depth, the result, in time, would have been to produce as good or better soil than much longer time would serve to produce of the new surface of the upper and denuded region. But it is obviously impossible for the various ingredients of the drift to have thus remained in mixture, and to be so deposited. The lower stones, pebbles, gravel, and other next heavier parts, (not yet rubbed down to fine earth by the moving power,) and moved in largest masses by the flood down its steepest course, would stop first and nearest below the falls, and in something like mixture with each other, and with the accompanying earth. These heavier stony parts by their subsequent disintegration would constitute soils the nearest in quality to those of the denuded region whence these materials were brought, with but little change. The like inference may be drawn as to the isolated patches of drift which fill former depressions in the since generally denuded region. The flood, having dropped these heavier parts of its burden, would next, (having less violence of current, because then passing even a less inclined surface,) drop the coarser sand in the stronger currents, and finer sand in the less rapid waters. This sand was spread over the whole of the gently inclined planes of the first surface, and far past the previous shore line of the ocean. At later times, and in broad spaces of more tranquil water, the finest sand, with a very little clay intermixed, was deposited, in other and higher beds; and in the still rapid water, this fine earth was carried much nearer to the present ocean, and thence spread over broad spaces of the present surface of low land. This mainly silicious mixture is commonly known as clay, or clayey soil. There is very little of true clay soil in all the drift region. The pure clay, and all other of the lighter parts of the transported earth, including most of the lime and organic matter, and parts of original fertile soil, were mostly floated off into the ocean, and so lost to the land over which it had passed. Even the pebbles of limestone, soapstone (containing magnesia,) the slates and other clay-stones, all being of the softer rocks, were rubbed down, by their long rolling and attrition, to the finest particles, which remained suspended as long, and were floated as far, and were as generally lost, as the most fertile parts of the previously existing soil. Under such circumstances, of removal and suspension of the materials, and the manner and places of their final deposition of the drifted earth—or any conditions to be supposed, if in accordance with the operating cause, in a great and violent descending flood—how was it possible that any earths could be deposited generally over, or even under, the latest formed surface, which would be fit materials to become subsequently fertile soils, or improvable sub-soils? Or was it possible that the actual materials for soils and sub-soils so deposited, could, on the general average, be equal in fertilizing ingredients, to either the average of the whole transported earth, or to the igneous rocks still remaining as the new surface of the upper denuded region, and serving to produce new soils by their subsequent disintegration and mixture? On the contrary, everything in the supposed process of the removal and transportation of the drift materials, was conducive to the production of the actual low degree of fertility formerly and naturally existing on the far larger portion, including all the table lands and high surfaces, of the now tide water region.

But there were, on the narrow margins of the high lands bordering on the rivers, and still more in their lower and broader terraces, and in sundry other low depressions of surface, many exceptions to the general rule of the depositions of sterile earth over the drift region. Many bodies of such lands were formerly of great natural fertility, and have continued to be of very superior agricultural value. These exceptional rich soils may be easily accounted for.—First: all the more fertile and lighter particles of the original soil, or of fertilizing materials, were not carried to and lost in the ocean.—Some would be retained by eddies, and deposited during the more tranquil conditions of the water. Secondly and mainly: After the flood had subsided so as to leave bare the highest broad intervals of table land, and the water, reduced as much in violence as in volume, was divided into as many separate currents as overspread the courses of the present great rivers, these currents, while still cutting down and lowering their deepest channels, were at the same time depositing their suspended earth wherever the water was shallow, obstructed, and of course more tranquil. These conditions were necessarily offered over all the outer spaces, or shallow margins of the then separated currents. The action of the upper waters, in tearing up and bearing off earth, and grinding down rocks, though abated, had not ceased, and the turbid water, still brought down vast quantities of earth, into the lower currents. The lighter, finer, and richer of these materials would be directed to the shallow and slower-moving waters, and there be deposited, and produce rich soils. The earliest soil so deposited, would be when the separated currents still covered the now highest river banks or borders, and which are generally rich for more or less distance, rarely more than half a mile. from the river or from its lower grounds. These high surfaces, to slight observation, seem as elevated, and as belonging to, the nearest and always poor table land. Hence, the marked superior fertility of the margin, or highest river land, has seemed strange and unaccountable. But I infer that these much richer strips along the high river banks are invariably of somewhat lower elevation than the adjacent table land, and therefore were covered by the shallow and comparatively tranquil waters of the subsiding flood, and so received a share of its rich deposit. As the currents subsided still more, and successively were confined to narrower limits of breadth, the lower terraces, (or surfaces of "low grounds") were successively cut down out of the previously deposited and poor drift earth, and their new surfaces were again added to by the much richer deposit of the water, when it had there subsided so as to be shallow and comparatively sluggish. Thus the river terraces were enriched, and made the most fertile and valuable land of all the tide-water region.

When the water had subsided to within the present beds of the rivers, and the sources of supply were reduced to springs and rain-floods, as now in operation, then the drift deposition ceased, and alluvial agency first began—which has since continued, and will continue to raise and enrich the bordering low ground which may be overflowed, by the deposits of mud left there by the turbid freshes.

The higher terrace, or "second low-grounds," is commonly and erroneously called alluvial land, and its unequal formation ascribed to alluvial agency. In no possible case, in the present condition of the earth, could the rivers have risen high enough to overflow and deposite transported mud on their "second low-grounds," or higher terraces of the tide-waters. These higher terraces were entirely formed, first, of the older of the general drift deposit; secondly, they were reduced something below their present height of surface, by secondary denudation, the current tearing up and sweeping off all of the higher and more recent beds of drift earth—and thirdly, when the water over this lately reduced surface had become so low as to be nearly tranquil, then it deposited the lighter and richer matters, which constitute the present rich but various soils of such lands. If this reasoning should not remove all the previous belief of these terraces being of alluvial formation, any enquirer may easily obtain other and sufficient proof, by examining any deep ditch or other excavation in such land, in which the non-alluvial character of the inferior earth will be obvious to the eye.

There is a remarkable result of the agencies here supposed, which has often attracted notice, and which would seem unaccountable except upon the views here presented. The "second low-grounds," or the broad higher terraces of the principal rivers, where passing through the drift region, possess, for each river, much uniformity of agricultural qualities and character.

Though there may be, and usually there is, much variation of texture and other qualities in different bodies of low-grounds on any one great river, still they all have more or less of one general character—and are more alike, than the most similar of such lands on two different rivers. Thus in Virginia and N Carolina, the low grounds of the lower Rappahannock, the Pamunkey, the Powhatan, (miscalled James), the Chickahominy, the Nottaway, the Roanoke and the Tau, all have low grounds of qualities very uniform for each river, and those of each river different from the lands of most of the others. To most well informed farmers, if a large body of "second low-ground" or "high terrace" land, on either of these rivers were named, without description—and even though the particular land and its neighborhood were entirely unknown—every such hearer would at once form an idea of the kind of land and something like its value, merely from knowing the river near or on which it was situated. As the rivers, and their alluvial deposits have no bearing on the lands in question, their remarkable uniformity of qualities and character can be caused only by there having been one common mode of original formation, and there having been different supplies of materials, and from different localities or sources, for the lands bordering on such of the different rivers. The separated and subsiding great currents supposed in the latter time of the drift period and operation, and their then separate sources of water and burden of suspended earth, would seem to produce and to explain all these remarkable results—which seem inexplicable in any other manner.

The rich soils of the tide-water region form but few exceptions to the general condition of a low grade of natural fertility. Of such low and poor quality are all the table lands of the broad and high intervals, and narrow ridges, between the rivers, and also much of the still broader and lower sandy flats nearer to the sea-coast. These lands, and much more, formed by deposits from the flood while it still covered the highest ground, from the manner of their formation, were necessarily at first poor at the surface, as well as through the different inferior beds. Then, began those operations of nature, by which surface earths, if not destitute of all capacity for being enriched, are gradually converted to soils—which are richer or poorer according to the greater or less value of the mineral constituents of the earth. First, a scanty growth of diminutive plants would live and die, and, to the small extent of their remains, would be increased the organic matter at the surface. The soil, thus slowly and gradually enriched, in time would bring more and larger plants, and finally trees, which, sending down their roots to considerable depths, would draw up, and by their death and decay, leave on the surface the little proportion of lime and other ingredients essential to fertility, which the roots could reach. Thus slowly, and in many centuries, and by means of the growth and death of many successive races of plants, all the scanty mineral manures that had been within twenty feet or more below, might be drawn up and placed at the surface, and so enable the soil to hold and to combine with proportional quantities of organic manuring matters, furnished immediately from the decay of preceding plants grown on the soil, and, remotely, from supplies furnished by the atmosphere. As the latter supplies are inexhaustible, there would be no limit to the increase of fertility of land thus at rest, and with unlimited time, provided there were present enough of all the mineral matters required to combine with the organic matters, and together to constitute a fertile soil. But, unfortunately, all the higher lands of the drift region, and most also of the lands of medium elevation, owing to the manner of their geological formation, are throughout, and greatly deficient in the essential ingredient of lime—without some of which, every soil would be absolutely and entirely arren—and without enough of which, no soil is valuable; or can become or remain rich. To apply the needed lime on these soils, (after the necessary draining,) was the great and especially profitable work left, by the Creator, for man, the cultivator to perform. And wherever that has been done, the experienced and beneficial results have been even more than equal to all that these theoretical views and deductions would promise in advance.

The great drift region, (as here understood,) has been added to and in part covered, by two later formations of surface earth for extensive though minor portions of the whole great space embraced within the boundaries of the drift deposit. There are, the formation of the beach and coast sands, thrown up by the ocean, and accumulated and transported by the winds—and the peaty or swamp formation, by vegetable growth and deposition. These interesting subjects have been designedly passed by here, to be separately considered and discussed in later parts of these sketches.

PART II.

SKETCHES OF LOWER NORTH CAROLINA, &c.

AGRICULTURAL FEATURES OF LOWER NORTH CAROLINA, AND THE ADJOINING TERRITORY.

I.—*General Remarks. The public but slightly informed of the region in question, and especially with lower North Carolina in general.*

The eastern portion of North Carolina presents a large region, of remarkable features, topographical, geological and agricultural.—The enclosed broad sounds, and other waters, are not less interesting, for their recent and great changes; and, besides, they have been the scenes of some of the minor but romantic and interesting incidents of history. Into Roanoke Sound, by the then broad open passage from the ocean, which is now dyked across by dry land, Sir Walter Raleigh's ships entered, and on Roanoke Island they planted the first, though but ineffectual, settlement of British colonists in America. In another portion of these now almost landlocked waters, there occurred many of the acts of Teache, or Blackbeard, the celebrated pirate, and finally, the naval engagement in which he was defeated and killed. If the lands of this region were even worthless for agricultural and economical uses, they would deserve and reward the investigations of the exploring and laborious geologist; and if destitute of all scientific interest, they would deserve far more attention than ever has been bestowed on them, for their peculiarities of agricultural character, and capabilities for high improvement and profit. Yet, there is no equal space of territory in all the States of the American Union that has been so little visited or seen by other than its residents, and of which the character and values have been so little noticed or known. It is rare that any stranger enters this *terra incognita*. And even of the residents of other parts of North Carolina, of the class inclined and accustomed to travel for business or pleasure, where one such has seen this portion of their own country, one hundred have visited the remote States of the north or south, or west.

The region here referred to, except as to the line of sea-shore, has no exact geographical limits—or at least there is no present information upon which to designate the extreme southern and the whole western boundary. I would include all of the low-lying and very level land, which is the universal character of all the coast-lands of North Carolina, and for a breadth of two to five or more counties westward. As soon as the surface begins to loose its apparent almost perfect level, and to swell perceptibly into rising slopes, there should be placed the western or upper boundary of the low and flat region which is here referred to generally. The same character of country extends northward to the Chesapeake bay and its lowest western affluent rivers; and how far south of North Carolina I am not sufficiently informed to say. In addition to the one universal feature of low and level surface of the highest and firmest lands, it is much intersected by narrow strips of lower and swampy but also firm ground; and also, immense spaces are occupied by large and boggy swamps, which were impassible, and almost impenetrable by man, until his improvements and labors had produced artificial passage-ways.

This great region affords sundry somewhat connected, but yet substantive subjects, for separate treatment. Such are the now cultivated land and its agricultural condition, and the improvements most needed—description of the great swamps, and such agricultural improvements as have been there made—the geological origin and structure of the different great classes of lands—notices of the ocean sand-beach, and the enclosed sounds, and other navigable waters, and the changes that have occurred in both, &c. Some others, or perhaps all, of these several divisions of the whole great subject may be hereafter discussed. For the present, I will confine myself to sketch the agricultural features, condition, wants, (and errors of culture,) and capabilities of the particular and peculiar agricultural region which lies between the Chesapeake bay and Hampton roads, and Nansemond river, on the north, the ocean on the east, and Albemarle sound on the south. On the west, the outline would include all the Dismal Swamp. But all the great space, and the circumstances of that Swamp proper, will be passed over now, to be resumed and considered in another and substantive article. The further extension of the western boundary would include the lower Chowan, and the basin of the lower Roanoke. The area designated includes some of the oldest agricultural settlements and oldest towns, and (on the Roanoke especially) some of the richest lands on our Atlantic border. It is also intersected by sundry lines of public travel, and some of which (the land and water steam-lines to Norfolk) have long been used by numerous passengers. Still, all these circumstances do not make this particular agricultural district an exception to the general rule or condition of all the great low-land region, of being unseen, unknown and little appreciated by strangers. Of the many thousands of travelers who visit, or pass through Norfolk or Portsmouth on the great routes, scarcely one ever treads the soil, except in the towns—or ever sees any of the lands of the country, except in the rapidly changing glimpses afforded from a steam car, or the more distant and uncertain views from a steam-vessel. Princess Anne county, which reaches within three miles of Norfolk, and Norfolk county, lie wholly in the designated section; and these counties, out of the towns, are as little known to the residents of all other parts of Virginia, as any counties west of the Alleghany mountains. Yet, within the heart of one of these counties, and within a few miles of the other, are the important towns of Norfolk and Portsmouth, and the noblest harbor, and one of the most important government dock-yards and naval stations, of the United States. And the country has been as little appreciated as it was little known; and even by its residents, until recently, and by those who knew it best, as well as by strangers, who had only heard it spoken of and described in the most contemptuous epithets. And, though recent improvements of prices of lands, and in fewer and more remarkable cases, of products and profits, and still more, and longer, in some of the North Carolina counties, indicate much actual improvement and higher appreciation, still very few, even of the most intelligent proprietors, are yet fully aware of the true and great wants of their lands, and their great capability for improvement. Proper drainage alone would double the productive value and the profit of the whole great area of what is usually considered the *now dry* land, and of the firm and partially drained swamps. In addition to the peculiar grounds for agricultural improvement and profit in the land itself, no known region possesses such great facilities for navigation, and for choice of markets. And, in every respect, no where is there a region where agricultural improvement is more needed, and is more available, and offers more prospective profit; and no where have the great advantages offered by nature been more neglected, or seem to be less known.

For the present, my remarks on this region will be applied especially and particularly to the portion lying east of Perquimans river. My personal observations did not, at first, extend farther west; and much of whatever may be here said of the country extending beyond Perquimans, and including the lower Roanoke valley, will be on report deemed entirely reliable,

II.—*Peculiar characters of the low-lands, in surface and qualities of soil.*

The most striking feature of this firm low-land region, is its very low and level surface. Large bodies, say of 1,000 acres or more together, are more uniformly level than any as large spaces of alluvial, or other bottom land, on any of the great rivers of Virginia. Such bottom-land as borders the Pamunkey river, for example, might be called undulating, compared to the general greater flatness of the whole great region under consideration. The numerous smaller swamps, interspersed, (which receive and conduct off the overflowing surface water,) are, usually, not much lower than the adjacent highest ground. So far as the eye would indicate, changes of level of even so much as a foot of difference, can rarely be perceived, except in the swamps and depressions which convey the rivers and smaller streams, or temporary rain floods. But changes of level which are barely perceptible to the eye, are usually made abundantly distinct by the gathering of water on the slightly depressed surfaces, which serve to make the numerous swamps of *firm soil.* A stranger, if traveling through the country in any and different directions, might suppose that the surface of the land was nowhere higher than ten feet above ordinary high tide, or the usual height of the navigable and level waters ; but the real heights are greater than would thus appear to the eye. In the interior of Princess Anne county, at Level Green, (the farm of Edward H. Herbert, Esq.,) where the surface seems to the eye as low as any—the elevation, as determined by levelling instruments, is about twenty-one feet above tide, Still, the variations of our surface-levei are so gradual, (except as to the beds of watercourses,) that it is often difficult, if not impossible, to reach any outlet for drainage of a few feet of fall, without conveying the water by a ditch of some miles in length, and through as high, or higher ground. This feature of the surface presents the greatest impediment to the drainage of the interior lands, and especially upon the ordinary method of mere surface drainage, by open and shallow ditches.

But with all the slight undulations of surface levels, there is nothing to obstruct the view, except the standing crops and fences on the farms, and the trees on swamp or other forest lands. Except for these obstructions, any object of the size of a man, or horse, could be seen over miles of intervening space and distance. In all the great area now under consideration, there is not (native to the locality) a stone, or even a small pebble ; and, in few cases, but a little of small gravel.* The soils vary, in different places, between open and light sandy loam, and very close compact gray clay, (so-called ;) or, perhaps, more correctly, extremely close and compact soil and sub-soil, composed mostly of the minutest particles of sand,

* There may be, and probably are exceptions, as higher in the tide-water region, in some coarse and imperfect sand-stone, recently formed, by ferruginous spring water filtrating through coarse sand, and, in the course of time, cementing with a deposit of iron the before separate and loose grains of sand. There are many such recent formations of this stone.

and which, therefore, are stiffer, closer and more intractable under cultivation than the finest or true clay elsewhere. Of such red and yellow clays as make many of the best soils and subsoils of the upper country, (above the falls, or among the mountains,) none are seen here.

III.—*Peculiar characters of the rivers, and the many fit for navigation.*

The water-courses are numerous, and many of them are deep enough to be navigated by sea-vessels. In some of the smaller rivers, in parts too narrow and crooked for the ordinary small vessels to turn about or to pass each other when meeting, there is enough depth of water to float a ship. A glance at this section on a large map of North Carolina will show the great number and close neighborhood of these rivers which flow, nearly parallel to each other, into the northern side of Albemarle sound. The lower parts of these rivers, where of widths, severally, from one to five miles, are more properly estuaries or large creeks, (in the proper sense of that word, and not as usually misapplied,) kept full by the refluent water of Albemarle Sound—just as they would be, and to nearly equal height, if there was no other supply of water from head-springs or rain floods. But even as ascending these rivers, and after they are contracted to very narrow widths, and, as appearing on the map, the upper channels might be inferred to be merely shallow and insignificant streams, they are, in fact, deep, though narrow rivers, of level and slow-moving water, and continuing deep almost to their visible head sources; and offer good facilities for navigation to such extent, in number and in length of rivers and their sundry branches, that one-half of them are superfluous, and, therefore are not put to use. If any obstructions exist, they are made merely by trees fallen across, and are easily removed. The whole country, and especially from Perquimans county to Currituck Sound, is pervaded by broad and deep estuaries near to the Sound ; and their head waters, extending near or into the Dismal Swamp, make, with their many branches, a net-work of natural still-water canals, narrow and crooked, indeed, but as deep, as smooth, and as sluggish as artificial canals, and free from the changes of levels and the obstruction of lock-gates, which accompany the benefits of canal navigation. Most of these rivers receive their head waters from the Dismal Swamp or other Swamps. The water of all is black as seen in the rivers, and the color of Brandy or Madeira wine as seen in a glass, being thus deeply colored, as are all the swamp waters, by the vegetable extractive matters in and on the boggy swamp soils. This discoloration is not entirely lost in the salt tide-water of Elizabeth river, at Norfolk, nor in Currituck Sound; where nine miles wide, below the former (and now closed) Currituck inlet, which, not many years ago admitted deep sea-vessels.

In traveling along the public road from Elizabeth city, North Carolina, to Currituck Court House, within the distance of seven miles, we passed four navigable water courses, including the Pasquotank and two of its branches. Three of these had draw-bridges for the passage of masted sea-vessels. The fourth stream had no draw-bridge, because it was not needed in such close vicinity to others; and, also, because, though this branch had abundant depth and an open channel for sea-vessels, it was so narrow and crooked that the banks and trees standing on the borders would entirely obstruct the masts and yards. Such great and numerous natural facilities for navigation, as in the many rivers of this region, are unequalled; and they are exceeded by the aid or art, only in the canal navigation of the Dutch Netherlands.

IV.—*General want of Drainage, and of proper views on the subject.*

Level as is the general surface, and slight the variations of height, in adjacent spaces of all the peninsula between the waters of the Chesapeake and Albemarle, still there are frequent slight changes; and these, more than great changes elsewhere, are marked by consequent differences of character. Every farm of a few hundred acres has some of its surface of swamp, and usually undrained.—What is called high or dry land is, indeed, the highest and dryest, but mostly still and always suffering more or less for want of sufficient drainage. The parts which may be only from two to three feet lower than the neighboring highest surfaces, are, because of the depression only, swamps of wet though firm ground. These swamps are very generally of firm soil, and the boggy swamps are of entirely different materials and formation. In all this flat country there are very few springs showing at the surface, and but rarely any springy or oozy places. The water and the wetness of the numerous smaller swamps are due entirely to rains. On the higher spots, or larger high spaces, the early settlements were all made, and tillage has there been continued, with but little respite, to this time. The intermixed lower lands, or smaller swamps, were deemed worthless, and their culture was rarely attempted until within recent times. Yet, even with the imperfect superficial drainage which only is in use, these swamp lands are found to be best, and of fertility rarely exceeded anywhere. Some of this firm swamp, in Perquimans, of which Mr. J. T. Granberry's estate in part is composed, and which but lately has been drained or brought under cultivation, he bought lately at $55 the acre, unreclaimed. A highly intelligent neighbor told me that he remembered when the same land could not have been sold for 75 cents the acre, and was deemed of no value whatever for tillage.

The soils and also the subsoils vary in texture from moderately light to extremely stiff, close, impervious (now) to the descent of water, and remarkably intractable under tillage, and almost always either too wet or too dry for good ploughing, even under good farmers. Under the worst cultivators such soils are sometimes mud or mire, and sometimes of clods almost as hard as brickbats. These soils are general or common in Perquimans only. Yet, on good farms, of this very difficult soil, there are seen the best (and excellent) crops of wheat, and other best crops, of all the counties on the sound. The greatest drainage labors and most of the best farmers and best cultivation are also in that county; yet even there and though many of the ditches are of great size, and the drainage labors are remarkable for their extent and cost, still, almost every where, the tilled land is but partially and insufficiently drained.—On much the larger portion, perhaps nineteen-twentieths of all the cultivated and even highest surface of the whole region, the drainage is much worse and still more insufficient.

V.—*The true principle of drainage for this region and the geological facts on which the principle is founded.*

The great error of the method of drainage, general in all this region, is that the drains or ditches are designed, and only operate, to draw the superfluous and, therefore, injurious rain-water from and over the surface. The principle I would propose to substitute, is to draw off (and keep drawn off) the water which is in excess some feet below and up to the surface, and by thus removing the before constant saturation or glut of the lower earth, to permit the excess of falling rain to sink into the lower earth, and thence pass off below, instead of being kept on and near the surface, as now and heretofore, until it either can flow off on the surface to ditches, or is evaporated. Both the existing error and the evil effects and also the benefit of the proposed substituted plan are dependent on the geological structure of the land, and especially of its inferior beds. But, in advance of all description and reasoning as to the causes of the supposed existing phenomena and of tracing the effects in reference to draining, I will simply assume the truth of the great and all-important fact on which my plan and reasoning are founded.—This fact is, that the whole of this low and flat country, at some few feet below the surface, (within the extreme limits of from 2 to 8 feet, and more generally from 3 to 5 feet,) has underlying it a bed of pure sand, which, at least in all wet seasons, is glutted with water from its bottom to its top. This fact is unquestionable, and may be tested easily by every proprietor. But I have to infer, from the geological structure of the region and on reasoning, which would require too much space to state here, the further fact, that this underlying bed of water-glutted sand is nearly horizontal, but, like the overlying earth and its surface, has a gentle and general dip or declination toward the seacoast, or in a south-easterly direction.*

* The geological views were presented in Part I, of these series, at page 37, and after.

As to the general presence of the sand bed, it is proved by every well that is dug, and not only here, but in such higher localities of the tide-water region. In the higher country, and at higher levels of surface, the sand-bed lies deeper and also, there, generally, its upper part is dry, (or without water,) though, by digging deeper, the lower sand, there also, is always found filled (but not surcharged) with water. A like bed of sand underlies most, or all of the bottom or low land, along the rivers in the higher tide-water counties in Virginia ; and, as I infer from but limited personal observations, such sand, with much more regularity of position and operation, underlies the whole superficial layers of the great low-land region here under consideration. But in these low-lands, the sand-bed is naturally always glutted with water, which water is a source supplying moisture to the overlying earth, and also, by being already as full of water as it can be, the glutted sand-bed is an effectual barrier to the descent of more rain-water from the surface of the land. This sand-bed is, therefore, the great cause of the existing wetness of the upper beds, and surface soil, and the reason why the usual surface draining is so imperfect in operation. And the same feature offers the manner and means for effectual drainage.

Of course, very few particular facts, and in narrow spaces, have been learned from my own personal observations in this low country. But I had previously discovered the underlying and also water-glutted sand-bed, (concealed from all previous knowledge, as a general fact,) below the broad bottom lands of my own farm on the Pamunkey river, (in Hanover county, Virginia,) and had long studied its effects ; and in reference to it, had devised, and conducted successfully, extensive draining labors. At first, I had supposed this remarkable and then newly discovered feature to be peculiar to the particular locality of my own farm ; but in the progress of my draining operations, and the necessary study of the whole subject, and the true principles of drainage, I came to infer, that the same feature, of an underlying sand-bed, belongs to the whole of the lands of our great tide-water region, and that this sand-bed, where dipping lowest, and glutted with water, was the great cause of the evil of excessive wetness of the low-lying soils above. I felt so confident of the correctness of my deductions, that it induced me at the first time of leisure, to visit the region in question, to seek and to find the facts to confirm and to sustain my theoretical views. And before my first visit to this country, I offered to a friend, residing therein, advice for the proper drainage of his farm (by seeking for and tapping the glutted sand-bed,) which he acted upon to some extent, and found therein the precise effects and all the benefit that could have been expected from his limited first operations on this new principle.

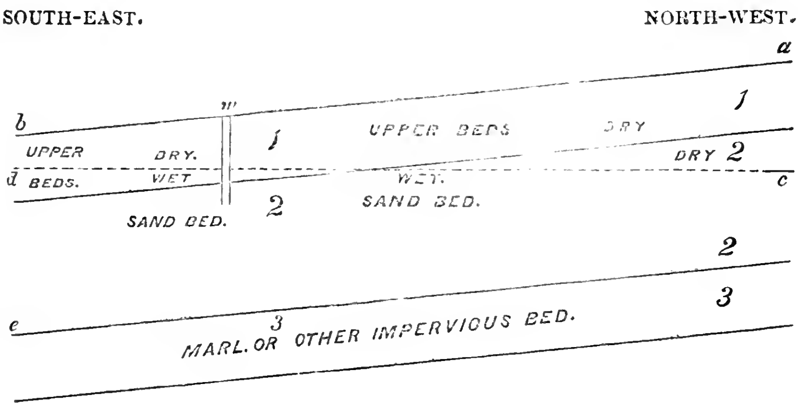
To obtain numerous evidences of the very general existence and position of the sand bed, it was not required for me to dig or bore into the under-lying beds, or even to see the surface of every locality. Every farm house is supplied with water by one or more wells, and these numerous and long used wells, go far to supply all the facts required. Whether the sand-bed exists, and near enough to the surface to affect its natural drainage, may be learned usually from inquiries about the wells, their depths, and the cause of the varying quantities of their supply of water. From even but a few such examples, and applying thereto my general views derived from practice and experience of draining in far-distant localities, I was confirmed in the general opinions previously formed, in advance of all personal observation. The conclusions thus reached, and for which I will proceed to argue for the conviction of others, may be thus stated; that nearly all the higher and firm, as well as the lower lands, lying between the Chesapeake and Albemarle Sound, are rendered and kept too wet, not (as universally alleged,) because the soils or their under beds are of too close texture to permit the superfluous rain-water to sink, and so be discharged by percolation; but because the underlying sand-bed is already surcharged with water, and by its supplying moisture upward, renders moist earth incapable of drinking up more water from above.

In the upper and middle ranges of the tide-water counties of Virginia, the reaching the sand-bed, and its being dry when reached, are essential conditions to the construction of a good ice-house

—the dry sand bottom serving immediately to absorb, and convey away, by downward filtration, all the water formed by the melting of the ice. This is the operation of the principle of drainage of the higher beds, by the agency of a dry (or drained) upper layer of the sand-bed below. It is also essential to the utility of every well, that it should be sunk through the upper and dry layer (if there be such) of the sand-bed, and into the water-glutted lower part, for the purpose of its furnishing a permanent supply of water. And if, as generally in the flat low country, the sand-bed is full of water to its top, (unless after long drouths.) and is so surcharged that the water is pressed upward, then, in wells there dug, not only would water be obtained as soon as the sand-bed was reached, but the water would rise still higher, and even near to the surface of the land in very wet seasons. Thus, every well in this low country may afford evidence of the existence, height, and character of the sand-bed at its top, and also the height to which water will rise therefrom, and how near the surface of the land the upper bed must be injuriously affected by the water-glut below, and whether permanently, or but for the times of wettest seasons. Hence, it follows, that little as has heretofore been noticed, or thought of, in regard to these important facts, and the more important deductions from them, and few as are the residents who have thought at all on these particular points, it is only necessary for farmers and thinking men to reflect upon, and apply the facts they already know, to be assured of the true principle and method of drainage for their land, which will now be more fully explained and argued.

VI.—*The underlying sand-bed and its opposite operations in regard to draining.*

Whether the underlying sand is of one continuous bed connected throughout, or broken, or separated, is not important, it is enough that it is general, and nowhere known to be wanting. Neither is its general thickness known, nor is its bottom but rarely accessible or known. But it is certain that this sand-bed lies upon some lower bed, impenetrable to water from above, and which bed, in many known cases, is marl. But whatever may be the lower bed or its texture, the sand-bed itself, however open and loose in texture, if already glutted with water, is incapable of receiving more. Therefore, there is no layer of earth so impenetrable by water, as any earth, and even sand, already full of water ; and, in less degree, all dampness or moisture of the underlying bed of earth is so much impediment to the reception of rain-water from above. The following rough figure will serve to exhibit a profile or section of the supposed strata of the low-lands, but to render the differences of level apparent to the eye, it is necessary greatly to increase the thickness of the strata, and the rate of their dip, in the figure, exceeding the natural and actual conditions.



Suppose this figure to represent the surface soil, (*a b*,) and also the inferior beds, all dipping very gradually, and very much less than in the figure,) from northwest to southwest, or in the direction from the falls of the rivers toward the ocean. The finely dotted line, *c d*, indicates the horizontal level. The upper bed, (1) next below the surface soil, let us first suppose here to be clayey, or of close texture, and not readily permeable by water. The next below is the sand-bed, which is wholly glutted with water, or partly dry (at top,) according to its level, or dip, or the variable supply of water, and its manner of discharge. The next bed, (3,) is of marl, or other impermeable earth, or otherwise, from its constant wetness, incapable of receiving more water from above.

Now, of all the excess of rain-water that falls on the whole surface of the tide-water region, (as everywhere else,) part flows off over the surface of the land, and of that which remains, part is sooner or later evaporated, and part sinks as low as it can be admitted into, or absorbed by the lower earth. The greater discharge of rain-water by its flowing off will be on hilly surfaces, and soils of close and compact texture. The greater discharge by downward percolation, or filtration, will be on the most sandy or porous earth, if dry before and to enough depth,) and the more so if on level surfaces. Whatever water is not taken off by these two modes, can be removed only by evaporation, and until so removed, the remaining excess of water must saturate the soil, if not cover it in part, in stagnant pools, and, for the time, destroy its productive power, and prevent all proper tillage labors. Every transient occurrence of such wet conditions, even if each one be transient, is enough to render even rich arable land of very little value.

Of the rain-water that falls on the higher lands at and beyond *a*.) and that sinks into the earth below, and which is too much to be held absorbed by the next beds, (1, the excess must sink still lower, and go to supply or to surcharge the sand-bed (2,) below. And all the water in that bed, whether filling it wholly, or only its lower portion, would be slowly but continually pressing laterally in the direction of the dip, (towards *c*,) to seek (and find, ultimately,) a long delayed discharge in the lower channels of rivers. Although the beds of earth may be nearly horizontal, the slightest degree of their general dipping must induce the operation stated. Thus, the supply of water to glut the sand-bed is not only increased by rain-water fallen immediately above, and over porous upper beds, (at 1,) but also another and continuous supply is pressing on laterally, derived from higher levels of the sand-bed (2,) and from rains that fell many miles distant, on the higher country. And therefore, while the upper layer of the sand-bed in the higher country, (or temporarily in the lower country,) may be left dry, (as represented above the level of the dotted line at *c*) at the lower level of the same sand-bed, and at the same time, it will be necessarily surcharged with water, which, not finding sufficient discharge in its gradual and slow descent along the dip of the bed, presses with all the weight of its higher-lying water in every direction, and not only downward and laterally, but also upward. This is evident even to the eye. For if the water received partly on a higher and distant surface, (near to and also far north westward of *a*,) serves to keep the water in the sand-bed no higher (at any one time) than the horizontal line at *c*, it will still fill the whole depth of the sand-bed as descending farther eastward. As the sand-bed dips, the water confined therein (by the higher bed being but slightly permeable,) would be pressed by the weight of the higher and remote water, (rising to *c*,) and, by a well known law of hydrostatics, would rise as high as the line *c*, if having an upward vent. And precisely such a vent is afforded by a well, sunk at *w*, in which the water reached in the sand-bed (2) will rise to the level of *d c*, or as high as may there be the then height of the supply of water near *c*. Thus, in nearly every well in this low-land region, the water usually rises above the sand-bed which yielded the water; and after great falls of rain, or long-continued wetness of the earth, the water supplied by percolation only, and mainly from a distance, rises much higher than usual, and in some cases, to within one or two feet of the surface of the land.

So far, for more clear explanation, it has been supposed that the higher bed, (1,) was more or less impervious, and so served to confine in the lower sand-bed its water, and greatly to resist and impede its escape by upward discharge. But if, as is more general, the higher bed (1) is of texture permeable to water, that difference does not materially vary the circumstances as to the need and manner of draining. A pervious upper bed will absorb more freely and speedily all the water that hydrostatic pressure would force upward, so as to leave much less visible results of such pressure in particular places, as in wells and deep ditches. But in either case there would be the same general evil to the upper earth and surface soil, of moisture derived from below; and the same remedy required, of discharging the injurious supply of water, by tapping its reservoir below.

To whatever height the water (proceeding from the sand-bed) can rise in the unobstructed passage afforded by a well, (or an auger hole, bored for trial,) to the same height must there exist the force to raise the water, though more slowly, by filtration, but by the same hydrostatic pressure in all the neighboring ground. The bed of earth lying over the glutted sand may be so close (in its moist condition) as to be impervious to the descent of rain-water, from the surface, which would act only by the pressure of gravity. But scarcely any earth is close enough to prevent the absorption of water, pressed upward by the much stronger force acting on the water confined below. Therefore, even when the sand-bed may be as low as six or eight feet below the surface, and a bed of unusually low texture between, the confined water may be so strongly pressed upward as to reach within two feet of the surface. In such cases, injurious moisture will rise still higher, by capillary attraction, and more evidently over sandy than a close sub-soil or under-bed. It is owing to this condition of things that many spaces, without showing any standing or flowing or even the slightest oozing water, either at the surface or in shallow ditches, are always damp and cold, produce only aquatic grasses or weeds, and exhibit every indication of wetness, except the actual and usual presence of water. But after every rain, and even light rains, water will stand in puddles on such places, if level, even though the soil and sub-soil are sandy and open. For moist sand is soon filled by water to repletion, and wet sand will hold water on its surface like a dish.

Thus, I infer that the whole of this low land is underlaid by a sand-bed, glutted with water to its top, and which sand-bed is generally so near the surface soil as to affect it injuriously by water from below. But even if this confined water lay too low to affect the surface earth directly, it would do it indirectly, by preventing the rain-water from sinking, and its excess being discharged by downward percolation. If the sand-bed below were dry, or always free from water for its upper twelve inches only, (as near *c*,) that upper layer of dry sand would serve as natural under-draining for all the upper earth. Such is the condition of things under the excellent and dry low grounds of Brandon, on James river; and such is inferred to be the case with all the similar low lands, which, though level and of stiff soil, require but little draining labors, and can dispense with all under-draining. The upper layer of the universal sand-bed, being there dry, is always ready to receive and to discharge below all water sinking from above. Thus these fine lands are under-drained by nature. And the only reason why that general under drainage is not perfect in operation, and ample for all wants of the land, is that this dry sand is many feet (10 to 14) below the surface of the land, and the intervening beds are of clayey and compact texture. Even these impediments would not prevent the surface being generally and perfectly dry, if without any artificial drainage. But the natural draining process is too slow, and therefore the aid of some surface ditches are there needed to pass off more quickly the temporary rain-floods.

But when, instead of the upper sand being dry, and so serving to drain the upper beds, the whole sand-bed is full of water, and that water is pressed upward, then all the upper beds are kept more or less wet or moist, and are thereby rendered unable to receive any more rain-water from above by filtration or percolation. The stiffest and closest clay, when dry, is full of minute fissures; if no moister than usual at some feet below a dry surface, such clay will absorb water from above, and slowly pass any excess, by percolation, to an absorbent or receiving bed below. But earth made wet or moist by water forced upward from below, whether it be close clay or loose and coarse sand, can receive no more from above, and all excess of rain water left there in pools must remain until evaporated.

We may best estimate the enormity of this evil, of the wet earth below preventing the rain-water from sinking, by the condition of the level woodland still remaining in a state of nature and without any aid from ditches. On such land, in wet seasons and usually in every winter and spring, the excess of rain-water remains and covers most of the surface, and in many cases for weeks or months together. This is universally ascribed by the proprietors and neighbors to the soil or its under-earth being too stiff and close to permit the descent of water; and this is held even where the upper bed is open and light enough for any purpose. Now let us proceed to examine the actual remedy, or the drainage plan in general use, and its effects, and next the different principle of drainage and method which I propose.

VII.—*The usual and general plan of draining and its radical defects.*

The actual plan or system of draining which is in general and approved use in this region is very uniform in the general principle and features, and also very simple. It consists in digging numerous ditches, mostly shallow and small, merely for the purpose of collecting therein and conveying from the field so much of the excess of rain-water as will flow over the surface. These ditches are at various distances, according to the greater or less excess of wetness of the land, and they are of various degrees of imperfect effect, according to their number and depth. But on no farm is this mode of ditching effectual for drainage, and on a few only has it ever approached that desired end, where the ditches were much deeper than usual and great labor has been bestowed, though on an erroneous system.

The numerous swamps, so-called, or spaces, either broad or narrow, a little more depressed or level than the adjacent ground serve to afford ground for outlets in deep and large ditches acting as main water-carriers through these swamps to some one of the numerous rivers or deep creeks with which the whole country is intersected. Some of these deep and main discharging ditches may severally receive the waters from two or three different farms and properties, and extend for miles before reaching the final outlet. Still, by combined effort for the common benefit, these longest ditches may be made cheaply enough for their object, and may be made deep enough to suit for any system of drainage.

Supposing that a proper outlet has been secured through which to discharge the water into the river, then each farmer next proceeds to dig the receiving smaller ditches to collect the excess of rain-water from the field. In most cases the farms are so level that the ditches may be laid off in almost any direction, and usually they are made to coincide with the cardinal points of the compass, or otherwise made parallel with, or perpendicular to some road or other straight and long outline of the field. As the most laborious, and also the most perfect draining on this plan, and on the stiffest soil, is seen in Perquimans county, the operations there will be held especially in view in the following description:

In beginning a large drainage operation, or in renewing and substituting a former irregular and imperfect laying off, the main ditch of the field or farm is first dug to discharge into some common main water-carrier, or other deep outlet. But so uniform is the general level and shape of surface, that the required main ditch can usually be made straight, and to agree, in the preferred manner, with the other smaller ditches, and with the direction of the ploughing. Into the "main" and deepest ditch, (usually 3 to 4 feet deep,) and at right angles to it, and 1,000 feet apart, the parallel "leading" ditches enter, which are 2 to 3 feet deep. Then crossing the last, and parallel to the main ditch, and 150 feet apart, (on some farms, only 125 feet) are dug narrow "tap ditches," 18 or 20 inches deep, and which empty, at both ends, into the "leading ditches." The land is tilled in 5 feet beds, laid off parallel with the smallest or tap ditches. Still, all these ditches, with the narrow beds and their alleys, (or water-furrows,) are deemed insufficient to carry off the excess of rain-water, without the further aid of "hoe-furrows," which are opened first by a plough, and afterwards cleaned out by hand-hoes for every ploughing of the field, because every ploughing (or horse-tillage) fills them. These "hoe-furrows" are made across the narrow beds, at irregular distances of from 18 to 25 yards, and empty into the tap ditches. A "hoe-furrow" is made to pass through every slightest cross depression, and wherever else deemed most necessary. Thus the alleys of the five feet beds first receive the surplus and overflowing rain-water; and so much thereof as can flow off over a level, or nearly level surface, passes out of the open ends of the alleys (from both ends) into the leading ditches, or across the beds along the hoe-furrows into the tap-ditches, and thence to the leading ditches. From the latter the water passes into the broader and deeper main ditch, and from it to the common outlet of the farm. The hoe-furrows (or grips) are a little deeper than the alleys of the 5 feet beds. The alleys may be 6 or 7 inches below the crowns of the beds. This plan is, on some farms varied by the leading ditches, running parallel to the main ditches; but the number of ditches and furrows, and the spaces between, are not varied.

The object of this plan, and the only possible operation of it, is to draw off the excess of rain-water mainly *over the surface*; and even with all these numerous ditches and furrows, on perfectly level land no water can flow off until it has saturated the soil, or stands above it in numerous little shallow pools: and if the field is under tillage, and has been deeply ploughed, all the ploughed layer will suck up as much rain-water as it can retain, before any surplus will begin to flow off over the surface, or, by lateral and horizontal percolation, to ooze out from the soft soil into the lower furrows and ditches.—Such draining at best only begins to remove the injurious excess of water from the soil, after it has effected all the damage it can do for the time. It is true that every hour of the continuance of the water would greatly increase the first damage of the saturated soil, and that continuance the numerous drains serve to cut short and reduce, in time and evil effect.

Some of the main ditches in Perquimans are of much greater depth, and of unnecessary width at the bottom, (which should always be narrow, no matter how wide at top and how deep a ditch may be.) Mr. J. T. Granberry's main ditch is 7 to 8 feet deep; and though without its being so designed, this ditch reached the sand-bed and tapped its glut of water. This great depth had been sought only for the different purpose of having a sufficient vent for the great quantity of surface water to be discharged from the field.

This system cuts up every field, by spade-dug ditches, into separate spaces of little more than three and a half acres each. Then bridges are required at suitable crossing places over every main and leading ditch, and also over every tap-ditch when they are crossed by a farm road or a temporary track for hauling in a crop. As many other rough wooden structures are required to give passage to water and to exclude hogs wherever a fence crosses the tap or other ditches. The labor necessary to dig and keep open all these ditches with all the other accompaniments and the increased labor of tillage, &c., among these open ditches, must be enormous. It would not be much more costly, and would return much more nett profit, to adopt, instead, the modern English system of deep and covered under-draining—which system, after all, is but the drainage of surface water, derived from rains, by downward filtration, and as soon as may be effected after the rain has fallen on the surface in excess.

This plan of draining by numerous ditches separating and surrounding small rectangular spaces, was first used on the low (embanked marsh) rice-lands of South Carolina, where it was not inconvenient for tillage, inasmuch as no ploughing or other team labor was practicable on the soft and miry soil. Thence the same system was transferred to much of the high and firm land under cotton culture, but which needed some attention to drainage. Such ditching was practiced as late as 1843, on much land in Charleston district which scarcely needed a ditch (dug by the spade) any where. But there, while these frequent ditches were deemed indispensable by many planters, they were also deemed so great an impediment to the plough that that implement was excluded therefrom, and these fields were cultivated by hand-labor entirely. In Perquimans full use is made of the plough despite of the many obstructing ditches. And it has not been very long since cross-ploughing also was in use among these many ditches—the corn rows being laid off and ploughed across as well as lengthwise of the long and narrow rectangles. Of course the culture then must have been flat or without beds and intervening alleys, preserved throughout the year's tillage, as since and now.

VIII.—*Evidences or illustrations of the existing injuries from superfluous water, and of the proper means for relief.*

The plan or principle on which I would propose to drain the lands of this low country is very different from what has heretofore been unusually aimed at, and, but partially effected. Instead of removing the excess of water by passing it off *over the surface* through numerous shallow and open tap-ditches, I would, by a few deep and mostly covered drains, tap the glutted sand-bed below, and thus as much as practicable, lessen or entirely abate the previous upward pressure and direction of the confined water, and thereby relieving the upper bed of earth of its present supply of moisture from below, make it dry and permeable, and so permit, for the future, the excess of rain-water to sink into the drained upper bed, and be thus drawn off by percolation to the still lower sand-bed, (then empty enough at top to receive such temporary additions,) and thence the water to pass along the dip of the sand-bed, and far beneath the surface of the land, to the nearest deep stream or other place of discharge.

It is admitted that, except as to my own limited operations and experience, on a single farm, (Marlbourne), there is almost no such practical proof of the effects here anticipated in regard to this great low-land region, of which so little is well known to me. But recent, few and limited as have been my means for examination and investigation in this region, there can be no doubt of the general existence of the one important natural feature on which my plan and reasoning rests, viz: the under-lying and glutted sand-bed, having a general, very slight, continuous dip. If this is the general and natural condition of the land, and if it is a sufficient cause for its present wetness, then it follows that the true principle of drainage, which sound theory would direct, is to draw the water from the *bottom*, and not from the top, as is the only function of shallow ditches. It may be, in some few localities, that the glutted sand-bed lies too low to be reached by ditches without too great labor and expense. But even such objections to the practical operations will not invalidate the correctness of the theory. And such good objections to practice probably exist in but few cases of limited localities.

It is manifest, to the least consideration, that the usual and universally approved plan and procedure cannot drain this land. As to the moisture infiltrating from the glut below, or driven upward by hydrostatic pressure, or drawn still higher and diffused as mere dampness by capillary attraction, it is obvious that this moisture cannot be lessened by any number of ditches in the upper earth. As to the excess of rain water, when remaining separate on the surface, some of it will flow off in shallow ditches. But none will so pass off from a level surface until the excess of water stands in small pools. Nor can any of the surplus water escape by filtrating laterally through the soil until the soil or upper earth has drunk up more rain-water than it can retain. These conditions of extremely wet earth, (and the more if of recently and deeply ploughed land,) must exist before the present system of drainage can even begin to act, and must still remain in force after the ditches have ceased to draw from the land that portion of the water which cannot be held absorbed. All the still remaining water, (and enough for the time to convert tilled soil to mire,) will be removed only by evaporation, as none can sink into the earth below in its present and usual wet state caused by the glut of water in the sand-bed, and the moisture always rising therefrom.

The best farmers seeing the imperfect operation of this plan of draining, have sought the desired improvement in digging all their ditches deeper than usual. But, unless such deepening reached and tapped the sand-bed, the deeper ditches could not gather any water from below, and could convey no more from the surface of the land than would be done by shallower ditches in somewhat longer time.

IX.—*The upper beds always permeable if drained.*

But even if it be conceded to my argument that the sand-bed could be tapped, and the previous upper layer of its water be drawn off and kept permanently lowered, it would still be denied by most of the farmers that the rain-water can then sink through the earth.—This denial would be founded on the supposed impervious texture of the intervening bed of earth. This belief of the under earth being impermeable to water is not only general in Perquimans, (and with much color of truth there,) where the upper earth is extremely close and stiff, and in some places eight feet or more in thickness, but also in Princess Ann and Norfolk counties, where the soil and under earth are abundantly porous, and not generally more than four feet thick.

Further, the immense quantity of rain-water which remains long, and covers much of the surface on the forest land in its natural condition, and which water passes off where ditches have been dug, makes it seem incredible that even half of all this water could sink through the earth below. It is also a prevailing belief that there is more rain in this region than general. I presume that no more rain falls from the clouds, but as very little of the excess of rain-water sinks into the earth, (because of its wetness below,) there is far more of the surplus rain-water to be removed and discharged by ditches than in other localities. In some of the nearly as level but higher lands of parts of Southampton and Surry, in Virginia, scarcely a ditch is required, and there is no evil of rain water remaining on the surface. There, in furnishing a pervious soil and sub-soil and dry underbeds, nature has effectually under-drained such lands, and in so doing has enabled most of the surplus rain water to disappear by downward filtration. The great quantity of rain water in low-lands which passes off in the ditches is owing to the small absorbing power of the always wet lower earth, and, in less degree, of the upper also.

X.—*Examples of the effects of the true principle of drainage, in both artificial and natural operations.*

Though there has been very little practice in this region on the plan of tapping and drawing off the confined water of the inferior sand-bed, and almost none by design, there still have been some such operations, and with marked beneficial results. Mr. J. T. Granberry, in Perquimans, and Mr. E. H. Herbert, in Princess Ann, tapped the water of the sand-bed when they anticipated nothing of the important effect, and merely designed to make unusually large and deep ditches, Mr. W. Sayre, then of Norfolk county, acting on my general views and advice, given to him before I had seen his land, or even any part of the region in question, sought for and found the wet sand bed at four or five feet deep, and to which no ditch on his farm or near to it, had before penetrated. He deepened the greater length of his general outside ditch to the sand, and found great increased draining benefit therefrom in the single year which he afterwards continued to own and reside on the farm. One of the effects could scarcely be mistaken. In the summer after the first opening of this deep encircling ditch to the sand-bed, the well, half a mile distant from the ditch, ceased to supply water, and continued thus nearly dry until in the following winter. This well, (or another very close by,) had always before, and as far back as known, yielded water abundantly, and through the dryest seasons. The subsequent and long failure must have been caused by the cutting off, by the deep outside ditch, the supply to the well of water from the sand-bed. It is difficult to appreciate such slow and gradual effects, or to know always to what particular causes to ascribe them. Such effects from this mode of drainage may be slowly increasing for years before reaching their maximum of beneficial operation.

But on this principle there are many other and great drainage operations which nature has executed, and which show the beneficial results that are here promised. Every river or smaller deep water channel in this low-land is, in effect, a deep drain cut into the glutted sand-bed, and which cut or tapping has been operating to draw off the neighboring confined water, and to prevent its upward pressure so far as circumstances permitted. Along the sides of every river and deep branch, the bordering lands, for half a mile or more in breadth, are much drier than any other adjacent lands of equal elevation and like surface. This is the case in Durant's Neck, where the land is very level and also lower than is usual for the firmest soil. This is the long peninsula of good land lying between Perquimans and Little river, and extending to Albemarle Sound.

The depressed shore of a river does not serve the better to drain bordering land because the river is a mile or more in width. A covered drain, having but a four-inch pipe or passage for water, if serving to reduce and convey away all the excess of under water, and to prevent its previous upward pressure, and so leave the upper layer of the sand-bed dry, would, for draining effect, serve all the purposes of the widest river of no greater draining depth. If the natural depression for the rivers's passage serves to drain by lateral percolation half a mile width of the bordering land, a deep artificial drain sunk a foot or two into the sand-bed, and whether open or covered may be expected to do as much. And if so, deep parallel drains a mile apart perhaps might drain the intermediate land. And such drains, even if 10 feet deep and covered, would still be made and kept at less cost than the never-ceasing trouble of the numerous shallow and open ditches in Perquimans. But in most other places, as Princess Anne and Norfolk counties, the glutted sand-bed is not usually more than four feet below the surface, and drains sunk into the sand and if four or even eight of them to the mile of width or cross-distance, would not be very costly, and could scarcely fail of their object.

XI.—*Drainage vertically by boreholes.*

Where the water is closely confined in the sand-bed by the compact texture of the wet overlying earth, and the upward pressure of the confined water is considerable, (because of the quantity, or height, or weight of the water at the higher sources,) a portion of the water may be drawn higher than the top of the sand-bed by the use of the auger. As in most of the wells the water rises to more or less height above the top of the sand, so it would rise as high in holes bored by an inch auger. And if the main or discharging ditches were sunk but a few inches lower, then the water could be thus drawn up in holes bored in such ditch, the water rising through the boring would continue to flow off along the bottom of the ditch. In such cases, the holes, if found operative, should be bored every thirty to fifty yards in a new ditch, as some will not act at all. Each such bore, when acting to bring up a continued stream is an artificial "boiling spring." And if there is sufficient quantity and force of the water thus rising, there is no more reason why the artificial boiling spring shall be obstructed and its flow stopped, than a natural one.

XII.—*The presence of quick-sand both as an impediment or an aid to effectual draining.*

It was by such borings (commenced for a very different object) that I first discovered the general existence and the properties of the water-glutted sand-bed on my own farm, and by them drew up and passed off water in considerable quantity before my main ditch had been sunk within two feet of the sand-bed. But if it is practicable and safe to go deeper with the spade, this vertical draining, in open ditches, should be but a temporary expedient, as it was in my own case. If the water will rise, say two feet in such bore-holes, to the then bottom of an open ditch, it will operate partially to reduce the glut of water below, and prevent so much of its upward pressure. But the reduction will not be of any water that cannot force its passage so high. The greatest value of the fact of thus draining up water by boring, is the sure indication it affords of the still greater success of a future deeper digging of the ditch. If water thus rises to the height of two feet, it will rise with much more force and longer continuance if the ditch is sunk deeper and the water has so much less height to rise. If by still later and deeper digging the ditch is sunk into the sand, then there will no longer be vertical or boiling springs, but, instead, water oozing or flowing in laterally from the upper sand and along the whole line of such digging. Of course, and the more if the sand is very fine, such continuous opening is better than any number of auger-holes, even if the bores should always continue open and discharging.

The inability to execute, at once, so extensive and costly an operation, compelled me to deepen my main ditch at different times and in several successive years. But there is another reason for such gradual deepening, which will probably be found to operate in all diggings into the sand-bed in this low country. It is most likely that this water-glutted bed is everywhere a "quick sand," almost semi-fluid, and which, as soon as dug into, will flow in from the sides and fill with sand the deeper excavation. And if the digging is persisted in it will cause caving or falling in of the solid and dry upper margins of the ditch, so that any effectual or permanent deepening at that time will be impracticable. If quick-sand is the greatest impediment to continued and successful deepening of the digging, its presence is also the surest proof of the necessity for the work and the best surety for its final and complete success. Quick-sand is nothing but a very pure and loose sand of which all the interstices are glutted with water. There is no coherence of the different particles of such sand, and the water contained therein is nearly as much in bulk as the solid matter of the sand itself, and when drained and passing off the water is continually renewed by lateral supply from more or less remote and higher sources. Hence quick-sand is semi-fluid, and flows in almost as freely as water, fills every lower cavity of an open ditch, and is like to enter every crevice of the filling material of a covered drain, and finally to choke the narrow conduit. Nothing can be worse than quick-sand to oppose the immediate and complete excavation of a ditch, whether to be covered or left open. But delay and time afford the remedy.—When quick-sand is reached, the digging should at first go no deeper than its surface, or no deeper into the sand than may be without causing damage. Then the before confined water, which rendered the sand "quick" or semi-fluid, will find a discharge into the ditch. The previous upper pressure will be removed. Later the water will subside, leaving free the upper sand, thus drained into the ditch, and as low as the level of the discharge. In a year after the first operation, the then bottom of the ditch will no longer be of quick-sand, as at first, but will have become firm, and may then be deepened some six or eight inches more, before reaching what is still quick-sand below. Thus so much deeper and fuller discharge is given to the water, and so much more of the quantity removed, that thereby another layer of the then highest quick-sand is gradually converted to dryer and firm sand, and which may also be subsequently taken out safely by the spade. In this manner, and easily, and with best effects, I have, in three successive years, gained two feet of depth below the original surface of a bad quick sand, in which at first I could not keep open the shallowest permanent passage. If all the glutted sand bed of the low country (as inferred) is also of quick-sand, in like manner it may at first be barely tapped by ditching, and afterwards, and gradually, be dug into deeper, until all the the injurious excess of under-water has been reduced and removed.

XIII.—*Tests by which to judge, in advance, of the expediency or success of desired draining operations, and illustrations of effects.*

Such is my view of the cause of the general wetness of this low land region, and such the proposed remedy. If the principle is sound, and the deductions true, it is enough for my argument, and also for very extensive applications of the theory in practice. But it is not for me, slightly informed of particular facts and localities as I am by personal observation, to offer particular directions for practical operations, or to state the natural and various conditions of different localities, which may either invite or discourage and forbid efforts to drain by means of reaching the deep-seated sources of the injurious waters. In many or most localities of this great low-land region the proposed means may be used both cheaply and profitably. In others, owing to the greater depth of digging necessary, the operation, though equaliy sure of success, might be of more cost than profit. Every judicious farmer acquainted with the local details can best determine as to the applicability of my general plan to his own farm and vicinity. But there are certain indications and preliminary tests of the need for and probable success of such undertakings, which each farmer should consult in advance. These will now be mentioned.

The shallow wells on every farm will have shown whether a sand bed has been reached, whether its being tapped brought up water, and at what height above the sand, if any, the water stands permanently, and how much higher after winter or the wettest season. These facts would serve to show how high the water may be drawn up by borings, and how much below that height it may be sunk by deep ditching. Thus, any depth of ditching below the highest temporary rising of the water, in wells or bore-holes, would do *some* good in draining off or reducing the glut below, and its upward pressure, though such benefit might be but for the wettest seasons. But the deeper the digging the greater would be the reduction of the hurtful excess of water. And the remedy would not be complete, until the main ditches were sunk into the sand bed, so as to take off from the adjacent ground, all the former upward pressure of the under water and also render the upper layer of the sand-bed dry, and therefore capable of freely imbibing the new supplies of rain-water infiltrated from above.

Next, as to the assumed permeability to water of the upper bed of earth. It has been admitted that the upper beds, even if of the most sandy and loose texture, if full of water below, are impermeable to more water standing on the surface. But if such wet earth be deprived of all superfluous moisture, (as by any proper draining,) then, what was impervious before may become as pervious as desirable. Every one has observed such change in clay, when dug into, and the sides and bottom of the excavation left exposed to a drying atmosphere. Of course, such extent of drying, and the consequent great opening of fissures, is not to be looked for under the covering earth. But in long droughts, earth not affected by under-water, will become as dry as dust for four feet or more below the surface. This is often seen in the digging of graves in summer; while in that dry condition there must be formed innumerable small pores and fissures, caused by contraction, in the most compact earth, through which water would freely sink, and in great quantity, and as low as the earth had thus dried, and fissures been formed. And these fissures could not be again entirely closed by wetness and expansion of the earth, so as to exclude all precolation of water. It is not for me to assert that there will be enough of these fissures, and reaching to sufficient depth, to serve to carry down by percolation all the excess of rain-water, even when gradually falling on the earth. But there can be no question that water will be so absorbed and conveyed away in great quantity, in a soil with under-beds thus drained, when the same earth, before being drained, would have been incapable of absorbing any water below the quickly saturated surface soil.

For the good effect and success of the plan of draining the earth from below, it is not necessary that all or even a large proportion of the water in the sand-bed shall be so drained off. It may be that the bed is twenty feet thick. However thick the bed, its being full of water and surcharged, (proved by the water pressing upward,) shows that the supply of water from the higher parts of the country is greater than the sand bed has openings for its lateral discharge. Thus, suppose the whole natural discharge of the sand-bed, into rivers and other outlets, and by evaporation, to be in volume, as 19, and the supply of water from rains, and from the more elevated distant part of the bed, to be as 20, then it is seen that the excess of supply of 1 part can only be removed by being forced upward through the earth. This is the water that operates injuriously, directly, by causing wetness to the under earth, and indirectly, by preventing the excess of rain-water from being discharged by sinking. Then, if by tapping the sand-bed, this twentieth part of the water only is removed, the whole upward pressure, with the surcharge is prevented.

But further, if by deeper draining the still full (but not overgorged) sand-bed has its water drawn off and lowered only one foot of its 20 or more of supposed depth, that upper foot of sand, thus made dry, will serve as underdraining (or absorbent) material for all the upper earth, and may receive and continually pass off all the surplus rain-water that may thereafter fall on the surface. Such is the fortunate natural condition of the best low ground farms on the lower James river, before adverted to—best, not so much for their great natural fertiliy, and good constitution, valuable as these are, as because they are thus under-drained by nature. The upper layer of the sand-bed under these lands, is always dry for some feet down. This dry layer, though some 12 feet or more below earth of clayey texture, is the true cause of the usual dry condition of those soils. And although the wells reach water in abundance at a few feet lower in the sand, that water has no upward pressure, and cannot damage the higher beds of earth and soil. In these cases the natural means for the lateral discharge of water from the sand-bed, (in its high level,) are greater than needed for the quantity supplied. Therefore, the higher layer of the sand-bed is kept free from water, and always ready to receive, and convey still lower, any new and temporary supply from the upper beds and soil. If, on the contrary, the average supply of water had ever so little exceeded the means for average discharge; this upper layer of sand would have been always over-gorged with water, and the surface would suffer with wetness, as do the low-lands on the Pamunkey river, and all this great low-land region here under consideration.

Though wet earth is perfectly impervious to the entrance and passage by percolation of more water from the surface (pressing downward, and by its own weight only,) I doubt whether any earth in the tide-water region is impervious. If previously drained, at least, none such has occurred in my extensive draining labors and experience. Much soil is made more impervious by having been ploughed or tilled when wet. This operation approaches, in effect, to what is called "puddling," or kneading wet clay, or loam, which is done for the purpose of closing all the pores, and making the earth impervious to water. Such, in the greatest perfection, is the working of clay for pottery, and in less degree, for making tiles and bricks. Hence it is that deep and proper ploughing, introduced on land before often ploughed wet, and always shallow, has well known draining effect, because the "puddled" and impervious pan is broken up, and the rain-water then permitted to sink through the natural fissures of the lower earth.

NOTE.

It was after the whole of this article had been written that I saw (May, 1857,) in the city of Charleston, South Carolina, the best exemplification, and practical proof, of the soundness of the views expressed above. Under the city, and also, (as inferred from a superficial and hasty glance,) under all the higher ground of the whole neighboring country, there lies the bed of sand as described above. The top of the sand is generally within three feet of the surface of the higher and firm ground on which the city is built. As deep in this sand as to the level of twenty inches above low tide mark, excavations were then in progress, in which were to be constructed large culverts, designed to carry away, with the drained water, the filth of the city. These deep culverts were in and across the higher parts of the site of Charleston, and extending on a level from the tide-water of one river to the other. The greatest depth was fourteen feet—and more than ten feet in some places in the sand-bed, and rarely less than seven. The sand was wet to its top; and a little below, it was quick, and becoming more and more fluid, and yielding more and more water as opened, to the bottom of the excavation. Water was usually reached at the depth of three feet below the surface of the street. In the street fire-wells, the water usually stood still higher. I saw one, just before it was drawn off, and laid dry by the new and deeper digging for the culvert, in which the water stood within 18 inches of the surface of the ground. No digging for agricultural draining could have been afforded of one-fourth this depth into the quick-sand—nor could any works for agricultural objects and profits, only, have been completed speedily, and at such great expense of labor and other appliances. Therefore, no mere agricultural drainage operations could have offered such full and satisfactory evidences of the correctness of my theoretical views, as did then, and will still more hereafter, this great city work, of which drainage was but a secondary object, and a mean sought to be used, (in the collected spring-water, held back, for a time, by flood gates,) to wash and float off to the rivers, the soluble and other putrescent filth of the city. The ditch, opened to lay the culvert in, was 10 feet wide, with perpendicular sides. As soon as the excavation reached the upper quick-sand, a narrow trench only was then dug along the middle, and kept deepest by the strong force of as many laborers as could have room to work. This central and narrow trench served to drain the sand which was then left on the sides—and by being thus made dry, it became almost immediately firm—and in a few hours this former quick-sand could be easily removed by shovels. But before entirly removing this layer of sand to the outer limit of the designed excavation, the farther caving in (from without the limits) was prevented by driving down a close shield of thick boards, placed vertically, and with their lower edges sharpened. These boards were supported, and kept in their designed direction, by a strong frame work of timbers, stretched across the entire width of the ditch. These sharpened boards were driven downward as the excavation was lowered, and were always kept a little below the still fluid surface of the sand, and which would cave in, if not at first held up by this strong and continuous barrier. After thus securing the sides, and removing the sand through a course of some

XIV.—*Some of the farming practices of the low-lands—Defects and proposed improvements—Rotations of crops—Pea-fallow, and narrow and broad-bed tillage.*

In my hasty journeys through this country, though diligently engaged in taking general and superficial views, I had but little opportunity to observe extensively, or to examine the details of farming. Therefore, nothing like minute description will be attempted and only general remarks offered on some of the most striking advantages and capabilities of the lands, and defects of their culture.

The early settlements were made on the dryest places, and on most of these, tillage has been continued almost incessantly, from the first settlement to recent, or to the present time. Under such treatment, and with the necessary, or at least certain and frequent wet ploughing of land, always too wet in winter and spring, it is surprising that fields so abused have not become poorer than they are. I saw none that were so unproductive as the poorest fields of the higher tide-water counties in Virginia, which have not been marled or limed, or as all such most exhausted lands were before marling and liming were begun; and wherever the formerly most reduced lands have latterly been occupied by good farmers, they have been greatly and rapidly improved. Sundry such cases are to

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2 feet thick, then another like narrow trench would be dug, and by its aid, another layer of quick-sand would be first drained, and then thrown out. In this manner, the designed level for the bottom would be reached, and therefore the culvert (of arched and well cemented brick-work, laid on a floor of plank,) was constructed, and for each portion, completed very soon after the excavation had been begun. Thus, by great expense of labor, and of mechanical supports and other appliances, this work, for each short distance, might be completed, and made secure, in a day, which, if for agricultural draining, might have required, (in the necessary intermission of labor,) years for completion, and to be sunk only one-third as much depth into quick-sand.

But though the depth of this great work, for the draining and cleansing of a city, can never be imitated, or even approached in depth, in the country, or for agricultural profits, it is not therefore the less in proof of the correctness of my previous views of the natural features which cause the general wetness of the low country, and the proper and efficient means for, and the true principle of drainage for such lands. And, in advance of the completion of this work, and of all manifest draining results thereof, I will venture to predict that these results will be such as must be inferred from my reasoning stated above, and that these results will be evident for all the ground within half a mile, or perhaps much more, from the lines of the draining culverts.

be seen, and especially in Perquimans county. The oldest tilled lands are here referred to. The greatest recent improvements have been the bringing under culture the extensive firm swamp lands which have lost little or nothing of their original and great fertility.

On the farms of Messrs. Francis Nixon and J. T. Granberry, I saw the manner in which these swamp lands are brought under cultivation. The large trees, not needed for timber or fuel are belted and so killed. The heavy forest growth is mostly of gum, poplar, oak and large swamp pine, used for naval timber,) some of the latter of great size. The smaller growth is cut down more than once, and mostly dies. The land is used for grazing, until the roots are enough rotted to permit ditching and ploughing. This will be in about five years after the belting of the trees. Then the principal ditches are dug on the plan before described, and as they are to remain, except that when encountering a very large tree in the route, the ditch is there curved around the tree. The next spring, (or before) the smaller ditches are also cut, and the land ploughed and planted in corn.

There is no marl in this region, except at a few exposures of small extent —or rather, the marl lies too deep to be accessible. Some marl has been excavated and used in Princess Anne. There are extensive Indian banks of mussel-shells on the borders of the Chowan river; and in Currituck, an Indian bank of oyster-shells stretches almost continuously for forty miles along the eastern margin of the sound. There are also in shallow waters of the sounds immense beds of oyster-shells, in the places where the animals lived, before being killed by the water becoming fresh. So there is no want of material for calcareous manuring, independent of the supplies of lime and of shells, available from the waters of the Chesapeake. Some of the Indian bank-shells have been used, and more lime, and to good effect, as reported, and better than ought to be expected on land not well drained. Next after supplying the first necessity, draining, liming would be especially beneficial to all the lands of this region. Besides other reasons, and benefits to be gained, lime applied on the new and rich lands would serve the better to preserve their fertility; and, on the poorest lands, it will enable the most speedy and complete acquiring of fertility. But the best effects from lime can be counted on only on land previously well drained, or, otherwise, not needing draining.

The great crop, of the North Carolina counties is corn. Next to this, and especially in Perquimans, is wheat. These two are the only great crops for market. The lands generally, if not suffering much from wetness, produce corn well. On the new clearings of firm swamp lands, ditched well on the ordinary plan, fifty bushels to the acre may be made. I saw a small field of wheat in Princess Anne, (where that crop is rarely attempted, and never on large spaces,) and several large fields in Perquimans, that in growth equalled what I had just before seen on some of the best lands on James River. There is no better land for the growth of wheat than the soils of close and medium texture here. But the imperfect draining of the fields must prevent the product and quality of the grain being in proportion to the growth of straw; and, moreover, the humid air of the whole region, (caused mainly by the general want of draining, and the consequent great evaporation from the earth,) makes the wheat crop more liable to be dis eased with rust.

It was with much surprise, some years ago, that I heard that the best and largest crops of wheat in Perquimans, and in some other parts of this region, were still reaped by the sickle, or reap-hook.—This primitive mode of harvesting, which is older than the days of the patriarch Jacob, and which formerly was general in the United States, as it still is in Europe, I had supposed had everewhere, in this country, been substituted by the more expeditious scythe and cradle, if not by the still more modern reaping machine. And when first informed of the ancient usage remaining here, I had erroneously inferred that it indicated very slow progress in agricultural knowledge and improvement. But, when on my visit, while finding this practice far more extended than my previous idea of it, I also heard reasons in its defence, which seem to maintain its good economy. Neither is this practice confined to small crops. The best farmers and largest wheat growers, who sometimes make crops of more than five thousand bushels, reap them with the sickle. I knew that, by this mode, there might be avoided much of the great waste of wheat that is usually made by cradling; but had supposed that the slower operation of the sickle, and the high prices of harvest labor, and the scarcity of laborers at any price, had caused this implement to be abandoned everywhere in the United States, except for spots of rank and tangled wheat, or on steep hill sides.—Even for these latter circumstances, in which the proper use of the sickle would always be preferable, I have not been able to resort to it, because none of our laborers are now accustomed to it, and they would make awkward and very slow work. But in this district, the regular use of the sickle has never been abandoned, or suspended, and, therefore, the laborers are expert; and in a heavy growth of wheat, a good hand, with the sickle, can reap more wheat than he could on the same ground, with the cradle, besides saving much more of what is cut down. The difference of waste will more than pay the difference of amount of labor and greater expense through a crop. Further, by using the sickle, and cutting as high as can be to save the wheat, most of the tall straw is left standing as stubble in the field, which is the cheapest, and as good a disposition as can be made of it for manuring the land, and makes a vast saving of labor in the hauling, threshing and stacking, compared to the handling of all the greater length of straw, as usually cut by the scythe and cradle, or by a reaping machine. But, if admitting that the reaping of a heavy growth of wheat by the sickle is preferable, still, in a merely agricultural country it could not be done, for want of the additional force of hands which this process certainly requires. But in the peculiar condition of this district, this objection does not apply. There is so great a number of laborers employed in cutting timber, and in the fisheries, that there are enough, for the higher wages of harvest, to supply the then extraordinary demand for labor on every wheat farm.

Light growths of wheat are often reaped by cradling; and where both modes are thus in use together, the more extensive use of the sickle is, in itself, good evidence of the heavy crops of wheat raised here by good farmers, and on good land. Perquimans has generally stiff soil, and is much the best wheat producing part of this region, (not including the Roanoke bottom.) In Pasquotank the lands are also good, but lighter and better for corn. Those of Camden and Currituck are inferior in value of soil and agricultural products, and also as to improved farming. Currituck, especially, is so intersected by navigable waters, and bounded by the sound and the ocean, that the labors or pursuits of the residents are all more or less connected with the water and its products.

Except corn and wheat there is scarcely a crop of large culture raised for market in the North Carolina counties. Cotton, which is so universally and extensively cultivated in the nearest higher counties in North Carolina, and even to some extent in those of Virginia, is not attempted here, as a crop for market. The general prevalence of wet soil is a sufficient cause for the absence of this crop. Oats, and especially hay, would be good crops for this humid climate and soil. But neither is raised for market, and hay scarcely at all, the fodder and shucks of corn serving in the place of hay, as everywhere in our corn-growing country. Yet vessel loads of coarse and mean hay, from the northern States, are continually brought here for the use of the towns, and for the teams of the lumberers working in the swamp forests. There is no better country for grass east of the mountains. On the farm of Edward H. Herbert, Esq., Princess Anne, on a large space, and elsewhere in Norfolk county, in small lots, I saw dry meadows of orchard grass and clover that would have been deemed good for the best grass districts, and which, well attested both the fertility and good drainage of the fields on which these crops grew.

In the counties in Virginia, where near to Norfolk, and with easy access by the regular steamers to the great Northern cities, "truck" farming or cultivating green vegetables and fruit for sale, is the sole business on sundry of the most valuable farms, and it enters more or less into the culture of many others. This business is carried on exclusively, largely, and successfully in Norfolk county, on river farms only, and within a few miles of the wharves. The limitation to these localities is compelled, first, because of the necessary ready access to the steam-vessels, and also because it is only in close neighborhood to a considerable town that numerous laborers can be hired whenever wanted for gathering vegetables and fruits, which requires, rarely, many hands, and for short and uncertain lengths of time. This kind of farming is the most perfect in all its operatrons, the most costly in money and labor and the most productive, not only in the gross returns, but in nett profit, and, as reported, it is the only kind of farming in the county that is well conducted. It is not long since this "truck farming" has been established on anything like its present important position; and in that time, the lands near Norfolk and Portsmouth, suitable for this business, and so used, have increased, in market value and price, from 500 to 1,000 per cent.

This market gardening, or "truck-farming," in these large operations, is a peculiar and remarkable branch of agriculture, which well deserves thorough examination, and more full report, than this slight notice. It is an important and admirable kind of what in England is called "high farming," requiring great expenses, but returning so much the larger profits. Compared to nearly all other farming of the surrounding and neighboring lands, the "truck" farms appear like an oasis in a desert. The quantity and the cost of manures applied on these farms, and the magnitude of other expenses, and still more the great returns of products and profits would be astonishing, if not appearing incredible, to a stranger. Still, this business is the most laborious employment of a proprietor, exacting unceasing attention, care and anxiety, for every hour. Nothing short of untiring industry, care, and also good judgment, can attain success and its great rewards; and even all these will not always prevent heavy losses. The business is precarious, and subject to great changes and hazards, and losses, which no industry or care can guard against. A single severe frost, at an unusual time, may destroy a valuable crop, for which all the expenses have been incurred, except for the gathering and shipping; and which loss may reduce the nett receipts expected by thousands of dollars.

In the Virginia counties, the required drainage and culture are of much easier execution than in Perquimans, and yet both are more negligently performed. No where does there seem to be any regular system of rotation of crops. This essential part of good farming is neglected everywhere by poor and bad farmers. The most energetic and successful cultivators and improvers here have been so much occupied in the heavy labors of clearing and draining their new and rich swamp lands, that they had no opportunity to use any regular rotation of crops. This is a sufficient reason as to the newly cleared lands, for which, for some years, regular rotation would not be required, and would even be improper. But this circumstance, and the continued additions of new surface to the tilled land should not prevent the older and poorer land being kept under a proper rotation, or at least under a proper succession of crops. And the neglect is the more reprehensible and strange, inasmuch as the farmers of this region possess peculiar facilities for rotation, in the pea-crop, and a climate admirably adapted to its growth. The limited territory on which both the pea and the wheat crop can grow well, (the one suiting so well to prepare for and aid the growth of the other,) I deem the most favored of all agricultural regions. Still more strange appeared to me the general negleet of peas as a manuring crop in this region, from some of the best farmers of which I obtained most of my early practical instruction as to this particular value of the pea-crop. Yet this great means for improvement, on most farms, seems to be but little used or appreciated. It is true, that peas are planted, as a secondary crop, in every field of corn, and the returns are highly valued.—But this pea-crop, except so much as is gathered for seed or for sale, is generally eaten on the ground by the hogs designed for slaughter, (greatly indeed for benefit in that respect,) so that very little of the crop, except the roots and stems, go to manure the land. I heard of no separate crops of broad-cast peas, (or "pea-fallow,") to prepare and manure for a succeeding wheat crop, the most valuable use to which the pea-crop can be applied. It is a frequent practice here for the land in corn (and secondary peas) not to be sown in wheat the autumn of the same year, (as is usual in Virginia,) but for

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the field to remain until the autumn of the following year, and then to be sown in wheat. This practice leaves the field idle and useless all the spring and summer, when in that time it might be sown in peas, and bring a manuring and cleansing crop to precede the wheat, without any loss of time or of land. This is a regular part of my own established rotation, and, as supposed, its best feature, though my more northern position and shorter warm season render the pea-crop much less productive and beneficial than in this more favored region. Still more than this omission, another is common and as reprehensible. Wheat, in some cases, is made to follow wheat in two successive years. If, in such cases, there was merely interposed between these two crops a broad-cast crop of peas, (for which there is plenty of growing time,) that addition only would serve to substitute a cleansing, enriching, and judicious succession of crops, for one that is inexcusable and abominable.—Clover is made on most of the good farms of Perquimans, and used as a preparing (or fallow) crop for wheat. With the superior facilities for the best growth of peas, if I were farming in this region, I should much prefer pea-fallow to clover-fallow, to precede wheat.

The reason offered for the total omission of pea-fallow is the great and engrossing tillage labors required for the great crops of corn, and also for the wheat harvest, both of which occur with and include the very time in which the land for broad-cast peas should be ploughed and sown. This is true, and a sufficient reason, if it is necessary to plant in corn as much land as the laboring force can cultivate. But it would be much better to secure the great benefit of a manuring pea-crop to precede wheat, by the (temporary) sacrifice of omitting to plant as much corn as would release enough labor for the additional pea-crop. This sacrifice was a necessary incident of my own change (in 1848) of the five-shift rotation, without pea-fallow, to the six-shift, with one entire field under broad-cast peas. The fields of both corn and wheat, by this change, were reduced, severally, to five-sixths of their previous size. Yet the wheat crops have continued since to increase, on the general average, and to exceed more and more the previous entire product, and so have the corn-crops, except in the first year only of the reduced extent of cultivation. Yet the advantages of manuring by the pea-crop in my locality and climate are very inferior to those of this region of North Carolina.

While the many firm swamps remained generally under forest, these lands afforded excellent "range" for live stock, or a great quantity of food, especially for cattle and hogs. But this benefit, (if it was one,) has almost ceased in the best cultivated parts of the counties on the sound. Such is Durant's Neck, the narrow and level and very low peninsula which stretches for twelve miles between Perquimans and Little River to Albemarle sound. This land, being but a few miles wide anywhere, and bounded nearly around by these deep waters, is in consequence better drained, naturally, than the interior lands, and is very productive. Nearly all this "neck" is enclosed, and an unusually large proportion of the whole is under tillage, and there is scarcely any unenclosed forest or waste land for ranging live stock, and none that affords any grazing profit. I know no place where it would be so profitable to dispense with fences, as is done by mutual agreement, by the proprietors of three several neighborhoods in Prince George county, Virginia, each including from 4,000 to 8,000 acres, and making from 10 to 15 farms and separate properties. If the cultivators of Durant's Neck would do the like they would only have to make one short and straight fence to enclose all their fine farms, and save all the cost of their present useless fences. Yet every farm and field is now separately fenced in, and some of the proprietors have no materials for fencing, and buy, and transport from a distance, all their rails. This locality, more strongly than any other, shows the absurdity of our fence law, and also the strength and long vitality of old habits and opinions, when the former good reasons for them have long ceased to exist. If the live stock were reduced in numbers to one-fourth, and these were well kept, by being herded within the farms, one cow would yield as much profit as four do now. And when the grazing stocks were so lessened in number there would be much surplus grass left to manure the pasture or other land. While three-fourths of all the present fencing might be dispensed with, the other fourth would serve to make a sufficient pasture enclosure for every farm. For nothing in geometry is more clearly demonstrable than the proposition that it will require greatly less length of enclosure to fence in the cattle of any well cleared and settled section of country, than to fence in all the fields and crops to protect them from the cattle if left at large. One-fourth of the present fencing in Durant's Neck would suffice not only to make on every farm a proper pasture enclosure, but also the general and joint barrier fence against all other people's stock. Most of the farmers in Prince George, who have joined in these arrangements, if not situated on the border, have no fence except the pens in which to confine the animals at night. But this extreme course is not true economy.

In Princess Anne, there still remains so much uncleared ands wamp land, that the leaving cattle to range at large is deemed very profitable to the owners, and perhaps, in general, it is there more an offset to the expenses of fences, under our fence law, than in any other county of lower Virginia. The open swamps bear reeds in great quantity, which afford abundant and excellent food for cattle through winter and summer. There are herds of cattle that have become wild, and are made use of when wanted for beef, only by being hunted and shot. These wild cattle would be very profitable to their owners, as they require neither food nor attention, except that they are as much at the disposal of every other person who may be inclined to shoot and steal them.

It becomes a slight observer of a newly seen agricultural district of novel and peculiar character, to be diffident of his own opinions thereon, and more especially, when they are in opposition to those of the judicious and experienced resident farmers. One of such subjects I will mention, though without any view of urging the superior value of my opinions and practice, in this respect on my friends in this region, who unanimously and strongly protested against them, at least for their lands. Their experience of facts, in contradiction, certainly deserves more to be respected than my theoretical views as to this region, even though they have been sustained by the results of my own practice and experience elsewhere.

As stated before, the tillage generally, and on the best managed farms, is in narrow beds (five feet,) for corn, and the same size is preserved for wheat. The beds are reversed for every crop, both of corn and wheat. I will not here repeat my objections to this narrow bed tillage, nor my reason for preferring (where any are necessary) beds of twenty-five or more feet in width. These views have been stated and argued at length in different former publications. (The latest and fullest articles on tillage in broad beds, and also on drainage in general, are in "Essays and Notes on Agriculture," 1855.) I will only say here, that all the reasons for preparing wide beds for low and flat lands generally, apply with greater force to the lands of this region, and especially in Perquimans, because they are of more regular level, and with fewer alternations of slight depressions and elevations, than any other low-lands within my knowledge. The best farmers here, with whom I have argued this question, object on various grounds to my broad beds, but especially, because their frequent cross "hoe-furrows" are deemed indispensable, and if the broad and higher beds, and their deeper alleys were in use, the "hoe-furrows" would have to be made still deeper, and require more labor to dig, and to renew after every ploughing or horse-tillage, and be even inconvenient for the ploughs to cross. This objection would be valid, if, indeed, it would be necessary (with the broad beds, and deeper alleys) to retain the hoe-furrows; but this necessity I doubt. For with so much higher beds and deeper alleys between them, on land scarcely varying from a level, or from a regular and gentle slope, I think that the deeper alleys would substitute the hoe-furrows, and render them superfluous, except where a cross depression of surface required a particular cross grip. In my own practice, on the Pamunkey flats the surface is much more irregular, yet there are no grips kept across the beds, except along the cross depressions. If the inequalities of surface level were as rare as on the Perquimans lands, my cross grips would be fewer and less necessary than they are.

But if my plan of broad-beds would suit this region, there might still be added thereto another improvement, which I commenced using in 1855, and which has been continued since on the Marlbourne farm, with increasing confidence and approval. Without taking time here to describe and recommend the operation in general on the different circumstances of my own farm and practice, I will merely apply the plan to the present existing divisions and ditches of the Perquimans lands.* We will suppose that these present ditches are all necessary and proper to be retained—though such is not my opinion, if a different system of drainage were in use. Then suppose merely the change that each of the rectangular enclosed spaces of 150 feet wide, instead of being, as now, in thirty beds of five feet wide, was ploughed into six beds, each of 25 feet width. After two or three years ploughing and tillage, and gathering of these wide beds separately, they would be as high, and their intermediate alleys as deep as desirable. Then, instead of continuing to plough each bed separately, the first furrow should be cut alongside of the central alley, and turning the slice into it. This furrow should begin and end at 75 or 80 feet distance from the ends of the rectangular "slip," or at (or something less than) the same distance of the central alley from the sides of the slip.—Turning the plough at that distance, another furrow should be cut alongside, and throwing the slice to the first, thus making, a "list" in the former central alley. So the ploughing would proceed around this first list, cutting across the ends as well as along the sides, and throwing every furrow-slice towards the centre of the ploughing. This ploughing, though flush, and cutting across the ends as well as along the beds, and with no regard paid to the alleys,

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* When I first began this manner of flush ploughing of low and bedded land, and with considerable apprehension as to its complete success, it was not known to me that any other farmer had either used or thought of the same method. But, subsequently, when recommending it to the trial of E. H. Herbert, Esq., of Princess Anne, as an important aid to his usual efficacious practice of draining, he informed me that he had already introduced and used this plan of flush ploughing on his land earlier than my first trial of it, and had found the results entirely satisfactory.

A communication to the State Agricultural Society, particularly describing and directing this plan of flush ploughing, will be appended to this article.

would scarcely alter the outline of the previous surface, and would not lessen the height of the crowns of the beds or the depth of the alleys, except the central alley, which would in time be filled, and would not then be needed. The outside furrows would just reach the encircling ditches of the "slip," turning the depth and width of a furrow-slice from each at every repetition of such ploughing. One or two furrows run along each of the old alleys, after the flush ploughing, would clean them out and put the broad-beds in their original shape, and they would be more thoroughly broken by this mode of ploughing. Every successive ploughing of the land to prepare for any crop should be done in like manner. The tendency and operation would be to raise the central part of each rectangular division so ploughed around, and to lower and slope the sides and ends, or margins, next to the surrounding ditches. After a few such ploughings the shallow tap-ditches would be, to the eye, almost obliterated, or changed to mere ploughed alleys or grips. Yet in fact, they might be deeper than before, and would certainly be more operative for surface drainage than before. The preserving and cleaning out of these "tap-ditches," instead of requiring spades and shovels, would thereafter be as well done by the last finishing furrows of the plough. These ditches would no longer present any obstruction to the crossing of ploughs, or partly loaded carts. If desired, (and it might be even desirable in future time,) the corn-rows and their ploughing, in narrow beds, might be directed across the beds and tap-ditches. Further, the end margins of the "slip" being equally depressed, and sloped to the edges of the larger leading ditches, these would be much more easily crossed by teams, and fewer and smaller bridges would be required. Thus, in the course of time, each separate "slip" would be converted to one broad bed of 150 feet wide, and gently rounding surface, and 1000 feet long, (the present dimensions of the separate divisions) with sloped margins and ditches between, deeper than before, yet presenting either little obstruction, or none, to the crossing of ploughs and teams.

POSTSCRIPT.

LANDS ON THE CHOWAN AND ROANOKE.

A later excursion to a portion of Chowan county, and to some of the best farms on the Roanoke river, enables me to add something to the foregoing notes of this generally uniform region, and especially in remarkable exceptions, on the Roanoke, to this general uniformity of agricultural character.

In Chowan county, my view extended only over the lands within 12 miles of Edenton, and from 3 to 4 miles back from the Chowan river and Albemarle Sound. The general elevation of the surface is from 11 to 14 feet above the level of the Sound—and the land is more uniform in level than any other that I had before seen. The soils are moderately stiff, and of good texture for producing wheat. Before being cleared of the forest growth, and ditched, most of the surface of the land was subject to be covered by the water left by heavy rains. The system of drainage in general use is similar to that of Perquimans. But the small parallel (or "tap") ditches are wider apart—usually 180 feet. According to this system, the details of draining were well executed, and effective; and the lands best drained, (especially those of Dr. Thomas Warren,) were very fertile and productive. These, where seen in their natural state, seemed to the eye, and by their growth and wetness, to be swamp. But in fact, they are of the highest level of the neighborhood, and among the dryest, after being drained and cultivated. The natural forest growth was principally of black gum, ash, maple, with some oak and pine—and with these, a general undergrowth of reeds. For miles, no change of level of the surface was visible; and the slight general descent of surface could be known only by the direction of the flow of water in the larger ditches.—The farms bordering on the Sound, only, have some narrow depressions, of a few feet only in depth, which serve as exceptions to the otherwise general level of the surface. The water in the wells of Edenton and the neighboring country is generally about 13 feet below the surface of the land. This would indicate that the water-glutted sand-bed here lies too low to produce the damage elsewhere, usual to land, by keeping water on the surface—or to afford a facility for draining operations, by tapping the sand-bed by deep drains, or by boring. On these points, my hasty and limited observations, aided by inquiry, afford no information better than conjecture.

The broad Chowan is the only river of all this low-land region, east of the Roanoke, which receives any considerable supply of water from higher and distant sources, or is filled by any other than the refluent water of Albemarle Sound. And even as to the Chowan, all the water brought by its upper tributaries, the Meherrin, Nottoway and Blackwater rivers, if alone, would not usually fill the twentieth part of the broad and deep bed of the Chowan. So that even this greatest of these neighboring rivers is but a partial and limited exception to their general character of having almost no head-springs, or supplies from remote sources.

But the Roanoke is remarkably different in these respects. Its very distant sources are in the Alleghany Mountains, and they make large streams, at all times, even at the base of these mountains. Its bed, throughout its long course to Albemarle sound, is very narrow for the great quantity of water flowing therein, and which ordinary supply is enormously increased by the transient rain-floods coming from the upper country. These rise to great heights, and cause great injury to the very rich and extensive bottom lands bordering on this river. But for the rare and terrible disasters to the crops, caused by these high freshes, they would be of great improving benefit to the fertility of lands they overflow, in the abundant deposit of richest alluvium which the water leaves. This deposit has made, and maintains, the Roanoke lands the richest on the Atlantic slope; and they would be more valuable than the bottom lands of any of the rivers of that slope, but for their greater liability to be overflowed, which is owing to the remarkable narrowness of the whole bed and course of the river, compared to its length, and to the volume of water which it conveys. The bed of the river, and even to its outlet into the Sound, is too narrow to discharge its floods; and hence they overflow the bordering low grounds, of the second terrace as well as the first or lowest, to their great damage. Thus these rich alluvial low grounds of the Roanoke are greatly subject to disaster from being overflowed by floods, from which danger the low borders of the other rivers of Albemarle Sound are almost entirely exempt.

That the low lands of the Roanoke are so different from all of the neighboring rivers, is owing but in part to the great length of its course, from its distant mountain head-springs. This indeed causes the great volume of the floods, as well as their great burden of rich alluvium. But there is still an additional cause for the obstructed discharge, in the different geological character of the land over which the lower course of this river passes. The lower channels of the other neighboring rivers, on both sides, together with their bordering lands, seem all to have subsided, at some far remote time below their former levels. But the bed of the Roanoke seems to have preserved its original elevation, if indeed it has not been actually up-heaved still higher. The primitive rock shows in ledges under the channel of the Roanoke far below the foot of the great falls; and even high above the present height of water in the bank at Halifax ferry. The river is very uniform in breadth, and not varying much from about one hundred and twenty yards, from the falls to Albemarle Sound.

The "first low ground" or lowest terrace, gives the richest soil —which however is not black, or dark-colored, but of reddish yellow, or hazel loam. The "second low ground" is worse in quality, but still is good land. The "third" is still worse; and there is in some cases still a fourth terrace, nearly as high as, though evidently lower than, and different from, the highest table or ridge land, which is usually sandy and naturally poor.

Corn is the great crop of the Roanoke lands. Though fine crops of wheat are raised by the Messrs. Burgwyn, in Northampton, Co., N. C., and J. C. Johnson, in Halifax, giving evidence of the fitness of the low ground soils for that crop. Cotton is the next greatest crop to corn; and this culture is sufficient evidence that the lands on which it succeeds do not naturally suffer damage from under or spring water. The farmers have not much to do for drainage, except to exclude, by deep and broad ditches and their banks, and to vent by culverts, the streams and rain-floods coming in from the high lands, and, by dykes, to keep off the high floods of the river. Both these great objects are well effected only on the properties of a few of the planters—at enormous expense, but at far less cost than the alternative of losing the growing crops usually once in 7 to 10 years, on an average.

The land nearest to the river, whether of the first or second terrace, is always higher than the exterior of the same terrace farther back from the river. This shape of the surface offers the highest foundation for the dykes next to the river, where they are required to be placed. There are great differences and frequent changes in the elevation of ground bordering on the river, and consequently as much difference in the required heights of the embankments.—The home plantation of Th. P. Devereux, Esq., Connucanara, in Halifax county, North Carolina, is protected by an embankment rising to the height of 26 feet throughout above the low-water level of the river. The highest fresh yet known, before the embankment was made, rose 22 feet, and covered the whole plantation except a few acres. Much of the dyke, being on the margin of the highest elevation, is only 4 feet high. But one part, which seemed about half a mile long, is 14 feet high. To every foot of perpendicular height, there is given 5 feet width of base. On Polenta, in Northampton, another of Mr. Devereux's several plantations, (all of which are thus secured by embankments,) the dyke, for 200 to 250 yards of its length is 17 feet high, and more than 100 broad at the base. And these high embankments are not the only heavy expense. For it is through their highest parts (these being over the lowest surface of the land,) that it is necessary to keep open large culverts to discharge the waters of land streams and rain-floods, and from which by valves, to exclude the river-floods when these are higher than the interior water. On this and four other adjacent farms there are 7 of the large-sized culverts, which cost about $2000 each—and three of these are on one only of the farms. These culverts are constructed of wood, and of course cannot be very durable. Still, great as is the expense, for embankment and culverts, for each plantation, it is cheaply paid for in the safety of a single crop, which would otherwise be lost, if without this means for security from inundation. Such is the correct reasoning of each individual proprietor, and improver in this mode. And thus, each one of the few who have yet so improved, may secure his own possessions from the floods of the river. But it is obvious that every such embankment, operating as an obstruction, must serve to raise the floods somewhat higher on the lands still subject to be submerged. And should every proprietor exercise his equal right to embank all his own lands, and thus the general operation shall strive to confine the river within the limits of its shores, the attempt must fail, and the floods, rising higher in proportion to their lateral confinement, will overtop any dykes which can be made by separate individuals, each working on his own separate plan. It would be very far better, and the only means by which general success can possibly be attained, if the State were to require such works to be constructed on one uniform and the best general plan, for the benefit of all the lands and their proprietors. If such general plan confined the water to its present channel, that confinement would cause much increased velocity and power of abrasion, and thereby a deepening of the bed of the river, if the bottom is soft enough to be so deepened by washing. And if this effect would be prevented by only a few narrow ledges of rocks too hard to be lowered by abrasion, it might be well worth the expense of deeper passages being opened through such narrow and harder obstructions. All the additional and general depth that could be so gained, would serve for the improvement of navigation of the river, as well as to aid the operation of the embankments to protect the lands from the river-floods.

A NEW PLAN FOR PLOUGHING FLAT LAND IN AID OF DRAINAGE.

On the borders of the Atlantic tide water rivers, and for more extended spaces near the mouths of these rivers, there are many and large bodies of low land and of surfaces nearly level, or but slightly undulating. All such lands, naturally, are more or less wet and require drainage for their good tillage and production.—And whether drained effectively, or ever so imperfectly, such lands, under culture, usually require, and have a number of open ditches, to collect and carry off the streams, and the excess of rain and surface water. In former publications,* I have offered my views at length in regard to the proper modes of draining, and the subsequent tillage (in very wide beds,) of lands of this class—and therefore these important and main branches of the general subject need not be here discussed. Nor will either be mentioned, except incidentally, and as necessary for explanation of the later and auxiliary improvement by the manner of ploughing, which I design now to set forth, and to recommend.

Whether any field, or farm, of the flat surface in view, is drained properly or improperly, there will be many ditches running in different directions. Where the lands are most level (as in large spaces of interior lands of lower Virginia and North and South Carolina,) the ditches may be placed almost anywhere, and in any direction, to operate as designed. But more generally, and especially on the borders of rivers, the surface has so many and frequent though it may be but slight undulations, that the open drains, for

* "Essays and Notes on Agriculture," and the preceding portion of this Report.

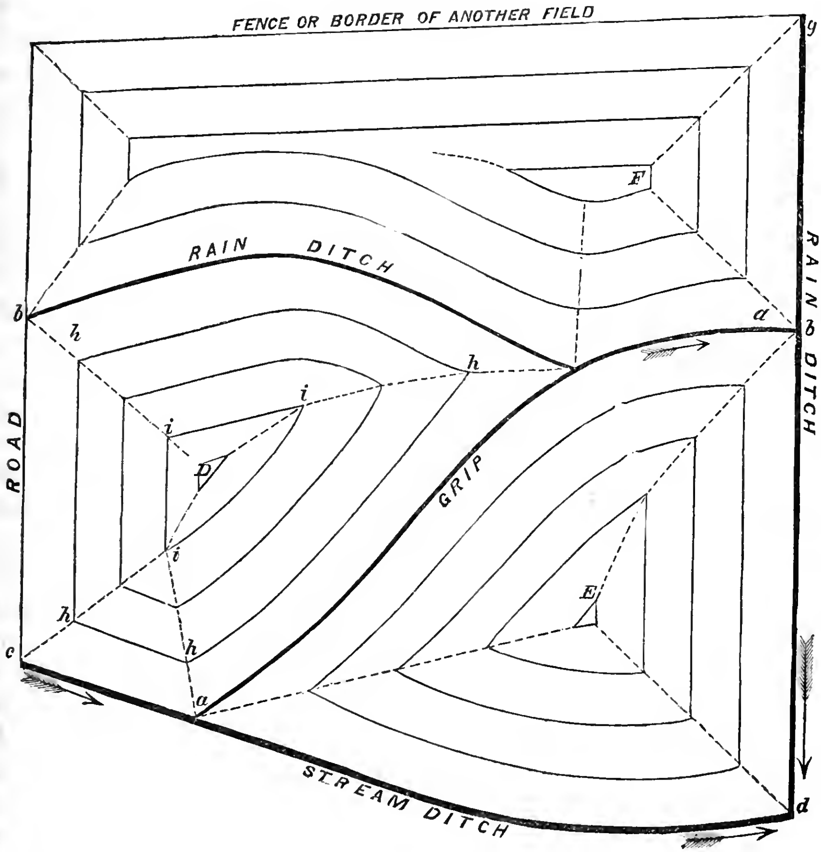
rain or surface water, must be placed precisely in the lowest depressions, and directed in the courses of these depresions. As these latter circumstances are the most usual, and are the most difficult, I will suppose them to exist, when making the following remarks.—Then, in a field of this kind, we may suppose there to be many slight and mostly narrow depressions, running in various directions between the somewhat higher and very much broader intervals of dryer land, but still not dry enough for draining to be dispensed with. Through all these depressions, (even where there are no springs to collect, or permanent stream to vent,) there pass open rain-ditches, which are impassable by ploughs and teams—or smaller grips, which, perhaps are ploughed across, and therefore require cleaning out, and almost renewing, after every ploughing of the ground. In either case, these open surface-drains, of whatever sizes, are great sources of trouble, and great impediment to tillage.

Further—as the depressions are usually but very little below the level of the near adjacent ground—and the line of the ditch is not at all lower than its borders—it follows that the earth thrown out in the first digging must raise the margins—perhaps to be raised still higher by every subsequent cleaning out of the ditch. These banks even if spread as far as to be thrown by shovels, still raise the margins—and if even but two or three inches higher than the ground, farther off from the ditch, this slight elevation seriously impairs the proper draining effect of the ditch.

Further—when the ploughs have to stop and turn at the sides of the ditches, they always bring there and leave some earth on the margins—and this serves still more to counteract drainage, and to cause future labor.

Such would be existing evils, even when great and unusual care is used to remove the first raised banks of ditches, and to prevent subsequent accumulations of earth there. But it is much more common, and far worse, to let the ditch banks remain to raise the margins—and further, to add to them by the subsequent ploughing, (if flush,) being so ordered that every furrow-slice, cut near to the ditch, is turned towards its banks.

Within the last two years, I have introduced a new manner of flush ploughing, which serves from the beginning to moderate the evils in question ; and which, in the course of time, will have the best effects in adding to the draining operation and effects of open ditches, of all kinds and sizes, and also in lessening the future labors for maintaining their proper operation.



The above figure or diagram, will enable me to explain more clearly the manner of ploughing. The whole space represents a field, or part of a field, which is divided by two long depressions into three irregularly shaped "cuts" or divisions, D, E, F. Along the middle of the larger interior depression, there had been kept open a narrow rain ditch, of the usual shape, *b*, *b*, say 2 feet deep, and 3 wide, (and which depth was necessary,) at which the plough and teams had to turn, because of the impassable obstruction. The other and smaller depression had a grip (*a*, *a*) say 15 inches wide and 10 deep, across which the ploughs passed, and which was filled and required cleaning out after every ploughing. A permanent stream ditch, *c*, *d*, is one of the boundaries, bordered on both sides by the lowest ground of the field. A rain ditch *g*, *b*, *d*, makes another boundary, a farm road another, and on the fourth side is a fence along side of the adjacent farm—or another field of the same farm.

It is desired to plough each of these cuts in such manner as to throw every furrow-slice from the outsides, and towards the centre. It is supposed that the ditch *b*, *b*, and the grip *a*, *a*, are in the best locations—that is, combining as much as possible the requisites of having the shortest courses that can be obtained in the lowest ground. If any defect of location exists, it should be corrected, and the ditch or grip be made correct in position. This being done, the next thing is to mark off the ground for ploughing. The field is supposed to have been left, after the last previous tillage, either in broad beds (25 feet or more,) high enough and well sloped—or otherwise in low and narrow beds, previously designed to be ploughed flush, and to be again bedded in the progress of tilling the corn crop. The farmer, or a careful and intelligent man, and a boy, having each one end of a strong but light cord (of strong hemp twine) about 75 feet long, will direct the ploughman where to mark. Taking one cut (as D,) the man walks along the outside lines, or as close thereto as the near horse of a plough-team can easily and safely walk. The boy carries the string stretched, and keeps it at right-angles to the out-side line on which the man walks. The plough-man, with a small one-horse plough, or coulter, follows the track of the boy, and barely scratches the ground, so as to make a perceptible mark. If a larger furrow were opened, it would be an inconvenience to the main work. Thus, if beginning on the cut D, the first line laid off, will be *h*, *h*, *h*, *h*, *h*, parallel to, and the length of the line distant from the surrounding boundary line of the cut D. At each angle, the plough should mark a little beyond its supposed full distance, and then be lifted back to the proper place indicated by the length of the string, when stretched from the next side. The intersection of the furrows will mark the exact place for the angle. Thus each successive marking will be made, parallel to and equi-distant from the preceding, until the work reaches nearly to the centre. If the last circuit made (*i*, *i*, *i*,) does not permit the line to be again used at its full length, it should be shortened, to any less length (say thirty or forty feet), and another and the smallest interior space (D) marked around. Next, the plough should mark a line from each of the angles of the inner space through the corresponding angles to the outer boundary, as the dotted lines are placed.

The cut is now ready to be ploughed. The plough is first run around the small interior space (D) turning the slices toward the centre. And as the furrows in the beginning are very short, it will be best (to save much trouble in the frequent turning,) not then to use a team of more than two horses. But as soon as the furrows are of sufficient length, this temporary expedient should be laid aside, and the larger plough and team suitable for the land be used. After a few furrows are cut around the inside marked circuit, so as to well designate the outline, then the small interior space D should be ploughed outward; or any way will serve. The plough then resumes its previous place and course, and continues to go around, and to turn the slices inward. The ploughman, in running every furrow should let the plough cut straight and fully up to and turn at the dotted lines. This will keep the work right at the angles, in which places it would otherwise be sure to get out of order. But with this care, and with cutting all the furrows as straight and as equal as every ploughman should do, the ploughing will go on as correctly as in any other mode—and with less loss of labor, and with more thorough execution. More thorough, because there will be no unbroken strips left, and only covered, as in all ridge or bed-ploughing—and no unnecessary and barren water-furrows made, where of no use, as in the closing of "lands" in all flush-ploughing. Further—as the ploughman approaches within a few yards of the next marked line, and still more when nearer, he has in that a test and gauge of his previous work, and a sure guide for the next succeeding. Wherever his last cut furrows obviously vary from being parallel to, or of equal distance from, the surrounding and nearest mark, he has but to make the width of his subsequently cut slices to suit and remedy the defects. The differences of texture or condition of the soil, or of the cover of vegetable matter, will cause the plough to gain more in width in some places than in others, if no care is used to prevent. But with the guidance of the parallel lines marking the widths, and the cross-lines indicating the proper points for the angles of the furrows, it will be easy for the ploughman, (or for any number of ploughs following each other on the same cut,) to make even and equal work, and to close at the outside lines, with but little loss of labor in broken furrows. It is obvious that the outside boundaries, whether made by ditches, fences, or growing crops on adjacent fields, can be ploughed more nearly to, in this mode, than in any other whatever.

The ploughs, and the depth of ploughing, may be any of description suitable to the soil. But, for the convenience of reference to effects, I will suppose the operation and conditions to be like my own. In that, the ploughs for breaking up, whether in winter, to prepare rough or grass land for corn, or in summer, to prepare clover, (or weed) land for wheat, are drawn by four mules, and usually in easy ground, cut and turn slices 7 to 8 inches deep and 12 to 14 inches wide.

First, let us consider the operation of the ploughing, in reference to its great and usually sole object, that of thoroughly breaking, loosening, subverting, and giving tilth to the soil, for sufficient depth, and also burying and covering the vegetable matter which stood on the previous surface.

The land is supposed (like mine) to have been left (at the previous tillage,) in straight and well shaped broad and high beds—say 25 or 27 1-2 feet wide, and about sixteen inches of difference of perpendicular height between the centre or crown of the bed, and the bottom of the alley. The new ploughing will necessarily cross the former ploughing, and the beds and alleys, in every variety of direction. In part, the furrows will run in precisely the same direction with the beds and alleys—in part, they will cross at right angles—and elsewhere, they will cross diagonally, at angles of different size. Before trial, I feared great difficulties, and especially in ploughing across the beds at right-angles. But, in practice, the difficulties were much less than expected— and, on the whole, less than belong to any other and usual mode of ploughing. When ploughing directly across the beds, it is true that the new furrow is of very unequal depths—perhaps 10 inches at the middle of the bed, and barely 1 to 2 inches when crossing the bottom of the deep and narrow alley. But these very different depths, if something more laborious to the team, are more suitable to the requirements of the soil in the extremes of thickness, made artificially by the former bedding The deeper ploughing under the crown of the bed is still the more beneficial, because that place had been broken but imperfectly, or not at all, by the previous ploughing, which raised the bed, and lapped the soil, without breaking it below, at the crowns of the beds. In the alleys, where the new ploughing barely scraped, the sub-soil had generally been previously reached, in deepening the alleys; and no greater depth of ploughing was needed, inasmuch as the beds are to remain as they were before. When the new ploughing is immediately across the old beds (or at right angles) the beds necessarily there retain precisely their former position, and, immediately after the new ploughing, appear even higher than before. In the alleys there was so little cutting, and so little of other earth thrown in, that there will be but little earth to clean out, to leave these beds in better shape, as well as in better tilth, than after any former ploughing.

The advantages of more easily and thoroughly breaking the ground, and the disadvantages of throwing more of the ploughed soil into the alleys, both increase as the direction is changed to be diagonal—and from diagonal to coinciding with the direction of the alleys. There could be nothing of this disadvantage (worth consideration) of throwing more earth into the alleys, if every furrow was of equal depth, whether in the highest or lowest places— or at the crowns of the beds and in the alleys. In that case, wherever any part of a furrow was opened, it would be filled by the next cut furrow-slice, of precisely equal size. But in practice the furrow-slices are not of equal thickness whether cut at the crown, or at the side of the bed, and in the alley, (—and they ought not to be equal—) and therefore the new flush ploughing does operate slightly to change for the worse the previous relative positions of the beds. But this change and damage, is less than is usually made by the careless ploughing of beds, in the same direction, and whether with the design of raising and preserving the same beds, or cleaving and reversing them. After the flush ploughing described, and in every direction, the former alleys are plainly to be distinguished. And, at a proper time and condition of the land, the running of a two-horse plough up and down in each alley, will sweep out cleanly all the loosened earth that would absorb rain-water, and obstruct its discharge, and leave each bed and alley in the best designed shape and condition for surface drainage. But this opening of the alleys cannot be well done immediately after the ploughing of each cut, nor until rain shall have fallen, and dried off, so that the loose and turfy earth has been somewhat consolidated. In the interval between the ploughing and the subsequent opening of the former alleys, the only evil and danger of the plan may occur, in the fall of so much rain that it will be long before the then water-glutted alleys will be fit for the plough; and when, consequently, great damage will be caused by this long water-soaking of the earth in the alleys. Every care should be used to prevent this evil.

This manner of ploughing should be used certainly for every winter ploughing, (to prepare for corn,) and it may be for any other time when the farmer is sure of being able to complete any one cut, before being stopped in any part of it by hardness of the soil caused by drought. On this account, it may be too hazardous to resort to this kind of ploughing, in summer, when "fallowing," or ploughing grass land to prepare for wheat. Except for this danger of being stopped by drought, summer would be the best time for the operation, as there would be then no danger of damage to the land from the occurrence of saturating and injurious rains, while the alleys were still partially choked by loose earth.

So much in regard to the effects of this mode of ploughing on tilth, and as affecting the preservation of the former bedding.—Next I will describe the much more important effects and the main object, in aid of surface-drainage. While the ploughing will be as cheap, and more effectual, as ploughing merely, it will at the same time, and with no more expense, greatly aid the other and proper labors for the most effectual surface drainage.

In general terms, the effect of every such ploughing is to remove the entire surface soil, to the depth ploughed, from the outside towards the centre, as much as the width of the furrow-slices. The amount of earth thus removed is enormous. It is dug and removed by the cheapest possible implement and process—and even this labor costs nothing for draining, in as much as it is required for and compensated as necessary tillage. As each furrow-slice removed is replaced by another, there will be but very little (and unappreciable) effect in altering the general level of each cut. But the effect will be considerable at the outside furrow, even at the first operation: and still more and more at every subsequent ploughing, so long as it may be expedient to continue the same manner of ploughing, for furthering the same object.

If the furrows were cut equal, with perfect accuracy, the results might be exhibited to the eye and understanding with geometrical exactness and force. And this can still be done, with due allowances for the imperfection of practical operations compared to theory. But to some extent, practice in this case may even surpass the theory stated. For, while the latter supposes equal dimensions of furrow-slices throughout each cut, in practice, it will be quite easy to cut the few outside slices of greater than the general depth, and so the more to lower the outside margin.

There is another thing which will be here mentioned, which should be understood hereafter in every named operation.—

When a boundary line of a cut is a ditch, (of the usual steep and irregular sides,) the team cannot safely walk so close to the edge as to plough and turn away all the margin earth. There must be from three feet to one foot left everywhere uncut (according to the depth or irregularity of the side of the ditch) which earth will require to be dug and pulled back by hand-hoes, which thus performs what the plow cannot do at first. This hoe work being always understood, and always required in aid of any manner of ploughing, (and much less in this than any other,) need not again be referred to. And the cutting to the edge of the ditch will be supposed to be effected by the plough, though always (for the earlier work) requiring to be finished by hand-hoes.

Then the effect of the first ploughing on this plan, by a four-horse plough, will be to remove the whole surface soil, for eight inches deep, a furrow's width (say twelve inches) in the directions from the outside to the centre. And the outside furrow-slice, or earth of the dimensions stated, will be removed entirely and permanently from its former position,—and its equivalent quantity distributed over the interior or central space of the cut.

This operation will lower the margin of the boundary ditches or grips, eight inches deep, and for a width of twelve inches.—When the like ploughing has been done on the adjoining cut, (E) and to the other side of the grip *a*, *a*, the furrow slices would thus be removed from both sides of the old grip, and nearly as deep. A furrow then run along its course, and back in the same track, would deepen the grip, partly fill and slope the borders, and thus, while the grip would be made deeper and better for drainage, it would be less an impediment to tillage, and less liable to be entirely filled by earth by being ploughed across.—When the like ploughing is subsequently repeated, another furrow slice is removed from the outsides of the cuts, and so much a more gentle slope is given to the grip. Then, and thereafter, the plough will be sufficient to clean the loose earth out of the grips. If more depth is desired, it can be given in closing the ordinary ploughing. And even if made of double the former depth, so wide and so gentle will be the slope of the margins, that the grip will present no serious obstacle to the crossing of ploughs, in any direction, of carts, or even of the passage, at work, of reaping machines.

The same operation of lowering and sloping off the margins of the deeper rain ditches would be proceeding in the like manner, and would only require longer time to approach or perhaps reach the same good results. Even the deepest stream ditches would be much improved, in their surface drainage operation; and their obstruction to tillage and to other team labors be greatly diminished.

PART III.

SKETCHES OF LOWER NORTH CAROLINA, &c.

OBSERVATIONS ON THE FEATURES AND CHANGES OF THE OCEAN SAND-REEF, AND THE ENCLOSED NAVIGABLE WATERS OF NORTH CAROLINA,

I.—*General remarks on the Sand-reef, its inlets and their changes and their operations on the enclosed waters.*

The broad spaces of navigable waters enclosed within the boundaries of North Carolina, are as peculiar and remarkable in character as the various kinds of low-land margins which surround them —and parts of which enclosing land scarcely permit those waters to connect with, and to discharge into the close adjacent ocean.— All the great waters, known under the names of different "sounds," and all the large estuaries and deep and nearly still waters of the sundry broad rivers discharging therein, may be considered as together forming one great lake of very irregular shape and out-lines. Pamlico Sound, from the great estuary of the Neuse river to Roanoke Island, is more than 60 miles long in a straight course, and 75 along the curve of the middle, and perhaps 35 miles at its greatest width, and about 25 of general average width, Albemarle Sound is about 50 miles long, and 10 or 12 of average, and 15 of greatest width. These two greatest Sounds and areas are connected by the narrower passages of Croatan and Roanoke Sounds, which severally separate Roanoke Island from the main land (of great swamp,) and the ocean sand-reef. Another connected sound is Currituck, extending from Albemarle Sound northward, between the main land and the ocean reef, and generally from 4 to 6 and in part 10 miles wide, along all the more northern coast of NorthCarolina. A still more northern extension, under the name of Back bay, generally much more narrow and shallow, stretches into Virginia, and comes to an end not many miles south of the Chesapeake Bay and Cape Henry. South of Pamlico the much narrower and shallow passage called Core Sound connects the former with the harbor of Beaufort, where there is a deep and broad passage into the ocean. South of this, and as far as the South Carolina line, the sand-reef continues, only interrupted, as a barrier to the ocean, by the entrance of the Cape Fear river, and a few other and much smaller "inlets," or deep breaches through the sand-reef.—Bogue Sound and its south-western continuations, from Beaufort harbor to South Carolina, make a continuous and regular body of enclosed water, from 1 to 4 miles wide, and one hundred and twenty miles or more in length, and generally navigable for vessels of light draft.

The larger of these sounds are shallow, and afford good navigation only to vessels drawing not more than eight feet of water. For vessels of no greater draft, the navigation of Albemarle and Pamlico is excellent, and is rendered safe from storms by the protection afforded by the reef, which makes the whole of the enclosed expanse of water one great and secure harbor. The upper or most inland parts of the sounds are deeper than where nearer to their outlets or to the ocean, and the many rivers which empty therein are mostly deeper, and generally much deeper than the deepest waters of the sounds—and most of these rivers afford deep and good navigation to near their highest sources in the Dismal or other great swamps. Taking the whole space within the outlines of Pamlico, Albemarle and Currituck sounds, and their connecting waters, and of all the deep, still and unobstructed waters of the many rivers discharging therein, there is not one of the Atlantic States, which has such great extent of good and smooth navigable water—and safe from storms also, by its typographical features, and entirely secured from any invasion, or effective blockade, by a hostile naval force.—But these remarkable and otherwise valuable characteristics are rendered almost nugatory by another remarkable feature of this region. There is now no access to the ocean, through the sand-reef, so good and deep as the narrow Ocracoke inlet, which now only permits vessels of six feet draft to pass over the bar across the inlet, after tedious delays and much danger, and which passage opens upon an unsheltered and most dangerous sea coast. The whole ocean shore of North Carolina is a terror to navigators, and is noted for the number of shipwrecks, and especially near Cape Hatteras.

This closed condition of the sand-reef did not always exist; and indeed, one of the most remarkable operations which produced the present state of things, occurred within very recent time. The changes of position and depth of the different "inlets," or passages for the ocean and sound waters across the reef-barrier, present one of the most remarkable conditions of this whole remarkable region.

The first colony settled by the English in America was on Roanoke Island, lying between Albemarle and Pamlico sounds—and to which settlement the name of Virginia was first applied. To reach this then first discovered island and its surrounding waters, Sir Walter Raleigh's vessels entered by a then open and broad and deep passage through the reef, (afterwards known as Roanoke inlet,) the permanancy of which no one could then have doubted; and the security and convenience of which entrance invited the planting of the English colony on this then accessible and magnificent ocean harbor. Now, that passage, and also other and later-formed navigable and deep inlets, have been completely closed, and even obliterated.

During great storms, the ocean often breaks across the sand-reef, and sometimes thus cuts new passages, which, for much the greater number, are sooner or later again closed by drifted sand. There are unquestionable evidences visible, in what are called "bulk-heads," (or points of sand stretching to and terminating abruptly, and with steep ends, in the water of the sounds) showing that many different inlets, formerly at different times, have been forced open by the ocean through the reef, and which were subsequently again closed by sand brought by the waves or winds. The newest of such inlets and the only one now navigable for sea-vessels, except Ocracoke (and north of the Beaufort harbor,) is near Cape Hatteras. This has been gradually becoming deeper as Ocracoke inlet has latterly been becoming more shallow. But while Ocracoke within a few years has become shallower by two feet, Hatteras inlet is not yet deep enough to offer a passage preferable to the diminished depth of Ocracoke. The accumulation of water brought by all the rivers into the sound, (or all that is not evaporated,) must have a discharge somewhere into the ocean—and any passage not actually needed for that discharge is liable to be filled up by sand, for want of sufficient force of the current of water to wash away the encroaching sand. But Core sound, long and shallow, and comparatively narrow as it is, offers a sufficient passage for escape to all these waters to the deep inlet of Beaufort harbor, and which is not affected by sand driven by waves or winds, it seems probable that the same natural causes, continuing to operate, may hereafter close all the more northern and now navigable inlets across the reef.

Formerly, and to within a recent time, the old Currituck inlet was deep enough for vessels drawing more than ten feet. Mr. B. T. Simmons, a respectable gentleman residing in Currituck county, informed me that he had sailed through this inlet in 1821, when it afforded throughout from ten to twelve feet depth of channel. It afterwards was more and more filled by sand, drifted by both wind and waves; and finally, in 1828, it was entirely closed by a single violent gale. The site of the former water-way, once more than a half mile wide, is said to be now diked across, the full breadth of the sand reef; and either very near or on the place, there has been raised by the wind a range of high sand hills.

The more southern and much larger portion of Currituck sound is mostly very shallow, and the channels very narrow and intricate, and also too shallow for sea vessels. Thus, after the closing of the old Currituck inlet, the navigation of this great body of water was no longer used, except for small boats. A subsequently opened branch, connected with the Dismal Swamp Canal, has offered the only water-way to market that is now in use. The shallow waters of the lower or southern portion of this sound contain numerous and extensive islands, mostly of rich yet firm marsh, covered by a luxuriant growth of water grasses. The cattle grazing on these marshes have acquired habits suited to their aquatic position—and wade and partly swim from one island to another, when separated by water of more than half a mile in width. Some few of the islands are of high land. One of these, Crow island, has forty acres of high ground, (the highest about eight feet above the water.) which was formerly the site of an Indian village, and the ground is covered and fertilized by the shells of oysters, clams, and some of sea shell-fish, left by the earliest inhabitants. The late resident proprietor, Captain Hatfield, here built a good mansion, and the natural situation makes it a beautiful and romantic place. Besides the surrounding broad water, and the neighboring green marsh islands, the prospect is further improved by the distant high sand hills on the ocean reef, which in their shape, though not in color, appear like the approaching traveller's first view of very distant mountains.

II.— *The deep harbor of Beaufort inaccessible from the back country. New facilities for reaching it in progress, or proposed.*

Beaufort harbor is the only deep inlet through the whole reef.—This will safely pass ships drawing seventeen feet, and into a secure and excellent harbor. But this noble harbor is connected with the Pamlico and the more northern sounds, only by the long and shallow strait called Core sound. This water affords barely four feet depth for navigation, over a bottom (as I was told) of loose and shifting sand, and that extending for so long a distance, that the deepening the channel, and keeping it open by dredging, would be of enormous cost, and probably even impossible to effect. Thus, the noble harbor of Beaufort has continued almost unused, and heretofore useless to the great back country, because it was thus cut off from the deep navigable waters of the interior. There is now in progress of construction a railroad of about ninety miles in length, to connect Beaufort harbor with the back country, by joining the existing Wilmington railroad at Goldsborough. As this new branch of railway will pass through a very unproductive country (east of Goldsborough) and lead to where (at present) there is neither a town, a market, nor purchasors, nor capital to buy with, it may well be questioned whether the existing trade can be thus diverted from Wilmington. This is already a busy, growing and thriving town, and a mart of much trade and enterprise, having good navigation of twelve feet draft to the ocean, and to which, the approach by railroad, (long in use,) from the intersection of the two roads, (according to the map,) not longer than, if so long as the other new branch, which will indeed go to a port of deeper passage to the ocean, but which as a market, as yet, is nothing. Without pretending to any particular knowledge of the localities and circumstances, I fear that this new road, will prove as useless as will the Petersburg and Norfolk railway made alongside the great James river, and having to compete with it for freights. And this latter work of (miscalled) internal improvement, more than all of many others in Virginia, will be a stupendous monument of folly, and waste of money to an enormous amount, for returns entirely inadequate to pay the expenses to be incurred—and for benefits ludicriously disproportioned to the cost of the work. The North Carolina road may lead to a poorer market than Norfolk, or to no market, at first ; but at least, as far as Newbern, it will not have a rival route alongside, of incomparably better facilities, and cheaper use. But judging merely from the general topographical features, of the land and water, as learned from the map, and from verbal reports, it would seem that a much better improvement than a railroad from Newbern to Beaufort, would have been to dredge the shoals of the Neuse river, where required, below Newbern, and to cut a deep canal for a few miles only through the intervening very low peninsula, which separates the deep water of the lower Neuse from the deep water of the nearest river emptying into Beaufort harbor. It is true that long ago there was an abortive attempt to make this important and yet very short canal, by uniting the waters of the Harlow and Clubfoot creek. This canal was made, and still is barely passable by small and light boats—but, for its greater object, has been an utter failure. Nevertheless, if the difficulties of deepening the Neuse shoals do not forbid the whole scheme being attempted, the execution of this short canal would be a very easy part of the whole improvement, for deep navigation. It is reported that the former digging of the canal failed because of the reaching of deep quicksands. But even if the in-flow of quicksand had to be guarded against by the driving still deeper than its bottom a row of piles, in contact, along each side of the whole route of the canal, that labor, for but three to five miles, would be an expense not to be regarded, in reference to so important an object. And after the outsides had been so piled, such dredging machines as are now operating on the Albemarle and Chesapeake canal would easily execute and preserve a permanent passage, to any required depth, and even if it were through what had been a general quicksand bottom.

III.—*The proposed canal through the reef at Nagshead. Former closing of the reef, and particularly at Currituck inlet, and the results on the interior waters.*

Heretofore and latterly, (or since the closing of Currituck inlet,) the great trade and navigation of the sounds, and of the country bordering on all their deep rivers, have only had outlets to markets either through the shallow and dangerous passage of Ocracoke inlet, or the still more shallow and tedious and costly passage through the Dismal Swamp canal to the waters of the Chesapeake. To obtain a much shorter and better outlet, for the trade of Albemarle sound, it has long been a favorite scheme, with many, to dig a canal through the sand-reef at Nagshead, from the sound to the ocean, where a deep passage (the old Roanoke inlet,) once was open, in the trust that the flow of water, thus to be produced, would keep the new passage open. But, inasmuch as a natural channel was here once open, far deeper and wider than any that can be made by the labor and skill of man, and which has become entirely closed, (as have been many smaller passages elsewhere,) it seems safe to infer that any artificial and small channel would remain open for but a short time. At this time, (May 1856,) the beginning of such a canal is now in progress at Nagshead, under direction of the Federal Government, with an appropriation of $50,000 to be so expended. That sum will not go far towards completing the work. And when it is suspended, the winds alone will soon fill the excavation with drifting sand, even without the more powerful aid of the waves driven by violent storms.*

The changes which have occurred to the waters of Albemarle sound and the neighboring waters, by the opening and closing of the inlets, offer for consideration many interesting facts, While Currituck inlet was open, half a mile wide and twelve feet deep, (within the memory of many now living,) the water of the sounds was salt. All kinds of the sea fish of the coast were abundent therein. The great extent of the still visible oyster banks show that the condition of salt-water must have continued previously for ages. When the inlet at Currituck was finally and entirely closed in 1828, fresh water from the rivers became the only supply—and in about two years time, the waters of both Albemarle and Currituck sounds, became, and have since remained, fresh generally—and are only saline, and that very slightly, (or "brackish,") after long continued dry weather, and with only the least or usual supply of water from the rivers, unaided by the much greater supplies from rain-floods and freshes in the Roanoke, especially, and other rivers.

During the time of gradual change from salt water to its being nearly or entirely fresh, the evil effects were of the same character

* This filling of the canal, by the wind alone, became, in the progress of the work, so rapid, that the further excavation was abandoned as hopeless, even before all of the money appropriated had been expended and wasted. I heard this in July. 1858, and also that the dredging machine was very nearly being lost, by being shut in by so much of the newly drifted sand, that if there had been more delays, it would have cost more to re-open a passage for its removal than the machine was worth.

and much worse, than such as are usually exhibited on all our tide-water rivers, where the fresh water and salt tides meet, and have supremacy alternately over the neighboring marshes. The oysters and other sea shell-fish all died. The water-grasses were entirely changed in kinds, by the gradual or speedy dying out of all the species favored by salt-water. The mosquitoes were more numerous than ever known in the same localities, before or since. Malarious diseases, also, were much more general, and more malignant.

The rise and fall of the ocean-tide on the coast of North Carolina, is very small. The accurate observations of the U. S. Coast-Survey, make the mean tide at Hatteras inlet, only two feet, and of spring tides, (showing extremes at full moon,) only 2. 2. Yet, when Currituck inlet was open, the tides, low as they are in the ocean, rose regularly through all Albemarle sound. Colonel W. Byrd, in his account of the running of the "Dividing Line," in 1728, stated that the tide then rose as far as seven or eight miles up the Chowan river. (Westover Manuscript, pp. 12 and 13 of the printed work). But now, notwithstanding the existing inlets and entrances of ocean water into the sounds, there is no rise of tide in Albemarle sound. The actual changes of elevation of the water, (in common parlance called "high" or "low tides,") have no periodicity, or regularity of return, and are caused mainly by the prevalence of winds, from different quarters—and in less degree, and more rarely, by temporary floods in the great rivers, and their subsequent subsidence. From these causes, there are irregular and considerable alternations of height and depression of the water—and sometimes, though rarely, as much as three feet or more between the extremes of highest and lowest surfaces. But generally there is but little variation of height—yet enough to make a narrow and clean sand-beach along the shores of the sounds and the broad estuaries of the rivers.

Even in Pamlico sound, where the more free ingress of sea-water keeps all the sound salt, the regular ocean tides do not reach to, or affect the water on the more remote shores of the main land. Or the tidal movement and changes are so small, as to be scarcely appreciable. Near Mattamuskeet Lake, I heard some old residents who maintained the existence of regular tides in the neighboring salt water of the sound. Yet another person, who had lived for thirty years near to the edge of the salt water, declared that there was no regular, or appreciable, changes of tide. Of course heavy winds from the east, which would cause unusual height of water on the sea-coast, and a proportionable increase of height of the ocean tides driven into the inlets, will cause a considerable but temporary rise of the surface of all Pamlico, and also of the more distant sounds.

The damming (by sand-drift) of the former inlets, by preventing the former free egress of the interior waters, must have served to raise the ordinary height of Albemarle sound higher than the level of the former tide at high flood—or say something more than two feet above tide-water. The marshes, about the junction of the Chowan and the Roanoke with the sound, and elsewhere, offer evidence of this permanently, yet recent increased height of the water, in their very low level, compared to the water, and to other tide marshes.

The broad waters of the sounds, are usually smooth, and offer very striking and beautiful prospects. The mere statements of distances made above would scarcely impress a reader with the extent of space offered to the eye. At Currituck Court House (on Currituck sound,) and also at Stevenson's Point, the extremity of Durant's neck, in Perquimans county, land could be seen only directly across the sounds. Looking both above and below, at both places, the sight stretched to a horizon of water only, as when far out on the ocean. And when sailing on the broader Pamlico sound, it was seldom that land was visible, except on the nearest side.

IV.—*The sand-reef considered as land or soil, and the several kinds thereof. The islands of the sounds.*

So far the sand-reef has been referred to merely as the barrier that shuts out the ocean, and as in that connection with the interior waters. It will now be considered more fully, as a peculiar kind and formation of land, and in its other relations.

The sand-reef, (commonly termed, by residents on the main-land, the "banks" or the "beach,") stretches along the whole sea-coast of North Carolina for about three hundred miles, and with an extension into Virginia. The few important breaches or inlets north of Beaufort harbor have been mentioned. There is not one of them navigable north of Ocracoke inlet, except the one newly opened, and still enlarging near Cape Hatteras. One other, Oregon inlet, has been passed through only by a small steamer of very shallow draft. The few still smaller breaches, scarcely need being described, as some such are opened for a time, and others closed, by almost every heavy gale of wind, causing the highest and most violent billows of the ocean to break across the reef. The long and mostly continuous sand-reef usually varies in width from a mile to as little as half a mile. In a few places, and for short distances only, it widens to two and three miles, and more.

The portion of the reef that extends from Ocracoke inlet to Beaufort harbor, until recently, was one continuous island, of some fifty miles in length, and of very regular general width, of less than three-quarters of a mile. New breaches are frequently made across the narrower and lower parts of the reef, by the ocean waves driven across by violent storms—and which breaches are usually soon closed again. One such was not long since opened through this before continuous island, and which is still increasing in depth, though not yet to more than two or three feet. It is ten miles south of Ocracoke inlet, and is known as Whalebone inlet. The small village of Portsmouth is near Ocracoke, on a wider part of this smaller island. The land there is one and a-half miles wide. Except this place, and a similar but smaller enlargement of the reef near Cape Lookout (where, about the light-house, there are a few inhabitants,) there are no human residents, and no cultivation. This is the case, without any exception, for thirty miles south of Whalebone inlet. The village of Portsmouth owes its existence to the fact of its adjoining the nearest water of Pamlico sound, where vessels must anchor and wait for fair winds and tides to cross the shallow and dangerous bar of Ocracoke inlet—and after passing outward, as usual but partly laden, to wait to receive the remainder of the cargo, carried across the bar by lighters. The occupations of the whole resident population of Portsmouth are connected with the vessels which have to wait here. Pilots, and sailors, or owners of vessels, make up the greater number of the heads of families and adult males—and the remainder are the few, who as shopkeepers, &c., are necessary to minister to the wants of the others. If Ocracoke inlet should be closed by sand, (which is no improbable event,) the village of Portsmouth would disappear—or, (like Nagshead) remain only for its other use, as a summer retreat for transient visitors, sought for health and sea-bathing. Another such settlement or village, and supported in like manner, is at Ocracoke, north of the inlet.

The whole reef consists of several distinct kinds and characters of earth or soil.

1st.—The ocean beach proper, or shore, or the space above low-water mark, and covered by every ordinary flood tide. This, as in all other cases along a low and sandy coast, is a very gradual slope, of beautifully smooth and firm sand. Here, (near Portsmouth,) sea-shells are brought up but rarely, and in small number; and these are soon driven by the violence of the waves upon the lower and broad sand-flat in the rear. For this reason, the beach, daily lashed by the waves, is of pure and homogeneous sand, rarely dotted by a shell, or a bunch of dead sea-grass, left by the preceding tide. As examined through a magnifying lens, (near Ocracoke inlet) the sand is almost entirely silicious, with scarcely any particles of shells intermixed, and the grains various in size, and not so fine as I had supposed in advance.*

* The scarcity of shell-fish, and in less degree, of the dead shells, on this beach, would indicate that the water, for a considerable distance out, is very shallow, and agitated to the bottom—both of which conditions are unfavorable to the existence of all shell-fish that do not burrow and shelter themselves in the sand, or bottom. I saw no living shell-fish brought up from its proper place, to the beach, by force of the waves—nor even any shell, so brought, that had not been long empty. The only such animal seen was a small

2d.—In the rear of the firm sea-shore, and lower than its highest ridge, or crest line, (above ordinary high-tide mark,) lies what I will distinguish as the *sand-flat*. This, opposite Portsmouth, is nearly a mile broad, and nearly of uniform plane surface, and elsewhere is of various less widths, in proportion as it occupies less of the general surface, or is less in proportion to the other kinds of ground. The flat very gradually descends, (imperceptibly, when there is no water thereon, to indicate differences of level) from its junction with the highest ridge of the shore, and becomes lower and lower, until nearly reaching the range of sand-hills—or, if these be wanting, either the higher marshy or firm land. On the sand-flat, every floating matter, and every thing too heavy for the waves to drive forward, is carried and left. Thus, the old sea shells and their fragments are all spread over this space ; and consequently, however slowly added to, they are numerous here. In every storm, the waves which rise highest on the shore, pass, in part, over the ridge or highest beach line; and the water thence flows and spreads, in a very shallow sheet, over the whole of this lower flat. To observe the effects of high waves, I rode to the beach, late on the rise of tide, when a strong wind, setting on shore, brought in high billows, which broke upon, and frequently passed over the highest ridge of the beach. When returning to the village, I passed across the sand-flat covered for three quarters of a mile by water received thus from the ocean, and then varying from one to three inches in depth. On the preceding day I had walked across the same flat, and then found it perfectly free from water and quite dry.

3d.—Whenever this sand-flat is dry at its surface, the dry and loose sand, (the texture being very open and soft,) is either lifted or rolled by strong winds--and, if driven landward, when reaching higher ground, or the growth on the marsh, or any other obstructions, the grains of sand there are stopped, and accumulate in low

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Donax, which burrows and conceals itself in the sand, a little beneath its surface, where the low beach was alternately covered and left bare by every advancing and retreating wave. These little animals, in variously tinted and wedge-shaped bivalve shells, are numerous , and though many are washed out of the sand by the passage of every wave, they so quickly again bury and conceal themselves that they would escape being seen by any but a close observer.

ridges or mounds—or, where circumstances are favorable, begin to form ranges of sand-hills, which are of all heights not exceeding about one hundred feet. The grains of fine sand, which form these high hills, are so easily moved and shifted by high winds, that every exposed portion of the surface may be said to be in movement—and gradually the entire hill is thus moved land-ward. And the grains of sand as driven by the prevailing high winds, from the sea, are mostly carried up the hill, until passing over the crest of the hill, they are sheltered on the opposite slope, and remain to be covered by other succeeding grains, and until again left bare, by the removal of the hill, and subject again to be blown onward. In this manner, on the broader sea-islands of Virginia, the cultivated ground, and even the habitations, have been gradually covered and lost under such slowly moving hills of loose sand. The broad sand-flat near Ocracoke, and the high sand mounds of latest formation, are bare of all vegetation, and entirely barren. This would be so, from the salt impregnation, if nothing else. But, in the course of time, when the sand has attained a few feet of elevation above ordinary high tides, stunted shrubs begin to grow, and partially bind and cover the before naked and loose sand. The first trees to spring are live-oaks. And these, while low, are kept so closely browzed by grazing animals, that they appear more like box bushes, kept artificially and closely trimmed in grotesque shapes, than anything like the natural and majestic growth of this tree, as seen in lower South Carolina. These moderate accumulations of sand, but where no high sand-hills have been raised, in longer time, make a wretchedly poor and very sandy soil, on which, where it is of sufficient height and extent, some worthless loblolly pines (*p. tæda*,) can grow, and where the inhabitants, (if any) may improve for, and cultivate some few garden vegetables. No grain, or other field culture is attempted south of Ocracoke inlet.

4th.—Another kind of land is marsh, subject either daily, or otherwise at much longer intervals, to be covered by the flood tides of the ocean. This marsh is wet, soft, and more or less miry on the surface—but, in general, is firm enough to bear well the grazing animals. The course salt-water grasses and weeds, which cover these marshes, serve to supply all the food, and for both winter and summer, for the live-stock living on the reef.

From the northern extremity, in Virginia, (where united with the main-land at the head of Currituck sound,) to Nagshead, opposite Roanoke island, the ocean sand reef generally varies from half a mile to two miles in width. Its surface is in some parts of blowing sand, either low or in sand-hills, and in others, of swamp, marsh. About five miles below Long island, (in Currituck sound, and in Virginia,) on the reef begins the portion called the "Wash Woods," which extends farther south some six miles, and is bordered, next to the ocean, by high sand-hills, and on the sound side by large marshes. In the central "woods" part some twenty families reside, who gain their living in part by agriculture. They cultivate small patches of Indian corn and sweet potatoes. For the latter, the soil is peculiarly well adapted, and they can be there raised in any quantities. Upon these products, and with fowling and fishing these inhabitants subsist. The large marshes are mostly owned by persons who reside on the main-land. The proprietors drive their cattle and sheep to these marshes, where they become fat enough for sale. Bullocks thus fattened will command from twenty to thirty dollars a piece. Sheep are there kept for their wool.

In the sound which separates this part of the ocean reef from the main-land, there is a chain of islands—Long Island Little Island, Ragged Island, Cedar Island and Knott's Island, of which last the north-end is in Virginia. The high or firm land of these islands is a rich loam, on a sub-soil of red clay and sand; and still lower is a bed of white sand in which (on Long Island) the well-water is as good as any usually obtained in lower Virginia.*

South of Knott's Island, (which is of considerable extent, is cultivated, andhas many inhabitants,) and the little Crow island, before described, which lies near the former, there is no grain or field culture on the reef, as far as to opposite Powell's Point, the southern extremity of Currituck county and the sound. There, the sand-reef is penetrated by Guinguy's creek, running nearly parallel with the ocean-beach and about a mile distant, and which makes a secure

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* For these facts, and others, in regard to these localities in Virginia, I am indebted to the Rev. Edgar Burroughs, proprietor and resident of Long Island.

and deep harbor for sea vessels. The land between the creek and the sound is a peninsula of the ordinary sand-reef formation and soil. This and the adjacent land reaching to the ocean is owned by Mr. —— Gallop, who is a cultivator of more surface than all the other proprietors put together, south of Knott's island. Though his land is of the usual loose blowing sand, it produces crops of 2,000 to 2,500 bushels of corn. Most of the ordinary culinary vegetables grow well on the best of these sandy soils, and there are abundant resources of manure, in the old Indian banks of shells, and immense quantities of fish caught in the seines, and worthless for other purposes, to make a rich material for compost manure. There is, however, as yet, no attention paid to these resources for increasing fertility. The greatest evil and obstruction to profitable cultivation here, is the blowing away of the sandy soil, where the surface is most exposed to the violent winds, and the spreading or heaping it over other ground. A part of Mr. Gallop's land, which he formerly knew when under good forest growth, since he has cleared and cultivated it, has been blown off to depths varying from two to five feet. This has exposed several considerable mounds of old oyster shells, formerly accumulated near the Indian huts, which were covered and entirely hidden by the soil when the forest was first cleared off. Thus it is manifest that the sand had been raised there after the time when the shells had been deposited ; and so these different elevations of the surface are shown to have existed at different times. The sand removed from this space (of some six or eight acres) is deposited thickly as far as some hundreds of yards distant. Wherever there is any obstacle on the surface, the sand is there accumulated highest. The sand is thus heaped up on each side of the fences, until they have too little elevation above the sand, to serve their purpose. And if it is necessary to keep a fence on the same line, it will in time be necessary to erect a second fence on the sand heaped over the first. However, it is only in particular places that the sand is thus removed or accumulated by winds. Across the creek from this peninsula, (on which Mr. Gallop resides, with a large family,) the reef proper is about a mile wide. In crossing it, I was surprised to find at first so good and large forest growth on what was evidently a soil formed originally by the sand blown by the wind. The land is high, and the surface very broken and irregular, so as to be compared in shape to a miniature resemblance of a mountainous country. The only trees of considerable size were loblolly pines, the only species seen in all this sandy land, formed of tributes from the ocean.

There were oaks and other trees of smaller size, and healthy growth. I was informed that live oaks, large enough for ship timber had been formerly cut down here, for that use. Of this wooded and more ancient sand-hill formation consists all of the reef bordering here on the sound. But about midway to the present beach, the surface changes suddenly to the more recent and naked soil, forming still higher hills, though not the highest of all the reef. These hills are of loose sand, generally fine, but in some parts coarse, and with still larger fragments of shells, brought to such high elevations as to indicate prodigious power of the winds that brought them to such heights. There is rarely seen so much of vegetable growth as a stunted weed on this sand—and in one lower basin only enough of vegetation lives to show a slight tint of green. But formerly this present waste was covered by a forest, in part of cedars, and many of them of large sizes, of which the dead remains are still standing or lying over the surface. The trees must have been killed by being covered by new accumulations of sand, which in later time was blown farther inland, and so again left exposed such trees as remained rotted during the long interval since they were buried.

On Hog Island, on the Atlantic, in Virginia, the cedars which have thus been uncovered, were so numerous as to be of much value, as timber for sale in distant markets.

Roanoke island, (which, however I did not see, because of accidental delays in the water trip,) is much the most important and interesting of all these islands. It contains several thousand acres of dry land. Though of the usual sandy soil, the land of this island is very productive, and especially in potatoes and garden vegetables. And on all these lands, the climate is so mild, that all vegetables are earlier in maturing than on the main land opposite and nearest. This and the other conditions will make these lands especially suitable for the "trucking business," or raising potatoes and other vegetables for the great northern cities. When the Albemarle and Chesapeake canal shall be finished, there will not only be rapid steam navigation to Norfolk, but the same mode of conveyance will serve to bring thence the numerous hands for getting the crops, which extra and temporary supply of laborers is indispensable for the business.

V.—*Grazing and rearing of live-stock. The wild horses, their qualities and habits—and the "horse-pennings."*

Except at and near Portsmouth, and where actual residents have possession, there is no separate private property in lands, on this reef, from Ocracoke to Beaufort harbor. But though there are no land-marks, or means for distinguishing separate properties, every portion of the reef is claimed in some manner, as private property, though held in common use. If belonging to one owner, the unsettled land would be valuable, for the peculiar mode of stock-raising in use here. But under the existing undefined and undefinable common rights, the land is of no more value to one of the joint-owners, or claimants, than to any other person who may choose to place breeding stock on the reef.

There are cattle and sheep on the marshes of this portion of the reef, obtaining a poor subsistance indeed, but without any cost or care of their owners. On the other hand, the capital and profits are at much risk, as any lawless depredator can, in security, shoot and carry off any number of these animals. But horses cannot be used for food, (or are not—) and cannot be caught and removed by thieves—and, therefore, the rearing of horses is a very profitable investment for the small amount of capital required for the business. There are some hundreds of horses, of the dwarfish native breed, on this part of the reef between Portsmouth and Beaufort harbor—ranging at large, and wild, (or untamed,) and continuing the race without any care of their numerous proprietors. Many years ago I had first heard of similar wild horses on some of the larger sea-islands of Virginia, and wrote and published (in the "Farmer's Register,") some account of them. But

I had supposed that the stock, (in the wild state) had ceased to exist there—and did not suspect that wild horses, and in much greater number, still were on the narrow sand-reef of North Carolina.

In applying the term *wild* to these horses, it is not meant that they are as much so as deer or wolves, or as the herds of horses, wild for many generations on the great grassy plains of South America or Texas. A man may approach these, within gunshot distance without difficulty. But he could not get much nearer, without alarming the herd, and causing them to flee for safety to the marshes, or across water, (to which they take very freely,) or to more remote distance on the sands. Twice a year, for all the horses on each united portion of the reef, (or so much as is unbroken by inlets too wide for the horses to swim across,) there is a general "horse-penning," to secure, and brand with the owner's marks, all the young colts. The first of these operations is in May, and the second in July, late enough for the previous birth of all the colts that come after the penning in May. If there was only one penning, and that one late enough for the latest births to have occurred, the earliest colts would be weaned, or otherwise could not be distinguished, as when much younger, by their being always close to their respective mothers, and so to have their ownership readily determined.

The "horse-pennings" are much attended, and are very interesting festivals for all the residents of the neighboring main-land. There are few adults, residing within a day's sailing of the horse-pen, that have not attended one or more of these exciting scenes. A strong enclosure, called the horse-pen, is made at a narrow part of the reef, and suitable in other respects for the purpose—with a connected strong fence, stretching quite across the reef. All of the many proprietors of the horses, and with many assistants, drive (in deer-hunters' phrase,) from the remote extremities of the reef, and easily bring, and then encircle, all the horses to the fence and near to the pen.

There the drivers are reinforced by hundreds of volunteers from among the visitors and amateurs, and the circle is narrowed until all the horses are forced into the pen, where any of them may be caught and confined. Then the young colts, distinguished by being with their mothers, are marked by their owner's brand. All of the many persons who came to buy horses, and the proprietors who wish to capture and remove any for use, or subsequent sale, then make their selections. After the price is fixed, each selected animal is caught and haltered, and immediately subjected to a rider. This is not generally very difficult—or the difficulties and the consequent accidents and mishaps to the riders are only sufficient to increase the interest and fun of the scene, and the pleasure and triumph of the actors. After the captured horse has been thrown, and sufficiently choked by the halter, he is suffered to rise, mounted by some bold and experienced rider and breaker, and forced into a neighboring creek, with a bottom of mud, stiff and deep enough to fatigue the horse, and to render him incapable of making more use of his feet than to struggle to avoid sinking too deep into the mire. Under these circumstances, he soon yields to his rider—and rarely afterwards does one resist. But there are other subsequent and greater difficulties in the domesticating these animals. They have previously fed entirely on the coarse salt grasses of the marshes, and always afterwards prefer that food, if attainable. When removed to the main land, away from the salt marshes, many die before learning to eat grain, or other strange provender. Others injure, and some kill themselves, in struggling, and in vain efforts to break through the stables or enclosures in which they are subsequently confined All the horses in use on the reef, and on many of the nearest farms on the main-land, are of these previously wild "banks' ponies." And when having access to their former food on the salt marshes, they seek and prefer it, and will eat very little of any other and better food.

These horses are all of small size, with rough and shaggy coats, and long manes. They are generally ugly. Their hoofs, in many cases, grow to unusual lengths. They are capable of great endurance of labor and hardship, and live so roughly, that any others, from abroad, seldom live a year on such food and under such great exposure. The race, of course, was originally derived from a superior kind or breed of stock; but long acclimation, and subjection for many generations to this peculiar mode of living, has fixed on the breed the peculiar characteristics of form, size, and qualities, which distinguish the "banks' ponies." It is thought that the present stock has suffered deterioration by the long continued breeding without change of blood. Yet this evil might be easily avoided, by sometimes exchanging a few males from different separated parts of the whole coast reef. It would be the reverse of improvement to introduce horses of more noble race, and less fitted to endure the great hardships of this locality. Such horses, or any raised in other localities, if turned loose here, would scarcely live through either the plague of blood-sucking insects of the first summer, or the severe privations of the first winter.

On the whole reef, there are no springs ; but there are many small tide-water creeks, passing through and having their heads in marshes, from which their sources ooze out. Their supply must be from the over-flowing sea-water. I could not learn, and do not suppose, that these waters, even at their highest sources, are ever fresh. Water that is fresh, but badly flavored, may be found any where, (even on the sea-beach,) by digging from two to six feet deep. The wild horses supply their want of fresh water by pawing away the sand deep enough to reach the fresh-water, which oozes into the excavation, and which reservoir serves for this use while it remains open.

VI.—*Supposed Geological position of the sand-reef, and the sounds. Ancient sand-hills serving to form barren soils on the main-land.*

To these persons who are acquainted with the peculiarities of the North Carolina coast only by maps, and general report, the existence and continuance of the long, low, and narrow sand-reef would seem an inexplicable mystery. In many narrow places, every great storm drives the highest billows across the barrier of loose sand. In numerous places, deep breaches have been forced through, and subsequently again closed. In other cases, such breaches have so increased as to become navigable inlets, and are still becoming more enlarged, in depth and width. But still, as new openings are thus begun, or are enlarged, the older are closing. And, taken altogether, from the time when the first vessels from Europe entered Albemarle Sound through the then open and broad Roanoke inlet, to this day—and in all the space of reef from Beaufort harbor to within Princess Anne county, Virginia, there has been a general and progressive diminution of the passage-ways for water through the whole long line of reef. With all the fluctuations, and temporary changes of these openings, there must, and always will be, enough in space, to permit the discharge into the ocean of the water of the rivers and sounds, without raising the surface level of the latter anywhere, much higher than the height of flood-tide in the ocean. But no more openings are necessary. And if more or deeper openings were made by the labors of man, for the purpose of navigation, they would be soon filled again by the opposing and far more powerful operations of nature.

If a stranger only knew of the present existence of the long and frail barrier of loose sand, and nothing of its long and victorious resistance to the ingress, and most violent assaults of the ocean, he would suppose that it would be swept away, and forever, by the first storm waves that rose higher than the ocean beach. But this occurs frequently, even by the force of moderate winds, and yet no such effects is even partially produced. When seeing the operation of high-running waves, over-topping the highest ridge of the shore, and the excess of water thence flowing in shallow streams over the lower sand-flat in the rear, it seems no longer strange that the shore should remain unbroken. Indeed, if there were no reef existing, but its site and foundation were a long shoal, of miles in breath, of but a few feet below the surface of the ocean, and composed of loose sand, it would seem to an observer of the present action of the waves, that it would raise such a reef as now exists, from the bottom sand of the supposed extreme shoal. And just so this reef was probably originally formed and raised to its present dimensions. The waves of the sea are most generally driven by the winds towards the land ; and with incomparably greater violence and power, than any can be driven by winds in the direction from the shore. Of course then, the far greater sand-moving power of the waves is exerted in the direction from the ocean, and towards the land. The ocean waves, when driven violently landward, (as is most usual in storms, and occurs with even moderate winds,) over a very wide and shoal bottom of loose sand, must operate to propel the upper layer of the sand in the direction towards the land. With the beginning of this natural operation, there would be raised, from the outer or sea-ward side of the sand shoal, a low ridge, (or it may be called a wave,) of loose sand—which would be continually added to by more sand brought in the same manner, and thus the ridge raised higher and higher, and spread broader and broader, as it was wholly and slowly moved towards the land. In a long time, and after thus having been moved for miles from the outer side of the shoal, the highest part of the ridge would be raised above the level of ordinary high-tide. Then, the waves rising and breaking upon the outer slope (then became a tide-beach, as now,) would deposit thereon the sand still brought along regularly from the outer parts of the shoal. And still higher waves, in violent storms, would sweep from this accumulation, or ridge more or less of the sand into the sheltered and stiller water behind the reef, and thus add continually to its height and breadth, so long as the outer shoal was near enough to the surface, and its sand loose enough, to readily supply new material for increasing the reef. Thus was the reef at first formed, and thus, by the extension of the reef barrier, the present waters of the sound were separated from the ocean.

The action and effect of the waves, or ocean-water moving violently towards the land, over high-lying and loose sand, are similar in the manner of operation to the action and effect of winds on dry sand. The latter operation we may see at any time on the sand-reef—not only in the moving of sand in enormous quantities, but also elevating it into high sand hills. The moving ocean water is as powerful an agent, operating in like manner, and upon a surface of as loose, though water-covered sand. And as the acting forces operate alike, so are the effects, in moving and raising the sand. But the water cannot raise the transported sand higher than the greatest height of the water itself—which is the limit of elevation by the force of water alone. After this the power of wind begins to operate, and without any such limit of height. Therefore the sand-hills are raised to heights overtopping all other ground for many miles distant, on the adjacent main land. And these sand hills, when on the main land, and a low coast, are gradually moved far into the interior, and, either still as high hills, or otherwise spread into plains, cover large spaces with sterile and almost naked sands. There are many such examples, of land thus derived from the bottom of the ocean, in both lower South and North Carolina.

There is another interesting question for consideration, which so far has been designedly left untouched—as to what was the origin, or manner of formation of the great basins, called sounds, enclosed between the sand-reef and the main land. If these waters were now throughout very shallow, it might be inferred that the bottom was part of the broadly extended original shoal, stretching out from the main land many miles into the ocean, and on the outer part of which, (as argued and described above,) the present sand-reef had been raised by the ocean waves. In that way, to account for the origin of the reef, would at the same time serve to explain the origin of the sounds. But this explanation is not sufficient for some of the most interesting of the facts. Pamlico and Albemarle sounds are now much deeper than we can suppose the outer shoal was, on which the reef was raised. Albemarle sound is generally eighteen feet deep from near Roanoke Island up as high as Bluff Point, in Chowan county, and twenty feet thence to the head of the sound, or mouth of the Roanoke river. The lower and broader waters of nearly all the rivers emptying into these two greater sounds, are still deeper than the waters of the sounds. Further, the bottoms of these rivers, and also of the sounds, not very distant from their shores, to more than twenty feet depth, are set with numerous stumps of large trees, which are firmly rooted, and evidently in the earth where they originally grew. These several facts, and especially the last, go to show that the land in all this space, was originally above the water, and has subsided, (by some ancient convulsion of the earth,) to its present low level. And thus, if the sounds were dyked in and separated from the ocean by the rising of the ocean sand-reef, they owe their depth to the subsidence of the land forming their bottoms. And this subsidence was probably still earlier than the formation of the reef, and was the first cause of the latter operation. For the geological operation of subsidence of one portion of the surface of the earth, is often, if not generally, accompanied by equal upheaval of surface elsewhere. And it is probable, when the long and irregular surface of the present sounds, and their connected estuaries, subsided, that, by a different and compensating movement of the same great convulsion, the outer ocean bottom was upheaved so as to be made shoal, and thereby to afford means for the waves subsequently to raise the sand-reef thereon, above the surface of the ocean.

VII.—*Artificial outlet from the navigation of the sounds through the Dismal Swamp canal. Improvement to health by raising the water level of Deep-Creek.*

Besides the passage through Ocracoke inlet, now reduced to six feet draft of vessels—and the long Core sound to Beaufort, through which only vessels of four feet draft can pass—the only other and safest and best outlet for the great commerce of the sounds is through the Dismal Swamp canal—though this affords passage to vessels of but five feet draft. This canal is twenty-two miles in length, as excavated, and empties at its northern end into Deep Creek, a branch of Elizabeth river, and at its south end, into the upper part (where deep, but very narrow and crooked,) of the Pasquotank river, which discharges into Albemarle sound. Norfolk and Portsmouth in Virginia, and Elizabeth City in North Carolina, are the nearest towns on these different waters, thus connected by this artificial navigation. The much greater length of the canal passes through the Dismal Swamp—and its water is supplied (at the summit level,) by a small canal, from Lake Drummond, in the central part of the great Dismal Swamp.

The canal, from its northern section, descends by locks of sixteen feet, into the water of Deep Creek, which was generally navigable, but sometimes was deficient of the required depth. In latter years.

to avoid the occasional detention of vessels by low tides in Deep Creek, the upper water of that stream has been raised by a dam, with a lock emptying below, where the tide water is always deep enough. This raising of the water above the dam (permanently to four feet above low tide,) has been not only a great benefit to navigation, but also in another important and unexpected matter, the health of the adjacent village, and the vicinity. Previous to this work, it was generally feared that the proposed damming up and raising of the water, and flooding the bordering marshes and other low land, would increase the previous great sickness of the place. And on this score, as well as for the land covered by the water, claims were made for remuneration, and suits at law for damages were about to be instituted. But the effect has been entirely opposite—and the facts well deserve consideration in regard to the question of means for better securing health in malarious localities. Since the depth and breadth of Deep Creek, (before of the irregular and varying changes made by the tide,) have both been so much increased, and kept at nearly the same mark, the place has become unquestionably and far more healthy than before. This effect, however unexpected by the residents, ought to have been anticipated, upon sound reasoning. The upper waters which supply Deep Creek are fresh, and are deeply impregnated, and darkly tinted, by vegetable extract, as are all the waters that flow through the Dismal, or other great swamps. The salt flood tides coming up from Elizabeth river, were intermixed with, or interchanged for fresh water—and the bordering marshes were alternately covered and soaked with salt and fresh water. Whatever may be the cause, such changes and interminglings of fresh and salt waters, in summer weather, always render the locality sickly. Now, by the damming up of the river, its raised water is always fresh, is nearly of uniform level at all times, and has clean, firm, and mostly steep banks and margins. The water is not stagnant, like mill-ponds fed by feeble or failing streams, but is supplied from abundant sources, and is frequently changed. And where discharged, by the lock, and waste outlets, into tide-water, the mixture of fresh and salt-water is effected at once, and over a bottom always deeply covered by water. These circumstances must greatly lessen, if not entirely prevent any evil effects resulting from the mixture.

The present raised surface of Deep Creek, (which may now be considered as an extension of the canal,) and which is five feet above low tide mark, is eleven feet below the surface of the northern level of the canal, which extends nine and a-half miles to the middle and summit-level. The water of this middle section is but four and a half feet higher than that of the adjoining northern section. From the summit level (nine miles long,) the canal descends by a lock of seven and a-half feet, to the south level of three miles long, and from that, by thirteen feet lockage to the upper navigable water of Pasquotank river. The ascending lockage from Elizabeth river (low tide-water) to the summit level, is twenty-one and a-half feet—and the descending, to Pasquotank, twenty and a-half feet. The whole length of the canal, within the outer locks, amounts to twenty-four and one-fourth miles. It would at first strike every observer that it was a great error of construction, as it is certainly a permanent and great addition to the difficulty and cost of navigation, that this middle section was not sunk four and a-half feet deeper, so as to dispense with twice that amount of lockage, at least, if not further to have level water from one end to the other of the excavated portion of the canal. It had been at first designed to thus sink the middle section. But the labor of excavating through a close and deep mat of living juniper stumps and roots, and the still lower stumps and roots and prostrate trunks of junipers of older growth, remaining unrotted beneath the earth—and the excavation to be made in the softest of mire, or under water—presented difficulties so enormous, that it was preferred to raise the level of the canal by embankments, and with two additional locks, to the present summit level. There are seven locks in all. The summit level of the canal is supplied with water from Lake Drummond, by a feeder of three miles in length, having three feet fall from the water of the lake to that of the summit level of the canal. Thus the height of the surface of lake Drummond above Elizabeth river at ordinary low water, is equal to twenty-four and a-half feet.

VIII.— *The Albemarle and Chesapeake ship canal in progress of construction, and its great importance to agricultural and commercial interests.*

Many years ago, in the publication of some notes of an early visit to part of lower North Carolina, I urged, as the greatest of improvements for that State, a ship canal, to be dug on a level, from the waters of Albemarle sound to those of the Chesapeake—to give free egress and passage, to any distant marts of vessels of as deep draft as could well navigate the sounds of North Carolina. I then looked only to the importance and incalculable value, of the great object—but knew nothing of the facilities and means, or the difficulties to be found in the topography of the intervening country. Such an improvement is now in the progress of execution—and when completed, it will offer to the commercial and agricultural interests of North Carolina the greatest boon that can be derived from any aid to facilities for transportation.

The "Albemarle and Chesapeake Ship Canal," had not been long in progress, when (in May, 1856,) I visited the three different places in which the excavating machines were at work. The entire length of digging, in two different places, will be but fourteen miles, all through very low and level ground. The main operation will be a straight cut from deep water in North Landing, (or Cohonk) river, (emptying into Currituck sound,) to deep and tide water at Great Bridge on the principal branch of Elizabeth river. This part of the canal will be level, eight miles long, and without a lock, except one at the junction of the level water (flowing back from Currituck sound) with the tide-water at Great Bridge—and which lock is necessary merely to regulate the difference between the usually uniform level of the Currituck water, and the changeable height of the tide-water of the Chesapeake. Another straight and level cut of five miles is to cross a low peninsula, mostly of marsh soil, stretching from the high land, between the deep waters of Albemarle and Currituck sounds. Some necessary dredging in the rivers, to obtain full eight feet depth, will make the entire depth of excavation fourteen miles. The width of water in the canal, at surface, is to be sixty feet. The depth will allow vessels of six feet draft, to pass through at first, and is to be deepened to eight feet, or more if required, afterwards. As there will be no lift-lock, (and only the tide-regulating lock,) there will be no difficulty in continuing to dredge and deepen the passage, after the canal is in regular use.

By this canal, the agricultural and other products of eighteen counties of North Carolina, embracing the most fertile lands in the State, will be offered a route to market so much cheaper, safer, and preferable in every respect, that it cannot fail to be substituted for those now in use, and which are costly in freight, slow in the times of passage, and hazardous either to cargoes or to vessels. These difficulties, even with all the mitigation afforded by the opening of the Dismal Swamp canal, have been continued and most oppressive burdens on the trade of North Carolina waters, and the productions of all the neighboring country—which the new, deep, and level canal will go far to remove. At all former times it would have been conceded, that to bring the products of all lower North Carolina, thus cheaply, safely, and speedily, to Norfolk only, would have been a vast benefit to the producing region. But by admitting the passage of such large sea-vessels, as the completed canal will allow, (carrying five thousand bushels of grain,) the cargoes may be carried safely, and without trans-shipment, to any port on our Atlantic coast, or to the West-Indies. The vessels must indeed necessarily pass through the noble harbor of Norfolk, and close by the wharves. If Norfolk should offer, as it can, and ought to do, prices as high as more distant markets—or so nearly as high, as to afford no gain in the vessels proceeding further, at higher cost of freight, then Norfolk will have, as it ought to have, all the purchaser's profit in these great additional supplies, and all the benefit of so much addition to its now existing producing back country. But if narrow and false views of self-interest shall keep the prices offered by Norfolk merchants much below those to be had in more distant markets—or less by more than the additional cost of freight, if extending the voyage to more distant markets—then the shippers will be entirely free and competent to choose and to seek the best markets—and Norfolk and Portsmouth will, in that case only loose, and will well deserve to loose, the profit of buying and selling all the productions of this great region, which is, or ought to be the proper back-country of Norfolk and Portsmouth. These two towns—or the one port and town which in fact they constitute—ought not only to secure all this great trade, coming by this new channel, and of which every cargo must be at least offered to their acceptance—but they ought to be the great commercial port and market of Virginia. If the merchants of Norfolk and Portsmouth fail to secure these great advantages, and especially the whole trade of eastern North Carolina, it will be entirely the result of their own fault.

If the increased facilities to navigation to be furnished by the new canal should be as great as are anticipated, the benefits will extend far beyond the range and higher boundaries of the existing navigation of the sounds. The rivers of North Carolina, or those flowing into Albemarle sound, above the limits of navigation for sea vessels, offer extensive channels for large boats, which have scarcely been put to any use. Such facilities have been vainly offered by the upper waters of the Neuse and the Tau, and the Meherrin and Nottoway rivers. These open and smooth water-ways, and the two first also long channels, in other countries would convey to market, in boats, all the products of their bordering and contiguous land. But, owing to the difficulties and expenses of the passage to sea, and the low prices offered by all easily accessible markets, the lower that agricultural products might be sent down upon these rivers, the farther they were from the best markets. Consequently no use was made of the extensive and easy upper river navigation. But when the obstructions to the Chesapeake and the ocean are removed, and the main expenses also, all these now useless water-ways will be put to their proper use, and the products of the bordering lands will be mainly transported by water instead of by land, as heretofore. Thus, not only will the production of all the existing back-country of the sounds be stimulated and increased by the reduction of expenses and increase of profits, but the area of the producing back-country will be greatly enlarged.

IX.—*Novel and remarkable manner of excavating the new Canal. Profitable benefit of this and similar works, to drainage operations*

The excavation of the new canal has been begun (May, 1856,) and is in progress at three different parts of the line, viz., in the five-mile cut, in North Carolina, and at both ends of the eight-mile cut in Virginia. The interest felt in the work and its object, and also in the manner of excavation, induced me to visit all the three operations. The whole route for excavation in North Carolina, is through a low and flat peninsula, mostly free from obstructions. The large cut in Virginia will be entirely along the course of a long and straight depression, the land being a low and wet swamp in its present condition. The highest points of elevation will not be more than four feet above the level of the surface water of the canal—and the whole excavation will not average more than two feet above that surface. Thus eight feet of excavation, throughout, will give six feet depth of water; and ten feet will give the complete and designed eight feet.

But this very low level of the land through the route, which so much lessens the amount of earth to be excavated, serves, in most places, to increase the difficulty of the work. The surface of the swampy ground is, in many places, so nearly level with the water, and the earth is so generally a quagmire of peat, and so full of dead roots and buried logs, under the water, and of living trees and roots over and at the surface, when but very little above water, that the difficulties of removing such obstructions are very great, and would be insuperable if by the use of ordinary utensils, and with hand-labor. But the means used were very different; and to me, were as novel as they seemed admirable. The excavation is effected entirely by steam-dredges of new construction, and great power. The one I saw in operation, near North Landing, was then in the most difficult ground, the very low swamp just above the bridge. The earth was barely above the water, and covered with heavy and thick swamp forest growth—and beneath the surface, in the former channel of the choked river, were buried numerous sound stumps and trunks of cypress trees, which had been covered deeply by the slow accumulation of vegetable soil, for ages past. The cutting through and removal of this mass of living and dead (but sound) wood, imbedded in semi-fluid mire, and from beneath standing water, could scarcely have been effected at all, except by the wonderful machine in use, which derives aid from the presence of deep water, in which no hand-labor could effect anything.

The dredging apparatus is in a vessel of fifty or sixty feet long, and is worked by a sixteen horse power steam-engine. There are seven of these dredging machines and vessels at the different places, and there will be built two more, of greater size and power. The excavation was begun at the edge of deep water, as enough water to float the vessel is necessary for the operation. Thence, the machines carried on the excavation regularly, to the full depth and width required for the early navigation. Two machines, one working a little ahead of the other, carry the full width of the canal. After finishing at one position, the vessel is moved forward, the head of the vessel facing the earth to be cut away, and there it is fastened to the bottom securely, by convenient appliances. An enormous beam, with an iron scoop, or box, at the extremity, is thrust forward and dipped into the water, just ahead of the vessel, and then drawn upward against the face of the bank to be cut away. If it be of any ordinary earth, hard or soft, the cutting edge of the scoop goes in easily, and the box rises, filled with its load of earth, which is forty cubic feet, the measure of the capacity of the box. The beam slowly swung around, (on the crane principle,) the bottom of the box is left open, and the earth falls out on the bank on one side. When the digging is easy, the scoop may be dropped and lifted, and will cut out and dispose of its forty cubic feet of earth, once in every minute. But, while the operation, as I saw it, was very much slower, its effect was even more remarkable and surprising, in reference to the difficulties. The obstacles could delay, but could not prevent the effectual operation of the machine. The living roots, of great size, were gradually loosened, and finally torn out. The stumps were undermined, by the scoop cutting beneath the main roots, and then lifted up. However such obstructions may retard the progress of the work, nothing can effectually resist, or defeat, the monster ditcher. The thrusting out of the beam, its sundry changes of position, suited to every required effort, the seizing and tearing up of the roots and earth, and finally, the slow stretching out of the enormous arm, and the opening and emptying of its hand—all moved by the unseen power of steam—made the whole operation seem as if it was the manual labor of a thinking being, of colossal size, and of inconceivable physical power.

At the other end of this cut, near Great Bridge (in Norfolk county,) the obstacles are inconsiderable, and the dredging much easier and more rapid in progress. There the earth is also low, wet and boggy; but not much encumbered by roots, or large shrubs or bushes.

The third place of excavation, in North Carolina, is still of different character. It is on the Currituck side of the peninsula, which is to be cut through to reach Albemarle sound. This is necessary, because the channel of Currituck sound south of this place, is too shallow for the designed depth of navigation. But as this obstacle made this cut necessary, its being made will have another benefit, in much shortening the whole passage. The excavation here is through a low and boggy marsh, scarcely a foot higher than the water. The marsh was covered by water grasses, then (late in May) about a foot high. These grasses were smaller, and different from the growth of the fresh-water marshes on James river. I saw there no coarse sedge, cat-tail flags, or wild-oats, the common plants of other fresh-water marshes. The grasses here are probably better food, and the marsh of firmer texture—as I saw many cattle grazing—and also sheep on other and higher parts. The bog soil was about four feet deep, resting on a firm blue clay. These earths were taken up by the dredge with great ease. The great difficulty here is the liability of the miry earth to run in again, after being heaped on the margins—or by its weight, to press down the soft mud of the margin, and force it into the excavation. It is earnestly hoped that neither these nor any unforeseen difficulties may prevent the speedy and perfect completion of this great work —which will give to North Carolina, for the first time a proper outlet for, and the proper use of her noble interior navigable waters.

X.—*The great fisheries on the sounds, and how conducted.*

The great fisheries in the rivers and sounds make a very important item of the productions of North Carolina. It would be interesting to know the statisties and annual returns of this branch of industry. This particular information I cannot supply. But, in addition to some general remarks, I will describe the manner of conducting a great fishery, as learned from one of the proprietors, and of which some part was also seen elsewhere.

The fisheries on the large rivers, by seines drawn to the shores, have been long in operation. But it has been but recently, compared to the others, that fisheries were first tried in the broad waters of the sounds. Though, previously it was supposed that the great expenses of such fisheries could not be repaid, and that in so broad a channel, but few of the fish could be reached from the shore, on trial the sound fisheries were found to be the most productive and profitable. Since, so many fisheries have been established, that the products and profits of each one has, in latter years, been greatly diminished.

The land and shore at Stevenson's Point, (the extremity of Durant's neck,) was the property of Messrs. J. T. Granberry and F. Nixon, and there, and by them, the first sound fishery was established, and conducted. Albemarle sound is there supposed to be nine to ten miles across, and in the edge of this broad space the seine is hauled. I will describe the manner of conducting this fishery, which does not differ materially from most others since established on the sound shore. The extremities of sweeps of the different fisheries almost touch each other—and extend, with but few intervals to the Chowan river. The labors and other facts of this and other like fisheries may well astonish those readers who were before uninformed as to the magnitude of the operations.

The seines used in different fisheries, vary in length from 2,200 to 2,700 yards and are eighteen feet deep, as fished. They are laid out at about a mile and a quarter from the shore. Of course the hauling ropes, from both ends, to reach the shore must be together more than two and a-half miles long. A seine is carried out by two large boats, each managed by twelve able hands, (in some cases ten suffice,) and is laid out beginning from the middle straight and nearly parallel with the shore. The boats, from each end of the seine, then row to the shore, letting the attached hauling ropes run out from the boats. The shore ends of the ropes are then attached to large capstans, each turned by six horses. Except two men required at each captan, one to drive the horses, and the other to watch and direct the passage of the rope around the shaft, all the other men attached to the seine are discharged to rest, eat, or sleep, as they may choose, until the ends of the seine reach the shore—except, that, at fixed and equal intervals, (indicated by marks on the ropes,) the few men employed at the capstans, are relieved by others. The fishing labors are carried on without cessation, through the twenty-four hours, except when suspended because of storms. Therefore, the hands, like sailors at sea, work and rest, not by day and by night, but by shorter "watches." Besides the fishermen, or boats' crews, there are fifteen other men employed on the shore, and forty women and boys, to trim, salt, and pack the herrings caught. The particular large draughts of herrings as well as the whole number caught by each seine in a season, have greatly diminished, as the seines have been increased in number. The seine at Stevenson's Point once brought in, and landed, 220,000 herrings at one haul. On the rare occasions of such enormous draughts of fish, and at other times when the cleaning and salting cannot proceed fast enough to save the fish if all were landed at once, and in warm weather, the ends of the seine are landed gradually, and a smaller seine hauled within the enclosed space, so as to land the fish no faster than needed, or than is safe. In this way, one draught of the seine has in some cases been more than twenty-four hours in being landed.

The first outfit of one of these seines, and the expenses of the first season, make from $12,000 to $15,000. Afterwards, the expense for the season is lessened by as much as will serve again of the seine, boats and fixtures. The hands are either hirelings for the time, or the cost is counted as such.

Considering that all these herrings, are fish of passage, and enter every spring from the ocean, it is astonishing that such multitudes should enter through the very narrow and shallow inlets through the sand-reef. It is understood by naturalists that fish of passage, if not obstructed, seek every spring to return to lay their eggs in their native rivers. If so, it would be an excellent policy to forbid by law the taking of such fish except within stated intervals of time, the best of the season. This would cut off only the least profitable extremes of time; and by permitting enough breeders to pass safely, the numbers of fish would be greatly increased for the future, and the fisheries enabled to obtain more fish within the limited time, than now in the whole usual time of fishing.

And if such a policy would be profitable in North Carolina, where only hauling seines are used, how much more are needed these and other restrictions on the shad fishing in the rivers of Virginia. There, the multitude of floating gill-nets, (many fished by northeners, who anchor and remain in our rivers, for the fishing season,) have ruined most of the former land fisheries, and yet cannot supply what the land fisheries have lost. The gill-nets hang the largest female shad, often ready to spawn, and which then loose their spawn in their struggles, even though they may escape. Thus these nets take or injure the best breeders, and prevent the breeding of far greater numbers than they secure. The number of fish to be annually taken in our rivers would be doubled, and the prices for fresh fish be greatly reduced below the recent high rates, if all fishing for shad was limited in time, and gill-nets, and especially foreign fishermen, were prohibited altogether.

Besides the main and direct profit of these fisheries, there is another, which is not availed of to one-tenth of the extent that might be done. This is the use, as manure, of the immense amount of animal matter in the "trimming" or garbage, of the herrings and other sale fish, and also of other fish, for which there is no demand, and which sometimes rot and go to waste, by hundreds of bushels. Of the offal that is used, the practice is, as it has been from the beginning, to deposit a fish, or a handful of the garbage at every station of corn, and cover it over, either before or after the planting of the crop. In this mode, much the larger portion of the animal matter finds nothing to combine with, or be assisted by—and as it putrifies, is wasted in the air. From the time of the first slight burying of this animal matter, and as long as any portion of it remains, the buzzards are attracted by the odor, and are engaged diligently in digging up and devouring the manure. If, instead of thus offering for the use of the plants, this richest of material in a shape and condition unfit for the food of plants—and in a manner by which nine-tenths of the value is wasted, while the remaining one-tenth becomes fit for use as manure, the whole might be saved in proper compost heaps, in mixture with other ingredients, which would absorb, or chemically combine with, or otherwise act to save and secure for future use this valuable material—which, as applied, rapidly escapes from the earth, to contaminate the air. Carbonate of lime (as in marl) alone, if near at hand, and available in sufficient quantity, would, in mixture with this animal matter, combine with the products of its then very slow decomposition, and so prevent all waste. But swamp, or other rich soil, or clay, would be useful as additional materials for the compost beds, and would enable a small quantity of carbonate of lime to serve, with a much larger proportion of such earth, as well as much carbonate of lime, if alone.

It no proper materials for composting were at hand, the animal matter, might be saved for future use as manure, and for distant transportation, by being dried by artificial heat, and thus rendered, while kept dry in casks, safe from wasteful decomposition. This process is now used at the north, to preserve for transportation an artificial manure composed principally of fish. If both these and other methods were used throughout our whole country, for securing from waste, and using as manure, all the refuse and wasted, and richest animal matters, including the human excrements of towns, and which now go to utter waste, the matters so saved would be equal, in quantity, quality, and value as manure, to all the enormous supply of Peruvian guano now imported and used, at the cost to agriculture of millions of dollars, and which, is of such uncertain and transient effect, that it may well be doubted whether the use will ultimately leave any clear benefit and profit to the purchasers and users of this costly manure.

XI.—*The wild ducks, and other water-fowls of Currituck sound, and their important value. Northern interlopers, and incendiary agents.*

In Princess Anne and Currituck counties, the killing of wild water-fowl is a branch of industry of considerable importance for its amount of profit. Its extent is scarcely known by any person out of this region. For myself I had never heard of it, as a regular business pursued for profit, and I was as much impressed with the novelty as with the singular features of the pursuit. If a full and graphic description could be given, by a competent eye-witness, and one well accustomed to the excitement and the hardships of this combination of pleasure and labor, the account would be highly interesting. On this occasion, not being either a participator or a personal observer, I will not attempt to carry description into detail; but will merely, from report of reliable informants, make some general statements of the business in question.

Since the closing of the former deep and wide Currituck inlet, the strip of ocean sand-beach, or reef, has been unbroken from the northern extremety, in Princess Anne, bordering on the Chesapeake bay, for some fifty-five miles, to the southern end of Currituck county—and still further to the great open beach of the sea across the reef. The narrow waters, or sounds, enclosed between the sand-reef and the main land, is in Virginia not usually more than two miles wide. In North Carolina it widens into Currituck sound, and is between five and ten miles wide, and has within it several inhabited islands. All these sound waters are shallow, and for the much larger extent, less than ten feet—and a large proportion, near the shores, under six feet deep. Since the complete closing of Currituck inlet, in 1828, and the water has become fresh, changes have been gradually effected in most of the productions. One of the most important was in affording new and remarkable attractions to wild fowl of passage. Three or more different kinds of fresh-water grasses, soon began to grow on the bottom of all the shallower waters, and even to where it is nine feet deep. They extend their top shoots to the surface of the water, and are prevented from rising above, because the slender and flexible stems need the support of the surrounding water, to float them, and so preserve their erect position. These different grasses now cover the whole bottom, within the limits of depth named. The seeds of some of these plants I found nearly matured in the latter part of May. But it is not until autumn that the various kinds of water fowl, passing from their far northern summer retreats, are attracted to this place, by the great abundance of their preferred food. Some kinds of ducks prefer one water grass, and some another. Some eat the seeds, and others the stems, others only seek and dig up the roots, for food.*

There are ducks of various kinds, of which the canvas-back is the most esteemed. There are also wild geese, and swans. Altogether they congregate in numbers exceeding all conception of any person who had not been informed. The shooting season continues through the winter. From description, I cannot imagine any other sport, of field or flood, that can be more likely to gratify a hardy

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* I preserved specimens of the three most common of these water plants, (though without the flowers, being obtained at a later time of growth,) and sent them, for identification, to a botanist, Professor M. Tuomey, Geological Surveyor of Alabama. He reported these to be, (1, with oval veined leaves,) *Potamogeton lucens*, Lin. (2, with linear leaves,) *P. pauci flora*, Pursh—and (3, with long grass-like leaves,) *Zostera marina?* Lin.

sportsman—unless the certain and great success is such as, by its certainty, to take away much of the pleasure of such amusements. The returns, in game killed and secured, through any certain time, to a skilful and patient and enduring gunner, are as sure as the profits of any ordinary labor of agriculture or trade, and far larger for the capital and labor employed.

Decoy ducks and geese are used to attract the flying flocks of wild ones. In most cases, the decoys are made of wood, painted to resemble the designed originals. In fewer cases the decoys are living geese and ducks, of wild kinds tamed or confined; and these are tied by one foot so as to swim at the place where it is designed that the flocks shall settle on the water. The wooden decoys are of course anchored, so as to float in natural positions. A small and natural-looking "blind" or screen, made of a few bushes, with rushes, dry water-grass, &c., is constructed within gun-shot distance of the place where the decoys swim. Behind the "blind" the gunner hides himself, and remains perfectly silent and still, to await the arrival of the "raft" of wild ducks. They are often so numerous as entirely to cover acres of the surface of the water, so that the observer from the beach would see only ducks, and no water between them. These great collections are termed "rafts." The gunner places his decoys, and takes his position, sometimes hours before daylight. It often happens that he waits, in the coldest weather, for hours before he gets his first shot. The flocks of birds, very frequently flying high over the position, are attracted to join any others they may see swimming, and so are apt to come over to the wooden decoys. But the living decoys seem to understand and enjoy the sport, and to join in it heartily The decoy ducks loudly and frequently quack in full chorus, so as the more strongly to invite the unsuspecting victims of their treachery. The living decoy ducks are arranged in two rows, on the right and left of the gunner, and tied by lines long enough to allow each duck to swim to some distance on every side from its place of anchorage. It is said, that when the wild ducks are drawn to the place, and alight among and surround the decoys, the latter will speedily swim apart on either side, as far as their confining lines permit, from the central space, which is swept by the deadly shot. The most effective shots are made after the ducks are alarmed (designedly) and just as the whole raft takes wing. Then they are far more exposed, and are killed, or crippled, in great numbers even by a single discharge. In some cases, the wild fowls continue to come so fast, that the gunners do not leave their blinds until near sunset, when they go to pick up and save all the dead birds that have not floated off, too far, and are lost. As there is no tide, or current, there is not usually so much loss by this delay as might be supposed.

The foregoing general statements, with many other particular and marvellous reports, I heard from various persons, and mostly at second hand. But the following particular facts I learned from the personal knowledge of a highly respectable gentleman, Mr. Edgar Burroughs, and a proprietor of a farm on the sound in Princess Anne. The shooting (as a business) on his shores is done only by gunners hired by himself, and for his own profit, and who are paid a fixed price for every fowl delivered to him, according to its kind, from the smallest or least prized species of ducks, to the rare and highly valued swan. Mr. B. has employed thirty gunners through a winter. He provides and charges for all the ammunition they require, which they pay for out of their wages. In this manner he is obliged to know accurately how much ammunition he gives out; and it may be presumed that the gunners do not waste it unnecessarily, at their own expense. Mr. B. in this manner, and for his own gunners and his own premises only, in one winter, used more than a ton of gunpowder, and shot in proportion, which was more than four tons, and forty-six thousand percussion caps. From this expenditure, along the shore of one large farm only, there may be some faint conception of the immensity of the operations, and the results, along shores extending for full one hundred and fifty miles, and on all of which the same business is regularly pursued. Even northerners, as a regular business, come on every winter, to Princess Anne and elsewhere, to shoot wild fowl, and sell them to the northern cities. These predatory encroachments are forbidden by the law and the usage of North Carolina, and therefore that territory is free from them. But we, in Virginia, submit tamely to this depredation, just as we, more or less, leave to the free use of the other northerners, the fish and oysters of our rivers. These tangible and obvious depredations on the common property of the commonwealth, might be effectually prevented, even though, in common with all the south, we continue to submit to pay the much heavier and various tributes to the north, imposed through the action of Congress. And what we loose directly by these northern interlopers, in taking from our citizens, the supply of wild fowl, oysters and fish, is not worth consideration, compared to the greater evils they may cause. These fellows, of the lowest character and estimation, are stationed among us, yet inaccessible to our scrutiny, for months at a time, and each one, it may be for many seasons in succession. The vessel of the oyster catcher and dealer, and the anchored lighter of the gill-net fisherman, are secure from all visits, except by authority of law, or by illegal violence. The hut of the gunner is nearly as safe from inspection and intrusion. Thus these rascals have every facility (and far greater than if they were as ill-disposed natives, with neighborhood acquaintance,) to deal with our slaves, and to corrupt them, to sell to them spirituous liquors and buy from them stolen goods—and to act fully as the lowest and least observed, and least scrupulous of abolition agents—and, from their opportunities, perhaps with more success than the more genteel northern abolition agents, who are permitted to overrun the southern states, in the various disguises of commercial drummers and collectors—pedlers of every grade—agents to sell patent rights and machines, and to beg subscriptions for publications—teachers, male and female, tract and Bible society agents and distributors, and ministers of religion, claimed to be better and purer than the religion of the Gospel. I would stop from the free entrance to our country and our firesides, all these northern agents, so far as State laws can prevent—and with the more stringent aid of public opinion and disapprobation, where the law could not act.

SKETCHES OF LOWER NORTH CAROLINA, &c.

PART IV.

THE ORIGIN AND MANNER OF GEOLOGICAL FORMATION OF THE GREAT SWAMPS OF THE ATLANTIC COAST.

In Britain and Ireland, and the neighboring northern parts of the continent of Europe, there are vast spaces of land covered by peat, a substance or soil composed for much the greater part, of vegetable material. In Ireland alone, the peat bogs cover 2,800,000 acres. In Scotland and the north of England, in Belgium, Holland, and other as cool and moist countries, peat is not less abundant, in proportion to the quantity of all other land. Aiton, in his "Essay on Moss [or Peat] Earth," quotes from the published country reports of the Board of Agriculture, the estimated amount of "waste lands" in Scotland alone, to be 14,000,000 of acres. He objects to this number as too low, and estimates "the waste land in Scotland at upwards of 20,000,000 of acres; and that a very large proportion of that species of land is covered more or less with moss-earth," i. e. peat or peaty soil.

Peat is the final product of dead, but undecomposed vegetable matters. Wherever, because of a cool and moist summer-climate, or other sufficient local causes opposing decomposition, there is left on the surface of the earth, of each year's growth and droppings, more of the annual vegetable growth than can rot in the succeeding summer, and these unrotted remains continue thus to accumulate from year to year, the result will be the formation of peat, made up of the partially decayed and insoluble vegetable remains; and the formation will continue to increase in thickness, and often also in breadth, as long as the inducing and favoring circumstances of the locality continue to operate.

The necessary conditions for the formation of peat, presented in a moist and cool climate, and the consequent slow and imperfect decomposition of dead vegetable matters, (or their annual decay being, on the general average, slower than their annual growth and accumulation,) are so generally operating in Great Britain, that it seems peat may there form anywhere, if land is left untilled and ungrazed, and also in want of drainage, and saturated with standing water. Even ordinary high pasture lands, in Scotland, if left long untilled, become of "moorish" quality, or acquire a thin layer of peaty covering over the surface of the original earthy soil.

Most persons in eastern Virginia and the more southern states are even now unacquainted with the existence of peat in this country. And until within latter years, the formation was not known, as being peat, to any observers. In this general ignorance, I was formerly fully involved. And, in a publication on soils, made in 1821, I assumed, as unquestionably true, that no peat existed, or could be formed, in eastern Virginia.* Yet my then residence was within seventy miles of the nearest border of the great Dismal Swamp, which, however, no one then had supposed to be a peat bog, and perhaps no one, of those who were best acquainted with that swamp personally, knew what peat was. On many farms of the higher country, in narrow bottoms or other small spaces of low, wet, and shaded surface, there exists peat earth, (in the agricultural sense,) as a black semi-fluid mire, but which, even now, is known to be peat by very few of the proprietors, or other neighboring residents.

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* The first publication and form of the Essay on Calcareous Manures, in the "American Farmer."

My former ignorance on this subject, at a time when, even if any better information existed, none had appeared in print, may be excused, inasmuch as others, better informed in scientific agriculture, and on this particular subject, remained much longer as ill-informed of the limits of peat growth. Professor J. W. F. Johnston, as late as 1844, in his "Lectures on the application of Chemistry and Geology to Agriculture," where treating of peat soils, has the following passage: "There is a certain range of temperature within which alone peat seems capable of being produced. Thus at the level of the sea, it is never found nearer the equator than 40° or 45° of latitude, while its limit towards the poles appears to be within the 60th degree." "Still, on the equator itself, at a sufficient altitude above the sea, the temperature may be cool enough [in summer] to permit the growth of peat." (Lect. XII.) This general rule, with the stated exception, as to high elevations, would still deny the existence of peat to all the eastern half of Virginia, and, consequently still more decidedly, to all the more southern parts of the Atlantic slope, and coasts. I remained under a like general opinion until in 1837; when, for the first time seeing and examining the Dismal Swamp, I was soon convinced, and published the opinion, that the whole of that great morass, to its bottom, was one great accumulation of peat, and peaty soil. Inference at first, and afterwards personal examiation, made me extend this opinion to all of the great swamps of North Carolina. And from analogy and inference only, without having seen, or even heard any particulars of the locality, I conclude that the great swamp Okefinokee, marked on the map of Georgia near the border of Florida, is of the same general peat formation.

Having then learned and corrected my previous error, by the facts observed of the Dismal Swamp, I also thereby learned the natural appearance of peat, and was afterwards enabled to recognize it in many small spaces in the higher country. Such also is generally the black miry soil (as seen in a state of nature,) of much or most of the Blackwater swamp.

But still the same substantial and true foundation for the general rule of peat-formation remains unshaken by these exceptions.

For peat to be formed, there are required (not any precise limits of latitude, or altitude, or even general temperature,) but such conditions of summer temperature, shade, moisture and its retention, and also of vegetable matters to be acted on, as, altogether, will permit the accumulation of vegetable remains, to be increased, in the course of years, faster than their decay and decomposition can proceed in equal length of time. Such conditions in numerous cases exist in northern Europe, within the limits of latitude stated by Johnston, and, it may be, rarely south of these limits. Still they have operated, and to very great effect and extent, in various parts of this much more southern and much hotter and dryer country; and after the formation of peat had been there begun, the conditions and causes conducive to the formation were increased more and more with the progress of their effects.

"The occurrence of standing water," says Professor Johnston, "is necessary for the production of peat." To this position I assent, and require further that the standing water shall be so shallow as not to forbid the growth of bog plants therein. In the standing water in old and choked ditches, along the side of the roads, and in shallow pools, under shade, in the low and flat forest land of North and South Carolina, there may often be seen growing, in and above, and also sometimes entirely under the water, a peculiar knot of moss (*sphagnum palustre?*) which diminutive as it is, is the most abundant source of durable material for the formation of peat. This little plant never rises more than a few inches in height. Its top, in its outlines, approaches to globular shape, and each one is something in form and size like a white clover cluster of blossoms. The plant generally, is of dull green color, with touches of lighter green intermixed, and the youngest shoots approaching to a pale pinkish tint. This moss grows only in shallow water, or on bog-soil saturated with water. It may be entirely covered under standing water, for considerable length of time, without being damaged. And yet, when left bare in times of drought, it is hardy enough to live, and to wait for the return of the usual and proper condition of partial submersion in water. This plant, forming a continuous close and thick mat covers the whole surface of the water-soaked and miry "juniper land" of the Dismal Swamp, or the "sponge" soil, so called there. This moss, (as I infer from general description,) is also the most common growth on peat in Britain, as stated by Aiton, in his interesting "Essay on the Origin, qualities and uses of Moss Earth," to which I was indebted for much of my earlier information on this general subject, in regard to Scotland, and for the interest excited, which led me to subsequent laborious personal investigations in this country, where the results and the phenomena, as well as some of the inducing causes of peat formation, vary in sundry important respects from these of Europe.*

The peat bogs of Britain, and of Europe generally, are entirely destitute of living trees, and (as there supposed) are now incapable of sustaining the growth of trees. But in this country, the peat lands are generally covered by heavy forest growth of subaquatic (or wet land) trees; and the juniper (or white cedar,) is seen nowhere except on the most entirely vegetable, spongy, and miry, of these vegetable soils. On such ground, which is scarcely more of earth than of water, and where every footstep sinks deep into mire and water through the thick carpet of green moss, slender and graceful juniper trees, though not very large, make a luxuriant and beautiful forest growth. And on other parts, where more of true earthy material is intermixed with the peat, or where clay lies near below, the much larger cypresses, intermixed more or less with black gum, maple, poplar, and other trees of drier swamp lands, rise to great sizes, and present magnificent though gloomy forest scenery. The peat bogs of Britain and Ireland, when dug into, often show the prostrate trunks of oaks and other trees of dry land growth—thus clearly indicating that the peat formation there had covered over a surface of what had formerly been dry and good soil. Our deep bog soils also have buried therein the stumps and trunks of trees, in very great quan-

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* This Essay originally appeared in the Edinburgh "Farmers' Magazine," and was republished by me in the "Farmers' Register (of Va.,) Vol. v., page 462.

tity, and extending to considerable depth, below the present surface. But these are always trees of aquatic growth—or such as still grow on the surface, or might grow there if not excluded by other hardier kinds, or if not prevented by the frequent occurrence of fires, which, in many localities, have killed to the ground, and prevent the growth of all but annual shoots.

Another (apparent) difference is that much of the European peat serves well, and is extensively used, for fuel. Ours (of the Southern States,) is combustible also. But it has never been used for fuel, and therefore, (and also because of its more reduced texture,) would seem to be unfit for that use. Again—when our peat soils have been drained, cleared, and tilled, they are, (at least for a few years, and generally much longer,) highly fertile, and none (when new) have ever been manured, or seemed to require such aid to their early fertility. But in England and Scotland, when peat soils are first drained or brought under culture, it is deemed an essential preliminary to manure them with dung or other putrescent matters, and especially to apply lime, and clay or other earth—the latter in very heavy dressings. But even with all these aids, it is comparatively but a recent discovery in Britain that peat bog soil, (called "moss earth" in Scotland,) was capable of being made fit for cultivation. Aiton, (who wrote in 1811,) says—"Until of late, the proprietors and possessors of moss-land were ignorant of its value as a cultivated soil, and contented themselves with the pasture it yielded and the game it produced. Those who first talked of raising grain, or roots, from moss, were held up to derision; and to this day, moss-culture is laughed at, and considered as a whim, even by the generality of farmers." So far Aiton referred to moss (or peat) land generally, including in these remarks all the firmer and better qualities—which he distinguishes as "hill-moss" and "bent-moss," from the worst kind, or "flow-moss," which seems, (of the three kinds,) to agree most nearly with the "sponge" soil of our juniper swamp, or other peat whereon not even juniper trees can now live. The former kinds are often on mountain tops and steep, or gently sloping hillsides—as water on the surface is enough to produce peat anywhere in Scotland. But, as to "flow-moss," Aiton says—"Where, from the surface being still more level, and the sub-soil close and impenetrable to water, and where by the rising of springs, overthrown trees, [originally,] or other obstructions, a still larger quantity of moisture has been detained, and continues to be kept on the surface, everything in the shape of grass or green [useful] herbage is banished, and the following plants grow up, viz.: Marsh fog (*sphagnum palustre,*) goldilock (*poly trichon commune,*) drab-colored fog (*bryum hypnoides,*) cotton-heads (*erio-phorum polystachion, &c.,*) turkey club-rush (*scripus cæspitosus,*) yellow fogs (*hypnum rutabulum et filicinum,*) heather (*erica vulgaris et tetralix.*) In such situations moss earth will be found of from two to fifty feet in thickness, and where the supply of moisture on the surface is still more abundant, the stratum is fast increasing. Moss of this description [when dried] is always loose, open, light, of a drab-color, and the vegetable fibre being still perceptible; and though it readily burns, makes but a weak fire. This is denominated "*flow-moss.*" Aiton subsequently speaks more fully of the understood character of this "flow moss," as being worthless—and of the then but recent improvements thereof—though, (by using the costly applications which I before referred to,) he deemed even this worst of peat soil susceptible of profitable improvement and culture.

The distinguished Scottish agriculturist, Lord Kaimes at an earlier time had, in a remarkable and costly operation, given evidence that the soil buried under the peat formation in Scotland, was worth more and was better worth uncovering, where circumstances permitted, than the overlying peat was of being drained and then improved for bearing crops. He owned a body of peat-covered land on the border of a large stream, the water of which he made use of to remove the peat, and float it off to the sea, so as to expose, and finally to bring under culture, the before deeply buried and more valuable original soil. This singular mode of improvement was not only prosecuted by Lord Kaimes, but after his death was continued by his son. This would seem to prove that this laborious cutting loose and floating away of the whole deep bed of peat was sufficiently compensated in bringing into use its previously covered bottom earth. Contrary to this better quality of the bottom earth, as soil, of these peate bogs of Scotland, the underlying beds of our peats, so far as known, are barren sand, under the central and the thicker parts, and at best but clayey and also barren subsoil under some other parts of the peat soil, in the great swamps.

From some of the several differences of character named, I infer that the European peats, produced under the climate most favorable to peat formation, (because the most unfavorable to the complete decomposition of vegetable matters,) are therefore more generally made up of undecomposed and insoluble, and therefore inert vegetable remains, than our peat soils—of which, a large proportion of the moss is of vegetable matter so much reduced, that, when in its place, it is a black slime or soft mire, feeling like the finest and lightest of very recent clay sediment. In this condition, if the chemical qualities do not forbid, this finely reduced peat, when drained, must be already fitted to feed plants, or to act as putrescent manure. Johnston speaks of the vegetable portion of British peat soils amounting to sixty or seventy per cent. of the dry weight. The remaining forty to thirty per cent. of the true earthy and mineral ingredients, would not constitute one-tenth of the bulk of a soil of so little specific gravity when dry. And if this sixty to seventy per cent. of the dry weight, or ninety per cent. of the bulk, (as supposed,) of the peat soil was of undecomposed, and entirely insoluble and inert vegetable matter, it is obvious why such a soil should at first be barren and worthless, and require heavy applications of manures, both earthy and putrescent, to render the newly drained soil fit to produce crops. On the other hand, if, by virtue of our hotter and longer summers, a large proportion of the yearly deposit of vegetable matters, on peat swamp, pass speedily into putrefaction (and so make true food or manure for plants,) leaving unrotted and insoluble but a small proportion, to go to increase the true peat formation, then it will be plain enough why such land, when first drained and subjected to culture, should at first be extremely rich and productive, however defective such soils may be in other respects, and in later time.

So much for the apparent differences of the qualities of British peat soils as learned from British writers, and of ours, as learned from my personal examinations and observations. I will now proceed to describe the peat swamps, in general and concise manner; and then to trace the supposed geological formation of our peat bogs and soils, and attempt to explain the remarkable and strange circumstances which belong to our great peat swamps.

The Dismal Swamp is the most northern of all here under consideration. This, from east to west is from fifteen to twenty miles across, and from its northern border, near Suffolk, in Virginia, to its southern extremity in North Carolina, the distance may be thirty to thirty-five miles. Towards the south, the outlines are irregular and ill-defined, the peaty swamp being there much interspersed with other low but firm land. But on all the other outlines, the division between the swamp and the surrounding firm land is better defined. All of the space within Virginia, and a considerable adjacent portion within North Carolina, together with a compact body of unbroken peat swamp, within which there is no other kind of land—and very little (and that only on the borders,) that has been drained, or cultivated.

South of Albemarle Sound, the surface of the contiguous counties of Washington, Tyrrell, and Hyde, and the greater part of Beaufort—or all of the peninsula included between Albemarle and Pamlico sounds—a compact area of fifty by sixty miles or more, is nearly all of one great and connected body of peaty swamp. The exceptions are in narrow strips of intersecting low but firm land. South of Pamlico sound, a similar low and flat surface extends to South Carolina, and from the narrow and shallow sounds of salt water near the ocean, there, back to various and considerable distances. Swamp lands make up one-fourth or more of all this great space—but in separated localities and smaller spaces than are found north of Pamlico sound. Of all this great extent of morass and bog lands, I have personally and carefully examined but small portions and these of the more remarkable localities. These are different parts of the Dismal Swamp, along different routes of access—the drained and also some of the undrained lands on Lake Scuppernong—the lands (mostly drained) around Lake Mattamuskeet—and the "Open Ground" savanna in Carteret county, and portions of the great swamps near Plymouth, and adjacent to Lake Waccamaw. Many other peat swamps of smaller yet considerable size, though as well known, will not be further noticed here, and numerous other swamps I have barely seen, as passing over the different routes of travel in North Carolina and South Carolina. And much of the information which I have obtained as to the topography and physical characters of all these lands, I have gathered from the verbal statements of reliable neighboring residents, as well acquainted with the localities as any persons were. Still, from all these sources, my materials are but few and imperfect for a report on so wide a subject, so little known—and to investigate which, satisfactorily, would demand much more time and labor than a mere amateur explorer could devote to it—and also more of varied scientific and agricultural knowledge than any one examiner would be like to possess.

Under the general term of *swamp*, there are two very different kinds of land embraced in common parlance, and both of which are usually to be found interspersed in the same large space. The first kind is either properly peat, or otherwise of soil largely composed of peat, (making what I will call peaty soil.) The other kind is of low, wet, and rich soils, deriving in large proportion alluvial accretions from the overflowing and turbid waters of bordering rivers, or rich washings from higher grounds, or other sources of such earthy supplies in addition to the deposits of vegetable remains, of successions of plants grown on the same ground. These latter swamp soils have so much more of true earthy than of vegetable material, that they are not combustible, and when drained, make rich and durable lands. These *firm swamp* soils, as I will call them, in contra-distinction to the *peat swamps*, are intermingled with the latter in position, and cannot always be distinguished by a view of the surface, and before their being drained and cultivated. But in advance of the sure testing by sufficient tillage, the original forest growth serves to distinguish this kind of land. If the original growth had been removed, a partial analysis of the soil, by burning and weighing the incombustible residue, will still better indicate its degree of earthy constitution. When of sufficient elevation above tide, or other standing water, the drainage of these firm swamp lands is very simple, though it may be very laborious and costly. And proper drainage is all that is required to make these lands of great productiveness, and of long enduring fertility, and value.

The swamp lands in large bodies are mainly another class—either composed of true peat, (as the "Open Ground" savanna, and the juniper swamps in general,) or they are principally composed of peaty material, though having intermixed therewith enough of true earth to make productive and useful soils for tillage. These latter, in their natural state, are unusually seen covered with heavy forest growths, of black gum, some cypress and fewer of poplar, maples, ash, and other sub-aquatic trees.

A stranger to this region, who had only heard it described generally and imperfectly, would naturally infer that the great swamps were of low surface compared to all the neighboring firm and dry land, and that these swamps, because of their lower level, received the water flowing in transient rain-floods, and perpetual streams from the surrounding higher and firm grounds; and that to these supplies from without, were mainly due the extreme wetness, and saturation of all these swamps in their natural condition, and the large surplus of water which is always flowing from them, in rivers and smaller streams, emptying into the nearest tide-waters. The true state of the case is very different. All the great peat swamps known to me are of higher general level than all or nearly all of the near adjacent firm and (so-called) dry land. Further, of each large body of peat swamp land, the central or interior portion is the highest. And of the many crooked and narrow and sluggish, but mostly deep rivers and smaller water courses, which meander through parts of these great swamps, all have their head springs in, and derive all their supplies of water from the swamps, and discharge themselves outside, and generally after having passed from the swamp to and through firm and dry, but yet lower-lying land. A glance at the maps of North Carolina and Virginia, will serve to establish the main point here asserted. In the great connected swamp, which covers most of the peninsula between Albemarle and Pamlico sounds, it will be seen that while Alligator and Pungo rivers, and sundry others of less volume, all flow out of the interior swamp lands, in several different and opposite directions to reach the sounds, there is not a stream that flows from the outer lands towards the swamp. Though not to be seen so clearly on the existing maps, yet actual inspection of the locality has shown the like facts as to the swamp region surrounding Lake Mattamuskeet. Such also is nearly, but not entirely, the condition of things as to the Dismal Swamp. To that, for a few miles length of its western border only, dry land of general higher level reaches—and from that small space only, there flow (or appear to flow) into the swamp a few small streams, of which the largest has enough water to work an ordinary mill. But with these few and slight exceptions, and for all the other and far more extensive of its border outlines, the Dismal Swamp does not receive any stream from without, while it supplies the head-springs, and all the upper waters of a considerable branch of the Nansemond river, the western and southern branches of Elizabeth river (all flowing northward and eastward to the Chesapeake,) and five other considerable rivers, flowing southward into Albemarle Sound—besides smaller streams. Whatever may be the amount of stream or rain-flood water that comes from without into the Dismal Swamp, the out-going water must exceed it fully twenty-fold.

In the interior, and on the highest surface of all these greatest bodies of swamp there are lakes of considerable sizes, filled with water to their brims, except in dry seasons—and in very wet seasons these lakes overflow their margins, and so increase the volume of the out-going streams. Lake Drummond in the Dismal Swamp is between oval and circular, seven miles long and six broad. Lake Scuppernong, (or Phelps) about of the same dimensions. Lake Mattamuskeet, before being lowered by partial drainage, was twenty miles long and seven wide. Alligator and Pungo lakes, of smaller sizes, than Scuppernong, and of about equal height of level, are in other parts of the same great connected body of high swamp—and in the swamp south of Pamlico, there are several other lakes, of which the largest and the most southern is Waccamaw, three and four miles across in different directions.

Inasmuch as there are no other visible sources, these lakes are commonly supposed to be the sources of supply of all the rivers and streams flowing out of the swamps except what is supplied immediately by rain, which is also commonly supposed to make but a small proportion of the whole. And then, to account for the immense quantity of water supposed to be furnished by the lakes, resort was had to the further supposition that they were supplied by a sufficient number of subterraneous springs or streams, proceeding from higher and perhaps distant ground. This theory of the supply of water to the Dismal Swamp is very old, and has, as the first known authority and supporter, the distinguished and generally well informed Col. Wm. Byrd. In his curious "Proposal to drain the Dismal Swamp," written long before the lake was first discovered, or the existence of any lake was suspected, he speaks of the rivers which flow from the swamp, and adds—"All these [the named rivers] hide their heads, properly speaking, in the Dismal, there being no signs of them above ground. For this reason there must be plentiful subterranean stores of water, to feed so many rivers—or else, the soil is so replete with this element, drained from the higher land which surrounds it, that it can abundantly afford these supplies. The last alternative supposition has been already shown to be erroneous—and the first (of subterranean supplies of water,) is not only groundless—but further, no such extraneous supplies of water are needed, to provide all the existing and continuing abundance and superfluity. This I will endeavor to show, in subsequent explanations and reasoning. For the present, I proceed to describe the appearance and physical characters of the great peat swamps, and thence to deduce the manner of their formation, and their supposed agricultural capabilities.

Whatever were the agencies and producing causes of formation of this low and flat country in general, it must be supposed by all that the earliest shape and figure of the surface of the land, before it was partially covered by later deposits, was not very different from what exists now under these later deposits, of alluvium, local drift, or peat growth, and accretions from ocean sand near the coast. It is not meant to assert that the elevation was formerly and now the same. On the contrary, as will be shown, there are evidences of subsequent changes of elevation, by extensive subsidence, and it may be, also by upheaval. But independent of all such changes, the former upper earth had at first the like generally flat surface, and was composed (as now) of fine sand mostly—and in some cases of sand so extremely fine, as to make a soil of very close and stiff texture. These flats, near to the coast, were also generally and necessarily poor. previous to any later deposition thereon of richer earth, or putrescent matters. On such broad and flat surfaces, as the central parts of the interval low ridges between the different rivers, there would be also many and separate small and shallow basins, having no natural outlets deep enough to drain them over the surface, and which therefore would hold the superfluous rain water, which fell thereon, until it could evaporate, or sink into the earth below. Soon, plants would begin to grow, and in due time the species of pine, which of all trees is best suited to such low, sandy, and poor, but generally not very wet land—though also capable of withstanding the injurious effects of water for a long time. This is the (*pinus tæda*,) "loblolly," "fox-tail," or "old-field" pine which, in lower Virginia and North Carolina, so generally covers, as second growth, the poorest worn-out fields—and also as well grows still better (though not as exclusively,) in original forests on low and miry lands. This tree, more than any other kind, would readily grow on the soils and surface supposed—sandy, poor, low, and generally moist, though without visible springs, bringing any streams or even oozes to the surface, and where standing pools of rain-water did not remain very long. These pines, when exclusively occupying the land, (as they propably would in these cases,) stand very close together—and whether young and small, or when standing as thinly as required for their old and very large growth, in all cases they make a close shade, both in winter and summer. Their dropped leaves cover the ground more abundantly than those of any other tree, even of the pine family, because they strongly resist decomposition. On poor land, covered by this species of pine, the leaves dropped in four or five successive years, may be on the ground at once, forming a thick and close cover of some inches deep. Still, after some time, say five years, the decomposition of the oldest of these crops of leaves will be completed; and thence forward, decomposition proceeds as regularly, and to as full effect, as elsewhere. The difference would be that five years would be required here to bring about as entire decomposition as would take place within one year or less, in regard to other kind of trees, standing on rich and calcareous soils. On such poor and pine-covered land as is under consideration, if dry, though at any one time there may be an accumulation of all the leaves dropped in the last few years, no portion of them will remain permanently undecomposed, and therefore the accumulation cannot continue to increase—and therefore, in such cases, and on dry land there can be no formation of peat.

But continued moisture of the air, and still more, of continued wetness of the soil and its cover, would bring in other agencies to resist decomposition—and causes for such changes would soon be offered.

Whatever may be the cause or true theory, (whether such as I have maintained elsewhere, or any other,) the facts are unquestionable that a bed of very pure sand underlies nearly all the land of the low country, at a few feet below the surface, and that that sand-bed is generally glutted with water to its top—or at any rate, and at all times, water rises in it to, and is permanently at, a little below its top. In such shallow depressions of sandy surface as have been supposed to exist, the general level of this water in the sand-bed would be just so much nearer the surface of the land as that surface was depressed. When rains fell on the depression, the surplus water would filtrate through the earth until reaching the sand glutted with water below. It could sink no lower, because no more water could be there taken up by sand already glutted. This additional supply of water could only be removed by its passing off on nearly a level, to the nearest deep river beds, or to other deep depressions—and as slowly as water must pass through fine sand. Under such circumstances, with the supposed thick cover of rotting and unrotted pine leaves on the surface of the earth, and the continual shade, it would not be long before the earth, from the water-glutted sand below to the surface, would become and remain permanently damp and moist, and finally wet—which would so much the more retard the sinking by percolation of the subsequent rains—which would keep the rain-water so much longer on the surface, saturating the coat of leaves, and sometimes forming temporary shallow pools above them—and all these things would serve to increase evaporation and its effect, of inducing colder tempature—

and to provide for the occurrence of more rain and dew—and to strengthen all the causes for the formation of peat. In the wettest spots, and in all the deepest depressions where the stagnant rain-water remained longest, the bog-moss would begin to grow, and would increase as circumstances favored its growth. The soaked pine leaves would supply acid extract—serving to retard the decomposition of all vegetable matters. The bog-moss (*sphagnum palustre*,) contains tannin, which being yielded to the water by the decay of the moss, would have still more antiseptic operation (or would the more resist decomposition,) than the acid alone, if without tannin. So long as the shallow stagnant pools, or other water at the surface, did not remain through droughts, the growth of *sphagnum* might be irregular and uncertain. But with the abiding moisture which could not fail to occur later, that plant would cover the whole of the shaded surface, and by its death and decay, and peculiar fitness for this end, would more and more increase the accumulation of vegetable matter, and prevent its complete decomposition—and the remaining and increase of such vegetable material is simply the growth of peat.

The foregoing reasoning will serve to explain why the formation of peat, in countries where it is of rare occurrence, should be confined to particular places, and even to very small spaces in the higher lands of the tide-water region, when numerous other places might seem to cursory observation, to be similar, and to afford equal facilities for the formation.

It was before stated as a fact known even now to very few proprietors and residents, that, besides the great bodies especially under consideration, there are numerous small patches of peat to be found, and where its existence, and its characteristics are not known, and if known, its value to the farm, would not be appreciated. Yet as an abundant source of organic material, for compost manure, such supplies of peat might be of great value to proprietors who would know how to put the material to proper use. To such persons it will be useful to indicate the causes of such formations of peat, and of course to indicate the circumstances and particular localities in which it shall be sought.

It has been shown that the great under-lying bed of water-glutted sand, when approaching near to the surface of the land, is of important operation in commencing and promoting the growth of peat. In the higher and more hilly tide-water lands of the southern states, I believe that this wet sand-bed, at or near the surface, is an indispensable condition, to the formation of peat ; and that with this condition, peat will always be formed, if there are also the conditions of shade, and enough vegetable dead matter for a beginning Such conditions are usually presented in the narrow and flat bottoms of natural valleys, of sandy soil and sub-soil, long covered or shaded by forest trees. The peat is usually thin, a black and semi-fluid mire, in which no animal could stand, but for the support of the roots of the growing water-bushes and grass, or after sinking to the solid sand below. Such narrow bottoms are almost always the sources of springs, or oozing water, which is an additional cause of general wetness, of the ground, and of greater early tendency to produce peat. In fewer cases, much larger surfaces of peat have been formed in originally lower parts of broad and rich bottoms. In such cases, it has usually occurred, after the whole bottom had been drained, cleared, and brought under culture, that the existence of the peat was first discovered by the cultivator, (though its true character still remained unknown,) by the peculiar and bad qualities of the soil for tillage and production. In such cases, the unproductive soil for tillage would be of great value as material for compost manure, to be profitably applied to more than a hundred times as much space.

When a first cover of peat had been formed, where any of the great swamps now are, of but a few inches thick, this would add new and great force to the agents of its first production—and this force would continue to increase with the increased thickness of the peat. This substance holds water like a sponge, and retains it in very great quantity, (as will be shown presently—) and the thicker the peat, the more rain-water would be absorbed, and the longer it would be retained—or the less would be yielded to evaporation, or by percolation.

This, with merely the continuance and the necessary strengthening and increase of these natural conditions and causes, peat, where once thus beginning to form, would continue to increase in thickness—and to retain more water throughout its mass, permanently. But the growth would not only be in height, but also in breadth. Suppose the growth (as above described) to have spread over a shallow basin, say to the depth of two feet, and that the margin of the peat was bounded by firm land, rising a little higher than the bottom of the previous basin, though then something lower than the new-formed patch of peat. The peat being glutted with water, whenever receiving a surplus, from more rain, would necessarily have as much water pressed outward, to seek discharge at the lowest levels of the peat, which would be at its outsides. This escaping water would be discharged upon the nearest adjacent firm soil—and this addition to its previous natural moisture, as well as the continued contact of the formed peat, would fit such ground for the same growth on its surface also. Thus, the formation would extend in breadth, in every direction, unless where reaching water, too deep for peat plants to grow in, or otherwise coarse and dry sand, on steep slopes, on which water, or enough moisture could not be retained. Thus, we may see that the first-formed and neighboring small patches, in the shallow basins, would spread until uniting with each other, across the higher intervals—and that, in such immense length of time as would be required, the peat formation would spread over broad spaces, and of great depth. Still the growth would be far slower here than in more favorable climates, where a much larger proportion of dead vegetable matter would remain undecomposed. If, for example, in Scotland one-tenth of all the year's droppings of dead vegetable matter is decomposed the next summer, and nine-tenths remain undecomposed—and that here, nine-tenths would be decomposed, and only one-tenth remain,—it is evident that the first growth of peat in the former country would be as much in one year, as would be here in nine years.

In the foregoing supposed circumstances, before much thickness of peat could have been formed, the first growth of pines. (which had preceded and originated the peat,) would have gradually died out, and their place would have been occupied by real aquatic trees and other plants. For though this kind of pine (*p. tæda*,) is capable of living on land of very low level compared to the neighboring standing height of water, and even if standing in a thin coat of peat—and can undergo irregular and rare overflows of salt water, (from storm-tides,) without apparent damage, still this pine is not an aquatic tree, and does not thrive, or usually live long, in a real deep and miry peat soil, (as does the pond pine, or *pinus serotina.*) Juniper trees (white cedar,) seem the best adapted to flourish in deep and true peat soils. And even these are partly rooted in the original and solid earth below.

The successive growths and deaths, and falling and subsequent covering of the trunks and limbs of the aquatic trees—and their being preserved from rotting by being kept always wet, and mostly buried—served to supply much of the materials, and the thickness of the peat swamps. Everywhere under the surface, and at various depths, there are to be found the bodies of trees, and generally in great quantity. When the canal was dug to drain Pungo lake, (a work ordered by the government of North Carolina,) the excavation exposed three successive and separate layers of fallen and buried trunks of trees, of different kinds. The upper layer (which was entirely buried and hidden by the covering swamp earth,) was of pine trees—(and these I infer were of the species *P. serotina*, which kind only prefers the wettest and peaty soil—) the next layer was of cypress, and the lowest of juniper trees. I learned these facts from the chief engineer Major Walter Gwynn, and also from Col. William B. Whitehead, who was a contractor to execute the work. The canal dug through the Mattamuskeet savanna land, (then bare of trees,) for the purpose of furnishing earth, by the excavation, to make an embankment for the public road, was so full of buried trunks and limbs of trees, as I heard from a gentleman who saw the wood lying along the canal, that he thought it would have been difficult to replace it in the canal, so that all would be, as before, below the former surface.

As the growth of a body of peat extended in breadth (as above explained,) the greater thickness would still be of the central parts; not only because there the formation had been much longest in progress, but also because all the conditions necessary for the growth were there the most favorable. How many centuries of centuries might be required, in this unfavorable climate for the formation of any stated thickness or breadth of peat, is beyond all powers of estimation. But with time enough, and without any counteracting circumstance, or agency, (as of fire, after its being introduced by man,) we can scarcely place limits to the extension of the growth of peat, in both depth and breadth, while there was a low and flat country for it to spread over.

It has been shown that, from the manner of its formation, a great peat bog would usually become highest in its central parts, even if the primitive surface there had been as low as, or lower in level than the present firm margins of the swamp. But such lower level would not be necessary for the origin and progress of the peat formation. It might as well commence in any slight basin-shaped depression, if moist enough, on the former highest level surface—and the formation of peat thence be spread over lower surfaces. This seems to have been the course in some localities. For example, the layers of clay and sand, which lie under the upper peaty layer in the drained land at Lake Scuppernong, are, respectively, (like the covering swamp-soil,) of highest levels near the lake, which is on the interior and highest *plateau* of the great swamp.

So far I have claimed no greater supply of water, from rains alone falling immediately on the land, than abundant for the formation of peat. But even if this has been made out, and clearly, still it may be denied that so much rain, superfluous for this operation, would be in excess, as to supply the regular flow of all the many rivers discharging the waters from these great swamps. I will attempt, and trust successfully, to show that, the rain alone, falling within the area in question, is enough for this supply also.

On the low and flat but firm and cultivated lands of lower Virginia and North Carolina, and where either an impervious subsoil, or (more generally,) a water-glutted inferior sand-bed, prevents much of the surplus rain-water from sinking, and escaping by downward filtration, every farmer there knows, that there is an annual excess of rain-water, which he must discharge by ditches, or he would rarely be able to make a crop, because of the too great wetness of the fields. Thus every farmer's common sense and observation, would prove to him that there is an average excess of rain, more than the land can absorb, and which excess passes off, by artificial or natural depressions, into the rivers.

But scientific and careful observations have been made, by aid of which we can approach nearer to precise results. According to the voluminous reports of Meteorological observations, (made at all the military posts of the United States, for the then preceding twelve years, and) published by order of Congress, the general annual average quantity of rain in lower Virginia is thirty-five inches, and in the southern part of lower North Carolina, forty-five inches. The chart on which these general average quantities are so marked, has the former of these numbers north of the Dismal Swamp, and the latter, south of Pamlico sound. Therefore, for the latitudes of the great swamps between, we may assume the medium, of these quantities, or forty inches, as the average yearly quantity of rain. Of the whole amount of rain-water that falls, a portion is taken up and used to nourish plants; another portion (in most cases,) sinks by filtration into the earth and another portion passes off into the air by evaporation, and the remaining quantity flows off over the surface, and serves to supply the streams. The observations by which the general results (shown in the chart referred to,) were obtained, of course must have been made, not in the swamps, but on localities of dry land, inhabited, and partially cleared and under tillage. And it should be noticed, that on such different surfaces, even if not far distant the circumstances of the respective quantity of rain and its manner of escape, would be very different. The general tall and dense forest cover of the great swamps would more attract the clouds, and so obtain more rain—and also, by excluding sun and winds, would prevent much evaporation that would occur on open and exposed surfaces. Of escape of the fallen rain-water by downward filtration, there could be none—because generally the surface, and always the deeper-lying swamp-soil is already glutted with water, and therefore no more can pass down, or get beneath and out of the swamp earth by downward percolation.

These, and also other minor causes, would together serve to increase the quantity of rain, or other moisture supplied to the swamps, and to lessen evaporation, and prevent escape of water by downward filtration; and from all three of these conditions, there would be so much the greater residue of water to flow off, and thereby to swell, or entirely supply the rivers having their head sources in the swamps. No estimate can be made of the quantity of water taken up by the living trees and other vegetation of the swamps. But its excess, (over what the growth of grass, would take up,) probably would not be more than enough to counterbalance the lessening of evaporation from the earth, by sun and wind, caused by this sheltering forest growth. On that assumption, then the only modes of escape for all this yearly supply of forty inches depth of rain-water, are, by flowing off, in streams, and by evaporation from the wet soil. The rate of the latter operation, in some other localities, has been carefully measured—and the results, allowing for all differences of the conditions, will enable us, by comparison, to approach the like results in the cases under consideration.

From Rees' Cyclopædia, article "Evaporation" is copied the following interesting observations of facts:

"With respect to the natural evaporation of water from the surface of the earth, the experiments of Mr. Hoyle and Mr. Dalton, of Manchester, are near the only ones that are sufficiently numerous from which to draw any conclusions. They took a cylindrical vessel of tinned iron ten inches in diameter and three feet deep; there were two pipes soldered into it, one at the bottom, the other at the top, for the water to run off into bottles; the vessel was filled with gravel, sand, and soil, and subsequently the soil was covered with grass and other living vegetables. It was nearly buried in the ground in an open situation and provision made for placing bottles to the two pipes. In this manner it was exposed to receive the rain, and to suffer evaporation from the surface, the same on the surrounding green ground. A regular register was kept of the water which percolated through the soil and ground into the bottles, and a rain gauge of the same surface was kept close by, for the sake of comparison. The results are contained in the table below, together with the mean evaporation from a like surface of water for the three succeeding years."

Water [escaping] through the two pipes.	1796	1797	1798	Mean.	Mean Rain.	Mean Evap. from Ground	Mean Evap. from Water.
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch	Inch.
January,	1.90	.68	1.77	1.45	2.46	1.01	1.50
February,	1.78	.92	1.12	1.27	1.80	.53	2.03
March,	.43	.07	.34	.28	.90	.62	3.50
April,	.22	.30	.18	.23	1.72	1.49	4.50
May,	2.03	2.44	.01	1.49	4.18	2.69	4.96
June,	.17	.73	—	.30	2.48	2.18	6.49
July,	.15	.03	—	.06	4.15	4.09	5.63
August,	—	—	.50	.17	3.55	3.38	6.06
September,	—	.98	—	.33	3.28	2.95	3.90
October,	—	.68	—	.23	2.90	2.67	2.35
November,	—	1.04	1.59	.88	2.93	2.05	2.04
December,	.20	3.08	1.88	1.72	3.20	1.48	1.50
	6.88	10.95	7.39	8.41	33.55	25.14	44.43
Rain,	30.63	38.79	31.26				
Evaporation,	23.75	27.84	23.87				

"From this table it appears that the evaporation from a surface of water is nearly twice as much as from green ground; also that about eight or nine inches of rain are left for the supply of springs and rivers. This surplus of water must be evaporated from the sea and return to it again by the rivers."

Where these observations were made, (in Manchester, England,) less rain falls than in this region—and, from the lower temperature of the summers, and less sunshine in England, there must be less evaporation, under like circumstances of soil, water and exposure. But on the other hand, the exposure to the open air, and to winds, and to so much of heat and sunshine as the climate afforded, was far greater in the subject of these scientific observations than are offered in our forest-covered swamps. And under and through the covering of growing and exposed grass, perhaps there was as much water taken up and conducted off by the plants (making part of the whole loss by evaporation,) as by the tall and dense forests, or other luxuriant growth of our great swamps. And if the different circumstances of the two localities are deemed balanced, and equal, then it appears that the mean depth of rain was 33.55 inches; the mean loss by evaporation, 25.14 inches; and the mean discharge of water by flowing off, was 8.41 inches. This last quantity all goes to supply the streams and rivers. And in such a locality as the great swamp region lying between Albemarle and Pamlico sounds, which can receive no streams or rain-floods from without, this quantity of water is sufficient to supply the continual flow and discharge into the sounds, of all the rivers and smaller streams which have their only sources in the swamps. The Dismal Swamp, though its supply of water, and that for its rivers, is for much the larger part derived immediately from rain, still it has also a small additional supply in streams from without. It is therefore that the amount of water constantly discharged from this swamp, is still more abundant than that from the other and larger swamps.

Before I knew of the existence of the above observations, or where to refer to any such facts or authorities, I had myself made an experiment to test the rate of evaporation, from water, and under shade. On July 25th, 1856, a cylindrical glass vessel, about five inches in diameter, was filled with water six and a-half inches deep, which was within one inch of the top of the vessel—and placed over the mantle of my bed-chamber. The room was often open, and generally all of every warm and clear day. For nearly all the time of observation, the shutters of the south window remained open, even when the window was not raised, so as to admit sunshine. But the sunshine did not approach near to the water; and it was, by the vessel as well as its position, secured from the access of winds. After cold weather, fire was sometimes made in the the fire-place, at night and morning only—but not generally. An open iron wire screen, (a common dish-cover) was placed over the vessel to exclude flies. But this was removed on November 25th. The vessel remained thus situated until it was broken by the freezing of the water in the severe cold weather of January 1857. The latest observation made was on January 8th, after five and a-half months of exposure, when the whole loss by evaporation was only two and one-third inches—equal to 5.05 inches for a year. Of course, in a situation thus protected from heat, and sun and wind, this small amount of evaporation is no indication of what would be the measure, when exposed in open air, to sun and wind. Under these latter circumstances, (as I infer they were,) the observations above quoted made the mean loss of *water* (alone) in a year, 44.43 inches —which is nearly nine times as much as in my trial. Now, between these remote extremes of exposure and measures of evaporation, the circumstances of standing pools in the great swamps may be supposed to be a medium—that is, that the exposure to evaporation there is as much less than in the English observations, as it is greater, and more operative, than in my experiment. Then, on this ground, if taking a mean between the two for the loss by evaporation of water, in the low and sheltered swamps, that quantity will be 24.74 inches; and, on the same premises, and proportional reduction, instead of 25.14 inches, the mean evaporation of water *from ground* in the English experiments, and that from the soil of the swamp lands, would be about fourteen inches only. Deducting the fourteen inches of evaporation from the forty inches of annual supply of rain, leaves twenty-six inches, or more than half to supply rivers and other streams. But such calculations and estimates, even though based partly on certain and accurate grounds, are doubtful; and these may not be worth being thus noted. But even upon the sure and unquestionable premises, it can scarcely be questioned that the great swamps derive from the atmosphere and clouds alone, enough water to supply all they retain, and all that they discharge in rivers.

There are some other circumstances not yet mentioned, or but slightly referred to, that seem to add to the power of swamp soils to attract and retain moisture, and t' ence to supply greater and continuing and regular quantities to the issuing streams.

When peat has been formed, the proportion of water absorbed and held, in the ground, will be more and more increased, compared to the quantity lost by evaporation, in proportion as the peat is increased in thickness. This substance, when dry, will absorb and hold a very great quantity of water. For trial of this power, I filled with peat a tin box, after having punctured many small holes, (outward) through the bottom. Water in excess was then poured over the peat, and the box left to stand on a support which permitted the superfluous water to pass away freely. After four hours, and when all dripping or exuding of water had ceased, the peat was weighed, and (deducting the known weight of the box,) made 5463 grains Subsequently it was carefully dried, and as thoroughly as could be, (though certainly not perfectly) and it then weighed 1087 grains. Thus this peat had absorbed and retained, rather more than four times as much weight of water as the weight of the dry peat.

But, on very broad and nearly level surfaces of peat, there is not only as much water held as the peat can permanently retain, by its great absorbing force, but this certain quantity may be greatly increased, for transient though long times, during which, this extra quantity of water is slowly working its passage by percolation, and nearly on a level, to find issues for discharge. Thus, the heavy rains, which, when falling on other lands, speedily pass off, on a peat swamp would be received into the before saturated soil, and the excess might not be entirely pushed out into the distant depressions and rivers, for months thereafter. And thus, by this long detention of any surplus of rain water, more than the peat can permanently retain, the supply to the sources of the rivers is equalized, and their volumes kept nearly uniform throughout both dry and wet seasons.*

The tall and far spread forest growth of the great peat swamps

* The recorded account of the remarkable circumstances of "Solway Moss," a peat bog in Cumberland, England, offers a striking illustration of the immense surplus of rain water which peat bogs are enabled to drink up and retain for a time, over and above the very large proportion of water which they retain permanently and strongly. This account was published, soon after the occurrence, in the "Scots' Magazine," for December 1771, and re-published in the "Farmers' Register," at p. 504 of Vol IV. Solway Moss (or bog) was about two miles by one and a-half, containing some one thousand four hundred acres. The surface of the bog was elevated at from three to nine feet above the level of the surrounding firm, and cultivated land. After a remarbably wet season, when the deep peat soil was surcharged with more rain water than it could retain even for the usual slow discharge, the coat of the distended bog bursted like a huge tumor, on its lower side, and the fluid mire flowed out, like liquid lava from a volcano, and covered over the adjacent farms and tenements. Within twenty-four hours, four hundred acres of rich arable land was thus covered, to the depth of from three to fifteen feet—and afterwards, the extended flood of peat mire covered as much more land, or eight hundred acres in all the previous home and place of agricultural labor of one hundred and ten inhabitants. The remedy proposed was to drain the new or transported peat, at a future time, and then to burn it off, to uncover the buried lands—and also, to drain and burn the remaining old bog, to prevent a recurrence of the like disaster.

in this country serve to attract the clouds, and to make rain thereon more frequent and abundant, than on lands generally cleared for tillage. The universally wet saturated soil, however retentive of its water, would still furnish much to evaporation; and this, going on under a dense shade, of tall trees and thick undergrowth, and where the wind could scarcely penetrate, to remove and change the stagnant air, would keep the air always humid, and ready to discharge its surplus load of moisture, in dew, on the same ground.

The surplus water supplied by rains, which the surcharged spongy peat soil could not imbibe, or retain long, would seek for the lowest passages to lower places of final discharge. When flowing over the swamp, these sluggish waters would wind about, and be continually changed in direction, by the numerous obstructions presented on the generally leval surface. Channels, thus formed, would necessarily be very crooked, and no broader (or deeper, at first) than the usual volume of the passing water required. As water thus passing over the surface, soaking through the thick carpet of bog moss, or more obstructed by exposed roots and fallen trunks of trees, would make very slow progress, these supplies also would be so protracted, as to render their several discharges continuous, and more regular than that of any small streams proceeding from and through dry lands.

In time, the channels or beds of these smaller bog streams would be always covered by water, and of sufficient depth to prevent any moss, or other larger plants growing therein. Then would begin another incident or process, of the general peat-bog formation, of which the effects are everywhere to be seen, and have been deemed unaccountable. The channels of the sluggish streams, which rise in and pass over the great bogs, and serve to discharge their black waters, are not only crooked and narrow, but generally also deep, out of all proportion to the greatest amount of water which it is the only function of these channels to convey and discharge. A depth of ten feet is not uncommon, and in some cases it is thirty feet, where one foot would be enough to pass all the water that ever flows along the channel. As these streams must have worn their own passage-ways, originally, why was this great depth of excavation made so uselessly? And how could it have been made, by so little water, flowing so slowly, and to depths so much below the present surface level of the neighboring waters—and in many cases, lower than the height of the ocean tides?

The depth of these channels of swamp streams and rivers, compared to the elevation of their peaty margins, must be due to one or both of the two different causes. The first in operation, is the manner of the growing of the living moss, and the formation of peat by its decay. The growth extends and presses to the very edge of the water, but cannot spread farther in that direction. Thereafter, the growth, by the deposition of dead materials, is extended upward only. Thus, the elevation of the margins, or banks of the streams continue to grow in height (with the peet surface generally) while the bottoms of the channels, having no such additions, and also receiving no alluvial or other earthy matter, remained as low as at first, or nearly so.

So much for the depth of these channels, compared to the height of their present banks, and the surface generally of the peat. But their depth below the level of the neighboring open waters, and in some cases even below the sea-water, needs another producing cause. And this is furnished, (and also other strange facts are explained,) in the supposition of a former subsidence, including the whole of this great swamp region, which occurred in long passed time, but much later than the beginning of the peat formation. I will proceed to state some of the many proofs, which, in my opinion, go to establish the fact of extensive and considerable subsidence.

In many parts of the swamps, in the digging of canals or deep ditches, the trunks of dead and fallen juniper or cypress trees, and also stumps, showing the crown, or junction, of the upper roots, have been found to the greatest depth reached in the peat formation. This, if presented alone, would only prove the gradual growth and deposition of the materials, and accumulation of the peaty soil, as already assumed and mentioned. The heart wood of juniper and cypress, when thus buried, is indestructible by rotting. Therefore, peat may have been forming for thousands of years, and have gained many feet in higher growth and thickness, since the oldest of these trees were prostrated. But in many cases, these trees and stumps, indicating clearly the former much lower level of surface on which these trees grew, are found under ground of which the present surface is too low to bear such trees—and, also, at levels lower than the present height of the salt water of Pamlico sound, and (as inferred,) below the height of ordinary flood tide of the nearest part of the ocean. Of course no trees could have grown, or any peat have been formed, so low—and, therefore, the peat and the earth below, with all it bore, must have subsided below its former level. In the canal extending from the border of Mattamuskeet lake to connect with Alligator river, in the "savanna land," the surface of which is not eighteen inches above the height of the water, and which surface is now too low for even junipers to grow on, the standing stumps of juniper trees were found at some depth below the present surface, and also below the level of the surface of the water, as kept up by the height of the back water of Alligator river.*

In addition to this proof of former subsidence, furnished by nu-

* After the writing of this article, I heard from Col. R. T. Paine, of Edenton, North Carolina, of another class of facts which still more fully prove subsidence in this region. Albemarle sound is from eighteen to twenty feet deep, and all the broad rivers and large creeks which empty therein are still deeper. In all these rivers and creeks, to the depth of twenty feet, or more, there are found upright stumps of trees, imbedded and firmly fixed by their roots, in the bottom and in their natural position, so as to be evidently now in the soil where they grew. The like stumps are in the bottom of Albemarle sound, and in Pamlico sound, and in water of as great depth, where such depth is found. The numerous and long fishing seines sweep over the bottoms of nearly all the deep waters of the rivers, and of large spaces of the sounds, and more than a mile from the shores. The necessity for cleaning the bottoms swept over by the seines, has shown the vast number of the submerged stumps, and their deep and fixed position. In deep water, the stumps are blasted, and loosened in the earth, by gunpowder. They are most numerous on bottoms where projecting points of swamp forest (now standing) extend to the water—and in such cases, the stumps taken from beneath the water are of species similar to the neighboring trees, of cypress or juniper. In some cases the stumps were of pine trees. Col. Paine saw a number of large stumps which had been recently taken up from below water twenty feet in depth, in North river, which enters the Albemarle next to Currituck sound. All these facts clearly prove subsidence of the original swamp surface, to as low as twenty feet below the present height of water of the sound—and nearly as much below the surface of the ocean.

merous facts such as stated in the foregoing passage, there were learned others, still more decisive, which show a still earlier and lower subsidence of the earliest formed peat. The only means available near Lake Mattamuskeet, for learning the kinds and changes of earth much below the surface, were offered in the excavations for wells. As the subject, in this aspect, had excited no interest there, no person had given to it such attention, or had accurately measured the thickness of the different strata penetrated. Still, as almost every person had dug one or more wells, and had general remembrance of the series and kinds of earth dug through, there was much information to be had, I heard particular statements of but few such diggings; but most of these were of very recent excavation, and of two of which the earth taken out, wholly or in part, still remained around the wells, unchanged even by rain, so as to show the most important specimens.

The wells dug on the drained swamp lands generally yield enough water, (but rarely otherwise than of bad flavor,) within twelve or fourteen feet of the surface; and no more depth was sought, except to make a reservoir below, deep enough to retain water to draw from at all times. Therefore the wells are rarely more than fifteen feet deep. The lower strata are not always alike. But generally, after penetrating through the universal upper peaty soil, and which varies in thickness from eighteen inches to more than six feet, (usually about three feet) the digging for each well reached compact and dry sand, like that at the bottom of the lake, and afterwards, a quicksand or mire, apparently formerly a marsh soil, and containing remains of rushes. A firm and tough mixture of sand and clay, (not mixed intimately,) is in some cases next to the upper peaty soil, in place of the almost pure sand which has the same position in other neighboring places. And this clay, as it is there called, is reached in some parts of all ditches of three or three and a-half feet deep. I belive that it is this same continuous bed, in some cases more of sand, and in others, clayey, which underlies the surface-soil, or upper peaty formation, throughout all the swamp region around Lake Mattamuskeet. There are other beds of lower earth often met with, which are not general. When wells have been dug as low as eighteen feet, oyster shells have sometimes been found at about that depth—which would show that there had been once the bottom of the sea, or a salt-water estuary.

But the most remarkable fact learned, was of two wells recently dug on the highest ground, which is called the "ridge." This slight elevation is narrow, and runs from Lake Landing, where it parts from the former margin of the lake (before it was partially drained,) in a curve, like the arc of a circle, and unites again with the old border of the lake, at seven to nine miles distance. The peaty soil on this ridge is thinner, (in some caces not more than twelve inches thick,) and the next layer below is of nearly pure and fine sand, precisely such as makes the bottom of the lake. Yet within a short distance from, and parallel to this "ridge," the upper swamp or peat soil is the thickest thereabout, being six feet or more. Of the two wells recently dug in this ridge, one had been excavated and observed with care, and of the other, the recently dug earth still was lying around, and subject (as well as specimens before preserved) to my personal examination. The latter (Dr. Sparrow's well,) passed through

(*a*) 1 1-2 feet of the ordinary black peaty soil—

(*b*) 4 1-2 feet of dry sand, firm, very fine, white, and pure, except having many thin *laminæ* of former fine peat sediment, each one soon running out to nothing, This sand, on a perpendicular section, shows numerous fine waving lines, as if of sediment left by water in gentle motion—

(*a*) 4 feet of black soil, part of pure peat formation, containing small roots, and the earth "in places," or where it was formed—changing to more clayey—and next

(*b*) 0 1-2 foot clay—and next

(*c*) quicksand, (or soft and fluid marsh mud, with water.

Mr. Ensley's well, (the deepest known,) near to the same ridge, and within a mile of the preceding.

(*a*) 7 to 8 feet of the usual black rich soil, peat formation. (Close by this layer is only one foot thick.)

(*b*) 2 to 4 feet of firm sand, described (as *b*) above—
1 to 4 feet more clayey, with some water—
(*c*) 4 feet of quicksand, or soft and sticky mire, with many small roots
(*d*) 4 feet of firm blue clay, of very fine texture, and cutting smooth like hard soap—interspersed with some thin *laminæ* of fine black peat sediment—and some roots of trees.
(*a*) 1 foot into black peat earth, without seeing any change ——thereof.

Twenty-three feet dug in all. The next morning after the last digging, there was so much water in the well that its deeper digging (as intended) was prevented.

In both these cases, true peat was found in lower and more ancient beds, and separated from the upper and newer peat, by beds of sand and clay, (and also other earths, in one case). These interposed beds of sand, &c., may have been of sedimentary or drift deposit—or, otherwise, they may have been thrown over by the waves of the ocean, and of matter swept from its then higher bottom. There is much to support the latter view. The extreme fineness and purity of the sand—its laminated structure, the wavy lines of *laminæ*, and the very thin layers of fine peat sediment, would indicate deposits made by the water of the ocean, or of the sound—and which deposits filled the void produced by the previous sudden subsidence of the land. Nothing but the entire absence of any remains of sea-shells in this sand seems to forbid the conclusion that the sand placed over the older and subsided peat, and below the upper peat, is of oceanic origin. And, on this supposition, perhaps the absence of old sea-shells may be satisfactorily accounted for. First—if what is now Pamlico sound, was then as now partially separated from the ocean, by a sand reef, then the sound waters would (as now)have but few sea-shell fish, and therefore could supply but few sea-shells in the sand. Next—even if shells had been more abundant, their long exposure to acid peat waters, with peat both below and above, may have caused the shells to be disolved and disappear.

In a short time after the last sentences were written, I learned from observations made elsewhere, to attach still less importance to the fact of the absence of remains of sea-shells, as negative evidence against the former oceanic formation of land. On the broader part of the sand-reef, of North Carolina, on which stands the small village of Portsmouth, near Ocracoke Inlet, the soil, as of the whole of the long reef, unquestionably has been formed by sand thrown up at first by the waves of the ocean. On the interior, lower, and more recently formed and lower surface of the sand, which is still often covered by the high storm beds and waves of the ocean, there have been thus brought numerous shells of dead sea-fish. These shells must remain there, and be covered, in the course of time, by later accessions of sand. Though sea shell-fish are scarce on that part of the coast, and of course the dead shells, yet the continued slow supply is enough to make them very numerous on the lower and more recent sand flats. Yet on the higher and older ground, about the village, which had the same original formation, no remains of sea-shells are to be seen. And, in answer to my inquiries, I was then told that no sea-shells were ever found in digging any of the many shallow wells (rarely more than three to four feet deep,) which are dug in the village. If half of the former supply had remained, some would have been found in every such digging. The shells must have been dissolved, and made to disappear, by the operation of some chemical solvent power in the earth. In Pamlico sound, though it is salt water, there are no sea-shells ; or, at least, I could find none on the shore of the sound near Portsmouth. Yet this should be a place most favorable to the presence and continued existence of the animals—because it is within two or three miles of Ocracoke Inlet, which has long afforded a broad passage for the entrance of the ocean water, at high tide and in storms, into the sound. The only shells which I there found were of a few species of animals belonging to estuaries of brackish water.

In these sounds, then, we may be sure of the former presence of sea-shells, and of their later total disappearance, without being able to assign the cause of the remarkable change. But as to the same change in peat soils, or in the sands below peat beds, and always wet with the peat water, the sure means for the entire disappearance of shells (if any had previously been present,) are not only easily to be conceived, or supposed, but are even unavoidable. According to the grounds I long ago first assumed, and the reasons then offered, for the existence of vegetable acid in many ordinary soils,* there are still stronger evidences of the universal and larger formation of such acid in peat and peaty soils. It was supposed by earlier writers, and of higher authority, that these vegetable soils contained acids, vegetable and also mineral, before there had been any assertion or suspicion of there being any acid in ordinary soil, of principally earthy constitution. And since the doctrine of vegetable acid in soil (other than peaty,) has been generally accepted, and fully admitted, by agricultural chemistry and scientific agriculturists, it is in peat that all of these would seek for the most certainly existing and largest proportion of vegetable acid, or the material of which it would certainly be formed at some later time, if natural causes were permitted to continue in operation. Therefore I need not adduce proofs or cite authorities, other than generally to Thaer, Johnston, and other recent and distinguished agricultural chemists, to sustain any position that peaty soils more largely than any other soils, are always impregnated by vegetable acid—and, of course, likewise the water passing through them, and blackened by other extracts. Sulphuric acid has also been supposed to be sometimes an ingredient of peat—which combining with iron, (always present,) would favor sulphate of iron, or copperas, which is a poison to useful plants. With these acids, or acid products, always present in peats, it is very sure, and easy to be understood, that any shells, or other carbonate of lime, in small quantity, below the peat, and exposed to its water, would be certainly decomposed, and no longer be visible.

It would seem, from these grounds, that the swamp waters, which have oozed through the peat soil, and which, as manifest both to sight and taste, are so full of its soluble matter, ought

* In 1821, in the first publication, as in every later edition of the "Essay on Calcareous Manures."

also to retain free acid, and which any capable chemist could easily make manifest. But I have never heard of a proper trial by competent hands, nor of any such result reported. The water is all more or less impregnated, and its taste affected, by vegetable extracts—but in very different manner. The water of Lake Drummond, though very dark colored, is perfectly clear. The strong flavor communicated to it by the juniper trees, is not disagreeable, and is even palatable to many who have been long accustomed to its use. In other swamp lakes, and in many particular places, the water varies in color and flavor. In some wells, the water is unfit for drinking because of its bad taste. In some, it even seems slightly acid to the taste. From one of these (near Fairfield, on Mattamuskeet,) which is called "the sour well," I brought a bottle of the water home, to test it by litmus paper. But it did not redden the paper —and, unless there was something wrong in my rough trial, it is to be inferred that there was no uncombined acid present. There are other proofs of the general presence of acid in the water of the Dismal Swamp canal, which is supplied by a feeder from Lake Drummond. I was informed, by the President of the canal company, that the iron hinges and other iron parts of the lock-gates are reduced and destroyed by corroding very speedily, compared to the same operation in any other known canal. This greater effect can only be the result of the presence of acid in the water, or of some combination of acid that is readily decomposed to make a new compound with iron.

This inferred infusion of acid, and in all its bearings, should be well considered in reference to the scheme now in agitation of bringing higher lying Dismal Swamp water, through pipes, to supply Portsmouth, the Navy Yard, and the shipping, for all purposes. The scheme is perfectly and easily practicable—the supply would be abundant for every purpose, (including the filling the dry dock,)—and the water of sufficiently good quality. But if there is any acid inpregnative, it would combine with and soon consume metal pipes—and perhaps thereby form salts, and to be passed off in the water, that would be injurious to health, if not even poisonous as drink. The substitution of earthern-ware, or tile pipes, would serve to avoid this danger, if the cause of such danger exists. But I have been led to digress from my argument to maintain the former subsidence of the lower peat—which will now be resumed.

Whatever may have been the manner, or cause, of the depositing of these interposed beds, separating the lower and upper beds of peat, that difficulty does not affect my position, viz: that the oldest peat, formed necessarily higher than the level of the ocean, or the sound, had subsided below its former level, and also below the level of the sound and ocean waters. The present low level of the ancient peat places this position beyond doubt.

The lower peat, as seen in specimens, in its materials, texture, and other marks, exhibits every appearance of peat in its original place of growth or formation. If it had been a deposit of peat sediment or fragments, which might have been washed off from a higher bed and carried into low depths of the water, and there deposited, the appearance would have been entirely and unmistakably different. Such sediment, washed up and suspended by the water of the lake, is continually carried along the course of the canal, and deposited by the more tranquil water, along the sides of the canal, and in Wysocking bay, into which the canal empties. Both the canal and the bay are thus much obstructed. The bay for some 70 acres, is already filled by this sediment to the depth of five feet, and the port, already much injured, will soon be unfit for vessels to enter. This peat sediment is divided into the finest parts, and when dried, is of uniform loose texture, much like fine black snuff.

These two wells, only, showed the older peat below, separated by beds of sand, &c., from the upper and later formed peat. Of two other diggings, (which were made merely for my examination,) the strata will be also stated. On the lowest part of the then exposed or dry sand, of the former bottom of the lake, (now laid bare, by its partial draining,) a pit was dug 7 feet deep—on a level 3 to 4 feet lower than that of the surface of the nearest peaty soil, (under cultivation,) bordering the former outline of the lake—and full 4 feet higher than the level of Pamlico sound. The strata reached were

(*b*) 2 1-2 feet of firm and fine white sand, the general bottom of the lake—laminated in their wavy planes, often separated by other thinner *laminæ*, of limited superficial extent, of fine peat sediment—with which, as light suspended matter, the reduced water of the lake is always turbid—

2 1-2 feet of wet sand, yielding some water—

(*d*) 1 foot of firm compact blue clay—

(*e*) 1 foot of same in thin layers, more and more thin as descending, and separated by thinner layers of sand. Rotted rushes and their roots therein. When dried the clay layers parted, showing pure sand between.

The thickest of the clay layers one fifth, and the thinnest one sixteenth of an inch. The sand between still thinner.

On the farm of Dr. M. Selby, at 1 1-2 miles from the above, and not a mile from the former margin of the lake, another pit showed these strata:

(*a*) 2 feet of usual rich peaty soil—

(*b*) 3 feet of usual intermixed sand and clay, separated, but not laminated—-

(*d*) 1 foot of firm and compact clay.

(*e*) 1 foot of laminated clay and sand, as of the preceding, (*e*,) but less regular.

Wherever the same kind of bed (as seen or reported) occurs in these different diggings, it is marked as similar, by prefixing the same letter—as *a* for the peat formation—*b* for the bed below the upper peat, whether of nearly pure sand, or elsewhere mixed with clay—*c* the quicksand or mire of former marsh deposited, &c.

From extensive personal observation, and inquiries directed to particular points, I conclude that the sand bottom of Lake Mattamuskeet is the same bed, or of the same geological origin and formation, (whether derived from the ocean, or sedimentary drift,) and identical with the bed every where hereabouts underlying the upper peaty soil. That it is sand in some places, and clayey in others, is no contradiction to my position. Where impure clay thus appears, that and the sand are imperfectly and irregularly intermixed (not laminated,) and seem as if sand and clay had been torn up from different neighboring places, by violent action of water, and again let fall, after a movement too short to produce either thorough separation or intermixture. Where the sand is nearly pure, as in the now dry part of the bottom of the lake, and as shown in the wells on or near the "ridge," there are plain indications of longer suspension in water, and of deposition from water having but gentle motion.

In the last pages, sundry incidental or connected matters have been brought in, which were not necessary to sustain the position of extensive former subsidence in this swamp region. The facts stated (of sand &c., interposed between the older and newer peat formations,) further prove that there the subsidence was sudden, and to a depth below the then ocean level. And, inasmuch as the upper peat bed or soil of the(long drained) lands of Mattamuskeet, is so thin, (from one to seven feet, and usually about three feet thick,) it may be that if enough deep excavations were made and observed, a more ancient peat formation might be discovered throughout, below the sand and clay beds. It should be observed, and is in accordance with my reasoning on the general subject, that the natural channels of rivers and smaller streams, (described as so deep elsewhere,) could not have been formed deeper than the bottom of the upper peat, or low- than the next underlying bed of sand or clay. Hence, as the upper peat here is usually thin, so the natural channels were as shallow at first,—and have been further much filled, within the memory of those now living, by sediment from the always turbid lake-water, or other sources.

Elsewhere, the former subsidence of the land is as clearly shown by existing facts. But there, instead of a sudden and considerable subsidence, (making a void below the surface of the ocean water, and even below its neighboring shoal bottom, inviting and requiring materials to fill it, to be transported from higher surfaces—as occurred here—the ancient subsidence of all the now thick peat beds was very slow and gradual, so that the surface was never sunk much below the standing height of the water, and therefore the production, deposit, and accumulation of peat, at the surface, was never suspended or interrupted. Therefore, while the whole area, and the underlying beds, were gradually subsiding, through great length of time, the surface of the peat, and to the very edges of the water courses, was still growing upward. Of course, with such gradual and nearly balanced subsidence and upward growth, the bottoms of channels, would become lower, while the waters in them, and the banks confining them, would be continually rising higher and higher—not absolutely, but in relation to the bottoms of the channels, and the earlier formed and lower portion of the same peat bed.

Having disposed of the facts and phenomena of subsidence, both sudden and gradual, I will now resume the consideration of the progress of the peat formation, and of the swamp earth and soils.

Whether the progress of peat formation, in any particular area, continued uninterrupted during the gradual subsidence of the land —or whether it was there suspended, by the sudden submersion of the surface, and re-commenced at a much later period, in either case, the later manner and progress of the formation would be alike. I have already traced that progress to the supposed great extension, in depth and breath, of the peat formation, and the higher accumulation on the interior or central parts—the causes and manner of structure of the peculiar and deep channels of water-courses, and the still increasing supplies, and sources of supply, of the waters rising in and flowing outward from the swamps to find outlets of discharge, it may be through dry and firm but lower lying lands. It has also been shown, from the manner of their formation, why the great swamps should be of highest level in their central parts. From this general shape of surface, there has proceeded the very important and modern operation of the action of fire, in modifying the natural characteristics of the peat swamps.

From the central part of a great body of swamp being of the highest level, and receiving no water except from rains falling immediately thereon, it would be a necessary consequence, that, in long continued droughts, these highest parts would become much dryer than their usually water-glutted state—and that the newest vegetable deposits on the surface, and even a few inches depth of the surface soil, would become dry enough to burn. Such temporary condition would cause no permanent effect, or danger of burning, before the existence and residence of man, and his use of fire. But afterwards the highest and dryest surfaces could not long escape being fired. Fire, when first occurring, and in a time of long previous drought, on the highest and then dryest space, might find dry fuel for some foot or more of depth. In the burning of this, the great and long continued heat of the smouldering fire would so dry up the moisture of the next layer of earth as to make it also fit for burning. Thus, deeper and deeper the burning might descend and destroy—each successive wet layer being dried, and rendered fit for fuel, by the heat of the burning above. In such time of drought, no refluent streams could come in to quench the fire. For the nearest surrounding surface, though then too wet to burn, was of higher level than all the still more remote or exterior parts of the swamp, and therefore could receive no streams from these outer parts. Thus, the burning area was surrounded by a broad and secure dyke, to keep out all the water of the swamp. No ordinary rain, falling upon the burning space could enough moisten the earth to stop its burning. And thus would the burning proceed, gradually sinking deeper and deeper, until reaching the bed of sand below. In this manner, must have been formed all the basins for the now existing lakes in the great swamps—by burning out all the former materials which filled the entire cavity—which was subsequently filled with water, by rains, and rain streams from the neighboring high swamp borders of the new lake. In the bottoms of all the lakes, charred roots and stumps are to be seen; and in some parts of the swamp, layers of ashes, some feet below the surface, covered over by more recently formed peaty soil.

When large lakes had thus been formed, as deep as the sand below the peat formation, new agencies of change were brought into operation. The high waves produced by violent winds, dashing against the banks of the lake, would wash into them, and remove them in time, and especially on the sides most exposed to high winds. The swamp earth thus washed off, and suspended in the water, would be, in part, lifted by the waves, and spread over the remaining and nearest high swamp surface, and thus serve still more to elevate the land bordering on the lake. The remainder of the fine and light peat washings, would be intermixed with the fine sand of the lake bottom, (itself liable to be moved by storm waves,) and deposited in sediment, and in thin and interrupted *laminæ*, when the lake was nearly tranquil. Numerous examples of all these operations are to be seen. If the standing trees and their interlaced roots did not serve to bind together and preserve the banks of swamp soil, it would be much more rapidly washed away by the violent waves—and in this operation, we may even anticipate a future greatly increased superficial extension of the lakes, where not lowered by artificial draining. But with this process of superficial extension, the depth of the lakes will be decreased, if the washings from the banks are partly left in the lake and without a channel to flow out. The artificial canal which has lowered Lake Mattamuskeet some four feet, and laid bare a broad and flat margin of its former bottom, has supplied such a channel. And as above stated it is continually bearing off the fine peaty matter, washed up from the still covered bottom, and suspended in the lake water, and with it, choking the first reached bay of Pamlico sound. The water of this large and very shallow lake, only, is always turbid, and is made so by this suspended fine peaty matter. Lake Drummond and Lake Scuppernong, the next largest in surface, and both much deeper than Mattamuskeet, whenever I saw them, were perfectly clear as to all sedimentary matter. But still, because of the infusion of soluble vegetable extract, the clear waters of Lake Drummond are as deep colored as Maderia wine—and as seen in the lake, or the deep swamp canals and rivers, seem almost black. The water of Lake Scuppernong is but slightly colored.

The warmth and length of our summers are so favorable to vegetable decomposition, that peat must form and increase here very much slower than in Great Britain—and the different manner of the formation is the cause of the very different agricultural characters of the peat soils of the two countries. It seems, from the British writers on this subject, that the peat of their country is mainly composed of entirely undecomposed vegetable fibre, of course insoluble, and therefore inert as a fertilizer, or ingredient of soil—or with but an extremely small proportion of decomposed and soluble matter, fit for early use as food for plants. The peat soils of Britain in some cases cover remains of ancient forests—but are now unable to sustain a living tree. The undecomposed and insoluble state of the peat, of these countries, is owing, not only to the cooler summer climate, but in part to the great quantity of the tanning principle in the moss plants from which the peats there are principally formed. Bodies of both men and beasts, that have been mired, or otherwise buried in peat bogs, have been discovered centuries afterwards, (as proved by the ancient fashion of dress, &c., of men and women,) perfectly preserved, and perfectly tanned. No such results have been heard of in this country; and there must have been numerous subjects for trial, in mired cattle, if not also in buried human bodies.

The larger portion of the vegetable growth, and subsequent deposits on our peat lands, is of trees, or of plants other than the moss, which is an important, or considerable growth only of the juniper lands, or of the savannas bare of trees. The nakedness of these savannas in many cases is produced, and in modern times, by the upper soil being burnt off, and the trees killed, and, by the burning, the surface of the soil being reduced so low, and made so subject to water, as to be unfit to support the growth of trees. Or it may be that the soil (in other cases) is too exclusively composed of undecomposed vegetable matter, to permit trees, or any useful plants, to be supported. This would seem to be the case on the great "Open Ground" savanna in Carteret county, North Carolina, (a body of nearly ninety thousand acres,) which lies high enough, but of which the soil contains less of earth, or even of reduced vegetable matter, compared to the unrotted and coarse, than any other peat or swamp soil that I have examined. The annual or very frequent recurrence of fires sweeping over the surface, though consuming only fuel lying on the wet surface soil, must also prevent the growth of trees, because the young shoots are continually killed above ground, until the roots also perish.

In the great swamps, the kinds of trees growing threon are deemed sure indications of the qualities of the soil, after their being drained for culture. The best lands, of the peaty formation, and of longest abiding fertility (under the usual increasing cultivation of corn,) have black gum for their principal natural growth. That growth indicates the near proximity (within a few feet of the surface,) of a sub-soil more or less clayey. A mixed growth of gum and cypress trees, is held next but less in value, and still less as the gums are fewer in proportion to the cypresses. All the foregoing lands, when drained, are extremely rich, highly productive (in Indian corn) from the beginning, and bear continual cropping for long time. No one has ever thought of manuring such lands, at first—and not usually even after long cultivation, and their being much reduced in products. The juniper lands are composed of unrotted peat nearly pure, and of but a very small proportion of well-decomposed vegetable matter—and that which is decomposed, before draining, is a black semi-fluid mire or sludge. The underlying earth of the juniper swamp land is said to be always of sand. Some of these lands (near the Dismal Swamp canal,) have been drained and cultivated, and produced heavy crops for a few years only. But afterwards the plants would not grow with any vigor, and would die before attaining half their full size. It is now generally understood that juniper land is worthless for cultivation. The savannas, or peat swamps bare of trees because too low to allow them grow, are worthless for any purpose.

After all, it is a mystery to me, why even the best of these peaty lands, of which still the larger proportion of their bulk is of pure vegetable matter, should possess so much and such durable fertility. In appearance, to the eye and to the touch, I found the best newly drained soil of Mattamuskeet swamp, to be precisely like the highest (and wooded) fresh-water tide marshes of James river, Virginia, such as I and many other persons have embanked, drained and cultivated. And these tide-marsh lands, which, at first, were of the highest grade of productiveness, in a few years so rotted away, and were thereby so lowered in height of surface, and therefore made so moist, that they were no longer worth cultivating. In fact, all the moss rotted away until the remainder was so low, and therefore permanently wet, as to resist the further progress of decomposition.

From my personal, and dear-bought experience, and from far more extended observations, of the rotting away of embanked marsh soils, (which are but peat soils of a different manner of formation, and much less elevation,) I had inferred that all other peat soils would pass through the same course; and, though requiring much longer time for the purpose, would finally reach the like end. I had supposed, that whatever in soil was of vegetable matter, (not in small and necessary proportion, and combined with the soil, but) separate, or pure enough to be readily consumed by burning, could, and in time would, be equally consumed by rotting, and complete decomposition, of which the final gaseous products would pass off and be lost in the atmosphere. But I am compelled to yield this opinion to the opposing experience of fifty and more years, of continual tillage on the Mattamuskeet lands, longest drained, and to the universal opinion of the oldest cultivators. Probably the truth will be found between the two extreme and conflicting opinions. No careful or reliable observations have been made, to test the question of the lowering of the surface, by the rotting away of the vegetable portion of the soil. And my confidence in the general opinion of residents in this respect, has been much lessened, by hearing other opinions as confidently urged, which were manifestly erroneous.

Most of the higher, and therefore the better lands, around lake Mattamuskeet, are drained and under tillage. A few extensive and very valuable farms have been drained and cultivated for many years on Lake Scuppernong—and still less land has been reclaimed of the main body of the Dismal Swamp, and none of its interior portion, near Lake Drummond. But all these, and others smaller of such improvements in other places, make a very small proportion of the good peat swamp lands. Besides the juniper lands, which are deemed worthless for cultivation, there are extensive bodies of cypress lands, owned by wealthy companies or individuals, who deem it more profitable to use the swamps to produce cypress shingles and timber, than to drain and clear any portion. The juniper trees are very valuable, for furnishing shingles. Every deep burning of any portion of juniper swamp, exposes numerous dead but sound trunks, before buried and concealed, from which much shingle timber is obtained. Thus though the great fires, which occur after almost every unusual drought, kill the living trees, and burn and destroy much of the upper earth also, they are often the cause of exposing much greater values, in the before buried juniper trunks.

When destructive fires occur in drained or cultivated soils, they usually proceed from the burning of some dead tree. The fire extending downward, follows the dead and dry roots, under the ground and from them the lower earth takes fire, and burns beneath the surface; and the burning may be concealed, or its extent not known, until the upper soil falls into the cavity burnt out below. The upper soil, being most decomposed, is much less combustible than the lower earth.

When new and untilled but drained soil takes fire, the burning is more extensive and destructive. A surface long tilled is comparatively safe. Fields under growing corn, recently first tilled, have been burned extensively, destroying the crop, and also much of the soil. A public road was made near Lake Mattamuskeet, the material for which was the earth taken out of a canal alongside, and which was dug to supply the earth. The bed of sand was near enough to the surface to be dug into, and furnished the latest dug and upper covering of the road. Fire, communicated from the adjacent burning savanna, burnt underneath the road—and before it was suspected, the horses of some travellers, by their weight had broken through the sandy crust of the road, into the cavity below, which the concealed fire was still enlarging. In these cases much effort, and the labors of many hands, were required to extinguish the concealed, still more than the visible fires.

There has been one mode or process of peat formation, of very extensive operation, which has not been treated in the foregoing remarks. This is the formation of peat, or peaty swamp soil, under water. This process is usually commenced by the deposition, in the stiller deep waters, of fine vegetable matters suspended in the water, and transported from other and perhaps distant sources of supply. And of such may be the principal, or perhaps the only materials, until the deposit is raised nearly to the level of lowest covering water. But when water-plants can there grow, they will furnish additional and more abundant supplies of material—and thenceforward, the growth of the peat-soil will be much more rapid. When the surface of the peat is entirely above the water, then there can be received no more of transported materials—and thereafter, the manner of growth of the peat will be like that of peat of land origin; and either will be forwarded or retarded by like causes. In this manner were formed all the extensive marshes of the tide-water rivers of Virginia, of which the soil is peat, and of the most transient durability, or existence when drained. The cultivation of but a few years will serve to rot away half as many feet, of depth of the soil as had been rendered dry, and open to the entrance of air. In Wysocking bay, (part of Pamlico sound,) there is now such a process of peat formation in the early stage of progress, the sole material deposited being the fine peaty matter, always suspended in the water of Lake Mattamuskeet, and which is thence floated through the canal to its outlet in Wysocking bay, and which bay is now being rapidly filled by the deposit.

Of the later part of this process, after vegetation can begin to act, I am enabled to offer some examples in the words of an intelligent and accurate observer whose opportunities for and habits of observation have afforded the best evidence, on this particular branch of the general subject; and of which I knew almost nothing from previous information or personal examination. The following statements, were contained in a letter from the Hon. Robert T. Paine, of Edenton, North Carolina, who had previously read the foregoing pages, and which, with our preceding conversation, elicited the following interesting facts, which will be best presented in his own words, in the following extracts:

* * * * * "I could detail many facts, in proof of what you have written as to the origin and manner of formation of peat soils, by the gradual deposition of undecomposed vegetable matter, grown in water, or on wet earth—which facts have come under my own observation. Twenty-five years ago, an arm of the creek which, from the west, comes into the bay in front of Edenton, was one of my favorite places for angling. It was then about forty feet in width, more than one hundred and fifty yards in length, and with not less than seven feet depth of water. In late years, this water had become too shallow for angling. Still it afforded me much sport in shooting, it being a favorite resort for wild ducks. Two years ago I visited the place, in autumn, and found it so obstructed by the increase of vegetable matter, that, at the ordinary height of water, I could not propel above half way up a light canoe drawing not more than four inches of water. In several places, and over what once had been the deepest water, and quite one hundred yards below the head, swamp willows, at least two inches in diameter, were growing on knolls

some five or six feet across. These knolls were covered with very fine short grass. On forcing the canoe to one of these knolls, I found that I could depress it several inches by bearing on it with my foot; yet it would support my entire weight. Under the surface of the water, and three or four inches deep, was vegetable sediment, or deposit, which, when taken upon the paddle, resembled rotten oakum—and throughout the bed, grew in masses, the roots of the pond-lily, or "bonnet" plant. You could not have forced anything of broad surface into this bed of vegetable matter; but the blade of the paddle easily passed through, meeting with no resistance. The pond-lily will grow to the surface from the bottom of a considerable depth of water—sometimes as much as seven feet—yet the roots have a tendency to rise, and do gradually come to the surface, until the plant at last dies for want of water above the roots. So soon as they reach the surface, or soon after, the seeds of plants and aquatic trees, falling upon the mass, take root and begin to grow, and thus the formation of marsh is begun. The weight of the vegetable cover, as it is accumulated, continues more and more to press down the soil, until, in the course of time, that which was fluid becomes semi-fluid, and, still later, solid. I would here remark that the accretion of solid matter could not have been aided, to any perceptible extent, by washings from the high land. I could multiply similar examples. But it will be sufficient to say that the like change from water to land is going on rapidly along the whole creek, [which is an arm, or bay of Albemarle sound,] wherever there is marsh, and particularly in the little bays or coves of the creek, which make up into the marshes. * * * * The accumulation of vegetable matter, by growth, in water of even considerable depth, is almost beyond calculation. I have seen the bays in the vicinity of Nagshead [on the sand-reef between Albemarle sound and the ocean] so completely choked with a species of growing salt-water grass, (and that where the water was six feet deep,) as to make the water stagnant—and the grass was so densely matted on the surface of the water, that the small sea-shore birds walked upon it."

SKETCHES OF LOWER NORTH CAROLINA, &c.

PART V.

NOTES OF THE NATURAL FEATURES, AND AGRICULTURAL CHARACTER AND IMPROVEMENTS OF PARTS OF THE GREAT SWAMPS.

In a preceding article a general description was given of the great swamp formation of North Carolina and Virginia. That description presented and explained the general and most important features and characteristics of thls remarkable region, as a subject of natural history—and with especial regard to the geological facts, as causes of the existing, or formerly existing, conditions. But details and minute particulars were avoided, or only stated when necesssary, as examples, or evidences, of the general propositions therein enumerated and argued. In this piece, as a sequel to the preceding, it is proposed to enter more into details of description, of various scattered localities which have fallen under the writer's personal observation, at different times—and not only of the original and natural features, but more especially the changed, and later and present conditions which have been produced, on some small spaces only, by the labors of man, in draining, and cultivation of the soil, and other connected improvements.

THE DISMAL SWAMP.

This great swamp, more than any other seen, has much the largest proportion of "juniper land," or surface on which the juniper, or white cedar, thrives best, and is, or has recently been, the principal, or exclusive, forest growth. The thrifty, and extensive or general growth of juniper indicates the wettest and most miry (or sponge,") soil, which is always the most peaty, or most exclusively of vegetable formation. These trees are the most valuable for timber, (in shingles especially,) and such land is perfectly worthless for draining and cultivation, because of its almost entire vegetable composition. Such land, and such forest growth, before its last and complete destruction by fire, made up the larger portion of the main body of the swamp, and nearly all of its interior land. This soil is deep, and is said to lie on a bottom of sand. Near to the outer margin, and bordering on the surrounding firm land, and between Suffolk and Elizabeth river, the swamp soil is not more than from one foot deep (nearest the outside) to three feet further in—with a more clayey bottom earth—and the forest growth is of black gum, or cypress mixed with gum. Lands of this kind only, and in small proportion, even of this kind, have been drained, cultivated, and found of abiding productiveness. It is through the outer edge of the swamp, and of the portion the least swampy, that the Seaboard railroad passes, for a few miles only—and in which, the hastily passing traveller, if not informed, would not suspect that he was then in the great Dismal Swamp. The Norfolk and Petersburg railroad, now [1856] in the course of construction, passes through another and larger line of the swamp, and more towards its interior— but still mostly over the outer and thinner deposit, of vegetable soil, and almost wholly through gum forest. The former route I examined through, on foot—and also the latter, so far as it was then accessible—and for a distance said to present a fair sample of the ground of the whole route through the swamp. The recent excavation and embankment for this railroad has served to open the soil and its foundation much better to examination. The soil (nearly all covered by gum trees, and therefore of the most earthy and solid constitution of all the swamp,) so far as seen is but two and a-half to three feet deep before arriving at solid and real earth below. Both these conditions, of soil and sub-soil, seem to afford more desirable materials than would have been available farther in the swamp. Still, I infer (from the large proportion of putrescent matter in the soil) that much even of this embankment must rot away, and that the level of the newly raised surface for the road will sink in proportion.

The most important and interesting route, for examination, and also for the facility and pleasure of the conveyance, is along the Jericho canal, dug and used for transporting shingles from the interior of the swamp, and the lake, to the landing, at a tide-water creek, near Suffolk, empyting into Nansemond river, where the large sea-vessels are loaded. The canal is closed at the end near the creek, and its level is there more than twenty feet above low tide-water. The canal was dug twelve feet wide, four deep, and is ten miles long to Lake Drummond, and perfectly straight nearly throughout. A regulating lock at the junction with the lake, serves to keep the water in the canal at a uniform height, when long droughts may have sunk the water in the lake two feet or more, lower than usual. The canal water is level, from the lake (or from the lock) to the landing; and the water being supplied from the swamp, has a gentle current from the central portion of the canal towards both its extremities.

The firm land near the landing, on both sides of the canal, varies from one to two, and for a little space is from three to four feet higher than the swamp surface.* The true swamp is soon reached, and from the remaining eight miles or more, along the canal, its margin, formerly a raised bank, is at most, but a few inches higher than the

* This description and difference of the respective surfaces is general, so far as I have seen, whenever the margins of the large swamps, and the adjacent firm land meet. The interior parts of the great swamps, are higher, and much higher, than most, if not of all the highest surfaces, of the surrounding and adjacent firm and dryest land. But immediately where the surfaces meet, the firm land is there the highest—and seems to have served as a dyke, or barrier, to restrain and keep back, to the present time, the further lateral spreading and growth of the semi-fluid swamp soil.

water in the canal, and also the water generally overspreading the neighboring swamp surface. The tow-path, for the men propelling the boat, merely afforded better footing by being trodden and consolidated—and by poles having been laid along for the boat-men to tread upon, where the more depressed surface was covered by water. The peaty earth thrown out of the canal, when it was dug, must have made a broad and high embankment, of which scarcely anything now remains—nearly all having rotted away, and so disappeared. This sufficiently indicates how worthless is, and how short would be the very existence of, such soil, if drained and cultivated, and thus made liable to go into complete decomposition.

After an early and abortive effort to drain and cultivate some of the land, all the subsequent labors of the principal proprietors of the swamp (the Dismal Swamp Land Company,) have been directed exclusively to the very profitable work of getting shingles, and other timber. The proprietorship, and the objects of this company, (whose patent covers forty thousand acres of the swamp, and does not include the lake,) both operate to oppose and obstruct any attempts of other individual proprietors of other portions, for draining the better margin lands. And still more is this obstructed by the construction of the Dismal Swamp canal (for navigation,) which, by its high level, operates to dam and raise the water upon a large portion of the surface of the swamp.

The swamp forests, where preserving their original appearance—or where they have not been deformed or utterly destroyed by great fires, which have burnt both the soil and its covering growth—present scenery of solemn grandeur and of rare and peculiar beauty. The forests of gum and cypress, have not been much damaged by fires, or by the labors or improvements of man—and the trees usually remain of their proper great sizes, and venerable appearance, closely shading the wet, black and level soil. The junipers do not grow large, or they are so slightly fixed in their soil of semi-fluid mire, that they are overturned by storms before they reach large size. But when making the general cover, and though none may exceed twelve inches in diameter, a more beautiful forest growth cannot be conceived. These trees are evergreen—very like the cedar in general appearance, but taller, more slender, with long and straight and bare trunks, supporting tops of tapering, flexible, and graceful horizontal branches. Standing thick as they do naturally, the tops of the trees unite to form one wide-spread canopy of green, supported by thousands of visible slender and perfectly straight columns. The silent gliding of the traveller's boat on the black and still water of the canal, and for miles together in silence and solitude through such forests as these, or of the gigantic gum and cypresses, and thence entering upon the bosom of the broad and beautiful central lake—all serve to present a combination of the gloomy sublime and the beautiful of Nature, that is rarely equalled elsewhere.

As above described, was the appearance of the juniper land, and its covering forest, when I first saw it in 1836. Even then this beautiful locality was known as "the burnt woods," a designation obtained long before, and fixed by time and custom, in consequence of a then long passed destruction by fire. Some years after my first visit, in a time of unusual drought, and dryness of the earth, another such devastating fire swept over nearly all the swamp, and destroyed the trees, and also the soil, for a foot or more in depth, of all this broad space of juniper land, and generally of the like land, throughout the whole swamp. The Jericho canal passes for five or six miles through this scene of former remarkable beauty, and of as remarkable subsequent desolation. Many years have passed since this last catastrophe—(I believe it occurred in 1839—) and the land is again thickly covered, and has a very different appearance from both its former condition, preceding and succeeding the last great fire. None of the former growing trees are alive, and but few of the dead are still standing—charred and broken trunks, over-topping the new and thick under-growth, and serving now to deform, as much as formerly to embellish the scene. The entire surface, thus burnt away, is now covered by a dense and scarcely penetrable thicket of bushes, shrubs, briers and creeping vines, of different aquatic species, scattered among which are numerous young junipers, of but a few feet in height. It is a labor of great difficulty, and would be impossible for any one unused to the ground, to walk any distance (without cutting a passage) through this thicket, even if on firm ground. And the difficulty is much increased by the ground being all of the wettest and softest of miry bog, which but partially resists the sinking of footsteps, by aid of the interlaced mat of living roots of shrubs below the surface—and on some spots of less tangled cover, with the carpet of the thick-growing but diminitive plants of bog-moss, (*sphagnum palustre?*)

The destruction, by the last great fire, of valuable and living timber trees was enormous. But, for immediate use and profit, and even to this time, there was full compensation in the quantity of sound and good juniper trunks, which had been before too deeply covered to be got out, and which were made accessible and available, by the covering peat soil being thus partly burned off. Previously, there had been much recourse to the old buried timber. But this last great fire made it so accessible, as even to facilitate the previous and usual labors of the "shingle-getters"—until a new obstacle was presented, in the next springing thicket of shrubs and young growth.

From the main canal, at different points of departure, there are other branch canals, for smaller boats, and also a "horse-track" with extensive branches, to bring shingles, by boats or carts, from various remote points of the swamp, to the main canal. Some of these routes, both by water, and in walking on the "horse-track," were pursued far enough to show that I had already seen every variety of the soil and scenery. The horse-tracks, or paths for the mules, and the carts which they draw, are made of wood laid across the road way, and so rough that it would seem very difficult for the mules to find footing on them. Yet they draw over them (as I was told) carts loaded as heavily as would be required on ordinary roads. These tracks are made by laying, on the quagmire, long poles parallel and in the longitudinal direction of the route, and on these supports, pieces of split wood, rather longer than the width of a cart track, are laid across, and close to each other, on which the mules walk and draw the carts.

On the other side of the swamp and of Lake Drummond, and at three miles distance from the lake, the Dismal Swamp Canal, (for navigation) passes, and the public road is constructed on the eastern bank of the canal. I had once previously travelled this road, by the public stage-coach, for the purpose of seeing and being informed concerning the lands on the route. But unfortunately there was not one of my fellow-passengers who could give me any information of the country; and even the driver was a stranger, and knew less of the bordering lands and their condition, than I did, who then saw them for the first time. Subsequently, some gentlemen well acquainted with the various localities and every connected circumstance, kindly accompanied me on several different excursions, and aided my inquiries with their good information. To Col. Wm. B. Whitehead of Suffolk, and Capt. James Cornick of Norfolk, I was especially indebted for such aid. With Capt. Cornick, who is President of the Dismal Swamp Canal Company, I rode in a carriage on the road along the canal, far enough to see examples of every variety of ground, and to enable me to understand, and to make useful, what had been seen elsewhere in my previous passage through the whole route.

The road from Portsmouth reaches and crosses the canal at Deep creek—into which, and into Elizabeth river (at low tide water) the canal empties by locking down, sixteen feet in all, at two places. Thence proceeding southward, the canal passes first through firm sandy land, and the water-level is there higher than the surface of the soil. After a few miles, the swamp land, proper, is entered, and continues on both sides of the canal and road to the end of the canal, where it locks down into the Pasquotank river, at South Mills. All the central and larger portion of the canal, including its whole middle section and summit level, passes through what was originally juniper-covered swamp—though now there is rarely to be seen a juniper, and but few trees of any kind. The high level of the canal keeps the water higher over the swamp than would otherwise be, along all the western side of the canal, from which side the water would naturally flow to the lower southward side and land. But on the eastern side, the bank of the canal keeps off the water, and would aid the labors of private proprietors to drain on that side. Some few such attempts have formerly been made. Even on the juniper swamp, when first drained and cultivated in corn, fine crops were raised for two or three years; but after that time, nothing would grow to maturity. I infer that this failure was not because the land was "worn out," (as has been supposed,) but because the dried upper soil had so rotted away that its surface had sunk too near to the level of the water, and to the bottoms of the ditches. The first dug ditches had in no way been filled, or obstructed, and therefore were supposed by the proprietors to be as efficient as at first; and consequently it was not suspected that the ditches required deepening. In such cases, a ditch may have been at first four feet deep, and then efficacious. Its bottom may continue open to the full first depth. But if the whole surface soil has rotted away, and has been thus lowered in level say two and a-half feet, the ditch has then but one and a-half feet of actual depth, and of course would be inoperative, where draining to four feet depth was required. In proof of this, I heard of a piece of original juniper land which had passed through all the earlier conditions, from great productiveness, to sterility, and then was abandoned. A subsequent proprietor dug the old ditches much deeper, and the land again was made as productive as ever. But though such examples would go to sustain my position of the cause and present remedy for the soil, still, as such purely vegetable soil must continue to rot away, so long as it is well drained, it will be, at best but "perishable property," and probably not be in any case, worth the expense of improvement, for the profit of its transient productiveness.

The more valuable gum-swamp lands, adjoining the surrounding firm lands, and thence stretching out towards the central parts of the swamp, may be seen, extending in different points of forest growth, and more or less approaching the eastern side of the canal, though, but in few cases coming near. Of such original good soil are all of the very few good farms and productive fields, that are to be seen along the route, until near the southern outlet. It is understood hereabout that the gum and cypress swamp lands are valuable when drained, and of long enduring fertility under tillage —and that the juniper land is worthless. It is also asserted that the former soils have a clay "foundation," while the juniper land lies over sand—and this difference of the under-stratum is supposed to cause the difference of value of the over-lying soils. I doubt the alleged uniformity of positions of these different under-layers; and do not believe that the difference of sub-soil, at three or more feet below the surface could cause such great differences of productiveness and quality in the thick soil above. As before stated, the immediate causes of different values, are the more pure vegetable constitution of the juniper soil, and its less decomposed state—and the gum soil having less of its whole bulk of vegetable material—and that which it has, being much more decomposed, and earthy in texture, if not also in chemical constitution.

Except a few cases of tillage, and of productive land, all the surface along the canal, as far south as the North Carolina line, is in its original state of swamp, and also its natural state, except for the general and desolating effect of fires. There is no large or beautiful forest growth left anywhere. West of the canal, where the water is kept high and the surface wet always, the fires have only killed and kept down all large trees—but have not prevented a dwarfish and ugly growth of various kinds of trees or shrubs, none of which live longer than to reach thirty feet in height. But on the dryer eastern side, every living plant is sometimes killed and consumed by fire. Where such destruction had occurred within the few last years, the lands appeared, and so I supposed them when first seen, to have been formerly drained and cultivated, and subsequently abandoned to the encroaching water. But I now learned that these lands had been cleared only by repeated fires. By walking on the side of a wide ditch, (made for boating wood to the canal,) I obtained a view of the surface of some of this naked swamp. The former covering forest had been juniper, of which the charred roots and low stumps were exposed thickly everywhere, and those below the surface were still thicker. I could from that, well appreciate the enormous labor of digging a canal for navigation through such a mass of sound wood—or even of cutting small ditches for drainage. It was truly said by Capt. Cornick, that through such land, the canal, to the depth it was sunk, was cut, not by the spade, but principally by the axe, the saw and the mattock. The ditch, on whose low bank we walked to examine the swamp, had been dug only two years. It was wide and deep enough to allow the passage of narrow loaded wood-boats. Of course the earth thrown out must have served to raise banks of considerable size. Yet they had already sunk to not more than a few inches in height; and in a few years more, there will be nothing of them left in elevation. If the whole ground had been well drained, and tilled, the whole surface of the drained soil would have rotted away in like manner.

The growth on this land was (in November) a scanty cover of bunch-top broom grass, and other coarse and worthless grasses of wet and acid land. There are a few stunted pines, which have barely lived through the last fire, and will not live through the next one. Near to the canal, where the fires usually begin, (and at their beginning they can have but little power,) the pines, (all loblolly, or *pinus tæda*,) grow to six or eight inches in diameter; and alongside of the road, where its loose sand has been spread, by winds and rains, over the adjoining swamp soil, some of the pines are twelve inches or more through. All grow sparsely, and are short-bodied and unsightly. On the peat soil many of these pines are overturned by the winds, when less than eight inches in diameter; and few remain standing much longer. When so uprooted, it is seen that the roots had very slight and shallow hold on the wet soil. Yet these few dwarfish pines, ugly as they are, make the best natural feature in the landscape—than which nothing can be more wretched and desolate in appearance. Very different indeed it is from

* At a later time (in 1858) I saw like results of the rotting away of vegetable swamp soil exhibited on a much larger scale. Below South Mills, the southern extremity of this canal, the navigable passage was made by enlarging, deepening, and some straightening of the source of the previous very narrow and crooked course of that upper part of the Pasquotank river, then called the Mocassin Track. The passage is entirely through deep peat earth. The required excavation had furnished broad and high banks along much of the course—and in some parts, nearly as large banks as if there had been there no previous depression of a channel. It required no other testimony than the present view of the new and old water-ways, and the knowledge of how the passage had been formerly made, or improved by art, for the passage of large vessels, for the observer to be sure where very broad and high banks of the excavated peaty soil must have been placed. Yet now, scarcely any remains of them are visible—all the earth that was high enough to be usually dry, having entirely rotted away.

what I had anticipated of this road through the swamp—which, judging from what I had seen elsewhere of natural swamp forest scenery, I had supposed would present a magnificent avenue stretching under a dense shade, made by the over-hanging and interlocking branches of beautiful junipers, enormous gums, and cypresses of the growth of a thousand years.

But however unsightly are the natural features of the landscape, the canal throughout is an interesting and beautiful object. The road also is excellent. For a few miles, at both ends, the canal was excavated either wholly, or at bottom, through sandy earth. The excavation there supplied enough sand not only for the road alongside, but for the much greater length of the central part of the road, to add to which the sand has been brought in lighters. Thus, by sand added, the road has been made firm throughout its length of more than twenty miles.

Within sight of the road, within Virginia, there are but a few cases of good drainage and cultivation, and good land, on projecting points of the gum swamp. After crossing into North Carolina, the soil changes more to gum swamp, and the extent of drained and cultivated surfaces is much greater. But the growth of corn generally indicated either bad culture, or land previously neglected or impoverished. Along the last, or most southern section of the canal, its level again rises above the surface of the adjacent swamp. Still, at this place, are seen the only drained and cultivated lands on the whole route. These several farms have a discharge for their drainage into the much lower Pasquotank river, into which the canal empties, through its southern lock, at South Mills. But for this facility, afforded by the lower level and near neighborhood of the Pasquotank, all these farms would have remained inundated and irreclaimable bog, like all the other swamp bordering on the western side of the canal.

THE MATTAMUSKEET SWAMP LANDS.

The most extensive and important of all the drained and cultivated swamp lands on the Atlantic coast, and also the oldest of such improvements, surround Lake Mattamuskeet, in Hyde county, North Carolina. The country embraced under this designation extends to, and is bounded by Pamlico sound on the east and south, Pungo river on the west—and has no recognized limits on the north, through the wild or unreclaimed swamp which makes up the large remainder of Hyde county. All this space is a portion of the much greater area of swamp, which, with few and narrow intervals of firm land, extends to the mouth of the Roanoke river, and to and along the whole length of Albemarle and Croatan sounds—the whole great peninsula of swamp being some sixty miles in length, and fifty in breadth. In this great space, besides Mattamuskeet, there are three other lakes, Scuppernong, Alligator and Pungo—all of the latter being on much higher levels than the former. Though the natural and former level of Mattamuskeet is but about seven feet above that of Pamlico sound, (and of the ocean flood tide,) and only about one-third of the elevation of Lake Drummond and Lake Scuppernong, still, Mattamuskeet and its immediately surrounding lands maintain the general rule of occupying the highest level of nearly or quite all of the neighboring swamp country. From Mattamuskeet at its former and natural level, and still from its bordering lands, the surface water would flow outward, and descending in every direction, unless to the south. And in that direction, Alligator river has about the same height of level. Lake Mattamuskeet, in its former dimensions, or before being lowered in height, and much contracted in surface, by being partially drained, was twenty miles in length, and with a general width of about seven miles. The margin of the surrounding swamp land (as usual,) is the highest of the neighborhood. Because of sufficient natural causes, the former surface of the lake was usually and considerably lower than the border river; and thence it followed, that, in most years the border land was dry enough to admit of cultivation before there had been any attempt to lower the lake, and thereby to drain the whole neighboring swamp lands. The producing causes of this early and natural partial drainage were these: 1st, there was a natural narrow depression of the surface extending from the lake to the nearest part of the sound, through which, the lake water, when highest, passed off—and which current of water, in the long course of time, had worn down a still deeper channel, in a very shallow passage-way and outlet for the most superabundant water of the lake, and the bordering lands. 2d, The very large surface area of the lake, and its shallow depth, caused much more water to be removed by evaporation, and thereby the surface of the lake to be much deepened in all long summer droughts. This would produce so much the larger reservoir to receive and retain the next succeeding great supplies of rain-water —which, sometimes, during a whole winter might not ever replace the water evaporated during the preceding summer. And the lake being thus generally and considerably lower than the border lands, permitted them to be generally surface-drained by ditches emptying into the lake.

For these reasons, some of the highest lands on the margin of Lake Mattamuskeet, were under cultivation seventy years ago, and long before there was any attempt, or thought of draining upon a general plan of operations—and without any draining, except of each separate form, by its own small ditches emptying into the lake. Instead of profiting by even the natural channel of discharge for the highest water of the lake, the passage was actually dammed across, (at Lake Landing) to give height and permanency to the water-power to work a mill. And the subsequent and early partial deepening of the passage below, thence to Wysocking bay, neither aided the drainage of the lake, nor was desired for that purpose—but was done to add to the water-power of the mill, and for boat navigation to the sound.

Thus, without any aid from artificial means, the lake was most generally kept lower than its full height, by evaporation alone; and in rare cases the water was lower than now, since permanently lowered for general drainage. But on other, though also rare occasions, the surplus rain-water, flowing from the surrounding swamp lands, filled the lake to overflowing, and destroyed the crops on all the cultivated ground, or rendered its cultivation for that year impossible, or hopeless. From this cause, in 1836, the water rose and stood nearly to the doors of the dwellings on the highest ground, on the border of the lake—which is full seven feet above the level of Pamlico sound, and three to four feet above the present reduced level of the lake, When these calamities occurred, they were so much the more afflicting, because the visitation was universal. No farm and and no inhabitant escaped the total loss of the usual products of the whole year. And the narrow border of the Mattamuskeet was the only land then dug, at any time, and had the only inhabitants, to be seen for many miles of distance. While such was the condition of things, there was not a road, or any practicable passage by land, from the lake settlement to any part of *terra firma*.

At last, the government of North Carolina undertook to draw off a portion of the water of the lake, and so to permit all lhe higher lands to be permanently drained. In 1838, the present canal was dug seven miles long, from the lake, at Lake Landing, to its discharge in Wysocking bay on Pamlico sound—sixty feet wide, at the surface digging next to the out-let, and decreasing to forty feet next to the lake. Unfortunately, under a mistaken view of saving labor, the crooked route of the natural and previous passage-way was used throughout for the new canal. A straighter course would have been shorter, and nearly as cheap in the first excavation, and much more effective for use, and less liable to be filled by deposits of mud. This digging served to draw off about three and a-half feet depth of the previous high water of the lake—or of the height at such times as it could barely flow off before. The very shoal and level bottom of the lake next to the former shore, was laid bare for widths varying from half a mile to three miles. At one place only, Fairfield, on the north side, where the water was much deeper, the lake still reaches to its former bank and shore limit, where the land is now about four and a-half feet above the water.

The bottom of the lake, (including both the deepest and all the shallower parts now left bare,) is not of mud, or of bog-soil, as might have been supposed by a stranger, but a remarkably pure, and white sand, with a surface as smooth, as level, and as firm, as any land can have. In digging into the sand, two feet deep, near to the lowest margin then bare of water, no change in the sand was found, unless that it was still closer and harder, where lowest. The sand seems to have been deposited in very thin horizontal layers, from one-eighth to one-sixth of an inch thick, and these frequently separated irregularly by broken *laminæ* of fine black powder of pure peat-earth, of less thickness than one-sixteenth of an inch. The like powder, separated by the agitation of the water, in high winds, also covers much of the surface of the sand—and much of it is always held suspended by even the calmest water of the lake, in sufficient quantity to keep it turbid. This suspended matter is constantly brought, in the lake water, through the canal, and is deposited therein, in large quantity. But the much larger portion is carried to the nearest water of the sound, and there deposited, to the great injury of the port for vessels. It is estimated that a space of seventy or more acres of Wysocking bay, has been filled up, five feet deep, entirely by this vegetable sediment, and so much of the previous best part of the harbor, and shipping port, rendered inaccessible to vessels, that previously took in their cargoes there.* To provide for this great and increasing evil, the neighboring proprietors have recently dug another canal, from another neighboring and suitable part of the sound, to the edge of the state canal—but have carefully left a dam, or "bulk-head," between, to prevent the water and all its fluid sludge from entering the newer canal, and choking that also, and its outlet into the sound. Of this peaty powder the larger particles are heavy enough

* This operation of filling Wysocking Bay by transported peaty deposit, is the commencement of the formation of a future peat bog in that place. The formation would proceed much faster, hereafter, if it was in fresh water, instead of salt, so that fresh water aquatic plants might grow, when the water is sufficiently shallow, and add their undecomposed remains to augment the rising surface of the deposition of sludge, transported from the lake.

to sink in nearly tranquil water, but light enough to be lifted and carried along by moving water. It is entirely of vegetable origin and material, and as black as charcoal. But it has been so long water-soaked that it is difficult to burn when dried, and has lost all its soluble parts. Therefore, where covering any part of the dry bottom of the lake, it adds no value either as soil or manure—and (in its present condition) is as barren and worthless as the sand itself. The sand bottom left bare of water, has been slowly and scantily covered with grass, which is kept low by the grazing cattle. Nothing of larger size grows there. And the broad expanse of smooth and hard green surface, appearing to the eye perfectly level, offers to the observer an object of remarkable and peculiar beauty, very different indeed from its former appearance, but not less beautiful than the still remaining broad surface of the lake lying beyond these green sand downs. Barren as are these sands, yet, as covered with green, at some distance they would seem to the eye to be fertile as well as beautiful. And the blue water of the lake, as also seen at some distance, would not be suspected to be always foul and turbid with suspended sludge of black bog-earth. Riding or driving over these broad flats is very pleasant, both for the very firm and level ground, and for the surrounding scenery, of water on one side, and rich lands covered with luxuriant crops on the other. But there is one offset to the pleasure, and also the convenience of driving on the sands, in the obstructions opposed by the many farm ditches, made for draining the rain water from the neighboring fields into the lake. If these ditches were bridged, carriages might be driven over any part of these very extensive sand downs, as smoothly and safely as on the smoothest lawn, or sea-beach. Except for the absence of trees, and of shade, (which deficiency cannot be supplied,) there would be no more beautiful promenade in the world. It is surprising that the convenience, and great saving of distance, of having the public roads on the sand has not been appreciated and availed of. The route of the principal public road, now as formerly, is outside of and around the ancient shore of the lake. If the much shorter circuit of the present reduced water were used, from eight to ten miles of the whole circuit might be saved, and a firmer and better roadway be obtained.

The now remaining water of the lake is about sixteen miles long, and five wide, and scarcely anywhere more than three and one-half feet deep The outer and larger portion is less than two feet. I do not know the rate of descent in the present canal. But judging from the flow of the current, (then about a foot higher than the lowest water,) it certainly cannot be less than four feet of fall to the sound. Then by deepening the canal, at its upper part three and one-half or four feet, and less as descending, the whole lake would be drained, its bottom made dry, (except in the bed of the canal) and all the existing and unceasing supply of sludge and bog-mire would be ended, and the evils thereby caused, of choking the canal and the port, its outlet, would be entirely removed. At the same time the present very poor means of navigation along the canal, would be much improved—and still more, if greater depth to the canal was given, or lock-gates were placed thereon. But such improvements are hopeless, and would not now be even deemed desirable by the residents. The opening of the canal to its present depth, and the lowering so much the water of the lake, before the execution was strongly opposed by many of the swamp proprietors, as likely to be injurious to their interests, and to the best condition of the land. The further deepening of the canal, and the entire emptying of the lake would now have many more opposers, and few if any advocates.

The older and more extensive cleared lands are between the south side of the lake and the sound, and through which the state canal passes. Those proprietors whose lands were near to the designed route, and not of the higher levels, objected to the deepening of the canal because its (expected) much increased discharge of water, after heavy rains, would for the time, raise the water along the course of the canal. And even at this time, this charged effect is alleged as the cause of the later abandonment of some of the lands of lower level, nearest to the sound, which were once under tillage. The same objection, and also others, would now be made to the further and complete drainage of the lake. It is maintained that the lake now serves as a vast reservoir to receive the surplus rain-water discharged from the surrounding lands, and especially from the inundated swamps—and that the accumulated water thence flows off gradually through the canal. If there were no lake, but a deeper canal, or a narrow channel, instead, the discharge of surplus water, would be more rapid, and as supposed, would rise much higher along the lower part of its course, and would inundate and damage more land. This would be a very improbable, or, at least, an uncommon result, even if there was no restraint on the free passage of the water. The surplus water would begin to flow off at a level four feet lower than it does now, and therefore would be reducing its quantity much earlier. If still accumulating faster than the discharge, (as well might be in great rains, or very wet seasons,) the drained and sandy bottom of the lake would afford ample space for the raised water to spread over, and without damage to anything on that barren surface. If, however, the water should still be like to pass out in such quantity as to overflow, or otherwise damage, the low-lying lands near the sound, the discharge of water might easily be restrained and regulated and so kept harmless. At the old shore of the former lake, where the present barren sand flat joins with the rich and cultivated soil, a flood-gate might be placed across the canal, of such capacity as to permit the passage of no more water than the canal could well contain and discharge, without its rising high enough to damage the bordering fields. All the greater excess of water would be kept back on the bed of the lake, until gradually drawn off through the flood-gate. This plan would afford security against the apprehended damage from this cause. But, in my opinion, the flood-gate would scarcely be needed. The then drained and often dry sand bottom of the lake would absorb an immense quantity of water, when thus partially overflowed. And when the lowest bottom should be thus saturated, there would still remain many thousands of acres of the former, (and present) lake bottom to be overflowed, before raising the water in the lake, or in the canal, to the present usual levels.

From near the lake on its north side, (at Fairfield,) a navigable canal, twenty feet wide, extends to the upper part of Alligator river, and is kept filled by the refluent water of that river. The canal is not connected with the lake, because the entrance of the turbid lake water (when high) would be injurious, in choking the canal and its outlet with fluid sludge, as is in rapid progress in the state canal. As this canal (from Fairfield,) is kept filled with water to a level (that of the Alligator river,) it affords, for its length of four miles the best measure of the comparative heights of different parts of the bordering swamp. From near the lake, and thence to the beginning of the canal, the surface of the land is no where less than four and a-half feet, and at the highest ridge, is seven feet above the lake water. Such are the ordinary heights of surface near to all around the lake. Along the canal, the cultivated land maintains a height of four feet, for a considerable distance, and then gradually declines to "savanna" land, which is about a foot higher than the water in the canal, and for a mile in breadth, to the river, and which is totally worthless.

The original forest growth of the highest (and therefore) the best lands, was principally of black gum. A mixed cover of gum and cypress indicated the next best grade, and the land decreased in height of level, and value, as the proportion of cypress became more and the gum less abundant. On still lower surface, and also where the sub-soil approaches, near to a low surface, small "savanna" or pond pines, (*pinus serotina*) became the general forest growth. On the still lower or true "savanna land" no trees can now grow—and the thick cover is of tall and coarse water grasses—and this land gradually changes to the still lower river marshes. No juniper land is now seen in all this swamp region. The former juniper lands of Mattamuskeet have all been burnt over, and the former growth destroyed, as well as the upper soil itself—and the land is abandoned as worthless. This is the most general origin of "savanna land." Through this land, now bare of trees, wherever canals are dug, the buried trunks and other parts of juniper trees are found and often in great quantities, and at lower levels than such trees could now live.

The discharge of the ditches of the cultivated lands, in many cases is into the lake. But in many other cases, it is toward the sound, or elsewhere outward. And this should be wherever the surface dips outward from the lake, as is most general. To drain in the direction of the dip of the surface will be most efficient for the particular land so drained. Another and general benefit of such drainage would be, that so much less water would flow into the lake, whence to be discharged through the canal. The best and highest lands are generally nearest to and surrounding the lake ; and the belt of such best land varies in width usually from half a mile to two miles. In some cases it is still wider—and in others much narrower. These narrowest high margins only remain in forest, because deemed not worth being separately fenced, if cleared and cultivated.

If the lands under tillage, around the former margin of the lake average a mile in breadth, (as I heard estimated,) there are about fifty square miles, or thirty-two thousand acres. The land naturally is immensely rich, and very productive in corn, notwithstanding the necessary and great defects of texture of this, as of every vegetable soil. When new, the land brings about fifty five bushels of corn to the acre, and generally as much as thirty bushels after fifty years of continued crops of grain, without rest or manure to the fields. That the land had not produced more at first, was owing to the excess of vegetable material, (constituting the greater part of the bulk of the soil,) and imperfect draining—and for the oldest lands, the incessant cultivation under grain crops, without any aid to the soil. The good land sells readily for $75 to $100 the acre.

Before my first seeing any of these drained and durable swamp soils (near Lake Scuppernong,) I had supposed that they were almost wholly composed of vegetable matter, like the formerly embanked and drained tide-marsh lands of Virginia—and that like these lands, and also the drained juniper swamp of the Dismal Swamp, that these would in like manner, when drained and tilled, rot away and waste, until sinking so low as to be worthless, though requiring much longer time to reach that evil conclusion. I could not deem it possible that such vegetable soils should retain their productiveness, and (as generally believed) all or most, of their original elevation, under exhausting tillage for fifty years or more. And the actual results of durability, as they appear even to myself, still seem unaccountable, even after finding that these soils have more of earthy matter than I had at first inferred. Still, as they are all, and largely of peaty formation and constitution, much of the great excess of vegetable material must be liable to complete decomposition and waste—or the rotting away and loss of so much of the bulk of the soil. But I could not hear, about Mattamuskeet, of any admitted or unquestioned results of this kind. The oldest farmers of whom I inquired, (and some had resided here for seventy years,) had never suspected that their lands had become lower in surface—nor could they believe that any such effect is to be feared for the future. On the contrary. I found that some experienced farmers held the opinion that, after their land is first drained and cultivated, the surface actually becomes higher. Though the error of this opinion needs no argument to expose it, still its being entertained by experienced farmers, and long residents, is enough to prove the mistake of my former belief. that there had been *great* waste of the upper soil, and that such waste was still in rapid progress. I now suppose that some such waste, and consequent lowering of the surface, must have occurred on all these lands after their being drained; but that the amount of loss has not been very great on the best lands. The many good dwelling houses about Mattamuskeet were erected on brick foundation walls, and all have brick chimneys, and the masonry of both rests on the vegetable soil, merely well rammed previously. Yet no facts were heard of the sinking of such walls and chimneys, to any unusual or considerable extent. All these facts would seem to be sufficient evidences that no very great sinking or rotting away of the good soil occurred. The only facts learned which seemed to me evidence of the rotting and lowering of any other land, was not so supposed, or admitted by the neighbors. The lands near to the sound (near to Wysocking bay,) which were originally of low surface, but were formerly under regular cultivation, have long since been abandoned, and are now covered by large loblolly pine trees, (*pinus tæda*). It is generally believed, and alleged, that these lands became unproductive, not because of their surface being absolutely lowered, and thus being more damaged by the nearer height of the water of the sound, as it stood before, but because, by later openings of broader inlets of the ocean and its freer entrance into Pamlico sound, its surface has been more raised, relatively to the land—and also, from the more ready access of the ocean tides, that the water of the sound is much salter than formerly. But the great changes of this kind, (caused by storms enlarging, or making new inlets through the sand-reef,) were of as late occurrence as 1842—and this low land had been left out of cultivation long before. Besides—even if the greater openings of the reef had preceded the abandonment of the land, it could not have been the cause. The fewer and smaller are the passages through the ocean sand-reef, and the more impeded the entrance of the ocean-water, so much the greater must be the obstruction to the waters of the sound being discharged into the ocean, and necessarily so much the higher must be the ordinary and general level of the water of the sound. And therefore, while much more open and larger inlets for the entrance of the ocean-water would cause the highest and very rare storm-tides to rise higher on the lands bordering on the sound, these larger passages would operate to keep lower the usual and average level of the waters of the sound. It is disputed, among the neighboring residents whether even now there is any regular flow and ebb of the tide on the nearest shore of the sound. Those who maintain the affirmative, admit that the variations are very small, and scarcely appreciable by slight observation. On the other hand, one person who had resided for thirty years close to the water's edge, (near Wysocking harbor,) and enjoyed every facility for observation, declared that there are no regular tides, and in ordinary, only such variations of level of the water as are caused by the direction of winds operating on the surface of the sound—and the rare and extraordinary rises of water caused by the great influx of ocean-water during great storm-tides. The lake itself, is altered in level by strong and long continued winds, which perceptibly and considerably depress the surface of the water on the windward, and raise it on the leeward side.

Indian corn is almost the only crop made on the lands, and it thrives far better than any other grain, or any other crop of large culture. I have never seen such magnificent growths of corn, upon such large spaces. No part of the land is left without a crop, and corn alone covers nine-tenths of the whole surface. The few and much smaller crops of wheat seemed heavy to the first view—(it was during harvest—) but the grain is far inferior compared to the growth of straw, and the products fall short of their promise to the eye, when growing, or standing. Oats looked well But this crop is not deemed profitable, and is raised but by few farmers, and for farm consumption only.

Nearly all the drainage is too shallow, and therefore imperfect in effect. The soil is so porous and open, that its drainage is easy to accomplish wherever there is enough fall—and four feet of fall is deemed ample. Much land is cultivated in corn, and produces well, of which the level surface is not more than two and a-half feet higher than the water flowing, or standing, in the ditches. Many fields near to the sound, are of still lower level compared to the usual, or permanent height of the water in the adjacent ditches. When the surface has declined to eighteen inches only above the standing height of the water, and for all of lower surface, the land is left waste. Where such lower land was formerly cultivated, it is soon covered by loblolly pines, which when old enough, are of large size. They are not perceptibly damaged by this low land being very rarely overflowed by the salt water of the sound when raised to very unusual height by storm tides of the ocean. Such low land, and with such forest cover, makes a broad belt alongside the higher and cultivated lake lands. Of still lower level, and stretching to the sound waters, are savanna swamps, too low to bear trees—and still lower marshes, covered by coarse salt-water grasses. These lowest lands would be very valuable for grazing, but for two great evils, and complete causes of worthlessness. The cattle are annoyed by myriads of mosquitoes; and in summer, all fresh water, for their use, fails. The wells on the low borders of the sound, then supply only salt-water—and in dry seasons, the fresh-water in ponds and the neighboring ditches, supplied previously by rain-water, become either dry, or replaced, or changed by the refluent salt water of the sound. The then saltness of the water of the neighboring wells, is supposed to be the unavoidable consequence of the saline impregnation of the earth. But, I think, if care were used to exclude by dykes, the present close approach, and continued access, of the salt-water of the sound, that the well-water would soon become and remain fresh. The inhabitants of these localities obtain scant supplies of rain-water for drinking and other essential domestic and family uses—and when that fails, recourse is had to the always turbid and then warm water of the lake. At such times the cattle on the salt marshes suffer greatly, and in some cases perish, for want of fresh water.

The wells throughout the higher swamp lands yield water of various flavors, but in but few cases any tolerable for drinking, though fit for all other purposes. The best water is obtained in some wells dug on the highest "ridge," where the upper peaty soil is but one or two feet thick, and the next bed of earth is sand like that which makes the general bottom of the lake. The water, in abundance, is reached at from twelve to fourteen feet deep, and usually in a miry quicksand, seemingly of former marsh mud, with remains of aquatic vegetable growth, and which is offensive to the smell. In wet seasons, the water of most of these wells rises much higher than usual. The wells which afford the best water are sunk below the quicksand, to a lower source.

The occupants of the interior and better lands, who are generally in good circumstances, and all others who are provident, are well supplied with rain-water for drinking, collected from the roofs of their houses, and conducted into subterranean cisterns. The cheaper and usual substitutes for such cisterns above-ground, and used by the poorer class, are large cypress troughs.

All the soils are composed, in large proportion, of vegetable or peaty material. But from some peculiar causes, these soils contain more earthy matter than would be supposed from the general manner of formation of peat soils. The upper vegetable soil is generally from two and a-half to three and a-half feet thick. On the "ridge," the soil is but one and a-half to two feet deep. There and also elsewhere, the next bed is nearly of pure sand, like the bottom of the lake. Close by this ridge (which is the poorest of the higher land,) the vegetable soil is the deepest of all these lands, six feet or more. The whole next underlying bed, though (as I infer) it is one continuous bed, varies in texture, in different places, from the nearly pure sand just mentioned, to the same so intermixed with clay, as to be adhesive when wet, and making hard clods when dry. This is much the most general texture of the sub-soil of the higher lands.

Hyde county is deemed the richest and most productive in North Carolina, and yet nearly all its cultivation and production are within the small cleared belt surrounding this lake. I could learn but little of the agricultural statistics. It is said that the annual export of corn, from the lake lands, is more than five hundred thousand bushels.

It is not required, for any purpose, to say much of the agricultural practices of the Mattamuskeet lands. The good lands are densely populated by an industrious and thriving people. The settlement is more isolated, and difficult of access, than any other place known. Even now, there is no public conveyance for a traveler, by land or water, approaching nearer than the town of Washington, North Carolina. But formerly, the place was much more secluded. The approach of a visitor from abroad was next to impossible. And for a resident of the settlement to go abroad, with all the aid of his knowledge of localities and facilities, was a most arduous undertaking. Until within comparatively recent time, there was no road, or land route practicable for a rider on horseback, to any other settlement, and for many miles of distance across miry swamps intersected by deep rivers. The only now existing land route, leading to the interior country, is a road made at the State's expense, and constructed by the only available means of excavating a large canal, to supply earth to make a broad bank, on which is the road. In digging this canal, (through savanna land, bare of trees) such a quantity of dead but sound wood was found and removed, and which was at first left alongside, that it appeared to an eye witness impossible to replace all the wood in the canal from which it had been taken. Much of the earth thus obtained to make this road, was of the sub-soil of sand, which gave much more of true earthy and permanent material for the embankment. But even with this admixture of sub-soil, the road is still so largely composed of combustible matter, that it has frequently taken fire, and required much labor to have the fire extinguished, and the road saved from being entirely burned away. Before this road was in use, any traveller from or to the lake lands, had to pass over a long and unfrequented water route, in a boat large enough to take his horse safely, until reaching land firm enough for a horse to travel over, and thence perform the long remainder of his journey. Under such difficulties of intercourse, the settlement could be but rarely visited by strangers. A community necessarily so isolated, and shut out from personal communication with others, and of persons all in similar conditions of labors and objects, must necessarily have acquired and retained the same agricultural opinions, and practices; and nowhere are they more uniform, abiding and fixed, than here. There can nowhere be found people so perfectly contented and satisfied with their present condition, and who do not even imagine the possibility of improvement being found in any change of procedure. The proprietors entertain no doubt of their occupying the richest land in the world—(in which opinion they are not far wrong—) and also that it is managed in the best possible manner. Therefore it is not in the vain hope of making converts there, that I will state, generally and cursorily, and omitting all details and minor matters, some of the principal wants and defects there observed, and some of the principal improvements needed.

The ditches dug in this peculiar soil, if merely "let alone," would keep open for a long time, and need less labor for repairs, and cleaning out, than any seen elsewhere. The digging is easy, where not obstructed by cypress stumps, or buried juniper logs. The open vegetable texture of the soil, and its great depth, makes it drain well, and far, by lateral percolation, to wherever a lower neighboring outlet is afforded. Yet the principal ditches are never deep enough; and even those of largest size, acting to receive and convey away, to distant outlets the surplus water of a whole farm, or of several farms, rarely remain open three feet deep. Probably they were dug deeper at first. But as hogs have free access, at all times, to the ditches along all public roads—and for some months of every year to all ditches, and even the largest canal—of course all are in the course frequently, of being more or less filled by the rooting of hogs on the ditch sides, and by their wallowing beds made in the bottoms. No covered drains are made anywhere. Yet they would operate admirably in this porous soil; and moreover they would here have the especial benefit that they could not be choked, or otherwise damaged by the rooting of hogs.

The raising of hogs, and fattening them in ample supplies, al most without feeding, is a great and justly valued benefit here. But, as obtained, I doubt whether the pork is not fully paid for, in the additional expenses of fencing required, and the damage to. and repairs for, the ditches and canals, which are incident to the mode of rearing and fattening hogs. The newly reaped wheat and oat fields, in the grain scattered and left therein, offer one important supply of food for hogs—which is much the greater, because of the great and unnecessary waste in harvesting—and that too, in the primitive mode of reaping entirely by the sickle, or reaphook, of which the admitted superior advantage is the permitting a cleaner and more complete saving of the crop. The cornfields are all sown in a secondary crop of peas, on which, and the waste-corn left in gathering, the hogs are put, and become fat with but little other food. Thus a plentiful supply of meat is obtained for every farm, at very little cost of food, but at heavy cost otherwise, in the necessary increased fencing and ditching. For besides the great damage of the hogs rooting and obstructing every ditch and canal, and rendering the drainage, (with all the repairs,) much less operative, it is another condition, necessary to this hog-economy, to fence separately every field, so that the hogs of each farm may be confined therein, separately at the proper time for gleaning the waste of each crop and field. This is universally done—even on farms on which all the excellent cypress timber has been exhausted, and where the rails and all the materials for fencing have to be bought, and brought from a distance, at great cost.

The crops of corn frequently suffer, and greatly, by being blown down, by the violent winds which pass over the sound from the ocean. But, even on the lowest tilled lands, there is rarely any damage from the highest rise of the water of the sound, when caused by hurricanes. There have been but three such "hurricane tides," by which much land was overflowed and the crops injured, in the last thirty years. The ordinary access of salt-water, from the sound, to the lowest tilled lands, and the consequent injuries therefrom, might be excluded by even a low and cheap dyke raised along the lower margin of all such land, bordering on the sound, and along the margins of the larger canals. By this simple and cheap safe-guard, thousands of acres of fertile land might be added to the space now under culture.

Canals may be so cheaply excavated in all this region that the cost might be well afforded in many other places, for the benefit both of navigation and drainage. If dug deep enough to pass, or to hold water a foot deep, that depth would serve for much ordinary transportation, and it might be deepened temporarily, by raising the level of the water by flood-gates. Besides this, and also the draining benefits of such deeper diggings, another important incidental advantage might be gained, and from nearly every deep farm ditch, in using the clay sub-soil as manure for the surface vegetable soil. In Britain, such dressings of earth are deemed all-important and essential, for the improvement of the drained peat-soils of that country—and they are applied at much greater cost than would be required about Mattamuskeet. Thus we have the long experience of British farmers, as well as sound reason, if in advance of all facts, to fortify my position. Here, even when the clay is reached in ordinary ditches, and thrown upon the margins, it is left there, and acts only to obstruct the surface drainage. No one has moved off the incumbrance to improve the texture of the adjacent land. And it would be deemed the height of folly, and waste of labor, to deepen canals and ditches merely to obtain from the bottoms, the under-stratum of clay, to be applied as manure to the rich surface. If the ditches were opened deeper and on a uniform plan, they might be farther apart, and fewer in number than are deemed necessary now. The better drainage of every farm, and the extension of good drainage and culture over much land now left waste, besides the main and direct benefits, would prevent much of the moisture of the air, as well as of the earth, which is now so great an evil. It is from this cause, as I infer, that all the grain here produced, with every care used, is more or less damp after being housed, and is especially liable to be heated, or otherwise damaged in barns, or subsequently in vessels, when carried to market. Further, by general better drainage, there would be great improvement to health, and abatement of the existing plague of myriads of mosquitoes—which latter is the greatest existing annoyance of the whole locality.

From the existing conditions of the land and the waters of this lake region, every stranger would infer the general and worst effects of malaria, in producing disease and death. But I was assured that such was not the fact, and that the residents suffered but little from autumnal diseases. And this I could readily believe, even after making proper allowance for the too favorable view, as to health, which every man takes of his own place of residence. The people I saw had the appearance of enjoying at least ordinary good health. Among the number I saw there were three neighboring resident proprietors, each of seventy or more years of age, and then in good health. Few of the residents remove to or visit the high lands in the Autumn, and these few for short times, and more in pursuit of pleasure than health. Nevertheless, admitting, as I believe is true, that the lake lands are much more healthy than the low main land (and what is called dry land) of Eastern North Carolina, still much improvement, even in this respect, would be made here by a general system of prover drainage.

In the total omission of all rest for the fields, and of all manuring crops, (excepting the secondary crop of peas among corn, which is mostly consumed by hogs,) it is a necessary consequence that much of the old land has been considerably reduced in production, from by fifty to seventy years of such exhausting culture. Still, no cessation of grain cropping is permitted. And it is but in rare cases that any more manure is made than the farmer cannot avoid being obtained from his confined animals—or that half of this small amount is carried out and applied to the fields, before the other half is wasted by decomposition, and the gaseous results are carried off into the air. The large stocks of hogs, when not gleaning the grain fields, are in the roads, which are all fenced lanes. These lanes, for three-fourths of the year, are the only enclosures, or daily and nightly quarters for all the hogs; and there is left to waste, and to contaminate the air, and that principally near the mansions, all their excrements, as well as much of those of the cattle needed to be kept about the homestead. The great summer range for the cattle and sheep is on the sand downs left bare of water around the present margin of the lake.

The defects of economy in the agricultural habits of this country, have in great measure been the results of the great productiveness of the lands, even under the actual defective management. If the proprietors would only use the abundant and ready means offered by their favorable circumstances, they might double the value, and nett profits of their already very rich and productive lands.

THE SCUPPERNONG SWAMP LANDS.

Next in extent and production to the drained lands of Mattamuskeet, and far superior to them in perfection of drainage and tillage, and in other points of interest, stand the drained swamp lands on the East side of Scuppernong Lake, and which drain into Scuppernong River. This highly interesting locality I had previously visited and examined in 1839, and then published in the "Farmers Register," a full description of the soil and its natural features, and the remarkable improvements effected by the intelligence and industry of the proprietors. After the long time which had since passed, I have recently (in April 1857,) again seen these farms. My principal objects were to see the later extension of the drainage and cultivation, and other improvements which had been made, and especially to gain information and the best evidence of facts and observations, as to the disputed operation of the sinking, or rotting away of the swamp soils. Referring for details, and many connected matters of interest to my former more full publication, I will here be either very concise, or silent, as to matters formerly treated—and describe, generally, the present condition of the lands, with as little repetition as admissable of any matters which have been treated of before.

Lake Scuppernong, (formerly called "Phelps,") is from six to seven miles in diameter, and of irregular roundish oval circumference. This, with the neighboring lakes, Alligator and Pungo, occupy a part of the highest level of the great swamp region of North Carolina, covering the four Counties of Washington, Tyrrell, Hyde and Beaufort, and the peninsula lying between Albemarle, Pamlico and Croatan sounds. Lake Scuppernong is divided nearly equally by the line between Washington and Tyrrell Counties. The lake is on the border of the highest swamp *plateau*, and from its northeastern side the surface of the land slopes downward to the Scuppernong River, which is from four to seven miles from the lake. On the upper portion of this slope, and bordering on the lake for some seven miles, is the body of drained land now under consideration. The cleared and tilled land now makes nearly five thousand acres, belonging to some five or six different proprietors—but which is in one connected and compact body. The only exceptions are the pieces of wood-land left for farm use on each separate property. The general plan of drainage is the same on all the farms. The difference of level, of the margin of the lake (where the land is highest,) and the Scuppernong river is eighteen feet. Of course, the "fall" and discharge for the drainage waters, and the rapidity of the descent, are as great as could be desired. And the immense quantity of water (derived from the immediate supplies by rain only,) which this soil held before being drained, and the prodigious quantity now continually discharged, are astonishing and convincing evidences of the great power of such soils to attract and retain water.

Before any drainage had been attempted, and also now after all that has been done, the height of the lake water has varied by three or four feet only at different times—and sometimes for years together—as the seasons were either extremely wet or dry. With the earliest efforts to drain these swamp lands, by ditches, there was also as much required a low embankment along the high margin of the lake, to prevent its highest water from over-topping even the high margin. And to make and keep up such long embankments (which now make the firm and beautiful road and avenue along the lake border,) was the heaviest tax on the labor of the earliest drainers and improvers. Subsequently, the oldest and great Collins canal was excavated, from the Scuppernong river to and into the lake, and draining thence as much water as the capacity of the canal would receive, or rather as much as it was permitted to receive. This oldest canal is over six miles long (from lake to river,) twenty feet wide, and four feet deep where most shallow. The water in this canal, when the lake stands highest, would have eighteen feet of perpendicular descent. Of this amount of descent, six feet is the measure of the first quarter of a mile from the edge of the lake—the slope of the land being there so much greater than farther downward. Therefore, it is evident, that if through even one such canal, the lake water were permitted to flow unrestrained, that the water received would be more than could be discharged through the more gradual slope of the remoter surface—and that these lower lands would be submerged. It was expected at first that the canal, even as limited and restrained, would draw off so much water as to greatly reduce the height of the lake. But this was not the object of the proprietors, and neither has there been any such appreciable result. Although another similar canal, of fifteen feet width, was afterwards constructed by Mr. E. Pettigrew, all the discharge which both these canals cause have not served to make any sensible and certain diminution of the height of the lake. I infer that there must be some diminution; but that it is so small compared to the effect of dry seasons that the separate and continual and regular operation of the canals, in lowering the water, cannot be seen, or correctly appreciated.

The main objects of these canals were, 1st, to receive and discharge the water from all the ditches of the respective farms; 2ndly, to afford transportation by water, to the river, for the products of the farms, and 3rdly, to furnish abundant water-power to work mills and all other necessary machinery. The first and most important object is best advanced by the supply of water from the lake being excluded, and the canal having to convey no more than the drainage water from the bordering fields. The second and third objects only require a moderate and limited supply of water from the lake. And all three of these objects would be frustrated, if the canals were allowed to run full, or to take in as much water from the lake as their capacity would admit. Thus, it may be understood, that so far as the drainage of the land is concerned, the canals draining water from the lake does no good whatever, and is sometimes detrimental. For whenever it is necessary, for purposes of navigation, to let the canals run much fuller than usual, the drainage of all the lower lands along the canal is obstructed for the time, because the height of the water is too near to the level of the surface of the land.

Besides these two oldest canals, there have been excavated in latter years three others, of still larger discharge, and for draining from the land only, and which do not communicate with the lake, or receive any water from it. All these new canals convey as much water as their dimensions will pass, and discharge much water even in the dryest times—and yet all the canals do not afford enough discharge for wet seasons. One of these new canals was constructed by Mr. Collins—for another farm in this body—which at its beginning, and on the highest ground, is but six feet wide, and widens to thirty feet, on the lower and more level ground, and to the river. Another, dug by Mr. Charles Pettigrew, increases in the same manner from six to twelve feet, which it is for much the greater part—and in one place, where passing through a sandy knoll, or ridge, it is twenty-two feet deep, and more than fifty feet wide at top—and must be made wider, either by excavation or by caving in of the sides. Another canal of Mr. Pettigrew's, made to receive and carry off the water coming in from the "Dismal," (as the great undrained body of swamp is called,) is thirty feet wide, and four feet deep at least—and which is not of sufficient capacity by one-half. This is designed to be made both wider and deeper. These enormous works, necessary in advance of any effectual drainage, serve to explain the fact that millions of acres of the richest and best swamp lands still remain unreclaimed, and which may be bought even now at low prices—and which, in former times could not have been sold for ten cents the acre. The purchase money to be paid for such land is nothing compared to the enormous cost required for the draining, clearing and bringing the land under cultivation. Whenever the land is part of a much greater "Dismal" lying as high, or higher, and all saturated or overflowing with water, the proprietor has not only to take off the water from his own land, but to exclude the surplus water from the surrounding lands, and perhaps water coming from miles of distance. Hence, no small proprietor, unable to command an adjacent and sufficiently deep outlet, can reclaim his own property, surrounded, or nearly surrounded by similar swamp lands, unreclaimed. But for large spaces, which will justify expensive and large canals, no investments and operations will pay better profits. And these successful and profitable enterprises might be undertaken by numerous and even small proprietors, if the commonwealth, or any other common interest, would open a few great and level canals, from one navigable river to another, along the best routes for the objects in view, through the great "Dismal." The works executed by but three or four individuals, on the Scuppernong swamp lands, show what may be effected, and to great profit, in this way. The main canals, here proposed, would, in the first place, furnish excellent smooth water navigation, for both travel and transportation, between points which are now entirely separated, and inapproachable each to the other. Next, the earth thrown out of the canal would make an excellent and firm road, far superior to the ordinary swamp roads, scarcely passable, and in some cases impassable, made of logs covered by earth. And next, and which is the main benefit, these canals, if wide and deep enough, would go far to drain off the overflowing waters of the whole great swamp, and offer out-lets for the smaller drains of every neighboring proprietor. If such works were constructed at the expense of the commonwealth, the cost would be fully repaid to the treasury in the increased receipts of taxes, on the new agricultural capital and income that would be thus created--besides the hundred-fold greater benefits to general and individual interests.

The general system of drainage of all these lands is similar to what is in use in all this low country, and which was probably first copied from the plan of draining the more southern rice fields. The great canals receive the drainage water collected by the largest ditches, which enter the canal at right-angles, and a quarter of a mile apart. Into these larger ditches enter smaller ones, parallel with the canal and one hundred and ten yards apart when the land is new and most open, and at fifty-five yards when it becomes close. The rectangular pieces, surrounded by these larger and smaller crossing ditches, are ploughed in five feet beds, parallel with the smaller ditches; and these beds are crossed, at intervals, by cross-furrows, or grips, which are deeper by a few inches than the alleys of the narrow beds. As this plan of drainage, and also the seeming objections to it, have been fully treated in preceding publications of mine, (especially in Part II.,) no more will be said on these heads here. But, according to this plan, the effect of the drainage is good—and no doubt is aided by the general slight slope of the surface, in the direction of the beds and the parallel smaller ditches.

The soil near the lake so long as known, has always been of more earthy composition, and thinner than farther off. The soil now, within three hundred yards of the lake, is only from ten to twelve inches thick. The subsoil is a good clay, generally blue when moist, in some cases nearly black, and in others whitish blue, and still whiter when dry. It is penetrated by the small and rotted roots of plants or their open passages. The clay subsoil, where so near the surface, is often reached and brought to the surface by deep ploughing. I think it would be beneficial thus to mix it with the vegetable soil, wherever it can be done by the plough—and perhaps it would pay, as manure, if obtained from under the deeper soil, by digging ditches into the clay, and spreading it over the surface.

Whatever may have been the cause, the soil near the lake (and which is also the highest surface,) is not only thinner, but is firmer, and less like swamp soil than elsewhere. This is not only seen on the land long under tillage, but in the adjacent forest land, not yet drained. Farther from the lake, and on the lower levels of the slope, the soil is much deeper now, and was still more so when first cultivated, and of more peaty constitution. Still the subsoil is the same fine bluish clay—and under the clay there is everywhere a bed of sand, which lies so low that it has been rarely touched in digging the deepest ditches.

The original growth of all this now drained and cultivated land was mainly of black-gum and cypress, and other trees usually growing in company with these. On portions, formerly there were groves of unmixed black laurel, with the singular beauty of which I was much impressed in my first visit. But by cold winters, or some other cause, these beautiful trees have been since killed, and very few are now alive.

Where fires have swept over the native forest land when it was unusually dry, in some cases the entire forest growth was killed, and the upper layer of the soil also was burnt und consumed. I saw such cases, where the trees so killed had been mostly prostrated by the different operations of fire and of winds afterwards, by which the land was more effectually cleared than could have been by the axe, without fire. And if the drains had been previously dug, such land could be brought under tillage with a saving of the greater part of the usual cost of clearing. But if not brought under culture, the land so cleared by fire, is covered by a new and different forest growth. Over a large space of such land, on the farm of Mr. Charles Pettigrew, the second forest growth is of the pond pine, (*pinus serotina*,) without any other kind of pine, and scarcely any other kind of tree, other than small shrubs, as the gall bush and fetter bush.

All this soil is more or less of vegetable constitution. And extremely rich as it is everywhere, for the first few years after being drained and cleared, the land is so loose and puffy, and its vegetable matter is so imperfectly decomposed, that the production of the land is small compared to its later crops. As the vegetable matter is rotted, and the texture becomes closer, the soil becomes more productive. But because of the increased closeness of the soil, it requires more care in draining. At its then best state, this land is as rich as any land can be. But the proprietors do not therefore think that it can bear continual cropping, or that it is not benefitted by being manured. And not only is the farm-made putrescent manure applied—but the land is allowed more rest than I would have supposed was required. Lime also. (as might have been inferred in advance,) has been found especially beneficial. Mr. Collins has limed about seven hundred acres—and in some cases, for experiment, has put as much as three hundred bushels to the acre; and in every application has found certain and speedy benefit and profit.

The principal crop is Indian corn, which is doubtless the best adapted to this peculiar soil, and is therefore most sure and profitable in general. Wheat is grown to much less extent, and sometimes produces very heavy crops. Clover, and cotton have both been found productive—a sufficient evidence of the soil being well drained. Rice also has been made, by dry culture, and as much has been raised in that least productive mode, as fifty bushels of rough rice to the acre. Tobacco has been tried, and grew well; but the cured leaves were deemed too coarse and thick. This may forbid the producing of tobacco of particular qualities—but still I infer that on such rich land, other and coarser qualities of tobacco might be raised to great advantage.

In regard to the important question of the sinking, or rotting away of these soils, after their being drained and cultivated, and the rate or measure of this process, I will now proceed to state some of the evidence, in facts learned from the two resident and principal proprietors of the cultivated lake lands, Messrs. Josiah Collins and Charles Pettigrew. These gentlemen, as residents, occupants, and farmers, have known these lands, and all their changes, throughout their adult lives—and by information obtained from their respective parents who were the preceding occupants and earliest improvers, they are well acquainted with the history of the drainage operations, and the effects from the beginning. There could be no better witnesses in reference to their opportunities for observation, and their ability to observe and to judge correctly. But it must be admitted that very few of even the most intelligent residents and agriculturists of all this great swamp region have heretofore even suspected the existence and progress of the natural wasting action in question—or at least, its full measure and importance. Many residents on similar lands elsewhere, and some of the most intelligent, of whom I have inquired on this subject, had never suspected or heard of the opinion before—and most of them remained incredulous as to the danger of any such important loss of the vegetable soil by its decomposition. Every person, even the least informed or observant knows and admits that these lands, after being drained and tilled, become more consolidated and close. This universally understood, effect is ascribed to the joint operation of two causes: 1st, the drying of soil before saturated and distended by water, and the consequent contraction of the parts, and general "settling" of the surface; 2ndly, the later and gradual decomposition of the coarse and loose fibrous matter, which at first makes the larger portion (in bulk) of the upper soil, and which, by its decay, is reduced to closer and more compact and apparently earthy texture. Nearly all persons are ready to admit, from these causes, an early and limited settling and sinking of the surface, of a few inches only, or to such small extent that no importance was ever attached to the result, or any loss of value feared. But no one formerly, and few even now, would suppose that the rotting away, and waste of soil would proceed farther, and much farther, by the complete decomposition, and resolving into the primary gaseous elements, and escape into the air of much of the vegetable parts of the swamp soil. This is the natural and gradual operation which I maintain, and which will be greater or less in the measure of effect in proportion to the large amount of vegetable matter in the soil, (and its being not combined with the soil, as small proportions may be and usually are—) and to the extent of conditions favorable to the progress and completion of decomposition. Even the very intelligent and long experienced observers whose knowledge and testimony as to facts I shall cite, have not thence deduced, nor apprehended, any such injurious final results as seem to me inevitable. And lest my general proposition shall be improperly extended in the application to particular cases, and especially in reference to these lake lands and other like swamp soils, let me here state some general limitation. How much of organic or vegetable matter, any soils can combine with, and hold as useful constituent parts, I profess not to know. But I have no doubt that whatever may be such proportions, in different soils, so much of the organic matter will remain to the soil, without danger of waste, under a proper and lenient system of culture. But if there be in the soil a far greater proportion of vegetable or putrescent matter than the soil needs, or can combine with, then that all the excess, in course of time, will be decomposed completely, and pass off in the final gaseous results of decomposition—provided that the conditions of the soil are entirely favorable to the progress of decomposition. Such effects, amounting to the entire waste of the whole dried and producing soil, I have experienced, and have known in many other cases by sure information, in cases of the embanked tide-marshes of Virginia. And similar facts of the waste (though it has not been so understood, or usually even suspected by the proprietors,) of drained juniper swamp lands. But in both those notable kinds of cases, the soils had probably nine-tenths of their bulk of pure vegetable matter—and there had to rot away but two or three feet of the soil, before the surface was sunk to nearly the level of permanent water or wetness. The general proposition is the same as to the higher or more earthy, and more valuable gum and cypress swamp soils of Lake Scuppernong. But these surfaces even if capable of being so much lowered might sink four or six feet, and yet be high enough for good drainage—their earthy parts may be sufficient to combine with and so retain an abundant proportion of vegetable parts, for the highest measure of fertility—and further, their subsoil of clay may of itself constitute a fertile, and certainly a permanent addition to the soil, should the latter waste away to any conceivable extent. Thus, there is nothing in my general proposition that would contradict the general opinion of the abiding fertility and permanent value of what are deemed the best swamp lands of the low country. With these explanations, stated to guard against misconstruction, I return to facts observed and stated by the proprietors above named.

These gentlemen suppose that their land bordering on the lake, and for some hundreds of yards off, was, from the first, of thinner and more compact soil than the ground more remote from the lake. Not having looked for, or thought of the possibility of considerable lowering of the surface there, they speak only upon general opinion and belief as to the early effects. But since their attention has been called to the subject, they have learned nothing to make them sure that there had or had not been a lowering of this higher surface of the sloping area.

As to the surface more remote from the lake, and lower down the slope, there is no question of there having been a general lowering of the surface, varying in different places from more than one foot to more than three feet of depth. Of the many particular facts noted by one or both of these gentlemen—and of which some (in wood-land) remained to be shown to me—a few cases will be sufficient to cite, as examples.

On each of the lake farms on which these gentlemen severally reside, there is a piece of land left under its original forest growth, to supply fuel, &c. These pieces are surrounded by some of the larger ditches of the farms, and therefore are partially, and but very imperfectly drained, compared to the tillage land. Therefore, because of the continued wetness of (at least) the under part of the soil, the shading of the surface, and the soil remaining unbroken, the decomposition here must have been slow, and imperfect even in any length of time, compared to its progress in land well drained and under tillage. Yet even in such land, there were visible any number of facts which clearly proved that the surface is throughout much lower than formerly. Upper roots of old trees are now from one to two feet above the surface, which could not have grown at first except below the surface. The cypress "knees," or protuberances which rise from the horizontal roots above the surface, in many cases were elevated more than a foot, still higher on two diverging roots—which is never seen on an original surface. The lateral roots of living trees, in some cases passed over old logs lying now on the surface, and which must have been covered by earth when the root passed over. Even young trees, of a few inches in diameter, which had sprung up years after the partial drainage of these lands, showed by their roots that the surface had continued to sink long since its being drained. The wood-land of Mr. Collins, in which we made this examination is from half a mile to a mile from the lake. That of Mr. Pettigrew, in which like facts were observed, is much nearer—perhaps within a quarter of a mile of the lake.

When a field is cleared up and brought under tillage, usually some years after its drainage, and after considerable subsidence of the surface, "ground logs," or trunks of trees formerly buried, and invisible when the land was first ploughed, continue to show as time passes, and require to be removed when they too much obstruct the tillage labors. Mr. Collins in this manner, has had to make two successive and general removals of ground logs in considerable numbers, at different times, of which not one was visible at the surface many years before, and after the first ploughing. With these two successive layers of formerly concealed "ground logs," there must have rotted and passed away at least an equal thickness of the soil.

Mr. Charles Pettigrew knew of the lowering of certain parts of the surface of his land, of more than three feet. He also stated another fact, which is so precise, that there is no possibility of mistake, or of exaggerated estimate of the measure of effect. Before his father's labors of reclaiming were begun, there had been a large ditch dug, and completed to such distance as it was extended, before the work was abandoned in its unfinished state. The "guage," or measure by which this ditch had been dug and shaped, had been preserved, and it was known that its depth was three feet. The stumps of trees, cut off even with the original bottom of this ditch, served to show precisely the level of the bottom. In after time, one of the large canals dug by Mr. E. Pettigrew, took in this much older ditch; and it was then seen that the cut stumps, which showed the former bottom of the ditch, and which had been three feet below the surface, were then even with the surface. Of course three feet depth of the upper soil (though so far very imperfectly drained,) had rotted away. These facts are sufficient for proofs, to sustain my position. If necessary, any number of like particular facts could be adduced, but which would not strengthen the proof, unless by the greater number.

I selected sundry specimens of the soils, and some of sub-soils, of the swamp lands, to determine the quantities of organic or vegetable matter contained, by the proportions destructible by combustion. For these partial analyses, and conducted with scientific knowledge and skill to which I make no pretensions, I have been indebted to Major Wm. Gilham, Professor of Chemistry at the Virginia Military Institute:

SOILS AND LOCALITIES.	ORGANIC MATTER.
1. Soil of Dismal Swamp, Virginia, under gum and cypress forest growth generally, but with some juniper, two feet under surface, adjoining Norfolk and Petersburg Rail Road, contains per cent, - - - - - - - - - - - - - - - - -	48.40
2. Soil of former gum and cypress land, Dr. M. Selby's farm, near Lake Mattamuskeet, North Carolina, fifteen years under continual tillage, - - - - - - - - - - - - - - - - -	21.11
From Swamp lands near Lake Scuppernong, North Carolina,	
3. Land of Josiah Collins, Esq., three hundred yards from the Lake, under tillage twenty-four years, and had been limed, - - - - -	33.28

4.	Clay sub-soil, under the preceding (2), - -	7.91
5.	Land of W. S. Pettigrew—under tillage eleven years—taken at twelve inches deep, - - -	41.38
6.	Do. second year of culture—at fifteen inches depth, - - - - - - - - - - - - -	61.66
7.	Do. Under forest growth, twelve to fifteen inches below surface, - - - - - - -	65.88
8.	Do. In clay sub-soil, two feet under surface, - - - - - - - - - - - - - - -	5.28
9.	Charles Pettigrew's land—newly drained and cleared of the forest growth, - - - - - -	67.00

THE "OPEN GROUND" SAVANNA AND DESERT.

This place known as the "Open Ground," is a body of eighty-seven thousand acres of swamp or peat land, belonging to the State of North Carolina. Until recently, it has been generally saturated with water, and in wet seasons mostly so covered, that in walking on any part, every step on the spongy surface would sink deep, and every foot-print made would be immediately filled with water. This tract lies between Ward's creek and Adam's creek, both of which empty into North River. It is in Carteret county, and from twelve to sixteen miles from the village and sea-port of Beaufort. Nearly the whole of this great savanna, except some pine-covered ground in narrow strips on the margins, is destitute of trees, and nearly so of bushes, and of any shrubs of as much as two feet high. Not far from the outside pine land where I entered the savanna, there are within it many widely scattered small pines, none more than twenty-five feet high, and mostly under ten feet—and all of which seem nearly dead, and many entirely dead. The fires, which have frequently passed over this land have been sufficient causes why neither trees nor shrubs should live long, as by every successive fire, they would be mostly killed down to the surface of the soil. The whole of the savanna was a miry and quaking bog, until the partial draining operations of the State, effected a year ago, [in 1855.]

The peculiar features of this great savanna, had been the cause of much curiosity and discussion, as to its value for agricultural purposes. Even now, and in the neighborhood, opinions on this point, are undecided or opposed. The central portion, (here as in other great swamps, the highest part,) had been ascertained to be twelve feet higher than the tide-water of the sundry surrounding creeks which had their highest head-springs in this morass, and which thence flowed in different directions, outward, to North river or its tributary creeks. - There was plenty of fall for good and effective drainage, which fact, as well the result of the practical trial, would show that the drainage is simple and easy. The entire absence of trees and shrubs would render the clearing for tillage (after draining,) very cheap, compared to clearing off the heavy forest, of most swamp lands. If then the land were rich, like many of the wooded swamps, or even half as rich, this land would be of immense value for tillage, or (as might have been inferred,) more certainly for pasturage.

To test the effect of drainage, the government of North Carolina appropriated five thousand dollars to be expended for works of limited extent. Under a contract for this purpose, last summer a ditch of ten feet wide and about four in depth, was brought up from Ward's creek (tide-water,) to the higher part of the savanna, and then a mile square, ditched around, by ditches apparently five feet wide and three deep. Through the middle of this square the large ditch passed, and into which the smaller surrounding ditches emptied, and through which they are discharged into the creek. Thus, the square mile is divided by ditches into two rectangular pieces, each a mile long and half a mile broad.

I visited this ground on July 3rd, 1856. The weather then had been very dry, for some weeks. There was not much water then flowing from the deeper central ditch; and the bottom of the others, for the longer stretches of their higher parts, were without enough water to flow. The land included within the ditches, and as far as I examined outside also, was perfectly dry at the surface. If fire had been then applied, I am confident that the whole upper layer of soil, for some inches at least, would have been burnt off. Long ago, but after the ditching, and before much drying of the land had been yet caused, a fire that burnt over the dead or dry growth also burnt up much of the banks of the shallower ditches, and in many cases spread some ten feet off, consuming from four to eight inches depth of the original soil. At this time, dry as is the surface, and covered in all lower spots, by dead and dry moss, (*sphagnum palustre*) but a few inches depth of soil would burn, as damp earth was still near below. But if the ground escapes being burnt over for a year or two more, and it should then be fired after a long dry season, the drained square mile, and much also of the surrounding ground, will be burnt out some feet in depth. And then if the lower ditch should be choked, the burnt and excavated space will become a lake, as has occurred from the same operation of burning in sundry other of the great swamps without the aid of any previous drainage.

The upper layer, of about two feet, is mostly a mass of matted roots, of which but few have rotted enough to even appear to the eye as soil or earth. Wherever there remained on the surface of the ditch-bank a sod of this layer, as cut and thrown out by the spade, and exposed to a year's rains, the finer parts were washed from the upper surface, the small fibrous roots, still unrotted, only were visible, and the whole lump, with its earthy parts and with still some remaining moisture below, was light enough to float in water like a cork. Below this layer, was one of about one and a-half feet, which, as seen well exposed all along the ditch sides, seemed to the eye to be good and rich black soil, of close grain and texture, and free from fibrous roots, except a few, and those well advanced in decay. This layer at least, for its slight depth, seemed to offer a rich agricultural soil, though of course still a soil of vegetable formation. The dry lumps of this layer, where remaining on the banks, and where not charred by the fire which had consumed the dry sods of the upper layer, preserved their earthy appearance, and were very hard, and of black color. But when thrown into the water, with enough force to be sunk below the surface, these lumps, also would immediately rise, and float. How long they would continue to float I did not stop, (for want of time) to notice. After being thoroughly moistened, doubtless they would sink; and also when thoroughly saturated and distended by water, this earth would again be as heavy as in its former state of soft mire.

Below the last layer, and as exposed generally in the deeper digging, is the sub-soil of nearly pure sand, and yellowish color, showing an admixture of iron. The former saturating water having been ferrugineous, probably served to render still worse the quality of the peat above, as soil. In the shallower surrounding ditch, most remote from the outlet, none of this sand-bed was visible, and the lowest earth showed (on the bank,) a reddish brown tint, more like clay than sand. If anywhere the under-layer is of clay, instead of sand, it would add much to the little promise of agricultural value. I had no means, and indeed no time or inducement, to dig deeper in the ditches, to seek for the surface and the kind of the bed next below, where it was not visible in the ditches. Neither did I subject specimens of the two layers of soil to any more rigorous test than their being floated in the ditch water, to ascertain how large a proportion of their weight is of vegetable, and therefore, of combustible matter. What I saw satisfied me that the land is, so nearly worthless for tillage, that it was not worth—(from one having no interest but curiosity) more troublesome and accurate examination of the physical and chemical constitution of the savanna.

Many persons, in this neighborhood have contined to this time to entertain high estimates of the possible value of this land. Since the ditching of last summer, sundry proposals have been made to the Literary Board, and refused, to purchase portions of a few thousand acres each, at different prices offered from ten cents to twenty-five cents per acre; and one dollar for one or two thousand acres of the already drained portion. I have since heard that the last offer has been accepted. Before my seeing the land, and when knowing no more than I could gather from the published report of the State Agricultural Surveyor, (made some years ago,) and my own supposition as to the manner of formation and the constitution of the soil, I had formed a very low estimate of the possible agricultural value.

Still, I thought that such land, even with very imperfect and cheap ditching would at least make valuable pasturage, capable of well supporting many thousands of cattle, and yielding large numbers sufficiently fattened for sale for beef. And, if profitable at all for tillage, that the total absence of trees and shrubs would, after draining and a superficial burning, make the ploughing easy to perform. Under these impressions, and before seeing the savanna, if it had been offered to me for ten cents the acre, I would have bought the whole, at a venture. But it required but little of my walk of four miles along the ditch banks and the adjacent ground, to dissipate all my ideas of such accruing profits. I would have expected, even if before the partial drainage, and still more afterwards, to find there grazing the cattle of all the surrounding residents and farms, if not many more from greater distances. Instead of this, not one grazing animal was seen, nor do I believe that there was one on all the immense savanna—and for the good and sufficient reason that there was no grass or other food for the support of a single cow. I did not notice a single tuft of any apparently good grass. Yet there is enough growth of some other kinds to render the whole surface one impasable thicket, if the fires could be kept off for but two successive summers. The present living plants, except their roots, are all the growth of the present season, produced since the last fires killed everything above ground. The principal plants observed, were what seemed something like a species of huckleberry bush, and other shrubs, very young and not known to me—and a species of China brier (called bamboo,) which is a strong and hard vine covered with numerous small and sharp thorns. This growth stands everywhere, and if it had not been so young and small, would have effectually barred my progress. There were scattered spires of the bunch-topped, (or wet-land) broom-grass—many of the curious trumpet plant (*saracenia flava*) which is a natural bug trap, and some of the kindred pitcher plant—with other flowers of weeds of wet and sour savanna lands. But the plant which had formerly covered most space, and though then apparently dead still covered every small depression, where water had formerly stood, and perhaps half of the entire surface, is the bog moss, (*sphagnum palustre*,) which, by its general growth, and its tannin, and its astringent and acid nature resisting decomposition, serves more than all other plants to furnish material for the formation and growth of peat bogs. This moss is now everywhere dead and dry, and its remains make a kind of thick carpet, the parts cemented or felted together, closely covering all the spots where moss grew.

There was afforded, in the effects of the burning, evidences still more strong of the worthlessness, or intractability of the upper layer, under any attempt at tillage. In consequence of the partial drying of the land, much of the ditch banks had last year been burnt off, and the fire in some parts had spread a few yards, into the adjoining ground, and had consumed the upper part to the depth of six to eight inches. This would have been the very process deemed best for preparing for and facilitating ploughing—and I had thought (in advance,) would have given a clear and friable layer of earthy texture for the plough to operate in. Every living root had indeed been killed in the burnt spots. But the following rains had washed the exposed fibrous roots and made the few earthy particles sink or disappear—so that the new surface as low beneath as my fingers could reach, seemed not less a mat of tough unrotted fine fibrous roots, than the former surface layer, was, where not burnt. In either, the good operation of a plough would be impossible, before an upper layer of these roots shall rot.

The whole surface, so far as I saw and trod upon, was quite dry, but soft and spongy, and so yielding to footsteps as to render walking thereon even more difficult and laborious than on the very rough and also soft and yielding banks of the ditches.

The whole broad surface of the "Open Ground" presents a singular and remarkable scene of desolation and solitude. There was no appearance that any human being had gone as far into the ground as the remoter ditches, since they had been finished. The tracks of a large bear, and a raccoon were seen in the soft mud in the ditches. But not a living creature was seen, except a few small frogs in the ditches and a few water-frequenting insects (like small dragon flies) hovering over the water. Whether it was owing to the brisk breeze, or to the absence of all animals to serve for the support of mosquitoes and biting flies, it is certain that I saw neither in the savanna.

SKETCHES OF LOWER NORTH CAROLINA, &c.

PART VI.

NOTES ON THE PINE TREES OF LOWER NORTH CAROLINA AND VIRGINIA.

Pines made a large proportion of the trees of the primitive forests of the eastern and lower lands of North Carolina and Virginia. And when any of these lands had been cleared and cultivated, exhausted and abandoned, then a new growth of pines formed the universal unmixed cover. As nearly all the lands of lower Virginia had been thus treated, and in succession had reached this second growth, which thus covered all the then poorest and most worthless lands, a general cover of pines, and the term "pine old-fields," came to be generally understood as indicative of the poorest and meanest of lands. For this reason, and also because of the growth of pines being so common and pervading, these trees were not only undervalued, but despised. If a natural forest of various trees was thinned out to make an ornamental grove near a mansion, every noble pine would be certainly cut out, as if a deformity, and a worthless cumberer of the ground. In planting trees for the embellishment of homesteads, if any proprietor had in select-part ed any of our native pines for that purpose, his taste would have been deemed as ridiculous as it was novel and strange. For the most magnificent pines, or the unmixed evergreen of a pine forest in winter, to be admired, it was requisite that the observer should be a stranger, from some distant region, in which pine trees and pine forests were not known. Then, indeed, and in all such cases, their remarkable beauty and grandeur would be fully acknowledged and felt.

All of the many species of pines have the properties of being resinous, bearing their seeds in cones; which, however varying in size and form, have a close general resemblance, and there is a like general similarity of shape, differing from all other trees, of their peculiar evergreen leaves. These spring from sheaths, or are held in clusters of two, three or more leaves to each sheath, according to the species of the tree. The leaves, differing from all others, except of the kindred family of the larch, are long and slender, almost as thick as their width, and of equal diameter throughout their length, except immediately at the extremity, which is a sharp point. The new leaves, as on other trees, grow only on the new twigs (or 'water-sprouts') which shoot out in the spring, from the last year's buds. But the leaves of the preceding year's growth remain attached to the older branches through a second summer, if not the autumn also. In some species the leaves sometimes in part remain into the third year before dropping off entirely.

Some of our species of pines are of such distinct and marked appearance, that the most careless observer would not fail to distinguish them. Such are the southern long-leaf pine, (*pinus australis*,) the Jersey pine (*p. inops*,) and the white pine, (*p. strobus.*) But many farmers who have long lived on cultivated lands, among pines, have not learned always to distinguish other still more common species. And even when this knowledge is not wanting, still there is such confusion and misapplication of the vulgar names of all the kinds, that it is difficult for any one to speak of or to inquire concerning any one pine, by the vulgar name of his own neighborhood, without the name being misapplied by an auditor from another locality. Thus, the name "yellow pine," in different places is used for three different species, of all of which the heart-wood is more or less yellowish. The name "spruce pine" is used in Virginia for one species of pine, and farther south for another. And the several designations of "long-leaf pine," "short-leaf," "old-field pine," &c., are merely terms relative, or used in contrast with other different growths, and are each applied to different kinds in different places. Even the botanical names, though serving generally for exact designation, in most cases have either no special application, or are entirely erroneous as to their meanings. Such are the designations "*mitis*," "*inops*," and especially "*palustris*," as descriptive terms of species. Further, the qualities and value for timber, and even appearance of pines of the same species, are so much varied by different conditions of situation and growth, that some of the most experienced and intelligent "timber-getters" (or "lumberers") consider as two distinct species, trees which belong to the same. I have, myself, until recently, been under some of these mistakes as to the species with which I had longest been familiar. Under such circumstances I cannot even now be confident of avoiding errors. But even my mistakes, (if corrected by others better informed) as well as my correct descriptions and designations, may serve to clear away much of the obscurity and error in which this subject has been involved.

One of the most remarkable and valuable qualities of some of the pines is, that their winged seeds are distributed by winds to great distances, and in great numbers, so that every abandoned field is speedily and thickly seeded, and the kind of pine which is most favored by the soil and situation, in a few years covers the ground with its young plants. The growth, especially of the most common second-growth pine, (*p. tæda*,) is astonishingly rapid, and even on the poorest land. And while other land might still be bare of trees, that which favors this growth would be again under a new and heavy, though young, growth of pines. This offers, (especially in connexion with the use of calcareous manures,) the most cheap, rapid and effectual means for great improvement of poor soils. And besides this greatest end, the cover of the more mature wood, if marketable for fuel, will offer the quickest and greatest return of crop that could have been obtained from such poor and exhausted land.

I will now proceed to remark on each of the several species of pines found anywhere in the region in view, and will commence with such as are most easily and certainly to be distinguished, before treating those less distinguishable, or in regard to which there may yet remain any doubt or uncertainty.

The Long-Leaf or Southern Pine. Pinus Australis of Michaux, Palustris of Linnæus.

The name *palustris*, notwithstanding its high authority, is altogether inappropriate, as this pine prefers dry soil and is rarely seen, and never in perfection, on wet or even slightly moist ground. *Australis* is peculiarly appropriate, as this tree is limited to a southern climate.

This species barely extends a few miles north of the southern boundary of Virginia, in the south-eastern counties of Southampton and Nansemond. Few, if any, stand in the lower and wetter lands of the more eastern counties in the same southern range. The long-leaf pine prefers dry and sandy soils, and is found, almost without interruption, says Michaux, "in the lower Carolinas, Georgia and Florida, over a tract of more than six hundred miles, from north-east to south-west, and more than one hundred miles broad;" but not, (as that author also says,) from the sea to the mountains, or near to either, in North Carolina. In that State it extends westward not much higher than the falls of the rivers, and towards the sea, no farther than the edge of the broad border of low, flat and moist land. Its general and best growth also equally indicates a sterile soil. The mean size, sixty to seventy feet high, with a nearly uniform diameter of fifteen to eighteen inches for two-thirds of the height. Some trees are much larger and taller. Leaves ten to twelve inches long, (fourteen and more on some young trees,*) growing in threes, (to each sheath,) and about one-sixteenth to one-thirteenth of an inch in breath. The cones from seven to eight inches long, and two to two and a-half broad before opening, of the scales or seed-covers, or four inches when spread open. The seed-

* I have since found and measured leaves nineteen and a-half inches long, in Barnwell, South Carolina.

covers of the cones armed with short, strong and not very sharp spurs. The seeds, when stripped of their shells, are white and larger than a common grain of wheat, and are of agreeable taste, having a resinous flavor. They are so eagerly sought for by hogs, that scarcely any are left on the ground to germinate. For this cause, as well as the great destruction of the trees, in tapping them for turpentine, these pines are rapidly diminishing in number, and if not protected, this noble species will almost disappear from the great region which it has heretofore almost exclusively covered and adorned. This tree is especially resinous, and is the only pine that is tapped for turpentine. Scarcely a good tree in North Carolina has escaped this operation, unless in some few tracts of land where that business has not yet been begun. This tree also has furnished the best of pine lumber; but its durability is said to be much lessened by the tree, when living, having been made to yield turpentine. The heart is large and the grain of this timber is close, and only inferior in that respect to the short leaf yellow pine, (*p. mitis* or *variabilis*.) For naval architecture, timber of this tree, when large enough for the purposes required, is preferred to that of all other pines.

The broad belt of land stretching through North Carolina, which has been covered by the long leaf pine, except for the borders of rivers, is generally level, sandy and naturally poor. Even if it had been much richer and better for agricultural profits, the labors of agriculture would still have been neglected in the generally preferred pursuit of the turpentine harvest. But so poor were the lands and so great the profits of labor, and even of the land, in the turpentine business, compared to other available products, that capital thus invested has generally yielded more profit than agriculture on the richest lands. Therefore, it is neither strange nor censurable, but altogether judicious, while these great profits were to be obtained, that nearly all the labor of this region was devoted to making turpentine, instead of enriching and cultivating the soil. But the effect of the course pursued has been not only to limit agricultural labors to the narrowest bounds, (as was proper,) but also to prevent almost every effort for improving the soil and the productions of the small extent of land under tillage. However, the juncture is now reached when this formerly most profitable turpentine business must be gradually lost; and then agriculture and improvement of fertility will not only be attended to, but will be especially rewarded in many portions of this now poor region, which yet promises great resources for being fertilized. The rapid destruction of the forests of long leaf pine is not only the necessary result of the two causes before stated, but the work has been still more rapidly forwarded in some places, by another cause. At one time, in years past, there was a sudden and wide-spread disease of this kind of pine, caused by the attack of some insect unknown before or since. Fortunately the operation, though far extended, was not general. But wherever it was, the destruction of the living trees was nearly or quite complete. For thousands of acres of pine forest together, and in a single summer, every tree was killed. The evidences of such destruction in the still standing dead trunks, are now seen in many places, and most extensively, as I lately saw, along the route of the Wilmington and Manchester Railway, not many miles south of the Cape Fear river. Similar extensive, and as transient destructive visitations, had occurred long before. One of these I remember to have read of forty years ago, in a communication to the Memoirs of the Philadelphia Agricultural Society. Partial as these depredations have been, as to species, any one proprietor, or many adjacent proprietors, in the route of these ravages, might have the whole value of their pine forests utterly destroyed in a few weeks.

The great beauty and striking appreance (to a stranger) of a southern pine tree, of great size and fine form, are owing to the long and straight and slender trunk, and to the very long leaves and large cones. In the close growth of forests, the branches, like other old and good timber pines of other species, are crooked, irregular, rigid and unsightly. But these and all defects are overlooked in their forest growth, when all the numerous trees make but one great and magnificent object, their tops meeting to make one great and thick canopy of green, supported, as far as the sight can stretch, over the open space below, by innumerable tall columns of the long and straight and naked bodies of the pines.

The Cedar Pine. (Pinus inops.)

This pine, like some others, has sundry names, and some of which are also applied elsewhere to other species. In Virginia it is known in different places as the "spruce" or "river" or "cedar pine." The last vulgar designation, which will be here used, has been applied because of a slight general resemblance of the growth and appearance of the tree to the cedar; at least more so than of any other pine; and so far the name is descriptive and appropriate. The most general vulgar name farther north is "Jersey pine," which is adopted by Michaux.

This pine is generally seen only of young growth and small sizes. Where long established, and of largest sizes, in Virginia, it is rarely found exceeding fifteen inches in diameter. The trunk is not often straight enough for sawing into timber. The bark is very thin, and also smooth compared to all other pines of this region, and the sap-wood also is very thin. Of the older trees, nearly all the trunk is of heart-wood. Though the tree is but moderately supplied with resin, it makes good fuel, and much better than the other pines of Virginia, of new growth and but moderate sizes, such as are mostly used for fuel, for market, and especially for the furnaces of steam engines. The leaves of this pine grow in twos, (from each sheath,) are generally shorter than any other kind, usually from one and a-half to two inches, and about one-twentieth to one-sixteenth broad. The cones usually are from one and three-fourths to two and one-fourth inches long, and three-fourths to one inch thick, when closed. The separate seed-covers on the cones have each a small and sharp prickle, curved backward. The cones are set drooping backward on the branches; and they remain so long before falling, that the old and the new together sometimes stand on a tree as thick as the fruit on an apple tree. The branches are much more slender, tapering, and flexible than of other pines, and the general figures and outlines of the well-grown trees are more graceful and beautiful. When making the entire growth of a thick wood, and on the slope of a hill-side, where the tops of the higher trees are seen above the trees next below, and all thus best exposed to view, the foliage and the whole growth, so disposed, are singularly beautiful.

I have not observed this tree anywhere in North Carolina. It is but sparsely set and mostly of young growth in the south-eastern parts of Virginia. But the growth is there increasing and spreading. In Prince George, on and near James River, the young trees are far more numerous, and more widely scattered now than was the case forty years ago, when I knew them there only on some small spots near the river banks. On the lower Appomattox, in that county, this is now the principal pine growth, and of its large sizes. In Westmoreland, and the other parts of the peninsula, between the lower Potomac and Rappahannock, this is now the main growth, and the great supply for market fuel, which is so great a product and labor of that region. Yet I have heard, from Mr. Willoughby Newton, that it is remembered when not a tree of this species was to be seen in all the extent of that peninsula. It is now there the regular second-growth pine, which first springs on and occupies all abandoned fields, as do the other "old field" pines, of different species, in other parts of Virginia and North Carolina.

The White Pine. (Pinus Strobus.)

This tree, of beautiful foliage and general appearance, and which grows to a magnificent height, is not known in eastern North Carolina, and is so rarely seen anywhere in Virginia east of the mountains, that it scarcely comes within the limits of my designed subject for remark. However, it is named for the contrast it presents, and thereby setting off more strongly the opposite qualities of other species. But its description need not occupy more than a small space. This is the great timber pine of the northern states. In travelling westward from the sea coast through the middle of Virginia, this tree is first seen in the narrow valleys of the North Mountains in Augusta county. It is there called the silver pine. The small trees are beautiful and the large ones magnificent. The bark of the young trees is very smooth, (in this differing from all other pines,) and the branches spring from and surround the young stems in regular succession, and three or four from the same height, on opposite sides, as do the young side shoots of dogwood. The leaves grow in fives, (from each sheath,) about four inches long, and very slender and delicate, and of a bluish green color, and silken gloss.

This pine, different from all of the other species growing in our region, prefers such fine soils as are found on the alluvial but dry margins of rivers, and in mountain glens.—[*Darlington's Agricultural Botany.*]

Short Leaf or Yellow Pine. Pinus variabilis. (***P. mitis*** *of Michaux.*

Cones, length one and three-fourth to two inches. Breadth (as closed,) three-fourths to seven-eighths. Nearly smooth, the prickles being very short, slender, and weak. Leaves, length, on different trees, one and three-fourths to three inches; breadth, one twenty-fourth to one-twentieth. The leaves grow mostly in twos, (from each sheath,) and many trees, if but slightly examined, might seem to show that this was the universal law of this pine. But on most trees there are also leaves, in much smaller numbers, growing in threes, intermixed with the others. This variation is especially apt to occur, partially, on very young trees of rapid growth On one tree, of eight inches diameter, cut down to furnish specimens of cones, I found so many of the leaves in threes, that those in twos did not amount to one in twenty. The leaves in threes being in greater number, I have not observed elsewhere. Generally, the leaves in twos on any one tree, are very far the most numerous.* All the specimens, from which the measurements were made, I gathered in the old forest land of Marlbourne farm, Hanover, Virginina. The lengths of leaves on different trees vary much, and, in some cases, even on the same tree and twig, and also the sizes of cones on different trees, as

* Very lately, (1860) I observed a second growth tree *p. variabilis* which, in two hundred counted sheaths of leaves, had one hundred and ninety-five in twos, and but five in threes. It is very uncommon that the disproportion is so great, either in the great number of leaves in twos, or of threes, as in the other case stated above. To other than very careful examination, the leaves of one tree would have appeared wholly in threes, and of tho other wholly in twos—and therefore that neither tree belonged (as in truth both did) to the species of short leaf or yellow pine, or *p. variabilis*.

well as the proportions of leaves in twos and in threes. From these marked variations, I am disposed to believe that some trees are of hybrid generation, or crosses between the pure short-leaved tree of the species, and the *P. tæda.* But whether this surmise is correct or not, and however great and many may be the variations, this species, notwithstanding its variations, is easily distinguished by its short leaves in twos, from any of the three-leaved species—and it cannot be mistaken for the cedar pine, (*p. inops*) the only other short and two leaved species, because of the great difference of general appearance. The short-leaf yellow pine, (*p. variabilis*,) in middle and most of lower Virginia, is the great and valuable timber pine of that region, and makes the best timber of all, because of its more resinous heart-wood and very close grain. The most beautiful and highly valued floors of lower Virginia, and which are no where equalled, are made of plank of of this tree. Old trees, in original forests, are from two to three feet in diameter, and usually are mostly of heart-wood. This is very durable. But the sap-wood, if exposed to changes of moisture, soon rots, as with all other pines. Formerly, nearly all the pines of the original forests in lower Virginia, and in dry and medium or stiff soils were of this kind. But as these and other trees have been cut out, and the forests thinned, other kinds, (mostly *p. tæda*, and in fewer cases, *p. inops*,) have made most of the later growth. And still more, and almost entirely, is this the case on abandoned old fields, whereon, though speedily covered by pines, very few of this species are to be seen. Yet in the upper country, at some distance above the falls, (as in Cumberland, Amelia, &c.,) though the abandoned fields are there also occupied by a second growth exclusively of pines, yet all these are of this kind, and scarcely a tree is seen of the *p. tæda*, or the "old-field" pine of the lower country generally. The same thing I have seen in Orange, North Carolina, on abandoned high land fields, near the head affluents of Neuse river.

When of recent and rapid growth, and especially when of second growth on land formerly cleared, this pine is mostly of sap-wood, in that respect like the *p. tæda* ; but still the former has more heart, and is of more durability, when exposed to the weather than the latter.

The yellow pine grows, (or formerly grew,) in great perfection, but in detached and scattered and limited localities, in sundry of the upper counties east of the mountains in Virginia. But, generally, in the Piedmont region, at fifty miles and farther above the falls, neither this nor any other pine grew in the original forests. In the range of counties next below the falls, it was formerly almost the only pine, and also the most common of all trees, of the original forest growth. It lessens in quantity, or in proportion to other species, as we descend towards the sea coast, and also as we go southward. After reaching the low, flat lands neat the sea coast, and the southern region where the long-leaf pine first appears, the yellow pine is seen but rarely. But as far south and east as Pitt county, N. C., at one place, and in Beaufort county, near Washington, I saw that nearly all the forest pines, on some spaces, were of this species, and of large size and fine form. The spots on which they thus show, are of dry soil, and, probably, also more clayey than in general, so as to favor more the growth of this than of the long-leaf pine. Also, between Plymouth and the great swamp in Washington county, N. C., this pine, of large size, and very perfect form, and with long and straight trunks, is the main original forest growth, on level, stiff soil, which, though firm land, and called dry, is so low and moist that I was surprised to find thereon this kind of pine. These facts, and especially the last case, go to show that a close or clayey soil, or sub-soil, has more power to promote the growth of this pine, than it is opposed by the increased approach to southern climate, and low and damp soil, both of which are un favorable to this pine, and very favorable, respectively, to other species. This pine is also seen, in few cases and of bad growth, in the always wet and miry, and often overflowed, swamps bordering on Blackwater river in Virginia, south of the Seaboard Railway.

Loblolly Pine. (*Pinus tæda.*)

This called "long-leat" in the Piedmont counties of Virginia, where the "short-leaf" is common, and this is rare—and "old-field" pine in most of the lower counties, where that designation is correctly descriptive. But as both these provincial names are elsewhere applied to other pines, I prefer the vulgar name used in South Carolina, of "loblolly," which, though unmeaning, will not mislead by having more than this one application.

The loblolly pine (*p. tæda*) is rarely seen north of Washington, D. C. I saw a few on exhausted land near Bladensburg, Maryland, within a few miles of Washington. Proceeding southward they become more and more abundant, but do not extend westward many miles above the line of the falls of the rivers. This supposed western limit of its growth, and the supposed cause of this boundary, were discussed in Part I. of this series. On all the exhausted and abandoned naturally poor soils, both dry and moist, certainly, and much, also, of the naturally good, but exhausted, south and east of this upper limit, the loblolly pine springs soon and speedily, and thickly covers the surface. With some exceptions already named, where the cedar pine is the common second growth, the loblolly pines make the almost entire, and also abundant, second growth, on these abandoned lands. In the original forests, probably, it was formerly rather a scarce tree, as it is still, where there has been not much cutting out and thinning of the natural forest. It is only as a second growth that this pine has become abundant, and only on all the poorest and worst natural soils that it has taken almost entire possession of the ground, and seems to exclude other trees, and to thrive in proportion to the base quality of the soil—and more especially in proportion to the deficiency of lime in the soil. But, also, sandy soil and warm climate are further promotive of this growth; and, therefore, as proceeding southward, through eastern North Carolina, the loblolly pine, as a second growth, thrives more and more in general. I have even seen some few large and flourishing pines of this species, on the Rocky Point land, which seemed to be certainly calcareous.

As it is a disputed question, which will be considered hereafter, whether the great Swamp or Slash Pine, a valuable tree for lumber, is of the same species, or different from this, for the present I will speak only of such trees as are undoubtedly of the kind known as "loblolly" pines.

These make the general, and in many places the exclusive, second growth from some ten or twenty miles above the lower granite falls, to the sea coast. Within these extreme limits, almost every exhausted and abandoned space is soon covered by this growth, whether naturally poor or rich, of medium texture or sandy, wet or dry. The only known exceptions are spots of old cleared lands, which, from some cause, were highly calcareous, on which the loblolly pine refuses to grow, or if growing, shows plainly an unhealthy and unthrifty growth.

The cones on different trees are from three to five inches long, and from one to one and five-eighth inches thick, (as closed.) The prickles on the seed-covers, stout and strong, and not pointed very sharp. The leaves from five to seven and a-half inches long, and from one-sixteenth to one-thirteenth broad They grow in threes, and, as I believe, universally so on trees of considerable size. But on trees of but a few years' age, of rapid and luxuriant growth, some few of the sheaths will be found to contain four leaves. But this is the exception, and a rare one. The general rule is that the leaves grow in threes. By this rule, though, these trees may vary from each other in the lengths of leaves, and sizes and shapes of cones, still, all are readily distinguishable from any specimen of the short leaf or yellow pine, (*p. variabilis*,) however near such specimen may approach to other usual characteristics of the loblolly pine.

The grain of this wood is very open, the wide intervals soft, and the wood, as timber, of the most worthless description. There is very little heart-wood in large trees—none, or almost none, in the small—and the heart-wood is but little resinous, solid, or durable, as timber. The sap-wood, (when growing) seems much more resinous than the heart. Trees of two feet in diameter usually have but two or three inches of this poor heart-wood. It is only when of small growth, and but rarely then, that the trunks can be riven by wedges, without more labor than profit. When split before growing too large, and after being seasoned or well dried, this wood makes quick burning fuel, of which immense quantities are sold to the north, as well as at home, for the furnaces of steam engines and other uses.

Worthless and despised as is this tree for timber, and for most other uses, it is one of the greatest blessings to our country. It rapidly covers, and with a thick and heavy forest growth, the most barren lands, which otherwise would remain for many years naked and unimproved by rest. By the fallen leaves, which from this tree are very abundant, the impoverished soil is again supplied with the deficient vegetable matter, and, with other aid, may be restored soon to fertility. And the crop of wood, where near enough to market, may be worth threefold of what would be the value of the land, if without this product.

It is not only on dry or arable land that this tree grows vigorously and to a large size. Such may be seen on land much too wet for tillage, and too low for drainage—as on some of the abandoned lands near Lake Mattamuskeet, where the surface of the ground is not more than eighteen inches above that of the adjacent waters of Pamlico Sound—and where, also, the salt water is raised by violent winds and strong tides still higher, and sometimes so as to cover the land on which the pines stand. The power of these trees to resist such unnatural visitation and changes of condition, and without apparent injury, is remarkable.

The Great Swamp Pine; or, the Naval Timber Pine. The Slash Pine.

During my first visit to the low lands of North Carolina, bordering on Albemarle Sound, in 1856, I first heard of and saw pines of unusual large sizes and peculiar character, and which were understood by all of the most experienced and intelligent lumber cutters to be of a different kind from any of the species I have described, or any other known in North Carolina or Virginia. My principal source of information and instruction, in regard to this pine, was Edward H. Herbert, of Princess Anne, a gentleman of much intelligence, and who has for twenty years been principally and very extensively engaged in contracts to supply to the navy yards of the government, timber suitable for the construction of ships of war. In this business he has examined the whole country and has bought, cut and supplied to the government naval stations, much of the largest and best timber, (such only being fit for the masts and other spars of the largest ships of war,) that could be procured in lower

Virginia and North Carolina. He has found no pines of any kind except of that now under consideration, large enough and having enough of heart-wood, to make the masts, spars and other timber of the largest required size. It should be observed that the proposals advertised for, to supply, by contracts, timber for the United States navy yards, mention and recognize but two kinds of pine timber, "white" and "yellow pine." The former is of the northern white pine, (*p. strobus*,) and the latter designates especially the long-leaf southern pine—but which in usage includes also the short leaf yellow pine, (*p. variabilis*,) and the great pine now to be described. This tree grows only on low and moist land, and is the better for timber, and grows larger, in proportion to the greater richness of the land. It is the principal and largest timber pine in the original forests of all the low, flat and firm, but moist lands, bordering on Albemarle Sound, and also farther south—and I have seen it growing as well, but much more sparsely, on the rich swampy borders of the Roanoke, and in the best gum lands bordering on the Dismal Swamp, and some on the low bottom lands of Tar River. Among the other gigantic forest trees on the rich and wet Roanoke swamps, (on the land of Henry Burgwyn, Esq.,) mostly of oak, gum, poplar, &c., the few of these pines which yet remain, tower far above all others, (twenty feet or more,) so as to be seen and distinguished at some miles distance. I have visited several standing trees and the stumps of others that had to be cut down, which measured either nearly or quite five feet in diameter, and were supposed to have been from one hundred and fifty to one hundred and seventy feet in height. But the sizes and heights of the trees may best be inferred from the list below of hewn (or squared) stocks, which was furnished to me from Mr. Herbert's timber accounts. These stocks were cut in Bertie, North Carolina, and made the whole of one raft which was then (May. 1856,) on its passage through the Dismal Swamp Canal to New York. The stocks were thence to be shipped to Amsterdam for naval construction, under a contract with the Dutch government:

	FEET LENGTH.	INCHES SQUARE.	NUMBER OF CUBIC FEET.
1	47	25	204
2	66	19	165
3	86	30	537
4	79	31	527
5	88	23	337
6	65	20	181
7	74	26	347
8	80	26	376
9	68	24	272
10	58	22	195
11	86	30	537
12	58	30	363
13	74	26	347
14	74	26	347
15	70	28	381
16	70	27	368

But even the longest of these stocks do not approach the magnitude of one which was cut at a previous time in Bertie and sold in New York by Mr. Herbert. This was eighty feet in length and thirty-six inches square at the lower end. He sold it to a dealer for five hundred dollars, and the buyer re-sold it for six hundred dollars. This stock did not retain its stated diameter (at the butt) to its upper extremity, but was there from twenty-eight to thirty inches square. All these stocks were nearly all heart-wood. It is required that two-thirds of the surface of each side of every stock shall be of heart-wood. Of course this condition permits but little sap-wood, and that only in the angles of the squared stocks. Thence, also it follows that the proportion of heart-wood in these trees must be very large. The timber must be resinous or it would not be good, and it must be durable, or it would not serve for the masts and other great spars of ships of war, exposed to alternations of wetting and drying, and for which the best materials only are permitted to be used. The grain of this heart-wood is not generally very coarse, but more so than the long leaf, and still more than the short leaf yellow pine. Mr. Herbert, the better to aid my investigations, procured from the navy yard of Gosport, a thin cross section of the stock used for a mast of the United States war steamer Roanoke, which also he had cut in Bertie. The section is of the stock hewed to twenty-seven inches square, and of which but a very little sap wood was in two corners of one side only. As the tree was not entirely straight, the centre of the heart is thrown considerably to one side of the centre of the end of the stock, where the section was cut off. The heart wood was thirty-four and a-half inches diameter, and contained one hundred and eighty-six rings, (as measured and counted on the wider side, or radius, which, from the centre of the heart, measured seventeen and a quarter inches.)

The remaining sap-wood, three and a quarter inches, contained one hundred and sixteen rings, or thirty-two and one-third average to the inch.

Whole number of rings left visible in the stock three hundred and two.

A radius of three inches from centre, of heart wood, took in nineteen ring marks.

A radius of six inches from centre of heart wood, took in thirty-four rings, or five and two-thirds average to the inch.

The outer inch of sap wood, (not outside of the tree,) forty-nine rings.

The outer rings in the sap-wood, visible in the corners, were so very close as to be indistinct; and, perhaps, some of them were omitted in the counting, though the examination was aided by a magnifying glass. In addition, and which makes a much larger omission, neither corner extended to the outer part of the sap-wood of the tree; and, therefore, if only an inch was cut off, it made the loss of at least fifty rings and years' growth. It is probable that this tree had considerably more than three hundred rings, indicating as many years of life and growth. How much older must have been the tree which made the largest stock named, or other trees of five feet or more in diameter!

With such size and value of this tree, and such marked differences from every other pine known in the same region, it is not strange that nearly all opinions of the residents, and of those of most practical acquaintance with pines and their timber, should have agreed, and without exception or doubt, that this was a peculiar species. So I learned from every source of instruction, and so I believed until recently, when the comparison of all my information and personal observations made me not only doubt the fact of this being a distinct species, but induced me fully to believe that this tree, of the most magnificent and superior size and valuable and remarkable qualities for timber, is identical in species with the universally despised loblolly pine, which is almost without heart-wood, and is the most worthless and perishable material for timber; and that great age and slower growth, and in some measure a better and a moister soil, are all that have caused the different qualities and the great superiority of the old swamp pines. I know that this opinion would be deemed absurd by persons the most acquainted with these different trees and their timber. I will proceed to state the grounds for my change of opinion.

When, at first, fully believing (as instructed by others) that this swamp pine was a different kind, it was necessary thence for me to infer that Michaux, who personally and carefully examined so many of our forests and trees, and also all other botanists, were ignorant of the existence of this noble tree, which exhibits its superior magnitude over so much extent of our country. It is probable, indeed, that even the laborious and careful Michaux did not, in his travels, pass through, even if he entered, the lowland region on and near the Albemarle sound—a region which is still almost a *terra-incognita* to all other persons than the residents and near neighbors. For if these trees had been seen on their natural soil, in their most perfect conditions of size and value, whatever might have been their species, they could scarcely have passed, as they have done, without being mentioned by any botanical writer. If not the *p. tæda*, these trees cannot belong to any other of the species of this country; and therefore, they would the more attract a botanist's attention, and induce particular notice and description, as presenting a new and before undescribed species—or at least new in this locality. And if they had been observed, and recognized as the *pinus tæda*, a scientific observer, like Michaux, could scarcely have omitted all notice of the remarkable differences between these large and valuable timber-trees and the ordinary and understood general character of that well-known species. If the usually accurate Michaux had known this tree, its great size and value for timber, and its preferred moist and rich soil—and if he had also known that it was the *pinus tæda*, or loblolly pine—he could not have used the following expressions, in describing the latter species, as he has done, without limitation or exception. He says of the loblolly pine: "In the lower part of Virginia, and of North Carolina north-east of Cape Fear river, over an extent of nearly two hundred miles, grows wherever the soil is dry and sandy." And again: "It exceeds eighty feet in height, with a diameter of two to three feet," &c. "In trunks three feet in diameter, I have constantly found thirty inches of sap wood, and in those of a foot in diameter, not more than an inch of heart." "The concentrical circles of the long-leaf pine (*p. australis*) are twelve times as numerous in the same space" [as of the loblolly pine]. "This species applied only to secondary uses [for inferior purposes]; it decays rapidly when exposed to the air, and is regarded as one of the least valuable of pines. Though little esteemed in America, it would be an important acquisition to the south of Europe," on account of its rapid growth and fine appearance, and use of the timber for "secondary" purposes.

The only pines of the higher range of country which resemble, or even approach, the lowland swamp-pine, in character, is what is there called the "slash pine," common in the higher tide-water counties, and growing on high land, but only either in the narrow, oozy bottoms, or in the forest "slashes," or shallow depressions of the table or nearly level ridge lands. These depressions have a close and stiff, though still sandy, soil and sub-soil, serving to hold the rain-water and to convert the depressions to shallow ponds in wet weather, in winter and spring, until the collected rain-water evaporates in summer. In these very limited spaces, only, grow the few slash pines—of large size, and of coarse-grained, but durable and large, heart-timber. This, and also the swamp-pine of the low country, have their leaves in threes, and both the leaves and cones of the like sizes and general appearance with those of the common loblolly pines. For want of botanical knowledge, or any aid of instruction from others better informed in these respects, I could not compare these trees by their marks of botanical description and distinction of species. Experienced lumber cutters can readily distinguish these trees by their general appearance, in respect to their value and fitness for timber; but I have found no one who could certainly distinguish them by any differences of their growth, and the sizes or shapes of their leaves or cones, from the *p. tæda.* Further, no one can certainly designate either a young swamp or slash pine. They are only known as such when old enough to have large heart-wood.

If the loblolly pine will become by sufficient age on rich soil, a "swamp pine," it may seem very strange that even the largest of the former (known to be the loblolly) never show large heart-wood. But nearly all these largest trees are of second growth, on abandoned fields, and few have ever reached sixty years old before the land is again cleared. And even if left to stand much longer, which I have never known, no second growth pine can date farther back than the exhaustion and abandonment of the earliest cleared lands, or about two hundred years. In the case of the pine for the mast of the Roanoke, the latest found ring of heart-wood is certainly of growth one hundred and sixteen years old, at least. Of the few loblolly trees (admitted to be such) standing in original forests, the growth was slower, and for their size, their heart-wood is of larger size than those of second growth, on land formerly under tillage. Some of these trees will be offered as examples; and, in some cases, it would be difficult even for a timber cutter to pronounce whether particular trees, which will be named, should be classed as old loblolly pines, or swamp or slash pines, (according to localities) too young, or of too rapid growth, to have large hearts, or to be good for timber. Even where the best of these swamp pines are cut there are some trees of so much smaller-sized heart-wood that the cutters have found it necessary to designate them by such terms as "yearling [i. e. young] swamp pine," and "bastard swamp pine." All these things go to confirm my position, that there is no specific. difference between the loblolly and the swamp and slash pines.

The dimensions, &c., of sundry trees of this species, which appear in the following statement, with but one exception, were observed and noted by myself. The list includes trees of second growth, which all persons would pronounce to be loblolly pine; others of original growth, which are undoubted such as are deemed swamp or slash pines, and good timber trees; and others, which it would be difficult for those persons who maintain that there two kinds to say to which they belong:

	Number	DESCRIPTION OF SOILS.	Diam of trunk (exclusive of bark) at height of stump.	Diameter of heart-wood.	Total number of rings in tree, at stump.	Number of rings in heart-wood.	Maximum width of rings (in heart) to inch.	Minimum width of rings (in sap) to the inch	Number of rings in outside inch of sap wood.	REMARKS.
2d gro'th	1	Dry, sandy slope.	20	2	48	7	1–2	1–6	6½	Formerly cultivated and worn out; still poor.
	2	Dry, sandy slope.	21	4	44	8	. .	. .	8	
	3	Dry, sandy level.	10	0	. .	. .	. .	. .	. .	
	4	Dry, sandy level.	11	1¾	.	. .	. .	.	.	
Land never cleared.	5	Dry, sandy slope.	17½	2	40	3	. .	. .	. .	Land, less than medium fertility.
	6	Dry, sandy slope.	22½	6	48	7	1–2	1–14	12	
	7	Dry, sandy slope.	19	4½	49	5	. .	. .	15	
	8	Level rather moist.	18	5¼	75	7	1–2	1–30	. .	Not oozy, but would require draining if tilled.
	9		21½	9	74	18	3–5	1–30	12	
	10	Sandy and oozy	21½	6	58	13	1–4	1–13	6½	On flat at foot of, and near to, oozy hill-side. All the above in Hanover.
	11	Sandy and oozy	32	8	95	32	1–3	1–16	9½	
	12	Sandy and oozy	21	6	96	43	3–20	1–25	12	
	13	Stiff sandy bottom.	26½	9¾	97	28	. .	.	16	Prince George county.
Forest.	14	Oozy slash.	39	32	141	63	3–5	1–28	17	Tree 130 feet high—Hanover, Virginia.
	15	Oozy slash.	37½	27½	204	85	1–4	1–18	15	Tree 110 feet—Hanover.
	16	Oozy slash.	37½	31	269	187	1–5	. .	66	Hanover.
	17	Low but, but firm sandy.	42	35¼	283	207	. .	. .	. .	Tree 148 feet } Washington Co., N. C.
	18	Firm, low and moist.	60	47	280	170	. .	. .	. .	Tree 170 feet }
	19	Low and rich.	41	34½	302	186	1–3	1–60	49	Mast of the Roanoke steamship-of-war, from Bertie, N. C.
	20	Firm, low, moist.	46	39	. .	184	. .	. .	. .	Near Tauborough, North Carolina, these dimensions at thirty feet high—the lower part having been removed for timber, and stump damaged.

The trees numbered 14, 15 and 16, may unquestionably be put with the "swamp pines" of the low country. Those numbered from 7 to 12, of much less age, only approach, in sizes of heart-wood, to good timber, which they might have attained to, if left to grow two more centuries.

It is not only the loblolly pine that is extremely deficient in heart-wood until of advanced age. Though in less degree, this defect is often found also in the short-leaf pine, (*p. variabilis*) which, generally, is the best yellow-pine timber-tree of the higher country. Some trees of this kind, of original forest growth, of twenty or more inches in diameter, have less than four inches thickness of heart. If of second growth, these trees would have had still less of heart generally.

It is not always plain where to fix upon the dividing line in a tree, between the wood and sap-wood ; nor is the line of junction always regular or parallel with the rings of grain near the earth. Also, in trees like No. 16, which are nearly all of heart-wood, the little sap is so resinous that it can scarcely be distinguished, except as being living wood, when the tree is first cut down.*

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* Whilst engaged in the investigation of this subject, and particularly as to the question of the species of the valuable "swamp pine," and its being identical in species, or not, with the worthless "old field" or loblolly pine, I sought scientific information from Dr. James F. McRae, of Wilmington. No person was better qualified to instruct, and to decide doubts, on this question, than Dr. McRae—not only because of his extensive botanical knowledge, but, also, as being a native and long resident of the region in which these pines (generally supposed of two different kinds) grow in great number and in ther greatest perfection of size and luxuriance. Failing to find him at home, I made my inquiries by letter, and subsequently received from him, though after this writing was completed, full confirmation of the correctness of my position—that the above trees, deemed so different by all lumber-cutters, are the same. The question of identity had previously attracted Dr. McRae's attention, not only as a botanist, but as a proprietor of pine forest, in which these trees were abundant, and of which it was important to designate those best for timber and for sale. He says, in his letter, that "both kinds [deemed the most distinct and altogether different by all timber-cutters and carpenters,] when subjected to the closest botanical scrutiny, show no signs of specific difference. Of this you will be better assured, when I inform you that I have recently had the pleasure of a visit from the Rev. M. A. Curtis, (than whom there is no better botanist south of the Potomac) when we examined together two varieties of the p. tæda spoken of, and he unhesitatingly agrees in opinion with me as to their identity." "You will find the two varieties of the p. tæda recognized by Elliot, who calls the 'swamp pine' p. tæda, and the 'loblolly' var. Heterophylla"—[which latter is recognized by all other botanists as simply p. tæda.]

Pond Pine. Pinus Serotina.

Michaux says that this pine is "rare and fit for no use"—and states the "ordinary size, thirty-five to forty feet in height, and fifteen to eighteen inches in diameter." By these and other indications, I sought in vain for this pine, by such slight and distant observation as is afforded to a traveller, through wet lands,—and in some cases failed to distinguish it, even when my later and more close inspection showed that it formed the principal, if not the sole forest growth for miles together. This great oversight was caused to me by the inaccuracy of Michaux's description of the height, and also by the actual general resemblance of the trees to the *pinus tæda.* And between these two, as species, the residents best acquainted with both have not observed any difference. It is true that, differences of general appearance, and of growth, are recognized by all—and even a different name, the "savanna pine," is commonly applied to the species now under consideration, where the trees make the general growth, on the wettest savanna or boggy swamps. But the usual smaller sizes, and apparently more imperfect or stunted growth, and ugly shapes of the "savanna pines" are ascribed to the exposed unfavorable and unnatural situation in which they stand, in mire and water, and not to any fixed difference of kind between these and the *pinus tæda* on dry or dryer soils. Indeed, the cones furnish the only certain indication of the pond pine. They remain on the tree, and unopened, for six months (or perhaps a year) after ripening—are very compact, and some of them (but not always, as we would infer from the description and

Dr. McRae says that the experienced timber-cutters profess to be able to distinguish, at the first glance the difference between the two (so-called) kinds of pine. And this they can generally do, from external signs—that is, they can judge whether a standing tree has much heart, [which they would call "swamp pine" generally, but to which, near Wilmington, they give the name of "rosemary pine," which elsewhere is given exclusively to the p. variabilis,] or but little heart, in which case they call it loblolly. But, by external examination, with the aid and direction of one of the most experienced and intelligent lumberers, who was fully satisfied of the difference of these trees, and of his ability always to designate them, Dr. McRae found that even the actual and only differences, as to the size of heart-wood and the comparative value for timber, in numerous cases, could only be determined by applying the axe, and so reaching the heart.

figure given by Michaux,) are perfectly egg-shaped. But more generally, while they approach this shape, they are rather broader near the base, and more pointed at the top, so as to be about midway in shape between conical and oval. The cones, three or four together, often grow out from and surround a twig. Their close surface and their remaining closed so long, and also their peculiar forms make these cones more beautiful than any others. The cones, and especially those in clusters, would be valued as mantel ornaments. The cones are about two and a-half inches long, and one and seven-eights broad. The leaves grow in *threes*, and are from five to seven inches long; and very like those of the loblolly pine. I have never met with these pines in Virginia, though, from description, I infer that they are found, in numbers, in parts of the Dismal Swamp.* I first was enabled to recognize and identify the tree, as the *pinus serotina*, in the low swamp lands north of Lake Mattamuskeet, along the canal to Alligator river. There it grows in considerable numbers, mostly from eight to twelve inches in diameter and rarely eighteen. They form the sparse but unmixed forest growth on large surfaces of wet savanna land on both sides of Pungo river. These were peat lands, which had been burnt over, and are so low and wet as to be deemed worthless. But also, on the rich swamp land near Lake Scuppernong, (the farm of Charles Pettigrew, Esq., in Tyrrel county,) which had not yet been brought under culture, and which had been burnt over and left naked, many years ago, the next succeeding forest growth was wholly of the pond pine, and of which many of the largest appeared to be eighteen inches in diameter, and eighty feet high. Also, on the thinner swamp soil near the canal of Mr. McRae, in Washington county, (near Plymouth, North Carolina,) the general forest growth, for a mile or more, and generally of large size, is of this particular pine. Yet neither Mr McRae, nor any of the neighboring residents, had suspected that these trees were of different species from the

* Since the opening of the Norfolk and Petersburg rail road through the Dismal Swamp, I have seen that most of the pines along the route are of this species.—1860.

ordinary loblolly or "old-field" pine; and under this mistaken impression, this body of swamp land is generally supposed to be of little fertility, becaused covered (as supposed) by a growth, which indicates poor land. I do not pretend to pronounce, on my very cursory view, that this land is not of inferior fertility—nor that the pond pine may not grow on poor land, provided it is peaty and very wet. But, this pine growing and thriving, and either generally or exclusively making the forest cover, is certainly no indication of poor soil, because it grows thus on the richest, of which the case cited above of the Scuppernong swamp land is full proof.

This tree has more heart, and more resin in its sap-wood, than the loblolly; and very different from the latter, the pond pine furnishes good and durable timber, for such purposes as the small trunks will suit. Masts for small vessels are made of those growing on the very low and wet swamp of Mattamuskeet. As a wet (and perhaps, also, a peaty.) soil is most favorable, if not essential, to the growth of this pine, it is probable that on the wettest land it may have the most heart-wood, and serve best for timber. Where it grows on dryer (though still wet) land, near Lake Scuppernong, it had been understood that this pine had more heart-wood, and was of more value, than the *pinus tæda* of the neighboring dry and poor lands—but the superiority was not so marked, or appreciated so highly, as I heard of in other places, where the pond pines grew on much wetter lands.

Pitch Pine. Pinus Rigida.

I have seen and recognized this tree (as supposed) in but very few cases in Prince George's Co., Md., and in Culpepper, Va. But all that were observed were trees of young growth, and therefore the only indications of the kind were in the leaves and cones. The trees which I saw and supposed to be of this kind, had leaves thicker and more rigid than usual of other common kinds, three to four inches long, and growing in *threes.* The cones (in Maryland) about two inches long, and as seen open, nearly spherical in general outline. In our Alleghany region, this tree supplies much of the pine timber used in buildings, and in planks exposed to view, would attract notice by the great number of knots. But except in small trees, which only were accessible to me, and which do not offer good and reliable specimens of growth, &c., I had no opportunity for fully examining the growing trees, and comparing them with others. I have never (with certainty) seen and known this tree in lower Virginia or North Carolina.* But as it would seem from some of Michaux's works that it is in this region, and as possibly, I may even have seen trees of this speeies without distinguishing them from some other kind, I will abridge the description given in the American edition of Michaux's work. Some passages of this description seem to contradict others, to which contradictions I will invite notice by marking them in italics. Michaux says of the *Pinus rigida* that it is "known in all the United States by the name of 'Pitch pine,' and sometimes in Virginia as 'black pine.'—*Except the maratime parts of the Atlantic States*, and the fertile regions west of the Alleghany mountains, it is found throughout the United States, but most abundantly *upon the Atlantic coast*, where the soil is diversified, but generally meagre." "In Pennsylvania and Virginia the ridges of the Alleghanies are sometimes covered with it. Near Bedford, in Pennsylvania, where the soil is more generous, the pitch pine is thirty-five to forty feet high, and twelve to fifteen inches in diameter." "Its most northern localities are Maine and Vermont, where it does not exceed twelve to fifteen feet high." "*In lower parts of New Jersey, Pennsylvania and Maryland*, it is frequently seen in the large swamps filled with red [white?] cedar, which are constantly miry, or covered with water; in such situations it is seventy to eighty feet high, and twenty to twenty-eight inches in diameter."—"It supports a long time the presence of sea-water, which, in spring-tides, overflows the *salt meadows*, where sometimes this tree is found alone, of all its genus." "The buds are always resinous, and its triple leaves vary in length

* I have since seen a few young trees of this species in Albemarle, on the road from Charlottsville to Ridgeway on the Rivanna. These compared to the surrounding and ordinary growth of pinus variabilis, were, very different—and especially in the much thicker and more rigid leaves of the p. rigida—and also in the general appearance, in tint and outlines, of the two kinds of young trees.

from one and a-half to seven inches, according to the degree of moisture of the soil.''—"Size of cones depend on nature of the soil, and varies from less than one to more than three inches in length. They are pyramidal in shape, and each scale is pointed with an acute spire about two inches [lines?] long." A note to this text of Michaux, by J. J. Smith, says that the *p. rigida* some times attains the height of one hundred feet, and four or five in diameter.* J. J. Smith also adds a characteristic of this pine, which I have not known in any other. "It differs from other trees of this family in its stump throwing up sprouts the spring after the tree has been felled; but these do not attain any considerable height. The fallen trunk also throws out sprouts the succeeding summer."

Michaux further says that the *p, rigida* is remarkable for the number of branches which occupy two-thirds of the trunk and render the wood extremely knotty. The concentric circles widely distant; three-fourths of the larger stocks consist of sap. On mountains and gravelly land the wood is compact and surcharged with resin; in swamps it is light, soft, and composed almost wholly of sap. From the most resinous stocks is procured the lamp-black of commerce. Tar is made of this pine in the northern States and Canada, as it is of the *p. variabilis* in lower Virginia.

Perhaps the foregoing description may enable some observer to be more successful than myself in finding and distinguishing this pine in the low country of Virginia or North Carolina. Also it may prevent from being confounded with this pine either the *p. serotina*, (which Michaux says "strikingly resembles" the *p. rigida*,) or the *p. tæda*, when in low and wet ground, or exposed to wet, or sometimes reached by salt water.

Having now described separately each species of this region, and some others for better distinction, I will return to more general remarks. or the consideration and comparison of different species in connection.

The short leaf yellow pine, (*p. variabilis*,) is the principal tree of

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* This statement of sizes, induces a suspicion that the writer, (Smith,) had mistaken the great swamp pine (p. tæda,) for the p. rigida.

the original forests of the upper range of the tide water region of Virginia, and also above the falls as far up the country as the usual growth of any pines extend continuously. For, at some distance above, as supposed from change of soil, the entire growth of pines ceases and gives place to a general growth mostly of different kinds of oak. Proceeding south-eastward to the low and wet country, this pine becomes more scarce, and is more and more substituted by the swamp or loblolly pine as original growth; and more southward and on higher lands, and throughout eastern North Carolina, the long leaf pine generally is the principal pine of the original forests. When any of these several forest growths were cleared off for tillage and the lands were afterwards worn out and then thrown out of cultivation, several different pines, in different places, as second growth, entirely occupy these exhausted lands, and in most cases the second growth is entirely different in species from the pine of the first growth. Thus, in nearly all of the tide-water region of North-Carolina and on most of that of Virginia, the almost universal second growth pine is the loblolly, or "old field" pine, as thence called, which succeeds to the original short leaf pine below the falls in Virginia, (and also for a short distance above) and also to the original long leaf pine in North Carolina, and occupies, exclusively, in the abandoned former places of both, the ground which this pine had originally, but partially shared with the short leaf and other trees. In the Northern Neck of Virginia, on some other lands near to rivers, and also in the more northern counties above the falls, (as Fairfax,) the cedar pine, (*p. inops*) is the principal second growth, or is the "old field" pine of those lands. Further, the southern and lower Piedmont lands of Virginia, but not so low as the line of the falls, when abandoned, also are covered and exclusively with *their* "old field" pine, and which is so termed in Amelia, Cumberland, and that range of counties, and in Orange, in North Carolina. But the second growth pines of this higher range of country is not like that of the lower range, but is no other than the short leaf yellow pine, (*p. variabilis.*) Thus it is the loblolly, which is the almost entire second growth of nearly all the tide-water region, refuses to grow at a short distance (generally varying from five to twenty miles) and at an irregular line of termination, above the falls, while the short leaf pine continues thence and covers all the abandoned fields for some distance farther up the country, after which that particular pine growth also ceases. Yet, because of the same name of "old field" pine being used in both places, many farmers and residents suppose both pines to be of the same species. And very many farmers of the lower country where the first and second growth pines are of different species, (*variabilis* and *tæda*, respectively,) suppose them to be the same kind, but altered in appearance and manner of growth by the difference of the lands and other circumstances. Of these facts, in regard to remote localities, I have to rely more on information than on my own limited personal observation. But in Prince George and Hanover counties, in which I have resided, and in more of the upper and middle range of the tide-water country, I have seen much, and have noted such general facts as these:

In the original forests of the ordinary poor soils, or of medium fertility and dry land, not one pine tree in fifty is a loblolly, and all the others are short leaf pines. And of the few loblolly pieces there found, they are of smaller and younger growths, if scattered among the short leaf pines, or if (as rarely) a number of loblolly pines are seen near together and occupying the ground either partially or exclusively, it is either when the short leaf pines had been formerly cut out or otherwise destroyed, or where the moisture of the soil forbade their healthy growth, or where the ground, (in soil, sub soil and all below for sundry feet,) was so sandy as to be unfavorable to the short leaf pine, though not to the loblolly.

As particular observations, made with a view to certain objects, are always more accurate and reliable than far more extended and general observations made without any particular object, I have recently made for this purpose a particular examination on parts of the forest and worn-out lands of Marlbourne farm. First, in a body of original forest land, high, dry, of sandy soil, but having clay below, and of but moderate productive power, (or below medium fertility,) short leaf pines made the principal growth, and all of the largest pine growth. The loblolly pines were not one to fifty of the former, and nearly all of these few were of small size. On one side of this body of old forest land is a very poor old field of similar soil, abandoned from eight to ten years past, and now covered thinly with young pines of five years old or less. (The earlier of this second growth had been cut down.) Of these young trees, perhaps one in ten to twenty is a short leaf pine, and these are always of smaller sixe than the much more numerous loblolly pines. On the other side of the forest land there is another small body of "old field pine" growth the largest trees being about ten inches through, and mostly of different smaller sizes. Of these, not one in three hundred was a short leaf, or any other than a loblolly pine, and few others, of short leaf, were so small that if all are let alone to stand, these last will certainly perish, because being so over-topped and shaded by the others of much larger sizes and greater vigor of growth.

From these and other more general observations, it would seem that in this region the loblolly pine was more lately introduced (or the winged seeds transported here from abroad by the winds,) than the short leaf, and could not obtain a proper seed-bed and maintain a healthy growth in lands already and completely occupied by other established pines and other trees. But when worn-out vacant lands were offered, the opposite result followed. The seeds of both these kinds of pines were everywhere numerous enough, and were so readily transported to great distances by the winds, that there was no deficiency of either kind on any land. But, in such vacant fields, or when these two kinds of pine were equally in possession, the loblolly pine is much the fastest grower, and in a few years over-tops the smaller short leaf pines, which, therefore, are unthrifty, and in time are overpowered and die under the shade and crowding of the larger and more vigorous loblolly pines. Hence, in a thick and long standing second growth, however numerous the slower growing short leaf pines may have been at first, not one might live when the eldest of the others had reached to forty years. On the particular abandoned lands where pines of second growth thrive best and grow fastest, they usually stand so thick, when young, that many of the smaller and weaker necessarily must die, and thus make room for the more vigorous. In such cases, of course the short leaf trees, of slower growth and smaller size, would certainly be among the first to perish. It is only when the growth is thin, owing to some unfavorable conditions of the soil, that in this region the short leaf pine can live in numbers, intermixed with the loblolly, as second growth; there being, in that case, enough space for both to live.

But in the higher range of country other causes operate. The land there is naturally much richer than the dry land in the lower country, the soil red, more clayey and having not enough acid, (or having too much lime,) to permit the growth of the loblolly pine, which is especially favored by the most acid soil, and also by sandy soil. But the short leaf pine can grow and thrive on soils stiffer, richer and better constituted for fertility, and therefore can occupy such land to the entire exclusion of the loblolly pine. But still, even the short leaf species does not thrive as well on a good agricultural soil not very deficient in lime. Therefore, according as the soil is better constituted for tillage crops, these pines are more sparse and slow in growth, and on the best natural soils they will not grow at all, as on the South West Mountain lands and the Limestone soils of the more Western mountain country, and rich alluvial bottoms everywhere.

I will here present an opinion on this subject which will not be maintained by argument, to do which would require too much space, and would be here out of place. This opinion is, that the soils and upper layers of all the tide water region of Virginia and North Carolina, and also an adjacent strip, of irregular breadth and outline, above the falls, are of drift formation, the materials of the drift having been washed by an enormous flood from the lands lying above, and which were denuded in supplying that material That the whole region so formed by drift is extremely deficient in lime, (and much more so than the denuded region above,) and therefore naturally acid, consequently especially favorable to the growth of loblolly pines. If this opinion is correct, it will be much more important than merely for assigning the necessary localities and actual limits for the healthy growth of loblolly pines. For the ascertaining the limits of the drift formation and the places where it is present or absent, will serve to indicate where lime, as manure, will either be highly beneficial, as in all the low country, or where it will probably be of little benefit, or none, as is said to be generally the case on the red Piedmont lands. This subject of drift formation and the drift-formed region and its localities, I have treated at length elsewhere, (in Part I.) and therefore will pursue it no farther here.

From the various facts and opinions stated in the foregoing pages, it will have appeared incidentally that some (if not all) of the species of pines, are especially good and reliable indications of the character and constitution of the soils on which they grow, and in some cases of climate also. Thus all the pines common in this region, prefer to grow on soils, if dry, of but moderate or a low degree of natural fertility. The white pine, (*p. strobus*) which, however, is not of either the lowland or the Piedmont region, is the only species known to prefer well constituted, rich and also dry agricultural soils. The long leaf pine, (*p. australis*,) requires a southern locality or climate, and with that, a dry, sandy, and poor soil, and also sandy subsoil, and its healthy and general growth is an indication of the presence of all these different requisites. The short leaf pine, (*p. variabilis*) prefers stiffer soil or under-lying earth, both to be dry. This will bear more of lime in the soil than either the preceding, (except *p. strobus*) or than the loblolly. The cedar pine, (*p. inops*,) is more rare, and its habits less known to me. But this would seem, (as a second growth,) to prefer and indicate still better original soils, however exhausted subsequently, than either of the preceding pines of this region, and also of more clayey constitution. The loblolly grows well both on dry, sandy and poor soils, and on moist, deep and rich soils. But in both of these very different positions it must have acid soil. And this last condition is caused and provided by the great deficiency of all forms of lime in the poorest natural soils, and also by the great excess of vegetable matter and of moisture in the low and rich and swampy or peaty lands.

POSTSCRIPT.

1865.—It was some length of time after the completion of the foregoing observations, and also after their earliest publication, that my attention was first drawn to a peculiarity of the growth of the cones of pines, which perhaps is still unknown to nearly all other persons, including the best botanists. There are to be seen, by close observation, on some pine trees every year, (and on a few trees they may be numerous,) very small cones, immature when others are fully ripe, and which vary between a quarter and less than three-quarters of an inch in length, according to their kind, when other cones on the same or other trees, the growth of that year, have reached their full sizes. I had often seen these small cones, and had supposed them to be abortions, which would be killed by the cold of winter, and drop off soon after. My friend and kinsman, the Hon. Thomas Ruffin, late Chief Justice of the Supreme Court of North Carolina, first suggested to me a different character of these cones, which opinion I am now convinced is correct. This is, that the cone of the pine requires two years (or summers,) to complete its growth, from the first formation to maturity. These small cones have all the growth that is made in the first year. They are found only on the "water-sprouts," or latest formed wood of the trees, the growth of the last summer. As these youngest extremities of the branches grew after the last spring's flowers had dropped, and the small cones on these extremeties, sprang still later, it is therefore certain that these cases could not have been impregnated during their first year's growth; but will be impregnated next spring from the farina of the flowers which will put out a year later—and after which necessary operation, the cone and its seed will reach full growth and maturity by the next autumn. I have observed this peculiarity of growth only in the three kinds of pines which only are common in lower Virginia, viz: *pinus variabilis, p. tæda, and p. inops;* but it is inferred that the same characteristic belongs to all the species of pines.

SKETCHES OF LOWER NORTH CAROLINA, &c.

PART VII.

NOTICE OF THE RECENT IMPROVEMENT OF EDGECOMBE COUNTY, NORTH CAROLINA; AND ESPECIALLY BY MEANS OF COMPOST MANURING.

Edgecombe county, or as much of it as I saw, in its surface is almost a level, unbroken by any deep depression except the Tar river, and its considerable tributaries. There are, on almost every farm, slight depressions, usually very narrow and long, of swampy character naturally, and which serve a most useful purpose, as proper routes for open drains, and out of these ditches to furnish material of earth for compost heaps. In many cases, these slight depressions of level spread out into extensive swamps—as on Cotton Valley and Strabane farms—which when cleared of their gigantic forest growth, and drained, make very rich and productive land. The clearing is very laborious, though the labor is lessened and divided, by belting, and so "deading" the large trees. The ditching also cut through matted roots and among standing trees, is laborious, but durable and effectual for drainage. The soil is deep, but rarely peaty, and of such good earthy constitution, and on such sound subsoil as to be of great and permanent productiveness, under proper tillage and treatment.

The higher land is firm and mostly dry, naturally. Most of it is of some one or other intermediate grade between sandy soil and medium loam. Very little is too sandy to be of excellent texture for cotton, corn and peas—and not much, (though there is some land,) quite close and stiff enough for wheat and clover. As the culture of the latter two crops is attempted on very few farms, and to but small extent, it may be considered that the land generally is of the best possible texture for all the great crops best and well suited to the climate; which, in the order of their usual extent of culture, are in the order named above, of first cotton, next corn, and last peas.

The soil (exclusive of swamps) is pine-bearing and acid, and therefore especially requiring, and profited by, applications of lime. Marl very extensively underlies the land, and has been found, and is used as manure, on many farms. It has been eminently beneficial, wherever properly used--and where known early, was the foundation of all other improvements since introduced. The commencement of improvement, as reported, was to me especially interesting.

Until some fifteen years ago, the agriculture of Edgecombe was, like most other of the more southern counties, in a very low condition. It was not then far from the truth, as to Edgecombe, as is even now erroneously supposed of it by many strangers, that its chief productions were turpentine and ague and fever. As was generally the case formerly, in lower Virginia, as well as still later in lower Noth Carolina, no one attempted the durable enriching of his land, and not many thought of taking the least care to avoid complete exhaustion at some future time. At that time, four farmers in the county were subscribers to and readers of the Farmer's Register, and from its contents they learned the value of marling. Three of them had marl, and began its use. These were James S. Battle, (recently desceased,) Exum Lewis, and Dr. Dicken. Their success induced others to follow their example. Soon other materials were tried. One farmer began to make composts of earth and marl, and stable manures; another added ashes--a third cotton-seed--and others added other and smaller materials, such as salt, gypsum and guano, but in few cases, and to limited extent.

But whoever may be the just claimants of minor parts of the now general system of compost manuring, it is admitted that Baker Staton, now of Cotton Valley, first practised it extensively, and became an examplar to his countymen in that mode of improvement—as he is understood and reported to be in general good management and good cultivation. His successful and admirable results in the use of compost manure, in my opinion, were necessarily and greatly forwarded by his having first (or very early in his course) marled all his land; and mostly in advance of his compost applications. It is to be lamented that this course has not been general among all those having marl accessible. Correct views of the action of marl on putrescent manures would have caused this practice of previous marling (or liming) to be deemed essential. But the loss of value caused by the omission of previous marling is mostly concealed by the applications of compost being annually repeated—so that the degree of durability of each separate dressing cannot be known. And the subsequent application of organic matter (supplied in the composts) was still more visibly operative, in making the previous marling the most highly beneficial. Before the improving system was begun in Edgecombe, the practice (as then and now too general in South Carolina) was to take crops almost every year from each field, and to return less in manure than was abstracted from the land by the crops. Of course, the culture was regularly exhausting, and most of the cultivated lands had been thus made poor, and were yearly becoming poorer. Under such circumstances, (as I have urged elsewhere,) calcareous manure can have very little effect. Mr. J. S. Battle, named above as one of the pioneers in marling, and who at a later time became one of the most successful operators, after having applied marl for some four years, actually suspended the further use, under the belief that he had not been paid for his labor. Then he commenced the composting practice; and wherever his compost happened to be laid on ground formerly marled, (as stated to me by his son, Wm. S. Battle,) "the compost acted like a charm," and gave sufficient encouragement for his resuming and continuing the use of marl, as he did, with zealous perseverance and success.

I will now state generally, and in the cursory manner which only is permissible in a hasty sketch like this, the ordinary practices in making compost manure, of which the main features are now general in Edgecombe, and which, to more or less extent, is in use on almost every farm.

The ditches on every farm, in their original banks, and the earth taken out in subsequent cleanings and deepenings, furnish the main supply of material, and which is nowhere yet exhausted. Much of this is of swamp or other rich soil. But some, from greater admixtures of sand, of even poor upper soil, and very often of comparatively poor subsoil, is much poorer—and as it seemed to me, too poor to be worth removal for manure. Still, all such is used for compost. Besides, the nearest wood-land (even if of poor soil,) is often skinned of its upper surface—and all the upper earth in the fence corners is scraped up and removed, repeatedly—and there are additions to the more abundant earthy materials for compost. A large portion of all such earthy material, as before stated for Panola,* is used to bed cattle and other live stock, in summer pens, (six inches deep or more,) and make the foundation, and a large ingredient of the general mass, with vegetable litter, in the winter pens. In the latter part of winter, the whole mass then in the stock pens in thrown up in low ridges, for better admixture and ripening, and then hauled out, to be applied, for cotton, in the drill, which is the universal practice. Where marl is available, that makes a large part of the earthy foundation. It would be much better if marl formed the larger or only supply of bedding for the pens in summer, when highly putrescent matters are so liable to decompostion, and the consequent almost total waste of the greater and richer part of their substance.

As soon as the crops are "laid by," in July and early in August usually, the making of manure, and collection of materials, begins. On all the arable ground not then under a crop,(which indeed is very little on most farms in summer,) the earth is carted to a pile in the centre of every acre, 100 single mule cart loads of earth to each, or about 500 bushels. To each pile is added 30 bushels of cotton-seed—and the earth and cotten-seed often are all. But either in addition to, or without cotton-seed, the stable manure, as fast as it is produced, is given—and all the materials are thrown into a heap, and as well intermixed as may be. Marl, where to be had, is also added, and ashes. On Panola, last year, in the compost heap on each acre, besides the 100 loads of ditch-bank earth, or of the "brown

*The farm of Messrs. John S. Dancy and Robert Norfleet.

deposite" of the river freshes, there was forty bushels of marl, ten bushels of ashes, thirty of cotton-seed, and one bushel of both gypsum and salt. But the two latter ingredients are rarely used elsewhere.

In the spring, the compost heaps already in the fields, (and mostly made through the past winter,) and also the compost manure ridged up in the stock pens, are carted and laid in the drills, the land having been previously ploughed. The manure is quickly covered by the plough; and the planting of the several crops, in their proper order, soon follows.

Ashes are not only saved from the ordinary sources of supply of every farm, but from other sources, and with peculiar economy and care. It has been ascertained that rapid burning and large fires consume and destroy (or rather it should be said, drive off into the air,) a large proportion of the ashes which wood yields. This waste is very great in the burning and draught of oridinary fire-places, and much greater in the customary large log-heaps and violent fires of cleared wood-land. Hence, for the wood of new clearings, and of drift wood deposited by the freshes of the river, small fires and slow burning are used. The quantities of ashes thus obtained are very great. Messrs. Norfleet and Dancy pay to their negroes eight cents per bushel for all the ashes they will furnish; and they make a considerable supply from the numerous dead trees in the woods, and scattered drift logs. The larger collections of drift wood are burnt by the proprietors.

All these materials, and every other putrescent matter that accident may offer, are used in compost, or intermixture. And the general benefits are such, that the belief has become very extensive that intermixture, alone, of any two or more different materials, serves to create new and important manuring value. The received reports of the general results of the practice, as shown in the large and increasing crops, and increased fertility of the lands so treated, are such as to permit no doubt to be entertained of there being great benefit and profit in the general. But still I would question the propriety of using, and of twice moving, and more than twice hauling, the poorer of the earthy material used, as well as the economy and profit of some of the attendant labors. Of this, more hereafter.

With such industry to procure materials, and with the unlimited supplies of the larger and poorer kinds, the amount of compost manure to be made is limited only by the labor that can be so directed. And the quantities actually made are enormous. Every careful farmer thus manures his whole cotton field, and more or less of land under crops. Of the Panola farm, having six hundred acres of cleared land in all, compost was applied last spring to three hundred and fifty acres now under culture, and guano to fif y acres more, four hundred in all manured. The land now (or lately) under crops, is two hundred and twenty in cotton, two hundred and twenty-five in corn, eight of sweet potatoes, thirty-seven of oats, and one hundred of broadcast peas as a manuring crop; in all five hundred and ninety acres under crops. The products of this farm for the only two years completed under the present owners, with a safe estimate for the growing crops, would exhibit to those persons knowing the circumstances, great progress of improvement. But to others, the mere statement of increase, without explanations, would be delusive, as the necessities of the farm at first required labor to be withheld from cropping; and the first two years' crops were therefore on much smaller spaces, as well as on unimproved and much poorer land. Even as to other cases of older and long continued culture and increase of crops, which I will cite to show some of the greatest improvement and profit, all are liable to the objection of there having been more space added by new clearings, and also increase of laborers. This obstacle to accurate statements of increase must necessarily apply to all improving farmers, of a country as yet but partially opened for culture.

Mr. Baker Staton has increased his cotton crops from sixty bales to three hundred and two, (four hundred pounds are counted to the bale.)

Mr. James S. Battle when beginning to marl owned and cultivated four separate farms in Edgecombe, on all of which he made at most two hundred and seventy five bales of cotton. Subsequently, he gave two of the farms to two sons—and on the other two farms only, subequently increased his crops to six hundred bales. On the other two farms, his sons have respectively made about one hundred and eighty-five and one hundred and ninety-five bales—or nearly one thousanb bales from the three proprietors. From the six hundred bales made lately by the father, there should be deducted fifty ; which was the previous product of another farm which he had lately bought. The subsequent increase on that new purchase fairly belongs to Mr. Battle's general increase, from his own improvement of land.

Mr. Robert R. Bridgers and Mr. J. L. Horn, besides having respectively the ordinary incentives to increase their crops, have for some years been engaged in a friendly but ardent contest with each other for superiority. Their crops of cotton for the last seven years will be here stated in connection.

	R. R. BRIDGERS.	J. L. HORN.
1847	19 bales.	27 bales.
1848	33 "	43 "
1849	53 "	54 "
1850	88 "	83 "
1851	136 "	137 "
1852	185 "	165 "
1853	170 "	182 "

Mr. Horn's farm is on Town Creek, where there is no marl, and where ashes are largely used instead. His whole farm consists of but 317 acres. Half of his arable land, would not have yielded to him at first more than 10 bushels of corn to the acre.

Mr. Robert R. Bridgers stated that he knew that the farming of Mr. Mercer, on Town Creek, yielded better returns than his own. But, different from most others, Mr. Mercer raised not only cotton for sale, but also corn and pork ; so that a like statement of his cotton crop, if reported, would not do justice to his improvements and profits, in comparison with others, with whom cotton is the principal crop, and the only sale crop.

There are many others who in the last ten or twelve years have, by compost manures, doubled their crops—fewer have tripled theirs, and still fewer, including the above named, have increased them fourfold.

If we had heard for the first time of these most usual practices, in advance of their ascertained effects, there are few who would not utterly disbelieve in the great benefit of using such poor materials, and in any nett profit from the whole laborious composting and application, to be repeated almost every crop, and the manuring and the cropping repeated every year. And if one, or a few farmers only had even had some year or two of experience, and reported the beneficial results, their favorable opinions would be ascribed to their sanguine temperament, mistake, or errors of judgment. But when so many farmers, of all and various conditions, have concurred for ten years or more in the same general procedure, and in so doing, have stopped the former general progress of impoverishment, and have produced great improvement of lands, and increase of crops and of profits, there remains no ground for a doubt as to the general beneficial results, and great profits, of the general procedure for such improvement. And their increased products and profits have been made on lands cropped almost every year, (an omission is very rare,) and without any thing like a rotation of crops. Cotton occupies the same ground almost continually, and always for at least four or five years in close succession.

But in addition to these considerations, I have seen other and like facts of composting elsewhere, which were alleged to produce great benefit, and were sustained by ample and similar evidence. In Talbot county, Maryland, a few years ago, I saw in operation nearly the same system of making compost manures, and heard the like reports of general benefits thence derived. The practices varied only in the different supplies of material. In Talbot, besides ditch banks, head-lands, or margins of fields, and other rich highland soil, tide-marsh mud was accessible, and was largely used for the chief material of compost heaps. Also refuse or very low-priced fish, when to be obtained in quantities, sometimes made part of the richer parts of the bed or heap. Not only did intelligent proprietors so operate and improve on their own lands, but poor men who were but tenants at will—who paid rents that with us would be deemed much too high, (one-half of the wheat, and one-third of all other products of the rented farms—) and who yet had been growing richer in long course of such business. As in Edgecombe, so in Talbot county, the practice was so extended, had so long continued, and the effects were so well known and established in general opinion, that there was no room to doubt the ordinary and great benefits, even though there might have been many errors in the details, and many losses in particular and wrong parts of the generally good system.

Thus, in two remotely separated communities, having not the least communication with or knowledge of each other, there have separately sprung up systems of manuring almost precisely alike.

My commendation of the general system of compost manuring in Edgecombe, and testimony of its benefits in improving both crops and land, have been sufficiently stated. I can also testify (though such might be inferred as incidents to all great and general improvement of lands,) that the farmers are intelligent in pursuing their plans—zealous and industrious in their labors—and managing well in the peculiar system they aim to pursue. I will now take the liberty of noting some things in which I think they err, either in acts of commission or omission.

1. In their compost system, I think they err in using much earth as material which is too poor to pay for two transportations and more handlings. Enough of rich earth might be found and used instead, on almost every farm—or still better, marl for the flooring of stock pens.

2. A still earlier and more general error, is to omit the general and light marling (or liming) of all the fields in advance of the compost applications, or as early as possible. I say *light* marling, because the marl making part of the compost would at every application serve to add to the quantity of marl, until the soil had been made sufficiently calcareous. If this most valuable material is not to be obitaned on or near every farm, marl, nearly as rich as pure lime from the more southern counties, might be brought by the rail road—or lime boated up the Tar river. At some times even the lime from Maine has been thus obtained as low as one dollar the cask. Mr. D. Bullock once bought one thousand casks of lime at that price, and used it as material for compost.

3. There is much loss of labor in the manner of carting the materials and carrying out and applying the compost manure. The carts are all small, drawn by one mule, and have the ordinary narrow wheels. The carting of materials in summer is mostly limited

to the time between the "laying by" the crops, and the beginning to gather fodder. None of this time can be lost; and if much rain occurs the ground is made soft, and the hauling heavy. Further—when carting out the manure in the spring, to be put in the open drills, the field has then been ploughed, and of course the hauling is laborious. Hence, the ordinary loads of earth, or of compost, are estimated at only five bushels to the one-mule cart. Now, on dry or firm ground, and on so level a surface, a mule can easily haul eight bushels of moist marl or earth—and a two-mule cart, eighteen bushels, as I have fully tested in my extensive marling labors. And if using wheels five inches wide on the tread, the ground would be kept smooth and firm under the wheels, even if in a condition of moisture which would cause the ground to be cut up and become miry under narrow rimmed wheels. Two mule carts would require but half the present number of drivers. These remarks apply as well to the hauling of marl from the diggings.

4. The compost heaps are mostly, or to a great extent, built on the fields, each one in the middle of the acre which it is to cover. Of course, from the heap to the most distant parts of the acre, is but little more than forty yards—and this is the extreme distance to which the carts have to haul from each heap, and much of the hauling is within the distance of twenty yards. To use carts for such short trips is a great waste of labor—even though each cart may make one hundred and twenty or more trips in a day. For such short distances, I think it probable that wheelbarrows, (running over moveable plank tracks,) would be cheaper—or scrapers, if the texture of the compost admitted the use of the scraper.

5. The roads ascending from marl-pits (when such ascending roads are used) for want of uniform grading, and as gentle ascent as the ground would well allow, cause great increase of drought, and loss of power in hauling. Also, in every case observed, there were serious defects in the manner of working the pits, causing great loss of labor, and in some cases of marl also. All these defects might have been found out and remedied, by an attentive reading of my directions for working marl-pits, in the last (5th) edition of the

"Essay on Calcareous Manures." This book was in the hands of most of these marlers; and their failure to attend to the instructions there given, and their readiness to admit the same from my verbal directions, is an evidence of how much more effective is the one mode of advice than the other. Printed and general instructions, however applicable to practice, and to usual and various circumstances, are rarely attended to and observed in practice even by the most intelligent readers. Yet the same persons, and also the less informed persons who rarely read for agricultural instruction, will eagerly listen to, and gladly profit by similar verbal directions, offered for each particular case and locality.

6. The good (or improving) land is cultivated so generally every year, that it may be said to have no cessation of crop-bearing; and when under cotton, there is rarely a change to any other crop. It is alleged, (and I do not mean here to oppose the correctness of the opinion,) that the production of cotton, and quality of the product, are not impaired by the longest known continuation of culture, with five or six hundred bushels of compost manure, (mainly of earth as above described) annually supplied to the land. Even if so, the improvement might be more rapid, and products still better, if with more change of culture, and especially if preceding cotton, if only one year preceding two or three of continued cotton, by a manuring pea crop. There is no such thing attempted as any regular rotation of crops in Edgecombe.

7. A general error is to make too limited use of peas as a manuring crop. This is the most valuable plant for manuring in a southern climate—(and is there as valuable as clover in a more northern and humid climate—) and nowhere does it grow better, with more certainty and more luxuriance, than on the soils of Edgecombe. Yet except as the universal secondary crop among corn, peas are rarely grown—and beneficial as is this mode, it is not sufficient to bring into operation half of the manuring value of this inestimable plant and crop, for this region.

8. Owing to the wide extent of cotton culture, and the small extent of forage crops and products—and the entire want of grass

culture and of meadows, even on the lands admirably suited for grass—there is a frequent scarcity of hay. To supply the deficiency, *northern* hay is imported, and used not only by the townsmen, but to more or less extent by some of the farmers of the country. This is a shame—a disgrace to the agriculture of Edgecombe, which I trust will not be suffered to continue much longer.

Thus, I have as freely condemned what I deemed wrong, as applauded what is right. But in censures thrown out on such slight opportunity for observation, it is more than probable that the cause may be in some degree mistaken. And even if not mistaken, the censure is apt to be deemed correct in opinions entirely opposed to those of the censured.