MARYLAND
GEOLOGICAL SURVEY

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Also with the coöperation of several members of the scientific bureaus of the National Government.

LETTER OF TRANSMITTAL

To His Excellency EDWIN WARFIELD,

Governor of Maryland and President of the Geological Survey Commission.

Sir:—I have the honor to present herewith a report on The Physical Features of St. Mary's County. This volume is the fifth of a series of reports on the county resources, and is accompanied by large scale topographical, geological, and agricultural soil maps. The information contained in this volume will prove of both economic and educational value to the residents of St. Mary's County as well as to those who may desire information regarding this section of the State. I am,

Very respectfully,

WM. BULLOCK CLARK,

State Geologist.

JOHNS HOPKINS UNIVERSITY,
BALTIMORE, *March, 1907.*

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ILLUSTRATIONS

PREFACE

This volume is the fifth of a series of reports dealing with the physical features of the several counties of Maryland.

The *Introduction* contains a brief statement regarding the location and boundaries of St. Mary's County together with its chief physical characteristics.

The Physiography of St. Mary's County, by George B. Shattuck, comprises a discussion of the surface characteristics of the county, together with a description both of the topographic forms and of the agencies which have produced them. A fuller discussion of this subject has been presented by Dr. Shattuck in his report on the Pliocene and Pleistocene deposits of Maryland.

The Geology of St. Mary's County, by George B. Shattuck, deals with the stratigraphy and structure of the county. An historical sketch is given of the work done by others in this field to which is appended a complete bibliography. Many stratigraphical details are presented, accompanied by local sections.

The Economic Resources of St. Mary's County, by Benjamin L. Miller, deals with the economic possibilities of the various geological deposits of the county. Those which have been hitherto employed are fully discussed, and suggestions are made regarding the employment of others not yet utilized.

The Soils of St. Mary's County, by Jay A. Bonsteel, contains a discussion of the leading soil types of the county and their relation to the several geological formations. This investigation was conducted under the direct supervision of Professor Milton Whitney, Director of the Bureau of Soils of the U. S. Department of Agriculture.

The Climate of St. Mary's County, by C. F. von Herrmann, is an important contribution to the study of the climatic features of the county. Mr. von Herrmann is Section Director in Baltimore of the U. S. Weather

Bureau and is also Meteorologist of the Maryland State Weather Service.

The Hydrography of St. Mary's County, by N. C. Grover, gives a brief account of the water supply of the county which, as in the case of the other Coastal Plain counties, affords but little power for commercial purposes. The author of this chapter is a member of the Hydrographic Division of the U. S. Geological Survey.

The Magnetic Declination in St. Mary's County, by L. A. Bauer, contains much important information for the local surveyors of the county. Dr. Bauer has been in charge of the magnetic investigations since the organization of the Survey and has already published two important general reports upon this subject. He is the Director of the Department of International Research in Terrestrial Magnetism of the Carnegie Institution.

The Forests of St. Mary's County, by C. D. Mell, is an important contribution and should prove of value in the further development of the forestry interests of the county. Mr. Mell is a member of the U. S. Forest Service.

The State Geological Survey desires to extend its thanks to the several national organizations which have liberally aided it in the preparation of several of the papers contained in this volume. The Director of the U. S. Geological Survey, the Chief of the U. S. Weather Bureau, the Chief of the U. S. Forest Service and the Chief of the Bureau of Soils of the U. S. Department of Agriculture have granted many facilities for the conduct of the several investigations and the value of the report has been much enhanced thereby.

THE

PHYSICAL FEATURES

OF

ST. MARY'S COUNTY

THE PHYSICAL FEATURES OF ST. MARY'S COUNTY

INTRODUCTION

St. Mary's County comprises, with Anne Arundel, Prince George's, Charles, and Calvert counties, what is commonly known as Southern Maryland and is the most southern county of the group. It is located between the parallels 38° 2′ and 38° 31′ north latitude and the meridians 76° 19′ and 76° 53′ west longitude and covers an area of 369.1 square miles. St. Mary's was the first county established. No record of the date of its erection exists, since its jurisdiction at first was co-existent with that of the Province. The first evidence of its existence as a county is the appointment of a sheriff in January, 1637-8, at the same time a sheriff was commissioned for the Isle of Kent, which for a time was known as a "Hundred" of St. Mary's County. Four years later, 1642, a county court was established on Kent Island and the jurisdiction of St. Mary's was limited to the Western shore. Settlements at the time were only along the shores of the Potomac and Patuxent rivers and thus in reality the extent of St. Mary's County was about the same as to-day, although technically it may have included all of southern, central and western Maryland.

In 1650 Anne Arundel and old Charles counties were erected out of this larger territory to accommodate the new settlement on the Severn and the growing one on the Patuxent. By 1654 old Charles County was changed to Calvert County, which then included the inhabitants on both sides of the Patuxent. St. Mary's County was thus restricted to the settlements along the Potomac which did not extend beyond Maryland Point at the great bend in the river. By the establishment of Charles County in 1658 St. Mary's was finally reduced to its present limits on

the west, Calvert County may have continued to control the southern shore of the Patuxent for a short time, but it seems more probable that after 1658 St. Mary's possessed the same limits as are prescribed by her boundaries to-day.

For a short time during the supremacy of the Puritans, from 1654 to 1656, St. Mary's County was known as Potomac County, Calvert and Anne Arundel counties being called Patuxent and Providence counties respectively.

St. Mary's County is very nearly surrounded by navigable waters except along its northern and northwestern boundaries adjacent to Charles County. It is bounded on the east by Chesapeake Bay, while its northern and southern boundaries are mainly formed by the Patuxent and Potomac rivers. The Wicomico River forms part of its western boundary.

St. Mary's County is a peninsula across which from northwest to southeast runs an elevated plain which gradually declines from an elevation of about 180 feet near Charlotte Hall to 100 feet in the vicinity of Ridge. From this highland the streams drain to the north and east by short courses into the Patuxent River and Chesapeake Bay and to the south and west by longer channels into the Potomac River and its tributary streams. The County-town is Leonardtown, situated in the south-central part of the county near the head of Breton Bay, an estuary of the Potomac River.

The people of St. Mary's County are chiefly agriculturalists, the soils of the county being well adapted to the growth of tobacco, corn, wheat, and rye, while small fruits, especially peaches, can be successfully raised. Truck farming can also be successfully pursued. The lumbering interests of the county were important in the early days and with the introduction of modern methods of forest management might again be revived, as there are many tracts in the county where valuable woodlands could be advantageously developed.

St. Mary's County is prominently identified with the oyster industry, valuable oyster grounds being found along the borders of the county both in the Chesapeake Bay as well as in the Patuxent and Potomac rivers. Many of the citizens of the county are employed in the oyster business

which has been the source of large revenue in the past and under modern methods will doubtless again revive.

The mineral resources of the county are not important, although extensive areas are underlain by clay and marl, the former affording the basis for the manufacture of common brick, while the latter can at times be advantageously employed for the improvement of the land.

The transportation facilities of St. Mary's County are mainly furnished by the Baltimore, Chesapeake and Atlantic Railroad which runs frequent boats to the various landings on the shores of the Patuxent and Potomac rivers. A branch line connecting with the Popes Creek Branch of the Philadelphia, Baltimore and Washington Railroad reaches the northern limits of the county at Charlotte Hall and plans are on foot for the extension of this road southward through the county to a terminus near Point Lookout. With the completion of this line St. Mary's County will be in close communication both by rail and water with Baltimore and Washington.

The present volume contains a discussion of the physiography, geology, agricultural soils, hydrography, climate, terrestrial magnetism and forestry of the county, which together constitute the physical features. All of these are essential to an understanding of the natural resources and possess an interest not only from an economic but from an educational view-point.

W. B. C.

DEVELOPMENT OF KNOWLEDGE CONCERNING THE PHYSICAL FEATURES OF ST. MARY'S COUNTY, WITH BIBLIOGRAPHY

BY

GEORGE BURBANK SHATTUCK

Introductory.

The miscellaneous observations made by the early explorers of St. Mary's County pertained to subjects which have now become distinct fields of investigation. Notes which relate to discoveries in geography and geology have been gathered from various sources by the author who has grouped together the most important of them under their respective heads. The review of geographic research begins with a summary of the exploration made by Capt. John Smith in 1608 and ends with the recent work of the State Geological Survey during the summer of 1906. The account of the geologic research begins with Wm. Maclure's investigations in 1809 and ends with the latest publications made in 1906.

Historical Review.

St. Mary's County, which occupies a narrow neck of land between Chesapeake Bay on the east and the deep estuary of the Patuxent and Potomac rivers on the north and south, is favorably situated for exploration and colonization and was consequently visited and settled by the Europeans at a very early date. As is customary in a new country, explorations were at first incomplete and the maps made by the early geographers far from correct. But as time advanced and the country became more thoroughly explored, the rough preliminary maps were replaced by more exact and satisfactory ones. The history of exploration

in St. Mary's County is, therefore, a narrative of the gradual accumulation of information which at first was vague and general, but now has become definite and specific.

THE HISTORY OF GEOGRAPHIC RESEARCH.

The first geographic exploration[1] in the region which is now known as St. Mary's County was carried on by Captain John Smith and a few companions in the summer of 1608, although the results were not published until 1612-14. The motive which prompted Smith to this undertaking was the exploration of Chesapeake Bay and the adjacent country, so that the examination of St. Mary's County was only a portion of the work accomplished. His description of the country in the vicinity of St. Mary's County is as follows:

"But finding this Easterne shore, shallow broken Isles, and for the most part without fresh water, we passed by the straits of *Limbo* [Hooper or Kedge Straits.] for the Westerne shore; so broad is the bay here, we could scarce perceiue the great high clifts on the other side: by them we Anchored that night and called them *Riccards Cliftes* [Calvert Cliffs]. 30 leagues we sayled more Northwards not finding any inhabitants, leaving all the Eastern shore, lowe Islandes, but ouergrowne with wood, as all the Coast beyond them so farre as wee could see; the Westerne shore by which we sayled we found all along well watered, but very mountanous and barren, the vallies very fertill, but extreame thicke of small wood so well as trees, and much frequented with wolues, Beares, Deere, and other wild beasts. We passed many shallow creekes, but the first we found Navigable for a ship, we called *Bolus* [Patapsco]."

Smith did not spend in all much more than a month in his exploration of Chesapeake Bay, but in this short time gathered material which was afterward presented in a remarkably well proportioned map, if one considers the difficulties which he encountered and the extremely rough methods of surveying which he employed. This map remained for a

[1] For illustrations of these early maps and the conditions under which they were made, see Mathews, Maps and Mapmakers of Maryland, Md. Geol. Survey, vol. ii, 1898, pp. 377-488.

long time unsurpassed and served as a basis of exploration and settlement. In examining the map which Smith compiled from notes taken on this famous voyage of discovery, one is struck with the accuracy with which the main features of St. Mary's County are recorded. The curved shore line of Chesapeake Bay from Cedar Point to Point Lookout is characteristically portrayed and the irregular courses of the Potomac and Patuxent rivers, together with their more important estuaries are defined with surprising accuracy and the surface of the county is dotted over with names of Indian settlements and with trees of various kinds which were probably meant to indicate different types of forest growth.

In 1635 the Lord Baltimore map appeared. This map included most of tidewater Maryland, but when compared with the Smith map of the same region, is far less accurate in detail and very much more crude in execution. St. Mary's County is well defined and in outlines does not differ markedly from the same region represented by Smith. A hillock shows roughly the position of the Drum Cliffs and the same methods which were used by Smith are employed to represent forests.

In 1651, the Farrer map of the environs of Chesapeake Bay and the surrounding country was published. This map, which was drawn by Virginia Farrer, was distorted so as to prove that "in ten dayes march with 50 foote and 30 horsemen from the head of Ieames River, ouer those hills and through the rich adiacent Vallyes beautified with proffitable river which necessarily must run into yt peacefull Indian Sea" one might arrive in New Albion or California. In this map, the region now occupied by St. Mary's County was so distorted that the map was practically useless.

Fiften years later, in 1666, George Alsop published a map which embraced the environs of Chesapeake Bay from a point in Virginia a little south of the Potomac River northward to what is now in part Delaware and Pennsylvania. The map was issued in a small pamphlet and was based on personal observation throughout the region represented. Although many of the details which were placed on the map had been obtained by personal exploration, still Alsop was doubtless familiar with the early Smith map and was guided not a little by it. The map is on

a larger scale and shows more detail than represented by Smith, yet it adds little to the real knowledge of the region, because of its diagrammatic character and extremely distorted proportions. It is just such a map as might be produced by a rover or an untrained hunter who had explored the region in a general way. The representation of the Patuxent and Potomac rivers is extremely diagrammatic and conventional while the St. Mary's River, called by Alsop "S. George River," is the only tributary to the Potomac which is represented on the map. The other reentrants along the border of the Potomac are represented by a wavy outline of the shore. Isolated hillocks are used to indicate higher land and scattered trees to represent the presence of forest growth. The location of St. Mary's City is indicated by a group of houses.

The map which Smith published in 1612 was not excelled by other explorers until 1670, when Augustin Herrman brought out a map of the region extending from southern New Jersey to southern Virginia. Herrman, it seems, offered to make a map of Lord Baltimore's territory provided Lord Baltimore in return would grant him a manor along Bohemia River; this proposition was accepted in 1660 and Herrman soon after began to fulfil his part of the contract. He was engaged in this work for about ten years, and the map which he finally produced indicates that he had considerable talent, not only as a surveyor, but also as a draughtsman. This map was published in 1670 and embraced the territory from the southern half of New Jersey to Southern Virginia and westward to the limit of tide-water. The cartographic work of St. Mary's County was the best which had appeared up to that time. The name "St. Mary County" here appears on the map, together with a number of the more important settlements scattered over the area. The coast line bordering the Bay is represented more accurately than in preceding maps and an attempt is made to show the configuration of St. Jerome Creek. The winding courses of both the Patuxent and Potomac rivers are shown in considerable detail and the position of the principal tributaries to both streams is well brought out. Names of settlements indicate the location of villages.

The next general map of the Chesapeake shore to appear was published by Walter Hoxton in 1735. Hoxton was a captain in the Merchant Marine service between London and Virginia. In regard to his own map, he says:

"In this Draught all the Principal Points, and all the Shoals and Soundings are Exactly Laid Down, but as I have not had Opportunity to Survey all of ye Bays, Rivers and Creeks, I have distinguisht what is my own doing by a Shading within the Line, from the outer part of the Coast which to make this Map as complete as at present I am able, have borrow'd from the Old Map, & are Traced by a Single Line without Shading. N. B. The Depths of Water are set down in Fathoms as farr up as Spes Utie Island, but above that in Feet." The particular point which is of interest in regard to this chart is the mapping of the shore line from Point Lookout northward to North East in Cecil County, and the indication of various depths of water in the Bay by means of figures placed over the spot where they occur, after the manner still employed by the United States Coast and Geodetic Survey.

In 1776, at about the time of the outbreak of the Revolutionary War, Anthony Smith published a chart of Chesapeake Bay on a scale of 3½ miles to the inch. This chart was intended for a guide to navigators, and such information as shoals, channels, islands, and the various depths of water were represented.

After the close of the war, in 1794, Dennis Griffith assembled all available information and published a map of the entire State which was not excelled until Alexander began the publication of his maps in the fourth decade of the last century. In this map, the shape of St. Mary's County was quite accurately portrayed and the configuration of the Bay shore was an improvement on that of Herrman, but the shore line of the Patuxent River was considerably generalized. There was additional information regarding the small streams which drain the surface of the region and many of the localities which occur on the most recent maps were indicated.

A marked advance in the cartography of this region occurred in 1835, when Prof. J. T. Ducatel, then State Geologist of Maryland, published

his geological report of St. Mary's County. This report was accompanied by a map of the region prepared by John H. Alexander. This map of St. Mary's County was the best that had been produced and was not excelled until the present Geological Survey published the St. Mary's County map. In the Alexander map, the topography was expressed by contours and the map executed on the scale of 1:200,000. The prominent points along the Bay shore and the Patuxent River were mapped and named, and the little streams which drain the interior of St. Mary's County were indicated. A new feature in the map was here introduced in the mapping of roads, of which the principal ones were shown. Prominent points in the topography were indicated.

During the summer of 1845, the United States Coast and Geodetic Survey began a detailed survey of Chesapeake Bay. Work was commenced first about Havre de Grace and the head of the Bay and by 1851 had reached as far south as Point Lookout. The Potomac and Patuxent rivers were last to receive attention and the latter was not mapped until 1860.

The maps, which were subsequently published, attained a very high grade of workmanship. Besides the position of the shore line, they indicated by means of numerals, the depths of water in feet and fathoms, the character of the bottom and the topography of the coast for about two miles back from the shore line.

With the exception of the State map published by Martenet in 1865, which has been revised from time to time, no other map work of importance was undertaken until 1890, when the United States Geological Survey began systematic topographic work in southern Maryland. In that year, the coast line and the interior of St. Mary's County were surveyed and subsequently published in eight sheets. Each one of these sheets, however, included portions of territory lying outside of St. Mary's County. These sheets are, beginning with the northern, Prince Frederick, Brandywine, Drum Point, Leonardtown, Wicomico, Point Lookout, Piney Point, and Montross. The cartographic work of the United States Geological Survey was in advance of any which had been previously attempted in St. Mary's County. The quality of the work was

no better than that published by the United States Coast and Geodetic Survey, but while the former confined its efforts mostly to the water-ways and mapped the adjacent land only a mile or two from the coast, the United States Geological Survey mapped the entire land area. The map was printed in three colors, blue, brown, and black. The hydrography was represented in blue and went into great details, including not only the larger water-ways, but also the smaller streams and their minute branches. Relief was represented by contours with a 20-foot interval and printed in brown; while the culture, including highways, bridges, railroads, houses, and the names of important localities, was printed in black.

The present Maryland Geological Survey, in co-operation with the United States Geological Survey, revised this map in the year 1900, and it is on this base that the geologic formations of the county have been mapped.

THE HISTORY OF GEOLOGIC RESEARCH.[2]

From an early date the attention of geologists has been attracted to St. Mary's County. The reason for the great interest in this region is probably due not only to the extensive deposits of fossil beds which are found within its borders, but also to the fine and continuous exposure which is found along the Bay shore and the banks of the Patuxent and St. Mary's rivers. The observations which were made led to conclusions which, in the early days of geologic research, were vague and oftentimes erroneous; but as time advanced and the principles underlying geologic history have become better understood, the papers which have been contributed on the region have become more satisfactory and the work more explicit and meritorious. As in the geographic research, so in the geologic, the evolution has been from the vague and general to the detailed and specific.

[2] Many of the broad generalizations of the early investigators in southern Maryland apply to the entire region although specific localities are seldom mentioned. In preparing this historical sketch, it has been necessary to refer to these papers although few of them mention the name of St. Mary's County.

The first paper of importance was published by William Maclure in 1809. Although this contribution dealt in a broad way with the geology of the United States, yet it shed considerable light on St. Mary's County. He included the entire Coastal Plain of Maryland in one formation, the "Alluvial," and so represented it on a geologic map. He also described the unconsolidated Coastal Plain deposits from Long Island southward, indicated the boundaries of the Alluvial formation and noted the presence of fossils. This paper was reprinted in substance in various magazines in 1811, 1817, 1818, and 1826. Maclure's views seem to have attracted considerable attention at first, for in 1820 Hayden incorporated them in his "Geological Essays" and attempted to establish the theory that the Alluvial was deposited by a great flood which came down from the north and crossed North America from northeast to southwest. The following year Thomas Nuttall referred the Coastal Plain deposits to the Second Calcareous formation of Europe, pointed out the fact that it occupied the country east of the primitive and transition formations of the Piedmont Plateau, and fixed Annapolis as about its northern limit.

The next year, 1822, Parker Cleaveland brought out his treatise on Mineralogy. In this interesting volume he reproduced Maclure's map and recorded the occurrence of selenite crystals in the Alluvial soil on the St. Mary's bank of the Patuxent River. He probably had in mind the locality directly opposite Solomons Island.

Professor John Finch, an Englishman, who was travelling in America at about this time, visited the Coastal Plain of Maryland and was so impressed with its interesting geology and vast deposits of fossils, that, on his return to Europe, he published an account of his experiences in southern Maryland, and drew some interesting conclusions regarding its geology. Previously, in an article which appeared in 1824, he took exception to the classifications proposed by his predecessors. He believed that the deposits included under the term "Alluvial" were contemporaneous with the Lower Secondary and Tertiary of Europe, Iceland, Egypt, and Hindoostan. He went farther and divided Maclure's "Alluvial" up into Ferruginous Sand and Plastic Clay. He believed that the Plastic Clay was Tertiary, and based his conclusions on the presence of amber,

FIG. 1.—VIEW SHOWING TOPOGRAPHY AT LEONARDTOWN.

FIG. 2.—VIEW LOOKING UP THE PATUXENT RIVER SHOWING DRUM CLIFF.

which he found at Cape Sable, correlating it with the amber of the Baltic. He also assigned to the Plastic Clay certain of the Indian kitchen-middens, which are found along the shore of Chesapeake Bay, thus opening a controversy regarding the age of these interesting deposits of oyster shells which did not reach a final settlement until many years later. He believed that the materials composing his Ferruginous Sand and Plastic Clay were deposited by a flood from the north or the northwest, agreeing somewhat closely with Hayden in this particular. His correlations were based almost entirely on lithologic distinctions, supported by a general similarity of fossil forms. No critical study of the fossils was undertaken, however, and few localities were given and no geologic boundaries whatever. It is consequently impossible to ascertain where he intended to place the formations which we now ascribe to the Eocene, Miocene, and Pleistocene periods. One thing, however, he perceived very keenly—that the deposits in southern Maryland would with future work be separated into many distinct formations. This prophecy has since been fulfilled. During the same year Thomas Say described the collection of fossil shells made by Finch, and among them appeared many forms from St. Mary's County. This collection is still preserved in the British Museum.

In the year 1825 J. Van Renssellaer assigned the deposits of the Coastal Plain to the Tertiary, and divided them into Plastic Clay, London Clay, and Upper Marine. He further correlated the deposits of Maryland which we now know as Miocene with the Upper Marine of Europe and probably in part with the London Clay. It should be noted here, however, that Finch had previously used Upper Marine in a different sense. He had applied it to the sand dune formations of Cape Henry and Staten Island, while Van Renssellaer adopted it for a true fossiliferous formation of very much greater age than the deposits which Finch had embraced under the same name. Three years later, in 1828, Morton, although accepting Van Renssellaer's correlation of the great deposits of fossil shells in the Maryland Coastal Plain with the Upper Marine of Europe, apparently used the term in a much wider sense than its author had employed. He also gave a list of the fossil forms occurring in the

Upper Marine, and included some which have since been shown to be later than Miocene. During the same year Vanuxem divided the Alluvial and Tertiary of the Atlantic Coast into Secondary, Tertiary, and Ancient and Modern Alluvial. In this classification the Miocene of southern Maryland was included in a part of the Tertiary. He stated further that vast numbers of "Littoral" shells occurred in the Tertiary analogous to those of the Tertiary of the Paris and English basins.

Conrad brought out his first publications bearing on the Miocene geology of Maryland in 1830. He agreed with Vanuxem in placing southern Maryland in the Tertiary and pointed out a number of localities where fossil shells were found. Two years later Conrad published another paper in which he divided up the Coastal Plain deposits into six formations. This was the first time that the Coastal Plain had been classified so as to show its extreme complexity, and from this time on it has been dealt with, not as a deposit containing a few formations but as a series of deposits complex in composition and age. Conrad at this time ascribed the Miocene of Maryland to the Upper Marine and made it equivalent to the Upper Tertiary of Europe.

The following year John Finch published another book on his travels in Maryland which had been made almost a decade before. In this narrative, Finch gives a most interesting account of the great delight which he experienced in collecting from the enormous deposits of fossil shells in St. Mary's County.

The following year Morton published another paper in which he proposed a classification of the Coastal Plain deposits. In this no distinct reference was made to Maryland, but it is probable that he still regarded the Miocene of this State as Upper Marine.

During the same year also Isaac Lea described some fossils from the St. Mary's River and regarded then as older Pliocene. He, too, doubted the existence of the Miocene in Maryland.

The next paper of importance was published by Conrad, in 1835, in which he assigned the Miocene deposits to the older Medial Pliocene. In the following year Ducatel referred the deposits of St. Mary's County to older Pliocene and distinctly stated that they were not Miocene. He

also published a map of southern Maryland in which various deposits were marked and the names of the formations given in red letters.

W. B. Rogers was the first to recognize the presence of Miocene deposits in southern Maryland. He made the announcement in 1836 that part of the Maryland Tertiary belonging to the Miocene. He noted the great difference between the fossil and living species, showing that the Medial Tertiary contained but 19 per cent of living forms. He thought that the extermination was due to a fall of temperature. In the same and following year he described many fossils from the Miocene of southern Maryland, and in 1842 he correlated his Medial Tertiary with the Crag of England and stated it was Miocene. The boundaries which he gave the Miocene at that time were not greatly different from the boundaries which are ascribed to the Chesapeake Group of to-day. In 1844, Rogers assigned the diatomaceous earth to a position near the base of the Miocene.

About this time much interest was created in the Miocene problem of Maryland by Sir Charles Lyell. He regarded these deposits as Miocene, and gave at some length his reasons for this opinion. He also stated that the Miocene of Maryland agreed more closely with the Miocene of Lorraine and Bordeaux than with the Suffolk Crag. Lonsdale also concluded from the corals collected in the Miocene which were submitted to him for examination, that the American deposits were probably accumulated while the climate was somewhat "superior" to that of the Crag and "perhaps" equal to that of the *faluns* of Lorraine, but "inferior" to that of Bordeaux. In the same year Conrad described and figured many fossils from the Calvert Cliffs.

No more papers of importance appeared on the Maryland Miocene until 1863, when Dana brought out his first edition of the Manual of Geology. In this work he took occasion to propose the term "Yorktown epoch" for the period during which the Miocene of the Atlantic coast was deposited. The next paper of significance was published by Heilprin in 1881, in which he discussed the Miocene at some length, and divided it into an "Older period" and a "Newer period." The Older period contained the older portion of the Miocene of Maryland; and the Newer

period, the later portion. He subdivided the Newer period again into the Patuxent Group and the St. Mary's Group. The next year, the same author revised his classification and divided the Miocene into three groups as follows: the Carolinian or the Upper Atlantic Miocene, including the Sumpter epoch of Dana; the Virginian or Middle Atlantic Miocene, including part of the Yorktown of Dana and the Newer group of Maryland; and the Marylandian or the Older Atlantic Miocene, including the rest of Dana's Yorktown and the older period of Maryland. He suggested that the Virginian was of the same age as the second Mediterranean of Austrian geologists and the *faluns* of Touraine, and that the Marylandian was, at least in part, equivalent to the first Mediterranean of Austrian geologists and *faluns* of Léognan and Saucats. Three years later the same author published a map showing the distribution of these formations along the Atlantic coast. In 1888 Otto Meyer took exception to Heilprin's correlation and conclusions, and introduced the term *Atlantic Group* to embrace the Tertiary of the Atlantic States, and *Gulf Group* for that of the Gulf States.

Three years later Darton employed the term "Chesapeake Group" to cover a portion of the Miocene, and in the following year Dall and Harris published their report on the Miocene deposits in the Correlation Papers of the U. S. Geological Survey, and used the term "Chesapeake Group" to include the Miocene strata extending from Delaware to Florida. These deposits were made during the Yorktown epoch of Dana and the group included a large part of Heilprin's Marylandian, Virginian, and Carolinian. Two years later Harris, basing his work on a study of the organic remains found in the Miocene, subdivided the Miocene faunas of Maryland into the Plum Point fauna, the Jones Wharf fauna, and the St. Mary's fauna.

The following year Darton, by bringing together a large number of well records throughout the Coastal Plain from New Jersey southward, rendered a most important service to the study of the Miocene problem in Maryland by suggesting the structure and extent of the beds throughout the region. The following year Dana admitted Harris's faunal zones, but still retained the term "Yorktown," to part of which he as-

signed the Maryland beds. In 1896 Darton published a bulletin under the auspices of the U. S. Geological Survey, in which he brought together a large number of well records throughout the Coastal Plain. He also published the Nomini folio, and thus was the first to express, on a contour map, the development of the Miocene throughout a large portion of Southern Maryland.

In 1898 Dall published a most important summary of existing knowledge of the Tertiary of North America, in which he suggested a classification of the Maryland Miocene deposits and correlated them with other parts of North America and of Europe.

Throughout all southern Maryland there is a well-defined mantle of clay, loam, sand, and gravel which occupies the divides as well as certain of the larger valleys. At first this was confused with the older deposits on which it lies and was included with them in all geological discussions of the region. Little by little it became apparent that these surficial deposits were distinct in age from the more fossiliferous beds beneath. but the relation which existed between them was not understood and little attention was given to the matter. To go into a full discussion of the history of this separation would be to repeat much that has already been said. Those who desire to look into the early history in more detail are referred to the Report on the Pliocene and Pleistocene of Maryland, Maryland Geological Survey, 1906. It was not until Professor W J McGee published his investigations of these deposits in 1887 and 1888 that their true relation with the underlying formations was at all understood. He gave the name of Columbia formation to this entire series of deposits and divided them into fluviatile and interfluviatile phases which he considered contemporaneous. Later, Darton, who took up the work where McGee left it, discovered the Lafayette formation in St. Mary's County and divided the Columbia formation of McGee into an Earlier and a Later Columbia. In 1901, Shattuck, who had studied the region in still more detail, separated the same deposits into four formations, the Lafayette, Sunderland, Wicomico, and Talbot, the three latter of which he united under the general term Columbia Group. He also showed that these were developed in terraces lying one above the

other in order of their age, the oldest lying topographically highest. The same year, J. A. Bonsteel published a report on the soils of St. Mary's County.

The next year Shattuck published a report on Cecil County in which he referred to the lignite deposits of St. Mary's County and suggested an explanation of their origin. In 1904 the Miocene deposits of Maryland were fully described by Clark, Shattuck, Dall, Glenn, Martin, and others. In this report a geologic map, sections and many photographs were published. In 1906 the St. Mary's Folio, by Shattuck and Miller, was published by the U. S. Geological Survey. This contained a summary of the geology of the county and a geologic map of its southern portion. Clark and Mathews also published a summary of the physical features and geology of Maryland in which St. Mary's County was given considerable attention. Before the close of the year the report on the Pliocene and Pleistocene deposits of Maryland appeared under the authorship of Clark, Shattuck, Hollick, Lucas, and others. In this report the surficial deposits of St. Mary's County are discussed at great length.

BIBLIOGRAPHY.

Containing References to the Geology and Economic Resources of St. Mary's County.

1624.

SMITH, JOHN. A Generall Historie of Virginia, New England, and the Summer Isles, etc. London, 1624. [Several editions.]

(Repub.) The True Travels, Adventures and Observations of Captaine Iohn Smith in Europe, Asia, Afrika, and America, etc. Richmond, 1819, 2 vols.—from London edition of 1629.

Pinkerton's Voyages and Travels, vol. 13, 4to, London, 1812, pp. 1-253—from London edition of 1624.

Eng. Scholars Library No. 16. (For bibliography of Smith's works and their republication, see pp. cxxx-cxxxii.)

1634.

ANON. A Relation of the Successefull beginnings of the Lord Baltemore's Plantation in Mary-Land; Being an extract of certaine Letters written from thence, by some of the Adventurers to their friends in England. Anno Domini 1634.

Shea's Early Southern Tracts, No. 1, 23 pp. 4to.

1807.

SCOTT, JOSEPH. A Geographical description of the states of Maryland and Delaware. Phila., Kimber, Conrad & Co., 1807.

1809.

MACLURE, WM. Observations on the Geology of the United States, explanatory of a Geological Map. (Read Jan. 20, 1809.)

Trans. Amer. Phil. Soc., o. s. vol. vi, 1809, pp. 411-428.

MACLURE, WM. Observations sur la Géologie des États-Unis, survant à expliquer une Carte Géologique.

Journ. de phys., de chim. et d'hist. nat., tome lxix, 1809, pp. 204-213.

1811.

MACLURE, WM. Suite des observations sur la Géologie des États-Unis.

Journ. de phys., de chim. et d'hist. nat., tome lxxii, 1811, pp. 137-165.

1817.

MACLURE, WM. Observations on the Geology of the United States of America, with some remarks on the effect produced on the nature and fertility of soils by the decomposition of the different classes of rocks. With two plates. 12mo. Phila., 1817.

1818.

MACLURE, WM. Observations on the Geology of the United States of America, with some remarks on the probable effect that may be produced by the decomposition of the different classes of Rocks on the nature and fertility of Soils. Two plates.

Republished in Trans. Amer. Phil. Soc., vol. i, n. s., 1818, pp. 1-91.
Leon. Zeit., i, 1826, pp. 124-138.

1820.

HAYDEN, H. H. Geological Essays; or an Inquiry into some of the Geological Phenomena to be found in various parts of America and elsewhere. 8vo. pp. 412. Baltimore, 1820.

1822.

CLEAVELAND, PARKER. An elementary treatise on Mineralogy and Geology. 6 plates. 2d Edit. in 2 vols. Boston, 1822.

1824.

FINCH, JOHN. Geological Essay on the Tertiary Formations in America. (Read Acad. Nat. Sci., Phila., July 15, 1823.)

Amer. Jour. Sci., vol. vii, 1824, pp. 31-43.

SAY, THOMAS. An Account of some of the Fossil Shells of Maryland.

Jour. Acad. Nat. Sci., Phila., vol. iv, 1824, pp. 124-155. Plates 7-13.

1825.

ROBINSON, SAMUEL. A Catalogue of American Minerals, with their localities. Boston, 1825.

VAN RENSSELAER, J. Lectures on Geology; being outlines of the science, delivered in the New York Antheneum in the year 1825. 8vo. pp. 358. New York, 1825.

1828.

VANUXEM, L., and MORTON, S. G. Geological Observations on Secondary, Tertiary, and Alluvial formations of the Atlantic coast of the United States arranged from the notes of Lardner Vanuxem. (Read Jan. 1828.)

Jour. Acad. Nat. Sci., Phila., vol. vi, 1829, pp. 59-71.

1830.

CONRAD, T. A. On the Geology and Organic Remains of a part of the Peninsula of Maryland.

Jour. Acad. Nat. Sci., Phila., vol. vi, pt. 2, 1830, pp. 205-230, with two plates.

1832.

CONRAD, T. A. Fossil Shells of the Tertiary Formations of North America illustrated by figures drawn on Stone from Nature. Phila. 46 pp. [vol. i, pt. 1-2 (1832), 3-4 (1833)].

(Repub.) by G. D. Harris, Washington, 1893.

(Part 3 was republished with plates, March 1, 1835.)

1833.

FINCH, I. Travels in the United States of America and Canada. 8vo. 455 pp. London, 1833.

LEA, ISAAC. Contributions to Geology. 237 pp. 6 plates. Phila., 1833.

(Rev.) Amer. Jour. Sci., vol. xxv, 1834, pp. 413-423.

1834.

DUCATEL, J. T., and ALEXANDER, J. H. Report on the Projected Survey of the State of Maryland, pursuant to a resolution of the General Assembly. 8vo. 39 pp. Annapolis, 1834. Map.

Md. House of Delegates, Dec. Sess., 1833, 8vo, 39 pp.
Another edition, Annapolis, 1834, 8vo, 58 pp., and map.
Another edition, Annapolis, 1834, 8vo, 43 pp., and folded table.
Amer. Jour. Sci., vol. xxvii, 1835, pp. 1-38.

1835.

CONRAD, T. A. Observations on a portion of the Atlantic Tertiary Region.

Trans. Geol. Soc., Pa., vol. i, part 2, 1835, pp. 335-341.

——— Observations on the Tertiary Strata of the Atlantic coast.

Amer. Jour. Sci., vol. xxviii, 1835, pp. 104-111, 280-282.

DUCATEL, J. T. Geologist's report, 1834.

——— Another edition. Report of the Geologist to the Legislature of Maryland, 1834, n. d. 8vo, 50 pp. 2 maps and folded tables.

DUCATEL, J. T., and ALEXANDER, J. H. Report on the New Map of Maryland, 1834, [Annapolis] n. d. 8vo, 59, i, pp. Two maps and one folded table.

Md. House of Delegates, Dec. Sess., 1834.

1836.

DUCATEL, J. T. Report of the Geologist. n. d. 8vo, pp. 35-84. Plate.

Separate publication (see Ducatel and Alexander).

DUCATEL, J. T., and ALEXANDER, J. H. Report on the New Map of Maryland, 1835. 8vo, 84, 1 pp. [Annapolis, 1836.]

Md. Pub. Doc., Dec. Sess., 1835.
Another edition, 96, 1 pp. and maps and plate.
Engineer's Report, pp. 1-34; Report of the Geologist, pp. 35-84.

——— Report of the Engineer and Geologist in relation to the New Map to the Executive of Maryland.

Md. Pub. Doc., Dec. Sess., 1835 [Annapolis, 1836], 8vo, 84, 1 pp., 6 maps and plates.
(Rev.) Amer. Jour. Sci., vol. xxx, 1836, pp. 393-394.
Jour. Franklin Inst., vol. xviii, n. s., 1836, pp. 172-178.

ROGERS, WM. B. Report of the Geological Reconnoissance of the State of Virginia. Wm. B. Rogers. Phila., 1836. 143 pp. Plate.

1837.

DUCATEL, J. T. Outline of the Physical Geography of Maryland, embracing its prominent Geological Features.

Trans. Md. Acad. Sci. and Lit., vol. i, 1837, pp. 24-54, with map.

DUCATEL, J. T., and ALEXANDER, J. H. Report on the New Map of Maryland, 1836. 8vo, 104 pp. and 5 maps. [Annapolis, 1837.]

Md. House of Delegates, Dec. Sess., 1836.

Another edition, 117 pp.

1838.

CONRAD, T. A. Fossils of the Medial Tertiary of the United States. No. 1, 1838. [Description on cover 1839 & '40.] 32 pp. Plates I-XVII.

(Repub.) by Wm. H. Dall, Washington, 1893.

WAGNER, WILLIAM. Description of five new Fossils, of the older Pliocene formation of Maryland and North America. (Read Jan. 1838.)

Jour. Acad. Nat. Sci., Phila., vol. viii, 1838, pp. 51-53, with one plate.

1840.

CONRAD, T. A. Fossils of the Medial Tertiary of the United States. No. 2. 1840. [Description on cover 1840-1842.] pp. 33-56. Plates XVIII-XXIX.

(Repub.) by W. H. Dall, Washington, 1893.

1841.

CONRAD, T. A. Description of Twenty-six new Species of Fossil Shells discovered in the Medial Tertiary Deposits of Calvert Cliffs, Md.

Proc. Acad. Nat. Sci., Phila., vol. i, 1841, pp. 28-33.

1842.

CONRAD, T. A. Observations on a portion of the Atlantic Tertiary Region, with a description of new species of organic remains.

2d Bull. Proc. Nat. Inst. Prom. Sci., 1842; plates, pp. 171-192.

——— Description of twenty-four new species of Fossil Shells chiefly from the Tertiary Deposits of Calvert Cliffs, Md. (Read June 1, 1841.)

Jour. Acad. Nat. Sci., Phila., vol. viii, 1842, pp. 183-190.

——— Descriptions of new Tertiary Fossils.

2d Bull. Proc. Nat. Inst. Prom. Sci., 1842, pp. 192-194, two plates.

HARLAN, R. Description of a New Extinct Species of Dolphin from Maryland.

2d Bull. Proc. Nat. Inst. Prom. Sci., 1842, pp. 195-196, 4 plates.

MARKOE, FRANCIS, JR. [Remarks and list of fossils from Miocene.]

2d Bull. Proc. Nat. Inst. Prom. Sci, 1842, p. 132.

1843.

CONRAD, T. A. Description of a new Genus, and Twenty-nine new Miocene and one Eocene Fossil Shells of the United States.

Proc. Acad. Nat. Sci., Phila., vol. i, 1843, pp. 305-311.

1844.

ROGERS, H. D. Address delivered at the Meeting of the Association of American Geologists and Naturalists.

Amer. Jour. Sci., vol. xlvii, 1844, pp. 137-160, 247-278.

ROGERS, WM. B. [Tertiary Infusorial formation of Maryland.]

Amer. Jour. Sci., vol. xlvi, 1844, pp. 141-142.

1845.

CONRAD, T. A. Fossils of the (Medial Tertiary or) Miocene Formation of the United States. No. 3. 1845. pp. 57-80. Plates xxx-xlv.

(Repub.) by W. H. Dall, Washington, 1893.

LYELL, CHAS. On the Miocene Tertiary Strata of Maryland, Virginia and of North and South Carolina.

Quart. Jour. Geol. Soc., London, vol. i, 1845, pp. 413-427.

Proc. Geol. Soc., London, vol. i, 1845, pp. 413-427.

1849.

BAILEY, J. W. New Localities of Infusoria in the Tertiary of Maryland.

Amer. Jour. Sci., 2d ser., vol. vii, 1849, p. 437.

GIBBES, R. W. Monograph of the fossil Squalidae of the United States.

Jour. Acad. Nat Sci., Phila., 2 ser., vol. i, 1849, pp. 191-206.

1852.

DESOR, E. Post Pliocene of the Southern States and its relation to the Laurentian of the North and the Deposits of the Valley of the Mississippi.

Amer. Jour. Sci., 2d ser., vol. xiv, 1852, pp. 49-59.

FISHER, R. S. Gazetteer of the State of Maryland compiled from the returns of the Seventh Census of the United States. New York and Baltimore, 1852, 8vo, 122 pp.

HIGGINS, JAMES. The Second Report of James Higgins, M. D., State Agricultural Chemist, to the House of Delegates of Maryland. 8vo. 118 pp. Annapolis, 1852.

Md. House of Delegates, Jan. Sess., 1852 [C], 8vo, 126 pp.

1856.

HIGGINS, JAMES. Fifth Agricultural Report of James Higgins, State Chemist, to the House of Delegates of the State of Maryland. 8vo. 91 pp. Annapolis, 1856 (published separately).

Also Md. House of Delegates, Jan. Sess., 1856.
Md. Sen. Doc.
Another edition, pp. 15-18 omitted, 8vo, 90 pp.

1860.

TYSON, P. T. First Report of Philip T. Tyson, State Agricultural Chemist, to the House of Delegates of Maryland, Jan. 1860. 8vo. 145 pp. Annapolis, 1860. Maps.

Md. Sen. Doc. [E]. Md. House Doc. [C].

1861.

CONRAD, T. A. Fossils of the (Medial Tertiary or) Miocene Formation of the United States. No. 4. 1861(?). pp. 81-89, index and plates xlv-xlix.

(Repub.) by W. H. Dall, Washington, 1893.

TYSON, P. T. [Letter from Mr. Tyson of Maryland on Tripoli.] (Read Dec., 1860.)

Proc. Acad. Nat. Sci., Phila., vol. xii, 1861, pp. 550-551.

1862.

CONRAD, T. A. Catalogue of the Miocene Shells of the Atlantic Slope.

Proc. Acad. Nat. Sci., Phila., vol. xiv, 1862, pp. 559-582.

TYSON, PHILIP T. Second Report of Philip T. Tyson, State Agricultural Chemist, to the House of Delegates of Maryland, Jan. 1862. 8vo. 92 pp. Annapolis, 1862.

Md. Sen. Doc. [F].

1864.

MEEK, F. B. Check list of the Invertebrate Fossils of North America. Miocene.

Smith. Misc. Col., vol. vii, art. vii, 1864, 32 pp.

1866.

CONRAD, T. A. Illustrations of Miocene Fossils, with Descriptions of New Species.

Amer. Jour. Conch., vol. ii, 1866, pp. 65-74, plates 3 and 4.

1867.

CONRAD, T. A. Descriptions of New Genera and Species of Miocene shells, with notes on other fossil and recent species.

Amer. Jour. Conch., vol. iii, 1867, pp. 257-270.

HIGGINS, JAMES. A Succinct Exposition of the Industrial Resources and Agricultural advantages of the State of Maryland.

Md. House of Delegates, Jan. Sess., 1867 [DD], 8vo, 109, iii pp.
Md. Sen. Doc., Jan. Sess., 1867 [U].

1871.

SHALER, N. S. On the Causes which have led to the Production of Cape Hatteras.

Proc. Boston Soc. Nat. Hist., vol. xiv, 1871, pp. 110-121.

1880.

DANA, J. D. Manual of Geology. 3d edit.

1881.

HEILPRIN, ANGELO. On the Stratigraphical Evidence Afforded by the Tertiary Fossils of the Peninsula of Maryland.

Proc. Acad. Nat. Sci., Phila., vol. xxxii, 1880, pp. 20-33.

1882.

HEILPRIN, ANGELO. On the relative ages and classification of the Post-Eocene Tertiary Deposits of the Atlantic Slope.

Proc. Acad. Nat. Sci., Phila., vol. xxxiv, 1882, pp. 150-186.

(Abst.) Amer. Jour. Sci., 3 ser., vol. xxiv, 1882, pp. 228-229. Amer. Nat., vol. xvii, 1883, p. 308.

1884.

HEILPRIN, ANGELO. The Tertiary Geology of the Eastern and Southern United States.

Jour. Acad. Nat. Sci., Phila., 2 ser., vol. ix, 1884, pp. 115-154, map.

——— Contributions to the Tertiary Geology and Paleontology of the United States. 4to. 117 pp., map. Phila., 1884.

RAU, CHAS. Prehistoric Fishing in Europe and North America.

Smithsonian Contrib. Knowledge, vol. xxv, 1884, 360 pp.

1885.

WILLIAMS, JR. A. (Editor). Infusorial Earth.

Mineral Resources U. S., 1883-1884, Washington, 1885, p. 720.

1888.

CLARK, WM. B. On three Geological Excursions made during the months of October and November, 1887, into the southern counties of Maryland.

Johns Hopkins Univ. Cir. No. 63, vol. vii, 1888, pp. 65-67.

UHLER, P. R. Observations on the Eocene Tertiary and its Cretaceous Associates in the State of Maryland.

Trans. Md. Acad. Sci., vol. i, 1888, pp. 11-32.

1890.

CLARK, WM. B. Third Annual Geological Expedition into Southern Maryland and Virginia.

Johns Hopkins Univ. Cir. No. 81, vol. ix, 1890, pp. 69-71.

DALL, WM. H. Contributions to the Tertiary Fauna of Florida.

Trans. Wagner Free Inst. Sci., Phila., vol. iii, 1890-1895, 570 pp.

1891.

CLARK, WM. B. Report on the Scientific Expedition into Southern Maryland. [Geology; W. B. Clark. Agriculture; Milton Whitney. Archæology; W. H. Holmes.]

Johns Hopkins Univ. Cir. No. 89, vol. x, 1891, pp. 105-109.

DARTON, N. H. Mesozoic and Cenozoic Formations of Eastern Virginia and Maryland.

Bull. Geol. Soc. Amer., vol. ii, 1891, pp. 431-450, map, sections.
(Abst.) Amer. Geol., vol. vii, 1891, p. 185.
Amer. Nat., vol. xxv, 1891, p. 658.

LINDENKOHL, A. Notes on the submarine channel of the Hudson River and other evidences of postglacial subsidence of the middle Atlantic coast region.

Amer. Jour. Sci., 3d ser., vol. xli, 1891, pp. 489-499, 18 plates.

MCGEE, W J The Lafayette Formation.

12th Ann. Rept. U. S. Geol. Surv., 1890-91, Washington, 1891, pp. 347-521.

WOOLMAN, LEWIS. Artesian wells and water-bearing horizons of Southern New Jersey (with a "note on the extension southward of diatomaceous clays and the occurrence there of flowing artesian wells.")

New Jersey Geol. Surv., Rept. State Geologist for 1890, 1891, pp. 269-276.

1892.

BABB, CYRUS C. The Hydrography of the Potomac Basin.

Amer. Soc. Civ. Eng., vol. xxvii, 1892, pp. 21-33.

CLARK, WM. B. The Surface Configuration of Maryland.

Monthly Rept. Md. State Weather Service, vol. ii, 1892, pp. 85-89.

DALL, W. H., and HARRIS, G. D. Correlation Papers—Neocene.

Bull. U. S. Geol. Surv. No. 84, 1892.
House Misc. Doc., 52d Cong., 1st sess., vol. xliii, No. 337.

DAY, D. T. (Editor). Infusorial Earth.

Mineral Resources U. S., 1889-90, Washington, 1892, p. 459.
The statistics for the year are also given in the Eleventh Census.

SCHARF, J. THOMAS. The Natural Resources and Advantages of Maryland, being a complete description of all the counties of the State and the City of Baltimore. Annapolis, 1892.

1893.

CLARK, W. B. Physical Features [of Maryland]. pp. 11-54 of Maryland, its Resources, Industries and Institutions. Baltimore, 1893.

DALL, WM. H. Republication of Conrad's Fossils of the Medial Tertiary of the United States. Phila., 1893.

DARTON, N. H. Cenozoic History of Eastern Virginia and Maryland.
Bull. Geol. Soc. Amer., vol. v, 1893, p. 24.
(Abst.) Amer. Jour. Sci., 3d ser., vol. xlvi, 1893, p. 305.

HARRIS, G. D. The Tertiary Geology of Calvert Cliffs, Maryland.
Amer. Jour. Sci., 3d ser., vol. xlv, 1893, pp. 21-31, map.

——— Republication of Conrad's Fossil Shells of the Tertiary Formations of North America. 8vo. 121 pp. 20 plates. Washington, D. C., 1893.

WHITNEY, MILTON. The Soils of Maryland.
Md. Agri. Exper. Sta., Bull. No. 21, College Park, 1893, 58 pp., map.

WILLIAMS, G. H. Mines and Minerals [of Maryland].
Maryland, its Resources, Industries, and Institutions, Baltimore, 1893, pp. 89-153.

WILLIAMS, G. H., and CLARK, W. B. Geology [of Maryland].
Maryland, its Resources, Industries, and Institutions, Baltimore, 1893, pp. 55-89.

1894.

CLARK, WM. BULLOCK. The Climatology and Physical Features of Maryland.
1st Biennial Rept. Md. State Weather Service, 1894.

DARTON, N. H. An outline of the Cenozoic History of a Portion of the Middle Atlantic Slope.
Jour. Geol., vol. ii, 1894, pp. 568-587.

——— Artesian Well Prospects in Eastern Virginia, Maryland, and Delaware.
Trans. Amer. Inst. Min. Eng., vol. xxiv, 1894, pp. 372-397, plates 1 and 2.

——— Fredericksburg Folio. Explanatory sheets.
U. S. Geol. Surv. Geol. Atlas, folio No. 13, Washington, 1894.

1896.

DARTON, N. H. Artesian Well Prospects in the Atlantic Coastal Plain Region.
Bull. U. S. Geol. Surv., No. 138, 1896, 228 pp., 19 plates.
House Misc. Doc., 54th Cong., 2d sess., vol. —, No. 28.

——— Nomini Folio, Explanatory sheets.
U. S. Geol. Surv., Geol. Atlas, folio 23, Washington, 1896.

1897.

BAUER, L. A. First Report upon the Magnetic Work in Maryland, including the History and Objects of Magnetic Surveys.

Md. Geol. Surv., vol. i, 1897, pp. 403-529, plates xiv-xvii.

CLARK, WM. BULLOCK. Historical Sketch, embracing an Account of the Progress of Investigation concerning the Physical Features and Natural Resources of Maryland.

Md. Geol. Surv., vol. i, 1897, pp. 48-138, plates ii-v.

——— Outline of Present Knowledge of the Physical Features of Maryland.

Ibid., vol. i, 1897, pp. 139-228, plates vi-xiii.

MARYLAND GEOLOGICAL SURVEY, Volume One.

The Johns Hopkins Press, 1897. 539 pp. Plates and maps.

MATHEWS, EDWARD B. Bibliography and Cartography of Maryland, including Publications relating to the Physiography, Geology and Mineral Resources.

Md. Geol. Surv., vol. i, 1897, pp. 229-401.

1898.

CLARK, WILLIAM BULLOCK. Administrative Report.

Md. Geol. Surv., vol. ii, 1898, pp. 25-47.

DALL, W. H. A Table of the North American Tertiary Horizons, correlated with one another and with those of western Europe, with Annotations.

18th Ann. Rept. U. S. Geol. Surv., 1896-97, Washington, 1898, pp. 323-348.

MARYLAND GEOLOGICAL SURVEY. Volume Two.

The Johns Hopkins Press, 1898. 509 pp. Plates and maps.

MATHEWS, EDWARD B. An Account of the Character and Distribution of Maryland Building Stones, together with a History of the Quarrying Industry.

Md. Geol. Surv., vol. ii, 1898, pp. 125-245.

——— The Maps and Map-Makers of Maryland.

Ibid., pp. 337-488, plates vii-xxxii.

MERRILL, GEORGE P. The Physical, Chemical and Economic Properties of Building Stones.

Ibid., vol. ii, 1898, pp. 47-125, plates iv-vi.

SHATTUCK, G. B. Two Excursions with Geological Students into the Coastal Plain of Maryland.

Johns Hopkins Univ. Cir. No. 137, vol. xv, 1898, pp. 15-16.

1899.

ABBE, CLEVELAND, JR. A General Report on the Physiography of Maryland.

Md. Weather Service, vol. i, 1899, pp. 41-216, plates i-xix.

CLARK, WILLIAM BULLOCK. The Relations of Maryland Topography, Climate and Geology to Highway Construction.

Md. Geol. Surv., vol. iii, 1899, pp. 47-107, plates iii-xi.

JOHNSON, ARTHUR NEWHALL. The Present Condition of Maryland Highways.

Ibid., pp. 187-263, plates xv-xxviii.

MARYLAND GEOLOGICAL SURVEY. Volume Three.

The Johns Hopkins Press, Baltimore, 1899, 461 pp. Plates and maps.

SIOUSSAT, ST. GEORGE LEAKIN. Highway Legislation in Maryland, and its Influence on the Economic Development of the State.

Ibid., pp. 107-187, plates xii-xiv.

1901.

BONSTEEL, J. A. Soil Survey of St. Mary's County, Md.

Field Oper. Div. Soils for 1900, U. S. Dept. Agri., Second Rept. Div. Soils, 1901, pp. 125-145, with map.

MARYLAND GEOLOGICAL SURVEY. Maryland and its Natural Resources.

Official Publication of the Maryland Commissioners, Pan-American Exposition, Baltimore, 1901, 38 pp., map.

MARYLAND GEOLOGICAL SURVEY. Maryland and its Natural Resources.

Official Publication of the Maryland Commissioners, Inter-state West Indian Exposition, Baltimore, 1901, 38 pp., map.

SHATTUCK, GEORGE BURBANK. The Pleistocene Problem of the North Atlantic Coastal Plain.

Johns Hopkins Univ. Circ., vol. xx, 1901, pp. 69-75.

Amer. Geol., vol. xxviii, 1901, pp. 87-107.

1902.

BAUER, L. A. Second Report on Magnetic Work in Maryland.
Md. Geol. Surv., vol. v, Baltimore, 1902, pp. 23-98. With maps.

MARYLAND GEOLOGICAL SURVEY. Volume Four.
The Johns Hopkins Press, Baltimore, 1902.

NEWTON, R. BULLEN. List of Thomas Say's types of Maryland (U. S.) mollusca in the British Museum.
Geol. Mag., dec. iv, vol. ix, 1902, pp. 303-305.

RIES, HEINRICH. Report on the Clays of Maryland.
Md. Geol. Surv., vol. iv, 1902, pp. 203-505.

1903.

Maryland Geological Survey in co-operation with U. S. Bureau of Soils. Map of St. Mary's County showing the agricultural soils. Published on topographic base, prepared for Md. Geol. Surv. by U. S. Geol. Surv.
33¾ x 38¼, contour 20 feet, 8 colors and patterns, scale 1/62,500.

———— in co-operation with U. S. Geological Survey. Map of St. Mary's County showing the geological formations. Published on topographic base, prepared for Md. Geol. Surv. by U. S. Geol. Surv.
33¾ x 38¼, contour 20 feet, 7 colors and patterns, scale 1/62,500.

1904.

BAGG, RUFUS M., JR. Systematic paleontology of the Miocene deposits of Maryland: Foraminifera.
Md. Geol. Surv., Miocene, pp. 460-483, plates cxxxi-cxxxiii, 1904.

BOYER, C. S. Thallophyta-Diatomaceae.
Md. Geol. Surv., Miocene, pp. 487-507, plates cxxxiv, cxxxv, 1904.

CASE, E. C. Mammalia, Aves, Reptilia.
Md. Geol. Surv., Miocene, pp. 3-70, plates x-xxvii, 1904.

CLARK, WILLIAM BULLOCK. The Miocene deposits of Maryland. Introduction and general stratigraphic relations.
Md. Geol. Surv., Miocene, pp. xxiii-xxxii, 1904.

——— Echinodermata.
Md. Geol. Surv., Miocene, pp. 430-433, plates cxix, cxx, 1904.

DALL, W. H. The Relations of the Miocene of Maryland to that of other regions and to the recent fauna.

Md. Geol. Surv., Miocene, pp. cxxxix-clv, 1904.
Abstract: Science, new ser., vol. xix, pp. 502-503, 1904.

EASTMAN, C. R. Pisces.

Md. Geol. Surv., Miocene, pp. 71-93, plates xxviii-xxxii, 1904.

GLENN, L. C. Pelecypoda.

Md. Geol. Surv., Miocene, pp. 274-401, plates lxv-cviii, 1904.

HOLLICK, ARTHUR. Angiospermæ.

Md. Geol. Surv., Miocene, pp. 483-486, Fig. 1, 1904.

MARTIN, G. C. Malacostraca, Cirripedia, Mollusca (except Pelecypoda), Brachiopoda, Vermes, Radiolaria.

Md. Geol. Surv., Miocene, pp. 94-97, 130-274, 402-404, 430, 447-459, plates xxxiii-xxxiv, xxxix-lxiv, cix, cxviii, cxxx.

SHATTUCK, GEORGE BURBANK. Geological and Paleontological Relations, with a Review of Earlier Investigations.

Md. Geol. Surv., Miocene, pp. xxxiii-cxxxvii, 1904.

ULRICH, E. O. Hydrozoa.

Md. Geol. Surv., Miocene, pp. 433-438, plate cxxi, 1904.

——— and BASSLER, R. S. Ostracoda, Bryozoa.

Md. Geol. Surv., Miocene, pp. 98-130, 404-429, plates xxxv-xxxvii, cix-cxviii, 1904.

VAUGHAN, T. W. Anthozoa.

Md. Geol. Surv., Miocene, pp. 438-447, plates cxxii-cxxix, 1904.

1906.

CLARK, WILLIAM BULLOCK and MATHEWS, EDWARD B. Report on the Physical Features of Maryland.

Md. Geol. Surv., vol. vi, part i, pp. 27-259, plates i-xxiii, 1906.

CLARK, WM. BULLOCK, HOLLICK, ARTHUR, and LUCAS, FREDERIC A. The Interpretation of the Paleontological Criteria.

Md. Geol. Surv., Pliocene and Pleistocene, pp. 139-152, plates xxxii, xxxiii, 1906.

CLARK, W. B. Crustacea, Mollusca, Coelenterata, Protozoa.

Md. Geol. Surv., Pliocene and Pleistocene, pp. 173-210, 213-216, plates xii-lxvi, 1906.

HAY, O. P. Reptilia.

Md. Geol. Surv., Pliocene and Pleistocene, pp. 169, 170, pl. xl, 1906.

HOLLICK, ARTHUR. Pteridophyta, Spermatophyta.

Md. Geol. Surv., Pliocene and Pleistocene, pp. 217-237, plates lxvii-lxxv, 1906.

LUCAS, F. A. Mammalia.

Md. Geol. Surv., Pliocene and Pleistocene, 157-169, plates xxxiv-xl, 1906.

SELLARDS, E. H. Insecta.

Md. Geol. Surv., Pliocene and Pleistocene, pp. 170-172, pl. xl, 1906.

SHATTUCK, GEORGE BURBANK. The Pliocene and Pleistocene Deposits of Maryland.

Md. Geol. Surv., Pliocene and Pleistocene, pp. 23-152, plates i-xxxi, 1906.

SHATTUCK, GEO. B., and MILLER, B. L.

St. Mary's Folio.

U. S. Geol. Surv. Geol. Atlas, folio No. 136, Washington, 1906.

TRUE, FREDERICK W. Description of a new genus and species of fossil seal from the Miocene of Maryland.

Proc. U. S. Natl. Museum, vol. xxx, pp. 835-840, plates lxxv-lxxvi, 1906.

ULRICH, E. O. Molluscoidea.

Md. Geol. Surv., Pliocene and Pleistocene, pp. 210-212, fig. 10, 1906.

THE PHYSIOGRAPHY OF ST. MARY'S COUNTY

BY
GEORGE BURBANK SHATTUCK

Introductory.

In the main, there are two methods of discussing the physical features of a region. The first and older method is to describe in great detail the various topographic features which the region possesses, without regard to their origin, mutual relations, or significance. This method has its place and is still used to-day, but is at best a mere catalogue of geographic facts. The second and modern method of discussing the topography of a region begins where the former leaves off. It assumes a knowledge of the leading physical features and seeks to point out the relations which they bear to one another as well as the causes which have brought them into existence. It will be seen that the latter is the more scientific of the two. In discussing the physiography of St. Mary's County, both methods will be employed. The topographic history of St. Mary's County, although complex and extremely interesting is not as diversified as that of many of the other counties of Maryland. The reason for this is found in the fact that the county lies entirely within the Coastal Plain, while many of the other counties of Maryland lie in more than one physiographic province. It is a matter of regret that the geologic record of St. Mary's County is so imperfect that many of the earlier episodes in its history have been lost entirely or can only be partially recovered. Other and later portions of its historical record, however, are so much more complete that they can be read in their leading features as easily as if they had recently occurred. In discussing the physiography of St. Mary's County, the topography of the region will be first described and then the geologic history which has brought about the principal surface features will be outlined.

Topographic Description.

Maryland may be considered as divisible into three grand physiographic provinces which are, beginning with the eastern, the Coastal Plain, the Piedmont Plateau, and the Appalachian Region. The Coastal Plain extends from the outer margin of the continental shelf westward to the edge of the Piedmont Plateau, or approximately to the position occupied by the Baltimore & Ohio Railroad as it crosses the State from Delaware to Washington. The relief throughout the Coastal Plain region is low and its western margin slowly rises to an altitude of about 300 to 400 feet as it merges with the Piedmont Plateau. The Piedmont Plateau extends from the western margin of the Coastal Plain to the eastern boundary of the Appalachian region. It is considerably higher than the Coastal Plain, attaining in Carroll County an altitude of over 800 feet, and has been deeply dissected by the river valleys which cross it. Its western border merges with the Appalachian region at Catoctin Mountain. The Appalachian region occupies the remainder of the State. It consists of parallel ridges of rugged mountains over 3000 feet in height, separated by broad valleys and crossed by narrow water gaps. Many of the counties of Maryland present a variety of topographic features resulting from the fact that they lie in more than one of these regions. St. Mary's County, however, lies entirely within the Coastal Plain and it is due to this fact that its scenery, although picturesque and in a measure diversified, does not present the variety which is found in some of the other counties of Maryland. In a report on Cecil County [1] recently published, two types of the topographic characteristics of the Coastal Plain were defined. They were described in the following words: "In Cecil County the Coastal Plain contains two contrasted types of topography. One type is a flat, low, featureless plain, and the other is a rolling upland attaining four times the elevation of the former and resembling the topography of the Piedmont Plateau more than that typical of the Coastal Plain. Elk River is the dividing line between these two types of topography. On the east side of it is

[1] Cecil County, Maryland Geological Survey, 1902

FIG. 1.—A NEARER VIEW OF DRUM CLIFF.

FIG. 2.—VIEW SHOWING THE FOSSIL BED AT DRUM CLIFF.

the low land of the typical Coastal Plain and on the west of it are the rolling uplands."

St. Mary's County contains only one type of Coastal Plain topography, which is the Western Shore type, but the broad flats along the north bank of the Potomac River suggest an Eastern Shore topography. Its former level surface has been so extensively dissected by streams which run east and northeast into Chesapeake Bay and the Patuxent River on the one hand and south into the Potomac River on the other, that the country now possesses the character of a rolling upland, such as is customary to associate with the eastern margin of the Piedmont Plateau. The surface, although resembling a dissected plain, is in reality made up of three distinct systems of terraces, which lie above one another like steps in a flight of stairs. The oldest, which is topographically highest, occupies the center and the other terraces are grouped about it in concentric arrangement in order of their age.

The oldest terrace, having been subjected to erosion longer than the others, is more dissected and its surface, which was originally level, has now been modified so as to present a gently rolling aspect. The next younger terrace, although it also has suffered from erosion has not yet reached the advanced stage of the oldest, while the terrace which is topographically lowest and therefore the youngest of the three has suffered least of all by erosion and, in fact, has been subjected to the work of streams for so short a time that its surface for the most part retains its originally level and unbroken character.

Each of these terraces is separated from the one just below by a well-defined scarp-line similar in appearance to the sea-cliff which separates the lowest terrace from the modern beach. In approaching the main divide of St. Mary's County, one travels for some distance over an unbroken flat, which constitutes the lowest and youngest terrace. The surface of this plain gradually rises toward the interior. At its inner margin, which is about 45 feet in height, it is terminated by an abrupt scarp of 10 to 20 feet, which leads up to the surface of the middle terrace. This also is a flat, lying higher than the former and extensively eroded by the headwaters of streams which rise within it. This middle flat in

its turn gently rises toward the interior until at a height of about 75 or 80 feet it is terminated by a second scarp some 20 to 30 feet in height, which blends at its upper edge with the rolling surface of the highest and oldest terrace. The latter is the main divide of the county, although not the oldest terrace. It has suffered greatly from erosion, especially along its borders, where it no longer has a plain but a rolling topography. This terrace in its turn rises gradually toward the northwest. At a height of about 180 feet it is abruptly terminated by a third scarp, which rises 20 feet to the surface of the oldest and highest terrace of the series. This terrace, which is present in the vicinity of Charlotte Hall, is but slightly represented in St. Mary's County. To the northwest in Charles and Prince George's counties it has a much more extensive development and remnants of it are found scattered along the eastern slope of the Piedmont Plateau from Washington northeastward through Maryland, Delaware, and Pennsylvania to the Delaware River. It also is present in Virginia and southward. In the vicinity of Charlotte Hall this terrace is represented by a series of small outliers which bear the same relation to the main body of the terrace as the islands scattered along the Eastern Shore bear to the mainland behind.

Throughout the southern half of St. Mary's County, especially in the vicinity of Ridge, the inner margins of the three lower terraces do not have the same elevations as in the region just described. The lowest rises from tide to a height of about 10 feet. It is here abruptly terminated by a scarp about 10 feet high. The next terrace slopes from the top of this scarp to a height of about 45 feet. At this point the second scarp rises and joins the terrace above at a height of about 60 feet. Although there is this difference in elevation between the three lower terraces in the southern half of the county and the same terraces in the northern half, the transition from one to the other is not abrupt but gradual and one may trace them as they gently rise from Point Lookout northward to the margin of the county. It would appear then that there has been a slight tilting of the surface in southern St. Mary's County.

To the four terraces just described a fifth may be added, although it

does not form a conspicuous element in the topography. This fifth terrace is the beach and wave-built flat which extends along the shore of Chesapeake Bay and the Patuxent River. It is everywhere present and its width depends in a large measure upon the force of the tidal currents which sweep over it.

When the distribution of terraces on the south bank of the Patuxent River is compared with that on the north bank of the Potomac, it will be found that there is a much greater development of the lowest terrace in the valley of the latter. This lack of harmony between the two river valleys is apparently due to the erosion of the lowest terrace from the south bank of the Patuxent River. From Horse Landing Creek southward to Cuckold Creek the lowest terrace has been almost entirely removed, but just across the river on the Calvert County side this terrace has an extensive development. South of Cuckold Creek the lowest terrace is represented by broad flats, but is almost entirely absent from the shore of Calvert County on the north bank of the river. It thus appears that the Patuxent has removed this terrace first on one and then on the other side of its valley.

Taken as a whole, the divide of the county is lowest in its southern portion between Chesapeake Bay and St. Mary's River, where it has an elevation of about 60 feet and rises gradually until its greatest altitude is reached near Oaks, where it has a height of about 200 feet.

THE DRAINAGE OF ST. MARY'S COUNTY.

St. Mary's County, occupying, as it does, the southern extension of one of the two peninsulas in Southern Maryland, is entirely surrounded by water except along its northwest border, where it joins Charles County. Its northeastern margin is washed by the waves of the Patuxent River and its eastern and southern margin by those of Chesapeake Bay, the Potomac River and its estuaries. These three bodies of water receive the drainage of the entire county. The divide which separates the headwaters of the streams which flow into the Patuxent-Chesapeake basins from those which flow into the Potomac River is an extremely irregular

line. It enters St. Mary's County near Oaks and runs southward to Point Lookout, coincident with the direction of the Three Notch Road. From Oaks to Hermanville its general trend is southeast, although it departs first on one side and then on the other from this general direction. From Hermanville it turns abruptly to the southeast and continues this direction to Point Lookout. Throughout its entire course the divide is situated northeast or east of the line passing down the center of the county.

The most important tributaries of the Patuxent and Chesapeake waters are Indian, Trent Hall, Persimmon, Horse Landing, Cat, Cole, St. John, and Cuckold creeks, which enter the Patuxent; and St. Jerome and Deep creeks, which enter Chesapeake Bay. Most of the streams entering the Potomac are much larger and are converted into estuaries throughout their lower courses. They are the Chaptico, St. Clement, McIntosh, Herring, St. George, and Smith creeks, and St. Mary's River.

As would be expected from the position of the divide, the streams which empty into Chesapeake Bay and the Patuxent River are very much shorter than those which find their way into the Potomac River. They also flow through deep, steep-sided gorges. Those which enter the Potomac River have much longer courses and, as a rule, wider valleys with more gentle slopes. This difference between the streams flowing north and those flowing south is probably in part due to the more active erosion of the Patuxent River and Chesapeake Bay. It will be remembered also that where these river courses are shorter and steeper, there the lowest terrace has suffered most from erosion. Along the Bay shore similar conditions held before the second terrace was deposited as are now found along the Calvert Cliffs in Calvert County, for at the inner margin of this latest terrace there is a steep escarpment which was cut in precisely the same manner as Calvert Cliffs are being cut to-day. The pushing back of the shore-line toward the divide so as to throw the whole out of symmetry was doubtless accomplished while this latest terrace was being deposited.

THE STRUCTURE OF THE COASTAL PLAIN.

The materials of which this region is built consist of clay, loam, sands, gravel, and boulders. These deposits are loose and unconsolidated, except where local ledges of ironstone have been developed. Although the materials which have built up St. Mary's County have been deposited at various times and belong to a large number of geological horizons, still they all lie either horizontal or nearly so. Those which have been tilted most, seldom exceed a dip of 12 feet to the mile. The structure of the region, therefore, has not materially influenced the drainage, and the streams flow from its surface as if they were flowing from a country composed of unconsolidated deposits of clays, sands, and gravel horizontally bedded throughout.

Topographic History.

A detailed study of the topographic features which have been described above and of the materials out of which the land is composed has revealed many of the incidents which have produced the present relief. An outline of the topographic history will now be given under the following four stages, beginning with the oldest:

1. The Lafayette Stage.
2. The Sunderland Stage.
3. The Wicomico Stage.
4. The Talbot Stage.
5. The Recent Stage.

THE LAFAYETTE STAGE.

At the close of the Miocene period the area now occupied by St. Mary's County, together with contiguous regions, was raised and subjected to a long period of erosion. This was followed by a deformation of the Middle Atlantic slope of such a character that the Coastal Plain was depressed more than the Piedmont region to the west. At this time St. Mary's County was entirely submerged and the highest terrace was deposited as a thin veneer throughout the region. It is not known how far inland the Lafayette sea advanced, but it is probable that its shore-

line wrapped about the Piedmont Plateau at an elevation of 500 feet or more above the present sea level, and the valleys of the Appalachian region may have been converted into fjords.

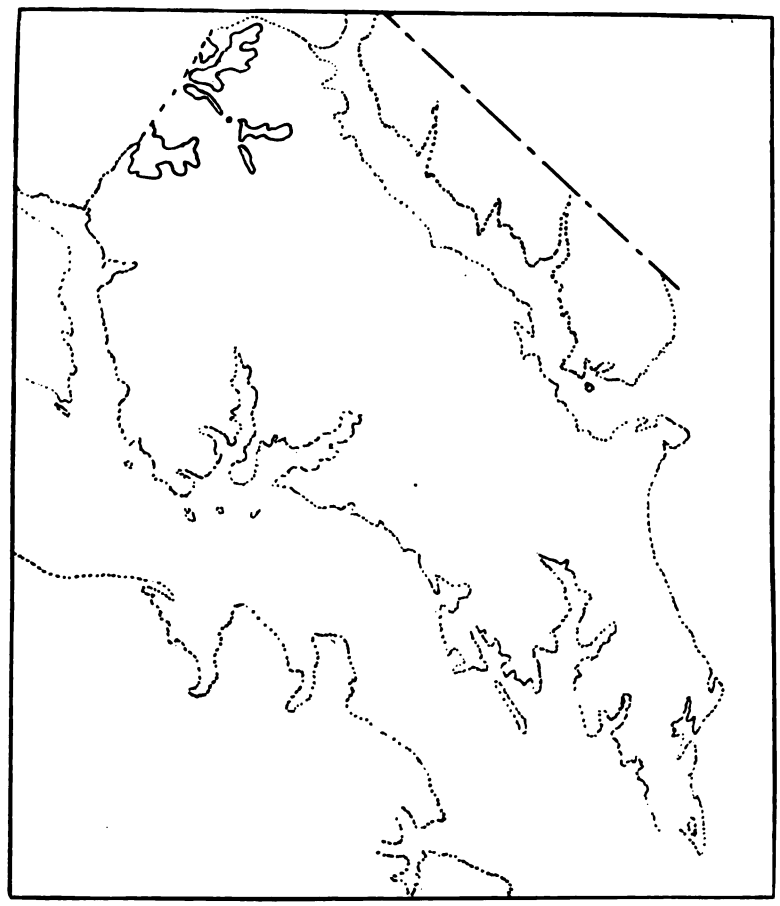


FIG. 1.—Diagram showing the approximate position of the shore-line of the Sunderland sea.

THE SUNDERLAND STAGE.

The Lafayette stage of terrace building was brought to a close by the elevation of the region once more above the surface of the ocean. Rain and rivers at once began to erode this new land surface and to

rapidly remove the materials which the Lafayette sea had but just deposited.

The salient features of the Coastal Plain as a whole, as well as those of St. Mary's County, were outlined at this time, although they do not appear to have received their full strength and final touches until after the close of the Talbot stage. It is probable that the valleys of the Potomac and Patuxent rivers, together with their larger tributaries, were cut at this time, and that the trough in which Chesapeake Bay now lies was also excavated by the Susquehanna River, which flowed down from the north and out to the ocean somewhere in the vicinity of the present outlet of Chesapeake Bay. It is not probable that at this time these depressions were cut to their present depth. They have apparently been deepened during each successive uplift.

At the close of the post-Lafayette elevation the terrace which the Lafayette sea had deposited had suffered considerably from erosion, and had been so largely removed from St. Mary's County that large areas of the underlying miocene deposits were exposed. On this surface the Sunderland sea advanced when the region sank once more beneath the ocean. The depression during this subsidence was not as great as during the Lafayette stage, although when it had reached its maximum the county was again submerged with the exception of a few islands near Charlotte Hall. The appearance of the region during this maximum subsidence is shown in Fig. 1.

THE WICOMICO STAGE.

As the region slowly rose above the waves, the terrace which had just been deposited by the Sunderland sea was gradually elevated to dry land and now forms the main divide of the county. As this surface gradually appeared above the ocean, it was vigorously attacked by subaerial erosion and much of it was destroyed by the rivers, which rapidly advanced their valleys across it. After the county had stood for some time above the ocean, it was again depressed to receive the waters of

the Wicomico sea. As the ocean advanced once more, the valleys of the Patuxent and Potomac river systems were transformed into estuaries, Chesapeake Bay took the place of the Susquehanna River, and a narrow

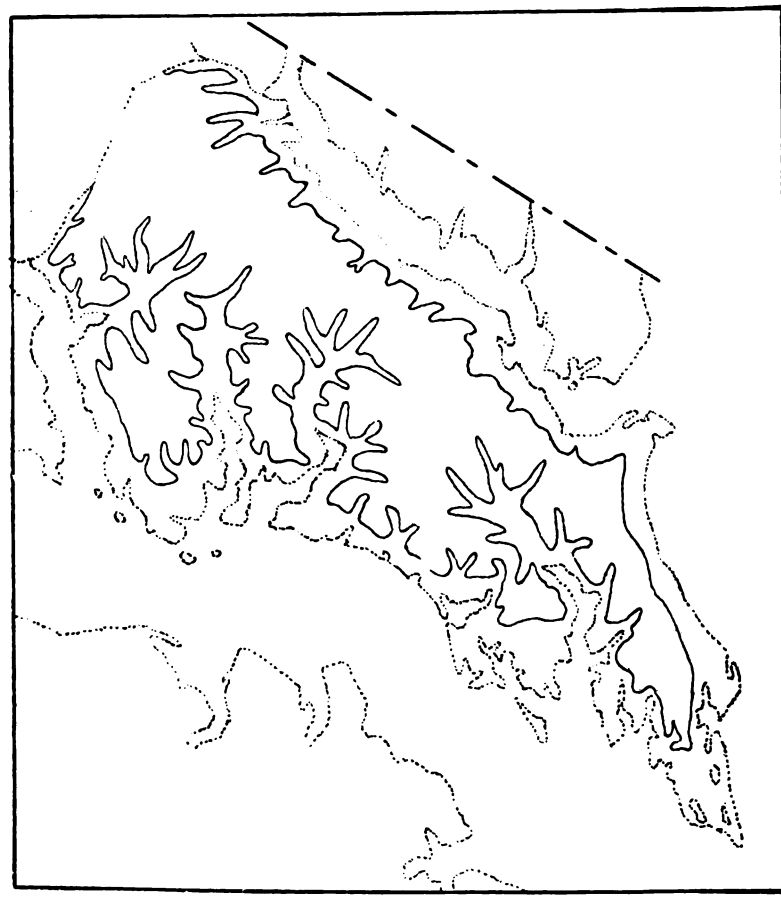


FIG. 2.—Diagram showing the approximate position of the shore-line of the Wicomico sea.

neck of land broken into numerous peninsulas, which now corresponds to the higher parts of St. Mary's County, was the only portion of the region above water. The appearance of the county at this time is roughly represented in Fig. 2.

THE TALBOT STAGE.

The Wicomico subsidence, like those which had preceded it, was brought to a close by another elevation of the region, and with the uplift of the land the third terrace, which had been deposited by the Wicomico

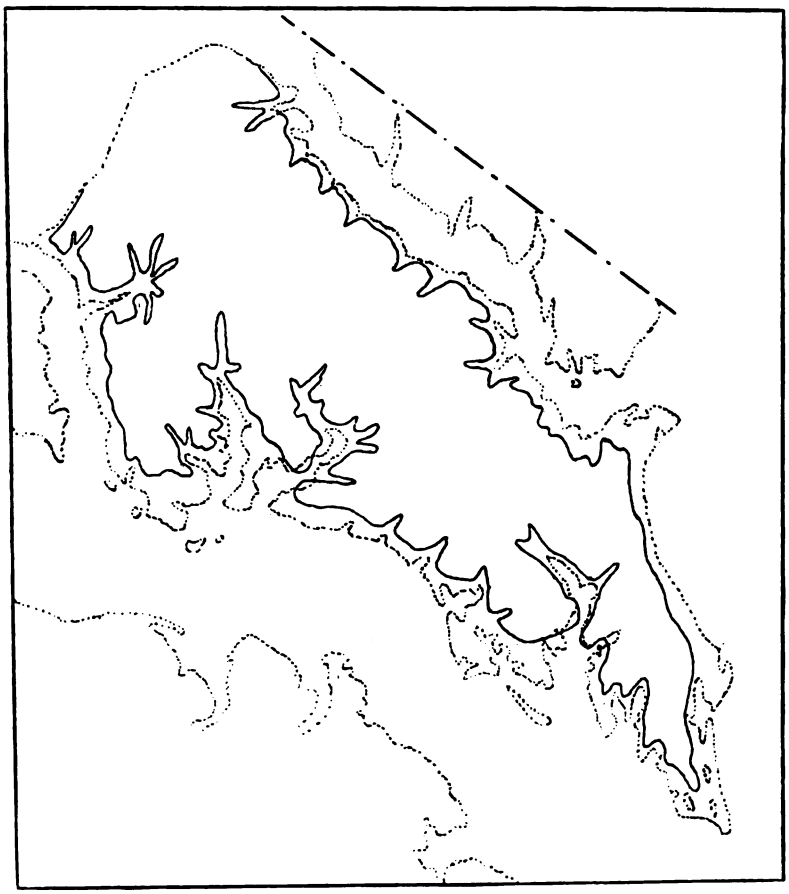


FIG. 3.—Diagram showing the approximate position of the shore-line of the Talbot sea.

sea, was raised above the surface of the ocean. Erosion of the entire county quickly followed the uplift, but had not proceeded far when the region once more sank beneath the water but not to the extent which

it had during the previous depression. The appearance of St. Mary's County at this time is roughly shown in Fig. 3. The lower courses of all the river valleys were once more transformed into estuaries and along the eastern margin of the county the waves of Chesapeake Bay cut a continuous scarp from Hermanville to Ridge similar in every respect save elevation with the famous Calvert Cliffs which are now being cut by the modern waves of Chesapeake Bay. At the base of this scarp and around the entire margin of the county the Talbot sea was depositing the youngest of the terrace systems which are now elevated to form land.

THE RECENT STAGE.

Another elevation of the region brought the Talbot stage to a close, and the surface was once more attacked vigorously by erosion and finally was lowered somewhat beneath the waters of the Patuxent River and Chesapeake Bay. There is every reason to believe that this submergence is still in progress and that the land is gradually sinking. It is impossible to say how much the land was elevated at the close of the Talbot stage, but it is probable that it stood much higher than it does to-day for mud and silt which have been deposited since the close of the Talbot stage are now found filling all the estuaries and creeks, not excepting the Patuxent River. This filling amounts to about 50 feet. During this uplift the Susquehanna River flowed the length of Chesapeake Bay, receiving as tributaries all the rivers which now drain the Coastal Plain of Maryland and Virginia and reached the ocean some miles beyond the present shore line at Cape Henry. At the present time the waves of Chesapeake Bay and of the Patuxent River are engaged in cutting against the Talbot terrace exactly as the waves during the Talbot stage did against the Wicomico terrace, and the waves in the Wicomico stage did against the Sunderland terrace. A new terrace is, therefore, being formed under the waves below the Talbot and separated from it by a well-defined scarp-line.

THE GEOLOGY OF ST. MARY'S COUNTY

BY
GEORGE BURBANK SHATTUCK

Introductory.

Special attention is given in the following pages to the stratigraphy, structure, and areal distribution of the various deposits which are found within the borders of St. Mary's County. These deposits are all unconsolidated except where the local conditions have produced unimportant indurations. The deposits of St. Mary's County are among the youngest deposits in Maryland. They do not date back further than the Miocene and extend with occasional breaks down to the present. The geologic history of St. Mary's County is complex, however, and was frequently interrupted by erosive intervals, so that portions of the geologic history have been destroyed and lost. These breaks are made manifest by the existing unconformities between the beds of different materials.

The various formations of St. Mary's County in their regular sequence of superposition are as follows:

Age.	Formation.	Group.
Pleistocene	Talbot, Wicomico, Sunderland	Columbia.
Pliocene	Lafayette	
Miocene	St. Mary's, Choptank, Calvert	Chesapeake.

The oldest deposits of St. Mary's County are the three formations of the Chesapeake Group, which are Miocene in age. They are, beginning with the oldest, Calvert, Choptank, and St. Mary's. In this county, if the geological relations are the same as elsewhere, the Calvert formation rests unconformably on the Eocene, although the contact is not visible;

the Choptank in turn rests unconformably on the Calvert, but passes into the St. Mary's formation without a break. The materials of the formations which compose the Chesapeake Group consist of marls, clays, and sands. Each formation is abundantly supplied with fossils. After the St. Mary's formation was deposited, the region was elevated and extensively eroded, and later submerged to receive the deposits of the Lafayette formation. These consist of clay, loam, sand and gravel and are deposited in a terrace which is the oldest of the series described above. A long period of erosion followed the deposition of the Lafayette terrace and the subsidence which brought it to a close permitted the deposition of the Columbia formations. These are, beginning with the oldest, Sunderland, Wicomico, and Talbot. They are all unconformable with whatever lies beneath them, and they are also unconformable with each other. They are developed in terraces, lying one above the other, and separated by well defined scarp-lines. The materials which enter into them are composed of clay, peat, sand, gravel, and ice-borne boulders. As a group, they record what took place in St. Mary's County while the regions to the north were covered with the great ice sheet.

The Miocene.

The Chesapeake Group.

The Miocene deposits of the Middle Atlantic slope have been described under the name of the Chesapeake Group. In Maryland, the materials which compose the formations of this group consist of clay, sandy-clay, sand, marl and diatomaceous earth. The sandy-clay members are, when freshly exposed, greenish to greenish-blue but slowly change under the influence of the weather to a slate or drab color.

It has been found possible to separate the beds of the Chesapeake Group into three formations, which are designated, beginning with the oldest, the Calvert formation, the Choptank formation and the St. Mary's formation.

THE CALVERT FORMATION.

Calvert County has suggested the name for this formation because of its typical development there. In the famous Calvert Cliffs along

the eastern border of this county the waves of Chesapeake Bay have cut an almost unbroken exposure rising nearly 100 feet in height and extending from Chesapeake Beach to Drum Point, a distance of about 30 miles.

Areal Distribution.

The Calvert formation which lies at the base of the Chesapeake Group in Maryland crosses the state from northeast to southwest. On the Eastern Shore it is found in the southeastern corner of Kent County, throughout almost the entire extent of Queen Anne's County and the northern portions of Talbot and Caroline counties.

On the Western Shore the Calvert formation is found extensively developed in Anne Arundel, Prince George's, Charles, Calvert, and St. Mary's counties. It appears as a long line of outcrop extending from the hills near the head of South River estuary to a place on the Calvert Cliffs near Point of Rocks. With this breadth, it extends across southern Maryland from Chesapeake Bay to the Potomac River, and is developed along the latter stream from the hills north of Washington to the mouth of the Wicomico.

Notwithstanding this great development, the Calvert formation is seldom met with on the surface of the country but must be sought in the cliffs of the larger estuaries and in the walls of stream gorges. As on the Eastern Shore so on the Western, the Calvert formation is covered by younger formations.

The distribution of the Calvert formation in this county is shown on the geological map which accompanies this report. It is found throughout the northern portion of the region as far south as a line connecting Roslyn Creek on the Patuxent with the lower portions of St. Clement Creek, in the Potomac Valley. Throughout this region the Calvert formation is so extensively covered over by the sand and gravels of the formations belonging to the Columbia Group that it is nowhere found along the divides but occurs in the valley walls of important streams. To the north in neighboring regions the Calvert formation lies unconformably on the eroded surface of the Nanjemoy formation. This rela-

tionship is nowhere visible in St. Mary's County, for the Eocene beds dip below the surface of the Patuxent River several miles to the north of the borders of this county, but there is every reason to believe that the same relations hold here as in contiguous regions. The exposures of the Calvert formation in this county are neither typical or extensive, but uncovered areas are occasionally to be met with in the valleys of Indian, Trent Hall, Persimmon, Horse Landing, Cat, and Roslyn creeks in the Patuxent River valley, and Chaptico and St. Clement creeks in the valley of the Potomac River.

Strike, Dip and Thickness.

The strike of the Calvert formation is in general from northeast to southwest, but the outcrop frequently becomes very sinuous, because of erosion and changes in topography. Thus in the northern portion of the county streams have carved out deep valleys, producing a most irregular outcrop, which departs widely from the direction of strike.

The dip is, as a whole, about 11 feet to the mile toward the southeast. Apart from the exposures in the Calvert Cliffs of this state and the Nomini Cliffs of Virginia, there are no good localities for determining the dip, and as it must be calculated as a whole over extensive regions, many of them beyond the borders of the county, slight changes which may occur are not often brought to light. The Calvert formation is not typically developed in St. Mary's County and, in fact, has almost disappeared beneath the level of tide when it enters the northern borders of the region. It is, therefore, not to be found lying high in the stream valleys, as in Calvert County, but occupies their lower portions and disappears entirely from view in St. Clement and Roslyn creeks. There is, therefore, little opportunity for studying the dip of the Calvert formation from its exposures in this county.

The full thickness of the Calvert formation is likewise not developed within the borders of this county and indeed has nowhere been actually observed. The formation has been diagonally truncated above by the Choptank and younger formations under which it lies unconformably. This relation, which is well shown in Calvert, is very much obscured

in St. Mary's County. The formation appears to thicken rapidly down the dip until, at Crisfield, in Somerset County, it shows a thickness of 310 feet in an artesian well. As the base of the Calvert formation is nowhere visible within St. Mary's County, the thickness of the formation must be determined, as was the dip, by studying regions beyond these borders. From various calculations it appears that the average thickness of the Calvert formation in this county is about 185 feet.

Character of Materials.

The character of the materials of the Calvert formation are, as a whole, quite uniform. They consist of clay, marl, and diatomaceous earth. In St. Mary's County only the two former are typically developed. The diatomaceous earth is not present as a well defined member. Throughout the entire extent the formation is abundantly supplied with fossils. These crumble readily on exposure to the atmosphere and are seldom discernible except where active erosion constantly exposes fresh surfaces. The clay and marl are dark brown to bluish-green when fresh and change to various tints of buff on exposure to the weather.

Stratigraphic Relations.

The Calvert formation in St. Mary's County is believed to lie, as explained above, unconformably on the eroded edges of the Eocene. This unconformity is in the nature of an overlap, but is nowhere visible in this region. Above, the Calvert formation lies unconformably beneath the Choptank.

Sub-Divisions.

Beyond the borders of this county the Calvert formation falls into two divisions which are known as the Fairhaven diatomaceous earth and the Plum Point marls. Only one of these sub-divisions, the Plum Point marls, is found in this county. These marls consist of a series of sandy clays and marls in which are imbedded large numbers of organic remains including some diatoms. The color of the material is bluish-green to

greenish-brown and buff. Fossil remains, although abundant, through the entire member, are usually found massed in beds. In Calvert County there are two of these, from 30 to 35 feet apart, and with a thickness varying from 4½ to 13 feet. In St. Mary's County, however, these fossil beds are not conspicuous, but the Plum Point marls, in which they are imbedded, may be occasionally seen in the area of the Calvert formation, as explained above. On the Potomac River, the banks are usually very low and composed of Columbia sand and gravel. In consequence of this, the Plum Point marls are seldom met with. On the Maryland side of the river they may be seen in the low cliffs at the mouth of Choptank Bay, and on the Virginia side a considerable thickness of the marls is exposed the entire length of the Nomini Cliffs.

The actual thickness of the Plum Point marls within St. Mary's County is nowhere open to observation and cannot be accurately determined, but it is probable that at least 150 feet of the average thickness of the Calvert formation should be assigned to this sub-division.

From a detailed study of exposures along the Calvert Cliffs, in Calvert County, it has been found possible to sub-divide the Plum Point marls into twelve zones. In St. Mary's County it is certain that only the higher zones are present, but the lack of exposures has made it impossible to determine which or how many of these occur in this county. The fact that the Choptank formation lies unconformably above the Calvert introduces another element of uncertainty, for some of the higher zones found in Calvert County may be absent in this region or the Plum Point marls, in St. Mary's County, may contain higher members than are to be found in the same division in Calvert County.

THE CHOPTANK FORMATION.

The Choptank River has suggested the name for this formation because of its great development on the northern bank of that estuary a short distance below Dover Bridge in Talbot County. In this locality the Choptank formation is very fossiliferous, and may be seen at the base of a low cliff which borders the stream for some distance.

FIG. 1.—VIEW SHOWING THE ST. MARY'S FORMATION OVERLAIN BY TALBOT, NEAR ST. MARY'S CITY.

FIG. 2.—A NEARER VIEW OF THE FOSSIL BED SHOWN IN FIG. 1.

Areal Distribution.

The Choptank formation, which constitutes the second member of the Chesapeake Group in Maryland and lies immediately above the Calvert formation, is found in Caroline, Talbot, and Dorchester counties, on the Eastern Shore, and Anne Arundel, Calvert, Prince George's, Charles, and St. Mary's counties on the Western Shore.

Strike, Dip and Thickness.

The strike of the Choptank formation is in general from northeast to southwest; but because of erosion, particularly on the Western Shore, as pointed out above, the outcrop is very sinuous and the strike appears to change locally.

The dip does not appear to be constant throughout the entire extent of the formation. In Calvert County, where the Choptank is best exposed, the northern portion of the formation down to Parkers Creek seems to lie almost horizontal; but south of this point the base of the formation dips away at about 10 feet to the mile. Because of this structure, the Choptank formation occupies hilltops in the northern portion of its area and gradually occupies lower and lower levels, until in the southern portion of its area it is found in river bottoms and finally disappears beneath tide. The best place to examine the dip of the Choptank formation is along the Calvert Cliffs between Parker Creek and Point of Rocks. Here an almost unbroken exposure may be seen dipping gradually toward the southeast.

The thickness is variable. In the Nomini Cliffs, Virginia, it is present as a 50-foot bed between the Calvert formation below and the St. Mary's formation above. This is the thickest exposure which is open to direct observation. In the well section at Crisfield, mentioned above in connection with the Calvert formation, the Choptank formation attains a thickness of about 175 feet. It will thus be seen that like the Calvert, it thickens as it passes down the dip. The average thickness in St. Mary's County appears to be about 112 feet.

Character of Materials.

The materials composing the Choptank formation are somewhat variable. They consist of fine, yellow, quartz sand, greenish-blue sandy clay, slate-colored clay, and at times ledges of indurated rock. In addition to these materials there are abundant fossil remains throughout the formation. The sandy phase is well shown in Drum Cliff, on the Patuxent, where the indurated layers mentioned above are also visible. The clayey phases are not well exposed in this county, but may be seen in Calvert County along the Calvert Cliffs, near Point of Rocks, and southward. Fossil remains are abundant in Drum Cliff and along the branches of Cuckold Creek.

Stratigraphic Relations.

The Choptank formation lies unconformably on the Calvert formation. This unconformity is in the nature of an over-lap but is not easily discernible even where the contact is visible. The best place to observe it is in that portion of the Calvert Cliffs just below the mouth of Parker Creek. Even here, the unconformity cannot be seen while standing on the beach but may be observed from a boat a short distance from the shore. There are also certain differences between the fauna of the Calvert and that of the Choptank. How far this unconformity continues down the dip after the beds disappear from view is not known, as the data from well records are too meager to draw any conclusion regarding this question. Above, the Choptank formation lies conformably beneath the St. Mary's formation.

Sub-Divisions.

The Choptank formation has been subdivided into five zones which may be characterized as follows:

Zone 16.—This zone varies in composition from yellowish sand to bluish or greenish sandy clay. It is about 10 feet thick and may be found exposed along the Calvert Cliffs from near Parker Creek southward to a point a little north of Flag Pond, where it disappears beneath the beach. Where the Choptank first makes its appearance in

the Calvert Cliffs at Parker Creek this zone is absent, and Zone 17 of the Choptank rests immediately upon Zone 15 of the Calvert. Zone 16 is for the most part unfossiliferous, although about 3 miles south of Governor Run a few fossils have been discovered in it, of which the following are among the number: *Ecphora quadricostata, Venus campechiensis var. cuneata, Dosinia acetabulum, Phacoides contractus,* etc.

Zone 17.—The Choptank formation carries two well-defined fossil zones. Of these, Zone 17 is the lower one. The material composing this stratum is mostly yellow sand along the Calvert Cliffs. It is almost entirely composed of fossils, the yellow sand simply filling in the spaces between the organic remains. The fauna of this zone is extremely large, but the following will suffice to give an idea of some of the types:

Ecphora quadricostata, Turritella plebeia, Panopea americana, Corbula idonea, C. cuneata, Metis biplicata, Macrocallista marylandica, Venus mercenaria, V. campechiensis var. cuneata, Dosinia acetabulum, Isocardia fraterna, Cardium laqueatum, Crassatellites turgidulus, Astarte thisphila, Pecten coccymelus, P. madisonius, Melina maxillata, Arca staminea, etc.

This zone makes its appearance along the Calvert Cliffs at Parker Creek, where it is about 6 feet in thickness, and is continuously exposed until it dips beneath tide a little north of Flag Pond. It may also be seen at various points on the Patuxent River. It appears to thicken considerably southwestward along the strike, for where best exposed on the Patuxent River it is at least 18 feet thick near the mouth of St. Leonard Creek and over 30 feet thick at Drum Cliff, in St. Mary's County. This zone corresponds to "Zone e" of Harris.[1]

Zone 18.—This zone is for the most part unfossiliferous, although in places it carries some imperfect fossils and fossil casts. The material of which it is composed is for the most part yellowish sand above but grades down into bluish clay below and at times the entire stratum is composed of bluish clay. In thickness it varies from 18 to 22

[1] Tertiary Geology of Calvert Cliffs, Maryland. Amer. Jour. Sci., vol. xlv, 1893, pp. 21-31.

feet along the Calvert Cliffs, where it is continuously exposed from Parker Creek to a point a few miles south of Flag Pond. Where this zone is exposed at Drum Cliff it is thinned down to about 8 feet in thickness.

Zone 19.—This constitutes the upper of the two great fossiliferous zones of the Choptank formation. Like Zone 17 it is composed almost entirely of fossils with the interstices filled with reddish and yellow sand. It varies in thickness from 12 to 15 feet along the Calvert Cliffs and is continuously exposed from Parker Creek southward to near Cove Point, where the stratum dips beneath the beach. The following is a partial list of fossils found in this zone: *Balanus concavus, Corbula idonea, Macrocallista marylandica, Dosinia acetabulum, Cardium laqueatum, Phacoides anodonta, Crassatellites marylandicus, Astarte thisphila, Ostrea carolinensis, Pecten madisonius, Arca staminea,* etc. This zone corresponds to "Zone f" of Harris.[2]

Zone 20.—This zone lies at the top of the Choptank formation. It consists of greenish sand which is frequently oxidized to a red color, and at times it carries bands of clay. It seems to be devoid of fossils and is 15 feet thick, although it has frequently suffered by erosion. It may be best seen near Flag Pond, where it is overlaid by the St. Mary's formation.

THE ST. MARY'S FORMATION.

The name of this formation has been suggested by St. Mary's County on account of its great development within that region. The formation is found exposed in numerous places along the St. Mary's River in the vicinity of St. Mary's City. In Calvert County it is best seen along the Calvert Cliffs from Point of Rocks southward to Drum Point.

Areal Distribution.

The St. Mary's formation, like the Calvert and the Choptank formations, crosses the state from northeast to southwest. On the Eastern Shore, it is present, if at all, in Caroline, Talbot, Wicomico and Dorchester counties.

On the Western Shore the St. Mary's formation is found developed

[2] Loc. cit.

in southeastern Calvert and St. Mary's counties. In this region it is very much obscured by a mantle of younger material belonging to the Columbia Group and is, therefore, seldom seen on the surface. Good exposures, however, are found along the Bay shore and the Patuxent River and its tributaries. The most extensive exposure is found in Calvert County along the Bay shore from Point of Rocks to Drum Point. In St. Mary's County the surficial cover of loam and gravel has greatly obscured the St. Mary's formation, and consequently there are few places where it can be observed. But from the vicinity of Hollywood southward to St. Jerome Creek the St. Mary's formation is well developed. In the northern portion of its area it occupies the higher portions of stream valleys and is underlaid by the Choptank formation. Further to the south, in the valley of St. Mary's River, the Choptank formation has disappeared and the St. Mary's formation is the only representative of the Miocene. Good exposures of this formation may be seen on the Patuxent River, near Millstone, on the Bay shore at Langleys Bluff, five miles south of Cedar Point, where it forms the base of a section at beach level beneath the overlying fossiliferous beds of the Talbot formation. It also occurs in the valley of St. Jerome Creek, and is well developed along the banks of St. Mary's River and its tributaries. At Windmill Point on the St. Mary's River, as well as on the Patuxent, half a mile west of Millstone, the St. Mary's formation contains clusters of gypsum crystals.

Strike, Dip and Thickness.

The strike of the St. Mary's formation, like that of the two preceding ones, is from northeast to southwest. On the Western Shore, because of the great diversity in the topography, the outcrop is extremely irregular and departs very widely from the direction of the strike. The St. Mary's formation rests conformably on the underlying Choptank and is overlain unconformably by younger materials. The dip averages about 10 feet to the mile toward the southeast.

The thickness of the St. Mary's formation in southern Maryland varies from a few to about 280 feet. In this county, where the formation lies between the Choptank beneath and the Sunderland above, it is

eroded entirely away and disappears in the vicinity of Hollywood. Further to the southeast, in the well-boring at Crisfield, it attains a thickness of about 280 feet, although it is possible that the upper portion of this may be Pliocene. The average thickness of the St. Mary's formation in this county is about 140 feet.

Character of Materials.

The materials composing the St. Mary's formation are clay, sand, and sandy clay. As exposed in this county, it is typically a greenish-blue sandy clay bearing large quantities of fossils and resembling very closely the sandy clay of the Calvert formation described above. Locally, the beds have been indurated by the deposition of iron.

Stratigraphic Relations.

The St. Mary's formation lies conformably on the Choptank formation. It is overlain unconformably by clays, loams, sands and gravels belonging to various members of the Columbia Group.

Sub-Divisions.

There are certain faunal differences which separate it from the Choptank formation. It has been subdivided into the following zones:

Zone 21.—This zone lies at the base of the St. Mary's formation and conformably on the Choptank formation. It consists of a drab clay carrying sandy bands of about the same color and appears to be devoid of fossils. It may best be seen along the cliffs south of Flag Pond, where it has a thickness of about 15 feet.

Zone 22.—Lying immediately above the last mentioned stratum is another band of drab clay in which thin beds of fossils are developed. These first made their appearance in the cliffs south of Flag Pond, and although the continuity of this bed is interrupted along the Bay shore by talus slopes and overgrowth of woodland, still it is believed to be continuous with the fossil-bearing beds at the base of the cliff at Cove Point. The following are some of the more important fossils found in this zone: *Balanus concavus, Terebra inornata, Mangilia parva, Nassa peralta, Columbella communis, Ecphora quadricostata, Tur-*

ritella plebeia, T. variabilis, Polynices heros, Corbula inequalis, Pecten jeffersonius, Arca idonea, etc. This stratum is about 14 feet in thickness. It corresponds to "Zone g" of Harris.[1]

Zone 23.—This zone is composed of drab clay and sand. It has suffered considerably from erosion, but along the Calvert cliffs it carries some fossils of which *Turritella plebeia* is the most important. It shows a thickness of 30 feet, but is unconformably overlain by the Pleistocene sands and gravels.

Zone 24.—A break in the stratigraphic continuity of the St. Mary's formation occurs south of Drum Point and the exact relation of this zone to those preceding is not definitely known. It is believed, however, to lie very close to Zone 23. At Chancellor Point on the St. Mary's River, where it has been studied, 15 feet of bluish sandy clay are exposed, overlain unconformably by Pleistocene loams. At this place a large number of fossils are present, of which the following may be mentioned: *Aceteon ovoides, Retusa marylandica, Terebra curvilirata, Conus diluvianus, Surcula engonata, Fulgur fusiforme, Turritella variabilis, Panopea goldfussi, Callocardia sayana, Venus campechiensis var. mortoni, Isocardia fraterna, Phacoides anodonta, Pecten madisonius, P. jeffersonius,* etc.

LOCAL SECTIONS.

I. *Section at Drum Cliff near Jones Wharf.*

			Feet.	Inches.
Pleistocene.		Reddish yellow loam, sand, and gravel	42	
Miocene.	Choptank Formation.	Greenish clay containing poorly preserved remains of *Balanus concavus, Panopea americana, Phacoides contractus, Cardium laqueatum, Pecten madisonius, Ostrea carolinensis,* etc. (Zone 19, in part)	6	6
		Greenish unfossiliferous clay (Zone 18)	8	
		Brownish and greenish fossiliferous sand partially indurated above, solidified to solid rock at base, carrying the following species: *Balanus concavus, Ecphora quadricostata var. umbilicata, Turritella plebeia, Corbula idonea, Macrocallista marylandica, Dosinia acetabulum, Cardium laqueatum, Crassatellites turgidulus, Astarte thisphila, Pecten madisonius, Melina maxillata, Arca staminea, Scutella aberti,* etc. (Zone 17, in part)	30	
		Total	86	6

[1] Loc. cit.

II. *Section at Chancellor Point.*

			Feet.
Pleistocene.	Talbot Formation.	Sandy loam	10
Miocene.	St. Mary's Formation.	Bluish sandy clay carrying the following fossils: *Actaeon ovoides, Retusa marylandica, Terebra curvilirata, Conus dilurianus, Surcula engonata, Fulgur fusiforme, Turritella variabilia, Panopea goldfussi, Callocardia (Agripoma) sayana, Venus campechiensis var. mortoni, Isocardia fraterna, Phacoides (Pseudomiltha) anodonta, Pecten madisonius, P. jeffersonius*, etc. (Zone 24, in part)	25
		Total	35

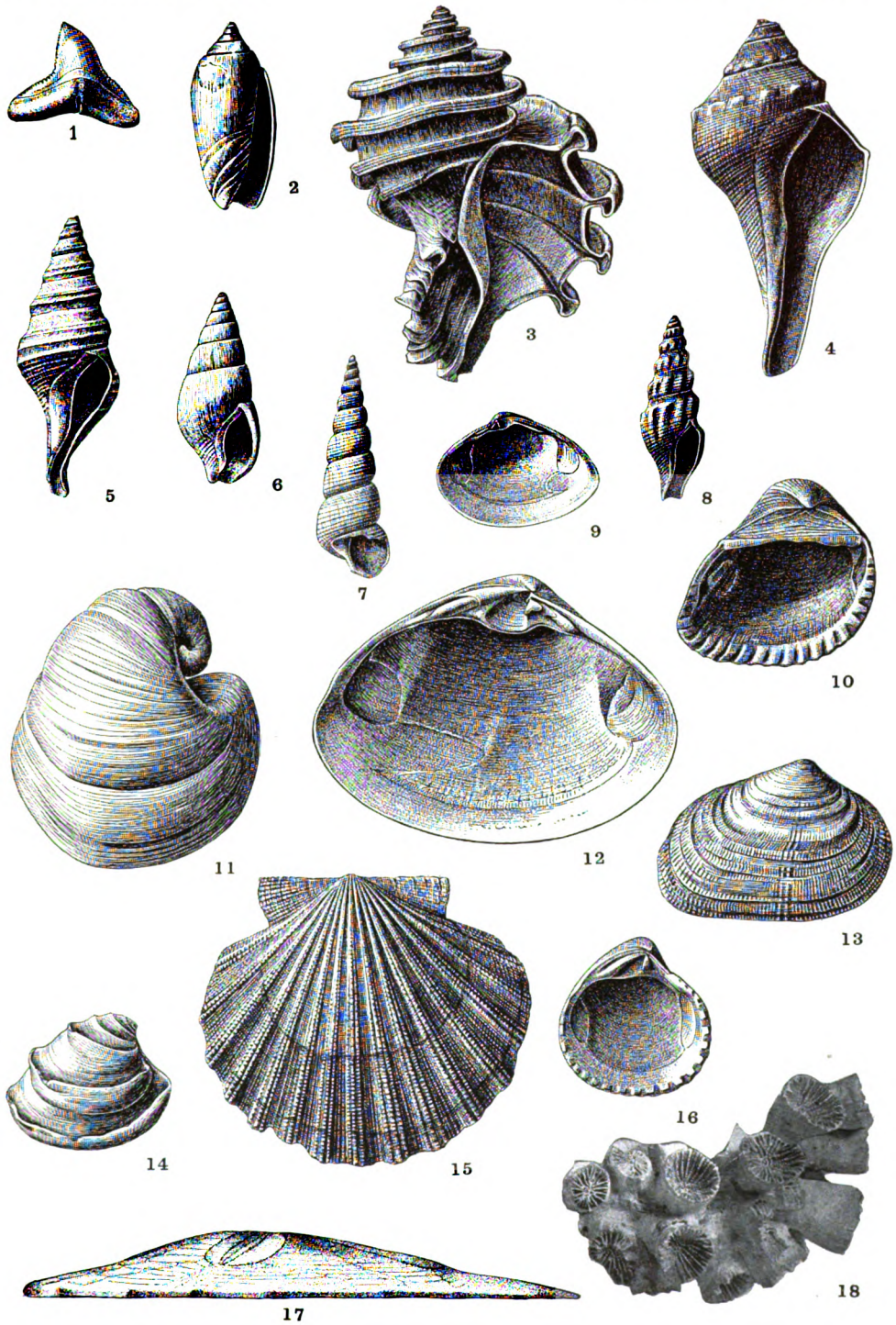
III. *Section at Cuckold Creek.*

			Feet.	Inches.
Pleistocene.	Talbot Formation.	Section obscured	5	
Miocene.	Choptank Formation.	Dark sandy clay carrying characteristic fossils of Zone 17. (Zone 17, in part)	5	6
		Total	10	6

ORIGIN OF MATERIALS.

The materials which compose the Miocene deposits of St. Mary's County may be divided as regards their origin into two classes, viz., the silicious and arenaceous materials, which are land-derived, and the calcareous materials, which are of organic origin. The ultimate source of the former was doubtless the rocks of the Piedmont Plateau and regions beyond in Western Maryland and neighboring territory, but more immediately they have been derived from older coastal plain deposits; the one which enters into the Miocene most conspicuously being the Eocene. Near the contact of the Miocene and Eocene, a rolled fauna derived from the latter is reworked in the former and occasionally grains of glauconite, which were in all probability formed in the Eocene occur in the lower portions of the Miocene.

The organic remains, which consist, for the most part, of shells of mollusks and bones of vertebrates, are usually in a very good state of



CHARACTERISTIC FOSSILS OF THE MIOCENE OF ST. MARY'S COUNTY.

1. Carcharias egertoni (Agassiz).
2. Oliva litterata Lamarck.
3. Ecphora quadricostata (Say).
4. Fulgur fusiforme Conrad.
5. Surcula biscatenaria Conrad.
6. Columbella communis (Conrad).
7. Turritella plebeia Say.
8. Mangilia parva (Conrad).
9. Mactra clathrodon Lea.
10. Arca staminea Say.
11. Isocardia markoëi Conrad.
12. Spisula subponderosa (d'Orb.).
13. Asaphis centenaria (Conrad).
14. Chione alveata (Conrad).
15. Pecten madisonius Say.
16. Venericardia granulata Say.
17. Scutella aberti Conrad (lateral view).
18. Astrangia lineata (Conrad).

preservation. They have been but slightly disturbed since deposited and evidently now occupy the same relative positions which they did at the time when they lived.

The Pliocene.[4]

Within Maryland the Lafayette is the only formation which has been referred to this period. The age of the Lafayette has long been in doubt and there is not yet sufficient data to correlate it definitely with any period. All that can be said is that it is younger than the Miocene which it covers and older than the oldest Pleistocene beds found in the same vicinity. Within this State no fossils have been found of Pliocene age in the deposit. Elsewhere fossil plants and animals alleged to have been discovered within the Lafayette are not of a character sufficiently definite to determine its age. It is, however, certain that, after the deposition of the Miocene beds, there was a long interval of erosion before deposition of the Lafayette beds began. Likewise, at the close of Lafayette deposition, another long period of erosion occurred before the Columbia deposits which are of Pleistocene age were laid down. The Lafayette formation thus occupies a stratigraphic position between the youngest known Miocene and the oldest known Pleistocene in the vicinity, and is separated from each by a long period, during which erosion was in progress. These facts, together with the absence of any undoubted Pliocene deposits in this region, have led to the reference of the Lafayette formation to the latter period. This is, however, only a provisional correlation and more positive evidence is needed before the question can be regarded as settled.

THE LAFAYETTE FORMATION.

The Lafayette formation has been named from Lafayette County, Miss., where Hilgard found it typically developed. It consists of clay, loam, sand and gravel mixed together in varying proportions. It is developed in a terrace which is stratigraphically older and lies topo-

[4] A fuller discussion of the Pliocene in Maryland may be had by consulting the report on Pliocene and Pleistocene, Md. Geol. Survey, 1906.

graphically higher than those which constitute the various formations of the Columbia Group. Since its deposition it has suffered considerably from erosion.

Areal Distribution.

The Lafayette is one of the most widely developed formations of the Coastal Plain, extending from New Jersey southward to Florida, and thence around the Gulf coast through Texas into Mexico. In Maryland it has suffered considerably from erosion since it was deposited, and is found best developed between Anacostia River and Charlotte Hall. The representatives in St. Mary's County, then, constitutes the southern portion of this area. In this county the Lafayette formation occurs as isolated outliers which are grouped about Newmarket and Charlotte Hall. One of these, the largest, extends from the headwaters of Indian Creek to Charlotte Hall, and smaller areas continue the formation southward along the divide to the vicinity of Mechanicsville. Another area lies southwest of Newmarket and continues over into Charles County. Many streams have forced their headwaters back into the body of the Lafayette formation, so that it no longer is as continuous as when first deposited, but has developed a sinuous outline. The streams which did this cutting and destroyed the continuity of the Lafayette formation in St. Mary's County no longer exist. Their valleys are filled in with deposits belonging to the Columbia Group. A younger generation of streams, however, is rapidly pushing their headwaters backward to continue the work of destruction left unfinished by their predecessors.

Structure and Thickness.

The base of the Lafayette formation is nowhere visible within St. Mary's County, but the surface lies at an elevation of about 200 feet. It is developed as a flat-topped terrace, and it is probable that its average thickness is about 30 feet. Within this county no dip or slope are discernible, but taking the formation as a whole from Washington City southward to Charlotte Hall it has been found to gently decline toward the southeast at the rate of 5.5 feet per mile. It is probable that this

attitude has been partly brought about by deformation, while much of it must be attributed to the original attitude in which the Lafayette was deposited.

Character of Materials.

The materials which compose the Lafayette formation in St. Mary's County consist of clay, loam and fine gravel. In the railroad cutting which passes through the formation at Charlotte Hall there is exposed about 20 feet of a brownish-clay loam locally changed to a reddish color and bearing fine gravel scattered throughout in ill-defined layers. In other places beyond this county, where the Lafayette is typically developed, the gravel is much coarser and a bipartite division is discernible whereby the finer materials are more abundant toward the top and the coarser toward the bottom of the gravel, although the gravels are frequently found imbedded in the clay and loam above, and these in turn are mixed abundantly with the gravel below. There are no good sections for studying this deposit in St. Mary's County.

Stratigraphic Relations.

The Lafayette formation is built as a terrace, lying unconformably and somewhat irregularly on the eroded surface of the Choptank beneath. Its surface constitutes the highest portion of St. Mary's County, but its margins are believed to run out under and to be unconformable beneath the edges of the Sunderland formation.

Origin of Materials.

The materials which compose the Lafayette formation have been derived from most of the older rocks in the region throughout which it is developed. The clay and loams contain materials re-worked from the Miocene, Eocene, Cretaceous, and decomposed crystalline rocks from the Piedmont, while the gravels have largely been derived from the quartz veins of the Piedmont and the gravel beds of the Potomac.

The Pleistocene.

The Columbia Group.

The Columbia Group is the name applied to a series of beds of clay, loam, sand, gravel, and ice-borne boulders, which are stratigraphically younger and lie topographically below the Lafayette formation. They are widely distributed over the surface of the Coastal Plain from Atlantic Highlands southward to Mexico and are Pleistocene in age, being the last formations which have been laid down in the region before the Recent deposits were formed. The formations which constitute the Columbia Group are, beginning with the oldest, the Sunderland, Wicomico, and Talbot. These deposits were laid down for the most part during the

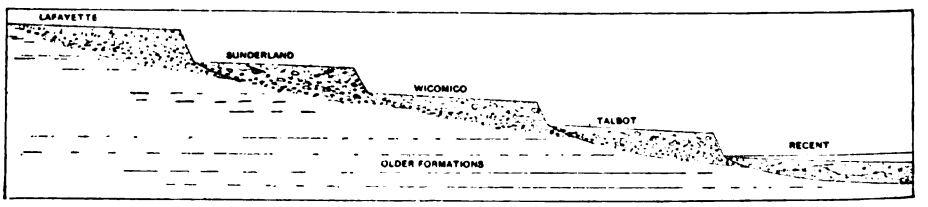


Fig. 4.—Diagram showing ideal arrangement of the various terrace formations in the Maryland Coastal Plain.

glacial period, but a definite correlation of them with the glacial deposits of New Jersey and other regions is not practicable in the present state of knowledge. When the field relations which exist between these two great classes of deposits are more accurately known, a correlation will, no doubt, be possible. The various formations of the Columbia Group lie unconformably on whatever rocks are beneath them. The clay, peat, loam, sand, gravel, and ice-borne boulders, out of which they are composed, occur in irregular beds or are developed in lenses. They are mixed together in varying amounts and grade over into each other both horizontally and vertically. Two of the formations, the Sunderland and Talbot, carry determinable vegetable remains, and the latter has yielded in addition fragments of fossil insects. The various members of the Columbia are developed in terraces lying one above the other in order of their age, the oldest occupying topographically the highest position

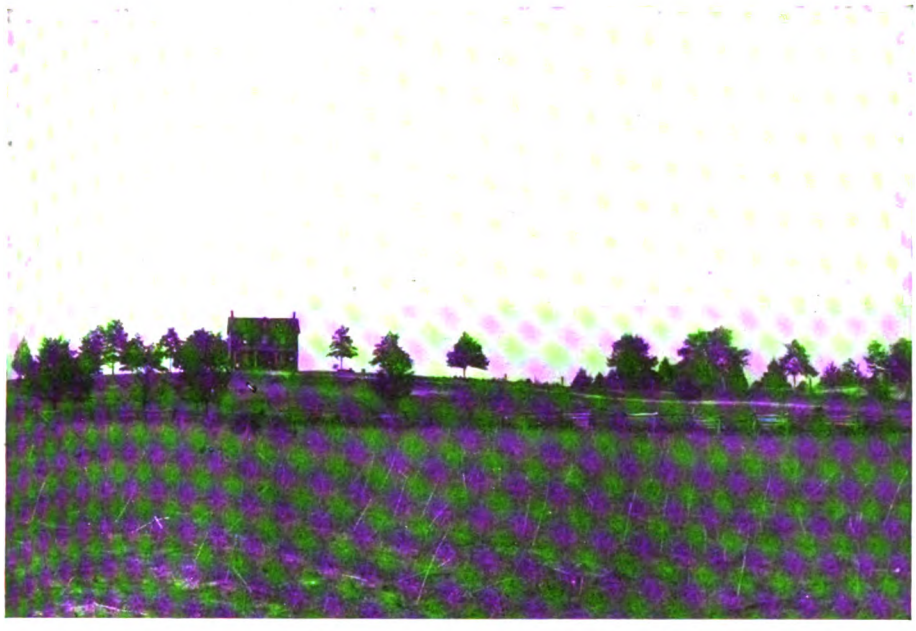


FIG. 1.—VIEW SHOWING LAFAYETTE-SUNDERLAND SCARP, SUNDERLAND SURFACE IN THE FOREGROUND, CHARLOTTE HALL.

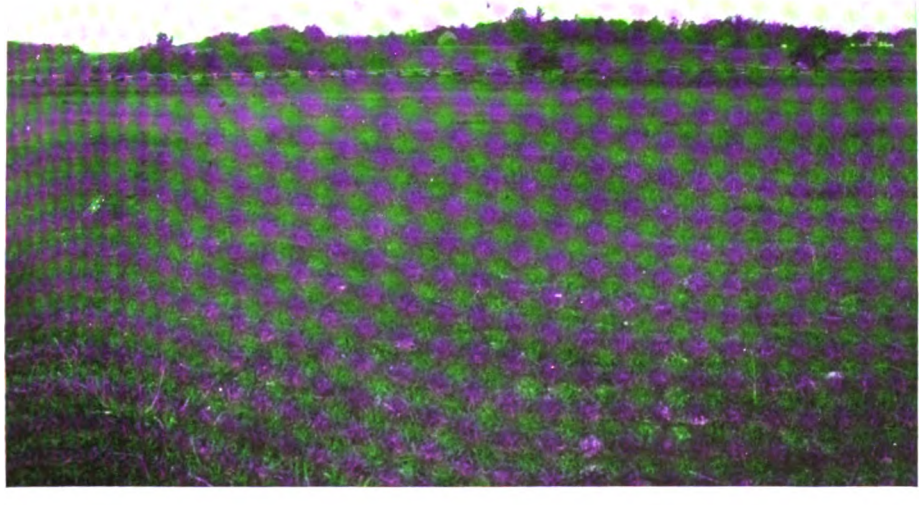


FIG. 2.—VIEW SHOWING LAFAYETTE-SUNDERLAND SCARP, SUNDERLAND SURFACE IN THE FOREGROUND, NEAR CHARLOTTE HALL.

(Fig. 4). They all dip gently toward the surrounding waters and together are widely distributed over the surface of the county and obscure in a great measure the older deposits which lie beneath them.

THE SUNDERLAND FORMATION.

The Sunderland formation has been named from its typical development near the hamlet of Sunderland in Calvert County. It consists of a wave-built terrace, which was formed by the waters of the Atlantic Ocean or its estuaries when the country stood at a lower level than to-day. It is distributed over the entire county occupying the divides between the headwaters of the principal streams. Since the time of deposition, the Sunderland formation has suffered extensively from erosion. Waterways have opened up their valleys through it and have transformed a once continuous mantle of loam and gravel into a series of isolated patches with sinuous outlines occupying the higher portions of the county, and its once level surface has now been changed by the same processes into a gently rolling upland.

Areal Distribution.

The Sunderland formation is the most widely developed of the Pleistocene deposits in St. Mary's County. With the exception of the isolated outliers of Lafayette in the vicinity of Charlotte Hall, it occupies the highest divides from the northern margin of the county, near Indian, southward to Ridge, near Point Lookout. On either side in both the valleys of the Patuxent and Potomac rivers, as well as in the gorges of the streams which are tributary to these estuaries, the Sunderland formation is surrounded by terraces of the younger formations of the Columbia Group, which lie beneath it. These terraces are more extensively developed in the Potomac than in the Patuxent Valley.

Many streams have forced their headwaters back into the body of the Sunderland formation, so that it is no longer as continuous as when first deposited, but has developed a sinuous outline.

Structure and Thickness.

In the northern portion of St. Mary's County the base of the Sunderland formation lies at about 95 or 100 feet, while in the southern portion near Ridge it is obscured by deposits belonging to the Wicomico formation and is not visible. In the vicinity of Charlotte Hall the surface of the Sunderland lies at about 180 feet and at Ridge at about 60 feet. This difference in elevation of 120 feet between the two localities, which are 34 miles apart, amounts to a slope toward the southwest of 3.5 feet per mile. This gentle decline is probably in large part due to the original slope of the surface which was imparted to it while it was undergoing deposition beneath the surface of the Sunderland sea. There is, however, a slight element of tilting downward toward the southeast which is more prominent in the southern portion of the county than elsewhere. The surface of the Sunderland at Ridge is the lowest which has been observed anywhere in Maryland; it is probably due to both tilting and initial slope. The deformation in this region exhibited in the Sunderland formation is also found in both the Wicomico and Talbot formations, which here also lie lower than elsewhere in Maryland.

The thickness of the Sunderland formation is variable, but averages about 35 feet.

Character of Materials.

The materials which compose the Sunderland formation consist of clay, loam, peat, sand, gravel, and ice-borne boulders. These, as a rule, do not lie in well-defined beds, but grade into each other both vertically and horizontally. The coarser materials, with the exception of ice-borne boulders, are usually found with a cross-bedded structure, while the clays and finer materials are either developed in lenses or are horizontally stratified. The ice-borne blocks are scattered through the formation and may occur in the gravel beneath or in the loam above. There is distinguishable throughout the formation a tendency for the coarser materials to occupy the lower portions and the finer the upper portions of the formation, but the transition from one to the other is not marked

by an abrupt change. The coarser materials are frequently found above in the loam and the finer materials below in the gravel. Many of these materials are in an advanced stage of decay.

Stratigraphic Relations.

The Sunderland formation is built as a terrace, lying unconformably and somewhat irregularly upon the older Miocene and Lafayette deposits. This terrace was laid down about the margin of the Lafayette formation and the attenuated edges of the latter are believed to run out unconformably for a short distance beneath it. At Charlotte Hall the Sunderland formation is separated from the Lafayette by a well-defined scarp about 20 feet in height which resembles topographically a wave-cut cliff, softened by subaerial erosion. The surface of the Sunderland formation forms the surface of the high divide of St. Mary's County, except along its margin, where it seems to pass beneath the Wicomico as the margin of the Lafayette does beneath the Sunderland at Charlotte Hall.

A word may be added regarding the scarp at Charlotte Hall, as it seems to have been overlooked by former geologists. The height of the scarp is about 20 feet and separates the flat surface of the Lafayette above from the plain surface of the Sunderland below. The Lafayette surface stretches away in an unbroken plain, gently rising toward the Piedmont, and the Sunderland extends southward toward the ocean. Just beyond the main scarp-line there are in the vicinity of Charlotte Hall a number of outliers of Lafayette which rise above the general flat of Sunderland. These bear the same relation to the main Lafayette deposit as the outliers of the Talbot formation, which now rise above the surface of Chesapeake Bay, bear to the mainland close by. This topography at Charlotte Hall might be easily overlooked by one making a hurried reconnaissance, and might be entirely misunderstood by one unaccustomed to the geology of the Coastal Plain. The narrow, flat reentrants which separate the main body of the Lafayette from the outliers might be looked upon as a valley cut by stream erosion and the presence of opposing scarps where the outliers face the main body of

the Lafayette formation might be considered as indicative of river banks. On the southeast side of these outliers, where they face toward the Sunderland sea, there is no opposing bank, but they drop away to the Sunderland surface, which is unobstructed by other prominences toward the southeast. It is evident that these outliers were once portions of the mainland and that the narrow flats which ramify among them were formerly stream valleys cut in the body of the Lafayette formation, but with the advance of the Sunderland sea these drainage ways were submerged and filled and the divides which separated them were either submerged or else cut up into a series of outlying islands. A similar topography may be seen on the Eastern Shore of Chesapeake Bay to-day.

Another line of evidence is furnished by the presence of a beach gravel on the surface of the Sunderland formation as it approaches the base of the Sunderland-Wicomico scarp. The Lafayette in this region carries very little gravel and waves cannot produce a shingle beach unless there is gravel at hand out of which to make it. At Charlotte Hall the waves of the Sunderland sea concentrated on the beach the small amount of gravel which they secured by the erosion of the Lafayette scarp. It may also be added that there are ice-borne blocks in the body of the Sunderland formation beneath the scarp-line, but none have yet been discovered in the Lafayette formation above.

An even more significant feature of the topography in the vicinity of Charlotte Hall is furnished by two generations of stream valleys. One of these, the older, is now dry and unoccupied. It penetrates the Lafayette formation and formerly drained from it into the Sunderland sea. The other generation of valleys are now being rapidly extended inland from the Patuxent and Potomac rivers. They are steep-walled and V-shaped and at the present time have worked their way so far back on the divide as to drain the edge of the Sunderland formation in the vicinity of Charlotte Hall. These two valley streams not only are distinct in age, but they have no physical connection whatsoever.

In almost every place where good sections of Pleistocene materials are exposed the deposit from base to top seems to be a unit. In other places,

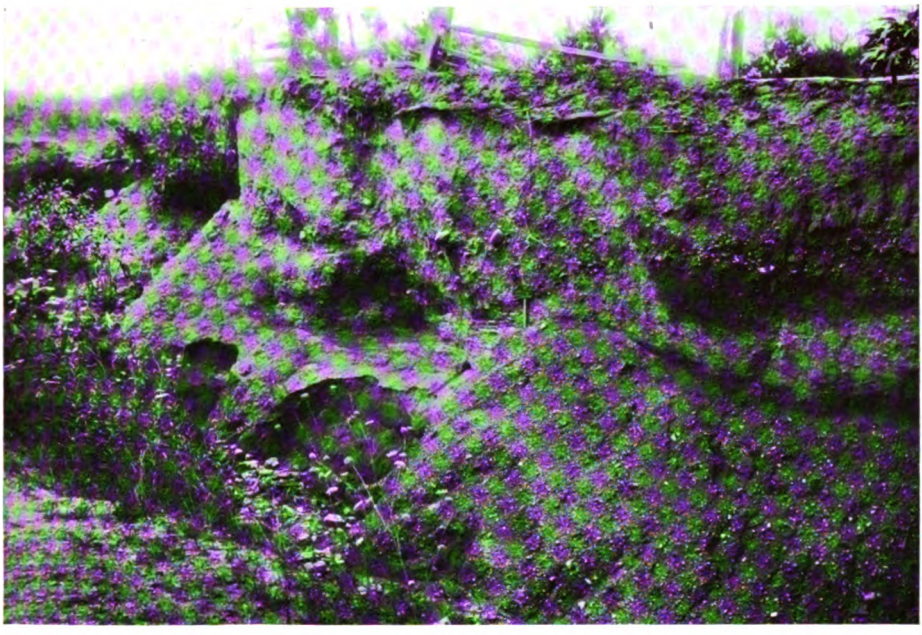


FIG. 1.—VIEW SHOWING SECTION OF SUNDERLAND FORMATION NEAR ST. MARY'S CITY.

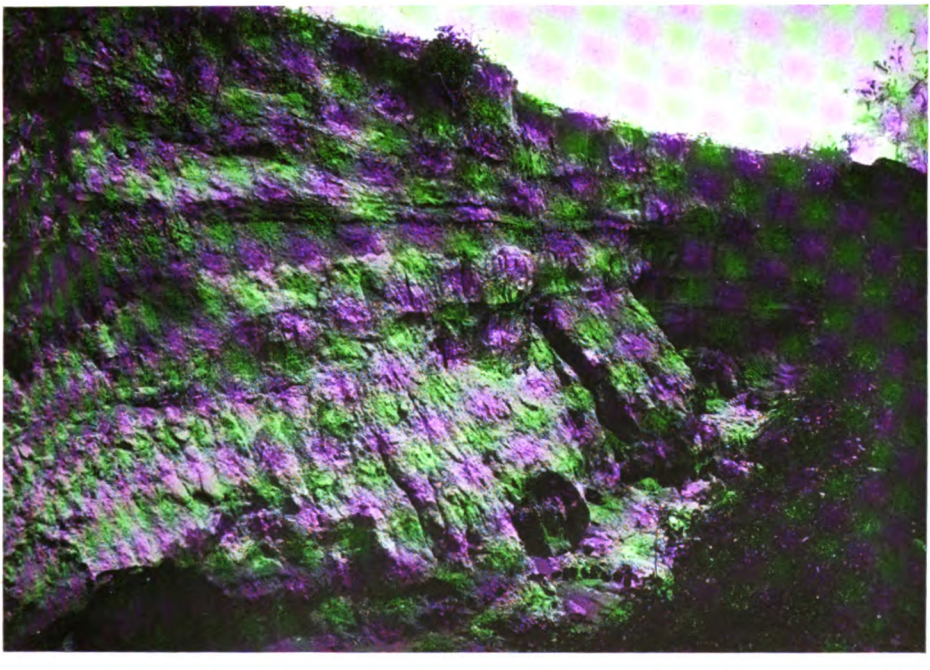


FIG. 2.—VIEW SHOWING AMPHITHEATRE AT HEAD OF YOUNG VALLEY IN SUNDERLAND FORMATION NEAR MORGANZA.

however, certain layers or beds are sharply separated from underlying beds by uneven lines similar to the irregular lines of a cross-bedded deposit. These breaks disappear in short distances, showing clearly that they are only local phenomena within the same formation produced by the contemporaneous erosion of shifting shallow-water currents, and in closely adjoining regions they seem to have no relation to each other Since the Pleistocene formations occupy so nearly a horizontal position it would be possible to connect these separation lines if they were subaerial erosional unconformities. In the absence of any definite evidence showing these lines to be stratigraphic breaks separating two formations, they have been disregarded. Yet it is not improbable that in some places the waves of the advancing sea in Sunderland, Wicomico, and Talbot times did not entirely remove the beds of the preceding period of deposition over the area covered by the sea in its next transgression. Especially would deposits laid down in depressions be likely to persist as isolated remnants which later were covered by the next mantle of Pleistocene materials. If this is the case each formation from the Lafayette to the Wicomico is probably represented by fragmentary deposits beneath the succeeding Pleistocene formations. Thus in certain sections the lower portions may represent an earlier period of deposition than that of the overlying beds. In those regions where older materials are not exposed in the base of the escarpments each Pleistocene formation near its inner margin probably rests upon the attenuated edges of the next older formation. Since lithologic differences furnish insufficient criteria for the separation of these late deposits and sections are not numerous enough to distinguish between local inter-formational unconformities and widespread unconformities resulting from an erosion interval, the whole mantle of Pleistocene materials occurring at any one point is referred to the same formation. The Sunderland is described as overlying the Jurassic (?), Cretaceous, Eocene, and Miocene deposits and extending from the base of the Lafayette-Sunderland escarpment to the base of the Sunderland-Wicomico escarpment. The few deposits of Lafayette materials which may possibly underlie the Sunderland are disregarded because unrecognizable. Similarly the Wicomico is described as including

all the gravels, sands, and clays overlying the pre-Lafayette deposits and extending from the base of the Sunderland-Wicomico escarpment to the base of the Wicomico-Talbot escarpment. Perhaps, however, materials of later age may occasionally rest upon remnants of the Lafayette and Sunderland formations, and the same is true of the Talbot formation.

Local Sections.

The materials which compose the Sunderland formation vary rapidly from place to place. The following sections, however, will give an idea of the character of this formation.

I. *Section in road leading from Leonardtown to Wharf.*

			Feet.
Pleistocene.	Sunderland Formation.	Tough red sandy clay and gravel	20
		Sandy clay carrying decomposed gravel and boulders	10
Miocene.	Choptank Formation.	Greenish sandy clay	20
		Obscured	50
		Total	100

II. *Section 1 mile west of Leonardtown on road leading toward McIntosh Run.*

			Feet.	Inches.
Pleistocene.	Sunderland Formation.	Yellow sandy clay	3	
		Drab sandy clay and gravel with red mottling	5	
		Drab sandy clay with red mottlings carrying boulders	1	
		Drab sandy clay and gravel with red mottlings	3	6
		Red sandy clay and gravel	5	
		Red sandy clay carrying gravel and decayed chert pebbles	4	
		Obscured	16	
Miocene.	Choptank Formation.	Fine bedded sand and gravel	3	6
		Reddish sand, depth unknown	10	
		Total	51	

III. *Section on road at St. Clement Creek 1.5 miles north of Morganza.*

			Feet.	Inches.
Pleistocene.	Sunderland Formation.	Brownish red sand	3	6
		Iron crust		2
Miocene.	Choptank Formation.	Fossiliferous sandy clay	48	
		Total	51	8

THE WICOMICO FORMATION.

The next younger formation of the Columbia Group is the Wicomico. It has received its name from the Wicomico River in Charles and St. Mary's counties, for in the valley of this estuary it is found well developed. Like the Sunderland, it consists of clay, loam, sand, gravel, and ice-borne boulders which were deposited by the waters of Chesapeake Bay and its estuaries. Since its deposition it has suffered considerably from erosion.

Areal Distribution.

The Wicomico formation is not as extensively developed in St. Mary's County as its predecessor, the Sunderland. It is developed as a terrace, occupies a lower level and wraps about the margin of the Sunderland formation like a border. The formation can be best seen in the valleys of the Patuxent and Potomac rivers, and also in gorges of the larger estuaries tributary to the latter. Among these can be mentioned Wicomico and St. Mary's rivers, and St. Clement and Breton Bays. Extensive areas of the Wicomico formation are also found in the higher valleys of streams emptying into these estuaries and along the eastern margin of St. Mary's County facing Chesapeake Bay.

Many streams have forced their headwaters back into the body of the Wicomico formation, so that it no longer is as continuous as when first deposited, but has developed a sinuous outline and is broken into a number of isolated areas.

Structure and Thickness.

The base of the Wicomico formation is so extensively covered with the Talbot formation which wraps about it that it is difficult to determine the attitude of the former by comparing the various heights at which its base is found to rest. A much more accurate conception may be secured by comparing the altitude of its surface in various places. In the northern part of the county the surface of the Wicomico formation, where it abuts against the margin of the Sunderland, rests at about 100 feet, while at Ridge, under similar conditions, it has an altitude of about

45 feet. These two localities are separated by a distance of about 35 miles, making an average slope toward the southwest of about 1.7 feet per mile. This attitude is largely due to the original slope which the surface of the formation received when deposited, but in southern St. Mary's County an element of tilting seems to have brought the Wicomico lower than elsewhere in Maryland.

The thickness of the Wicomico formation is variable, but averages about 20 feet.

Character of Materials.

The materials which compose the Wicomico formation consist of clay, loam, sand, gravel, and ice-borne boulders. These, as a rule, do not lie in well-defined beds, but grade into each other both vertically and horizontally. The coarser materials, with the exception of ice-borne boulders, are usually found with a cross-bedded structure, while the clays and finer materials are either developed in lenses or are horizontally stratified. The ice-borne blocks are scattered throughout the formation and may occur in the gravel beneath or in the loam above. There is distinguishable throughout a tendency for the coarser materials to occupy the lower portions and the finer materials the upper portions of the formation, but the transition from the one to the other is not marked by an abrupt change. The coarser materials are frequently found above in the loam and finer materials below in the gravel, and are frequently much decayed.

Stratigraphic Relations.

The Wicomico formation is deposited as a terrace lying unconformably and somewhat irregularly on the older beds of Eocene and Miocene age. This terrace was laid down about the margin of the Sunderland formation and locally is believed to lap up on the thin eroded edges of the latter, which are supposed to run out a short distance beneath it. It is everywhere separated from the Sunderland formation by a well-defined scarp, which is an ancient cliff cut by the waves of the Wicomico sea during the post-Sunderland depression.

FIG. 1.—VIEW SHOWING SUNDERLAND SURFACE NEAR GREAT MILLS.

FIG. 2.—VIEW SHOWING SUNDERLAND-WICOMICO SCARP, WICOMICO SURFACE IN THE FOREGROUND, NEAR LEONARDTOWN.

Local Sections.

The materials which compose the Wicomico formation vary rapidly from place to place. The following sections, however, will give an idea of the character of this formation:

I. *Section at Drum Cliff.*

			Feet.
Pleistocene.	Wicomico Formation.	Sandy clay	5
		Reddish sand, loam, and gravel	37
Miocene.	Choptank Formation.	Greenish sandy clay containing fossils	44
		Total	86

II. *Section at Clifton Mills.*

			Feet.	Inches.
Pleistocene.	Wicomico Formation.	Reddish clay loam	12	
		Reddish sand and gravel somewhat decayed, carrying boulders as large as 1 foot in diameter	5	6
		Alternately drab clay and sand with iron crusts	15	
		Obscure	5	
Miocene.	St. Mary's Formation.	Sand, gravel, and boulders	15	
		Brownish sandy clay	10	
		Total	62	6

THE TALBOT FORMATION.

The Talbot formation has been named from Talbot County, Maryland, where it is extensively developed. In St. Mary's County it consists of a wave-built terrace composed of clay, loam, peat, sand, gravel, and ice-borne boulders, which have been deposited by the waves of Chesapeake Bay and its estuaries. The surface of the Talbot formation is coincident with the lowest of the terrace surfaces described above. Since its deposition it has suffered less from erosion than either the Sunderland or Wicomico formations.

Areal Distribution.

The Talbot formation is developed as a fringe about the margin of the Wicomico and occupies the lowest level of the three terraces. In

the valleys of the Patuxent and Potomac rivers, as well as in the depression of their principal tributaries, and along the Bay shore, the Talbot formation is well developed. It is best seen, however, along the margin of the Potomac River, where it occupies broad flats, particularly on the peninsula between Wicomico River and St. Clement Bay. Along the margin of the Patuxent River, between Horse Landing and St. Johns creeks, the Talbot, although present, has been reduced by erosion to a narrow belt scarcely separating the Wicomico on one side from the Recent beach on the other.

A large number of streams have started to sink guillies in the body of the Talbot formation, but as yet have not developed extensive drainage systems and the continuity of the deposit has been, therefore, little affected by them.

Structure and Thickness.

The base of the Talbot formation ranges in elevation from a few feet above to a few feet below tide. There seems to be no general rule for this variation and it is apparently due to deposition on a slightly uneven surface. The highest portions of the surface of the Talbot formation are found around the margin, where it abuts against the Wicomico formation. In the northern part of the county the surface of the Talbot formation, where it abuts against the Wicomico, has an elevation of about 40 or 45 feet. This same elevation is continued southward to the vicinity of Town Creek on the Patuxent, and Breton Bay on the Potomac. From these localities it declines gently toward the southeast until at Scotland, near Point Lookout, the surface lies at a height of 10 feet. This gentle decline is probably due to a slight tilting in the direction of the Atlantic Ocean. The same feature has been described for the Wicomico and Sunderland formations in this region. The thickness of the Talbot formation is variable. Near Millstone a thickness of about 30 feet has been observed. In many other places the formation has been found to thin down and disappear. Its average thickness is about 15 feet.

Character of Materials.

The materials which compose the Talbot formation consist of clay, loam, peat, sand, gravel, and ice-borne boulders. These, as a rule, do not lie in well-defined beds, but grade into each other both vertically and horizontally. The coarser materials, with the exception of ice-borne boulders, are usually found with a cross-bedded structure, while the clays and finer materials are either developed in lenses or are horizontally stratified. The ice-borne blocks are scattered throughout the formation and may occur in the gravel beneath or in the loam above. There is distinguishable throughout a tendency for the coarser materials to occupy the lower portions and the finer the upper portions of the formation, but the transition from one to the other is not marked by an abrupt change. The coarser materials are frequently found above in the loam and finer materials below in the gravel. They also show less decay than in the other surficial formations. Within the Talbot formation there are a number of lenses of drab clay, bearing plant remains. The most important of these are situated one mile north of Drum Point on the shore of the Patuxent River, about a mile below the mouth of St. Leonard Creek. These have been discussed at length in the succeeding chapter.

Stratigraphic Relations.

The Talbot formation is deposited as a terrace lying unconformably and somewhat irregularly on the older beds of Eocene and Miocene age. This terrace was laid down about the margin of the Wicomico formation and locally is believed to lap up on the thin eroded edges of the latter which are supposed to run out a short distance beneath it. It is usually separated from the Wicomico formation by a well-defined scarp, which is an ancient cliff cut by the waves of the Talbot sea during the post-Wicomico subsidence, but this relation is not always shown.

Local Sections.

The materials which compose the Talbot formation vary rapidly from place to place. The following sections, however, will give an idea of the character of this formation:

I. *Section on Bay shore at Langleys Bluff.*

			Feet.	Inches.
Pleistocene.	Talbot Formation.	Sandy loam containing scattered gravel	3	
		Coarse gravel	2	
		Cross-bedded gravel and sand	9	
		Fossiliferous greenish clay	8	
		Very coarse gravel		6
Miocene.	St. Mary's Formation.	Fossiliferous sandy clay occuring at beach level and extending downward to unknown depth	1	
		Total	23	6

II. *Section on Potomac River at Watles Bluff.*

			Feet.	Inches.
Pleistocene.	Talbot Formation.	Sandy loam	1	
		Sandy loam carrying gravel	2	
		Cross-bedded sand and gravel	3	6
		Sandy clay carrying Ostrea and Venus	2	
		Bluish clay, very fossiliferous, extending below tide	4	
		Total	12	6

III. *Section on Potomac River between Flood and Poplar Hill Creeks.*

			Feet.
Pleistocene.	Talbot Formation.	Sandy loam	1
		Gravel and sand with ice-borne boulders	4
		Gravel	2
		Dark clay bearing plant and invertebrate remains	3
		Total	10

IV. *Section along Potomac River 1.5 miles south of Sotterly Point.*

			Feet.
Pleistocene.	Talbot Formation.	Sandy loam	3
		Cross-bedded white sand	3
		Dark drab clay carrying vegetable remains extending downward indefinitely beneath tide	2
		Total	8

THE RECENT DEPOSITS.

The materials which constitute the Recent deposits consist of mud, clay, sand, and gravel. These are deposited in deltas, flood plains and beaches, in the valleys of rivers and estuaries. The deposition of deltas and flood plains has been going rapidly forward, at least since the settlement of the country by Europeans. Men are still living who distinctly

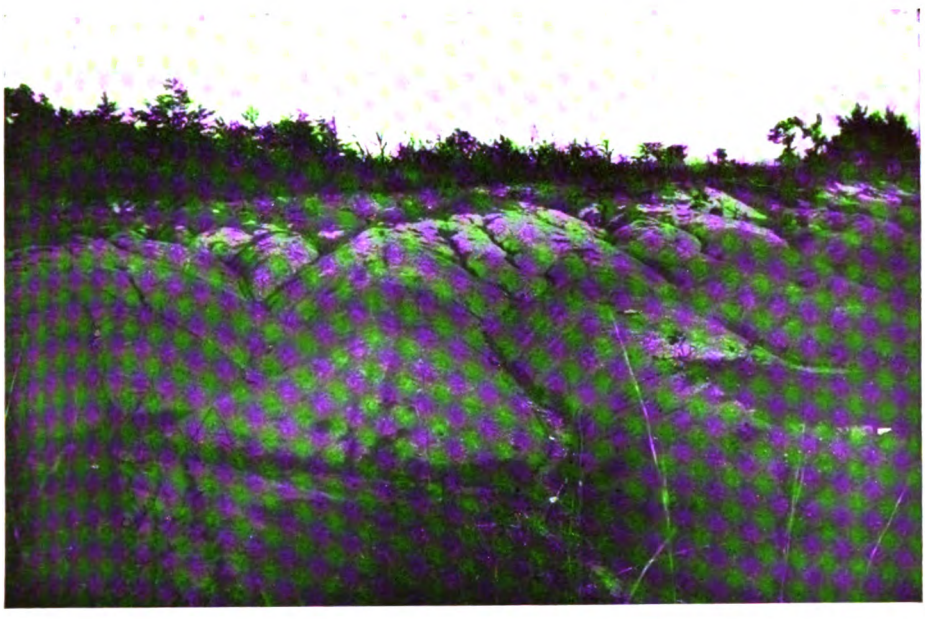


FIG. 1.—VIEW SHOWING SUBAERIAL EROSION ON SUNDERLAND-WICOMICO SCARP, NEAR LEONARDTOWN.

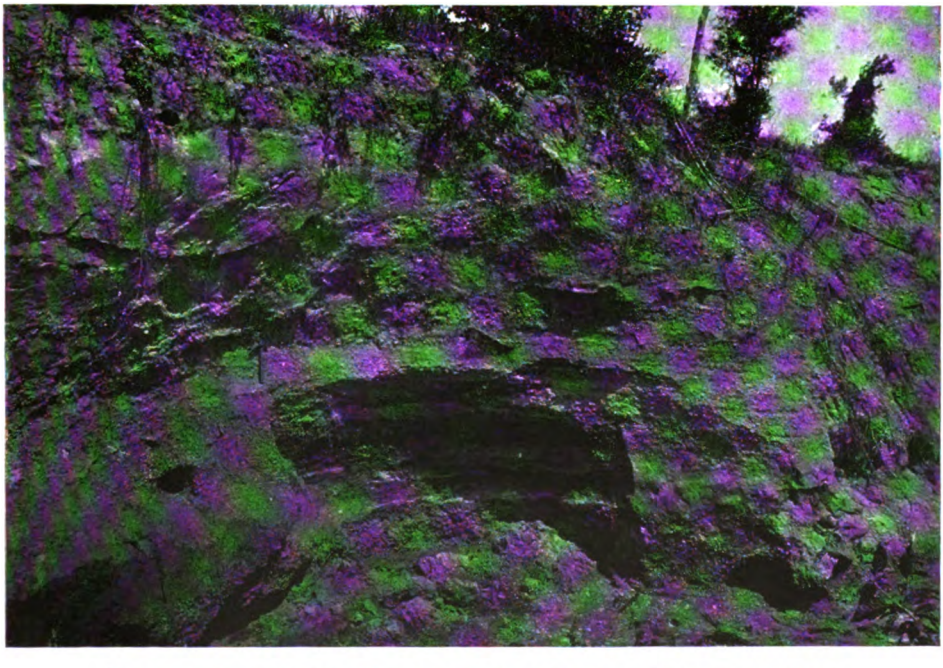


FIG. 2.—VIEW SHOWING SECTION IN WICOMICO FORMATION NEAR CLEMENTS.

remember when vessels moored and discharged their cargoes in places which are now occupied by extensive marshes or meadow lands. Such deposition would doubtless not have occurred if the forests had been allowed to remain undisturbed, but the advent of the white man and the consequent destruction of the forests exposed the loose material, which forms the Coastal Plain, to the erosive effect of rain and rivers with the result that rapid denudation toward the headwaters of streams has been accompanied by rapid sedimentation along the lower courses. Many of the larger estuaries, such as the Patuxent and St. Mary's rivers and St. Jerome Creek, and St. Clement and Breton Bays, have been filled in toward their heads, while shorter estuaries have been transformed to meandering streams. The most extensive beach and dune deposits are found along the Bay and Potomac shores at Point Lookout and Sandy Point. Behind this obstruction, which separates the ocean waters of Chesapeake Bay from an ancient irregular shore line, lie many brackish water lagoons which have already been considerably filled up with sediment since they were separated from the Bay.

ORIGIN OF MATERIALS.

The sources from which the Sunderland, Wicomico, and Talbot seas derived the materials for their respective deposits were principally confined to the Coastal Plain. The waves must have eroded large areas of the Cretaceous, Eocene, Miocene, and Lafayette and re-worked these materials into their own deposits. In addition to this, the Wicomico sea had the Sunderland deposits on which to erode and the Talbot sea had both the Sunderland and Wicomico land surfaces from which to derive materials. Wherever the Eocene sand and marls have been used in any considerable quantity, their presence is indicated by a peculiar greenish color imparted to the deposit. Miocene materials cannot be so readily detected, but they were, nevertheless, re-worked in large quantities. The rivers also brought in contributions from the Piedmont Plateau and the mountains of Western Maryland. This material was pushed along the bottom, drifted in suspension and floated along on ice-blocks.

Interpretation of the Geological Record.

Sedimentary record of the Chesapeake group.

The close of the Nanjemoy epoch was marked by an elevation of the region which brought the Eocene deposits above the ocean and exposed them to a prolonged attack of erosion. After the region had suffered extensively from the work of waves and rivers, it was again submerged beneath the ocean and the materials composing the Calvert formation were deposited. As the Miocene sea advanced little by little on the sinking surface of the mainland, the waves caught up and re-worked the clays and greensands of the various Eocene beds. The more obdurate fossils of the Eocene survived in a great measure the erosive work along the old Miocene shore and were carried out and deposited in deeper water. They may now be seen re-worked in the basal member of the Calvert formation. The old shore line of the Miocene sea which was formed during the Calvert epoch of sedimentation has nowhere been preserved in Maryland, but the materials which composed the Calvert formation in this county were deposited in seas of moderate depth in which an abundance of life was present, as is shown by the remains of diatoms and the extensive beds of fossil mollusks. The remains of whales and other cetaceans show that these vertebrates abounded in the ocean, and the discovery of a bone belonging to a gannet indicates that birds existed along the nearby shores. This particular form doubtless sought its food in the sea as the modern fishing gannets do at the present time.

The Calvert epoch was brought to a close by the elevation of the region once more above the level of the ocean. A period of erosion followed which was probably of short duration and closed with the depression of the region again beneath the sea. Then followed the deposition of the Choptank and St. Mary's formations, in which conditions similar to those just described for the Calvert were repeated.

Sedimentary record of the Lafayette formation.

At the close of the Miocene period St. Mary's County and adjoining areas were lifted above the ocean to form land. The full extent of

the uplift is not definitely known, but it is certain that the sea retreated eastward considerably beyond its present shore-line. Stream erosion at once began to attack this new land area and to cut it down to base level, where it remained for a long time until the crystalline rocks of the Piedmont Plateau were decayed to a great depth below the surface. The rocks of complex mineralogical composition were reduced to quartz sand and a red clay, while the quartz veins were broken up and scattered as angular pebbles over the surface. When, at the beginning of the Lafayete period, this land mass was tilted so as to elevate the Piedmont and depress the Coastal Plain below ocean level, the waters of the Lafayette sea advanced over the sinking surface and streams gorged with detritus from the decayed, uplifted Piedmont above, rushed down to the sea and poured their contents into the ocean. Either the waves were weak or the sea advanced rapidly or this decayed material was discharged in enormous quantities, for the sea was unable to cope with the detritus poured into it and deposited it unsorted on the bottom. The amount of this depression is not known, but it is certain that the land was submerged to at least 500 feet below its present altitude.

SEDIMENTARY RECORD OF THE COLUMBIA GROUP.

The sedimentation of the Lafayette formation was brought to a close by the elevation of the region once more above the ocean. After an extensive interval of erosion, during which the depressions of the principal estuaries in the Coastal Plain were made, the country was again lowered beneath the waves, and the deposition of the formations belonging to the Columbia Group began.

These formations, to which the names Sunderland, Wicomico, and Talbot have been applied, are developed in terraces lying one above the other in a vertical range from tide to an altitude of about 180 feet. Beneath these three terraces, there is forming to-day a fourth which extends from high-tide downwards beneath the waves.

The key to their interpretation is secured by studying the manner in which this recent terrace is forming. At the present time the waves of the Atlantic Ocean and Chesapeake Bay are engaged in tearing away

the land along their shores and in depositing the detritus on a submarine platform or terrace. This terrace is everywhere present and may be found not only along the exposed shores but also passing up the estuaries to their heads. The materials are extremely variable. Along the unbroken coast the detritus has a local character, while near river mouths, the terrace is composed of the debris contributed from the river basin.

In addition to building a terrace, the waves of the Atlantic and the Chesapeake are cutting a sea-cliff along their coast line. The height of this cliff depends not only on the force of the breakers but also on the relief of the land against which the waves beat. A low coast line yields a low sea-cliff, and a bold coast line, a high one, and each passes into the other as often and as rapidly as the topography changes, so that as one travels along the shore of Chesapeake Bay high cliffs and low depressions are passed successively. The wave-built terraces and the wave-cut cliffs are important features along the entire extent of the Bay shore, and should be sought for wherever other terrace surfaces are studied. It must, however, be borne in mind that there are places along the Bay shore where the sea-cliff is absent, or so low that it does not form a conspicuous feature in the topography. In addition to these features, bars, spits, and other wave and current-built formations of a similar character are frequently met with.

If the present coast line should be elevated, the submerged platform which is now forming would appear as a well-defined terrace of variable width with a surface sloping gently toward the water. This surface would fringe the entire Atlantic and Bay shores as well as those of all the estuaries. The sea-cliff would at first be sharp and easily distinguished, but as time passed, the least conspicuous portions would gradually yield to the levelling influences of erosion, and might gradually disappear altogether. Erosion would also destroy in large measure the original continuity of the formation, but as long as portions of it remained, the old surface could be reconstructed and the history of its origin determined.

If the topographic and geologic features which are associated with the terrace now forming are compared with those which accompany the

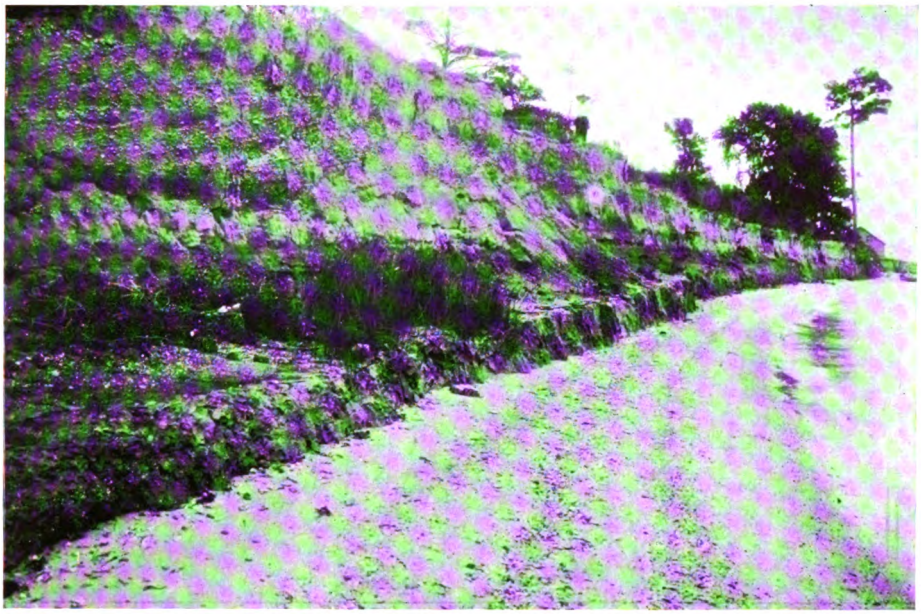


FIG. 1.—VIEW SHOWING THE FOSSIL BED IN THE TALBOT FORMATION AT WAILES BLUFF.

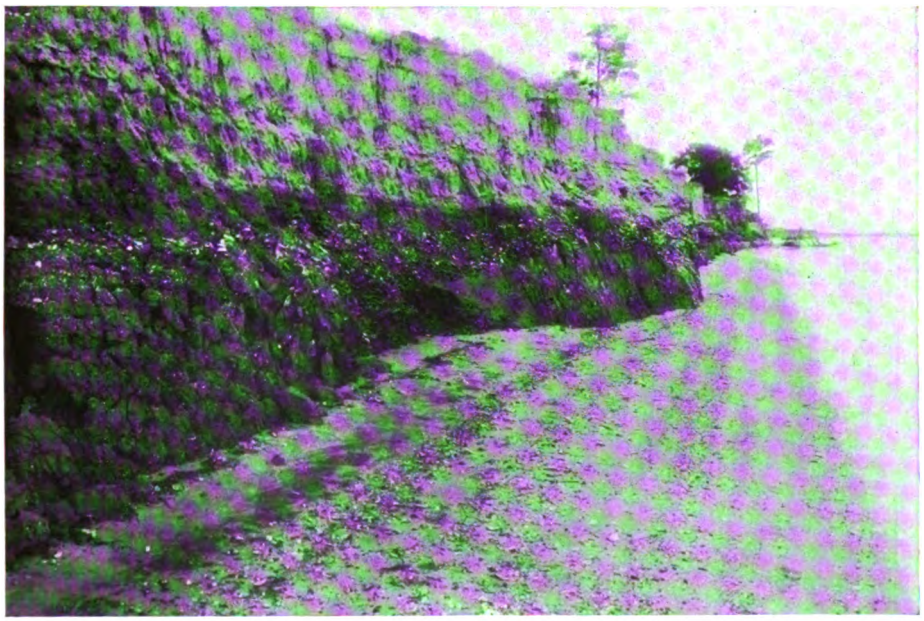


FIG. 2.—VIEW SHOWING THE FOSSIL BED IN THE TALBOT FORMATION AT WAILES BLUFF.

various terraces of the Columbia group, the analogy is found to be so striking that the conclusion regarding a common origin of both is irresistible, and there can be no reasonable doubt that the mode of formation of the modern terrace furnishes the key to the interpretation of the ancient.

The subsidence of the Atlantic Coastal Plain, which carried down beneath the ocean level the entire surface of St. Mary's County, gave opportunity for the waves to finish the destruction of such portions of the Lafayette formation as chanced to survive the erosive work of the streams. As St. Mary's County sank slowly beneath the water, the shore of the advancing Atlantic gradually worked further and further landward until it finally came to rest near Charlotte Hall. St. Mary's County at that time was being rapidly covered by an off-shore deposit of mud, sand and gravel. How long the sea remained in this position is not definitely known, but it is certain that it remained long enough for the waves of the Sunderland sea to cut a well pronounced scarp-line against the Lafayette. These ancient sea cliffs are to-day prominent features of the topography of southern Maryland and may be mapped as easily as the sea cliff which is now being cut by the waves of Chesapeake Bay and its estuaries.

While the Sunderland off-shore deposits were still in process of formation over the surface of St. Mary's County, the region rose again above the surface of the water and erosion began vigorously to cut away the loose sands and gravels which had been deposited just before. How extensive this uplift was, it is now quite impossible to say. It is equally difficult to determine its duration, but it was of sufficient length to permit the destruction of a large portion of this Sunderland formation, for many of the larger streams within St. Mary's County opened up deep valleys within it.

The question as to whether the Patuxent River first came into existence at this point or previously in the erosive interval which followed the uplift of the Lafayete formation has been discussed elsewhere in this volume.

After St. Mary's County had been subjected to erosion for a certain

period, it was again submerged, but not to the same extent as in the previous cycle, during the deposition of the Sunderland formation. The subsidence, however, was sufficient to drown the rivers which had opened up their valleys across the county and to transform these into estuaries, so that a waterway extended across Calvert County from what is now the mouth of Fishing Creek to the mouth of Hunting Creek. Another waterway from the south ran from Drum Point southwestward to what is now the head of the Hunting Creek estuary, and a third extended from what is now the mouth of Parker Creek across the divide to Battle Creek. Other streams of less importance were also transformed into estuaries, so that the county presented a most irregular shore line and the lower half of the region was transformed into a group of small irregular islands. The subsidence at this time amounted to about 90 feet. As the region remained at this level for some little time, the waves along the shore had an opportunity to do considerable erosive work and forced the shore lines back toward the rivers, widening the valleys which had been previously opened during the erosive interval which followed the uplift of the Sunderland formation. The material which was derived from the wave erosion was deposited along the floor of these estuaries, filling them in to a considerable extent and raising them up to a higher level than that which they possessed when the country was submerged at the beginning of the epoch. While this process of sedimentation was still in progress, the country once more rose above the level of the waves and permitted the streams to cut again in their old valleys. This epoch of elevation was apparently a short one for there was not enough time to enable the streams to completely reestablish themselves throughout the entire length of their former valleys. They had only partially begun the erosive work when the country was once more submerged beneath the waves and the deposition of the Talbot terrace was begun. At this time, the streams were once more transformed into estuaries, but not to the extent which they were in the previous Wicomico cycle of deposition. The land did not sink more than 45 feet below its present altitude and remained there for only a short time when it was once more raised and eroded. This epoch of elevation was the one

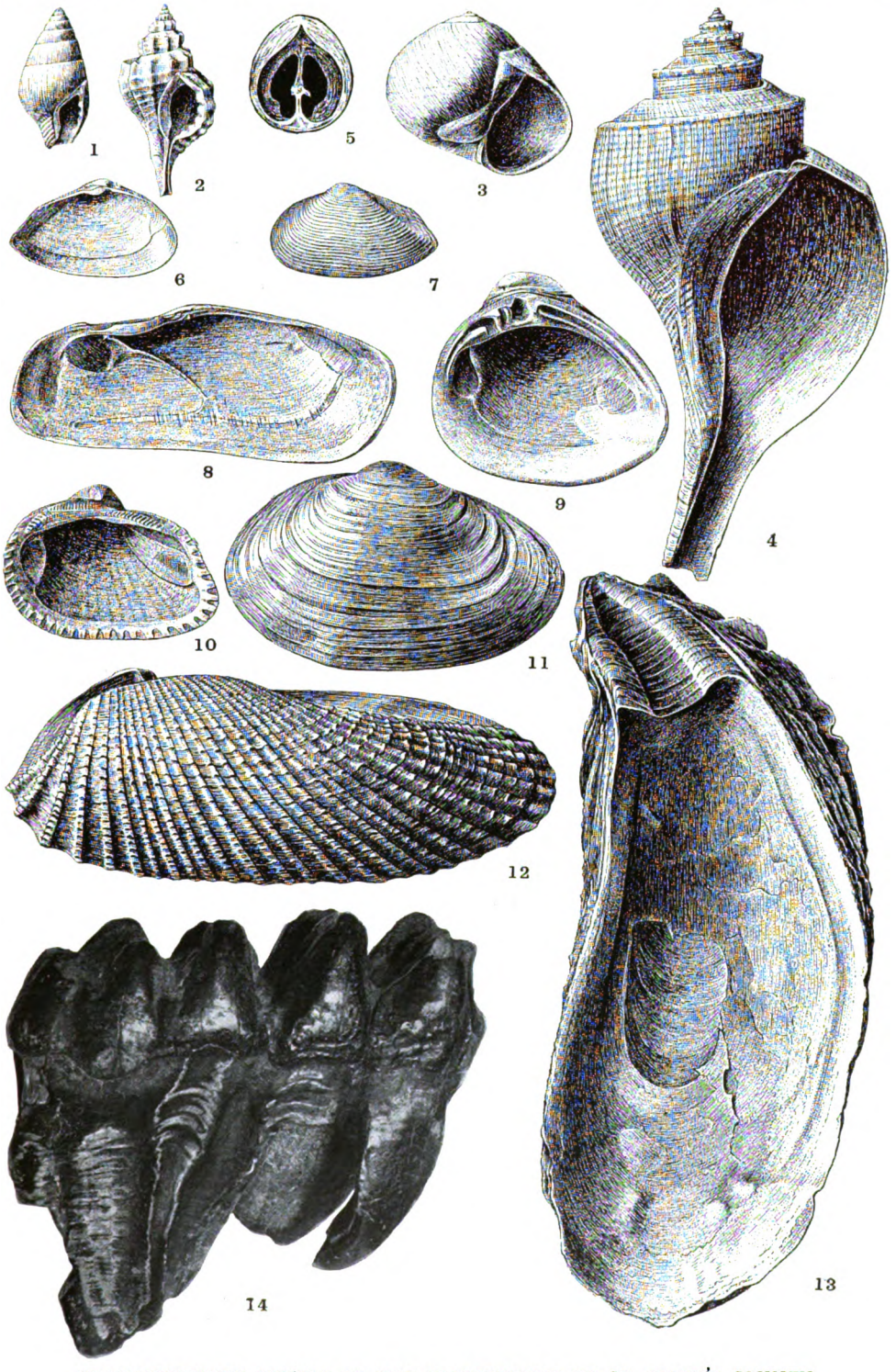
which ushered in the present cycle of events and permitted the cutting of the Recent sea-cliff. Since its initiation, the land has once more assumed a downward motion, and the entire coast line in this region seems to be sinking once more beneath the level of the waves.

Along the shore of Chesapeake Bay and the lower courses of many of its estuaries there occur at intervals deposits of greenish-blue clay developed as lenses in the body of the Talbot formation. Usually the base of the clay is not visible but its stratigraphic relations are such as to leave no doubt that it, or a thin gravel bed on which it occasionally rests, is uncomformable on whatever lies beneath. The upper surface of these clay lenses is everywhere abruptly terminated by a bed of coarse sand or gravel which grades upwards into loam and at its contact with the clay strongly suggests an unconformity. These clay lenses are in some localities devoid of fossils but in others they contain remains of marine and estuarine animals and land plants. Many localities for these clays are already known and as exploration advances new ones are frequently discovered. Some of the more typical exposures will now be described.

Along the shore, about a mile below Bodkin Point, Anne Arundel County, the variegated clays of the Raritan formation are finely exposed in a cliff some 30 feet in height. These clays occupy the greater portion of the section and carry an abundance of lignite more or less incrusted with crystals of pyrite. Sands and gravels of the Talbot formation unconformably overlie the clays and constitute the upper portion of the cliff. Half a mile farther south the cliff still maintains its former height, but the section has changed. Some ancient stream must have established its valley on the Raritan, for here the surface of that formation, like a great concave depression, passes gradually beneath the beach to appear again in the cliff 150 yards to the south. In this hollow, lying unconformably on the Raritan formation, is a bed of dark-colored clay about 15 feet thick. Bluish and greenish tinted bands of clay relieve somewhat its somber aspect, and at about its middle portion it carries a bed of peat. But its most striking feature is the presence of huge fossil cypress knees and stumps which are imbedded in its lower portion. These stumps

vary in diameter from 2 to over 10 feet, and after the removal of the surrounding clay, stand out prominently in the position in which they must have grown. Mr. A. Bibbins, to whom the author is indebted for notes on these deposits, has counted 32 of these stumps which were visible at one time, and also reports finding worm-eaten beechnuts intimately associated with cypress cones near the base of the formation. Sands and gravels of the Talbot formation overlie the whole. Immediately south of this outcrop the dark-colored clays are temporarily replaced by the Raritan formation, but they appear again a little farther down the shore, and afford an almost unbroken exposure for about a mile. The thickness of the clay in this locality is at first about 10 or 12 feet, but it gradually becomes thinner southward and finally disappears altogether. Casts of *Unio* shells and not vegetable remains, are its predominant fossils, while, like the beds containing the cypress swamp, it overlies the Raritan formation unconformably, and is itself abruptly buried beneath Talbot sands and gravel.

Another locality is on the Bay shore, about a mile northeast of Drum Point. Here, at the base of a cliff about 30 feet high, is a 2-foot bed of dark, chocolate-colored clay carrying gnarled and twisted sticks protruding in every direction from the material in which they are imbedded. Above this occurs a thin seam of lignite 1½ feet thick, which in turn is overlain with about 5 feet of slate-colored clay. At this point the continuity of the deposit is interrupted by a series of sands, clays, and gravels belonging to the Talbot formation, which extend upward to the top of the cliff. Although the base of this lignitic clay series is buried beneath beach sands, field relations lead to the conclusion that the deposit is very much younger than the Miocene clays on which it rests unconformably. A similar section is to be seen on the Patuxent River, about a mile below Sollers Landing. Large stumps here protrude from a dark, basal clay bed, some 5 feet in thickness, which is covered by 3 feet of sand, and this again is buried beneath 10 feet of Talbot sand and gravel. The relations of the basal clay to the underlying Miocene is again obscure, but indications point to an unconformity. Another section is exposed along the shore 1½ miles northwest of Cedar Point,



CHARACTERISTIC FOSSILS OF THE PLEISTOCENE OF ST. MARY'S COUNTY.

1. Ilyanassa obsoleta (Say) Dall.
2. Eupleura caudata (Say) Holmes.
3. Polynices (Neverita) duplicatus (Say) Dall.
4. Fulgur canaliculatum (Linné).
5. Hicoria glabra (Mill) Britton.
6, 7. Corbula contracta Say.
8. Tagelus gibbus (Spengler) Dall.
9. Rangia cuneata (Gray) Dall.
10. Arca (Noëtia) ponderosa Say.
11. Mya arenaria Linné.
12. Barnea (Scobina) costata (Linné) Dall.
13. Ostrea virginica Gmelin.
14. Tooth of Mastodon, Mammut americanum (Kerr) (greatly reduced).

where a thin bed of drab clay carrying vegetable remains is overlain abruptly with sands and gravels. Its contact with the Miocene is again unfortunately obscure. At the localities just described no animal remains have been discovered, but on the north bank of the Potomac, about half way between St. Mary's River and Breton Bay, there is a deposit of lead-colored clay, exposed for a quarter of a mile along the shore. It is buried at each end as well as above by sands and gravels and carries both lignite and *Rangia cuneata* (Conrad). Although the description given by Conrad is somewhat vague, it is highly probable that he visited this locality and collected specimens of the fossils. Two more localities still remain to be mentioned, Cornfield Harbor, and its companion deposit exposed 5½ miles south of Cedar Point on the Bay shore. Conrad was well acquainted with these deposits and to the former he devoted special attention. Each is about 10 feet thick, occurs at the base of a low cliff, is composed mostly of a dark, lead-colored clay, and is overlain abruptly with Talbot sand and gravel, while unconformity on the Miocene is beautifully shown at the base of the Bay shore section. A number of fossils have been described from the Cornfield Harbor locality, among which are *Ostrea virginica* Gmelin, *Arca ponderosa* Say, *Arca transversa* Say, *Venus mercenaria* Linné, *Mya arenaria* Linné, *Barnea costata* (Linné), *Crepidula plana* Say, *Polynices duplicatus* (Say), and *Fulgur carica* (Gmelin). In this exposure the lower 4 feet of clay carries the marine forms and above this there are 2 feet of sandy clay literally packed with *Ostrea virginica*. These same general relations hold for the similar deposits south of Cedar Point.

The stratigraphic relation of these lenses of clay which are surely unconformable on the underlying formation and apparently so with the overlying sand and loams of the Talbot formation is a problem which engaged the attention of the author until it appeared that the apparent unconformity with the Talbot, although in a sense real, does not, however, represent an appreciable lapse of time and that therefore the clay lenses are actually a part of that formation. In order to understand more clearly what is believed to have taken place, these clay deposits should be divided into two groups, those which carry plant remains con-

stituting one, and those containing marine and brackish-water fossils the other. Such as are devoid of fossils may belong to either one of the groups according to their situation but probably more frequently belong to the latter.

In a word, the clays carrying plant remains are regarded as lagoon deposits made in ponded stream-channels and gradually buried beneath the advancing beach of the Talbot sea. The clays carrying marine and

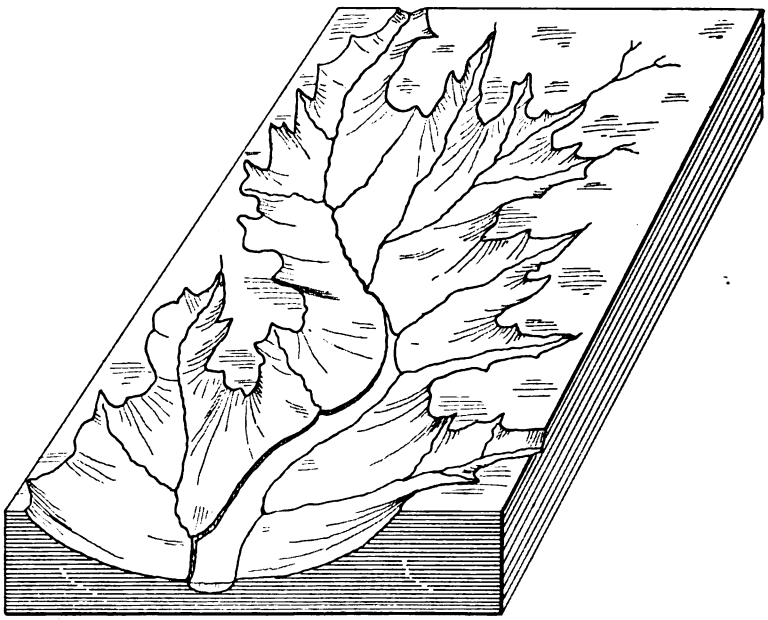


FIG. 5.—Diagram showing pre-Talbot valley.

brackish-water organisms are believed to have been at first off-shore deposits made in moderately deep water and later brackish-water deposits made behind a barrier-beach and gradually buried by the advance of that beach toward the land. Taking up the first class of deposits in more detail they are believed to have been formed in the following manner:

During the erosion interval which immediately preceded the deposition of the Talbot formation many streams cut moderately deep channels in the land surface, which on the sinking of the region again were trans-

formed into estuaries (Fig. 5). Across the mouths of the smaller of these drowned valleys the shore currents of the Talbot sea rapidly built bars and beaches which ponded the waters behind them and transformed them from brackish-water estuaries to fresh-water lagoons. These lagoons, however, were gradually changed into marshes and possibly to meadows by the inflow of detritus from the surrounding region and on the new land surface thus formed various kinds of vegetation took up

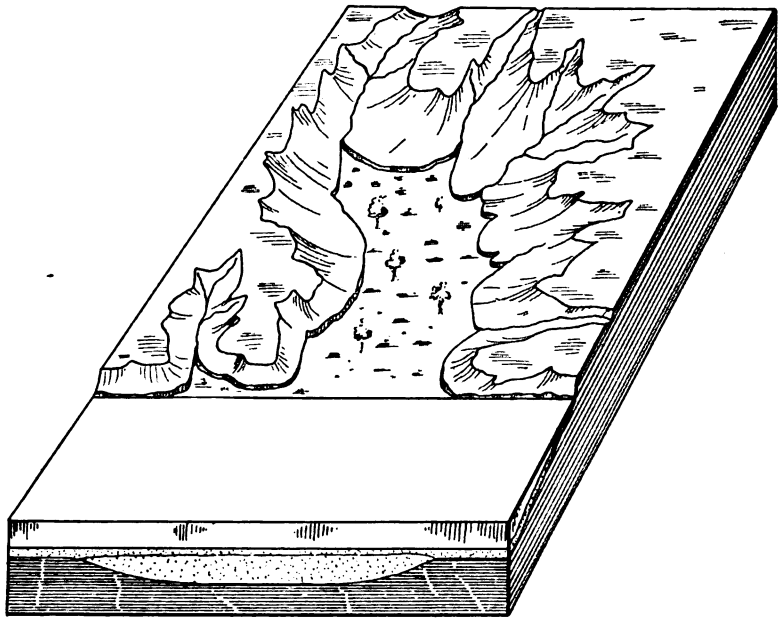


FIG. 6.—Diagram showing advancing Talbot shore-line and ponded stream.

their abode (Fig. 6). At first the beach-sands advanced in the lagoon and filled up completely that portion of the submerged trough which lay immediately beneath them, but later, as the lagoon was silted up more and more with mud derived from the surrounding basin, the advancing beach came to rest on this lagoon deposit as a foundation and arrived at length at the point where the lagoon had been filled up to the level of wave-base or higher. When this place was reached another process was added to that of beach advance. Heretofore the waves and wind had been simply pushing forward material over the advancing front

but now the mud deposit in the lagoon had actually reached the level of wave-work and had transformed the lagoon from a pond to a marsh or to a meadow, the breakers attacked the upper portion of the lagoon deposit and eroded it down to the level of wave-base as rapidly as they could reach it from under the superficial veneer of the beach-sands. Cypress, cat-tails, sedges, and other vegetation which had taken up their abode in the marsh would be overwhelmed with detritus by the advancing beach

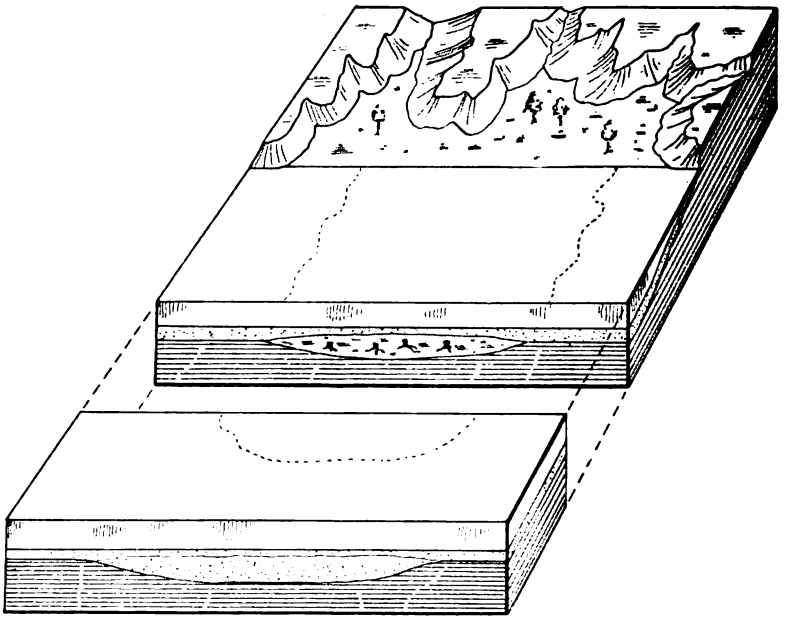


FIG. 7.—Diagram showing later stage in advance of Talbot shore-line.

and a little later be destroyed by the breakers. In this way all traces of life must be removed from the deposit except such as happened to occupy a position lower than wave-base. One, therefore, finds preserved in the clay water-logged trunks and leaves, nuts, etc., and roots of huge trees like the cypress. The area over which the waves had removed the upper portions of the lagoon deposit can be determined not only by the presence of truncated stumps but also by the character of the contact. Here there is a sharp division between the clay and the overlying sand and gravel while the area over which the beach advanced without cutting

FIG. 1.—VIEW SHOWING SWAMP LAND NEAR UNCLE.

FIG. 2.—VIEW SHOWING BARRIER BEACH NEAR MILLSTONE.

would be indicated by a partial mingling of the beach material with lagoon mud.

A still later stage in the process is illustrated in the accompanying diagram (Fig. 7) which represents a stage where the waves have so far advanced as to largely destroy the original stream channel. A small portion of the old lagoon still exists at the head of the swamp but its lower portions have long since been submerged and covered over by the advancing beach. The transverse section shows what is left of the lagoon deposits of mud carrying truncated stumps of cypress and other trees which happened to be buried deep enough to escape the destructive powers of the breakers. The broken line indicates the outline of the clay lens. Fig. 8 is a section through the same region made at right angles

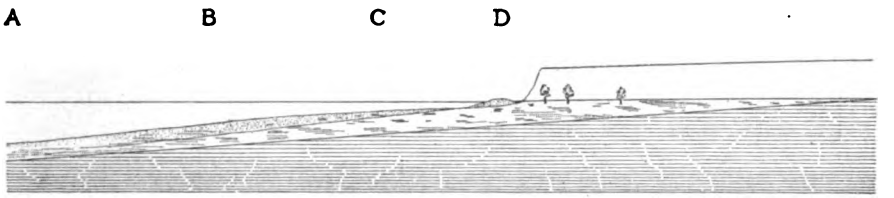


FIG. 8.—Ideal section showing advance of Talbot shore-line.

to the one just described. At *D* the breakers are forcing forward the beach upon the meadow. Just off from the beach the waves have swept away the sand and are eroding on the lagoon mud which reached out to them under the beach veneer. At *C* the waves have succeeded in cutting down the lagoon deposit to wave-base and have left behind a thin veneer of sand and gravel as the sinking land carries it below the reach of the waves. At *B* the lagoon deposit was not thick enough to reach the zone of wave-erosion and simply grades up into a thick deposit of sand and loam which passes out toward *A*.

The second category of clay lenses, namely those carrying marine and brackish-water organisms are understood to have been formed in a somewhat different manner. The lower portion carrying the marine organisms points to salt-water conditions and contains remains of sea animals which live to-day along the Atlantic coast. At the time when

this deposit was formed, the ocean waters had free access to the region and the blue mud in which they are now imbedded and in which they lived was a quiet-water deposit laid down some distance from the land Later, however, it would appear that a barrier beach was constructed shutting off a portion of the sea-bed which had formerly been occupied by marine animals and gradually allowing it to be transformed from salt-water conditions to those of brackish water. In this brackish-water lagoon the fauna changed to that found along our estuaries to-day and huge oysters flourished and left behind them a deposit of shell-rock. With the bar advancing landward this lagoon was gradually filled up with sand and gravel and finally obliterated.

The upper unconformity, then, in the case of the fresh-water and the brackish-water lagoons is real only in the sense that an unconformity in a cross-bedded wave- and delta-deposit is real. There is, it is true, a lack of harmony in the position of the beds and a sharp break is indicated but there is no indication of an appreciable time-lapse between the clay and the oyster-bed on the one hand and the overlying sands and gravel on the other, and the sea which eroded the clay to a fixed level immediately afterwards overspread the surface of the same with a veneer of beach sand. There is, therefore, no time break indicated by this unconformity and the lenses of swamp-clay as well as those carrying marine and brackish-water organisms are to be looked upon not as records of elevation and subaerial erosion but as entombed lagoon-deposits made in an advancing sea and contemporaneous with the other portions of the formation in whose body they are found.

The hypothesis here advanced is based on and reinforced by many observations along the present shores of the Atlantic Ocean, Chesapeake Bay, and its estuaries. Each step in the process described above is there illustrated and some of them are met with again and again.

As one passes along the shores of Chesapeake Bay and of the rivers which flow into it, stream channels are continually met which have arrived at more or less advanced stages in the above-mentioned process. Some are in part converted into lagoons, by bars built across their mouths, others show partial filling by mud washed in from the surrounding country,

and still others have reached the advanced stage of swamps or meadows in which various types of vegetation are flourishing. In addition to the usual undergrowth which is found in wet places, the cypress has taken up its abode in these bogs and has converted some of them into cypress swamps. For great stretches along the shore the advance of the sea is indicated by well-washed cliffs while in other places the waves are found devouring beds of clay which are situated immediately in front of lagoon swamps and separated therefrom by nothing but a low superficial beach. These clay beds invariably lie at and below water-level, are very young in age, and evidently pass directly under the beach to connect with the lagoon-clay beyond. This interpretation is made the more certain by the presence of roots in the wave-swept clays which but a short time before belonged to living plants identical with those now flourishing behind the beach, and point to a time not far distant when they also were a part of the lagoon swamp behind a beach situated a little farther seaward. At Chesapeake Beach a ditch has been cut through one of these beaches which shows a continuous deposit of clay from a lagoon swamp passing out under the beach to the Bay beyond. The waves are thus caught, as it were, in the act of eroding the upper portion of the lagoon deposit.

From a large body of data gained from over a wide area, it is evident that the erosion which occurred during the interval between the elevation of the Talbot terrace and the present subsidence of the coast was sufficient to permit streams to cut moderately deep valleys in the former. It would then appear that as the region was gradually lowered again beneath the present ocean the upper portions of the stream-channel in time passed below wave-base and whatever has collected in them since that period will be preserved beneath the advancing sea as a more or less fossiliferous clay lens apparently unconformable beneath beach debris.

The barrier beaches which exist at intervals along the Atlantic coast of New Jersey, Delaware, Maryland, Virginia, and southward show us how portions of the ocean-bed, which were formerly bathed by salt water and sustained a marine fauna, are now converted to lagoons behind

barrier beaches, and have passed over in varying degrees to brackish-water conditions bearing estuarine faunas.

Similar deposits to those just described have been seen by the author along the Rappahannock River, especially at Mosquito Point, and there is no reason to doubt that they occur in many other places along Chesapeake Bay and its estuaries, within the State of Virginia. From analogy, it would be expected that similar deposits would be discovered along Delaware Bay where conditions must have been identical with those which prevailed in Chesapeake Bay. That such deposits do occur along the shores of the Delaware there can be no doubt. The most noted of these is at Fish House on the New Jersey side of the Delaware River a few miles above Philadelphia.

FIG. 1.—VIEW OF ST. JEROME CREEK SHOWING DROWNED VALLEYS NEAR RIDGE.

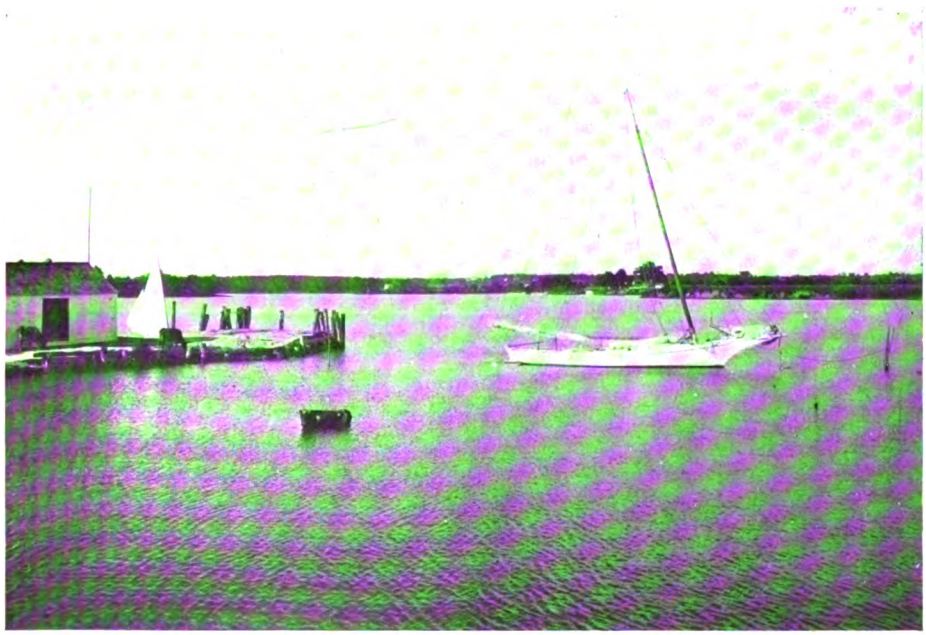


FIG. 2.—VIEW OF BRETON BAY FROM ABELLS WHARF.

THE ECONOMIC RESOURCES OF ST. MARY'S COUNTY

BY

BENJAMIN L. MILLER

Introductory.

The economic resources of St. Mary's County are neither varied nor especially valuable yet several of them are worthy of more attention than they have thus far received. Aside from the soils, which are foremost in importance and value and which are discussed in a subsequent chapter, the county contains several deposits of considerable economic value, none of which are, at present, utilized to their fullest extent. These are the clays, sands, gravels, glauconitic and shell marls, and diatomaceous earth. In addition, valuable water resources contribute much to the mineral wealth of the region.

Almost all of these products have an especial value to the residents of the county in that they either contain ingredients for soil enrichment or materials for the construction of good roads. Since agriculture is the chief occupation it is believed that the general recognition of the value of the natural products of the region will lead to their greater use. This would eventually enhance farm lands through increased soil fertility and easier land transportation.

The Natural Deposits.

THE CLAYS.

The clays constitute the most valuable economic deposits of the region. Every geologic formation represented in the county contains argillaceous strata, even though, in general, the deposits are composed principally of sand. The argillaceous beds are quite generally distributed throughout

the region and, in a few instances, have furnished materials for the manufacture of brick. They are not suitable for pottery or the finer grades of brick but make a fairly good variety of common red brick. Since the clay supplies are ample there seems to be no good reason why the county should not produce all the brick and tile of this character required for local uses. Should a ready market be found and better means of transportation obtained, brick for shipment might perhaps be produced at a profit. However, since other counties in the State more favorably situated with respect to markets and the main lines of railroads contain equally extensive clay deposits, sometimes of a better quality, it is not probable that St. Mary's County will ever become an important clay center. It should, however, produce enough brick to supply the local demand.

Should the experiments that are being tried elsewhere of using burned clay for road metal prove to be successful some of the clay of the county may be profitably used in this way. Since the sandy roads seriously interfere with the development of the region there will undoubtedly be an increased demand, sooner or later, for cheap road metal, and it is possible that the clay of this region may partially meet this demand. The clays occur in deposits of both Tertiary and Quaternary age.

TERTIARY CLAYS.—Although argillaceous beds occur very frequently in the Miocene and Lafayette strata of the State, in general they are too sandy to be of much economic importance.

The Calvert, Choptank, and St. Mary's formations of the Miocene all contain beds of sandy clay which are well exposed in many places along the Patuxent River and in the other stream valleys. The Calvert, which outcrops in the northwestern portion of the county, contains more of this clay than do the other Miocene formations, and the clay is less sandy. It is bluish-green to black when fresh, but becomes lighter in color on exposure. It has never been worked and is probably of little economic value because of its large percentage of sand, iron, and lime. The lime is derived from the numerous fossil shells which are either generally distributed throughout the sandy clay or massed in definite shell beds within it.

The Lafayette formation, which is represented in this county by several small outliers in the vicinity of Charlotte Hall, usually contains a surface capping of clay loam which, elsewhere in the Coastal Plain, has been quite extensively used for brick. However, in this region, its small areal extent renders it of little value.

QUATERNARY CLAYS.—The clays of the post-Lafayette of the county greatly exceed in value those of the underlying deposits and are found in each of the three Pleistocene members. Their mode of occurrence is very similar in the different formations as is also their general character. The clays occur in the form of a surface capping of clay loam representing the last stage of deposition in each epoch, and as lenses of light drab to dark brown clay contained in the body of the deposits. In all probability the surface loam was not everywhere developed and often where it was once present it has since been removed by erosion, so that it is by no means co-extensive with the various Pleistocene formations of which it forms a part. It is extremely variable in thickness, ranging from a few inches to 6 or 8 feet in St. Mary's County, while in other parts of the Coastal Plain it is often much thicker.

The Sunderland formation contains a greater development of clay loam than it does in Calvert County, and for this reason the upland roads which are generally located on the Sunderland-covered divides are less sandy than in Calvert County. The clay loam of the Sunderland constitutes the greater portion of the Leonardtown and Norfolk loams, whose distribution is shown on the soil map of the county. In many places the materials mapped as loam are entirely too sandy for the manufacture of brick, but in many other places in these areas clay suitable for common brick can be obtained. Where the clay can be used the cost of removal entails only a slight expense because of the small amount of stripping required. Similar clays, utilized in Virginia are obtained by merely removing the few inches of surface material which is filled with plant roots.

Beside the surface clay loams, lenses of plastic drab clay are frequently found near the base of the Sunderland deposits. These can be seen outcropping in many places on the steeper slopes. In general,

these lenses are of small extent but some are sufficiently thick and extensive to be worked, although in places they contain considerable vegetable material which renders them less serviceable.

The clays of the Wicomico formation closely resemble those of the Sunderland both in general character and mode of occurrence. The surface loams in many places are suitable for the manufacture of a fair quality of brick, although they have never been used for that purpose in the county. Elsewhere in the State and in adjoining States extensive brick plants obtain their material from the surface clay loam of the Wicomico formation. In a general way the areas of Sassafras loam shown on the soil map of the county approximately represent the development of the Wicomico surface loams. It must be borne in mind, however, that a soil map and a geological map are constructed on an entirely different basis and seldom do the lines defining the areas of certain soils coincide with the boundary lines of the geological formations. Some small portions of the Sassafras loam are of Sunderland age and some belong to the Miocene yet the greater part represents the Wicomico surface loam. Further small portions of the Wicomico surface loam are mapped as meadow soils on the soil map. The clay lenses of the Wicomico which resemble those of the Sunderland are not extensive enough to be of any particular importance.

The loam cap of the Talbot is more persistent than is that of the Wicomico and Sunderland formations, and is almost co-extensive with the distribution of the Talbot formation in this county. Just across the Patuxent River, in Calvert County, near Solomon's Island, brick was formerly made from the Talbot clay loam. In St. Mary's County these Talbot loam areas are most extensive along the Potomac River, where they cover the low, flat divides between the tributary streams. With the exception of the valleys of the smaller streams the meadow soil areas of the soil map approximately coincide with the distribution of the Talbot surface clay loam. As has been demonstrated by the brick plant in Calvert County, the Talbot loam produces a fair quality of brick.

Beside the surface loam of the Talbot, there are several other deposits

of clay present in this formation which doubtless have some value. They consist of lenses of bluish-green to black plastic clay which have been exposed through wave-cutting along the Bay and the Potomac River in the southern portion of the county. The best exposures of this material occur along the Bay shore about 5 miles south of Cedar Point, at Wailes Bluff, along the Potomac River, about 1 mile north of Cornfield Point, and on the east shore of Breton Bay, about one-fourth mile below Lovers Point. Similar clays occurring at Bodkin Point near the mouth of the Patapsco River have been tested and described by Dr. Heinrich Ries.[1] He states that the clay "burned to a good red color under ordinary conditions and to a deep brown when vitrified. Before this clay could be used in large ware it would be necessary to add sand to prevent excessive shrinkage." In certain outcrops these clays contain sufficient vegetable material to render them unfit for use but in others they contain very little organic matter.

THE SANDS.

Since the arenaceous phase predominates in almost every formation represented in the region, the county contains an unlimited supply of sand. The sand of the Pleistocene is used locally for building purposes, but since it is so readily obtained in all parts of the county no pits of any considerable size have been opened. It is said to be a fairly good building sand yet no better than quantities of sands in other parts of the State, hence the demand for it is purely local.

In some places the quartz sands of the Miocene seem to be pure enough for glass-making, suggesting the Miocene glass sands so extensively exploited in southern New Jersey, although they have never been used for that purpose in this region. Careful chemical analyses and physical tests, which have not been made, would be required to determine their usefulness in this respect.

Locally, the Pleistocene sands are rich in ferruginous matter which, in places, cements the grains together forming a ferruginous sandstone.

[1] Md. Geol. Survey, vol. iv, 1902.

Sands of this character possess a distinct value for road-making purposes, as they pack readily and make a firm road bed. Where the material can be easily obtained in large quantities good roads of this kind can be very economically constructed. The ferruginous sands are best developed in the Sunderland formation, principally because of the greater age of the deposits, although also represented in the Wicomico and the Talbot.

THE GRAVELS.

The Pleistocene formations contain numerous beds of gravel widely distributed throughout the region. They occur in pockets or lenses, either immediately at the surface or but thinly covered by the sands and loam. In the latter case they can be seen in many places outcropping along the valleys. These gravel deposits have only been used to a small extent in this section although similar deposits in the vicinity of Washington have been extensively worked. As ballast for roads they possess considerable value and will doubtless be extensively used in the future in the building of permanent roads throughout the county. They are probably inferior in value to the igneous rocks yet serve their purpose well when properly used. They are generally rich in iron, which acts as a cementing agent, although there are many places where the gravels lack this desirable material. In such cases it is necessary to add ferruginous sand or clay to bind them together. The gravels range in size from coarse sand to pebbles several inches in diameter. They are especially well developed at the base of the Sunderland formation and are exposed in almost every place where streams have cut through the overlying loam and sand. Many of these outcrops of Sunderland gravels are represented in the soil map as the Susquehanna Gravel areas.

THE BUILDING STONE.

Although the formations of the county are composed almost entirely of unconsolidated materials, yet locally indurated beds are not uncommon. In the absence of any better stone these indurated ledges furnish considerable material for the construction of foundations and well walls.

At Sotterly Wharf, on the Patuxent River, there is a firm ledge of Miocene rock which has been used for such purposes. Elsewhere ferruginous sandstones and conglomerates from the Pleistocene deposits supply the small local demand for rough building stones.

THE MARLS.

Extensive deposits of shell marl have a wide distribution throughout the Atlantic Coastal Plain and have been worked, at intervals, since the early part of the last century, when their value as fertilizers was first determined. However, their importance in the enrichment of soils deficient in lime has never been generally recognized. At present their use in Maryland has been almost entirely discontinued, although the deposits are practically inexhaustible. At the Nomini Cliffs, just across the Potomac River, in Virginia, shell marl has been dug for shipment and used in the manufacture of artificial fertilizers.

The Calvert, Choptank, and St. Mary's formations all contain beds of shell marl which are exposed in the river cliffs and valley slopes in many places throughout the county. The Talbot also contains deposits of shell marl at Langleys Bluff, on Chesapeake Bay, about 5 miles south of Cedar Point, and at Wailes Bluff, on the Potomac, about 1 mile above Cornfield Point. The shell beds of the Choptank are the most important and are particularly well exposed at Drum Cliff, on the Patuxent River. In places the shells are mixed with so much sand that the lime forms only a small percentage, but in other places the amount of lime exceeds 90 per cent.

The value of the shell marls and methods for using them are thoroughly discussed by Professor H. J. Patterson in a Bulletin of the Maryland Agricultural Experiment Station (No. 66, May, 1900). He states that the lime has an especially beneficial effect upon sandy soils, such as prevail throughout St. Mary's County, in improving their physical characteristics. This it does through its cementing action which renders such soils less porous and thus enables them to retain moisture better. Chemically, lime corrects the acidity of the soils through its neutralizing effect upon acids, acting upon other soil constituents, ren-

dering them available for plant food, and finally serves as a plant food itself. Many experiments which have been tried in various places all show the value of lime as a fertilizer, and experiments in this State show that better results were obtained by the use of shell marl than with burned-stone lime. No doubt, any of the soils of Calvert County might be considerably improved at small expense by the generous use of shell marl, deposits of which are readily accessible to a large part of the county.

THE DIATOMACEOUS EARTH.

Diatomaceous earth, infusorial earth, or tripoli is a siliceous deposit composed mainly of the microscopic tests of diatoms, a low order of aquatic plants. The material is soft, porous, light in weight, and very friable. When fresh it is greenish in color but on exposure to the air the color changes to buff or almost pure white. The diatomaceous earth occurs in the lower part of the Calvert formation and is well exposed in many places along the Bay and river shores and in the tributary stream valleys in the northwestern portion of the county.

The diatomaceous earth, on account of its porosity and compactness, is used in water filters. It is reduced readily to a fine powder and makes an excellent base for polishing powders. On account of its porous nature, diatomaceous earth is used as an absorbent in the manufacture of dynamite, while its non-conductivity of heat makes it a valuable ingredient in packing for steam boilers and pipes, and in safes. This latter is the principal use to which it is put. It has been thought that the diatomaceous earth might be of use in certain branches of pottery manufacture, which require on the part of the materials refractoriness and an absence of color when burned. Dr. Heinrich Ries tested a sample of the diatomaceous earth from Lyons Creek at cone 27 in the Deville furnace and found that the material fused to a drop of brownish glass. The non-refractory character of the diatomaceous earth is thus clearly demonstrated. It is also used in the manufacture of fire and heat-retarding cements and fire-proof building materials, such as solid brick and hollow brick for partition walls and floors.

Not all of the diatomaceous earth of the region is valuable, some containing an excessive amount of sand. At Lyons Creek wharf, in Calvert County, it is quite pure and has been worked for a number of years by the Maryland Silicate Company. Because of the limited demand for it and the considerable number of States in which diatomaceous earth is found it is improbable that the industry in southern Maryland will ever reach very large proportions.

The Water Resources.

The available water resources of St. Mary's County include the surface streams, natural springs, and the dug or driven wells. In the absence of large towns or great industries where large amounts of water are required, the streams have not been utilized for water-supply purposes. In fact, it is doubtful if they could ever be depended upon for potable water because of the large amount of vegetation which they contain during the summer months and the liability to contamination from the run off of the adjoining cultivated lands. In some instances dams have been constructed and the power utilized by small manufacturing concerns, but because of the gentle slope of all except the smallest streams the amount of water-power developed is very slight.

Springs.—The nature of the topography of the region with many stream-valleys cut almost to sea level combined with the gentle dip of the different beds of varying permeability afford excellent conditions for the development of springs. The ground water sinking through the porous Pleistocene deposits until the less porous beds of the Miocene are encountered, flows along the contact until it is tapped by some valley slope where it issues as a line of seepage or as a spring. A large percentage of the ground water is not checked at the contact of the Pleistocene and Miocene but passes downward through the sandy layers of the latter formation until its further progress is checked by more argillaceous beds along which it flows until the layer outcrops at the surface. The more deep-seated springs of the latter sort which penetrate Miocene beds are apt to be purer than the shallow springs and furnish an unfailing supply of excellent water. In addition to the increased danger of con-

tamination in the shallower springs, they are very apt to fail in dry weather.

Some of the springs are remarkable because of the large quantity of exceptionally pure water which issues from them, and also because of their continuous flow since the earliest settlement of the State with probably undiminished volume. The most famous one is Governor's Spring, a short distance east of St. Mary's City, which was the first permanent settlement in Maryland and for a long time its capital. Another spring, equally well known, is the excellent spring at Charlotte Hall which has long furnished the supply of water for the boy's school at that place.

While the spring-water is sometimes slightly charged with iron derived, in the main, from the Pleistocene deposits, it is, as a rule, remarkably free from mineral matter of any kind. Exceptions are the Diuretic Mineral Spring of Blakistone Island, from which water has been sold, and the chalybeate springs at Rock Springs, a few miles northwest of Blakistone Island.

Dug Wells.—Except on the top of narrow divides between deep valleys, the ground water level lies near the surface and abundance of water can be obtained from dug wells of shallow depth. On the narrow divides, however, the water table in the dry months of the year lies only a little above sea level, thus necessitating the sinking of wells almost to that plane in order to obtain a permanent supply of water. The highest divides in the county rise to an elevation of about 180 feet and in a few instances it has been necessary to sink wells to almost that depth to secure plenty of water during all seasons of the year. On the broad, low-lying flats bordering the Potomac River, on the other hand, it is seldom that the wells exceed 20 feet in depth and sometimes the water rises to the surface. In general the water in these most shallow wells is much more apt to be impure, although in many places it is used exclusively without any apparent injurious effects.

Artesian Wells.—As good water in sufficient quantity can be obtained almost everywhere in the county at moderate depths few attempts have been made to obtain artesian water, except in the low-lying regions

adjoining the Potomac and Patuxent rivers, where flowing wells can be secured at moderate expense. Also in those localities the water in the shallow wells is sometimes brackish and at times become stagnant and unfit for drinking purposes. Few flowing wells are known within the county with sufficient artesian pressure to force the water more than a few feet above tide. The well at Chaptico, which rises 22 feet above tide, is exceptional. The water obtained in the artesian wells usually contains some mineral matter in solution but not sufficient to interfere with its use for most purposes. When the wells are protected from surface contamination, the artesian water is the most healthful water obtainable in the county.

There seems to be three distinct water horizons that furnish the supply for artesian wells thus far sunk. One of these occurs in the deposits of the Aquia formation, one of the members of the Eocene, which probably underlies the entire county but nowhere appears at the surface in this region. To the northwest of St. Mary's County, in Charles County, it rises to the surface and outcrops along many of the streams. The other horizons occur in the Miocene strata, one near the base of the Calvert formation and the other probably in the Choptank formation.

The Eocene horizon.—This horizon supplies several artesian wells along the Potomac River in the western part of the county. A well at Chaptico from which the water flows to a height of 22 feet above tide penetrates this horizon at a depth of 291 feet. Another well, 275 feet deep, 2 miles west of Maddox, obtains its water from the Eocene, perhaps from strata somewhat higher than the water-bearing beds in the Chaptico well. Other wells supplied with water from the Eocene horizon include several wells at Oakley about 305 feet in depth, and one at Bushwood 287 feet deep. This horizon undoubtedly extends to the eastward, but since east of Oakley artesian water is obtainable from Miocene strata at shallower depths borings have not been extended to the Eocene horizon.

The Miocene horizons.—The principal water-bearing horizon for the greater part of the county lies near the base of the Calvert formation. Many wells have been sunk to this horizon and a good supply of water

has almost invariably been obtained. On the Patuxent River side of the county good flows of water are obtained from a 225-foot well near Sotterly wharf, from two wells 290 feet in depth at Millstone, and from two wells 257 and 287 feet deep east of Pearson post office. In some cases the wells have been sunk beneath the water-bearing horizon, thus making the horizon, from the depths of the wells, appear to be very uneven. In reality it seems to dip at a quite uniform rate to the southeast, and consequently the wells in the lower portion of the county are deeper than those higher up the rivers.

Along the Potomac River the Calvert horizon furnishes the water for the 190- and 205-foot wells at Leonardtown, a 270-foot well at Piney Point, numerous wells about 270 feet in depth on St. George's Island, several wells near St. Inigoes from 300 to 365 feet deep, a well on the west bank of Smith Creek 365 feet in depth, and two wells near Cornfield Harbor 360 and 370 feet deep.

One other water-bearing horizon has been found at Cornfield Harbor at the depth of 240 feet. This is probably within the Choptank formation. It is probably less extensive than the basal Calvert horizon, since it has not been noticed elsewhere.

The two principal water horizons described above have been penetrated by wells on the opposite side of the Patuxent River in Calvert County, and on the south side of the Potomac River in Virginia.

THE SOILS OF ST. MARY'S COUNTY

BY

JAY A. BONSTEEL

Introductory.

St. Mary's County comprises about 369 square miles of territory, bounded on the northeast by the Patuxent River, on the east by Chesapeake Bay, on the south and southwest by the Potomac River, and on the west by Wicomico River and Budds Creek. All of these waters except Budds Creek are either salt or brackish, and in the Patuxent and Potomac rivers the tides rise to points far beyond the boundaries of the county. On the north, for a distance of about 25 miles, the boundary separating St. Mary's from Charles County is an irregular land line, except along the northeastern portion, where Indian Creek forms the boundary.

The county is irregular in outline, constituting a large peninsula stretching southeastward and is the most southern of the Maryland counties occupying the western shore of Chesapeake Bay.

St. Mary's County lies wholly within the Coastal Plain area of Maryland. It consists of an interior upland division, rising from 90 to 200 feet above sea level, and of a low-lying foreland border varying from 15 to 45 feet above sea level. The county is very much indented by large estuaries or bays, particularly on the Potomac side. The streams of any length flow into the Potomac drainage system, while only steep-walled streams of short length are tributary to the Patuxent.

As in Calvert County, the basal skeleton of St. Mary's County consists of unconsolidated strata. The materials composing these strata are the same as in Calvert County. In the same way the later Pleistocene deposits are far more directly concerned in the formation of soil types than are the older strata, and the correlation of soil types with geological

formations given in considerable detail for Calvert County also applies to St. Mary's.

The chief geological difference between the two counties lies in the fact that in St. Mary's the Eocene strata do not reach the surface, while in Calvert they do, and the St. Mary's formation is much more widely developed in southern St. Mary's than in Calvert.

The Soil Types.

The soils have approximately the following areas:

Areas of the Different Soils.

Soils.	Acres.	Per ct.	Soils.	Acres.	Per ct.
Leonardtown loam	95,500	41	Norfolk loam	8,500	4
Meadow	54,200	23	Susquehanna gravel	7,350	3
Norfolk sand	27,500	12	Windsor sand	3,450	2
Sassafras sandy loam	17,500	7	Swamp	2,200	1
Sassafras loam	16,200	7			

The Norfolk Loam.

Norfolk loam extends as a long narrow strip along the highest portion of the divide between the Patuxent River drainage and that of the Potomac River. It also occupies small, irregular, scattered areas covering the flat plateau of the northern portion of the county.

Along the Three Notch Road, which follows the main divide of the county, the area occupied by the Norfolk loam presents a slightly rolling upland, varying from 120 to 165 feet in elevation. The highest elevations and the intervening hollows are included in the area covered by this soil.

The soil itself consists of a fine sandy to silty loam, reaching to an average depth of about 1 foot. When dry it is powdery and loose, resembling corn meal in texture, distinctly lacking the smooth, clayey feeling of the finer-grain Leonardtown loam. When wet it packs to a firm surface, which cakes slightly through sun drying. In plowed fields this soil, though distinctly sandy, may clod into large-sized lumps. The subsoil is a reddish yellow sandy loam, finer in texture than the

surface soil. It extends to a depth of about 30 inches and is almost universally underlaid by a coarse red sand mixed with fine gravel, having an indefinite depth.

The soil supports a natural growth of pitch pine, white oak and black oak, and chestnut, this latter tree occurring more frequently on this soil than on any other type represented in the county. The areas of Norfolk loam occurring in the northern portion of St. Mary's County, particularly in the vicinity of St. Joseph's. Church, constitute what is

MECHANICAL ANALYSES OF NORFOLK LOAM.

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
5110	2¾ miles W. of Sotterly.	Yellow sandy loam, 0 to 10 inches.	2.09	2.64	10.04	12.43	27.40	12.45	23.50	9.70
5112	1 mile E. of Newmarket.	Yellow sandy loam, 0 to 14 inches.	1.61	Tr.	.53	2.11	36.67	18.66	31.08	9.24
5111	Subsoil of 5110.....	Medium red sand, 10 to 40 inches.	2.10	2.61	12.46	14.35	31.94	7.78	13.89	14.91
5113	Subsoil of 5112.....	Red sandy loam, 14 to 30 inches.	2.03	0.00	Tr.	2.38	35.11	19.44	17.32	23.63

locally recognized as one of the most desirable tobacco soils in the county. The average yield per acre is about 1300 pounds, and the average price about 6 cents per pound. Wheat, corn, and clover are also raised on this soil in regular rotation with the staple tobacco crop. The yield of these crops on the Norfolk loam compares favorably with the average yield of the same crops over the entire area of the county.

The above analyses show the texture of the soil and subsoil of the Norfolk loam.

The Leonardtown Loam.

The most extensive soil type in St. Mary's County is the so-called white-oak or kettle-bottom soil of the upland. It extends from the vicinity of Ridge post office to the extreme northern limit of the county.

The surface is slightly rolling or gently sloping, and the broad, flat divides between the minor streams are covered by this soil. As the soil bears quite a variety of local names, it has seemed best to supplant them all by the name Leonardtown loam.

The extensive forests of white oak and pitch pine occurring over the upland region are found largely on this type of soil. Where small, irregular depressions without any outlet are found the sweet gum also flourishes. Where the Leonardtown loam is exposed on slopes to the washing action of rains, scalds or washes frequently form and they rapidly encroach upon the arable land. A permanent sod is the only sure cure for these scars, though brush dams cause a temporary delay in the progress of erosion.

The cultivated areas of Leonardtown loam vary considerably in the amounts of the various crops produced. Wheat, corn, and grass are best suited to this soil, while tobacco is better adapted to lighter, sandier soils. This soil type forms the nearest approach to the heavy clays of limestone regions that is found in the Coastal Plain of Maryland. A treatment similar to that employed on the limestone soils should increase the productivity of the Leonardtown loam.

The soil consists of a silty yellow loam, fine and powdery when dry, but puddling to a plastic clay-like mass when thoroughly wet. On re-drying, this mass usually bakes to a hard, firm surface, or if stirred before being sufficiently dried, it clods up into hard lumps. The subsoil consists of a brittle mass of clay lenses, lumps, and fragments separated from each other by seams and pockets of medium to fine sand. The subsoil, if evenly mixed, would form a somewhat sandy loam, but its peculiar structure causes it to act like a dense clay in its behavior toward the water circulation. The lenses of clay are slightly flattened and their edges overlap somewhat like the shingles on a roof. Consequently, water in its passage through the subsoil, follows a roundabout course along the sand-coated seams. Its progress downward is thus much delayed, and the subsoil is as impervious and as retentive of moisture as a heavy clay soil. The peculiar structure also gives rise to the brittleness noticed on plowing.

The bright-yellow color of the soil indicates a lack of organic matter. This can be corrected by plowing under green crops and by the application of stable manures. The tendency toward puddling and baking may be corrected by the application of lime.

As has been indicated in the comparison of this soil with the residual soils of limestone areas, the Leonardtown loam is a type best adapted to the production of grass and grain crops, and certain portions of the

MECHANICAL ANALYSES OF LEONARDTOWN LOAM.

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
5114	3 miles W. of Leonardtown.....	Yellow silty loam, 0 to 12 inches.	2.41	Tr.	.89	1.33	5.00	11.37	58.26	19.90
5116	1 mile S. of Loveville.....	Yellow silty loam, 0 to 12 inches.	2.24	0.00	Tr.	3.16	17.62	18.76	47.75	9.69
5118	4¾ miles E. of Leonardtown.....	Yellow silty loam, 0 to 10 inches.	2.97	Tr.	1.38	1.91	3.87	21.90	58.46	10.06
5127	2 miles S W. of Newmarket.....	Yellow silty loam, 0 to 9 inches.	2.11	Tr.	3.05	4.19	9.79	16.54	55.70	8.03
5115	Subsoil of 5114.....	Yellow loam, 12 to 34 inches.	1.96	Tr.	.76	1.19	5.26	13.92	55.02	21.94
5117	Subsoil of 5116.....	Yellow loam, 12 to 30 inches.	3.07	0.00	Tr.	3.28	9.08	11.96	49.24	22.59
5119	Subsoil of 5118....	Yellow loam, 10 to 30 inches.	2.44	.67	1.24	1.83	4.63	15.46	53.39	20.37
5128	Subsoil of 5127.....	Yellow loam, 9 to 30 inches.	1.56	2.22	4.78	8.49	15.97	10.77	36.42	19.20

area found in St. Mary's County are at present producing good hay and grain crops. The gradual introduction of live stock should largely increase the producing capacity of this soil, since the crops best suited to the soil can be fed directly to cattle. The saving in the fertilizer bill in this connection is an important item in farm economics.

The above analyses show the texture of the Leonardtown loam soil and subsoil.

The Susquehanna Gravel.

The layer of gravel which almost uniformly underlies the upland soil types, particularly the Leonardtown loam, reaches the surface along all the more deeply cut stream valleys and along the slopes separating

the upland from the low-lying foreland border. The gravel works down across the slopes wherever it reaches the surface, and forms long, narrow bands of a distinctly gravelly soil. While of no great importance either in area or in agricultural value, it forms a marked feature of the land surface. In some instances the component materials are coarse enough to form stony bands and patches along the slopes. In other cases the finer gravel accumulates sufficiently to form small areas of poor or almost useless soil. This is the case on some of the smaller hills of the northeastern part of the county, where broken fragments of iron crust mingle with the gravel and sands.

Grapes are cultivated to advantage on similar soils in other regions, and their adaptability to this soil should be tried on a small scale in St. Mary's County. In general, it would be better to allow forest growths to occupy the larger, more intractable areas.

The proportion of gravel in some of these areas is as high as 50 per cent, and with so coarse a texture it becomes almost impossible to maintain a sufficient supply of moisture to mature any long-growing crop. This is especially the case where the gravel areas lie on steeply sloping surfaces.

The Windsor Sand.

The Windsor sand areas are found only in the northern portion of St. Mary's County. They are marked by a strong growth of pitch pine and by the gravelly and sandy texture of the soil. At present these areas are imperfectly tilled to tobacco and grain crops, or occupied by small land holdings devoted to producing garden crops for household consumption.

The soil consists of a coarse to medium sand, containing considerable gravel. It extends to about 10 inches in depth, and is underlaid by an even coarser sandy and gravelly subsoil, frequently containing iron crusts in sheets and in broken fragments.

The value and capabilities of this soil have not been recognized as yet in this region. Its coarseness of texture, while precluding the profitable cultivation of grain crops, adapts it especially to the culture of

early truck crops and peaches. The latter crop when raised on the Windsor sand produces a superior quality of fruit both in color and taste, and the orchards found on this soil in other localities are long lived, healthy, and profitable.

The Windsor sand areas of St. Mary's County are all located within easy hauling distance of the present railroad points, and special crops of early fruits, vegetables, and peaches could find an easy and profitable market in the cities on connecting lines.

The surface of the Windsor sand is generally level and is little sub-

MECHANICAL ANALYSES OF WINDSOR SAND.

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
5129	Newmarket.....	Coarse sand, 0 to 9 inches.	1.43	5.48	14.29	14.04	38.63	15.16	8.10	2.76
5130	Subsoil of 5129.....	Sand, gravel, and iron crust, 9 to 28 inches.	1.02	10.20	20.92	12.18	29.30	11.58	10.99	3.81

ject to washing on account of the porosity of the soil. It is easily cultivated and easily improved, and should form a valuable type for the special crops already discussed.

The above analyses show the texture of typical samples of the soil and subsoil.

The Norfolk Sand.

The Norfolk sand illustrates the fact that a single soil type may arise from materials deposited at different geological periods. In St. Mary's County, soil of this type is found along the sloping sides of streams as an outcrop of some of the basal formations of the county; again it occurs along the lower courses of these streams as flat-topped terraces built up from the older material by river transportation; while small areas of it occur along the forelands as material carried still farther seaward.

All these deposits present the same sandy nature and form the same general type of soil, but they vary greatly in geological age.

Along the shallow stream channels of the forest area of the county narrow borders of this sandy soil are frequent. In the northern part of the county the streams have also cut into the sandy layer, which is the original source of this material. The covering of other materials has been washed away and considerable areas of Norfolk sand are exposed. Wherever found, this soil is recognized as well adapted to the Maryland type of tobacco, and it shares with the Norfolk loam in the

MECHANICAL ANALYSES OF NORFOLK SAND.

No.	Locality.	Description.	Organic matter and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
5133	4 miles E. of Leonardtown.	Fine yellow sand, 0 to 14 inches.	1.44	Tr.	2.74	7.88	38.57	21.77	22.37	4.82
5135	$1^{3}/_{4}$ miles SW. of Hillville.	Medium yellow sand, 0 to 10 inches.	1.36	1.64	8.74	13.60	34.69	18.76	15.89	4.87
5134	Subsoil of 5133.....	Medium red sand, 14 to 36 inches.	1.72	Tr.	2.31	5.88	34.91	20.66	22.52	11.96
5136	Subsoil of 5135.....	Red sand and gravel, 10 to 28 inches.	2.00	4.30	12.65	13.69	31.22	10.10	10.12	15.23

reputation of producing a good grade and a reasonable quantity of the crop.

The soil consists of a red or brown sandy loam, having a depth of about 9 inches. This is underlaid by an orange or red sand to a depth of 3 feet or more. The natural growth on this soil includes chestnut, oak, and laurel. The Norfolk sand is a typical early truck soil, and has been very successfully farmed in truck crops all along the Atlantic coast. It produces a quick growth and early maturity, and is therefore much better adapted to the trucking business than to the production of grain crops, which require a longer growing season. Peaches, pears, early potatoes, and the common garden vegetables should be raised much

more extensively than at present upon this soil whenever transportation facilities permit of marketing. The wild fruits like the blackberry, which flourish so remarkably on this soil, should be replaced by the cultivated varieties of the same fruits.

The table on the preceding page gives the results of analyses of this soil type.

The Sassafras Loam.

This soil type occurs in St. Mary's County at an elevation of from 60 to 90 feet above tide in the form of flat-topped terraces. It is generally

MECHANICAL ANALYSES OF SASSAFRAS LOAM.

No.	Locality.	Description.	Organic matter and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
5137	1½ miles W. of Sotterly.	Yellow silty loam, 0 to 9 inches.	2.22	1.21	4.51	4.57	14.94	13.26	49.87	9.45
5139	1 mile S. of Great Mills.	Yellow silty loam, 0 to 9 inches.	2.43	1.02	3.12	4.53	13.35	13.14	49.68	12.80
5138	Subsoil of 5137.....	Yellow sandy loam, 9 to 30 inches.	1.87	.84	4.51	5.79	22.62	10.54	33.84	19.61
5140	Subsoil of 5139. .	Heavy yellow loam, 9 to 30 inches.	2.17	Tr.	2.45	4.02	13.72	12.63	50.56	14.16

completely cleared and well cultivated. It forms the best corn producing soils of this and other areas and is well fitted for general farming purposes. It is formed from a mixture of sand and clay derived from much older strata and reworked and redeposited by stream action.

The soil consists of a slightly sandy yellow or brown loam, having a depth of from 8 to 12 inches. This is underlaid by a heavier yellow loam to a depth of nearly 3 feet. This subsoil forms a good storage reservoir to maintain a moisture supply during the growing season without retaining enough water to interfere with cultivation or plant growth. Wheat, corn, and the grasses do well on this soil, while a fair tobacco crop can be raised on it; but it approaches more nearly to an

easily worked medium grade of soil for general farming purposes. Pears and other fruits, together with tomatoes, asparagus, and canning crops should be introduced to give a greater variety in crops with increased opportunities for profits.

The use of lime and of green manures and stable manures will benefit this soil, though not so essential as in the case of heavier types.

The table on Page 133 gives the analyses of Sassafras loam.

The Sassafras Sandy Loam.

Sassafras sandy loam occupies the low-lying forelands along the Patuxent and Potomac rivers and along the shores of the numerous estuaries and creeks tributary to those rivers. In fact, this soil formation extends as a discontinuous belt of choice farm land almost entirely encircling the county.

Lying between the more elevated uplands and the tide-water courses of the chief rivers of the section, the Sassafras sandy loam slopes gently down from an elevation of about 35 feet nearly to water level, and presents a very nearly flat, though gently inclined, surface. Areas located on adjacent forelands are usually separated from each other by lower-lying strips of meadow lands located along the margins of the minor streams. To the rear of each area the surface usually rises with quite a steep slope to the more elevated plateau region.

The soil itself is probably a marine deposit, laid down at a time when the relative level of tide water in this region was at least 40 feet higher than at present, though the plateau portion of the county existed as dry land even then. The deposition of material derived from the upland by the streams of that day took place closely adjacent to the land area which existed there, and the coarser sands were deposited in those stream courses as noted elsewhere. The finer sand and silt, carried to a greater distance seaward because of the lightness of individual grains, were deposited in the region of tide water, with the coarser materials falling in shallower water near shore, as is the case with the present deposition in all regions. Thus, small sandbars and spits would be formed, and

organic matter from the mainland and from the tidal flats usual along low shore lines would be commingled with the sand and silt of the bottoms of the estuaries. In such a manner the sandy loams of this foreland portion of the county most probably originated. As the relative elevation of land and sea changed, this new-formed soil became exposed, and encroaching land vegetation further aided in the preparation of the loam for agricultural purposes.

The soil is a dark-brown sandy loam, having an average depth of about 14 inches. The subsoil is heavier, in most instances consisting of a yellow or reddish-yellow sandy loam. At 30 inches depth the subsoil is normally succeeded by a reddish sand, though frequently this is wanting and a silty drab layer is found, which extends nearly or quite to tide level.

This soil is so well recognized as a desirable farming land that all original tree growth has been removed and the area is occupied by cultivated fields. Corn, wheat, and tobacco are raised on the Sassafras sandy loam, and the yield of each is somewhat higher than the average yield for the county. The average wheat crop will consist of about 15 bushels per acre; that of corn about 7 barrels, or 35 bushels; while the tobacco will grow to 1600 pounds per acre, and will sell at 5 or 6 cents per pound. Of course, much larger crops are raised under favorable conditions, while unfavorable conditions of season or culture will correspondingly cause a decrease in yield.

In the Cedar Point area the production of green peas, tomatoes, and of sweet corn for canning purposes has been undertaken. The climatic and soil conditions are favorable to profitable production of these and other crops classed as truck or canning crops. Along the Patuxent River, near Forrest Wharf, the culture of broom corn is being undertaken. The success of this attempt has not been learned.

Owing to the location of this soil along the shore near shipping points, as well as to its texture and general properties, it is well adapted to the raising of fruits, vegetables, and general truck crops which derive value from being placed on an early market. Its position also makes irriga-

tion possible whenever the necessity for intensified cultivation shall manifest itself in this community.

The general character of the Sassafras sandy loam is indicated by the following mechanical analyses. It is noticeable that the subsoil in each case contains quite a large percentage more of clay than does the corresponding soil.

MECHANICAL ANALYSES OF SASSAFRAS SANDY LOAM.

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
5141	1¾ miles SE. of Stone Wharf.	Brown sandy loam, 0 to 16 inches.	2.55	Tr.	1.56	4.30	34.34	11.86	36.62	8.36
5144	2½ miles S. of Leonardtown.	Brown sandy loam, 0 to 9 inches.	2.22	1.72	10.83	18.96	19.85	6.44	31.94	8.56
5147	1¾ miles NE. of Trap.	Brown sandy loam, 0 to 8 inches.	3.50	3.49	12.30	9.40	5.88	10.16	48.62	6.24
5149	¾ mile NE. of Cohouck Point.	Brown sandy loam, 0 to 12 inches.	2.93	4.87	17.49	11.83	11.08	9.82	30.59	11.55
5142	Subsoil of 5141.....	Heavy brown loam, 16 to 34 inches.	1.66	.75	2.67	6.79	45.80	5.87	17.06	19.30
5145	Subsoil of 5144.....	Red loam, 9 to 30 inches.	2.53	1.58	12.36	18.69	15.99	4.62	30.43	12.80
5148	Subsoil of 5147.....	Yellow loam, 8 to 30 inches.	2.71	.99	7.03	6.15	3.76	11.20	51.80	16.48
5150	Subsoil of 5149.....	Yellow sandy loam, 12 to 30 inches.	2.15	2.98	13.72	12.18	9.74	8.78	26.13	24.20

The Meadow Land.

The natural meadow lands of St. Mary's County are usually flat or gently inclined areas occurring along stream courses or on the low, flat forelands bordering the tide-water areas. The meadows are usually rather wet, and in many instances they differ from adjoining soil types in their relation to drainage rather than in their texture.

The natural forest growth over the meadows includes white oak, willow oak, sweetgum, and poplar, with frequently a matted undergrowth of shrubs and vines. The meadows furnish a rather coarse, rank grass for grazing and, owing to the mild climate of the region, cattle frequently find pasturage throughout the winter.

The large meadow areas of the forelands are frequently cultivated to the general farm crops, but in wet seasons they are difficult of tillage, and even in the most favorable seasons they produce only wheat and grass to good advantage. They require extensive underdrainage; even open ditches are inadequate, for the soil is so dense and so near water level that surface drainage fails to lower the level of standing water sufficiently to aerate the soil thoroughly. The presence of excessive water in the soil thus tends to keep the ground cold and to delay seed germination and plant growth. Then, too, the organic acids tend to

MECHANICAL ANALYSIS OF MEADOW.

No.	Locality.	Description.	Organic matter, and loss.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
5151	2 miles SE. of Briscoe Wharf.	Gray loam, 0 to 8 inches.	1.84	Tr.	.88	.83	3.76	23.35	59.59	9.58
5153	One-eighth mile W. of Short Point.	Brown silty loam, 0 to 7 inches.	2.32	1.41	3.33	4.12	6.46	15.41	58.54	8.32
5152	Subsoil of 5151.....	Drab clay, 8 to 30 inches.	2.89	0.00	Tr.	1.73	5.38	10.30	47.55	25.77
5154	Subsoil of 5153.....	Drab clay, 7 to 32 inches.	1.61	Tr.	2.01	2.61	7.11	11.40	60.11	14.74

accumulate to excess, proving harmful to plant life and not fulfilling their function in the preparation of mineral matter to serve as plant food.

Proper underdrainage by lowering the water level will not only drain off surplus moisture, but will also permit a circulation of air, and thus aid in the natural improvement of the soil.

Many thousand acres of meadow land, now producing only a rank growth of grass or an uncertain crop of grain, can be made highly valuable by relatively cheap methods of underdrainage.

The soil of the meadow areas usually consists of 8 to 10 inches of gray silty loam underlaid by a subsoil of ash-gray clay loam. The soil mass is apt to be cohesive and clay-like when wet, but when subjected

to the action of the frost and air it becomes powdery and crumbly, and is very much improved in texture. Drainage and liming should be resorted to in order to produce this result on a large scale.

The texture of this soil is shown by the analyses on Page 137.

The Swamp Land.

There are three types of swamp lands in St. Mary's County—the tidal flats, which are wholly or partially submerged at each high tide; the fresh-water marshes, subject to frequent or constant inundation by streams; and the fresh-water bogs and swamps, due to incomplete head-water drainage or to natural or accidental artificial ponding of stream waters.

The salt marsh at the head of Chaptico Bay and the flats at the head of Breton Bay are the most extensive examples of the first class occurring in St. Mary's County. Except at especially high spring tides these areas lie about 5 feet above the water level. They support a growth of marsh grass and reeds and possess a silty soil mixed with partially decayed vegetation. Some marsh hay is cut over these areas, and cattle and hogs find pasture where the surface is sufficiently firm to support their weight.

These marshy areas are formed by the deposition of fine sand, silt, and clay, brought down by streams and by the higher tides, together with the decaying remains of the vegetation which gains a foothold on the drier areas. These marshes are constantly growing in extent, and in many instances cattle are feeding on marshy meadows where small-sized boats floated in the early days of the colonization of the county. Farther from the mouths of the larger tributary streams, above the highest reach of the tide, the fresh-water marshes occur, as is the case along the Chaptico Creek, McIntosh Run, and many of the streams flowing into the Patuxent River. These marshes are similar to the salt marshes, except that they are only subject to irregularly occurring inundations below fresh water instead of periodic submersion by the tides.

The third class of swamps occupy positions at the heads of some of

the main streams and along the upper courses of the majority of the smaller ones. The headwaters of the St. Mary's River drainage, found in the forest area around St. Andrew's Church, illustrate this condition markedly, though many other localities are very similar.

The surface in this forest area is slightly irregular and consists of Leonardtown loam and Norfolk sand. The hollows in both of these formations are swampy and grown up to gum trees. In wet seasons small ponds exist, which become dry, or nearly so, during the latter part of each summer. A slight clearing out of the natural drainage ways, connecting these ponds with stream courses, would destroy the ponds in most cases. Frequently the obstruction to drainage consists of a rank growth of vegetation, fallen tree trunks, and the accumulation of dead leaves and soil wash. In some few cases the grading up of highways or embankments constructed for proposed railways through the county has caused accidental artificial ponding of waters. These are of small extent and may be easily remedied by underdrainage.

The Agricultural Conditions.

The condition of agriculture in any community depends upon four factors—soil, climate, transportation facilities, and the mental and physical energy of the population. The first two of these factors are natural, while the last two are to a great degree artificial. Usually it does not lie within the power of any community, however energetic, to modify the soils or the climate of a region to any marked extent. The great exception to this statement is in the arid states, where irrigation has been introduced, transforming desert areas into fertile farms.

The actual conditions of the soil, the climate, and the transportation facilities of St. Mary's County have been treated separately in other chapters, but a general resumé of the interrelationships of these factors and a slight reference to certain social and economic conditions prevailing in the county are necessary to a full appreciation of the present status of the county by its own inhabitants as well as by strangers.

The usual farm practice in St. Mary's County is based on a rotation of crops, including tobacco, corn, wheat, and grass, or a season of fallow-

ing. This rotation is observed on all soils in all parts of the county, though some individual farmers have modified it. Thus, in a great majority of cases, the fundamental factor of soil differences is neglected. The success of the rotation in the county has depended upon the highly accidental factors of the location of the farm and the energy of the farmer. Thus, the energetic man located on the proper soil for the tobacco crop will be highly successful, while his no less energetic neighbor located on the wrong soil may be unsuccessful, and the unenergetic man may absolutely fail.

The natural selection of farm lands dependent upon these conditions has led to the abandonment of large areas of the Leonardtown loam to forest occupation, for the soil is not adapted to the culture of the quality of tobacco which buyers expect from the county. On the other hand, the Norfolk loam is tilled over almost every acre of its extent, because it is adapted to the production of this chief crop.

In the same way natural selection has led to the extensive cultivation of the Sassafras sandy loam, and it is worthy of notice that the very first white settlers, as well as their Indian predecessors, located on this soil type chiefly because of its location near water transportation, but also probably in part because it is an excellent soil for general farming purposes. Contrasted with this soil are the large areas of meadow land still clothed with forest growth, though similarly located to the Sassafras sandy loam. It is not entirely an accident that leads to these selections and to the introduction of new crops, such as peaches, on the Norfolk sand, or to the cultivation of canning crops and broom corn on Sassafras sandy loam. The climate of the region is suited to the crops, the soils are similar to those upon which the crops have been raised elsewhere, the facilities for transportation are in part equal to the necessities of the crops, while the energy required for their introduction is supplied by well-informed and progressive citizens of the county and of other regions.

A local and partly defined soil classification has been reached through this process of selection, though the areas suited to certain crops have not been located nor mapped over any part of the county until the present time. Nevertheless experience, often bought at a dear price,

and confined to the few who have ventured their money and their time, has led to the partial classification already noted. It is hoped that the classification, the map, and the description of soil types contained in this report will facilitate further development along the lines of soil selection for special crops, will encourage the introduction of new crops, and will lead to a generalization of the experience gained by the few for the use of the many.

Closely associated with the adaptability of certain soil types to certain crops is the two-edged question of fertilizer, which is dependent for its answer upon the quality of soil to be fertilized and the kind of crop to be raised.

Probably every soil type in St. Mary's County contains within 4 feet of its surface sufficient plant food to produce 100 crops of any kind which are raised or could be raised in the county. The necessity for fertilizer depends on the fact that much of this material is present in such chemical combinations and in such a physical state that some manipulation is required to release it and to bring it into solution in water so that the plant roots may absorb it. Certain chemicals found in commercial fertilizers and in stable manures tend to release this plant food and to form or supply soluble chemical compounds suited to the needs of the plants, while organic matter constitutes the best sponge for retaining the absolutely essential water supply in sandy soils, and acts equally well in loosening the too closely packed particles of heavier clay soils. The organic matter, through its decay, also furnishes actual plant foods and solvents for the preparation of other foods. The character of growth desired in special crops modifies the kind and amount of special fertilizers for those crops. For example, it is a generally accepted principle of tobacco culture in Maryland that liming land spoils the texture of the tobacco raised, causing it to spot and injuring the burning qualities for which it is so well known; therefore the use of lime on tobacco lands is precluded, though its use would be of undoubted advantage on all of the heavier soil types and upon most of the lighter types for other crops.

St. Mary's County possesses large stores of carbonate of lime in the

Miocene marl beds underlying all of the upland portion of the county and reaching the surface in nearly every cliff and stream cutting over the upper half of the region. This lime supply consists of the calcareous tests of marine shellfish which once lived upon the sea bottom when the ocean covered the county. The shells, buried in sand and elevated above water level, can be dug out by the wagonload and converted into excellent lime by sieving out the sand and burning the remaining shells, just as lime rock is burned to lime. The sifting would be unnecessary in the case of some of the deposits, since the small amount of sand present would be a benefit to the heavier types of land. The Leonardtown loam would benefit materially from such liming, except, of course, when tobacco is to be raised.

The plowing under of green crops, especially the leguminous plants of the clover and cowpea varieties, furnishes another method of enrichment highly desirable on almost all the soil types of St. Mary's County, and does not present the difficulties of liming, since this kind of fertilizer is of great benefit to the tobacco crop. These leguminous crops furnish a fair forage for cattle during a period of their growth, and if allowed to continue growing they produce a mass of organic matter for incorporation with the soil; and all the time, beneath the surface of the ground, certain minute bacteria, living on the roots, are taking nitrogen from the air and storing it in the soil, thus helping its enrichment.

The ordinary practice of putting from 200 to 400 pounds of commercial fertilizer, costing from $18 to $40 per ton, upon the farms of St. Mary's County has a double effect. It produces the crop, but it also enters a large item on the expense side of the farm account, and on some soils its continued use has the effect of burning out the soil, so that periods of fallowing become essential. For certain crops special fertilizers will always be necessary, and commercial fertilizers are to be commended highly, but in St. Mary's County on all soils the use of stable manure and the plowing under of green crops are to be preferred, while on the soils least suited to tobacco the abandonment of that crop and the free use of lime in conjunction with organic matter have already become necessary, as is shown by the forest areas given over to nature's cultivation.

Many of the farm buildings of St. Mary's County are of remote date. The farmhouses particularly are types of colonial structure, and the residence upon the farm at Sotterly is one built for the first governor of Maryland, while numerous other manor houses in the county are nearly as venerable. Even the less pretentious houses display the long sloping roofs, the gable windows, and the large end chimneys of the early colonial period. The atmosphere of antiquity, of romance, and of historic interest which surrounds these old residences and the equally venerable churches and farm properties gives a local color and a local pride to the county that can be shared only by other communities of equal age.

Outbuildings are not so essential in this climate as in regions of heavier snowfall, so the older farms are provided only with the tobacco barn, smokehouse, and corncrib of the plantation, the large stock and hay barns being almost totally unknown. Cattle can graze upon the meadow lands in all but exceptionally severe weather, and the side of some existing building or the shelter of woodland protects them during the coldest weather.

The fences are mostly built of rails and poles cut in the native forests, though some barbed and other patent wire fences have been introduced. The Virginia rail or worm fence is the most common type, while the mortised post, into which the ends of the rails are fitted, is also common.

No account of the condition of agriculture in St. Mary's County would be complete without a reference to the common draft vehicle and beast. Owing to the steepness of the grades and to the general difficulties attending land transportation, the ox-cart is usually employed for heavy hauling. It is no uncommon thing toward the latter part of June to meet from one to twenty 4-ox or 6-ox teams attached to heavy 2-wheeled carts, upon which one or two tobacco hogsheads are being drawn to the wharves for shipment. Each hogshead constitutes an unwieldy mass of about 800 pounds of tightly packed tobacco, and the successful transportation of some of these loads down the steep slopes from the upland to the wharf, under the existing road conditions, is no small feat of engineering.

The field labor is largely performed by the numerous colored population of the county, some of whom labored as slaves on the same farms where

they now work as free men. The majority of the workers, however, belong to a more recent generation.

There are no large towns in St. Mary's County. Leonardtown, the county-seat, is the largest, while Mechanicsville, at the terminus of the railroad, does a thriving business, and Charlotte Hall is the seat of a well-known school of the same name.

The tendency of the white population is toward the enjoyment of the seclusion of large estates, and frequently the manor house or farmhouse is reached only by a long avenue leading away to a distance of nearly a mile from the public highway. On the other hand, the colored population segregates into little communities, where land may be obtained cheaply, and little villages of frame and log dwellings are dotted over the county.

The Transportation Facilities.

A single branch line of railway, connecting Mechanicsville with the main line at Brandywine, is the only rail communication between St. Mary's County and the markets and cities of the State and the country at large. This lack of railroad communication is partly relieved by the steamboat service on the Patuxent and Potomac rivers and on the larger streams. As two lines connecting with Baltimore and Washington control the water transportation, this can scarcely be said to equal the needs of the county. The boats run only at long intervals and at rather irregular times, and the trip to Baltimore or Washington consumes from sixteen to twenty-four hours, depending upon the volume of freight carried.

For this reason the crops produced in the county are placed at a disadvantage with relation to markets when compared with those of other regions, and the variety of crops that can be raised with profit is considerably restricted. This is particularly evident in the case of fruit and truck crops and of dairy products. The truck lands of St. Mary's County are excellent, so far as soil and climate are concerned, but no one cares to enter into their cultivation to any extent so long as the cost and uncertainties of marketing remain as great as at present. Again,

the Leonardtown loam, the Sassafras loam, and the meadow lands are well adapted to dairying and to stock raising, but the time distance from markets and the actual uncertainty of any communication during winter months retard or prevent introduction of stock.

The waterways for extensive steamboat communication exist, grades well adapted for railway construction are to be found, and the construction of the roadbed presents only the simple engineering problem of cut and fill, with no consolidated rock formations to require blasting. The soils, the climate, and the natural advantages of geographical location all favor the upbuilding of the county. It is likely that outside influences have combined with a well-defined conservatism in the native population to retard the development not only of this but of other localities in the general region.

The internal communications of the county consist of highly varied wagon roads. The main roads follow the main divides, while public and private roadways lead out along the secondary divides and down to the lowland farms and to the wharves. Bridges are scarce, and the small streams are crossed by fords. The tide-water indentations along the coast and the marshes at their headward extremities separate the farms along the forelands, and it is possible to go only from one foreland to another by considerable detour inland, usually including a steep ascent to the upland and an equally steep descent to the adjoining foreland. Foot passengers can usually find a small boat to transfer them across such obstacles, and many of the farmers own sailboats, but regular ferries do not exist. There is no regular ferry or bridge across the Patuxent terminating in St. Mary's County.

The wagonroads consist of sand, loam, or clay, as they happen to cross such materials, and the rain wash and the wear of travel have cut the roads down for long distances far below the surface of the country. In many places where the roadway has been washed to a state of impassability teams have driven around the gully and established a new highway, or an overturned tree is avoided similarly. One road district in particular has secured fairly good roads partly through the

energy of its supervisor, partly because additional contributions above the annual tax have been given by residents of the district, and partly because the district contains better road materials than some others. The iron-stained gravels of the upland plateau should be used to a greater extent in surfacing its clay roads, but proper drainage and grading of most of the roads must precede any other work.

THE CLIMATE OF ST. MARY'S COUNTY

BY

C. F. VON HERRMANN

Introductory.

The extreme southern boundary of Maryland is located at the mouth of the Potomac River, near the Virginia shore, in latitude 37° 53′ N. Point Lookout, at the southern extremity of St. Mary's, is only a few miles farther north, and the region whose climate is to be discussed in this chapter, thus forms one of the most southern counties of Maryland. As the county is distant from the mountains, its surface level, and its coast line deeply indented by rivers and tidal estuaries, it is apparent that the factors immediately controlling the character of its climate are its relatively low latitude (38° 2′ to 38° 31′ N.) and the proximity of large bodies of water. The mitigating influence of water on climate has been sufficiently discussed in the chapter on the climate of Calvert County to which the reader is referred. In that sketch it was shown that the waters of the Bay and Atlantic Ocean have much less influence than might be expected on account of the prevailing off-shore winds. It was also shown that as the cold Labrador current flows near the Atlantic coast the waters bathing the shores of Maryland and the interior waters of the Bay are below the temperature normal to the latitude. The popular belief that the Gulf Stream itself has an influence on the climate of Maryland is quite erroneous. The temperature of St. Mary's County will probably be found to be slightly higher than that of its northern neighbor, Calvert County, but its northwest portion, which is farthest removed from the Bay will have a large range of extremes. In the present study of the various meteorological elements the inquiry should be kept in mind to what extent does the climate of

St. Mary's County differ from what may be designated the normal for its latitude.

This region shares all the characteristics common to the coastal plain, the most important of which, from a climatic point of view are, its low, level surface, its unconsolidated soil of sand and clay, and its considerable area of forests. The peculiarities of the drainage in this region is remarkably well shown in St. Mary's County. The water-shed lies very near the valley of the Patuxent River the entire distance from Charlotte Hall to Jarboesville, and farther south it continues quite near the Chesapeake shore. Thus the rivers drain south and southwest into the Potomac, at right angles to the general direction of drainage in the Piedmont Plateau. The general elevation is somewhat over 100 feet, approaching 200 feet in places. Isolated elevations of over 100 feet are found even in the extreme southeast portion of the county, for instance near Friendship, which is a few miles from the shore, north of Point Lookout. The level areas of 100 feet elevation are more numerous and broaden out toward the northwest portion of the county. All the meteorological stations, except Charlotte Hall (167 feet) have an elevation of less than 50 feet, that is they are situated on low ground at the head of small bays.

Climatic Data Available.

Although climatic records are available for seven stations in St. Mary's County, the periods of observations are all short and much broken. The earliest observations in the county were taken under the auspices of the Smithsonian Institution, by Mr. T. G. Staggs, at Ridge, from 1856 to 1857. Other early records are those by Dr. Alexander McWilliams, at Leonardtown, from 1858 to 1859, and by Rev. James Stephenson, at St. Mary's City, from 1859 to 1870. At Cherryfields (P. O. Valley Lee) observations were taken by Col. J. Edwin Coad for a period of five years, from 1893 to 1899. The rainfall records for St. Inigoes taken by Mr. James F. Ellicott, from 1871 to 1879, must be used with caution. For all of these stations only the mean temperatures and the monthly precipitation are available. The only fairly complete record

for St. Mary's County is that for Charlotte Hall in the northwest portion of the county. Here Prof. J. Francis Coad took meteorological observations from 1893 to 1904, but owing to frequent absence from station the records are unfortunately not continuous, varying in length from 7 years for June to 11 years for January. Table XXIV, page 176, gives the necessary information in regard to each station in the county. St. Mary's City, St. Inigoes, Ridge, Cherryfields, and Porto Bello are located not far apart in the southern portion of the county, near St. Mary's River; Leonardtown is at the head of Breton Bay; and the most northern station, Charlotte Hall, lies near the boundary of Charles County.

From the fact that records of temperature extending over many years, such as the period of 200 years at Florence, 100 years at Paris and 88 years at Baltimore, show no change from the annual course of temperature at present observed, in spite of the great variation in the monthly means, it is concluded that every place has a normal march of temperature which can be ascertained only by a series of observations of considerable duration. The length of the period required to obtain a correct normal depends largely upon the character of the climate. In tropical regions where the seasonal variations are small, five years are sufficient to give an annual mean temperature accurate to within 0.1°, but such is by no means the case in a variable, continental climate like that of the eastern United States. At Baltimore the probable error of the means for 88 years is still greater than 0.1°. Means for less than 20 years at any station in Maryland are far from representing true normal temperatures. At Baltimore the January mean temperature has varied from 43.9° in 1858 to 24.3° in 1893, a difference of 19.6°; at Solomons the variation in the February means was from 40.8° to 26.2°, a difference of 14.6° in 14 years. Therefore, in comparing short term records at several stations it is impossible to determine whether the differences observed are really due to actual differences in climate, or are due to the special character of the short period from which the means were derived. This is well shown by comparing the excellent record for 14 years at Solomons (1892 to 1905) with the 88 year means at Baltimore, when it appears that Solomons is colder than Baltimore

in January and February, an entirely erroneous conclusion; for by comparing the Baltimore and Solomons records for the same period of years, the proper relation of temperature for the two stations becomes at once apparent.[1]

Mean temperatures for short periods may, however, be corrected, when there is available for comparison a long record at a station not far distant, and similarly located with respect to its topographic surroundings. For Lamont has shown that in spite of the variability of the temperatures from month to month, the differences between neighboring places remain constant. These differences are fixed by physical causes and so may be strictly considered a meteorological constant (Hann). Baltimore is not very differently situated from other stations in southern Maryland, and its record for 88 years may be used as the criterion by which to ascertain the corrections to be applied to short term records to obtain the true normals. The application of the method may be conveniently illustrated by an example.

The January mean temperature at Baltimore (88 years) is 34.9°; the January mean for Charlotte Hall (10 years) is 34.0°. Charlotte Hall is 56 miles south of Baltimore, and cannot normally have a lower mean winter temperature than Baltimore. The correction to be applied is calculated as follows:

	1894	1895	1896	1897	1898	1899	1900	1901	1902	1904	Means.
Charlotte Hall	38.6	32.8	33.6	33.2	38.3	34.2	36.3	34.4	31.6	29.8	34.0°
Departures	4.6	−1.2	−0.4	−0.8	4.3	0.2	2.3	0.4	−2.4	−4.2	2.2°
Baltimore	37.4	31.4	33.3	30.8	36.7	32.7	35.3	34.4	31.5	27.4	32.8°
Difference[2]	1.2	1.4	0.3	2.4	1.6	1.5	1.0	0.0	0.1	2.4	1.2°
Departures	0.0	0.2	−0.9	1.2	0.4	0.3	−0.2	0.0	−1.1	1.2	0.1°

[2] Difference between Charlotte Hall and Baltimore. This first column of departures is the departure from the average of the mean temperatures; the last column of departures is the departure from the normal of the differences between Baltimore and Charlotte Hall.

The average of the variations of actual mean temperatures at Charlotte Hall is 2.2°, with a probable error for the 10-year period of plus or minus 0.6°; but the average of the variations in the differences between

[1] See the chapter on climate in Calvert County Report.

the Baltimore and Charlotte Hall means is only 0.1°, or twenty times less, and the probable error is only plus or minus 0.03°. As the mean for January at Baltimore for 88 years is 34.9°, and Charlotte Hall is normally 1.2° warmer (probable error 0.03°) the corrected January mean for Charlotte Hall is 34.9° plus 1.2°, which is equal to 36.1°. The corrected mean temperatures given in Table I have all been ascertained in this way.

In order to secure a fairly accurate mean temperature for St. Mary's County, the corrected means for the following stations have been employed, viz.: Charlotte Hall (9 years' record) situated in the northwest portion of the county, Cherryfields (5 years), St. Mary's (7 years), and St. Inigoes (7 years) in the southern portion of the county, and Solomons (14 years) near the middle of the northern shore.

The Temperature Conditions.

The average monthly and annual mean temperatures corrected as indicated are given in the second part of Table I. The upper portion of the table contains the original uncorrected data for all stations in the county. The annual mean temperature for St. Mary's County is found to be 57.1°. This is slightly higher (0.3°) than the mean for Calvert County. Spring (55°) and autumn (59°) have the same temperature as Calvert County, but summer (76°) is about a degree cooler, and winter (38°) a degree warmer, a difference which may be attributed to the superior influence of the Bay. The warmest month is July, with a mean of 78°, and the coldest January, with 37°, giving an annual range of 41°. The extremes in St. Mary's County are, maximum 104° at Ridge in July, 1856, and minimum 19° below zero at Charlotte Hall in February, 1899.[2] The range in absolute temperatures is 123°. Maximum temperatures of 100° or above have also been recorded at Charlotte Hall and St. Inigoes, and 2° below zero occurred at Leonardtown during the cold winter of 1893.

The monthly mean temperatures at all stations are given in Tables II, III, IV, V, VI, VII, and XV.

[2] See the remarks in regard to this record on page 168.

TABLE I.

TEMPERATURE DATA, ST. MARY'S COUNTY.

Stations.	Years.	Length of Record.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	Warmest Month.	Coldest Month.	Range.	Highest Monthly Mean.	Lowest Monthly Mean.	Range.	Absolute Maximum.	Absolute Minimum.	Range.
Charlotte Hall	1892-1905	9	34.0	33.4	44.5	53.0	64.6	73.0	77.0	76.2	70.6	57.4	46.0	37.1	55.6	77.0	33.4	43.6	81.8	25.8	56.0	102	—19	121
Cherryfields[2]	1893-1899	5	34.9	34.2	44.4	52.6	64.2	72.3	76.1	75.3	70.8	57.9	47.2	38.0	55.7	76.1	34.2	41.9	77.5	25.9	51.6	...	...	...
Leonardtown[3]	1858-1893	4	37.5	39.0	42.9	52.7	62.0	72.0	75.4	75.5	69.0	55.4	44.9	38.8	55.4	75.5	37.5	38.0	78.2	25.6	52.6	95	— 2	97
Porto Bello[4]	1895	1	31.3	28.2	46.5	54.0	66.8	73.8	79.0	76.2	70.4	....	....	..	....	..	....	....	.....	.....	....	....	....	....
Ridge[5]	1856-1857	1	26.6	43.3	41.8	49.6	65.5	78.8	84.1	....	73.1	59.2	48.6	34.6	....	....	....	....	.....	.....	....	104	— 1	103
St. Mary's[6]	1859-1870	7	35.2	36.9	42.7	55.0	61.9	72.6	76.1	78.0	70.5	57.8	47.2	38.9	56.1	78.0	35.2	42.8	79.7	27.1	52.6	96	4	92
St. Inigoes	1871-1879	7	38.2	40.1	44.1	55.2	64.9	73.8	79.4	76.1	68.5	58.9	50.1	39.5	57.4	79.4	38.2	41.2	82.0	32.1	49.9	100	10	90

CORRECTED MEANS[1] AND COUNTY AVERAGES.

Stations.	Years.	Length of Record.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	Spring.	Summer.	Autumn.	Winter.
Charlotte Hall	1892-1905	9	36.1	36.9	45.0	54.5	64.4	73.8	77.7	76.5	69.3	56.4	46.9	37.9	56.3	54.6	76.0	57.5	37.0
Cherryfields	1893-1899	5	37.1	37.7	44.9	54.5	64.4	73.6	78.1	76.6	69.7	59.6	49.4	39.1	57.1	54.6	76.1	59.6	38.0
St. Mary's	1859-1870	7	36.9	39.7	42.2	55.3	62.0	73.0	76.6	77.5	69.1	57.0	47.5	40.0	56.4	51.9	75.7	57.9	38.9
St. Inigoes	1871-1879	7	38.3	39.7	45.6	56.7	65.0	73.0	77.4	76.2	69.4	58.8	51.3	40.8	57.7	55.8	75.5	59.8	39.6
Solomons[7]	1892-1905	14	36.9	37.5	44.3	54.4	64.9	74.6	79.3	78.1	71.8	59.5	49.4	39.8	57.5	54.5	77.3	60.2	38.1
For the county	.....	.....	37.1	38.3	44.4	55.1	64.2	73.6	77.8	76.9	69.9	58.3	48.9	39.5	57.1	54.6	76.1	59.0	38.3

[1] Explanation in the text.
[2] Observations at 8 a. m. and 8 p. m. Same as *Valley Lee*.
[3] Records not continuous.
[4] Opposite St. Mary's, began 1905.
[5] Fragmentary record. Observations at 7 a. m., 2 p. m., and 9 p. m.
[6] Means of 7 a. m., 2 p. m., and 9 p. m. observations.
[7] In Calvert County.

TABLE II.

MONTHLY AND ANNUAL MEAN TEMPERATURES[1] AT CHERRYFIELDS, MD., 1893-1899.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1893	.....	.....	.....	.....	.....	.....	.....	.....	.....	59.3	46.9	39.5	....
1894	39.4	37.4	48.2	51.8	66.0	72.8	76.6	72.0	72.6	59.0	44.8	38.3	56.6
1895	33.2	25.9	41.8	52.9	62.8	74.2	78.2	76.0	72.2	53.4	46.9	38.3	54.2
1896	32.8	36.8	39.0	55.4	67.8	71.7	76.4	76.2	67.8	55.4	51.2	35.7	55.5
1897	31.8	36.4	45.2	52.9	61.5	70.5	76.8	74.8	69.4	59.9	47.2	39.4	55.4
1898	37.6	34.4	47.6	50.2	62.6	72.4	77.5	77.4	72.2	60.6	45.9	37.0	56.3
1899	34.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Means	34.9	34.2	44.4	52.6	64.2	72.3	76.1	75.3	70.8	57.9	47.2	38.0	55.7

[1] Observations at 8 a. m. and 8 p. m.

TABLE III.

MONTHLY MEAN TEMPERATURES AT RIDGE, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1856	.....	.....	.....	.....	67.8	79.1	84.1	.....	73.1	59.2	48.6	34.6	.....
1857	26.6	43.3	41.8	49.6	63.2	78.4	.....	.....	.....	.....	.....	....	.....

Table I and subsequent tables contain the monthly and annual mean temperature and total precipitation at all stations in St. Mary's County. Table XXIV gives the necessary statistical data. The following remarks are pertinent:

The observations at Charlotte Hall were commenced by Mr. R. W. Silvester in 1892, but were continued by him for less than a year, therefore, the larger portion of the work at the station is credited to Prof. J. F. Coad. In 1905 Rev. J. Neilson Barry became observer at Charlotte Hall, and it is hoped a new and valuable series of records will be secured for that station.

At Cherryfields the temperatures were observed at 8 a. m. and 8 p. m.; the means given in Table I, are the original records, but the corrected means were reduced to the equivalent of maximum and minimum readings by applying a correction determined by the difference between the means from 8 a. m. and 8 p. m., and from maximum and minimum temperatures at Baltimore. At Leonardtown the means are from observations at 7 a. m. and 2 and 9 p. m. These have not been corrected to the means of maximum and minimum temperatures because the differences are very small.

As regards precipitation the records at St. Inigoes are of doubtful value; at Charlotte Hall the irregularity of the record causes the rainfall to come out too small for the period.

TABLE IV.

MONTHLY MEAN TEMPERATURES AT PORTO BELLO, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1895.....	31.3	28.2	46.5	54.0	66.8	73.8	79.0	76.2	70.4	.....	.....	.....	.....

TABLE V.

MONTHLY MEAN TEMPERATURES AT LEONARDTOWN, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1858.....	42.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	40.4	41.1	.....
1859.....	37.3	38.2	49.9	52.1	64.2	72.1	75.4	74.4	69.6	51.7	48.1	39.8	55.6
1889.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	47.3	45.8	.....
1890.....	44.2	44.2	41.8	53.0	61.0	.....	.....	.....	.....	.....	.....	.....	.....
1891.....	.....	.....	.....	54.2	60.0	71.2	70.2	.....	71.2	.....	41.9	.....	.....
1892.....	.....	37.1	37.4	51.7	.....	.....	78.0	76.6	66.2	59.2	46.8	34.6	.....
1893.....	25.6	36.3	42.5	52.6	62.8	72.8	78.2	.....	.....	.....	.....	.....	.....
Means.....	37.5	39.0	42.9	52.7	62.0	72.0	75.4	75.5	69.0	55.4	44.9	38.8	55.4

TABLE VI.

MONTHLY AND ANNUAL MEAN TEMPERATURES[1] AT ST. MARY'S, MD., 1859-1870.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1859.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	40.8	.....
1861.....	35.6	42.6	44.4	54.1	61.1	.....	74.7	.....	.....	62.4	.....	40.1	.....
1862.....	38.4	38.8	41.8	53 9	61.9	72.2	75.4	78.8	70.5	61.8	48.3	40.0	56.8
1863.....	.....	36.8	.....	49.2	.....	70.9	76.9	.....	66.9	57.2	49.6	38.4	.....
1864.....	38.0	36.8	40.4	53.9	61.9	72.0	76.2	79.7	68.9	56.8	48.2	40.8	56.1
1865.....	32.4	37.0	49.9	58.7	64.5	76.6	76.1	75.5	74.9	57.3	47.4	40.8	57.6
1866.....	33.1	37.1	.....	57.0	61.2	.....	.....	.....	.....	.....	.....	.....	.....
1867.....	27.1	.....	40.2	56.0	60.8	71.9	.....	.....	71.3	59.8	.....	34.1	.....
1868.....	30.9	30.5	43.0	59.1	61.9	72.2	76.1	78.0	70.5	54.8	48.3	33.2	54.0
1869.....	39.5	36.9	39.4	53.2	.....	.....	77.5	.....	.....	52.6	41.6	40.0	.....
1870.....	42.1	35.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Means.....	35.2	36.9	42.7	55.0	61.9	72.6	76.1	78.0	70.5	57.8	47.2	38.9	56.1
Highest Means....	42.1	42.6	49.9	59.1	64.5	76.6	77.5	79.7	74.9	62.4	49.6	40.8	57.6
Lowest Means.....	27.1	30 5	39.4	49.2	60.8	70.9	74.7	75.5	66.9	52.6	41.6	33.2	56.1
Range.....	15.0	12.1	10.5	9.9	3.7	5.7	2.8	4.2	8.0	9 8	8.0	7.6	1.5

[1] Means from 7 a. m., 2 p. m., and 9 p. m. observations.

TABLE VII.

MONTHLY AND ANNUAL MEAN TEMPERATURES AT ST. INIGOES, MD., 1871-1879.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1871	.....	.....	.....	.....	.....	.....	.....	.....	65.7	.....	46.4	35.8	.....
1872	32.1	34.7	36.7	56.0	66.0	73.7	76.8	73.9	67.4	53.4	42.6	32.2	53.8
1873	35.0	44.5	42.2	53.4	63.0	73.5	80.0	75.7	70.6	58.9	47.8	.....	.....
1874	44.5	43.5	45.2	49.6	65.2	76.6	76.6	77.4	72.9	56.4	49.9	42.2	58.3
1875	33.6	34.8	43.6	51.4	65.2	74.4	79.5	74.9	68.1	59.1	47.7	45.0	56.4
1876	46.3	42.0	39.4	55.4	66.0	76.9	82.0	78.1	69.6	57.9	51.4	34.6	58.3
1877	35.8	42.6	47.8	54.6	63.8	74.9	79.8	79.5	60.3	64.6	62.9	47.8	59.5
1878	41.0	40.0	53.9	66.2	65.2	66.6	80.9	73.2	73.5	61.9	52.2	38.7	59.4
1879	37.4	38.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Means	38.2	40.1	44.1	55.2	64.9	73.8	79.4	76.1	68.5	58.9	50.1	39.5	57.4
Highest means	46.3	44.5	53.9	66.2	66.0	76.9	82.0	79.5	73.5	64.6	62.9	47.8	59.4
Lowest means	32.1	34.7	36.7	49.6	63.0	66.6	76.6	73.2	60.3	53.4	42.6	32.2	53.8
Range	14.2	9.9	17.2	16.6	3.0	10.3	5.4	6.3	13.2	11.2	20.3	15.6	5.6

The marked contrasts in the summer and winter mean temperatures in St. Mary's County are characteristic of a continental climate, and the differences become more striking if comparison be made between exceptionally warm summer months and unusually cold winters. The highest summer and the lowest winter means for each station are given below:

Station.	Highest Summer Mean.	Lowest Winter Mean.
Charlotte Hall	81.8° in August, 1900.	25.8° in February, 1895.
Cherryfields	77.5° in July, 1898.	25.9° in February, 1895.[1]
Leonardtown	78.2° in July, 1893.	25.6° in January, 1893.
Ridge	84.1° in July, 1856.	26.6° in January, 1857.
St. Inigoes	82.0° in July, 1876.	32.1° in January, 1872.
St. Mary's	79.7° in August, 1864.	27.1° in January, 1867.

[1] From observations at 8 a. m. and 8 p. m. uncorrected.

The highest monthly mean temperature in the county was 84.1° in July, 1856, at Ridge, and the lowest was 25.6° in January, 1893, at Leonardtown, giving a large range of 58.5°.

THERMAL ANOMALIES.

We may now inquire what relation does the corrected mean temperature for St. Mary's County bear to the normal temperature for its latitude, in which the effect of the distribution of land and water peculiar to the region in question may be considered to be equalized, if not elimi-

nated? The well-known isothermal charts showing the distribution of temperature over the globe are constructed by entering on a chart of the world the mean temperature for each station reduced to sea-level, and drawing lines through points which have the same temperature. From these charts it is possible to calculate the mean temperature of each parallel of latitude. The mean temperature for equidistant points on each parallel is ascertained, for instance, at the crossing point of every 10 degrees of longitude, giving 36 values, the average of which is the normal temperature for the parallel. This normal may be viewed as the temperature which would result at the given parallel from an equable distribution of land and water, instead of the irregular distribution found in nature. A comparison of the actual mean temperatures observed with the normal for the latitude will show whether a region is warmer or colder than the normal or the thermal anomaly of the region.

The parallel of 38° N. is the nearest to St. Mary's County. The mean temperatures for this latitude, as found by Spitaler, and the corresponding means for St. Mary's County are given below:

	Annual Mean Temperature.	January Mean.	July Mean.
Parallel of 38° N.	59.5°	44.2°	76.5°
St. Mary's County	57.1°	37.1°	77.8°
Differences	—2.4°	—7.1°	+1.3°

The comparison shows that the annual mean temperature of St. Mary's County is 2.4° lower than the temperature proper to its latitude. The thermal anomaly is negative throughout most of North America (except the Pacific and Gulf coasts) and the deficiency exceeds 7° in the region northwest of Hudson Bay. In winter St. Mary's County is 7.1° colder than the normal for its latitude, or in other words the character of the year is determined by the severe winter climate of the great continental interior. North of the Lakes and the St. Lawrence the thermal anomaly for January is — 18°, while it is + 30° between Iceland and Norway.

In summer the anomaly for St. Mary's is positive, but only slightly over a degree, the difference between the July means being 1.3°. The positive anomaly becomes greatest towards the interior of the continent,

TABLE VIII.

PRECIPITATION DATA, ST. MARY'S COUNTY.

Stations.	Years.	Length of Record.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	Greatest Monthly.	Least Monthly.	Spring.	Summer.	Autumn.	Winter.
Charlotte Hall[1]	1892-1905	9	3.13	3.26	3.02	3.86	3.38	2.89	4.09	2.69	2.64	3.66	1.85	2.32	36.79	7.08	0.31	10.26	9.67	8.15	8.71
Cherryfields	1893-1899	5	2.14	3.55	3.42	2.98	4.26	2.69	6.04	3.36	2.23	3.83	3.23	2.52	40.25	8.56	0.79	10.66	12.09	9.29	8.21
Leonardtown	1889-1892	2	1.30	3.68	3.41	3.60	5.24	2.64	7.35	1.21	1.52	1.13	4.40	1.28	36.76	10.32	0.05	.....	.....	.....	.....
Porto-Bello	1895	1	2.82	3.49	....	3.99	3.65	5.42	6.14	4.21	2.52	....	....	....	.....	.....	....	.....	.....	.....	.....
St. Mary's	1861-1870	7	3.55	3.41	4.26	4.06	4.03	3.17	3.61	5.35	3.01	2.78	3.39	2.91	43.53	14.98	0.27	12.35	12.13	9.18	9.87
St. Inigoes	1871-1879	7	2.52	4.06	4.94	4.23	4.27	2.12	3.67	6.54	4.77	3.67	3.44	3.36	47.59	15.15	0.25	17.44	12.33	11.88	9.94
Solomons[2]	1892-1905	14	2.81	3.65	3.29	3.13	3.42	3.26	4.83	3.66	2.64	3.09	2.41	2.86	39.05	7.88	0.37	9.84	11.75	8.14	9.32
Averages for the county: Charlotte Hall. Cherryfields St. Mary's St. Inigoes Solomons	.....	....	2.83	3.59	3.79	3.65	3.87	2.83	4.45	4.32	3.06	3.41	2.87	2.79	41.46	.....	....	11.31	11.60	9.34	9.21

[1] Most of the records are not continuous. [2] In Calvert County.

reaching +18° in Arizona and Southern California. It is — 10° between the coast of Labrador and Greenland. The line of no departure lies not far east of the Atlantic coast both in summer and in winter.

Precipitation.

Table VIII gives the monthly and annual precipitation for all stations in St. Mary's County. A critical examination of the material will lead to the conclusion that the annual average at St. Inigoes is above the true normal for the region; the total amount for the year 1872, which is 88.51 inches, is so much larger than the amount recorded anywhere else in the State that it should not be used. The period covered by this record (1871 to 1879) is too short to establish a normal record, moreover it is known to have been one with excessive rainfall, especially the years 1873, 1876, and 1879. The precipitation at Charlotte Hall appears too low, though it is known that there has been a rather marked deficiency in precipitation during the past 15 years in the eastern portion of the United States.

St. Mary's County receives annually slightly over 41 inches of rainfall. The greatest average occurs in July, with 4.45 inches, which is 11 per cent of the annual total, and the least falls in December, with 2.79 inches, which is 6 per cent of the annual amount. The precipitation is small and nearly equal in amount during January, June, and November. The uniformity in the distribution of rainfall is thus notable. Tables IX, X, XI, XII, XIII, and XVI contain the monthly and annual precipitation at all stations.

TABLE IX.

Precipitation at Cherryfields, 1893-1899.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1893.	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.40	8.27	3.34	.....
1894.	2.10	4.00	1.23	3.16	2.85	1.90	3.52	3.20	3.69	3.29	2.38	2.85	34.17
1895.	2.98	1.78	3.55	4.51	4.90	2.38	7.68	2.29	1.12	3.07	2.46	1.93	38.45
1896.	1.24	4.92	2.80	1.02	6.24	3.39	8.56	0.79	3.47	1.40	2.28	1.40	37.21
1897.	1.92	5.59	5.05	2.73	2.83	2.82	2.78	3.95	0.58	5.53	1.72	2.78	38.28
1898.	1.62	1.45	4.47	3.48	4.49	2.95	7.64	6.56	2.31	3.29	2.29	2.83	43.38
1899.	2.96	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Means.	2.14	3.55	3.42	2.98	4.26	2.69	6.04	3.36	2.23	3.83	3.23	2.52	40.25

TABLE X.

PRECIPITATION AT PORTO BELLO, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1895.....	2.82	3.49	.....	3.99	3.65	5.42	6.14	4.21	2.52	.....	.....	.....	.....

TABLE XI.

MONTHLY PRECIPITATION AT LEONARDTOWN, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1889.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.27	0.05	.....
1890.....	1.30	4.40	2.73	3.25	4.30	.....	.....	.....	.....	.....	.....	.....	.....
1891	.....	.....	.....	2.46	6.17	2.64	10.32	.....	0.74	.....	2.63	.....	.....
1892.....	.....	2.95	4.09	5.08	.....	.....	4.38	1.21	2.29	1.13	5.31	2.50	.....

TABLE XII.

PRECIPITATION AT ST. MARY'S, MD., 1861-1871.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1861.....	4.29	2.11	2.25	6.98	4.47	3.16	6.82	14.98	5.20	2.92	3.40	0.84	57.42
1862.....	5.08	4.45	3.79	5.32	4.87	4.38	2.27	2.90	2.64	2.45	3.20	3.50	44.85
1863.....	.....	5.14	.....	3.50	2.75	3.18	5.49	0.27	2.25	2.56	2.85	3.50	.....
1864.....	.....	1.20	3.81	6.56	2.83	1.19	0.93	5.05	2.85	1.98	2.30	1.85	.....
1865.....	4.20	2.88	0.84	3.48	3.12	2.56	.....	3.55	0.62	3.95	5.55	4.31	....
1866.....	2.53	4.26	.....	3.55	4.59	.....	.....	.....	.....	.....	.....	.....	.....
1867.....	1.12	.....	10.87	1.56	5.56	3.73	.....	....	1.33	4.22	.....	.....	.....
1868.....	4.55	2.60	3.69	1.75	...	4.00	.....	.....	6.15	0.68	3.95	2.90	..
1869.....	4.17	5.56	4.59	3.85	.....	.....	2.55	.....	.....	3.50	2.51	3.38	.....
1870.....	2.45	2.36	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1871.....	.....	3.56	.....	.....	.. ..	.....	.. ..	.....	.....	.....	.....	.....	.. .
Means.....	3.55	3.41	4.26	4.06	4.03	3.17	3.61	5.35	3.01	2.78	3.39	2.91	43.53
Greatest amount..	5.08	5.56	10.87	6.98	5.56	4.38	6.82	14.98	6.15	4.22	5.55	4.31	57.42
Least amount.....	1.12	1.20	0.84	1.56	2.75	1.19	0.93	0.27	0.62	0.68	2.30	0.84	.....

Excessive precipitation (10.00 inches or more in one month) does not occur frequently in St. Mary's County. Omitting the doubtful record of 1872 for St. Inigoes, it appears that the following large amounts have been recorded: Leonardtown, 10.32 inches, July, 1891; St. Mary's City, 10.87 inches, in March, 1867, and 14.98 inches in August, 1861; St. Inigoes, 15.15 inches in August, 1873, 12.95 inches in April, 1874, and 11.01 inches in August, 1875. At all stations amounts less than 1.00 inch frequently occur. The lowest record for each station is: Charlotte

TABLE XIII.

PRECIPITATION AT ST. INIGOES, MD., 1871-1879.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1871	.....	.....	.....	.....	.....	.....	.....	.....	5.08	.....	6.62	5.64	.....
1872	0.53	8.75	12.80	3.70	9.82	1.80	10.60	10.30	7.50	11.01	5.00	6.70	88.51
1873	3.63	7.67	1.86	1.45	4.20	0.50	1.50	15.15	5.50	6.50	2.77	.....	.....
1874	4.40	4.75	3.65	12.95	2.55	1.55	3.10	1.10	7.75	0.25	1.25	3.35	64.65
1875	4.25	3.45	5.35	2.75	1.30	3.70	3.00	11.35	1.45	1.15	2.60	3.00	46.65
1876	1.20	2.85	5.15	2.45	4.65	2.75	2.55	2.35	6.10	1.00	2.36	1.15	43.35
1877	0.95	1.05	3.30	3.40	2.55	1.85	3.20	1.00	4.05	3.60	3.55	1.20	29.70
1878	2.40	1.80	2.50	2.90	4.80	2.70	1.75	4.50	0.75	2.15	3.40	2.50	32.15
1879	2.80	2.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Means	2.52	4.06	4.94	4.23	4.27	2.12	3.67	6.54	4.77	3.67	3.44	3.36	47.59
Greatest monthly	4.40	8.75	12.80	12.95	9.82	3.70	10.60	15.15	7.75	11.01	6.62	6.70	88.51
Least monthly	0.53	1.05	1.86	1.45	1.30	0.50	1.50	1.00	0.75	0.25	1.25	1.15	29.70

Hall, 0.10 inch, February, 1901; Cherryfields, 0.58 inch, in September, 1897; Leonardtown, 0.05 inch, in December, 1889; St. Mary's, 0.27 inch, in August, 1863, and St. Inigoes, 0.25 inch, in October, 1874. The difference between the spring and summer rains is not very great, and autumn and winter are likewise very close.

The figures given in the precipitation tables show that while insufficient rainfall for the requirement of crops is likely to occur during almost any month of the growing season, an entire failure of crops on account of drought is impossible; at no station are two months in succession found with less than one inch of rainfall, and usually the amount is abundant at all seasons of the year. The summer months are likely at all times to show a greater variability in amount than the winter months, because the rainfall of summer is usually in the form of local showers or thunder-

storms, which often occasion heavy downpours over limited areas during brief periods of time, while in winter, rains are general over the State, and are necessarily less in amount.

For further details in regard to the climate of St. Mary's County, reference is made to the following brief sketch of the Climatology of Charlotte Hall.

THE CLIMATOLOGY OF CHARLOTTE HALL

Latitude, 38° 28′ N.; longitude, 76° 47′ W.; elevation, 167 feet. Observer, Prof. J. Francis Coad, 1893 to 1904.

INTRODUCTORY.

The station is situated in the northwest portion of St. Mary's County in the region of the greatest elevation of the land, on the line of the Washington, Potomac, and Chesapeake Railway. It is on a level plateau of considerable extent, lying between the headwaters of Trent Hall Creek and Gilbert Swamp. An exact description of the position of the instruments cannot be given; they were probably suitably located in the vicinity of the school in which Prof. Coad was an instructor. At present the instruments are exposed in a standard shelter in the garden south of the rectory of Trinity Glebe, about two miles from Charlotte Hall. The shelter is over sod, and the door opens towards the north; the thermometers are about 4 feet from the ground. The nearest woods are about 400 feet south of the shelter, and there are no large bodies of water in the vicinity.

For the convenience of the investigator it is advisable to adopt a uniform method of presenting the statistical material available for important individual stations, where this is possible. For Charlotte Hall records are available for 109 months, or 9 years, but observations were not continuous throughout each year, except in 1895, 1897, 1898, and 1900. The main features of the climate of this station are presented in the meteorological summary by months in Table XIV. Other details are given in the usual manner, in Tables XV to XXIII.

TABLE XIV.

METEOROLOGICAL SUMMARY BY MONTHS AT CHARLOTTE HALL, MD.

(Averages of 9 years from 1892 to 1904.)

Data.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Monthly Mean Temperatures	34.0	33.4	44.5	53.0	64.6	73.0	77.0	76.2	70.6	57.4	46.0	37.1	55.6
Highest Monthly Means	38.6	37.7	49.0	57.8	69.7	76.5	78.6	81.8	74.3	63.2	54.0	41.6	56.9
Lowest Monthly Means	29.8	25.8	39.2	49.8	62.5	69.7	73.4	73.8	66.2	51.0	39.7	30.7	54.6
Range	8.8	11.9	9.8	8.0	7.2	6.8	5.2	8.0	8.1	12.2	14.3	10.9	2.3
Highest Temperatures.	68	70	83	97	95	100	102	102	100	90	78	70	102
Year	1901	1898	1894	1896	1895	1893	1898	1900	1895	1900	1895	1896	1898
Date	9	12[1]	19[1]	19	31[1]	20	3	11	19[1]	6	21[1]	7[1]	July 3[1]
Means of the Highest Temperatures	61.9	65.8	75.6	86.5	91.7	95.5	97.1	96.6	95.0	84.1	75.2	64.6	82.5
Lowest Temperatures	−1	−19	11	25	35	41	42	52	39	23	16	2	−19
Year	1899	1899	1900	1896	1900	1894	1903	1894	1899	1895	1903	1901	1899
Date	2	11	18	9[1]	10	1	17	22[1]	28	29	26[1]	22	Feb. 11
Means of the Lowest Temperatures	8.4	2.4	18.2	27.3	38.2	47.3	50.2	54.0	42.1	29.8	21.5	9.9	29.1
Monthly Mean Maximum Temperatures	43.8	43.0	55.1	64.4	76.5	84.1	87.5	87.5	82.4	68.6	56.6	47.7	66.4
Highest Monthly Mean Maximum Temp.	47.3	47.8	59.9	70.3	81.3	88.8	90.9	95.1	86.4	74.8	64.4	53.5	71.7
Lowest Monthly Mean Maximum Temp.	39.7	35.4	49.8	60.1	73.2	79.0	84.1	82.8	78.9	64.4	50.5	40.5	61.5
Range	7.6	12.4	10.1	10.2	8.1	9.8	6.8	12.3	7.5	10.4	13.9	13.0	10.2
Monthly Mean Minimum Temperatures	24.8	22.9	33.9	41.9	53.5	61.2	65.4	65.0	58.8	46.2	35.4	27.5	44.7
Highest Monthly Mean Minimum Temp.	30.0	29.8	38.2	45.4	58.8	64.2	68.4	68.6	62.5	51.6	43.5	38.9	50.0

Lowest Monthly Mean Minimum Temp.....	20.0	16.3	28.4	39.5	49.7	60.2	58.1	62.0	53.6	37.7	28.9	20.9	39.6
Range	10.0	13.5	9.8	5.9	9.1	4.0	10.3	6.6	8.9	13.9	14.6	18.9	10.4
Absolute Range of Extremes	69	89	72	72	60	59	60	50	61	67	62	68	121
Greatest Daily Range of Temperatures.....	36	40	44	48	43	42	41	39	39	41	41	47	48
Means of the Greatest Daily Ranges.....	33.5	36.6	37.3	39.0	38.5	34.8	32.9	31.8	34.9	35.9	33.8	34.9	35.3
Mean Daily Range in Temperatures.....	19.0	20.1	21.2	22.5	23.0	22.9	22.1	22.5	23.6	22.4	21.2	20.2	21.7
Number of times Max. Temp. was above 90°	0	0	0	0	4	8	9	9	7	0	0	0	37
Number of times Min. Temp. was below 32°	23	21	12	3	0	0	0	0	0	2	11	20	92
Monthly Total Precipitation	3.13	3.26	3.02	3.86	3.33	2.89	4.09	2.69	2.64	3.66	1.85	2.32	36.79
Percentage of Annual	9%	9%	8%	10%	9%	8%	11%	7%	7%	10%	5%	6%	100%
Greatest Monthly Amount	4.15	5.75	4.61	7.08	4.98	5.18	6.78	5.58	4.79	6.21	3.19	4.10	7.08
Least Monthly Amount	1.75	0 10	0.91	1.03	1.16	1.06	2.82	0.94	0.95	0.93	1.08	0.34	0.10
Greatest Precipitation in 24 Hours	2.10	3.00	1.40	3.67	1.93	2.56	2.72	1.74	2.40	2.20	1.36	3.00	3.67
Year.....	1901	1899	1895	1895	1897	1900	1900	1893	1900	1897	1901	1894	1895
Date.....	11	12-13	2	8	13	17-18	12	12	15	25	23	26	Apl. 8
Mean Snowfall (unmelted).....	4.0	8.8	1.2	T	0	0	0	0	0	0	0.4	2.3	16.7
Greatest Monthly	14.0	39.5	6.0	T	0	0	0	0	0	0	2.0	4.0	51.0
Least Monthly	T	T	0	0	0	0	0	0	0	0	0	0	1.5
Prevailing Winds.....	NW	NW	NW	NW	NW	SW	W	W	S.	NW	NW	NW	NW
Number of Days Clear	13	15	12	13	13	10	14	16	19	17	14	16	172
Number of Days Partly Cloudy	8	7	11	12	13	13	13	11	8	8	11	7	122
Number of Days Cloudy	10	6	8	5	5	7	4	4	3	6	5	8	71
Number of Days Rainy	6	6	8	8	9	7	9	7	4	5	4	5	78

[1] On other dates also.

THE TEMPERATURE CONDITIONS.

Attention has already been invited to the fact that the mean temperatures for Charlotte Hall, during the period from 1892 to 1904 cannot be considered as normal for the region; they represent the conditions prevailing during a pèriod which careful examination shows to have been deficient in temperature as compared with the true normal. The

TABLE XV.

MONTHLY AND ANNUAL MEAN TEMPERATURES AT CHARLOTTE HALL, MD., 1892-1905.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1892.	31.0	37.7	.....	52.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
1893.	.....	.....	.....	.....	.....	76.5	.....	75.0	.....	56.6	44.6	39.5	.....
1894.	38.6	36.0	48.7	52.2	.....	73.6	77.6	74.2	72.2	58.0	44.0	37.6	.....
1895.	32.8	25.8	43.2	54.2	62.5	75.2	73.4	78.7	73.8	51.0	46.0	38.0	54.6
1896.	33.6	36.8	39.2	57.8	69.7	70.8	77.0	76.8	.....	55.5	54.0	38.4	.....
1897.	33.2	37.4	47.0	54.6	63.6	69.7	76.0	73.8	69.4	59.0	48.5	41.4	56.1
1898.	38.3	35.6	49.0	51.2	64.8	73.0	78.1	76.4	71.5	58.3	45.1	34.2	56.3
1899.	34.2	29.6	44.3	.....	64.7	.....	.....	75.7	66.6	58.9	45.6	41.6	.....
1900.	36.3	34.2	39.6	53.3	64.2	72.0	78.6	81.8	74.3	63.2	49.2	36.0	56.9
1901.	34.4	31.8	45.8	49.8	63.0	.....	.....	.....	.....	54.6	.....	33.8	.....
1902.	31.6	29.1	.....	.....	6.40	.....	78.6	73.8	.....	58.8	39.7	.....	.....
1903.	.....	.....	.....	.....	.....	.....	.....	.....	66.2	57.4	43.0	30.7	.....
1904.	29.8	.....	43.3	51.9	65.0	.....	.....	.....	.....	.....	.....	.....	.....
1905.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Means.	34.0	33.4	44.5	53.0	64.6	73.0	77.0	76.2	70.6	57.4	46.0	37.1	55.6
Highest Means.	38.6	37.7	49.0	57.8	69.7	76.5	78.6	81.8	74.3	63.2	54.0	41.6	56.9
Lowest Means.	29.8	25.8	39.2	49.8	62.5	69.7	73.4	73.8	66.2	51.0	39.7	30.7	54.6
Range.	8.8	11.9	9.8	8.0	7.2	6.8	5.2	8.0	8.1	12.2	14.3	10.9	2.3

deficiency resulted from the occurrence of several severe winters in rapid succession, namely, in 1895, 1899, and 1904.

The annual mean temperature at Charlotte Hall is 55.6°; this is 1.1° lower than the mean for Solomons, which is farther south and nearer the waters of the Bay. The variation in the monthly mean temperatures is considerable. The coldest month is February, with a mean of 33.4°; the warmest is July, with 77.0°, giving a mean annual range of 43.6°. February in 1895, 1899, and 1902 was very cold. The variations in the monthly means during warm summers and cold winters are better adapted to show the possible fluctuations in temperature in this region. In August, 1900, the mean temperature at Charlotte Hall was 81.8°,

the highest mean on record. The lowest, 25.8°, occurred in February, 1895, giving a range in monthly means of 56.0°.

TABLE XVI.

HIGHEST TEMPERATURES AT CHARLOTTE HALL, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1893	.....	.....	.....	.....	.....	100	100	96	.....	77	73	68	100
1894	58	68	83	84	.....	99	98	95	99	85	70	58	99
1895	62	65	70	87	95	.....	94	99	100	76	78	68	100
1896	59	64	70	97	95	89	95	98	.....	85	77	70	98
1897	64	63	80	90	85	92	90	90	92	88	78	70	92
1898	66	70	81	86	94	98	102	97	99	88	74	61	102
1899	60	.....	75	.....	92	.....	.....	97	95	88	73	67	.....
1900	66	70	69	84	95	95	100	102	100	90	78	65	102
1901	68	61	78	82	88	.....	.....	.....	.....	83	84	66	.....
1902	52	61	.....	.....	90	.....	100	95	.....	81	.....	.....	100
1903	.....	.....	.....	.....	.....	.....	95	.....	90	89	77	53	.....
1904	64	61	74	82	91	.....	.....	.....	.....	.....	.....	.....	.....
Means	61.9	65.8	75.6	86.5	91.7	95.5	97.1	96.6	95.0	84.1	75.2	64.6	82.5
Highest	68	70	83	97	95	100	102	102	100	90	78	70	102
Year	1901	1898	1894	1896	1895	1893	1898	1900	1895	1900	1895	1896	1898
Date	9	12[1]	19[1]	19	31[1]	20	8	11	19[1]	6	21[1]	7[1]	3[1]

[1] On other dates also.

TABLE XVII.

LOWEST TEMPERATURES AT CHARLOTTE HALL, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1893	.....	.....	.....	.....	.....	51	.....	53	.....	29	18	5	.....
1894	17	15	15	26	....	41	49	52	47	33	20	7	7
1895	10	− 5	22	29	38	.....	53	52	44	23	23	13	− 5
1896	5	5	13	25	38	49	55	52	.....	33	29	14	5
1897	5	16	26	32	42	45	58	57	43	36	24	14	5
1898	19	2	21	25	37	48	49	55	40	28	23	10	2
1899	− 1	−19	18	.....	36	.....	.....	57	39	27	19	14	−19
1900	7	3	11	27	35	50	55	55	42	30	19	11	3
1901	8	10	18	29	39	.....	.....	.....	.....	30	19	2	2
1902	11	1	.....	.....	38	.....	56	53	.....	27	.....	.....	1
1903	.....	.....	.....	.....	.....	.....	42	.....	40	32	16	9	.....
1904	3	− 4	20	25	41	.....	.....	.....	.....	.....	.....	.....	− 4
Means	8.4	2.4	18.2	27.3	38.2	47.3	50.2	54.0	42.1	29.8	21.5	9.9	29.1
Lowest	− 1	−19	11	25	35	41	42	52	39	23	16	2	−19
Year	1899	1899	1900	1896	1900	1894	1903	1894	1899	1895	1903	1901	1899
Date	2	11	18	9[1]	10	1	17	22[1]	28	29	26[1]	22	Feb. 11

[1] On other dates also.

The mean temperature of spring is 54°, of summer, 75°; autumn, 58°, and winter, 38°. Here also autumn is 4° degrees warmer than spring.

Tables XVIII and XIX give the means of the maximum and minimum temperatures at Charlotte Hall. The mean maximum temperature

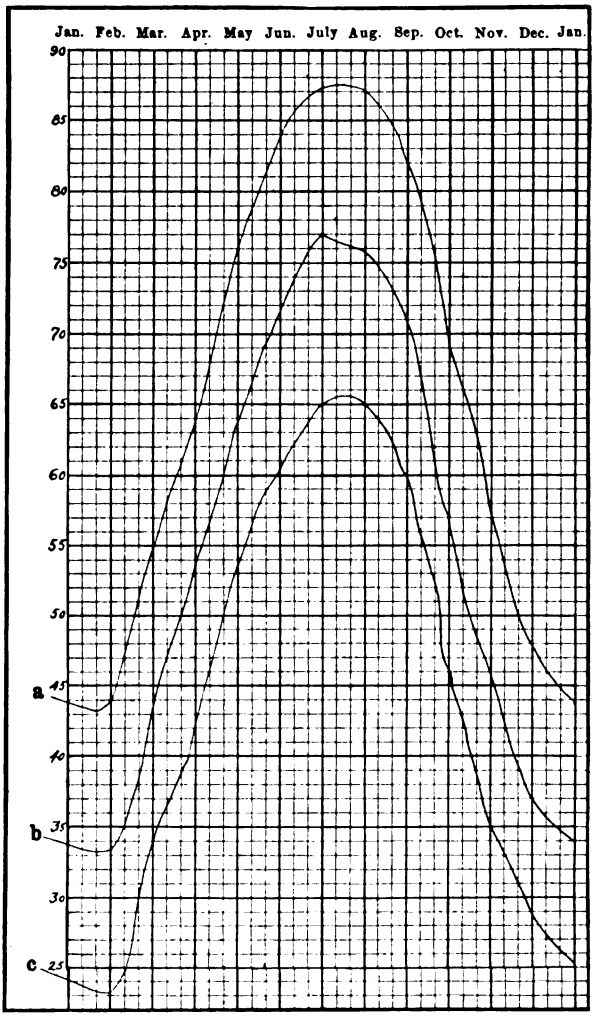


FIG. 9.—Temperature curves for Charlotte Hall. (a) mean maximum, (b) average, (c) mean minimum.

is found to be 66.4°, the mean minimum, 44.7°; therefore the mean daily range of temperature is 21.7°. The mean maximum temperature occasionally exceeds 90° and reached the rather high figure 95.1° in

August, 1900, but the record for that month is somewhat incomplete. Mean minimum temperatures below 20.0° were recorded in February, 1895 (mean 16.3°), and February, 1899 (mean 17.6°).

TABLE XVIII.

MEAN MAXIMUM TEMPERATURES AT CHARLOTTE HALL, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1893	.....	.....	.....	.....	.....	88.8	.....	86.7	.....	66.3	53.4	50.1	.....
1894	47.3	44.7	59.9	63.5	.....	87.1	89.4	84.3	81.8	68.3	52.4	46.4	.....
1895	41.2	35.4	53.5	64.8	73.2	.....	84.6	91.0	86.0	64.4	55.9	48.7	.....
1896	42.0	47.3	49.8	70.3	81.3	80.0	85.6	86.9	.....	65.3	64.4	49.3	.....
1897	41.6	45.0	57.1	65.4	73.6	79.0	84.1	82.8	79.4	67.5	58.4	50.4	65.4
1898	47.0	47.8	59.9	62.7	76.1	85.9	89.1	89.0	85.0	70.7	56.2	45.0	67.9
1899	45.4	41.5	54.7	.....	77.1	.....	.....	85.8	79.0	71.1	58.6	53.5	.....
1900	47.1	45.6	50.9	65.6	78.8	83.6	90.9	95.1	86.4	74.8	60.5	48.3	69.0
1901	45.8	42.4	57.0	60.1	74.4	.....	.....	.....	.....	68.1	50.5	45.0	.....
1902	41.2	36.9	.....	.....	76.5	.....	89.9	85.7	.....	69.8	.....	.....	.....
1903	.....	.....	.....	.....	.....	.....	86.2	.....	78.9	68.2	55.4	40.5	.....
1904	39.7	.....	52.8	62.6	77.9	.....	.....	.....	.....	.....	.....	.....	.....
Means	43.8	43.0	55.1	64.4	76.5	84.1	87.5	87.5	82.4	68.6	56.6	47.7	66.4
Highest Mean	47.3	47.8	59.9	70.3	81.3	88.8	90.9	95.1	86.4	74.8	64.4	53.5	71.7
Lowest Mean	39.7	35.4	49.8	60.1	73.2	79.0	84.1	82.8	78.9	64.4	50.5	40.5	61.5
Range	7.6	12.4	10.1	10.2	8.1	9.8	6.8	12.3	7.5	10.4	13.9	13.0	10.2

TABLE XIX.

MEAN MINIMUM TEMPERATURES AT CHARLOTTE HALL, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1893	.....	.....	.....	.....	.....	64.2	.....	63.4	.....	46.9	35.9	38.9	.....
1894	30.0	27.3	37.5	40.9	.....	60.2	65.7	65.6	62.5	47.8	35.7	28.9	.....
1895	24.4	16.3	33.0	43.7	58.8	.....	62.2	66.4	61.5	37.7	36.2	27.4	.....
1896	25.2	26.4	28.7	45.4	58.1	61.6	68.4	66.6	.....	45.7	43.5	27.5	.....
1897	24.7	29.8	37.0	43.9	53.5	60.4	68.0	64.9	59.3	50.5	38.6	32.4	46.9
1898	29.6	23.4	38.2	39.7	53.5	60.2	67.2	63.9	58.0	45.9	34.0	23.4	44.8
1899	23.9	17.6	33.8	.....	52.3	.....	.....	65.6	54.2	46.9	32.6	29.6	.....
1900	25.5	22.8	28.4	41.0	49.7	60.3	66.3	68.6	62.2	51.6	38.0	23.8	44.8
1901	23.1	21.1	34.7	39.5	51.6	.....	.....	.....	.....	41.2	28.9	22.6	.....
1902	22.1	21.3	.....	.....	51.6	.....	67.2	62.0	.....	47.7	.....	.....	.....
1903	.....	.....	.....	.....	.....	.....	58.1	.....	53.6	46.6	30.5	20.9	.....
1904	20.0	.....	33.8	41.2	52.2	.....	.....	.....	.....	.....	.....	.....	.....
Means	24.8	22.9	33.9	41.9	53.5	61.2	65.4	65.0	58.8	46.2	35.4	27.5	44.7
Highest Mean	30.0	29.8	38.2	45.4	58.8	64.2	68.4	68.6	62.5	51.6	43.5	38.9	50.0
Lowest Mean	20.0	16.3	28.4	39.5	49.7	60.2	58.1	62.0	53.6	37.7	28.9	20.9	39.6
Range	10.0	13.5	9.8	5.9	9.1	4.0	10.3	6.6	8.9	13.9	14.6	18.9	10.4

The curves of mean temperature and of mean maximum and mean minimum for Charlotte Hall are given in Fig. 9, which conveniently shows the range in average values for this station.

The extremes of temperature are slightly greater in this section of the country than farther south. It is to be observed that a comparison of the extremes at Baltimore and at most co-operative stations is scientifically not admissible; the thermometers at Baltimore are placed 80 feet above the ground, while at nearly all co-operative stations they are at an average elevation of about 5 feet. The extremes both of summer heat and winter cold are diminished with elevation above the earth's surface, although the mean temperature between 5 and 60 feet will

TABLE XX.

NUMBER OF TIMES MAXIMUM TEMPERATURES WAS ABOVE 90° AND MINIMUM BELOW 32° AT CHARLOTTE HALL, MD.

Maximum Temperature above 90°.							Minimum Temperature below 32°.								
Year.	May.	June.	July.	August.	Sept.	Annual.	Year.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	Annual.
1894 ...	.....	12	16	6	4	.....	1894 ...	0	12	19	17	20	9	3	80
1895 ...	3	.....	5	18	10	.....	1895 ...	8	12	19	26	25	14	2	106
1896 ...	6	0	5	11	.....	.....	1896 ...	0	5	20	25	17	19	5	91
1897 ...	0	1	0	0	2	3	1897 ...	0	6	14	25	16	5	0	66
1898 ...	2	10	11	13	10	45	1898 ...	2	12	23	18	23	12	8	98
1899 ...	3	.....	.....	7	2	.....	1899 ...	2	16	.....	25	22	9	..	.....
1900 ...	6	.....	16	.....	14	.....	1900 ...	1	9	27	.....	19	18	3	.....
1901 ...	0	.....	.....	.....	.....	.....	1901 ...	1	20	20	.....	23	11	1	.....
Means	4	8	9	9	7	37	Means	2	11	20	23	21	12	3	92

hardly vary a tenth of a degree (Hann). On clear, cold nights the temperature at 5 feet elevation may be from 5° to 10° lower than it is at 80 feet. The minimum temperatures in winter are lower at co-operative stations than would appear to be correct if comparison be made with the temperatures recorded at Baltimore.

During the past few years the range of extremes at Charlotte Hall, in common with most other stations in Maryland has been quite remarkable. The summer of 1900 was one of extraordinary warmth throughout the eastern United States, while the preceding February (1899) was extremely cold. During the warm wave of August, 1900, the maximum at Charlotte Hall reached 102°, on the 11th; while during the cold wave of February, 1899, the lowest temperature was 19° below zero, the ground being covered with snow. During this cold wave the lowest tem-

perature recorded in the history of the Baltimore station occurred on the 10th, 7° below zero. On this occasion there was consequently an inversion of temperature (a rise of temperature with elevation instead of the normal fall) showing that the cold air occupied a relatively thin layer near the ground. Maximum temperatures above 100° are not very frequently observed at Charlotte Hall, though this figure was reached once in June and once in July, 1893, also in July, 1898, 1900, 1902, and in

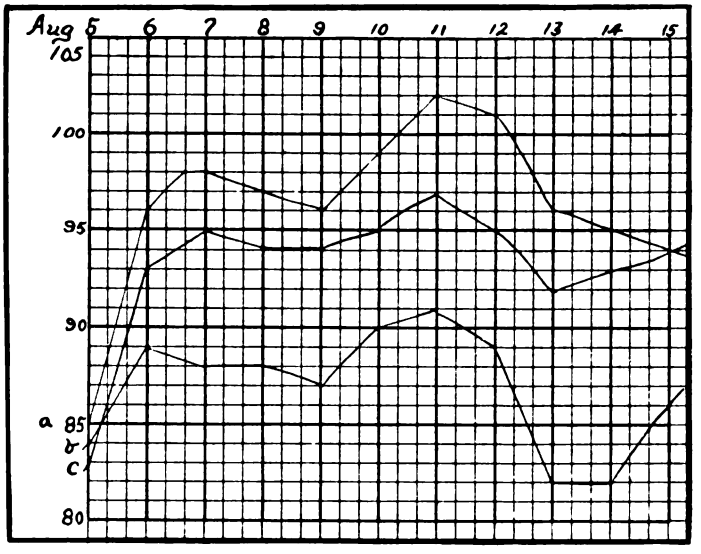


FIG. 10.—The warm wave of August, 1900, at—(a) Charlotte Hall, (b) Grantsville, (c) New Market.

September, 1900. Temperatures below zero were also experienced in February, 1895 (5° below zero on the 6th), and in January, 1899 (1° below zero on the 2d).

Duration of Warm Waves.

The maximum temperature exceeds 90° on the average 37 times per annum at Charlotte Hall; at Solomons only 20 times, showing the influence of the inland location of the former station. The record of maximum temperatures is somewhat broken, so that the following table of dates, on which the maximum was 95° or above, is not complete.

Dates on which the temperature was 95° or above at Charlotte Hall:

1893.—June 4, 5, 10, 19, 20, 25;[1] July 2, 8, 12, 13, 14, 15, 26, 30;[1] August 25.
1894.—June 23, 24, 25; July 12, 13, 14, 19, 20, 26, 27, 29; August 9; September 9, 10.
1895.—May 31; June;[1] August 9, 10, 11, 12, 15, 16, 24, 28, 29, 30; September 12, 19, 20, 21, 22, 23.
1896.—May 9, 18, 19; July 27; August 5, 6, 7, 8, 9, 10, 11, 12, 13.
1897.—None.
1898.—June 12, 25, 26, 28; July 1, 2, 3, 4, 18, 19, 20, 29, 30; August 1, 2, 3, 4, 7, 8, 23, 31; September 1, 2, 3, 4, 5, 6, 7, 18.
1899.—June;[1] July;[1] August 5, 20, 21; September 6.
1900.—May 15; June 3, 4, 5, 6, 7, 8, 15, 16, 17, 18, 19; August 6, 7, 8, 9, 10, 11, 12, 13, 14, 26, 27;[1] September 1, 5, 6, 7, 8, 9, 10, 11.
1901 to 1904.[1]

[1] Record incomplete.

The actual record for the August, 1900, "hot wave," 6th to 14th, is represented in comparison with other stations in Fig. 10. The temperatures recorded were: 6th, 96°; 7th, 98°; 8th, 97°; 9th, 96°; 10th, 99°; 11th, 102°; 12th, 101°; 13th, 96°; 14th, 95°. The September record was also rather remarkable, viz.: September 5th, 95°; 6th, 96°; 7th, 100°; 8th, 98°; 9th, 95°; 10th, 96°, 11th, 99°.

Duration of Cold Periods.

The minimum temperature at Charlotte Hall falls below the freezing point of water on the average 92 times in the year, as compared with 68 times at Solomons. During the cold winter of 1895 it was below freezing 106 times. The average number of times with a minimum below 32° is 20 days in December, 23 in January, and 21 in February. The frequency of freezing temperatures in April and October is also slightly higher than for other portions of the county.

The following record of the dates on which the minimum temperature was below 20° is also somewhat incomplete.

Days on which minimum temperature was below 20° at Charlotte Hall:

1893.[1]—December 2, 3, 5, 14, 21.
1894.—January 13, 28; February 2, 5, 6, 17, 24, 25, 28; March 27, 28; November 29; December 28, 29, 30.
1895.—January 1, 2, 5, 13, 14, 20, 24, 25, 30; February 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 23, 24; December 4, 6, 12, 13, 14, 15, 16, 17.

[1] Indicated record incomplete.

1896.—January 2, 4, 5, 6, 7, 11, 12, 15, 16; February 17, 18, 19, 20, 21, 22, 26; March 13, 14, 25; December 3, 4, 5, 22, 23, 24, 30.

1897.—January 7, 8, 9, 13, 25, 26, 27, 28, 29, 30, 31; February 1, 28; December 24, 25.

1898.—January 2, 4; February 1, 2, 3, 4, 5, 7, 17, 26, 27; December 2, 8, 9, 10, 12, 13, 14, 15, 16.

1899.—January 1, 2, 3, 8, 11, 19, 20, 27, 28, 29, 30, 31; February 1, 2, 3, 8, 9, 10, 11, 12, 13, 14, 15, 25; March 6, 8, 9; December 7, 17, 21, 26.

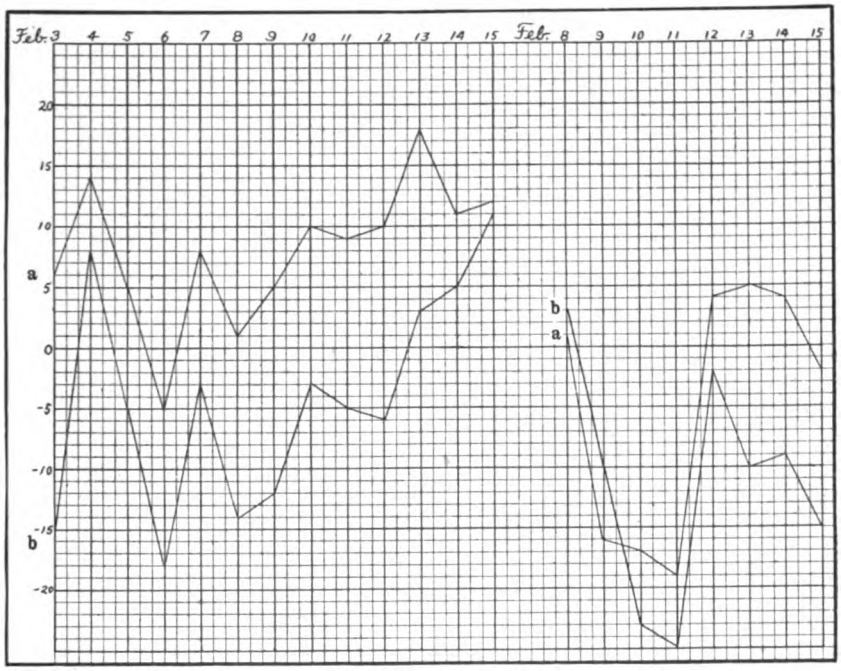


FIG. 11.—Minimum temperatures during the cold waves of February, 1895, and 1899, at—(a) Charlotte Hall, (b) Deer Park.

1900.—January[1] 2, 3, 27, 29, 31; February 1, 2, 3, 18, 19, 20, 25, 26, 27, 28; March 12, 13, 17, 18, 22; December 11, 12, 14, 15, 16, 17, 21, 22, 28, 29.

1901.—January[1] 3, 4, 5, 6, 13, 18, 19, 20; February 1, 2, 6, 7, 8, 11, 12, 13, 14, 19, 20, 21, 23, 25, 28;[1] March 6; November 20, 21, 22, 28, 29; December 4, 5, 6, 7, 8, 15, 16, 17, 18, 19, 20, 21, 22.

1902.—January[1] 7, 13, 14, 15, 17, 19, 20, 27 28, 29, 30, 31; February[1] 3, 4, 5, 6, 8, 9, 11, 12, 13, 14, 15, 19, 20; December.[1]

1903.[1]

1904.[1]—January[1] 3, 4, 5, 6, 8, 10, 12, 15, 18, 19, 20; February;[1] March 5, 29.

[1] Record incomplete.

The longest consecutive period of cold weather occurred in February, 1895; during that month the temperature was 32° or below on 25 days, and 20° or below from the 3d to 15th, as follows:

3d, 6°; 4th, 14°; 5th, 5°; 6th, — 5°; 7th, 8°; 8th, 1°; 9th, 5°; 10th, 10°; 11th, 9°; 12th, 10°; 13th, 18°; 14th, 11°; 15th, 12°. The following is the record for the cold wave of February, 1899 (temperatures 20° or below): 8th, — 1°; 9th — 16°; 10th, — 17°; 11th, — 19°; 12th, 4°; 13th, 5°; 14th, 4°; 15th, — 2°.

These two remarkable cold waves are illustrated graphically in Fig. 11.

Duration of the Crop Season.

The date of the last killing frost in spring averages somewhat later than at Solomons, the mean for eight years being April 15; the average date of the first killing frost in autumn is October 17, 27 days earlier than at Solomons. While the record for Charlotte Hall is not very complete, the figures, nevertheless, indicate that the proximity of the waters of the Bay lengthens the growing season, which is 6 months and 2 days at Charlotte Hall, as compared with 6 months and 21 days at Solomons. A light frost has occurred at Charlotte Hall as late as May 26 (1899), with a minimum temperature of 36°. The earliest light frost was apparently that of September 30, 1895.

The following table gives the dates of the first and last killing frosts as far as available:

KILLING FROSTS.

	Last in Spring.	First in Autumn.
1893		October 17.
1894	April 12.	October 15.
1895	April 12.	October 10.
1896	April 9.	October 25.
1897	April 21.	November 13.
1898	April 28.	October 24.
1899		October 2.
1900	April 15.	October 17.
1901	April 5.	October 16.
1902		October 30.
1903		October 27.
1904	April 22.	

PRECIPITATION.

The exigencies of Prof. Coad's private affairs necessitated his frequent absence from station, with the unfortunate result that the records of

TABLE XXI.

MONTHLY AND ANNUAL PRECIPITATION AT CHARLOTTE HALL, MD., 1892-1904.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1892	4.03	.....	3.76	4.47	.....	.....	.....	.....	.....	.....	.....	.....	.....
1893	.....	.....	.....	.....	.....	1.06	3.66	1.48	.....	4.48	.....	2.51	.....
1894	2.11	3.46	0.91	3.10	.....	1.15	2.91	2.79	2.04	..15	1.65	1.64	.....
1895	3.62	1.38	3.28	6.65	4.68	3.99	3.25	1.59	.....	2.65	2.20	1.97	.....
1896	1.89	4.87	3.82	1.03	1.16	4.38	2.82	0.94	.....	....	1.08	0.34	.....
1897	1.75	5.03	2.52	2.33	4.69	2.69	6.78	3.04	0.95	6.21	3.19	2.98	42.16
1898	3.30	1.10	4.33	3.42	4.98	1.76	4.27	4.00	1.69	2.96	2.40	2.73	36.94
1899	4.15	5.75	4.61	.....	3.21	.....	.....	5.58	4.36	4.39	1.41	1.75	.....
1900	3.54	4.44	2.05	3.55	1.79	5.18	5.44	2.07	4.79	2.62	1.89	2.89	40.25
1901	3.43	0.10	2.40	7.08	4.70	.....	.....	.....	.....	0.98	1.53	4.10	.....
1902	3.45	3.19	.....	.....	3.69	.....	.....	.....	.....	4.32	.....	.....	.....
1903	.....	.....	.....	.....	.....	.....	3.61	.....	2.02	4.89	1.26	.....	.....
1904	.....	.....	2.54	3.15	1.52	.....	.....	.....	.....	.....	.....	.....	.....
Means	3.13	3.26	3.02	3.86	3.38	2.89	4.09	2.69	2.64	3.66	1.85	2.82	36.79
Greatest amount	4.15	5.75	4.61	7.08	4.98	5.18	6.78	5.58	4.79	6.21	3.19	4.10	7.08
Least amount	1.75	0.10	0.91	1.03	1.16	1.06	2.82	0.94	0.95	0.98	1.08	0.34	0.10
Difference	2.40	5.65	3.70	6.05	3.82	4.12	3.96	4.64	3.84	5.33	2.11	3.76	6.98

TABLE XXII.

GREATEST PRECIPITATION IN 24 HOURS AT CHARLOTTE HALL, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1893	.....	.....	.....	.....	.....	0.52	1.80	0.58	.....	2.02	.....	0 70	.....
1894	1.00	1.07	0.26	1.09	.....	0.60	1.22	1.08	1.00	1.98	0.50	3.00	3.00
1895	1.02	0.50	1.40	3.67	1.12	.....	0.90	0.49	.....	1.28	0.68	1.10	3.67
1896	1.57	1.98	1.00	0.83	0.30	0.71	0.62	0.35	.....	.....	0.96	0.24	.....
1897	1.04	1.60	0.96	0.75	1.93	1.30	1.42	1.03	0.95	2.20	1.32	1.33	2.20
1898	0.76	0.86	0.92	1.21	1.52	0.54	1.98	1.74	1.45	0.72	0.69	0.80	1.98
1899	1.16	3.00	0.96	.....	1.00	.....	.....	1.63	1.83	2.20	0.86	0.90	3.00
1900	1.13	1.60	0.50	2.15	0.68	2.56	2.72	1.38	2.40	1.85	1.00	1.95	2.72
1901	2.10	0.10	0.80	2.50	0.95	.....	.....	.....	.....	0.35	1.36	1.30	.....
1902	1.25	1.20	.....	.....	1.52	.....	.....	0.59	.....	1.62	.....	.....	.....
1903	.....	.....	.....	.....	.....	.....	0.80	.....	1.00	1.29	0.82	.....	.....
1904	.....	.....	0.67	1.50	0.75	.....	.....	.....	.....	.....	....	.....	.....
Greatest Amount	2.10	3.00	1.40	3.67	1.93	2.56	2.72	1.74	2.40	2.20	1.36	3.00	3.67
Year	1901	1899	1895	1895	1897	1900	1900	1898	1900	1897	1901	1894	1895
Date	11	12-13	2	8	13	17-18	12	12	15	25	23	26	Ap. 8

rainfall at the station are much broken, especially during the summer months. It is probable that the averages found are slightly too low even for the period covered; certainly the mean for August (2.69 inches for 8 months) is rather low.

The precipitation for the interior of St. Mary's County may be expected to be somewhat smaller than the average for the county, and the record for Charlotte Hall may be accepted as fairly correct as a whole. The annual total for 9 years is 36.79 inches. The complete record for Solomons gives 39.05 inches. The station has not received a total of 10.00 during any month, the maximum record being 7.08 inches in April, 1901. Amounts less than 1.00 inch are not uncommon. The smallest total was 0.10 inch in February, 1901.

TABLE XXIII.

MONTHLY AND ANNUAL SNOWFALL (UNMELTED) AT CHARLOTTE HALL, MD.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1894	T	7.5	0	T	0	0	0	0	0	0	0	4.0	11.5
1895	14.0	13.5	T	0	0	0	0	0	0	0	T	3.5	31.0
1896	T	T	2.0	0	0	0	0	0	0	0	0.5	1.0	3.5
1897	6.5	7.0	0	0	0	0	0	0	0	0	0	T	13.5
1898	4.0	0.2	0	T	0	0	0	0	0	0	2.0	1.5	7.7
1899	6.0	39.5	6.0	0	0	0	0	0	0	0	0	0	51.0
1900	1.0	8.0	3.0	0	0	0	0	0	0	0	T	3.0	15.0
1901	T	T	T	0	0	0	0	0	0	0	T	1.5	1.5
1902	4.5	3.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Means	4.0	8.8	1.2	T	0	0	0	0	0	0	0.4	2.3	16.7
Greatest monthly	14.0	39.5	6.0	T	0	0	0	0	0	0	2.0	4.0	51.0
Least monthly	T	T	0	0	0	0	0	0	0	0	0	0	1.5

The largest average rainfall is found in July, when the normal is 4.09 inches, or 11 per cent of the annual total; the least occurs in November, with but 5 per cent of the annual amount.

The record of average, maximum and minimum precipitation is shown graphically in Fig. 12.

Excessive precipitation is even less frequent in the interior of this region than along the coast. At Charlotte Hall a fall exceeding 2.50 inches in 24 hours has been recorded in February, 1899 (3.00 inches), in April, 1895 (3.67 inches), in June, 1900 (2.56 inches), in July, 1900 (2.72 inches), and in December, 1894 (3.00 inches). Heavier rains for brief periods were not recorded.

The following were the longest periods of consecutive rainy days:

1896—May 19 to 26 (8 days), amount, 0.72 inch.

1897—July 16, 17, 18, 19, 20, 21, 23, 24, 26, 27, 28, 29 (5.78 inches). October 19, 21, 22, 23, 24, 25 (6 days), 5.22 inches.

1898—August 4 to 12 (7 days), 3.94 inches.

1901—April 19 to 25 (7 days), 1.45 inches. May 25 to 29 (5 days). 2.25 inches.

1903—October 6 to 11 (6 days), 3.79 inches.

The maximum record is found for July, 1897, when 5.78 inches fell during 12 days, with an absence of rain during the period on the 22d

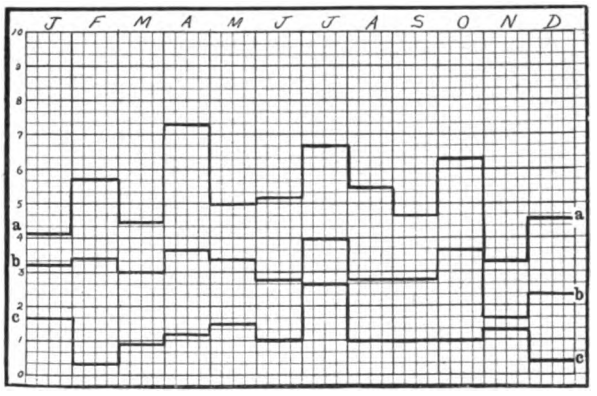


FIG. 12.—Precipitation for each month in the year at Charlotte Hall—(a) greatest, (b) average, (c) least.

and 25th. On the other hand the greatest duration of consecutive days without precipitation was 31 days, from February 4 to March 4, 1901. Other long dry periods occurred in 1893, October 27 to November 20 (24 days), and in 1896, April 2 to April 29 (28 days).

Snowfall (Unmelted).

The snowfall at this station does not greatly differ in amount from that received at Solomons; it occurs under similar circumstances, as regards the path of barometric depressions, and generally with winds in the northeast quadrant. The annual average is about 17 inches. The largest snowfall occurred in 1899, with 51 inches. The fall was

extremely large during February, 1899, which received 39.5 inches, of which 30 inches are supposed to have fallen during 24 hours on the 13th. Very little snow fell in 1896 (3.5 inches), and in 1901 (1.5 inches).

TABLE XXIV.

METEOROLOGICAL STATIONS IN ST. MARY'S COUNTY.

Stations.	Observers.	Period.	Yrs.	Latitude.	Longitude.	Elevation.	Remarks.
Charlotte Hall	R. W. Sylvester..... 1892 Prof. J. Francis Coad.. 1893-1904 Rev. J. Neilson Barry. 1905		9	38° 28′	76° 47′	167 ft.	Means from maximum and minimum temperatures. Records broken.
Cherryfields[1]..	Col. J. Edwin Coad....	1893-1899	5	38° 12′	76° 32′	7 ft.	Means from observations at 8 a.m. and 8 p.m.
Leonardtown .	Dr. Alex. McWilliams Geo. W. Joy.....	1858-1859 1889-1893	1 3	38° 18′	76° 38′	45 ft. 50 ft.	Smithsonian Institution record. Observations at 7 a.m., 2 and 9 p.m. During 1893 from maximum and minimum temperatures.
Porto Bello....	Alpheus Hyatt.....	1905	1	38° 10′	76° 26′	40 ft.	Established Jan. 1. 1905, by Md. State Weather Service.
Ridge.....	T. G. Staggs	1856-1857	1	38° 7′	76° 22′	50 ft.	Smithsonian Institution record. Observations at 7 a.m., 2 and 9 p.m. No rainfall.
St. Inigoes.....	James F. Ellicott.....	1871-1879	7	38° 9′	76° 23′	10 ft.	Smithsonian Institution record. Observations at 7 a.m., 2 and 9 p.m.
St. Mary's City	Rev. Jas. Stephenson.	1857-1870	7	38° 11′	76° 26′	45 ft.	Smithsonian Institution records; not continuous.

[1] P. O. Valley Lee, Md.

WINDS AND WEATHER.

The prevailing winds are from the northwest during winter in St. Mary's County, and from the west and southwest during summer months. The average number of clear days is fairly high. Specific data with regard to the number of thunderstorms, local wind storms, etc., are not available.

THE HYDROGRAPHY OF ST. MARY'S COUNTY

BY
N. C. GROVER

St. Mary's County forms the peninsula of land projecting into Chesapeake Bay, between the Potomac and Patuxent rivers. Although it is nearly surrounded by water, its hydrography is unimportant. Potomac, Wicomico, and Patuxent rivers, which, together with Chesapeake Bay, form its boundaries on all sides, except the northwest, are tidal streams within the limits of this county. The rise and fall of the tide, from Cohouck Point to St. Catherine Island, is about 1.9 feet; from St. Catherine Island to Point Lookout, 1.6 feet; from Point Lookout to Cedar Point, about 1.4 feet; from Cedar Point to Long Point, about 1.5 feet.

The most important streams in the county are Chaptico Creek, McIntosh Run, St. Clement, and St. Mary's rivers. In addition to these four small rivers, there are many smaller creeks along the coast, all of which have the same general characteristics. The basins and beds of the streams are flat, with considerable length of tidal flow. No water power is now utilized in the county, but at one time a small power on St. Mary's River was in use in a flour mill at Clements.

CHAPTICO CREEK.

This small stream is formed near the village of Chaptico by the junction of two branches, one rising near Charlotte Hall and the other near Mechanicsville, and has a total drainage area of 32 square miles. Its basin is composed mostly of timber land, with a few farms on the higher part. The slopes are gentle and the soil is generally sandy. The lower part of the basin is flat, and below the village of Chaptico

is a marsh. The effects of ordinary tide extend a short distance above the highway bridge at Chaptico. The banks of the stream are low and subject to overflow during high water. The velocity of the current is generally quite rapid until tide-water is reached. The discharge on July 9, 1904, was measured by current meter by R. J. Taylor at a point about one-half mile above the highway bridge near Chaptico, and found to be 12 second feet.

ST. CLEMENT RIVER.

St. Clement River has a total drainage area of 23 square miles. Its basin has a gentle, even slope and is almost flat in the lower part; on the higher part there are several farms, but near the stream the land is marshy and is covered with underbrush and timber. Below the highway bridge, at Clements, the basin is one large marsh. The effects of ordinary tide extend nearly to this bridge. The velocity of the current is rapid in the upper part of the stream, becoming sluggish as it strikes tide-water. The discharge on July 11, 1904, was measured by current meter by R. J. Taylor and found to be 6.6 second feet.

McINTOSH RUN.

McIntosh Run, which has a total drainage area of 26 square miles, empties into Breton Bay, near Leonardtown. Its basin is mostly timber land, with farms along the tops of the divides. The banks of the stream are low, heavily wooded and subject to overflow for almost the entire length of the stream. The bed is full of old logs and drift wood. In the upper part, the velocity of the current is generally rapid, while in the lower part the water stands in long, deep pools, with swift shoals between. At the head of Breton Bay, the stream flows into a marsh. The discharge on July 11, 1904, was measured by current meter by R. J. Taylor at the highway bridge, about one mile above Leonardtown, and found to be 4.7 second feet.

THE MAGNETIC DECLINATION IN ST. MARY'S COUNTY

BY

L. A. BAUER

Magnetic observations for the purpose of determining the magnetic declination of the needle, or the "variation of the compass," have been made by the Maryland Geological Survey and the United States Coast and Geodetic Survey at the following points within the county.

TABLE I.

MAGNETIC DECLINATIONS OBSERVED IN ST. MARY'S COUNTY.

No.	Station.	Latitude.	Longitude W. of Gr'nwich.	Date of Observation	Magnetic Declination on		Observer.	Remarks.
					Date west	Jan. 1, 1900, west		
		° ′	° ′		° ′	° ′		
6	Leonardtown	38 17.4	76 38.1	Sep. 12, 1896	4 43.2	4 53.1	L. A. Bauer	1896 Sta., C.H.
6A	"	" "	" "	June 27, 1900	4 54.6	" "	J. B. Baylor	Merid. L., S.M.
5	Mechanicsville.	38 26.6	76 44.7	Sep. 11, 1896	4 43.4	4 53.3	L. A. Bauer	Hotel Mattingly

All values refer to mean of day (24 hours).

Since January 1, 1900, the value of the magnetic declination has increased annually by about three minutes (3′), so that on January 1, 1906, for example, the north end of a compass would bear at the south monument of the Leonardtown meridian line about 5° 11′ W., on the average for the day.

DESCRIPTION OF STATIONS.

Leonardtown.—The 1896 station was in the southwest corner of the courthouse but has been superseded by the 1900 station, which is the south monument of the meridian line in the courthouse square, 9 feet from the wooden fence on the south side, and 9 feet from west wooden fence. The north monument is about 300 feet to the north of the south monument.

Mechanicsville.—In the garden of Hotel Mattingly, 18 feet northeast of mulberry tree and 9½ feet west of wooden fence.

For a description of the methods and instruments used, reference must be made to the "First Report upon Magnetic Work in Maryland," (Md. Geol. Survey, Vol. I, pt. 5, 1897). This report gives likewise an historical account of the phenomena of the compass-needle and discusses fully the difficulties encountered by the surveyor on account of the many fluctuations to which the compass-needle is subject. Surveyors of the county desiring a copy of this report should address the State Geologist. In the Second Report (Md. Geol. Survey, Vol. V, pt. 1, 1902), the various values observed in Maryland have been collected and reduced. Surveyors of the county desiring these reports should address the State Geologist.

MERIDIAN LINE.

On June 27, 1900, Mr. J. B. Baylor, acting under instructions of the Superintendent of the United States Coast and Geodetic Survey as issued to him, in response to a request from the State Geologist, established a true meridian line at Leonardtown, in the courthouse square. This line is marked by two substantial monuments, suitably lettered and firmly planted in the ground. (See description above.)

THE SOUTH STONE SHOULD BE THE ONE TO BE USED BY SURVEYORS WHEN MAKING THEIR TESTS, IF STILL WELL REMOVED FROM ALL DISTURBING INFLUENCES.

When the surveyor determines the value of the magnetic declination, it would be well for him to make the observations on several days, if possible. Probably the best time of day for making the observations would be towards evening, about 5 or 6 o'clock.[1] At this time the declination reaches, approximately, its mean value for the day (see Table II). The observations on any one day should extend over at least one-half of an hour, preferably an hour, and the readings should be taken every

[1] Or the surveyor may make his observations in the morning and early in the afternoon, at about the time of minimum and maximum values of the magnetic declination. He may regard the mean of the two extreme values as corresponding closely to the mean value for the day (24 hours).

ten minutes. Before each reading of the needle it would be well to tap[2] the plate lightly with the finger or a pencil so as to slightly disturb the needle from the position of rest it may have assumed. The accurate time should be noted opposite each reading and a note entered in the record-book as to the date, the weather and the kind of time the observer's watch was keeping. It is very essential that the surveyor should have some knowledge as to the error[3] of his compass. He can determine this by making observations as stated at the South Meridian Stone. He

TABLE II.

Month.	6 A.M.	7	8	9	10	11	Noon	1	2	3	4	5	6 P. M.
	′	′	′	′	′	′	′	′	′	′	′	′	′
January	−0.1	+0.2	+1.0	+2.1	+2.4	+1.2	−1.1	−2.5	−2.6	−2.1	−1.3	−0.2	+0.2
February	+0.6	+0.7	+1.5	+1.9	+1.4	−0.1	−1.5	−2.1	−2.5	−2.0	−1.2	−0.8	−0.4
March	+1.2	+2.0	+3.0	+2.8	+1.6	−0.6	−2.5	−3.4	−3.7	−3.3	−2.3	−1.2	−0.5
April	+2.5	+3.1	+3.4	+2.6	+0.8	−2.1	−4.0	−4.1	−4.2	−3.6	−2.3	−1.2	−0.2
May	+3.0	+3.8	+3.9	+2.6	+0.1	−2.4	−4.0	−5.0	−4.5	−3.6	−2.3	−0.9	+0.1
June	+2.9	+4.4	+4.4	+3.3	+1.1	−2.0	−3.6	−4.5	−4.5	−3.8	−2.6	−1.2	−0.2
July	+3.1	+4.6	+4.9	+3.9	+1.8	−1.2	−3.4	−4.4	−4.7	−4.2	−2.8	−1.3	−0.3
August	+2.9	+4.9	+5.4	+3.7	+0.4	−2.8	−4.7	−5.1	−4.9	−3.7	−1.9	−0.6	+0.3
September	+1.8	+2.8	+3.4	+2.5	+0.3	−2.7	−4.4	−4.6	−4.2	−4.0	−1.4	−0.3	−0.1
October	+0.5	+1.6	+3.1	+2.8	+1.4	−1.0	−2.7	−3.3	−3.4	−2.4	−1.3	−0.4	−0.4
November	+0.5	+1.2	+1.7	+1.8	+1.1	−0.5	−2.0	−2.7	−2.6	−1.8	−1.0	−0.2	+0.2
December	+0.2	+0.3	+0.8	+1.8	+1.8	−0.0	−1.6	−2.4	−2.3	−1.8	−1.1	−0.3	+0.1

should reduce the value of 4° 53′ to the date of his tests, by allowing an annual increase since January 1, 1900, as above stated, of 3′, and the difference between this value and his own will be his compass error.

If the surveyor has an instrument which admits of the refinement to take into account the change in the magnetic declination during the day, he may use the above table to correct his readings.

To reduce an observation of the magnetic declination to the mean value for the day of 24 hours, apply the quantities given in the table above with the sign as affixed.

[2] Great care must be taken not to electrify the needle by rubbing the glass plate in any manner. Remarkable deflections of the needle can thus be produced.

[3] I have found surveyors' compasses to differ at times as much as 1° from the readings with the Coast and Geodetic Survey Standard Magnetometer. The error may be due to a variety of causes, such as an imperfect pivot, non-coincidence of magnetic axis of needle with the geometric axis, loss of magnetism of the needle, or impurity of brass of which the compass box is constructed.

This table shows that during August, for example, the magnetic declination has its lowest value about 8 A. M. and its highest value at about 1 P. M., and that between these two hours the needle changes its direction about 10′, which amounts to 15 feet per mile. In winter the change is considerably less.

Table III shows how the magnetic declination has changed at Leonardtown between 1700 and 1905.

From this table it will be noticed that the needle is at the present time pointing about the same amount to the west that it did two centuries

TABLE III.

Year Jan. 1.	Needle pointed.	Year Jan. 1.	Needle pointed.	Year Jan. 1.	Needle pointed.	Year Jan. 1.	Needle pointed.
1700	5° 07′ W	1750	2° 23′ W	1800	0° 26′ W	1850	1° 56′ W
10	4 46	60	1 48	10	0 25	60	2 33
20	4 15	70	1 15	20	0 35	70	3 12
30	3 40	80	0 50	30	0 56	80	3 49
40	3 01	90	0 33	40	1 23	90	4 23
50	2 23 W	1800	0 26 W	50	1 56 W	1900	4 53
						1905	5 08 W

ago, and that in about 1805-10 the magnetic declination had its lowest value of about 25′ west, after which it began to increase again. In about a century, since 1805, the compass has, accordingly, changed its direction about $4\frac{3}{4}°$.

A street a mile long, laid out in Leonardtown in 1805 to run north and south by the compass, would, at the present time (1905), have its north terminus about 1/12 of a mile too far east!

The above table enables the surveyor to ascertain the precise amount of change in the magnetic declination or pointing of the compass between any two dates between 1700 and 1900. It should be emphasized, however, that when applying the quantities thus found in the re-running of old lines, the surveyor should not forget that the table cannot attempt to give the correction to be allowed on account of the error of the compass used in the original survey.

THE FORESTS OF ST. MARY'S COUNTY

BY

C. D. MELL.

Introductory.

The forested areas of St. Mary's County are evenly distributed throughout, as shown by the accompanying map. As a rule, timber is left standing along the streams and about swamps, and occasionally along the bay shores. The slopes near the banks of streams are seldom cleared, owing to the danger of their becoming gullied and otherwise eroded. This precaution gives considerable area under forest cover. On the higher reaches, and on the well-drained and sandy portions formerly cleared for farming purposes and later abandoned, the areas have grown up to scrub pine. Where the soil was not too poor, hardwood species, principally red gum, oaks, and hickory, have formed a mixed stand with the scrub pine. Loblolly pine takes the place of scrub pine in moister situations. There are 105,960 acres of forests, while 124,440 is farming land. The more fertile farming land lies along the Potomac and Patuxent rivers.

According to the testimony of the old inhabitants, the forests of this part of Maryland were originally composed chiefly of hardwood species. They claim also that when their fathers were boys there was hardly a pine to be seen, but that by the gradual clearing away of the original forest, and by the exhaustion of the soil, it could no longer yield a good crop of the exacting hardwoods. In consequence, the less exacting pine has come to form a considerable part of the forests of the county. Areas which are said to have been formerly covered with very desirable species of oaks, chestnut, poplar, and red gum are now covered with scrub pine and loblolly pine. The scrub pine came in from the north and the

loblolly from the south. This is evident from the fact that the scrub pine is very abundant in the northern part of the county, and decreases toward the southern part; while the loblolly pine is growing in pure stands in the southern part, becoming less abundant toward the north.

There were no treeless areas in the county, except those under cultivation, and small areas along the coast where brackish water comes in and renders the soil unfit for tree growth. These areas are usually covered with a dense mat of grasses and sedges.

The character of the present forests and their condition bears no resemblance to the original forests. The original forests have suffered so much from unconservative cutting that to-day only the less important timber species are represented on large areas. The post and black-jack oaks, sour gum, persimmon, chinquapin, birch, and scattered elm, beech, and ashes are the most frequent species. There is only a small amount of yellow poplar immediately bordering the streams. The pines are of small size and the hardwood forests are so mixed with small, uneven-aged trees that they cannot yield more than a home supply of lumber. The frequent extensive opening of the forest has resulted in dense growths of brush which rendered it almost impossible for the more important tree species to come in.

Character and Composition.

The forests of St. Mary's County are peculiar in being made up of trees very variable in age, kinds, and species. The occurrence of species changed markedly with the condition of the soil in different localities. Along the river bottoms where the soil is moist and gravelly the red gum, black ash, yellow poplar, and willow oak thrive most abundantly. In a zone just above this, where the soil is of sand and clay and well-drained, the white, red, scarlet, yellow, and Spanish oaks mingle with scrub pine, chestnut, hickory, and birch. Still farther up on the higher reaches the rock oak and chestnut predominate. Here the soil is sandy and well-drained, and scrub pine is rapidly taking the place of hardwoods.

The soil is sufficiently fertile to support a vigorous growth of all the

FIG. 1.—VIEW SHOWING MIXED FOREST GROWTH ON A CLAY SOIL.

FIG. 2.—VIEW SHOWING THE HEAD OF A TIDAL RIVER.

species just mentioned. Trees of all sizes are represented, from one-year-old seedlings to mature specimens of the original forest. In the bottom lands, the reproduction is very good, consisting chiefly of red gum, elm, and ash. On the better-drained areas, the young growth consists largely of sprouts of chestnut, oak, hickory, and maple. The frequent opening of the forests affords plenty of light for undesirable tree species to come in, such as the dogwood, black gum, mountain laurel, persimmon, chinquapin, and blue beech. These unimportant species, in addition to the scrub pine on well-drained areas, form 60 per cent of the stand, and in some places the proportion is even greater.

The climatic position of St. Mary's County is so favorable that it exhibits floral features similar to those of the adjacent Southern States. On this neck, loblolly pine finds its northern limitation. The following is a complete list of the trees native to St. Mary's County:

CONIFERS.

Common Name.	*Botanical Name.*
1. Pitch Pine	*Pinus regida* Mill.
2. Scrub Pine	*Pinus virginiana* Mill.
3. Loblolly Pine	*Pinus tæda* Linné.
4. Red Juniper	*Juniperus virginiana* Linné.

HARDWOODS.

Common Name.	*Botanical Name.*
5. Butternut	*Juglans cinerea* Linné.
6. Black Walnut	*Juglans nigra* Linné.
7. Butternut Hickory	*Hicoria minima* (Marsh) Britton.
8. Mockernut Hickory	*Hicoria alba* (Linné) Britton.
9. Pignut Hickory	*Hicoria glabra* (Mill) Britton.
10. White Willow	*Salix alba* Linné.
11. Largetooth Aspen	*Populus grandidentata* Michx.
12. River Birch	*Betula nigra* Linné.
13. Sweet Birch	*Betula lenta* Linné.
14. Blue Beech	*Carpinus caroliniana* Walt.
15. Beech	*Fagus atropunicea* (Marsh) Sudw.
16. Chestnut	*Castanea dentata* (Marsh) Borkh.
17. Chinquapin	*Castanea pumila* (Linné) Mill.
18. White Oak	*Quercus alba* Linné.
19. Post Oak	*Quercus minor* (Marsh) Sargent.
20. Chestnut Oak	*Quercus prinus* Linné.

21. Swamp White Oak.....*Quercus platanoides* (Lam) Sudw.
22. Cow Oak .....*Quercus michauxii* Nutt.
23. Red Oak .....*Quercus rubra* Linné.
24. Scarlet Oak .....*Quercus coccinea* Muenchh.
25. Yellow Oak .....*Quercus velutina* Lam.
26. Spanish Oak .....*Quercus digitata* (Marsh) Sudw.
27. Pin Oak .....*Quercus palustris* Muenchh.
28. Black Jack Oak.....*Quercus marilandica* Muenchh.
29. Willow Oak .....*Quercus phellos* Linné.
30. Slippery Elm .....*Ulmus pubescens* Walt.
31. White Elm .....*Ulmus americana* Linné.
32. Hackberry .....*Celtis occidentalis* Linné.
33. Red Mulberry .....*Morus rubra* Linné.
34. Sweet Magnolia .....*Magnolia glauca* Linné.
35. Yellow Poplar .....*Liriodendron tulipifera* Linné.
36. Papaw .....*Asimina triloba* (Linné) Dunal.
37. Sassafras .....*Sassafras sassafras* (Linné) Karst.
38. Witch Hazel .....*Hamamelis virginiana* Linné.
39. Red Gum .....*Liquidambar styraciflua* Linné.
40. Sycamore .....*Platanus occidentalis* Linné.
41. Service-berry .....*Amelanchier canadensis* (Linné) Medic.
42. Scarlet Haw .....*Crataegus coccinea* Linné.
43. Black Cherry .....*Prunus serotina* Ehrh.
44. Red-bud .....*Cercis canadensis* Linné.
45. Honey Locust .....*Gleditsia triacanthos* Linné.
46. Locust .....*Robinia Pseudacacia* Linné.
47. Staghorn Sumach .....*Rhus hirta* (Linné) Sudw.
48. Dwarf Sumach .....*Rhus copallina* Linné.
49. Holly .....*Ilex opaca* Ait.
50. Silver Maple .....*Acer saccharinum* Linné.
51. Red Maple .....*Acer rubrum* Linné.
52. Boxelder .....*Acer negundo* Linné.
53. Basswood .....*Tilia americana* Linné.
54. Flowering Dogwood .....*Cornus florida* Linné.
55. Black Gum .....*Nyssa sylvatica* Marsh.
56. Mountain Laurel .....*Kalmia latifolia* Linné.
57. Great Rhododendron .....*Rhododendrum maximum* Linné.
58. Persimmon .....*Diospyros virginiana* Linné.
59. Black Ash .....*Fraxinus nigra* Marsh.
60. White Ash .....*Fraxinus americana* Linné.
61. Red Ash .....*Fraxinus pennsylvanica* Marsh.
62. Nannyberry .....*Viburnum prunifolium* Linné.

There are a considerable number of exotic trees growing in this region which were introduced here by the early settlers who planted

them in yards and along roads and lanes. A few of these species have escaped from cultivation and are found mixed with the native trees along the borders of wood lots. The most important ones are:

Common Name.	*Botanical Name.*
Norway Spruce	*Picea excelsa* Link.
Silver Fir	*Abies pectinata* D. C.
English Walnut	*Juglans regia* Linné.
European Hornbeam	*Carpinus betulus* Linné.
Weeping Willow	*Salix babylonica* Linné.
Paper Mulberry	*Broussonetia papyrifera* (Linné) Vent.
Tree-of-Heaven	*Ailanthus glandulosa* Desf.
Paulownia	*Paulownia tomentosa* (Thunb.) Steudel.
Catalpa	*Catalpa kæmpferi* Seib. and Zucc.

Types of Forest.

The forests of St. Mary's County are conveniently divided into three types: (a) Mixed hardwoods, (b) mixed hardwoods and pine, (c) pure pine.

(a) The mixed hardwoods cover the largest percentage of forested land in this county, and invariably occupy the rich, gravelly soil along the water courses. The predominating species of this type are red gum, yellow poplar, black ash, sycamore, oaks, beech, and white elm. The most valuable timber is now being cut from this type, while several species are continually culled out for special purposes. Through this cutting the mixed hardwood type has greatly diminished in value. The best and also immature trees are removed, while the over-mature and forest tree weeds are left to grow and prevent the best species, such as the yellow poplar, ash, and red gum, from reproducing.

(b) The mixed hardwood and pine type occupies the area immediately bordering the mixed hardwood type. The principal trees represented are the red and white oaks, sour gum, scrub pine, and a small amount of loblolly pine. This type covers the well-drained areas which have never been cleared for agricultural purposes. This forest is more or less open, and shows a tendency to predominate, especially on the borders of open fields and roads.

(c) The pure pine type is found invariably on the higher situations and on land which has been cleared for farming purposes. In the central and northern part of the county, these pure pine forests consist mainly of scrub pine with a mixture of some loblolly in moist situations, while near the Bay shore and in the southern part of the county the loblolly pine occurs in pure stands in old fields and on cut-over land.

Valuable Commercial Trees.

Red Gum.—This species is confined chiefly to moist situations along streams and ponds. It is associated with yellow poplar, willow oak, black ash, beech, and oaks. The less important associates are ironwood, sour gum, chestnut, and loblolly pine. In a few places it forms pure stands of an acre or more.

Red gum is sought largely for veneer and fruit baskets. Several mills in St. Mary's County have been cutting red gum exclusively for some time. The bulk of red gum timber has, however, been harvested, and the demand is such that the timber is cut at a diameter of 8 inches on the stump.

In the meadows or in open places in the forest, where the underbrush is sparse or lacking, seedlings of red gum come up in pure stands. It requires abundant light in early youth, and considerable soil moisture, but with the necessary light and moisture it thrives equally well on sandy loam or clay.

Yellow Poplar.—The general soil and moisture requirements of the yellow poplar are very similar to those of red gum, with which it is commonly associated. This species was the first to be cut for building purposes, and at the present time there is very little mature yellow poplar remaining. The demand for this wood for paper pulp is constantly increasing. Along the streams there is some reproduction, but the less important species crowd it out. The young seedlings cannot endure shade, and, therefore, cannot grow up in locations where the ground is covered with a dense growth of weed trees. Sprouts grow from the stump but they very seldom become trees. Seeds are produced every year, but only a small percentage of them are fertile. Young trees

FIG. 1.—VIEW SHOWING RED GUM GROWTH ALONG STREAMS.

FIG. 2.—VIEW SHOWING REPRODUCTION OF RED GUM.

very rarely produce any good seed at all, and the older trees are being so rapidly removed from the forest that reproduction is hopeless.

White Oak.—This species occurs along the well-drained banks of streams and in alluvial soil generally. Originally, it occupied considerable areas of what is now agricultural land, and was largely associated with the red and black oaks, which are similar in their requirements of soil and moisture. There is considerable white oak scattered throughout the county, but owing to poor transportation facilities, it has a rather low stumpage value. The market demand for white oak ties and for bridge timber is steadily increasing, since the red and black are no longer accepted in this section by the principal railroads. The white and other oaks are used more generally for fuel in this county than any other timber, and command the highest prices for this purpose. A good deal of white oak dimension stuff is used locally. Some piles are cut and shipped out of the county.

The white oak is being rapidly replaced by less valuable timber trees, such as black jack and post oaks, persimmon, black gum, and scrub pine. Reproduction by both seed and sprouts requires considerable sunlight, which is often impossible under the unsystematic selective method of cutting now generally practiced. The older trees bear some seed every year, but very few are left to spring up. Rodents of the forest are very fond of the sweet meat of the white oak acorn, and so are the swine which are left to run through the woods the greater part of the year.

Chestnut.—The chestnut is peculiar to the higher, drier, and well-drained slopes. Formerly this species was much more abundant than it is now, at present being represented by old, and, frequently, over-mature trees scattered through the forest. There is little tendency to reproduce itself from seed, and the trees that are cut are frequently too old to sprout well from the stump. In consequence, there is very little chestnut left in the county. It is largely replaced by rock, post, and black-jack oaks, scrub pine, and black gum. The dealers are eager to buy the chestnut, and unless measures are adopted to extend and maintain the growth within a few years, very little of this timber will be available. Woodlot owners cut their chestnut for fencing material before

any other species except red juniper. It is also frequently sawn into staves for tobacco hogsheads. A few sawmills convert chestnut timber into shingles. It is also used to some extent for fuel, but brings a lower price than oak. There is very litle of this timber remaining in the forest suitable for telephone and telegraph poles, for which it was formerly very largely used, and for which there is a good demand.

Loblolly Pine.—In St. Mary's County, loblolly pine is most abundant on the sandy clay soil near the Bay shores, though it occurs frequently in the interior and on elevated slopes, mixed in with scrub pine and hardwoods. It appears to be rather tolerant of shade in this range, seldom coming up in the dense forest. In old fields, however, where there is no competition with other species, it does form dense stands. The best examples of pure growth are found in the southern part of the county near Point Lookout. Here it forms long, clear boles with small crowns, and is eagerly sought for piles, telephone and telegraph poles.

Reproduction is very good in all locations with suitable soil and sufficient light. Loblolly pine produces seed every year. Cones mature the second year and slowly discharge their seed during the autumn and winter, and usually remain on the branches until the end of another year. Open places in the forest where conditions are not too unfavorable are seeded up in the course of two or three years. The scrub pine is more prolific in its production of seed, and is more tolerant of shade than the loblolly pine, but the latter grows faster in its early youth and soon overtops the scrub pine. From the good reproduction of loblolly pine in southern St. Mary's County and that of scrub pine in the central and northern part, it is evident that these two species will furnish the bulk of the future timber supply.

Scrub Pine.—The scrub pine is less exacting than loblolly pine in its requirements of soil and moisture. It generally occurs unmixed with other species in old fields and in other open places. Until recently, this pine had no special use except for firewood, and was considered a weed. Now, however, the wood is used for various purposes, the most important one being for the manufacture of paper pulp. Large quan-

tities are annually shipped out of the county for this purpose. There are minor uses to which this wood is put, and other uses are sure to follow. It is largely used for fuel though none is shipped out of the county for this purpose. Considerable scrub pine timber is being cut and sawn into lumber for house construction locally, and practically all lumber used for tobacco hogshead staves is from this pine. Boards for fencing are largely cut from scrub pine. It is the principal timber used in locations where it comes constantly in contact with water, as in flumes for conducting water to mill-wheels and in irrigation ditches.

The scrub pine is a very prolific seed producer. It requires two years for the cones to mature, and the trees, having plenty of light, are generally loaded with cones which remain on the branches for three or four years after maturity. Seeds are shed rather slowly, and, being small, are easily wafted by the wind for considerable distances. Old fields bordering a growth of scrub pine come up to this species within a few years. It forms a very dense stand, and, being tolerant of shade, it does not prune itself of its lower branches until it is twenty or twenty-five years old. At the age of forty or fifty years the stand becomes more open, and mixed with hardwoods.

In locations where clear cutting is made and scrub pine is desired for a second growth it is necessary to leave from 3 to 5 seed trees to an acre.

Red Juniper.—The red juniper is common in all localities and soils in this county. It comes up in old fields where other reproduction is tardy, and is especially conspicuous as a roadside tree throughout this region. Long and regular rows have come up along roads and lanes from seed dropped by birds. The scarcity of chestnut brings this species into greater favor for fence posts and when the trees have attained a diameter of 4 or 5 inches breast-high, farmers generally prune them of their lower branches. Cedar posts sell with local dealers for about $20.00 per hundred.

The red juniper thrives best in sandy and loamy, moderately moist soil, but this county grows it in rather dry, sandy clay and gravelly soil. It prefers sunny, open situations. In the forest this species remains

small and stunted, but in open places it forms a long conical crown. It produces seed in abundance, but the percentage of germination is very low.

Transportation.

The lack of good transportation facilities in central and southern St. Mary's County has had considerable to do with regard to the amount of timber made available. There is very little timber being shipped into the county, and statistics gathered from the sawmills show that less than 2,000,000 board feet are shipped out annually. The bulk of the wood shipped goes out by boat and the remainder by rail. The Washington & Potomac Railroad runs into the county only a short distance from the north, with its terminus at Mechanicsville, and is connected with the Pennsylvania line at Brandywine, Maryland. This affords very little opportunity for the shipment of forest products by rail, unless shipments are hauled over sandy roads for long distances. Such hauling is so expensive that it does not pay to cut all the useful trees in a forest. Therefore, only the best of certain species, such as will warrant the expense of shipment, are cut. The remainder is left in the forest to rot or to hinder other desirable species from springing up. Accordingly, the owners of forest land in some sections of the county appear to have failed to realize the fullest production from their timber, and are willing to sell it regardless of the result it will have on their forests.

As a rule the wagon-roads in the county are not suitable for hauling very heavy loads. For the most part they are exceedingly sandy, and where grades occur they are gullied and so narrow at many points that they are almost impassable.

Present Wood Consumption.

The principal uses for wood are considered under the following headings:

Sawmills and their products, cordwood, railway ties, pulpwood, veneers, telegraph poles and piles, fence timber and staves.

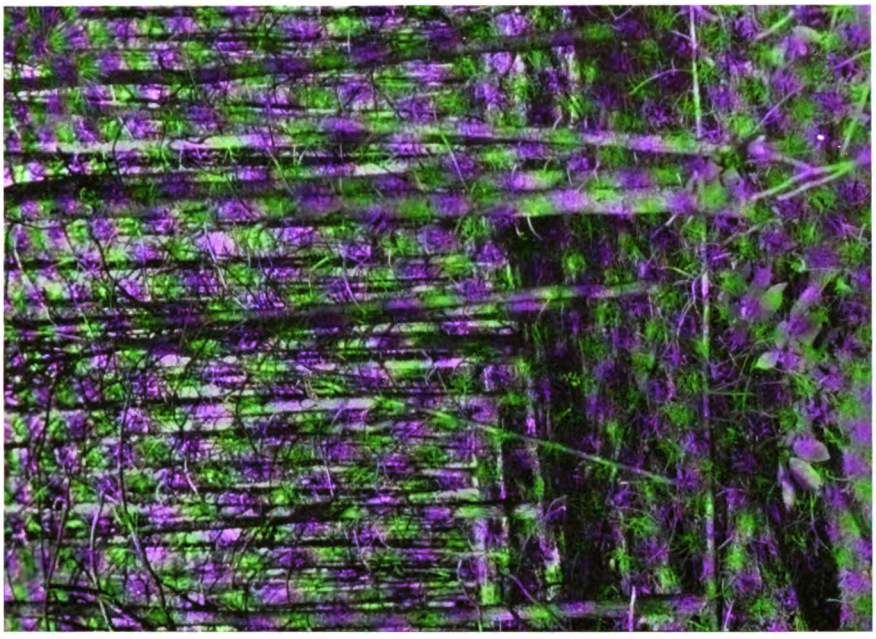


FIG. 2.—VIEW SHOWING GROWTH OF SCRUB PINE.

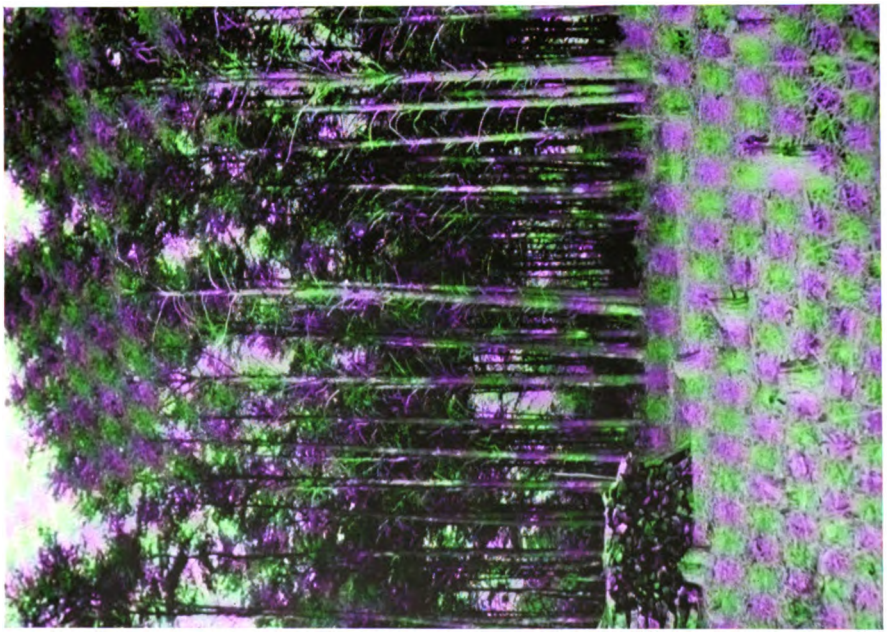


FIG. 1.—VIEW SHOWING GROWTH OF LOBLOLLY PINE.

SAWMILLS AND THEIR PRODUCTS.—There are about twenty-two sawmills cutting timber in St. Mary's County. The amount cut by each mill ranges from 25,000 to 1,500,000 board feet annually. These mills are scattered throughout the county, and have a combined annual cut of 7,075,000 board feet. The bulk of the timber cut in these mills is pine, oaks, yellow poplar, and red gum. Of these only the best grades are shipped out of the county.

In the southern part of the county about two-thirds of the timber cut is pine and one-third hardwood, while in the northern part this proportion is about one-third of pine to two-thirds of hardwood. On an average for the whole county, about one-half is pine and one-half hardwoods. A good deal of the best grades of pine and white oaks are sawn into construction timber and shipped out of the county, while the remainder is cut into boards, planks, and dimension stuffs for local use. Occasionally red gum is sawn for outside shipments, but until recently the market price of this timber has been so low that the mill men could not cut it profitably. Red gum is now bought largely for the manufacture of fruit baskets. It is also used locally for construction timber and for such less important purposes as staves for tobacco hogsheads, boards for fencing, and for shingles.

Of the entire amount of timber cut into lumber, only about 1,500,000 board feet are shipped out of the county. This leaves approximately 6,000,000 board feet for local consumption. With a population of nearly 16,000, this allows a consumption of 370 board feet per capita. The average consumption per capita in the United States is being placed at 510[1] board feet.

CORDWOOD.—The supply of firewood in St. Mary's County is a simple problem. Firewood is abundant and the cost per cord on the market is determined largely by the cost of cutting and hauling. The best quality of hardwood can be bought on the stump for less than 50 cents per cord in almost any locality, while scrub pine sells for 25 cents or less. It is estimated that approximately 2000 cords of firewood are

[1] Forest Economics, B. E. Fernow.

shipped out of the county every year. It goes principally to Baltimore and Washington. Hardwood brings $2.50 per cord at the wharf, and pine $2.00.

From the data gathered within the county it is estimated that the 4000 families in St. Mary's County use approximately 55,000 cords of wood annually, or an average of 14 cords per year for each family. Eleven cords can be cut on an average from an acre of forest land, so that the annual consumption of firewood in the county represents a stand of timber of about 5200 acres. On the 105,960 acres of forested land there is now standing approximately 1,165,560 cords of wood, counting 11 cords to an acre. This includes all standing timber over 4 inches in diameter on the stump. At the present rate of consumption it would require about twenty-one years for all the wood to be consumed in the county in the form of cordwood alone, not counting the annual increment of the forest in the meantime. The volume of this yearly increment of the forest is estimated to about balance the total consumption, though the kind and quality of the timber is constantly deteriorating under the present lack of proper conservative management.

Railway Ties.—The forests of St. Mary's County have long been an important source for ties and other railroad construction timber. The supply for these purposes is now, however, almost exhausted. Formerly several hundred thousand ties were cut and shipped annually, but during the last two years the shipments were less than 50,000 ties and hardly any bridge timber. Up to the last year (1904) the railroad companies accepted all kinds of oak and chestnut ties produced by the county, but at the present time (1905) they desire only white oak and chestnut. This will materially diminish the future cut of ties in the county. Moreover, owners of timber are somewhat reluctant to sell white oak to contractors who will not at the same time accept red and black oak timber.

The Spanish, red, yellow, and other black oaks are considered inferior grades by railroad companies, and experience has proved to them that the life of a tie cut from one of these oaks is only a little more than half that of a white oak tie. Contractors realize from 60 to 70 cents

for their white oak ties, depending upon the grade of tie. Chestnut ties range from 45 to 55 cents, delivered at the railroad. Two classes or grades of ties are distinguished by contractors and railroad companies. The first class includes ties which have a face of 8 inches or over and are free from all defects, such as knots and checks. Second class ties may have some knots and a face of not less than 7 inches. All oak ties must be hewn. Chestnut ties are cut largely from old mature trees, and are cut into their required dimensions in the sawmill.

Contractors hire choppers who cut ties at the rate of 10 cents for the best grade and 8 cents for the second grade.

PULPWOOD.—Yellow poplar and scrub pine are cut extensively for the manufacture of wood pulp. The latter is used in excess of the former solely because it is more abundant in the county. Experienced dealers in the county estimate that about four thousand cords of pulpwood are shipped annually out of the county. About one-fifth of this amount is yellow poplar.

Scrub pine, being much more abundant, is the staple timber for this purpose, and consumers of pulpwood have no difficulty in buying large tracts of it at very low prices. Stumpage prices of pine vary according to the distance from railroad or wharf, and also according to the age and density of stand. The different items making up the price per cord of scrub pine for pulpwood vary as follows:

Stumpage	$ .20	to	$ .25
Cutting	1.25	"	1.40
Hauling	1.30	"	1.50
Total	$2.75	"	$3.15

The scrub pine is cut during the spring and summer seasons when the bark can be taken off most easily. All trees above 4 inches in diameter a foot above the ground are cut into 5-foot lengths. A saw is used so as to insure uniform lengths and facilitates in loading on cars or boats. Scrub pine has only lately come into favor for pulpwood, and it is believed that the demand for this species will increase. Loblolly pine is not cut for pulpwood.

Owing to the scarcity of yellow poplar it is difficult to secure tracts from which this timber can be cut profitably. On an average, 2 cords may be expected from one acre of land where the soil is suitable for this species. Tracts yielding less than this are seldom worked for pulpwood because of the inconvenience of getting it out of the forest. Stumpage prices are usually high, and the trees are so widely scattered that it hardly pays to cut them. The following items show the first cost of a cord of yellow poplar pulpwood:

Stumpage	$ .90	to	$1.10
Cutting	1.40	"	1.60
Hauling	1.40	"	1.60
Total	$3.70	"	$4.30

Contractors' prices to consumers are generally from $4.50 to $4.75 per cord, delivered at the landing.

VENEERS.—The manufacture of red gum veneer for fruit baskets is constantly increasing, and the supplying of timber for this purpose has become a staple industry in St. Mary's County. Red gum timber can be bought from owners for 50 cents per cord on the stump. The cost of cutting and hauling is the same as that of yellow poplar, making the total cost for one cord of red gum at the wharf about $3.50. The market price is about $4.00 per cord containing 173.33 cubic feet. Sticks are cut 5 feet long with the bark removed. The cord measures 8 feet long and 5 feet wide, by 4 feet and 4 inches in height.

TELEGRAPH POLES AND PILES.—The available timber in this county desirable for piles, telegraph and telephone poles is white oak, chestnut, and loblolly pine. The demand and consumption of chestnut and white oak ties has been so great, however, that very few poles and piles have been cut from these species. Contractors for supplies of pole and pile timber from this county are, therefore, largely restricted to loblolly pine. Formerly, this pine could be bought rather cheaply in the southern part of the county, but of late the price, owing to the demand for other purposes, or for lumber, has increased so enormously as to prohibit the purchase of this timber for piles and poles. Large areas of old fields

which have come up to loblolly pine are now furnishing material more valuable for lumber than any other purpose.

It is believed that red, yellow, and black oak will find a place on the market for piles, since they are no longer accepted for railroad ties, especially if preservative treatment is resorted to. These oaks are never used for poles, but are constantly used locally for piling in the construction of private wharfs.

FENCE TIMBER AND STAVES.—Red juniper is the principal species used for fence posts, and is noted for its lasting qualities in contact with the soil. Sawmill men handle these posts at $20 per hundred, though none are shipped out of the county. Boards for fence material are largely cut from scrub and loblolly pines, and are quoted on the local markets at $11 per thousand board feet. Clapboards are cut from red gum, red oak, scrub pine, and loblolly pine.

Formerly a large number of fence rails and posts were cut from chestnut, but since this timber is becoming rather scarce in this county farmers resort to red and black oaks, scrub pine, and loblolly pine.

Staves for tobacco hogsheads are cut largely from scrub pine. Occasionally loblolly pine and red gum are used. These staves are sold by all sawmill men in the county and are 5 feet 4 inches long, and from 3 to 6 inches wide. They are quoted on the market at $8 per thousand board feet.

DESTRUCTIVE INFLUENCES.

FOREST FIRES.—The forests of this county have been remarkably free from destructive fires. There is no record of a fire having occurred within the county which caused any severe damage to the forests. The numerous streams of the county serve as natural firebreaks, being nearly at right angles to the prevailing winds. These streams are usually bordered by wet or damp soil and dense vegetation, which is scarcely ever in condition to burn readily, and furnish impassable barriers to any ordinary fire. The county is also so thoroughly cut up by areas cleared for farm purposes that they, with the numerous wagon-roads throughout

the county, serve as additional fire-lines. Even the little-used wagon-roads are usually gullied by erosion and devoid of vegetation.

On the other hand, the people of the county are notably very cautious in regard to fires, and as there are no very large tracts of forests not immediately under the care of the owner himself, or someone directly responsible, fires are not left to run on until they cannot be easily put out. The immediate danger to which numerous small dwellings or cabins scattered throughout the forests are subjected likewise tends to make the inhabitants careful regarding forest fires. The prevailing forest types, being of mixed hardwoods, are not especially subject to destructive fires since the forest floor is usually moist and in places even wet. On the higher elevations where the scrub pine predominates, and on the lower level sandy parts, where the loblolly is found, the soil is covered with a thin layer of needles which is not sufficient to feed a destructive fire.

The danger of fire from locomotives is very small, since there are less than ten miles of steam railway in St. Mary's County. Charcoal burning, which is a fruitful source of fires in neighboring counties, is not carried on here, and as this county is almost surrounded by water the liability of fire entering from adjoining localities is practically eliminated.

GRAZING.—This county is not well adapted to grazing. There is not enough of it carried on to damage forest reproduction. On account of insufficient fodder supply for winter use, very few cattle are kept by the farmers. Along the streams and wet places the growth consists of shrubs and trees, with very little grass, while on the cleared farming land the soil is so loose and sandy that cattle would soon trample the meadow grass into the sand and ruin the pasture.

A greater source of damage to the forests of St. Mary's County is that afforded by herds of swine which feed in the forest. During the fall and early part of the winter, they subsist on mast, but in spring and summer they dig up the forest soil in search of roots. The young growths are killed and the mature trees are seriously injured. Frequently, even large trees are killed outright. In their search for the soft inner bark of the oaks, chestnut, and pine, hogs remove the bark of

the lower part of the trunks as well as that of the roots, so far as they are able to dig them up.

OTHER DESTRUCTIVE INFLUENCES.—The following are also destructive to the forests of this region: injudicious cutting; clearing land better suited for forest growth; and erosion.

Injudicious cutting of the timber has been going on in this county since its settlement. Nearly all of the areas have been cut over many times for the purpose of securing certain timber species for special purposes. This constant stripping the forest of its most valuable timber has left not only too few and poor, immature trees as the only representatives of the more valuable species, but it has also permitted the less valuable species to become too abundant. As a direct consequence large tracts of forests now present a very irregular and uneven-aged appearance, with very few good timber trees remaining. The woodland owners of St. Mary's County do not fully realize the decline of their forest resources. When wood is needed but little discretion is exercised in the choice of trees to be cut, and no provision is made for the renewal or improvement of the stand.

Large areas throughout the sandy and rather unproductive regions of the county were stripped of their timber, and cultivated for farm crops for several years. When they ceased to yield a crop sufficient to pay for the tilling of the soil, they were abandoned and allowed to revert to nature. A scrubby growth of oaks, black gums, persimmon, and scrub pine now occupies these old farms. Frequently, such areas have come up to a pure stand of scrub pine which forms about 10 per cent of the forests of the northern half of the county. Formerly, the entire county was covered with a dense stand of hardwood timber with oaks, chestnut, and hickory predominating. The lands now occupied by the better forests are those which have never been cleared. These are narrow strips along the streams and Bay shores.

In the central part of the county the surface is rather undulating, especially along the streams. The earlier settlers cleared the land at the foot of the hills; the later settlers enlarged the fields by taking the timber from the hillsides. The loose, sandy soil on these cleared slopes

was soon washed down into the valley below, which rendered eroded areas unfit for further cultivation. (See Plate VIII). The more valuable bottom land along the streams is being covered with sand and gravel, washed there from higher places. Natural tree reproduction on such eroded hillsides is very tardy. Scrub pine is the only tree which will reclaim such areas. Farmers are, however, very cautious about such clearing at the present time, and seldom clear any land which is liable to erode.

Future of the Forest under Judicious Management.

St. Mary's County dealers in lumber and railroad ties are very eager to see both public and private interest taken in the preservation of their forests, and particularly in the young growth. They realize that some systematic management should be instituted if reasonable returns are to be expected in the future from the timbered areas. Farmers and owners of timber tracts realize that the woodlands are constantly depreciating in value in spite of the greater demand for forest produce. The best timber having been cut, the farmer is eager to find a market for the less valuable species. Every farmer owns some forest land from which he draws his fuel supply, fence material, and saw logs for building purposes. Frequently, ties, poles, and piles are cut during the winter to secure some income from the woodlot to pay taxes and other expenses, but usually very little care is taken as to where and how the trees to be cut are selected.

Woodland owners can enhance the value of their timber considerably by making what is generally termed improvement cutting instead of chopping down trees indiscriminately. Improvement cuttings can be carried on in all woodlots in this county with excellent results by removing overmature trees, and by thinning out undesirable species where they interfere with the growth or reproduction of more valuable kinds. Such a cutting gives the remaining trees enough room and light for their better development. There are numerous overmature and diseased chestnut, oaks, and red gum trees which are injuring the younger growth about them. These should be removed gradually as the material can

FIG. 1.—VIEW SHOWING REPRODUCTION OF LOBLOLLY PINE.

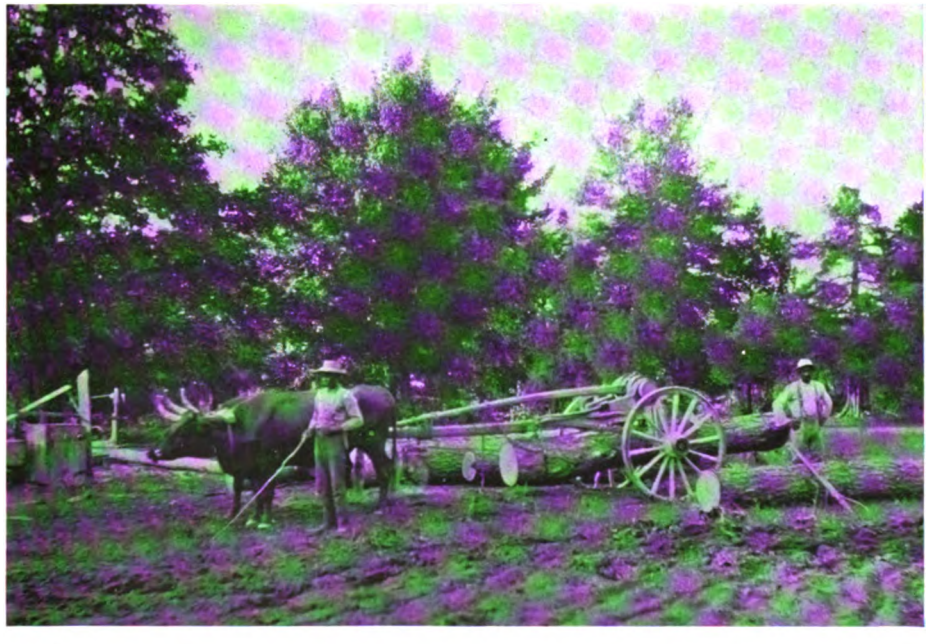


FIG. 2.—VIEW SHOWING METHOD OF TRANSPORTATION OF LOBLOLLY LOGS TO THE MILL.

be utilized. In mixed hardwood forests, the selection system of cutting should be put in operation. The principal of the selection method is that the trees should be selected and cut here and there in the forest according to the owner's purpose. In this method trees may be removed from year to year as they reach a required diameter, and the wood from the top of those trees in addition to that which results from the cutting of inferior species and diseased trees will yield fuel supply for the owner. For the production of telegraph poles and railroad ties the trees may be cut as soon as they reach the desired diameter, and for wood for construction purposes, considerable thinning must be made so as to give the larger trees sufficient light and growing space. In this way the forest is opened rather uniformly and at the same time sufficiently to permit the reproduction of desirable species.

In forests composed mainly of oaks and chestnut, which sprout well from the stump, it may be advisable to cut most of the good-sized trees over a part of the tract for the purpose of raising a crop of sprouts. Stumps should be cut low and slanting, so as to prevent rotting and secure strong and numerous shoots. Trees from seeds are, however, more desirable than those from sprouts if large timber is the object. Sprouts are frequently defective at the butt.

The pine forests are invariably even-aged and seldom need any further attention beyond that of protection from fire, which has thus far been no great source of damage in this county. The stand of pine necessarily needs to be rather dense, so that the lower part of the trunk will shed its branches early from want of sufficient light. In harvesting a growth of pine clear cutting is recommended with from 3 to 5 seed trees left distributed as uniformly as possible over every acre, if the area is again expected to grow up to pine. When broad-leaf trees are desired on such cleared areas, planting is advised. Acorns of red and white oaks may be planted four by four feet apart. Acorns for this purpose must be collected in early fall and put in boxes with alternate layers of sand. The boxes containing the acorns must be kept in a moist, cool place over winter. They may be buried in the earth about a foot below the

surface of a well-drained hillside. In early spring, the acorns should be planted in hills. It is preferable to plant three acorns to a hill.

The brush left after cutting may be burned where this is possible without injuring the trees left in the forest and at a season when there will be little danger of the fire spreading. Where this is not practicable, it should be scattered out over the forest floor so as not to be a hindrance to reproduction.

The whole aim in forest management is to secure new trees of the most useful kind to take the place of those cut out as soon as possible after the removal of the old. For the best results it is essential that fire and grazing animals be kept out of woodlots. Fire running over the forest soil consumes the litter and kills the seedling and sprouts and reduces the vitality of old trees and frequently kills them outright. By the removal of the litter the forest soil is exposed and becomes too dry to encourage the germination of tree seeds. Grazing animals do considerable damage to woodlots and should be excluded. Cattle browse upon young growth and trample it down. Swine not only eat the nuts of the chestnut, oaks, and hickories, but they also dig up the forest soil and kill young seedlings and sprouts.

Much damage to the young growth can be prevented if cuttings are made during the winter months, preferably when there is snow on the ground. Marking of trees may be done in the summertime when trees are in foliage, because at this time more accurate judgment can be exercised as to density of stand, condition, and health of trees.

There is very little attention paid to the management of woodlots in St. Mary's County. It is a simple problem, however, and every farmer can regulate the cutting of the timber and improvement in such a manner that it will not prove a burden to him financially. Every farmer should fully realize that protection and selection of cutting are factors of prime importance in managing his woodlots to secure the highest financial returns. In case woodland owners desire a special and more detailed plan for the management of their woodlots, they should make application to the State Forester, Baltimore, Md.

The demand for cordwood for home consumption is not likely to in-

crease in this county unless the proposed railroad should be opened and the population increased in the neighborhood of Point Lookout. It is believed, therefore, that it would not be profitable to manage a woodlot for the production of cordwood only, under present market conditions.

Summary.

The following is a summary of the principal facts determined by a brief study of the forests of St. Mary's County:

1. Almost one-half of the area of the county is covered with forests.
2. The most desirable timber has been cut.
3. Formerly, the forests consisted of hardwood species.
4. At present, 20 per cent of the forests of the county are scrub and loblolly pine, the pines tending to become the prevailing species.
5. The most valuable timber now standing is white oak, loblolly and scrub pines.
6. The hardwood forests are very uneven-aged and irregular in density of stand which renders lumbering difficult and unprofitable.
7. The white oak and chestnut which are the most valuable railway timbers are becoming scarce.
8. Yellow poplar and scrub pine are largely cut for pulpwood.
9. Red gum which was formerly of little use and importance is now in demand for lumber and the manufacture of veneer.
10. Fire and grazing which have retarded satisfactory reproduction have injured the mature timber of the county very little.
11. Forest land could be made fully profitable by carrying out the following recommendations: (a) Removing dead, dying, and over-mature trees. (b) Removing mature or inferior trees which are suppressing or hindering desirable young growth from coming up in the forest. (c) In case of excessive cutting leave at least from 3 to 5 seed trees to the acre. (d) Planting where desirable reproduction is not coming up reasonably soon after cutting. (e) Preventing fires and excluding grazing animals from areas where young growth is coming up.

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