FLORIDA GEOLOGICAL SURVEY

THIRTEENTH ANNUAL REPORT

FLORIDA STATE GEOLOGICAL SURVEY

HERMAN GUNTER, STATE GEOLOGIST

THIRTEENTH ANNUAL REPORT

PUBLISHED FOR
THE STATE GEOLOGICAL SURVEY
TALLAHASSEE, 1921

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LETTER OF TRANSMITTAL.

To His Excellency, Hon. Sidney J. Catts, Governor of Florida:

Sir:—In accordance with the law establishing the State Geological Survey I submit herewith, my annual report, being the Thirteenth in the series of annual reports thus far published by this Department. The report contains a detailed financial statement showing the expenditures up to June 30, 1920, together with a result of those investigations undertaken during the past year.

Appreciation of the interest you have shown in the work of the State Geological Survey and the assistance you have rendered is herewith expressed.

Very respectfully,

HERMAN GUNTER,
State Geologist.

November, 1920.

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HERMAN GUNTER, STATE GEOLOGIST.

INTRODUCTION.

The act establishing the Florida State Geological Survey was passed by the Legislature of 1907, being approved on June 3rd of that year. Among other provisions of the law is one requiring the State Geologist to make annually to the Governor a report of the progress made by the Survey. Since its establishment the following reports have been issued, the subjects treated being indicated by the titles of the separate papers listed under each annual report which make up the whole volume.

Those annual reports followed by an asterisk (*) are no longer available for distribution as a whole volume, owing to exhaustion of supply. It is frequently the case, however, that although the report as a whole is not available some of the separate papers making up the volume may be obtained. When this is the case such separates making up the respective annual reports as are still available are indicated by the dagger sign (†).

PUBLICATIONS OF THE FLORIDA GEOLOGICAL SURVEY

First Annual Report, 1908, 114 pp., 6 pls.*

This report contains: (1) a sketch of the geology of Florida; (2) a chapter on mineral industries, including phosphate, kaolin or ball clay, brick-making clays, fuller's earth, peat, lime, cement and road-making materials; (3) a bibliography of publications on Florida geology, with a review of the more important papers published previous to the organization of the present Geological Survey.

Second Annual Report, 1909, 299, pp., 19 pls., 5 text figures, one map.*

This report contains: (1) a preliminary report on the geology of Florida, with special reference to stratigraphy, including a topographic and geologic map of Florida, prepared in co-operation with the United States Geo-

logical Survey; (2) mineral industries; (3) the fuller's earth deposits of Gadsden county, with notes on similar deposits found elsewhere in the State

Third Annual Report, 1910, 397 pp., 28 pls., 30 text figures.*

This report contains: (1) a preliminary paper on the Florida phosphate deposits; (2) some Florida lakes and lake basins; (3) the artesian water supply of eastern and southern Florida; (4) a preliminary report on the Florida peat deposits.

Fourth Annual Report, 1912, 175 pp., 16 pls., 15 text figures, one map.

This report contains: (1) the soils and other surface residual materials of Florida, their origin. character and the formations from which derived†; (2) the water supply of west-central and west Florida†; (3) the production of phosphate rock in Florida during 1910 and 1911.

Fifth Annual Report, 1913, 306 pp., 14 pls., 17 text figures, two maps.*

This report contains: (1) origin of the hard rock phosphates of Florida†; (2) list of elevations in Florida; (3) artesian water supply of eastern and southern Florida†; (4) production of phosphate in Florida during 1912; (5) statistics on public roads in Florida.

Sixth Annual Report, 1914, 451 pp., 90 figures, one map.*

This report contains: (1) mineral industries and resources of Florida†; (2) some Florida lakes and lake basins; (3) relation between the Dunnellon and Alachua formations; (4) geography and vegetation of northern Florida†.

Seventh Annual Report, 1915, 342 pp., 80 figures, four maps.*

This report contains: (1) pebble phosphates of Florida†; (2) natural resources of an area in Central Florida†; (3) soil survey of Bradford county†; (4) soil survey of Pinellas county†.

Eighth Annual Report, 1916, 168 pp., 31 pls., 14 text figures.*

This report contains: (1) mineral industries; (2) vertebrate fossils, including fossil human remains†.

Ninth Annual Report, 1917, 151 pp., 8 pls., 13 figures, two maps.

This report contains: (1) mineral industries; (2) additional studies in the Pleistocene at Vero, Florida†; (3) geology between the Ocklocknee and Aucilla rivers in Florida†.

Tenth and Eleventh Annual Reports, 1918, 130 pp., 4 pls., 9 figures, two maps.*

This report contains: (1) geology between the Apalachicola and Ocklocknee rivers; (2) the skull of a Pleistocene tapir with description of a new species and a note on the associated fauna and flora; (3) geology between the Choctawhatchee and Apalachicola rivers; (4) mineral statistics; (5) molluscan fauna from the marls near DeLand.

Twelfth Annual Report, 1919, 153 pp., four maps.

This report contains: (1) literature relating to human remains and artifacts at Vero, Florida†; (2) fossil beetles from Vero†; (3) elevations in Florida†; (4) geologic section across the Everglades of Florida†; (5) the age of the underlying rocks of Florida as shown by the foraminifera of well borings†; (6) review of the geology of Florida with special reference to structural conditions†.

Thirteenth Annual Report (this volume) 1921.

Bulletin No. 1. The Underground Water Supply of Central Florida, 1908, 103 pp., 6 pls., 6 text figures.*

This bulletin contains: (1) underground water. general discussion; (2) the underground water of central Florida, deep and shallow wells, spring and artesian prospects; (3) effects of underground solution, cavities, sinkholes, disappearing streams and solution basins; (4) drainage of lakes, ponds and swamp lands and disposal of sewage by bored wells; (5) water analyses and tables giving general water resources, public water supplies, spring and well records.

Bulletin No. 2. Roads and Road Materials of Florida, 1911, 31 pp., 4 pls.*

This bulletin contains: (1) an account of the road building materials of Florida; (2) a statistical table showing the amount of improved roads built by the counties of the State to the close of 1910.

In addition to the regular reports of the Survey as listed above press bulletins have been issued as follows:

No. 1. The Extinct Land Animals of Florida, February 6, 1913.

No. 2. Production of Phosphate Rock in Florida during 1912, March 12, 1913.

No. 3. Summary of Papers Presented by the State Geologist at the Atlanta Meeting of the American Association for the Advancement of Science, December 31, 1913.

No. 4. The Utility of Well Records, January 15, 1914.

No. 5. Production of Phosphate Rock in Florida during 1913, May 20, 1914.

No. 6. The Value to Science of the Fossil Animal Remains Found Embedded in the Earth, January, 1915.

No. 7. Report on Clay Tests for Paving Brick, April, 1915.

No. 8. Phosphate Production for 1917, May 2, 1918.

No. 9. Survey of Mineral Resources, May 10, 1918.

No. 10. Phosphate Industry of Florida during 1918, June 5, 1919.

No. 11. Statistics on Mineral Production in Florida during 1918, October 6, 1919.

DISTRIBUTION OF REPORTS

The reports of the Florida Geological Survey are sent without cost to the citizens of the State and may be obtained by addressing a request to the State Geologist, Tallahassee, Florida. Postage should accompany requests from those living outside of Florida or if preferred reports can be sent by express collect.

RESIGNATION OF E. H. SELLARDS AS STATE GEOLOGIST.

After serving the State of Florida for almost fifteen years, three years as Professor of Geology and Zoology at the University of Florida and practically twelve years as State Geologist, Dr. E. H. Sellards tendered his resignation which became effective April 18, 1919. Dr. Sellards did not leave the services of the State without regret, for the work was most attractive, the field of labor and investigation rich and the associations formed in the prosecution of the great work that he had accomplished most pleasant. It was, however, the mounting cost of the daily necessaries and comforts of life with the decreasing purchasing power of the dollar that was the compelling force and deciding factor in the acceptance of a more attractive offer with the Bureau of Economic Geology and Technology of the State of Texas. No one was more familiar with the geology of the State of Florida and its economic resources than was Dr. Sellards and in his leaving the State has lost the services of a most thorough, painstaking, conscientious and scientific investigator.

PERSONNEL OF THE SURVEY.

Upon the resignation of Dr. E. H. Sellards as State Geologist, Mr. Herman Gunter, who has been with the Survey since August, 1907, was appointed as his successor. On July 1, 1919, Mrs. L. B. Robertson entered upon the duties of Secretary of the Department and served in this capacity until August 1, 1920. Dr. Joseph A. Cushman of the Boston Society of Natural History, a recognized authority on foraminifera, minute fossils of great importance in identifying geologic formations, has prepared a detailed report on the species of this group as represented in samples of drillings from several deep wells in the State. Dr. R. M. Harper has served as Assistant on the Survey in the capacity of botanist and geographer since April 1, 1920. A paper on the Geography of Central Florida by Dr. Harper accompanies this report, which is in continuation of a study and report on this subject covering northern Florida, contained in the Sixth Annual Report, published in 1914.

CHANGE OF LOCATION OF THE GEOLOGICAL DEPARTMENT.

Through the courtesy of the State Chemist the Geological Department occupied two rooms in the Chemical Building from early in 1908, or shortly after its organization, until March 1, 1920. One of these served as office and library while the other was used for the exhibition of geological material and for other purposes.

The legislature of 1919 provided for the inspection and analysis of gasoline and kerosene, carrying also the provision for appointment of an additional Assistant State Chemist to take care of the analytical work. Although the rooms occupied by the Geological Survey were at the expense of the State and even though they had been needed by the Chemical Division for some time, it was not until the law mentioned became effective that it was necessary for the Geological Department to find quarters elsewhere.

There being no available space in the Capitol building or in one owned or controlled by the State there was no other alternative than to get office and museum space in a building privately owned. In this the Geological Survey was fortunate for the Perkins Building on Monroe Street was at that time under construction, and quarters were arranged to suit the convenience of the Department, both as to office, library and museum space.

In its new location the Survey has one room containing 750 square feet which is now used for the exhibition of geological material and for the main working library. The other space, equal in area, is divided into four rooms, the offices for the State Geologist, Assistant and Secretary, while the fourth serves the purpose of mailing room and for storage.

MUSEUM.

In its new location the room used for the exhibition of geological material and for the main library occupies approximately 750 square feet. Six cases have been built which serve both the purpose of exhibition and storage, but much other material now in storage could be placed on exhibition if more space and additional cases were provided. The present cases are filled, both as to exhibition and storage space, and specimens collected in the future will have to remain packed in boxes until such time as ad-

ditional space becomes available. The collection of fossils and minerals will be added to as rapidly as they can be properly cared for.

LIBRARY.

The Survey library now contains several thousand volumes, and is a fairly complete reference library for our purposes. Many volumes, particularly those of foreign Geological Surveys, are stored elsewhere temporarily owing to an insufficient number of bookcases to accommodate them in the library.

RECOMMENDATIONS.

CLAY TESTING LABORATORY.

The clays of Florida should be investigated and reported upon. As is shown by the number of requests, demand for information on the properties of the clays of the State is increasing. The physical property of a clay can only be determined by proper clay testing machinery, with which the Geological Survey is not equipped. A clay testing laboratory should be installed so that a thorough, systematic investigation of the clays of the State could be made. At present space in which to install clay testing machinery is not available and the State Survey cannot make tests of clays until adequate provisions are made.

MEASUREMENTS OF STREAMS AND SPRINGS.

The water powers of the State should receive attention. A systematic study of these requires a knowledge of the drainage systems, which in instances are quite complicated. Gauges should be installed on the more promising rivers and streams and records should cover a sufficient period of time to give accurate data for seasonal variations of flow.

Likewise, the springs of the State should be gauged. In Florida are found the largest springs in the world, and estimates of flow from these should be available. Estimates of the volume of flow from many of these, particularly the larger ones, have been made at different times but it would be of considerable inter-

est and desirable to have data on the fluctuation of flow which could be gotten only by records covering a stated period.

Co-operation in the matter of the gauging of streams could be arranged with the Water Resources Branch of the United States Geological Survey and it is urged that provision be made for entering into such co-operation.

CO-OPERATION WITH OTHER ORGANIZATIONS.

The Florida Geological Survey has co-operated with the United States Geological Survey, as in former years, in the collection of statistics on the mineral production in Florida. This co-operation has been found highly desirable and advantageous since it eliminates the possibilities of discrepancies in statements which might occur when such statistics are collected separately by each Survey.

TOPOGRAPHIC MAPPING.

In this day of rapid development in the State coupled with undertakings of vast magnitude such as the enormous drainage projects, the plans for and the construction of permanent systems of highways, renewed activity in railroad extensions, etc., nothing could better serve as an essential aid in this development than detailed topographic maps. These maps are as accurate as the scale used (approximately a mile to the inch) will allow, showing every natural surface feature, such as rivers and creeks, springs, lakes, swamps and marshes, hills and valleys, sink-holes and rock outcrops in addition to artificial features as cities and towns, schools, churches and other buildings, railroads, highways, as well as minor roads, and bridges. In fact, such maps as these prepared by the United States Geological Survey are indispensable to the most intelligent development of many of the State's resources and industries. With their aid the construction engineer can lay out a right-of-way for either highway or railroad without the expense of the preliminary survey and the drainage engineer can lay out a system of canals and ditches in the office almost to better advantage than in the field. To the general public, and particularly to those who travel, the maps are of great convenience and benefit, for a moment's glance reveals the exact physiography and general nature of the country mapped.

As a base map on which to show the distribution of different soil types topographic maps are of very great assistance. Not only do they serve as an exact base map for the area to be soil surveyed, thus reducing the cost of the soil map itself, but they facilitate the study of the soils which, as is known, bear close relations with drainage and moisture conditions. They are practically indespensable in the preparation of detailed, final geologic maps and reports.

The accumulation of oil or gas in commercial quantity is greatly dependent upon favorable geologic structure of formations. With the constant increase of interest in the problem of oil and gas being found in Florida, topographic maps could facilitate accurate work on geologic structure. In a state like Florida, with comparative little relief and consequently but few continuous exposures of the different geological formations, evidence of structure must be gotten from many single disconnected exposures. The working out of structure so as to determine anticlines, synclines and folds in the strata is no easy problem at best, but these maps, showing as they do elevations by means of contours at 10-foot intervals, would make the problem easier of solution.

CO-OPERATION WITH UNITED STATES GEOLOGICAL SURVEY IN TOPOGRAPHIC MAPPING.

It is with an appreciation and realization of the value of such maps that the Florida Geological Survey is desirous of co-operating with the United States Geological Survey in their preparation. As many as 24 quadrangles lying wholly or partly within the State and covering about 250 square miles each, have already been topographically surveyed. According to an estimate by the United States Geological Survey the mapping so far completed covers seven per cent of the total area of the State. From the same source it is learned that only one other State in the entire United States falls below this percentage. All of the areas mapped, except seven lying in central peninsular Florida embracing a portion of the hard rock phosphate belt, and surveyed shortly after the discovery of phosphate, have been mapped in recent years. In fact, it was due primarily to military necessity for the information gained from such maps that the War Department co-operated with the United States

Geological Survey during the recent war and prepared the greater number of the maps embracing a portion of northeastern Florida.

The usefulness of these maps calls for the continuation of work along these lines, with the State bearing its proportionate part of the cost. To do this increased funds must be made available. The willingness on the part of the United States Geological Survey to aid in this work is shown by the offer to cooperate with the Florida Geological Survey on a dollar for dollar basis. In addition, the expense of printing and engraving is borne by the Federal Survey. It is recommended that at least $5000.00 be appropriated each year by the State for the prosecution of field work in order that the mapping may progress and be completed within a reasonable number of years.

OIL PROSPECTING.

Interest in the probability of finding oil and gas in Florida is increasing and much money is being spent in drilling test wells at the present time. During the past several years a number of such wells have been drilled in the State, particularly in the peninsular portion, the deepest in that section being one near Bushnell, in Sumter County, which reached a depth of 3080 feet.

The area in which prospecting is now most active is in the northern and western portion of the State. Wells are being drilled near Burns in Wakulla County about fifteen miles south of Tallahassee, near Clarksville in northern Calhoun County, near Chipley in northern Washington County, and two in Walton County, near Mossy Head and Bruce. Other wells are to be commenced in the near future, locations having been decided upon, operations only awaiting the delivery and placing of the drilling rig and other necessary machinery.

It is becoming more and more generally recognized that the accumulation of oil and gas is dependent upon the character and structure of the underlying geological formations. A detailed study of the geology of the region should be made before a location for a test well is decided upon. These studies should cover a large territory in order to make it possible to properly correlate the different formations and the structure within them. Some of the promoters of the wells that have been and are being drilled

in Florida have appreciated this fact and have decided upon a location only after considering reports on the geology covering their properties and surrounding country. In order, however, that the reliability of such reports be unquestioned they should be prepared by one who is a geologist of recognized standing thereby not only demanding but meriting that confidence be placed upon the results of his investigations.

The State Geological Survey in the regular course of its investigations has accumulated considerable data relative to the structure of formations in Florida. Much of this has been published in the various papers on geology as contained in the several annual reports but such data are constantly being added to. A study of the structure of formations in Florida is a rather tedious task owing to the comparative slight relief with correspondingly few continuous geologic exposures. In addition, erosion, especially by solution and subsidence, has been most active in our formations thus increasing the difficulty of working out structure in any particular formation or horizon. It is thus only through detailed work and cautious interpretations that the most reliable results can be obtained.

Of invaluable assistance in the furtherance of these studies would be topographic maps on which all surface exposures and other related data could be located and on which structure contours could be plotted. In addition accurate well records, based on samples of the drillings taken at frequent intervals, have contributed important data to our knowledge of the succession of formations in Florida. Efforts on the part of the Survey to secure well samples have had results and such sets of drillings as have been procured have been studied in detail, one paper being published in the Twelfth Annual Report and a second being included in the present volume. Through the courteous co-operation of well contractors and promoters the Survey is at present receiving excellent sets of carefully taken well drillings and it is a privilege to acknowledge this co-operation which will add much to our present knowledge of the geology of the State. It is urged that those who contemplate drilling any wells, particularly those that may go to exceptional depth, save samples of the cuttings and submit them to the State Geologist, Tallahassee, Fla., who will study them and submit a descriptive log. Too much emphasis

can not be placed on the importance of saving samples of the drillings from all the deep wells that are drilled for whatever purpose. These should be carefully collected at frequent intervals regardless of whether there is a change in the formation or not and properly labeled as to the depth from which they were taken.

Of interest in consideration of the subject of oil in Florida is a Press Bulletin of the United States Geological Survey which appeared during April 1920. This bulletin relates to Peninsular Florida, in fact that portion of the State lying from Suwannee County eastward. The title as first published is misleading in that it includes the entire State but from the subject matter it is readily seen that the area lying from Suwannee County westward is not treated. The bulletin referred to is herewith republished with the insertion of the word "Peninsular" in the title:

DRILLING FOR OIL IN PENINSULAR FLORIDA.

ADVICE GIVEN BY GOVERNMENT GEOLOGIST.

Wells have been drilled for oil in every State in the Union except the New England States and possibly four others—North Carolina, South Carolina, Nevada, and Idaho. Only sixteen states, however, can be called oil-producing. A number of deep wells have been drilled in Florida, the deepest being one near Bushnell, in Sumter County, which was carried to a depth of 3,080 feet. This well and one near Waycross, in southern Georgia, which was drilled to a depth of 3,045 feet, are two of the deepest wells in the Atlantic Coastal Plain.

GEOLOGISTS NOT HOPEFUL OF SUCCESS.

Although the deep wells drilled in Florida have yielded no indications of oil the interest in the possibility of finding oil there has not been diminished by their failure but has actually increased with the increase in the prosperity of the State, so that much money has been spent in drilling test wells in areas where oil is not likely to be found. As additional wells will no doubt be drilled in Florida the results of geologic field work done by O.

B. Hopkins, and other members of the United States Geological Survey, Department of the Interior, in co-operation with the Florida State Geological Survey, may have some value in future exploration.

The geologists of the United States Geological Survey are not very hopeful that oil will be found anywhere in the Atlantic Coastal Plain, because the stratigraphy and the structure of the beds of rock in that area are in many ways different from those of the beds in the Gulf Coastal Plain, where oil has been found.

GEOLOGIC FORMATIONS IN FLORIDA.

The intelligent selection of a location for drilling a test well involves the consideration of (1) the character of the formations that underlie within a reasonable drilling depth the area to be tested and (2) the structure of the beds, which controls the accumulation of oil. The beds in Florida lie nearly flat and are poorly exposed at the surface, so that the information thus far obtained in regard to both these features is meager. The formations that underlie the center of the peninsula of Florida at a relatively shallow depth do not, so far as known, appear anywhere at the surface in the State, but beds of the same age outcrop 250 miles to the north, in central Georgia. As these formations vary widely in character from place to place the only knowledge of their character in this part of Florida must be obtained from well borings.

The Ocala limestone, of Eocene age, found near Ocala, in central Florida, is the oldest formation exposed in the State. Oil will probably not be found in it or in any of the other younger formations that outcrop in Florida, for none of them contain much bituminous matter. They consist largely of limestone. The formations below the Ocala, which have been drilled into at a number of places, consist chiefly of white limestone, of Lower Cretaceous age. At Bushnell more than 2,800 feet of limestone, interbedded with thin beds of fine sand, of Lower Cretaceous age, has been penetrated by the drill. These limestones are probably underlain in this part of Florida at no great depth by old crystalline rocks, such as form the Piedmont area of northern Georgia.

If any showings of oil have been found in the wells so far drilled they were small, and the great thickness of limestone underlying the surface formations in Florida does not encourage an expectation that oil will be found there in commercial quantities, for oil is usually associated with thick deposits of shale, in which it presumably originated. The evidence available at the present moment does not seem to justify sanguine hopes of developing an important oil field in this State.

STRUCTURE OF THE ROCK BEDS.

The dominant structural feature of eastern Florida is an anticlinal fold, or arch, which trends south-southeastward and forms the axis of the peninsula. The axis of this arch passes near Live Oak, 10 to 20 miles west of Gainesville, and an equal distance west of Ocala, and is the southern continuation of the broad anticlinal area of south-central Georgia. Along this anticline there are two high areas. The highest part of one, called the Ocala uplift, appears to be in eastern Levy County; that of the other is near Live Oak. The Ocala uplift is the larger and the higher. On this uplift the Ocala limestone is found 120 feet above sea level. From that elevation it dips toward the east to a depth of 200 feet below sea level at St. Augustine and 500 feet below sea level at Jacksonville.

The Ocala uplift is separated from the uplift near Live Oak by a low area, or saddle, which runs parallel to the axis of the anticline to a point near Santa Fe River, in southern Columbia County.

From that point the beds appear to rise gently to form a dome-shaped fold near Live Oak. The Ocala limestone is found at Suwannee, Ellaville, Dowling Park, and Luraville, on Suwannee River, at elevations ranging from 35 to 45 feet above sea level, whereas the Chattahoochee limestone, which overlies it, is 120 feet above sea level at Live Oak. As the Chattahoochee here has an estimated thickness of 30 to 40 feet, the Ocala is probably 40 feet higher at Live Oak than at any of the exposures on the Suwannee or at Bass, a fact which suggests the inference that a dome-like uplift centers at Live Oak. This inference is strengthened by the fact that the top of the Chattahoochee limestone stands at an ele-

vation of only 75 to 80 feet above sea level along the Georgia-Florida line, or about 40 feet lower than it is near Live Oak. The existence of this dome appears to be indicated also by the swing of Suwannee River around Live Oak; instead of continuing its southerly course, it bends to the west-northwest near White Springs and circles around Live Oak before continuing its course toward the Gulf. The existence of the Okefenokee Swamp, which is drained chiefly by Suwannee River, may be due in part to the deflection of the river by the Live Oak uplift. From an elevation of about 80 feet above sea level at Live Oak, the Ocala limestone dips eastward to about 500 feet below sea level at Jacksonville and about 300 feet or more below sea level at Waycross.

BEST PLACE TO DRILL.

As the Live Oak uplift is smaller and somewhat better defined than the Ocala uplift it may offer more favorable conditions for the accumulation of oil or gas, if any exist in this region. The highest part of this uplift appears to be near Live Oak, and a well sunk near that place would therefore be structurally most favorably located. A well drilled here to a depth of more than 3,000 feet will probably penetrate limestone, thin beds of fine sand, and perhaps some shale.

"Wildcatting," as drilling for oil in an area not known to be oil bearing is called, is the wildest kind of speculation, and it should be indulged in only by those who are able to lose money. The United States Geological Survey does not recommend wildcatting in Florida; it merely suggests that the structure at Live Oak may be as favorable as at any other place in the State for the accumulation of oil, and that any company which desires to drill a test well in Florida should consider this locality.

In view of the increasing interest in the possibilities of finding oil in Florida and the insistent demand for information on this subject provisions have been made whereby it is planned to have a report ready for printing in our next annual report.

EXPENDITURES OF THE GEOLOGICAL SURVEY FOR THE PERIOD FROM JANUARY 1, 1919 TO JUNE 30, 1920.

There is given below a detailed list of the warrants issued showing the expenditures of the Survey from January 1, 1919 to June 30, 1920. A list of warrants previously issued has been published in the various Annual Reports. The total amount appropriated for the maintenance of the State Geological Survey is, as it has been from the beginning, $7,500 per annum; which was sufficient at first, but is wholly inadequate for maintaining an efficient department now since the dollar has shrunk to about one-half its former value. All accounts are approved by the Governor and are paid only by warrant drawn upon the State Treasurer by the Comptroller, no part of the fund being handled direct by the State Geologist. The original bills and itemized expense accounts are on file in the office of the Comptroller, duplicate copies being retained in the office of the State Geologist. The paid warrants are on file in the office of the State Treasurer.

LIST OF WARRANTS ISSUED FROM JANUARY 1, 1919 TO JUNE 30, 1920.

JANUARY, 1919.

Herman Gunter, assistant, salary for January, 1919	$150.00
Herman Gunter, assistant, expenses for January, 1919	18.05
Fred Collins, janitor services	10.00

FEBRUARY, 1919.

Herman Gunter, assistant, salary for February, 1919	150.00
Fred Collins, janitor services	10.00

MARCH, 1919.

Herman Gunter, assistant, salary for March, 1919	150.00
Fred Collins, janitor services	10.00
Economic Geology Publishing Co. subscription	3.50

APRIL, 1919.

E. H. Sellards, State Geologist, April 1-18, salary	123.63
Herman Gunter, assistant, salary, April 1-18	90.00
Herman Gunter, assistant, expenses, April, 1919	4.85
Daisy Gwaltney, stenographic services	6.00

Fred Collins, janitor services	10.00
H. F. Wickham, services in identifying fossils	25.00
Wrigley Engraving and Electrotype Co.	18.17
H. R. Kaufman, supplies	4.20
George I. Davis, postmaster, postage	23.95
E. O. Painter Printing Co., printing	371.00
Western Union Telegraph Co.	1.21

MAY, 1919.

Daisy Gwaltney, stenographic services	24.00
Fred Collins, janitor services	10.00
E. O. Painter Printing Co.	21.25
W. C. Dickson, freight and drayage	3.80
George I. Davis, postmaster	33.84
George I. Davis, postmaster	5.70
University of Chicago Press	3.60
T. J. Appleyard, printer	31.50

JUNE, 1919.

Herman Gunter, State Geologist, April 19 to June 30	501.37
Herman Gunter, State Geologist, expenses April to June	34.65
Daisy Gwaltney, stenographic services	36.00
Fred Collins, janitor services	10.00
E. O. Painter Printing Co., printing	400.60
W. C. Dixon, freight and drayage	13.84
Yaeger-Rhodes Hdw. Co., office supplies	6.50
H. R. Kaufman, office supplies	11.95
E. G. Chesley, Jr.. office supplies	7.75
T. J. Appleyard. stationery, printing, etc.	30.50
George I. Davis, stamped envelopes	67.24
American Railway Express	2.52

JULY, 1919.

Mrs. L. B. Robertson, stenographic services	100.00
Fred Collins, janitor services	10.00
H. & W. B. Drew Co., office supplies	3.01
J. F. Hill, office supplies	4.50

AUGUST, 1919.

Herman Gunter, State Geologist, expenses July and August	36.40
Mrs. L. B. Robertson, stenographic services	100.00
Sam Cobb, services	19.50
Fred Collins, janitor services	10.00
American Peat Society, subscription	3.00

H. & W. B. Drew Co., office supplies	1.08
Ed. H. Hopkins, lights in storeroom	47.95

SEPTEMBER, 1919.

Herman Gunter, State Geologist, salary July 1 to Sept 30	625.00
Herman Gunter, State Geologist, expenses	34.06
Mrs. L. B. Robertson, stenographic services	100.00
Sam Cobb, services	2.25
Fred Collins, janitor services	10.00
W. L. Marshall, work in storeroom	60.30
American Railway Express	1.07
G. I. Davis, postage	26.00

OCTOBER, 1919.

Herman Gunter, State Geologist, expenses October	31.22
Mrs. L. B. Robertson, stenographic services	100.00
Fred Collins, janitor services	10.00
John Wiley & Sons, publications	5.00
H. & W. B. Drew Co., supplies	25.65
American Railway Express	.89
T. J. Appleyard, 1,000 press bulletins	20.00

NOVEMBER, 1919.

Herman Gunter, State Geologist, expenses November	29.00
Mrs. L. B. Robertson, stenographic services	100.00
Fred Collins, janitor services	10.00
Miss E. W. Marshall, copy tabulations mineral resources	8.13
G. D. Harris, Bull. 31 of American Palaeontology	5.70
Joseph A. Cushman, special services	500.00
D. R. Cox Furniture Co., bookcases	60.75

DECEMBER, 1919.

Herman Gunter State Geologist, salary Oct. 1 to Dec. 30	625.00
Herman Gunter, State Geologist, expenses December	32.20
Mrs. L. B. Robertson, stenographic services	100.00
Fred Collins, janitor services	10.00
American Journal of Science, subscription	6.00
H. R. Kaufman, supplies	1.20

JANUARY, 1920.

Herman Gunter, State Geologist, expenses January	32.32
Mrs. L. B. Robertson, stenographic services	100.00
Fred Collins, janitor services	10.00

Geo. I. Davis, postmaster, postage	24.00
Economic Geology, subscription	4.00
American Peat Society, subscription	3.00
Scientific Materials Co., specimen jars	15.84
American Railway Express	3.17

FEBRUARY, 1920.

Mrs. L. B. Robertson, stenographic services	100.00
Fred Collins, janitor services	10.00
Orville Barnes, extra janitor services	4.50
Millhiser Bag Co., supplies	32.79
B. J. Temple, finishing floors	25.00
American Railway Express	2.10
Southern Telephone & Construction Co.	3.50
Dixon Transfer, moving office furniture	41.50

MARCH, 1920.

Herman Gunter, State Geologist, expenses March	23.54
Herman Gunter, State Geologist, salary Jan. 1 to March 31	625.00
Mrs. L. B. Robertson, stenographic services	100.00
Fred Collins, janitor services	15.00
Sam Cobb, services	14.25
Geo. B. Perkins, office rent	41.66
D. R. Cox Furniture Co., supplies	34.00
E. G. Chesley, Jr., supplies	42.25
Southern Telephone & Construction Co.	3.50
Yaeger-Rhodes Hardware Co., supplies	10.45
H. R. Kaufman, cleaning typewriter and supplies	11.00
D. Van Nostrand Co., publication	2.00
T. J. Appleyard, printing and supplies	15.59

APRIL, 1920.

Herman Gunter, State Geologist, expenses April	62.38
R. M. Harper, assistant, salary for April	175.00
R. M. Harper, assistant, expenses April	53.68
Mrs. L. B. Robertson, stenographic services	100.00
Sam Cobb, services	9.00
Fred Collins, janitor services	15.00
Geo. B. Perkins, office rent	41.66
Southern Telephone & Construction Co.	3.50
W. L. Marshall, job work	9.25
Scientific Materials Co., supplies	40.86
Commercial Fertilizer, subscription	2.00
D. R. Cox Furniture Co., office and library supplies	90.50

Leon Electrical Supply Co., supplies	1.65
American Railway Express	8.74
Clark's Book Store, supplies	4.54
T. J. Appleyard, mounting maps, letter heads	12.50
Tallahassee Variety Works, 3 showcases	398.15
W. C. Dixon, drayage	2.00
E. G. Chesley, Jr., supplies	4.50

MAY, 1920.

R. M. Harper, assistant, salary for May	175.00
Mrs. L. B. Robertson, services	100.00
Geo. B. Perkins, office rent	41.66
Middle Florida Ice Company, coupon books	10.00
H. H. Bohler, signs	16.00
Southern Telephone & Construction Co.	3.50
University of Chicago Press, subscription	3.60
H. & W. B. Drew Co., supplies	3.55
Sam Cobb, services	9.00
D. R. Cox Furniture Co., supplies	3.00
E. G. Chesley, Jr., supplies	5.00
Dixon Transfer, drayage	4.50

JUNE, 1920.

Herman Gunter, State Geologist, salary April 1 to June 30	625.00
R. M. Harper, assistant, salary for June	175.00
Mrs. L. B. Robertson, services	100.00
Geo. B. Perkins, office rent	41.66
Southern Telephone & Construction Co.	3.50
Yaeger-Rhodes Hardware Co., supplies	1.00
Geo. I. Davis, postmaster, box rent and stamps	31.00
Geo. I. Davis, postmaster, 2,000 stamped envelopes	43.44
H. & W. B. Drew Co., office supplies	4.90
American Railway Express	12.13
W. L. Marshall, repairs and job work	5.00
Scientific Materials Co., supplies	4.50

STATISTICS ON MINERAL PRODUCTION IN FLORIDA DURING 1918.*

HERMAN GUNTER

COLLECTED IN CO-OPERATION BETWEEN THE FLORIDA GEOLOGICAL SURVEY AND THE U. S. GEOLOGICAL SURVEY.

The total value of the mineral production in Florida during 1918, as shown by statistics recently compiled, is $8,009,646, an increase over that for 1917, amounting to almost one-half million dollars, the total for this latter year being $7,534,834.

The total mineral production in 1918 shows a decrease when compared with the output for 1917. This decrease in quantity is attributable to general labor conditions, transportation facilities and to governmental restrictions in force during the war period. Increased production costs were attended with an increase in price of the commodities marketed which is shown by the increase in the total valuation stated above.

BALL CLAY OR PLASTIC KAOLIN

The ball clays of Florida are white burning, refractory clays of high plasticity. The clay is quite widely distributed in central peninsular Florida being commercially produced in Putnam and Lake counties. The manner of occurrence is in association with a rather coarse sand and quartz pebbles, from which it is separated by washing. During 1918 three plants were engaged in mining ball clay in Florida. These were the Edgar Plastic Kaolin Company, Edgar; the China Clay Corporation, Okahumpka; and the Lake County Clay Company, Okahumpka. The value of the clay produced is not separately given, but is included in the total mineral production of the State.

*First published as Press Bulletin No. 11, October 6, 1919. Reprinted here with a few additions.

BRICK AND TILE

The conditions prevailing during the year 1918 were unfavorable to the brick and tile industry, due to governmental building restrictions, which of necessity reduced the demand and resulted in a decided decrease in the volume of business. The total number of common brick manufactured in Florida during 1918 was 17,561,000. In addition to building brick, there was also produced tile, drain-tile and fire-proofing brick. The total value of brick and tile products for the year 1918 was $181,339.

The following firms in Florida reported the production of brick during 1918:

Barrineau Bros., Quintette.
Campville Brick Company, Campville.
Clay County Steam Brick Company, Green Cove Springs.
Dolores Brick Company, Molino.
Florida State Reform School, Marianna.
Gamble & Stockton Co., 108 W. Bay St., Jacksonville.
G. C. & C. H. Guilford, Blountstown.
Glendale Brick Works, Glendale.
Hall & McCormac, Chipley.
Keystone Brick Company, Whitney.
Law & Co., Brooksville.
Lee Miller, Whitney.
Joe Messina, Palm Beach County.
Ocklocknee Brick Company, Ocklocknee.
Tallahassee Pressed Brick Company, Havana.
Whitney Brick and Manufacturing Company, Whitney.
Wilson-Owens Brick Company, Callahan.

FULLER'S EARTH

The Fuller's earth industry of Florida was very active during 1918. The abnormal demand for fuel oils and gasoline had its reflection in the increased demand for Fuller's earth. The principal use of the Florida Fuller's earth is in clarifying and filtering mineral oils, although during recent years experiments with this earth in the refining of edible oils and fats have proven very satisfactory, and its use for this purpose is increasing. Florida has been the chief producer of Fuller's earth since the beginning of

the industry, and is credited with approximately four-fifths of the total production in the United States for the year 1918. The statistics on production are not separately given, but are included with the total mineral production of the State.

The following companies are engaged in the mining of Fuller's earth in Florida:

The Atlantic Refining Company, Ellenton.
The Floridin Company, Quincy and Jamieson.
The Fuller's Earth Company, Midway.
The Manatee Fuller's Earth Corporation, Ellenton.

ILMENITE

The production of ilmenite (an oxide of titanium and iron, used chiefly in the manufacture of steel) from the beach sands at Pablo Beach, which was begun in 1916 by Buckman & Pritchard, Inc., was continued during 1918. The value of this product is not included in the summary statement of mineral production for the year. Considerable quantities of zircon and other rare minerals are associated with it.

LIMESTONE

The total amount of limestone produced in Florida for quick lime, building, road-making, railroad ballast, and agricultural purposes, and including also the flint rock associated with the limestone, is valued at $365,293. The following companies in Florida have reported the production of lime, limestone or flint for the year 1918:

Florida Lime Company, Ocala.
Blowers Lime and Phosphate Company, Ocala.
Crystal River Rock Company, Crystal River.
Live Oak Limestone Company, Live Oak.
Florida Crushed Rock Company, Montbrook.
E. P. Maule, Ojus.
Pineola Lime Company, Pineola.
A. T. Thomas & Co., Ocala.

PEAT.

Production of peat in 1918 was reported from Marion County by the Alphano Humus Company, Ocala, Florida. The peat pro-

duced by this company is placed on the market in the form of prepared humus and is used largely as a fertilizer filler. This being the only plant reporting for this year, the production is not listed separately, but is included with the total for the State.

PHOSPHATE

The following statement on the production of phosphate in Florida was issued by the State Geological Survey in June, 1919, as Press Bulletin No. 10*:

"The amount of phosphate rock shipped from Florida, although the production was very much curtailed during the European War, was greater in 1918 than that of the preceding year. The statistics, which are collected by the Florida Geological Survey in cooperation with the United States Geological Survey, indicate that during 1918 the total shipment of phosphate rock from Florida was 2,067,230 long tons, as compared with 2,022,599 long tons in 1917, an increase over that year of almost fifty thousand tons. Of this amount, 1,996,847 tons were land pebble phosphate, the remainder being hard rock and soft phosphate. Of the total shipments only 104,946 tons were consigned to foreign markets, showing a decrease over the amount exported in 1917. The domestic consignments, however, were more than 25,000 tons in excess of those for the preceding year.

"The increase in shipment was principally from the hard rock mines, the output from this area being more than three times that in 1917. The shipment from the pebble field for 1918 remained practically the same as for 1917. The decided increase of shipments from the hard rock over the pebble rock mines is quite the reverse of the past few years, since it has been from the pebble field that increases have been most rapid. During the period of the war, production was greatly interfered with, some companies closing for a portion of the time, others running periodically, still others operating regularly but at a reduced capacity of output. Regardless of market conditions, several mines operated during the year on a reduced scale, with the result that at the close of the year there were quantities of rock in storage awaiting shipment.

*The Phosphate Industry of Florida During 1918, by Herman Gunter, Fla. State Geol. Surv., Press Bulletin No. 10, June 5, 1919.

"The value of the phosphate shipped from Florida in 1918, according to returns from the producers, is as follows: Land pebble, $5,565,928; hard rock, including soft phosphate, $524,178, making a total valuation of $6,090,106. The value of shipments during 1917 was $5,464,493. An increase of more than $600,000 is thus indicated in total value of shipments for the year 1918 over that of 1917. The total production of phosphate rock in Florida since the beginning of the industry in 1888 to the close of 1918, according to statistics collected by the Florida Geological Survey and the United States Geological Survey, is estimated to be 35,210,314 tons, with a total valuation of $129,055,787.

"The quantity of rock mined during the year is necessarily not the same as the amount shipped, for there are variable amounts on hand and held in storage at the close of each year. The total quantity of phosphate mined in Florida in 1918 was 1,884,891 tons. The quantity mined in 1917 was 2,328,138 tons. This decreased output of 443,247 tons in 1918, as compared with 1917, reflects the conditions due to our entry into the war, such as difficulty in getting labor, restrictions placed on and subsequent shortage and increased cost of fuel and lack of shipping facilities."

SUMMARY OF SHIPMENT OF PHOSPHATE IN FLORIDA FROM 1914 TO 1918, INCLUSIVE

	1914	1915	1916	1917	1918
Pebble Rock:					
Exported	625,821	185,846	172,427	138,010	64,558
Domestic	1,203,381	1,122,635	1,296,331	1,865,981	1,932,289
Total shipment	1,829,202	1,308,481	1,468,758	2,003,991	1,996,847
Hard Rock:					
Exported	303,172	43,314	28,045	12,403	57,771
Domestic	6,517	6,816	19,042	6,205	12,612
Total shipment	309,689	50,130	47,087	*18,608	*70,383
Pebble and Hard Rock Combined:					
Exported	928 993	229,160	200,472	150,413	122,330
Domestic	1,209,898	1,129,451	1,315,373	1,872,186	1,932,288
Total shipment	2,138,891	1,358,611	1,5'5,845	2,022,599	2,067,230

Total shipments from beginning of mining in 1888 to 1918, inc., 35,210,278.

*Includes soft rock phosphate.

LIST OF PHOSPHATE MINING COMPANIES OF FLORIDA, 1918.

Acme Phosphate Company	Morriston, Fla.
Alachua Phosphate Company	Gainesville, Fla.
American Agricultural Chemical Co.	2 Rector St., New York, N. Y., and Pierce, Florida.
American Cyanamid Co.	511 Fifth Ave., New York, N. Y., and Brewster, Fla.
Armour Fertilizer Works	Union Stock Yards, Chicago, Ill., and Bartow, Fla.
P. Bassett	Newberry, Fla.
Peter B. and Robt. S. Bradley	92 State St., Boston, Mass., and Floral City, Fla.
J. Buttgenbach & Co.	Holder, Fla.
C. & J. Camp	Ocala, Fla.
Charleston, S. C., Mining and Manufacturing Co.	Richmond, Va., and Ft. Meade, Fla.
Coronet Phosphate Co.	99 John St., New York, N. Y., and Plant City, Fla.
Cummer Lumber Co.	Jacksonville and Newberry, Fla.
Dunnellon Phosphate Co.	106 E. Bay St., Savannah, Ga., and Rockwell, Fla.
Export Phosphate Co.	87 Milk St., Boston, Mass., and Mulberry, Fla.
Florida Phosphate Mining Corporation	Dickson Bldg., Norfolk, Va., and Bartow, Fla.
Florida Soft Phosphate and Lime Co.	Ocala and Citra, Fla.
Franklin Phosphate Co.	Newberry, Fla.
Holder Phosphate Co.	220 W. Ninth St., Cincinnati, O., and Inverness, Fla.
International Agricultural Corporation	61 Broadway, New York, N. Y., and Mulberry, Fla.
International Phosphate Co.	27 State St., Boston, Mass., and Ft Meade, Fla.
Lakeland Phosphate Co.	Lakeland, Fla.
Mutual Mining Co.	102 E. Bay St., Savannah, Ga., and Floral City, Fla.
Otis Phosphate Co.	Benotis, Fla.
Palmetto Phosphate Co.	812 Keyser Bldg., Baltimore, Md., and Tiger Bay, Fla.
Phosphate Mining Co.	55 John St., New York, N. Y., and Nichols, Fla.
Seminole Phosphate Co.	Croom, Fla.
Schilman and Bene	Ocala, Fla.
Societe Universelle de Mines, Industrie, Commerce et Agriculture	Pembroke, Fla.
Southern Phosphate Development Co.	Inverness, Fla.
Swift & Co.	Union Stock Yards, Chicago, Ill., and Bartow, Fla.
T. A. Thompson	Ft. White, Fla.

SAND AND GRAVEL

The sand produced in Florida is used principally for building, paving and road-making, filtering, molding, cutting, grinding and blast purposes. The gravel produced is reported as used for roofing material and for railroad ballast. Deposits of clayey sands and gravels occurring in the southern part of Jackson County have also been quarried and used as road surfacing materials. The total production of sand and gravel for 1918, as shown by returns from the producers, was 158,489 tons, valued at $48,768.

The companies reporting the production of sand and gravel in Florida during 1918 are the following:

Atlantic Coast Line Railroad Company.
Akerman & Ellis, Lake Weir.
Interlachen Gravel Company, Interlachen.
Tallahassee Pressed Brick Company, Havana.
Tampa Sand and Shell Company, Tampa.

SAND-LIME BRICK

The materials used in the manufacture of sand-lime brick are sand and lime. The bonding power of the brick is due to the chemical reaction between these ingredients. The chemical changes occur in the presence of heat, pressure and moisture and result in the formation of hydro-silicates of calcium and magnesium.

The sand used in the manufacture of sand-lime should be comparatively pure and preferably with some variation in the size of the grains. The mixture of lime, sand and water is cut in the form of bricks and conveyed to a hardening cylinder. Necessary heat and pressure are obtained in the hardening cylinder adapted for the purpose. The sand-lime bricks are placed in this cylinder and subjected to a pressure and temperature which vary according to the method of treatment.

Two companies were actively engaged in the manufacture of sand-lime brick in Florida during 1918 as follows:

The Bond Sandstone Brick Company, Lake Helen.
The Plant City Composite Brick Company, Plant City.

The production of sand-lime brick in Florida during 1918, although not separately listed, is included in making up the total mineral production of the State.

WATER

The total sales of mineral and spring water in Florida during 1918, as shown by the returns from the owners of springs and wells, amounted to 164,630 gallons, valued at $12,883.

The companies reporting the production of water for commercial purposes during 1918 include the following:

Espiritu Santo Springs Company, Espiritu Santo Springs, Safety Harbor, Florida.

Good Hope Water Company, Good Hope Mineral Water Well, Jacksonville, Fla.

Hampton Springs Water Company, Hampton Springs, Hampton Springs, Fla.

Purity Spring Water Company, Purity Spring, Tampa, Fla.

Tampa Kissengen Well Company, Stomawa Well, Tampa, Fla.

Summary statement of mineral production in Florida during 1918:

Common or building brick, fire-proofing brick, tile and drain tile	$ 181,339
Lime and limestone, including lime and ground limestone for agricultural use, and crushed rock for railroad ballast, concrete and road material	365,293
Mineral waters	12,883
Phosphate rock	6,090,106
Mineral products not separately listed, including ball clay, Fuller's earth, pottery products, abrasive material, sand lime brick, and sand and gravel	1,360,025
Total mineral production during 1918 valued at	$8,009,646

FORAMINIFERA FROM THE DEEP WELLS OF FLORIDA

(WITH MAP AND THREE PLATES IN TEXT)

JOSEPH A. CUSHMAN

A year ago I published the results of a preliminary study of the foraminifera of a number of deep wells of Florida.* A general account of the geological formations encountered in the drilling was given and but little attention was paid to the distribution of the species themselves. This paper gives the systematic information as to the foraminifera and especially those species of the Miocene and Upper Eocene formations. Those of lower age are not specifically described here as it is a rule of paleontology that new species should not be described from well borings because of the uncertainty of depth and the impossibility of giving a type locality from which future collections may be made. As a result these are simply placed in their genera and figures in most cases given in order that they may be available for future comparisons. In the previous paper already referred to mention was made of the sources of error which should be kept in mind in the study of well borings. Two things especially may again be noted: first that fossils may fall down from levels above that at which the drilling is actually taking place, especially when the well is not cased; and secondly, that fossils cannot be encountered until the depth has been reached at which they occur. Therefore fossils appearing below a horizon which has already been definitely fixed must have come from above and are accidental at that level. Many of the foraminifera from the well borings are not well preserved and little can be made out except the genus to which they belong. Also in several genera the different species have not been closely studied by workers on the foraminifera. Among numerous genera such as *Polystomella, Nonionina, Amphistegina*, etc., there are many different forms which are apparent in a study of the fossil material of the Coastal Plain and West Indian areas. These are usually

*Twelfth Annual Report of the Florida State Geological Survey, 1919, pp. 77-103.

rather definitely limited in their vertical distribution, and their careful discrimination should make possible a definite placing of these in their proper geological horizon. The various formations shown by the foraminifera will be discussed in the notes that follow. The location of the wells from which material was used are given in the following list and the accompanying map shows their distribution in the state. In the systematic portion of this paper references are given to the original descriptions and to published figures with a more complete reference to the distribution in the Coastal Plain area and that of the West Indies, both of which are related to the Florida well material.

The approximate locations of the wells, and the depths from which the material studied was obtained, are as follows, the numbers corresponding with those on the map. More detailed information about each was given in the previous paper and need not be repeated here. Samples were studied from the entire depth of the well unless otherwise indicated.

1. Panama City, Washington County, 470 feet.
2. Bonheur Development Co., near Burns, Wakulla County, 2,153 feet.
3. Jacksonville, Duval County, 980 feet.
4. St. Augustine, St. John's County, 160 to 1,051 feet.
5. Anthony, Marion County, 50 to 500 feet.
6. Eustis, Lake County, 100 to 180 feet.
7. Bushnell, Sumter County, 380 to 3,080 feet.
8. Apopka, Orange County, 50 to 390 feet.
9. Sanford, Seminole County, 95 to 113 feet.
10. Cocoa, Brevard County, a sample from 190 feet.
11. Tiger Bay, Polk County, 30 to 770 feet.
12. Okeechobee, Okeechobee County, 41 to 500 feet.
13. Boca Grande, Lee County, one inadequate sample.
14. Fort Myers, Lee County, 200 to 950 feet.
15. Marathon, Monroe County, 2,300 feet.

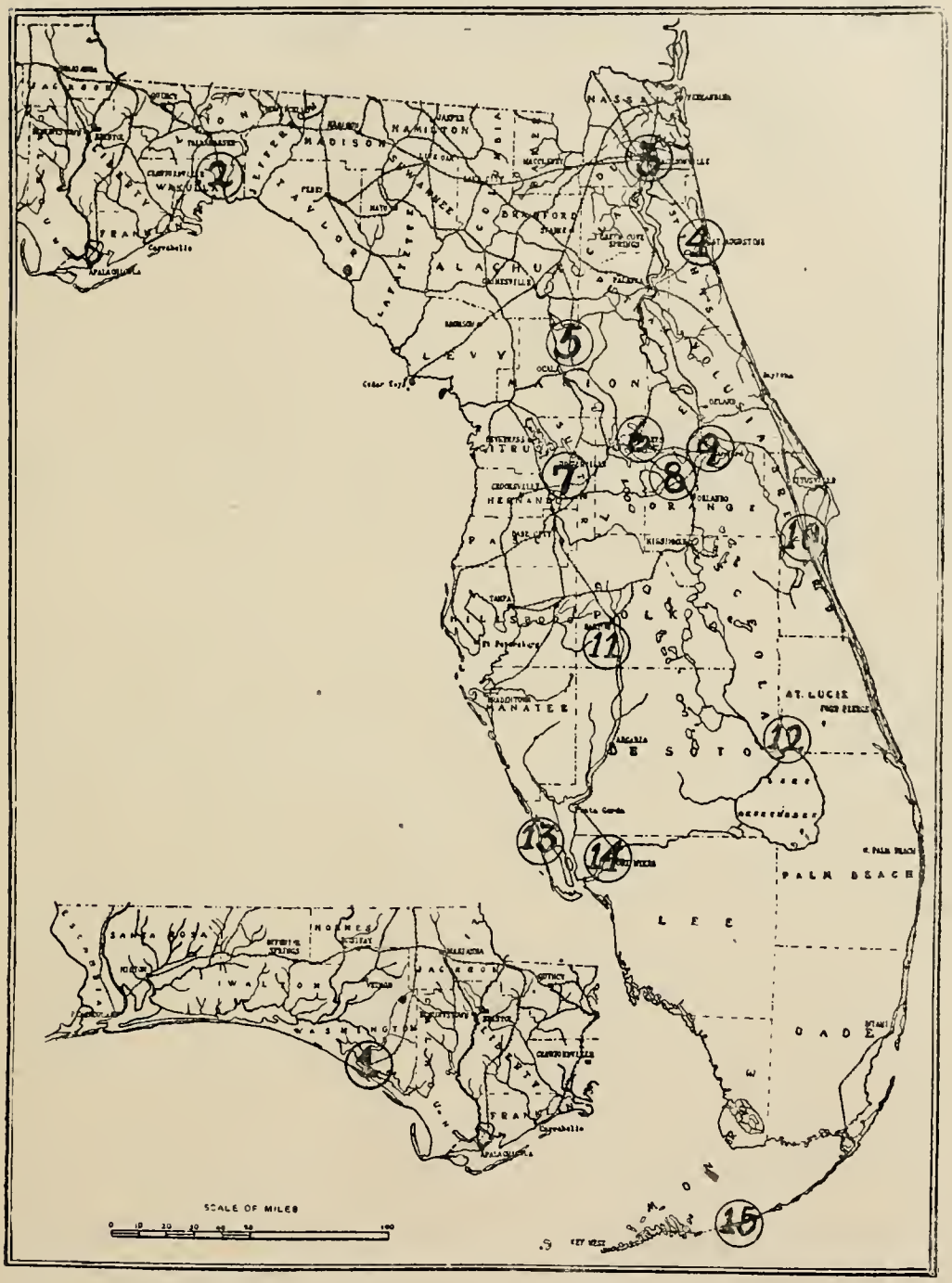

Fig. 1. Sketch map of Florida showing locations of wells from which foraminifera were obtained. Wells numbered as in the text.

PLEISTOCENE

From the known distribution of the Pleistocene of Florida several of the wells, and especially those in the southern part of the state undoubtedly penetrate Pleistocene sands for some distance near the surface. There are, however, no foraminifera in these sands which would give a definite clue as to their age.

PLIOCENE

In the earlier report I thought that there was a definite development of the Pliocene in the upper part of the well at Okeechobee. However, a study of the foraminifera from the upper levels—41 to 56 feet—shows that most of these have a Miocene relation rather than a Pliocene one. Therefore, the well samples give no definite information as to the distribution of the Pliocene below the surface.

MIOCENE

Only slight information was available at the time the previous paper was written, but a detailed study of the foraminifera has shown not only the occurrence of Miocene foraminifera in a number of wells, but that they have definite relations with the Miocene of other regions. The accompanying table shows the distribution of some of these Miocene species; their distribution in the Florida wells and their occurrence in related areas. As the table shows, certain of the levels in a number of wells are very definitely related to, if not identical with the Choctawhatchee Marl of Florida. This is especially marked in the well at Okeechobee, and the upper levels of the wells at St. Augustine, Fort Myers and Marathon The one species noted from the well at Jacksonville also seems to have this same relation. A number of species, especially those from the deeper parts of the wells at Fort Myers, Okeechobee and Marathon, seem to be more closely related to the Miocene of the Gatun formation of the Panama Canal Zone. A number of species also occur in the upper Oligocene of the Panama Canal Zone. The relations to the Miocene Marls of Cuba, Santo Domingo and Jamaica are also indicated.

As a result of this study, and allowing for errors in drilling, the Miocene may be rather definitely located at the following depths from these wells:

DISTRIBUTION OF MIOCENE FORAMINIFERA.

	Jacksonville.	St. Augustine.	Ft. Myers.	Okeechobee.	Marathon.	Choctawhatchee Marl, Fla.	Duplin Marl, N. & S. Carolina.	Carolinas, Virginia & Maryland.	Yumuri River near Matanzas, Cuba.	Santo Domingo.	Bowden, Jamaica.	Gatun formation, Canal Zone.	Upper Oligocene, Canal Zone.
Textulariidae													
Textularia abbreviata d'Orb.	---	200	---	---	---	---	---	X	---	---	---	---	X
Textularia gramen d'Orb.	---	200	---	403 458	---	X	---	X	---	---	---	---	---
Textularia agglutinans d'Orb.	---	---	---	380 403	---	---	---	X	---	---	---	---	X
Textularia panamensis Cush.	---	---	600	---	---	---	---	---	---	---	---	X	---
Verneuilina spinulosa Rss.	---	---	---	---	180	---	---	---	X	---	---	---	---
Gaudryina flintii Cush.	---	200	---	---	---	---	---	---	---	---	---	---	X
Clavulina communis d'Orb.	---	88	---	---	---	---	---	---	---	---	---	---	X
Virgulina squamosa d'Orb.	---	200 ---	---	158 245	---	---	---	---	---	---	---	X	---
Lagenidae													
Cristellaria rotulata Lmk.	---	---	---	---	398	---	---	---	---	---	---	X	---
Cristellaria americana var.	---	---	---	380	---	X	---	---	---	---	---	---	---
Cristellaria spinosa Cush.				458									
Polymorphina lactea (W. & J.)	510 550	200	---	---	180	X	---	X	---	---	---	---	---
Polymorphina elegantissima (P. & J.)	---	170	---	---	---	---	---	X	---	---	---	---	---
Globigerinidae													
Globigerina bulloides d'Orb.	---	---	---	380 403	180 398	X	---	X	X	X	X	X	X
Orbulina universa d'Orb.	---	---	---	380 403	---	---	---	---	X	X	---	X	---
Rotaliidae													
Discorbis bertheloti (d'Orb.)	---	---	---	41 56	---	X	---	X	---	---	---	---	---
Truncatulina refulgens (Mont.)	---	200	---	---	---	X	---	---	---	---	---	---	---
Truncatulina americana (Cush.)	---	88 200	300	41 458	180 398	X	X	X	---	---	---	---	X
Truncatulina pygmaea Hant.	---	---	360	---	398	---	---	---	---	---	---	X	X
Truncatulina basiloba Cush.	---	---	---	41 56	---	---	---	X	---	---	---	---	---
Rotalia beccarii (Linn.)	---	---	300	41 56	---	X	X	X	---	---	---	---	---
Nummulitidae													
Nonionina scapha (F. & M.)	---	---	---	87 94	180	X	X	X	---	---	---	X	---
Nonionina depressula (W. & J.)	---	88	---	---	---	---	---	X	---	---	---	X	---
Polystomella crispa (Linn.)	---	---	---	41 56	78	X	X	X	---	---	---	X	---
Polystomella craticulata (F. & M.)	---	88	680	---	---	---	---	---	---	---	---	---	X
Polystomella striato-punctata (F. & M.)	---	---	---	41 56	---	X	X	X	---	X	---	X	X
Amphistegina lessonii d'Orb.	---	---	300	56 62	180?	X	X	---	---	X	X	---	X
Asterigerina angulata Cush.	---	---	---	---	786	---	---	---	---	X	---	---	---

Figures are the depths in feet at which the species occur.

New City Well at Jacksonville, Duval County, Fla. The Miocene reaches its lowest limit somewhere between 510 and 550 feet. In this same range *Lepidocyclina* fragments occur, indicating that the line between these formations comes somewhere in those forty feet.

Ponce de Leon Well at St. Augustine, St. Johns County, Fla. Miocene foraminifera very definitely shown at 88, 170 and 200 feet. I had no material between 200 and 440 feet, therefore the lower limit of the Miocene can not be definitely determined.

Well No. 3 of the Palmetto Phosphate Company, near pit No. 1, about 2¾ miles northwest of Tiger Bay, Fla. Although the foraminifera were largely lacking or poorly preserved in the upper 310 feet, it is probable that a considerable amount of this should be placed in the Miocene.

City Well at Fort Myers, Lee County, Fla. From the specimens obtained at 300, 360, 600 and 680 feet, it is very clear that the levels between 300 and 600 feet should be definitely referred to the Miocene: that at 680 feet may possibly be Upper Oligocene. The material at 300 feet seems to be closely related to the Choctawhatchee Marl, while that at 360 and 600 feet is related to the Gatun formation of the Panama Canal Zone.

Well of the Okeechobee Ice and Electric Company at Okeechobee, Okeechobee County, Fla. Allowing for possibilities of error, the specimens indicate Miocene from 51 feet to 458 feet. Most of the species of the Okeechobee Well are clearly related to those of the Choctawhatchee Marl, and a few to the Gatun formation of the Panama Canal Zone.

Well of Florida East Coast Railway at Marathon, on Key Vaca, Monroe County Fla. Samples from 78, 180 and 398 feet all seem to be definitely Miocene and very closely related to the Choctawhatchee Marl, especially those from 78 and 180 feet; those from 398 feet are perhaps more closely related to the Gatun of the Panama Canal Zone. There is a considerable difference between the species found at Marathon and those found at the other wells in the region, probably due in part to the difference in ecological conditions, owing to the warmer waters in the southern part of the area.

MIDDLE AND UPPER OLIGOCENE

In the Tampa formation, which is now classed as Upper Oligocene, and in the upper Oligocene of Panama, Anguilla and Cuba, there are horizons characterized by species of *Orbitolites*. At Anguilla and Cuba these occur with a large form of *Gypsina globulus* Reuss. In the well at Marathon this same combination of *Orbitolites* and *Gypsina* occurs at a depth of 589 to 628 feet and probably represents an equivalent of West Indian Upper Oligocene. *Orbitolites* is present in the well at Panama City, and may possibly represent this same general age in that well.

LOWER OLIGOCENE

In a number of wells there are fragments of *Lepidocyclina* that may possibly be of Lower Oligocene age but they are not sufficiently well preserved to admit of specific determination. Therefore the Oligocene must be very questionably placed in any of these wells except in that at Marathon where at 852 and 900 feet there occurs the genus *Heterosteginoides* which I have found in the Oligocene of Panama and the West Indies.

EOCENE

The Upper Eocene represented by the Ocala Limestone can now be very definitely placed in a number of wells. The four species—*Lepidocyclina ocalana, L. pseudomarginata, L. pseudocarinata,* and *L. floridana,* together with *Heterostegina ocalana,* mark very definitely the facies of the Ocala Limestone which is developed in north central Florida. The accompanying table shows the depth at which these species occurred in a number of wells. There is no trace of *Orthophragmina* or of the species of *Lepidocyclina* and *Operculina* which are characteristic of the facies of the Ocala developed in northern Florida and southern Georgia. As already noted in the previous paper the Ocala Limestone seems very definitely to be only about 40 feet thick in the various wells in which it was found. Below the typical Ocala there occurs a horizon characterized by a large species of *Nummulites* and this in turn in one well—that of the Bonheur Development Company at Burns, Wakulla County, has a horizon marked by numerous specimens of *Rotalia armata* which, however, does not seem to be developed in any of the other wells.

In the well at Marathon on Key Vaca there are a number of rather large specimens which may be *Conulites americana,* or a related species. *C. americana* is known from the Eocene of St. Bartholomew, Leeward Islands, Haiti, Cuba and Panama. These specimens in the Marathon Well may therefore represent an Eocene horizon below that marked by the *Lepidocyclina.* The well is not cased below the point at which these appear, therefore this actual point of occurrence is somewhat vague. It, however, does represent an Eocene which is apparently typical of Panama and the West Indies, and unlike that of northern Florida.

DISTRIBUTION OF EOCENE FORAMINIFERA IN FLORIDA WELLS.

	Burns.	Jacksonville.	St. Augustine.	Anthony.	Eustis.	Sanford.	Cocoa.	Tiger Bay.	Marathon.
Lepidocyclina ocalana Cushman	----	510-550	----	----	----	113	190	360-400	-----
Lepidocyclina floridana Cushman	----	-------	----	----	----	113	190	360-400	-----
Lepidocyclina pseudomarginata Cushman	----	510-550	----	----	----	----	----	360-400	-----
Lepidocyclina pseudocarinata Cushman	----	-------	----	----	----	----	190	360-400	-----
Lepidocyclina species	50	-------	224?	----	----	----	----	-------	-----
Heterostegina ocalana Cushman	50	-------	----	----	----	113	190	360-400	-----
Nummulites sp.	150	550	----	50	138?	----	----	-------	-----
Rotalia armata d'Orbigny	180	-------	----	----	----	----	----	-------	-----
Conulites americana Cushman	----	-------	----	----	----	----	----	-------	1000+

Figures are the depths in feet at which the species occur.

LOWER CRETACEOUS

As already noted in the earlier report a number of the wells enter what seem to be Lower Cretaceous limestones characterized by *Orbitolina* and numerous other associated species. A table is given showing the distribution of these other species in the various wells where a species occurs in more than one well. As a rule these are from brownish crystalline limestones which come in below the Eocene represented by the abundant *Nummulites*. The conical and broader concave forms are present in a number of the wells and their relations have been noted in the earlier report.

DISTRIBUTION OF SPECIES OCCURRING WITH ORBITOLINA.

	Burns.	Jacksonville.	St. Augustine.	Anthony.	Eustis.	Apopka.	Tiger Bay.	Marathon.
Orbitolina (conical)	325	820-900	440	110	160	115	550	1248
Haplophragmium sp.	----	820-845	440	160	----	----	----	1720
Textularia sp.	----	----	440	----	----	25	720	----
Tritaxia sp.	----	702-725	----	----	----	310	720	----
Clavulina ? sp.	----	----	440	160	----	----	720	----
Bulimina sp.	----	----	440	----	160	250	----	1720
Pulvinulina ? sp.	----	820-845	785	----	----	115	----	----
Quinqueloculina sp.	----	845-900	440	----	----	115	----	1720

Figures in the columns indicate the highest points in feet at which the various species were recognized in the wells.

SYSTEMATIC LIST OF SPECIES

LITUOLIDAE

Genus Haplophragmium Reuss, 1860.

Haplophragmium sp.

Plate 1, figure 1.

A coarsely arenaceous species, largely coiled, but the later chambers showing the uncoiling character occurred at 1,027 feet in the Bushnell Well.

Haplophragmium sp.

Plate 1, figure 2.

A few specimens of an elongate form, not well characterized were found at 1,720 feet in the well at Marathon.

Haplophragmium sp.

Plate 1, figure 3.

Very irregular specimens, rather variable in shape, were found in the well at Anthony at 160 feet, and at Jacksonville, 820-845 feet.

Haplophragmium sp.

Plate 1, figure 4.

A single, rather poorly characterized specimen was found at 440 feet in the Ponce de Leon Well at St. Augustine.

Genus Conulites Carter, 1861.

Conulites americana Cushman.

Conulites americana Cushman, Publ. 291, Carnegie Institution of Washington, 1919, p. 43, fig. 3 (in text).

In the well at Marathon on Key Vaca there are numerous specimens which seem very close to this species described from St. Bartholomew and Cuba, and known from Haiti and Panama. This therefore represents an Eocene horizon, and is of interest if the West Indies can be definitely correlated with Key Vaca by placing more than a thousand feet below the surface fossils which in Cuba are now considerably above sea level.

Genus Orbitolina d'Orbigny, 1847.

Orbitolina species.

In a number of the wells a small conical species is found, sometimes in considerable numbers. This occurs at the depths indicated in the following wells: Bonheur Development Company, Burns, first noted at 325 feet; New City well at Jacksonville, 820-845 feet; Ponce de Leon Well, St. Augustine, at 440 feet; well of Compagnie Generale des Phos. de la Floride, at Anthony, 160 feet; well of J. Wiggins, at Eustis, 160 feet; well of Dundee Petroleum Company, Bushnell, first occurrence noted at 890 feet, but probably occurs much above this level; City Well at Apopka, 115 feet; Well No. 3, Palmetto Phosphate Company, 2 3-4 miles northwest of Tiger Bay, 550 feet; and well of Florida East Coast Railway at Marathon, on Key Vaca, 1,248 feet.

This species seems very close to a species which is abundant in the Fredericksburg series of the Comanchean of Texas, which in turn is very similar to a species found in the Lower Cretaceous of the Pyrenees of Spain.

Orbitolina sp.

In several wells at some distance below the conical species there is a much larger species, broad, low with a concave base like that of *O. texana* and species of the Lower Cretaceous of Europe. *O. texana* is characteristic of the Trinity series of the Comanchean of Texas.

It is found at the following depths in the Florida wells: Jacksonville, 900-980 feet; Bushnell, 1,000 feet, Marathon, 1,720 feet.

TEXTULARIIDAE

Genus Textularia Defrance, 1824.

Textularia abbreviata d'Orbigny.

Textularia abbreviata d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 249, pl. 15, figs. 9-12 (7-12). Bagg, Bull. Amer. Paleontology, vol. 2, No. 10, 1898, p. 18; Maryland Geol. Survey, Miocene, 1904, p. 470, pl. 132, fig. 4. Cushman, Bull. 676, U. S. Geol. Survey, 1918, p. 46; Bull. 103, U. S. Nat. Mus., 1918, p. 51, pl. 19, fig. 1.

A specimen which seems to belong to this species was found in the material from 200 feet in the Ponce de Leon Well, St. Augustine, Florida.

It is recorded from the Culebra formation of the Panama Canal Zone, and by Bagg from the Miocene of Maryland.

Textularia gramen d'Orbigny.

Textularia gramen d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 248, pl. 15, figs. 4-6. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 365, pl. 43, figs. 9, 10. Cushman, Bull. 676, U. S. Geol. Survey, 1918, pp. 8, 45, pl. 1, fig. 1; pl. 2, fig. 1; pl. 9, figs. 2-5.

Specimens of this species were found in two Florida wells, the Ponce de Leon Well, St. Augustine, at a depth of 200 feet, and the well of Okeechobee Ice and Electric Co., Okeechobee, 403-458 feet.

Besides being found in the Miocene of Maryland, Virginia and South Carolina, I have recorded it from the Miocene of the Choctawhatchee Marl of Florida, at Jackson Bluff and one mile south of Red Bay.

Textularia agglutinans d'Orbigny.

Textularia agglutinans d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminiferes," p. 136, pl. 1, figs. 17, 18, 32-34. Cushman, Bull. 676, U. S. Geol. Survey, 1918, p. 46, pl. 9, fig. 6; Bull. 103, U. S. Nat. Mus., 1918, p. 52, pl. 19, fig. 3.

The only specimens which can be referred to this species are from the Okeechobee well at a depth of 380-403 feet.

The species is recorded from several localities in the Miocene of the Coastal Plain and from the Culebra formation of the Panama Canal Zone.

Textularia sagittula Defrance, var. fistulosa H. B. Brady.

Textularia sagittula Defrance, var. *fistulosa* H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 362, pl. 42, figs. 19-22.

Brady described this variety in which the outer borders of each chamber in the adult are prolonged into tubular projections. He records it from tropical and sub-tropical localities.

It is interesting to find this species in the southernmost locality, that of the well at Marathon on Key Vaca, at a depth of 305 feet.

Textularia panamensis Cushman.

Textularia panamensis Cushman, Bulletin 103, U. S. Nat. Mus., 1918, p. 53, pl. 20, fig. 1.

A single, rather typical specimen of this species was obtained from the well at Fort Myers, at a depth of 600 feet.

The type of this species is from the Miocene of the Gatun formation of the Panama Canal Zone.

Textularia sp.

An elongate species, generally quadrangular in transverse section, gradually tapering toward the initial end, was found in company with *Orbitolina* in several of the wells.

They are as follows: City Well at Apopka, 250 feet; Ponce de Leon Well, St. Augustine, 440 feet; and Well No. 3, Palmetto Phosphate Company, 2 3-4 miles northeast of Tiger Bay, 720 feet.

Genus Verneuilina d'Orbigny, 1840.

Verneuilina spinulosa Reuss.

Verneuilina spinulosa Reuss, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 374, pl. 47, fig. 12. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol, 9, 1884, p. 384, pl. 47, figs. 1-3. Cushman, Publ. 291, Carnegie Institution of Washington, 1919, p. 34.

The only one of the wells at which this species occurred is that at Marathon, on Key Vaca, where it is found at a depth of 180 feet.

I have recorded it from the Miocene Marl of the Yumuri River, Matanzas, Cuba.

Genus Valvulina d'Orbigny, 1826.

Valvulina sp.

Plate 1, figure 5.

A single specimen from the well of the Bonheur Development Company at Burns, Wakulla County, at a depth of 325 feet, seems referable to this genus.

Chrysalidina ? sp.

Plate 1, figures 6 *a, b.*

At 1,262 feet in the well at Marathon, Florida, there is a species, tapering in form, with rounded chambers, and in addition

to the textularian aperture at the base of the chamber, the inner portion of the wall has a number of small perforations. This is in some respects like *Chrysalidina gradata* d'Orbigny, which he described from the Cretaceous of Europe.

Genus Tritaxia Reuss, 1860.

Tritaxia sp.

A species with concave sides, rather sharp angles, but the edges rounded, and the whole test rather short, with the sutures indistinct, occurs in several wells with the *Orbitolina.* It was recorded from the following: Jacksonville, 702-725 feet; Apopka, 310 feet; and Tiger Bay, 720 feet.

Genus Gaudryina d'Orbigny, 1839.

Gaudryina flintii Cushman.

Gaudryina subrotundata Flint (not *G. subrotundata* Schwager, 1866), Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 287, pl. 33, fig. 1.

Gaudryina flintii Cushman, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 63, fig. 102*a-c* (in text); Bull. 103, U. S. Nat. Mus., 1918, p. 56, pl. 20, fig. 4.

There is a single rather small specimen from the Ponce de Leon Well, St. Augustine, Florida, coming from a depth of 200 feet, which seems to represent this species.

A specimen from the Culebra formation of the Panama Canal Zone was referred to this species, but it has not been previously recorded in the American Miocene.

Gaudryina sp. ?

Plate 1, figure 7.

There is a species with a triangular early portion, and later very rounded biserial chambers which occurred in the well at Marathon, Florida, at a depth of 1,650 feet.

Genus Clavulina d'Orbigny, 1826.

Clavulina communis d'Orbigny.

Clavulina communis d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 268; Foram. Foss. Bass. Tert. Vienne, 1846, p. 196, pl. 12, figs. 1, 2. Cushman, Bull. 103, U. S. Nat. Mus., 1918, p. 57, pl. 20, fig. 6.

The only records for this species from the Florida well borings are the young specimens from Ponce de Leon Well, St. Augustine, 88 feet, and a more fully developed specimen at 200 feet.

Clavulina species.

There is a small specimen of this genus not well marked from the well at Fort Myers, Florida, from a depth of 720 feet.

Clavulina ? sp.

Plate 1, figure 8.

There is a large coarse species, with the early portion apparently triserial or coiled, and at a decided angle with the later part, which is short and circular in transverse section. These are not well preserved. They come from limestones in which *Orbitolina* occurs and may not belong to this genus.

They occur with *Orbitolina* in the following Florida wells: Anthony Well, 160 feet; Ponce de Leon Well, St. Augustine, 440 feet; and Tiger Bay Well, 720 feet.

Genus Bulimina d'Orbigny, 1826.

There are a number of species apparently belonging to *Bulimina* of the arenaceous group which are characteristic of the Lower Cretaceous, and which occur with *Orbitolina.*

Bulimina sp.

Plate 2, figure 1.

Specimens of an elongate tapering form with close-set oblique chambers occur at 440 feet in the Ponce de Leon Well at St Augustine, Florida and at 250 feet in the well at Apopka.

Bulimina sp.

Plate 2, figure 2.

A coarse, thick, arenaceous species occurs at 138 feet in the well of J. Wiggins, at Eustis, Lake County.

Bulimina sp.

Plate 2, figure 3.

There is an elongate species with very distinct somewhat remotely placed chambers which occurs at 160 feet in the well of J Wiggins at Eustis, Lake County.

Bulimina sp.

Plate 2, figure 4.

A species of fusiform shape and concave apertural face, with the rounded aperture near the middle, occurs at 2,310 feet in the well at Marathon. Genus *Buliminella* Cushman, 1911.

Buliminella sp. ?

Plate 2, figure 5.

Specimens from brown limestone at 1,720 feet in the well at Marathon are distinctive and are figured. They are of the *Buliminella elegantissima* group.

Buliminella sp. ?

Plate 2, figure 6 *a*, *b*.

In the deepest part of the well at Marathon there occurred a very low-spired form here figured, which seems like a very short *Buliminella* of the *B. elegantissima* group, but very low. A somewhat similar form of much larger size is found in the deeper portions of the well at 1,421 feet.

Genus Virgulina d'Orbigny, 1826.

Virgulina squammosa d'Orbigny.

Virgulina squammosa d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 267, Modeles, No. 64, 1826. Cushman, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 91, fig. 145*a*, *b*; Bull. 103, U. S. Nat. Mus., 1918, p. 58, pl. 21, fig. 6.

The only material which can be referred to this species is that from the well of the Okeechobee Ice and Electric Co., Okeechobee, Florida, at depths of 158-175 feet, and 240-245 feet.

I have previously recorded it from the Miocene of the Gatun formation of the Panama Canal Zone.

LAGENIDAE

Genus Lagena Walker and Boys, 1784.

Lagena striata (d'Orbigny).

Oolina striata d'Orbigny, Foram. Amer. Merid., 1839, p. 21, pl. 5, fig. 12.

Lagena striata Reuss, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 327, pl. 3, figs. 44, 45; pl. 4, figs. 46, 47. H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 460, pl. 57, figs. 22, 24. Cushman, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 19, pl. 7, figs. 4, 5.

The only specimens of the genus were found in the well at Okeechobee, at a depth of 380-403 feet.

Another variety of this species was found fossil at Panama.

Genus Cristellaria Lamarck, 1812.

Cristellaria americana Cushman, var. spinosa Cushman.

Cristellaria americana Cushman, *var. spinosa* Cushman, Bulletin 676, U. S. Geol. Survey, 1918, p. 51, pl. 10, fig. 7.

Specimens of this variety were found in two of the lots, 380-403 feet, and 403-458 feet, from the well of the Okeechobee Ice and Electric Company, Okeechobee, Florida.

They are very similar to the type specimens described from the Miocene of the Choctawhatchee Marl, one mile south of Red Bay, Florida.

Cristellaria rotulata (Lamarck).

"Cornu Hammonis seu Nautili" Plancus. Conch. Min., 1739, p. 13, pl. 1, fig. III.

Lenticulites rotulata Lamarck, Ann. Mus., vol. 5, 1804, p. 188, No. 3; vol. 8, 1806, pl. 62, fig. 11.

Cristellaria rotulata d'Orbigny, Mem. Soc. Geol. France, ser. 1, vol. 4, 1840, p. 26, pl. 2, figs. 16-18. H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 547, pl. 69, figs. 13*a*, *b*. Cushman, Bull. 103, U. S. Nat. Mus., 1918, p. 60, pl. 22 fig. 1.

The specimens which are from the well at Marathon at a depth of 398 feet are very similar to those that were found in the Miocene of the Gatun formation of the Panama Canal Zone.

Genus Polymorphina d'Orbigny, 1826.

Polymorphina lactea (Walker and Jacob).

Serpula lactea Walker and Jacob, Adam's Essays on the microscope, 2d ed., p. 634, pl. 24, fig. 4, 1798.

Polymorphina lactea (Walker and Jacob) Macgillivray. A history of the molluscous animals of the counties of Aberdeen (etc.), p. 320, 1843. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 559, pl. 71, fig. 11. Bagg, Maryland Geol. Survey, Miocene, 1904, p. 477, pl. 133, figs. 5, 6. Cushman, Bull. 676, U. S. Geol. Survey, 1918, p. 53, pl. 11, fig. 6.

Specimens which may be referred to this species were found in the well at Jacksonville at 510-550 feet; in the Ponce de Leon Well at St. Augustine, at 200 feet, and in the well at Marathon on Key Vaca, at 180 feet.

I have already recorded this species from the Miocene of the Choctawhatchee Marl, one mile south of Red Bay, Florida. It is also known from the Miocene and Eocene of Maryland and New Jersey.

Polymorphina elegantissima Parker and Jones.

Polymorphina elegantissima Parker and Jones, Philos. Trans., vol. 155, 1865, p. 438. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 566, pl. 72, figs. 12-15. Bagg, Maryland Geol. Survey, Miocene, 1904, p. 476, pl. 133, fig. 3. Cushman, Bull. 676, U. S. Geol. Survey, 1918, p. 54.

A single specimen of this species is from the Ponce de Leon Well at St. Augustine, Florida, at a depth of 170 feet.

Bagg has recorded and figured this species from the Miocene of the Calvert formation of Chesapeake Beach, Maryland.

GLOBIGERINIDAE

Genus Globigerina d'Orbigny, 1826.

Globigerina bulloides d'Orbigny.

Globigerina bulloides d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 277, No. 1; Modeles, 1826, No. 17, and No. 76; in Barker, Webb, and Berthelot, Hist. Nat. Isles Canaries, 1839, pt. 2, Foraminiferes, p. 132, pl. 2, figs. 1-3, 28. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 593, pl. 77; pl. 79, figs. 3-7. Cushman, Bull. 676, U. S. Geol. Survey, 1918, pp. 12, 56, pl. 3, fig. 2; pl. 12, figs. 4, 6; Bull. 103, U. S. Nat. Mus., 1918, p. 64; Publ. 291, Carnegie Institution of Washington, 1919, p. 38.

A few specimens of this common species were obtained from the well of the Okeechobee Ice and Electric Company, at Okeechobee, Florida, at a depth of 380-403 feet, and from the Well at Marathon on Key Vaca, at depths of 180 to 398 feet.

The species is also known from the American Miocene of Panama; the Coastal Plain of Florida and Virginia; Yumuri River,

Mantanzas, Cuba; Cercado de Mao, Santo Domingo, and Bowden, Jamaica.

Genus Orbulina d'Orbigny, 1826.

Orbulina universa d'Orbigny.

Orbulina universa d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminiferes," p. 3, pl. 1, fig. 1. H. B Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 608, pl. 78; pl. 81, figs. 8-26; pl. 82, figs. 1-3. Cushman, Bull. 676, U. S. Geol. Survey, 1918, p. 12, pl. 3, fig. 3; Bull. 103, U. S. Nat. Mus., 1918, p. 67; Publ. 291, Carnegie Institution of Washington, 1919, p. 40.

The only record from the well samples examined is 380-403 feet, at Okeechobee.

The species is known from the Miocene of the Gatun formation of the Panama Canal Zone; from Rio Gurabo, and Cercado de Mao, Santo Domingo, and from the gorge of the Yumuri River, Matanzas, Cuba.

ROTALIIDAE

Genus Discorbis Lamarck, 1804.

Discorbis bertheloti (d'Orbigny).

Rosalina bertheloti d'Orbigny, in Barker, Webb, and Berthelot, Hist. Nat. Iles Canaries, pt. 2, 1839, "Foraminiferes," p. 135 pl. 1, figs. 28-30.

Discorbis bertheloti (d'Orbigny) Cushman, U. S. Nat. Mus., Bull. 71, pt. 5, 1915, p. 20, pl. 7, fig. 3; fig. 23 in text; Bull. 676, U. S. Geol. Survey, 1918, p. 58, pl. 15, figs. 1-3.

Discorbina bertheloti (d'Orbigny) H. B. Brady, Linnaean Soc. London. Trans., vol. 24, 1864, p. 469, pl. 48, fig. 10; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 650, p.l 89, figs. 10-12.

This is the only species of *Discorbis* found in the well samples. It is from the well of the Okeechobee Ice and Electric Company, Okeechobee, Florida, at a depth of 41-56 feet.

I have recorded this species from the Miocene of Virginia and South Carolina, and also from the Choctawhatchee Marl, one mile south of Red Bay, Florida.

Genus Truncatulina d'Orbigny, 1826.

Truncatulina refulgens (Montfort).

Cibicides refulgens Montfort, Conch. Syst., vol. 1, 1808, p. 122.

Truncatulina refulgens (Montfort) d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 279, pl. 13, figs. 8-11; Modeles, 1826, No. 77. H. B. Brady, Rep. Voy. *Chal-*

lenger, Zoology, vol. 9, 1884, p. 659, pl. 92, figs. 7-9. Cushman. Bull. 676, U. S. Geol. Survey, 1918, p. 61, pl. 18, fig. 3.

A single specimen from the Ponce de Leon Well at St. Augustine is the only record for the species in the well samples. I have also had it from the Miocene in the Choctawhatchee Marl from Coes Mill, Florida.

Truncatulina americana Cushman.

Truncatulina americana Cushman, Bull. 676, U. S. Geol. Survey, 1918, p. 63, pl. 20, figs. 2, 3; pl. 21, fig. 1; Bull. 103, U. S. Nat. Mus., 1918, p. 68, pl. 23, figs. 2*a-c*.

This species seems to be a common one in the Miocene and Oligocene of America. It was originally described from the Miocene of the Choctawhatchee Marl at Coes Mill, Florida, from the Duplin Marl at Mayesville, S. C., and from Wilmington, N. C. It is also known from the upper part of the Culebra formation of the Panama Canal Zone.

In the borings from the Florida wells it has occurred as follows: Ponce de Leon Well, St. Augustine, at depths of 88 and 200 feet; well at Fort Myers, 300 feet; well of Okeechobee Ice and Electric Company, Okeechobee, Florida, 41-56 feet; 87-94 feet; 240-245 feet; 245-276 feet and 403-458 feet; well at Marathon on Key Vaca, 180, 305 and 398 feet.

Truncatulina pygmaea Hantken.

Truncatulina pygmaea Hantken, Mitth. Jahrb. ung. geol. Anstalt, vol. 4, 1875, p. 78, pl. 10, fig. 8. Cushman, Bull. 103, U. S. Nat. Mus., 1918, p. 68, pl. 23, figs. 3*a-c*.

Truncatulina pygmaea H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 666, pl. 95, figs. 9, 10.

Specimens occurred in the material from two wells, that from Fort Myers, at a depth of 360 feet, and from the well at Marathon on Key Vaca, at 398 feet.

It has been recorded from the Miocene of the Gatun formation and the Oligocene of the Culebra formation of the Panama Canal Zone.

Truncatulina basiloba Cushman.

Truncatulina basiloba Cushman, Bull. 676, U. S. Geol. Survey, 1918, p. 64, pl. 21, fig. 2.

This species was originally described from the Miocene of South Carolina, although the exact locality was not known. It is therefore interesting to again find it in typical form from the Well at Okeechobee, at a depth of 41-56 feet.

This is one of several species with the basal portions of the chambers variously modified, which occur in the Miocene and Oligocene of the Coastal Plain.

Truncatulina sp.

Plate 3, figures 1 *a, b.*

There is a large species of *Truncatulina* which occurs in the Bushnell Well at depths of 1,067 and 1,095 feet. Some of the specimens are well preserved and show a raised ridge along the line of coiling and raised borders to the chambers, the surface between punctuate. The ventral surface is strongly convex and peculiarly marked.

Genus Pulvinulina Parker and Jones, 1862.

Pulvinulina umbonata (Reuss).

Rotalina umbonata Reuss, Zeitschr. deutsch. geol. Gesellsch., vol. 3, 1851, p. 75, pl. 5, figs. 35*a-c.*

Pulvinulina umbonata Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1866, p. 206. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 695, pl. 105, figs. 2*a-c.*

A single specimen which resembles this species in its general characters was found in material from a depth of 200 feet in the Ponce de Leon Well at St. Augustine, Florida.

Pulvinulina sp.

Pulvinulina hauerii H. B. Brady (not *P. hauerii* d'Orbigny) Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, pl. 106, fig. 7*a-c.*

There is a single specimen in the Jacksonville Well which is close to the figure quoted above, which is, however, certainly not *Pulvinulina hauerii* d'Orbigny. This particular form is at present found in the Philippine and South Pacific regions and is one of a considerable number of species which occur in the Oligocene of America and are now living in the same or closely related form in the Indo Pacific.

Pulvinulina ? sp.

Plate 2, figures 7 *a, b.*

Associated with the conical *Orbitolina* in three wells there is a species which may be assigned to *Pulvinulina.* It is of small size, the dorsal side strongly convex, the ventral side less so, and when worn shows a peculiar series of openings about the umbilical area.

It is found in material from the following: New City Well at Jacksonville, at 820-845 feet; Ponce de Leon Well at St. Augustine at 785 feet; and City Well at Apopka, Orange County, at 115 feet.

This is another one of the species which is characteristic of the fauna of the upper *Orbitolina* Zone.

Genus Gypsina Carter, 1877.

Gypsina globulus (Reuss).

Ceriopora globulus Reuss, Haidinger's Nat. Abh., vol. 2, 1847, p. 33, pl. 5, fig. 7.

Gypsina globulus H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 717, pl. 101, fig. 8. Cushman, Publ. 291, Carnegie Institution of Washington, 1919, p. 44, pl. 4, fig. 7.

Large specimens which may be referred to this species are from the well at Marathon, on Key Vaca, at 598 feet. These are similar to those which were found at Anguilla, Leeward Islands, where, as in the Marathon Well, they occurred in company with *Orbitolites.*

Smaller specimens of the form which is characteristic of the Ocala limestone were found in the Jacksonville Well, at 680-702 feet, and occasionally below. These all probably came from the level of 510-550 feet where the Ocala evidently is entered and from which point downward there is no casing. Similar specimens also occur in the well of the Bonheur Development Company at Burns, Wakulla County, at a depth of 50 feet, and in the well of the Compagnie Generale des Phos. de la Floride, at Anthony, Marion County, also at 50 feet. This latter well is known to start in the Ocala limestone. Other species from Burns confirm the occurrence of the Ocala at 50 feet as indicated by the *Gypsina.*

The species of *Gypsina* referred to *G. globulus* in the Coastal Plain and West Indian region need careful study to discriminate between the different forms found in different horizons.

Genus Rotalia Lamarck, 1804.

Rotalia beccarii (Linnaeus).

Nautilus beccarii Linnaeus, Syst. Nat., 12th Ed., 1767, p. 1162.

Rotalia (Turbinulina) beccarii d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 275, No. 40; Modeles, 1826, No. 74.

Rotalia beccarii Parker and Jones. Philos. Trans., vol. 155, 1865, p. 388, pl. 16, figs. 29, 30. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 704, pl. 107, figs, 2, 3. Cushman, Bull. 676, U. S. Geol. Survey, 1918, pp. 18, 66; pl. 5, fig. 1, pl. 6, fig. 1; pl. 23, fig. 3; pl. 24, figs. 1, 2; pl. 25, fig. 1.

Specimens of the forms figured from the Miocene of the Coastal Plain were found in material from the well at Fort Myers, at a depth of 300 feet, and the well at Okeechobee, at a depth of 41-56 feet.

This has been recorded from the Miocene of Florida in the Choctawhatchee Marl of Coes Mill, and Jackson Bluff, as well as from the Miocene and Pliocene of several other states.

Rotalia armata d'Orbigny.

Rotalia armata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 273, No. 22; Modeles, 1826, No. 70.

Rotalina armata Terquem, Mem. Soc. Geol. France, ser. 3, vol. 2, Mem. III, 1882, p. 67, pl. 5 (13), figs. 14, 15.

In a single well, that of the Bonheur Development Company at Burns, Wakulla County, numerous specimens occur at 180 feet, and scattered below as casts which are very close to this species of d'Orbigny, which seems characteristic of the Eocene of the Paris Basin at some horizons.

The specimens are in such numbers in this well that it seems as though they may be later discovered somewhere in surface deposits of this same age in the Gulf region.

Occurring as it does below the horizon marked by characteristic species of the Ocala, it should be looked for elsewhere in a similar stratigraphical position.

Rotalia sp.

In the well at Marathon, on Key Vaca, a species of *Rotalia* occurs in some numbers at 1,273 feet. It is unlike those found elsewhere in the well samples, but is not well preserved as to details of the surface characters.

Rotalia ? sp.

In two wells, the New City Well at Jacksonville, at a depth of 680-702 feet, and that of J. Wiggins at Eustis, Lake County, at a depth of 138 feet, there is a large rotaliform species which seems more or less involute on both faces. The sutures are marked by raised lines. The peripheral margin is angled, the dorsal surface just within the periphery slightly concave.

NUMMULITIDAE

Genus Nonionina d'Orbigny, 1826.

Noniona scapha (Fichtel and Moll).

Nautilus scapha Fichtel and Moll. Test. Micr., 1798, p. 105, pl. 19, figs. *d-f.*

Nonionina scapha Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 102, No. 4. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 730, pl. 109, figs. 14, 15 and 16. ? Bagg, Bull. Amer. Pal., vol. 2, No. 10, 1898, p. 41 (335), pl. 3 (23), figs. 4*a, b;* Maryland Geol. Survey, Miocene, 1904, p. 460, pl. 131, figs. 1-3. Cushman, Bull. 676, U. S. Geol. Survey, 1918, p. 68, pl. 25, fig. 2; pl. 26, figs. 2, 3; Bull. 103, U. S. Nat. Mus., 1918, p. 73, pl. 25, figs. 6*a, b.*

In two wells, specimens evidently this species were obtained. These are 87-94 feet in the well at Okeechobee, and 180 feet in the well at Marathon on Key Vaca.

This species is known from the Miocene of the Choctawhatchee Marl of Florida, and from the Miocene of Maryland, Virginia, and South Carolina. It occurs also in the Gatun formation of the Panama Canal Zone.

Nonionina depressula (Walker and Jacob.)

Nautilus depressulus Walker and Jacob, in Adam's Essays on the Microscope, Kanmacher's Ed., 1798, p. 641, pl. 14, fig. 33.

Nonionina depressula Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 4, 1859, pp. 339, 341. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 725, pl. 109, figs. 6, 7. Cushman, Bull. 676, U. S. Geol. Survey, 1918, pp. 19, 67, pl. 1, fig. 6; pl. 26, fig. 1; Bull. 103, U. S. Nat. Mus., 1918, p. 72, pl. 25, figs. 5*a, b.*

A single specimen which may be referred to this species was obtained in the well sample from 88 feet in the Ponce de Leon Well at St. Augustine.

It occurs in the Miocene of the Gatun formation of the Panama Canal Zone and it has been recorded from the Miocene of Alabama and Virginia.

Nonionina sp.

Plate 3, figures 2 *a, b.*

At a depth of 380-403 feet in the well at Okeechobee, there are numerous specimens of a species of *Nonionina* which are very uniform in their characters.

Genus Polystomella Lamarck, 1822.

Polystomella crispa (Linnaeus).

"Cornu Hammonis orbiculatum" Plancus, Conch. Min., 1739, p. 10, pl. 1, fig. 2.

Nautilus crispus Linnaeus, Syst. Nat., Ed. 12, 1767, p. 1162.

Polystomella crispa Lamarck, Anim. sans. Vert., vol. 7, 1822, p. 625, No. 1. d'Orbigny, Foram. Foss. Bass. Tert. Vienne, 1846, p. 125, pl. 6, figs. 9-14. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 736, pl. 110, figs. 6, 7. Cushman, Bull. 676, U. S. Geol. Survey, 1918, p. 69, pl. 27, figs. 1, 4, 5; Bull. 103, U. S. Nat. Mus., 1918, p. 76, pl. 27, figs. 2*a, b.*

This species in Recent Seas is characteristic of tropical and subtropical waters. In the Miocene of America it is known, especially from the Choctawhatchee Marl of Florida, the Duplin Marl of North and South Carolina, and from the Gatun formation of the Panama Canal Zone.

In the Florida well samples it has occurred twice, from 41-56 feet in the well at Okeechobee, and from 78 feet in the well at Marathon, on Key Vaca.

Polystomella craticulata (Fichtel and Moll).

Nautilus craticulatus Fichtel and Moll. Test. Micr., 1798, p. 51, pl. 5, figs. *h-k.*

Polystomella craticulata d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 284, No. 3. W. B. Carpenter, Introd. Foram., 1862, p. 279, pl. 16, figs. 1, 2. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 739, pl. 110, figs. 16, 17. Cushman, Bull. 103, U. S. Nat. Mus., 1918, p. 77, pl. 27, figs. 3*a, b.*

In its fully developed form this species is characteristic of tropical shallow waters.

It has been recorded from the Culebra formation of the Panama Canal Zone in a somewhat different form from the recent species of the Indo-Pacific. This same form is apparently present in the Florida wells, specimens very similar having been found in the Ponce de Leon Well at St. Augustine from 88 feet, and 680 feet in the well at Fort Myers.

Polystomella striato-punctata (Fichtel and Moll).

Nautilus striato-punctatus Fichtel and Moll. Test. Micr., 1798, p. 61, pl. 9, figs. *a-c.*

Polystomella striato-punctata Parker and Jones, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 103, No. 6. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 733, pl. 109, figs. 22, 23. Cushman, Bull. 676, U. S. Geol. Survey, 1918, pp. 19, 69, pl. 8, fig. 4; pl. 26, fig. 4; pl. 27, fig. 2; Bull. 103, U. S. Nat. Mus., 1918, p. 74, pl. 26, figs. 3*a, b;* 4*a, b;* Publ. 291, Carnegie Institution of Washington, 1919, p. 49.

To this species have been assigned most forms of *Polystomella* which have a rounded periphery and short retral processes. In the American Miocene it is known from numerous states of the Coastal Plain, from the Panama Canal Zone, and from Santo Domingo.

The only well record is that from 41-56 feet in the well of the Okeechobee Ice and Electric Company at Okeechobee.

Polystomella sp.?

At 880 feet in the City Well at Fort Myers, Lee County, there occur numerous specimens of *Polystomella* which are almost all casts and not at all well preserved. These, for the most part, have rather short retral processes but have a large number of chambers. Attention is called to them for possible later comparisons with other localities.

Genus Amphistegina d'Orbigny, 1826.

Amphistegina lessonii d'Orbigny.

Amphistegina lessonii d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 304, No. 3, pl. 17, figs. 1-4, Modeles, 1826, No. 98. H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 740, pl. 111, figs. 1-7. Cushman, Bull. 676, U. S. Geol. Survey, 1918, pp. 20, 70, pl. 4, fig. 3; pl. 26, fig. 5; pl. 27, fig. 3; pl. 28, fig. 1; Bull. 103, U. S. Nat. Mus., 1918, p. 77; Publ. 291, Carnegie Institution of Washington, 1919, p. 50, pl. 7, fig. 7.

There are various forms, varieties, or species of *Amphistegina* in the American Tertiary which should be critically studied as from the fragmentary evidence at hand they seem very distinct at different horizons.

As *Amphistegina* is a tropical genus the occurrence in the wells would naturally be expected to be confined to those of the southern part of Florida. This is true of the actual records, it having occurred as follows: City Well at Fort Myers at 300 feet; well of the Okeechobee Ice and Electric Company at Okeechobee at 56-62 feet; and in the well of the Florida East Coast Railway at Marathon on Key Vaca, at 180 feet.

It is know from the Miocene of the Duplin Marl of South Carolina, the Choctawhatchee Marl of Florida, and the Miocene of Santo Domingo and Bowden, Jamaica, and in the upper Oligocene of the Panama Canal Zone.

Genus Asterigerina d'Orbigny, 1839.

Asterigerina angulata Cushman.

Asterigerina angulata Cushman, Publ. 291, Carnegie Institution of Washington, 1919, p. 45, pl. 13, fig. 1.

Numerous specimens from a depth of 786 feet in the well at Marathon, Key Vaca, are evidently this species, described from the Miocene of Santo Domingo at Rio Cana, and Cercado de Mao.

Genus Nummulites Lamarck, 1801.

Nummulites sp.

Numerous specimens of *Nummulites* occur in a number of the wells, usually just below the Ocala limestone where that formation is represented. The records in the various Florida wells are as follows: a fragment probably *Nummulites* from 400-470 feet in

the well at Panama City; especially at 150 feet and at lower depths probably derived from this level in the well of the Bonheur Development Company at Burns, Wakulla County; at 550 feet and below in the New City Well at Jacksonville, Duval County; abundant at 50 feet and scattering below in the well of the Compagnie Generale des Phos. de la Floride, at Anthony, Marion County; in the upper portions, probably above 138 feet in the well of J. Wiggins at Eustis, Lake County; at 410 feet especially and scattered below in Well No. 3 of the Palmetto Phosphate Company near Pit No. 1, about 2 3-4 miles northwest of Tiger Bay.

Genus Operculina d'Orbigny, 1826.

Operculina sp.

The only specimen that may be referred to this genus is from the well at Marathon on Key Vaca, coming from a depth of 589 feet, but this is broken and not specifically identifiable. Where *Operculina* was recorded in the earlier paper on the well samples, (12th Annual Report, Florida Geological Survey, 1919, pp. 77-103) a closer study has shown them to be *Heterostegina ocalana.*

Genus Heterostegina d'Orbigny, 1826.

Heterostegina ocalana Cushman.

Occurring with the various species of *Lepidocyclina* and also characteristic of the Ocala limestone this species confirms the age of the Ocala in the well borings. It occurred in recognizable form as follows: well of L. E. Morrow, Sanford, Seminole County, 113, feet; well of H. Bradford, Cocoa, Brevard County, 190 feet; and Tiger Bay at a depth of 360-400 feet. It is characteristic of the Ocala, especially in north-central Florida and is also found in the Ocala of Georgia.

Genus Heterosteginoides Cushman, 1918.

Heterosteginoides cf. panamensis Cushman.

Heterosteginoides panamensis Cushman, Bull. 103, U. S. Nat. Mus., 1918. p. 97, pl. 43, figs. 1-8.

This species is common in the Culebra formation of the Panama Canal Zone, and a related species has been described from Crocus Bay, Anguilla, Leeward Islands.

The only well from which specimens of this genus were found is that at Marathon on Key Vaca, where they occurred at a depth of 852 feet. It would then seem that the well at this depth entered or was in Upper Oligocene strata.

This genus may prove to be a synonym of *Miogypsina* which is also characteristic of the Upper Oligocene elsewhere.

Genus Lepidocyclina Gumbel, 1868.

Lepidocyclina ocalana Cushman.

This species which is typical of the Ocala limestone of Florida is found in recognizable form in the several wells: Jacksonville, first appearing at 510-550 feet, and fragments occur from this point downward, probably all having their source at this same depth as the well is not cased below this level. In the well of L. E. Morrow at Sanford, Seminole County, at 113 feet, specimens of *L. ocalana* occur in fragmentary form with other Ocala species. At Cocoa, Brevard County, from the well of H. Bradford, the species occurs in the only sample from 190 feet. In Tiger Bay well at 360-400 feet abundant specimens of *Lepidocyclina,* including *L. ocalana,* were found.

The Ocala limestone is therefore definitely placed by this and associated species.

Lepidocyclina floridana Cushman.

This species occurs with *L. ocalana* in the following wells: L. E. Morrow, Sanford, Seminole County, at 113 feet; H. Bradford, Cocoa, Brevard County, 190 feet, and at Tiger Bay, 360-400 feet and at various points below, evidently originating from this level.

Lepidocyclina pseudocarinata Cushman.

There are specimens of this species from two of the wells with the preceding: Cocoa, 190 feet, and at Tiger Bay, 360-400 feet.

Lepidocyclina pseudomarginata Cushman.

Specimens which may be this species were obtained in the Jacksonville Well at 510-550 feet, and a few fragments below. More definite specimens were in the material from the well at Tiger Bay, at 360-400 feet.

Lepidocyclina sp. ?

Fragments of *Lepidocyclina* which are not identifiable were obtained at numerous wells indicated in the previous report (12th Annual Report, 1919). These are too small and too poorly preserved to be of more than generic value.

FAMILY MILIOLIDAE.

Genus Quinqueloculina d'Orbigny, 1826.

Quinqueloculina cf. poeyana d'Orbigny.

Quinqueloculina poeyana d'Orbigny, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes," 1839, p. 191, pl. 11, figs. 25-27. Cushman, Bull. 676, U. S. Geol. Survey, 1918, p. 24, pl. 6, fig. 2.

A specimen from 41-56 feet in the well of the Okeechobee Ice and Electric Company at Okeechobee, has a sculpture consisting of longitudinal costae, somewhat similar to that figured in the references given above. The specimen from the well is, however, somewhat broader and shorter, and may not belong to this species.

Specimens with similar sculpture but of different shape more like *Q. pulchella* d'Orbigny, occur in the well at Marathon on Key Vaca, at a depth of 1,140 feet. By their appearance they may have come from the sides of the well far above this point as they are excellently preserved and do not look like other material from this depth.

Quinqueloculina sp.

Plate 3, figure 3.

There is a fairly large species found in several of the wells which is very peculiar in its sculpture. The exterior is either rough or covered with a secondary granular coating. Where this is worn through, a peculiar sculpture is seen, consisting of short longitudinal elongate pits filled with fine granular material of the surface. Specimens are not well enough preserved to show the apertural characters.

The species occurs with the conical form of *Orbitolina* in the following wells: New City Well at Jacksonville, at a depth of 845-900 feet; Ponce de Leon Well at St. Augustine, at 440 feet;

City Well at Apopka, Orange County, at 115 feet; and well at Marathon, on Key Vaca at 1,720 feet.

Quinqueloculina sp.

Specimens of *Quinqueloculina* with a rough surface are found at Apopka at 115 feet and in the well at Anthony at 375 feet. These are not well enough preserved to be identified specifically.

Genus Massilina Schlumberger, 1893.

Massilina sp.

Plate 3, figures 4, 5.

In the material from the well at Apopka there are specimens of this genus rather poorly characterized as far as external characters are shown. It is found with the conical species of *Orbitolina.*

Genus Triloculina d'Orbigny, 1826.

Triloculina sp.

A single specimen with traces of longitudinal costae was found in material from 138 feet in the well of J.Wiggins at Eustis, Lake County.

Triloculina sp.

At a depth of 720 feet in the well at Fort Myers several poorly preserved specimens of *Triloculina* were obtained. The exterior is rough and irregular and no characters are preserved which enable them to be specifically identified with certainty.

Genus Biloculina d'Orbigny, 1826.

Biloculina sp.

There are specimens represented mainly by internal casts from the well at Jacksonville at 820-845 feet, and from the Ponce de Leon Well at St. Augustine, at 440 feet, in both localities occurring with the conical form of *Orbitolina.*

Genus Peneroplis Montfort, 1808.

Peneroplis arietinus (*Batsch*).

Nautilus (*Lituus*) *arietinus* Batsch, Conch Seesandes, 1791, p. 4, pl. 6, figs. 15*d-f.*

Peneroplis arietinus H. B. Brady, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 204, pl. 13, figs. 18, 19, 22. Heron-Allen and Earland, Trans. Zool. Soc., London vol. 20, 1915, p. 602.

There are numerous specimens of this species from a depth of 720 feet in the well at Fort Myers. They are somewhat changed in character, showing traces of replacement by calcite, which has somewhat altered the external characters, but the form is very characteristic.

Peneroplis discoideus Flint.

Peneroplis pertusus (Forskal), var. *discoideus* Flint, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 304, pl. 49, figs. 1, 2. Cushman, Publ. 291, Carnegie Institution of Washington, 1919, p. 69.

This should take its rank with the other species of *Peneroplis.* So far as known it is limited to the West Indian region, being described by Flint from the shallow water of Key West Harbor, Florida. I have recorded it from the Miocene of Bluff 3, Cercado de Mao, Santo Domingo.

It occurred in material at 1,140 feet in the well at Marathon on Key Vaca, but the tests are unlike most of the others from this level and apparently came originally from some distance above.

Genus Orbitolites Lamarck, 1801.

Orbitolites americana Cushman.

Orbitolites americana Cushman, Bull. 103, U. S. Nat. Mus., 1918, p. 99, pl. 43, figs. 12-14; pl. 44, figs. 1, 2; pl. 45.

There are fragments of *Orbitolites* from the well at Marathon on Key Vaca at a depth of 589 feet which in the general characters of the interior very closely resemble the species which I have described from the Emperador Limestone and the Culebra formation of the Panama Canal Zone.

Orbitolites is characteristic of the American Upper Oligocene in the Tampa formation of Florida and the Anguilla formation of Anguilla and Cuba. Therefore this level of the Marathon Well should be Upper Oligocene.

Genus Alveolina d'Orbigny, 1826.

Alveolina ? sp.

Plate 3, figures 6 *a, b.*

In the well at Bushnell at 2,320 and 2,380 feet there are specimens which resemble *Alveolina* but instead of being fusiform are compressed in the plane of the axis. They resemble in a general way the *Orbiculina rotella* of d'Orbigny (Foram. Foss. Bass. Tert. Vienne, 1839, pl. 7, figs. 13, 14).

EXPLANATION OF PLATE 1.

Figure 1. *Haplophragmium* sp. X35. 1,027 feet, Bushnell Well.
Figure 2. *Haplophragmium* sp. X35. 1,720 feet, Marathon Well.
Figure 3. *Haplophragmium* sp. X35. 160 feet, Anthony Well.
Figure 4. *Haplophragmium* sp. X35. 440 feet, St. Augustine Well.
Figure 5. *Valvulina* sp. X35. 325 feet, Well at Burns.
Figure 6. *Chrysalidina* ? sp. X35. 1,262 feet, Marathon Well. *a,* side view; *b,* apertural view.
Figure 7. *Gaudryina* sp. X35. 1,650 feet, Marathon Well.
Figure 8. *Clavulina* sp. X30.

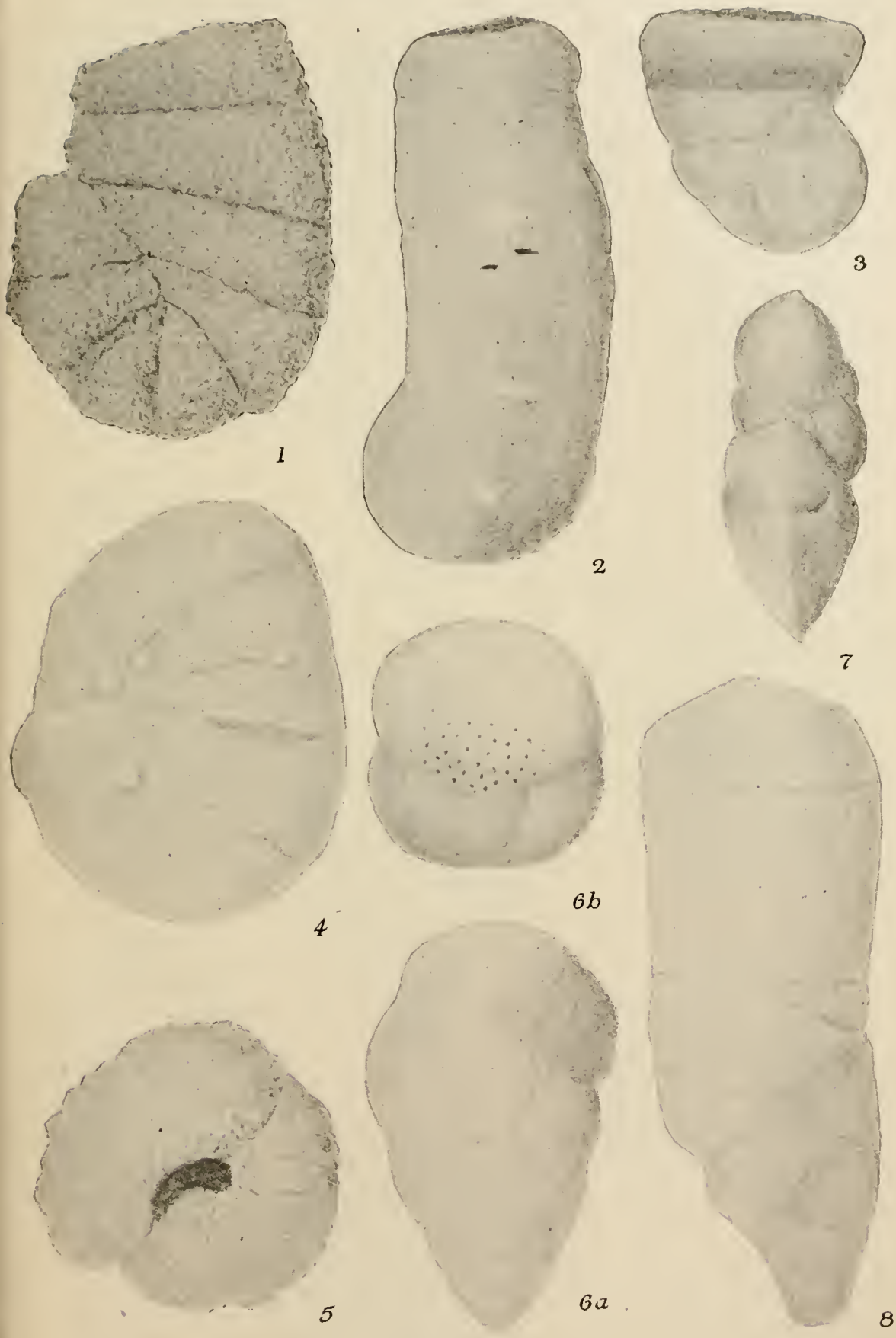

PLATE I.

EXPLANATION OF PLATE 2

Figure 1. *Bulimina* ? sp. X35. 440 feet, St. Augustine Well.
Figure 2. *Bulimina* sp. X35. 138 feet, Eustis Well.
Figure 3. *Bulimina* sp. X35. 160 feet, Eustis Well.
Figure 4. *Bulimina* sp. X50. 2,310 feet, Marathon Well.
Figure 5. *Buliminella* sp. X35. 1,720 feet, Marathon Well.
Figure 6. *Buliminella* ? sp. X50. 2,220 feet, Marathon Well. *a*, ventral view; *b*, dorsal view.
Figure 7. *Pulvinulina* ? sp. X50. 820-845 feet, Jacksonville Well. *a*, dorsal view; *b*, ventral view.

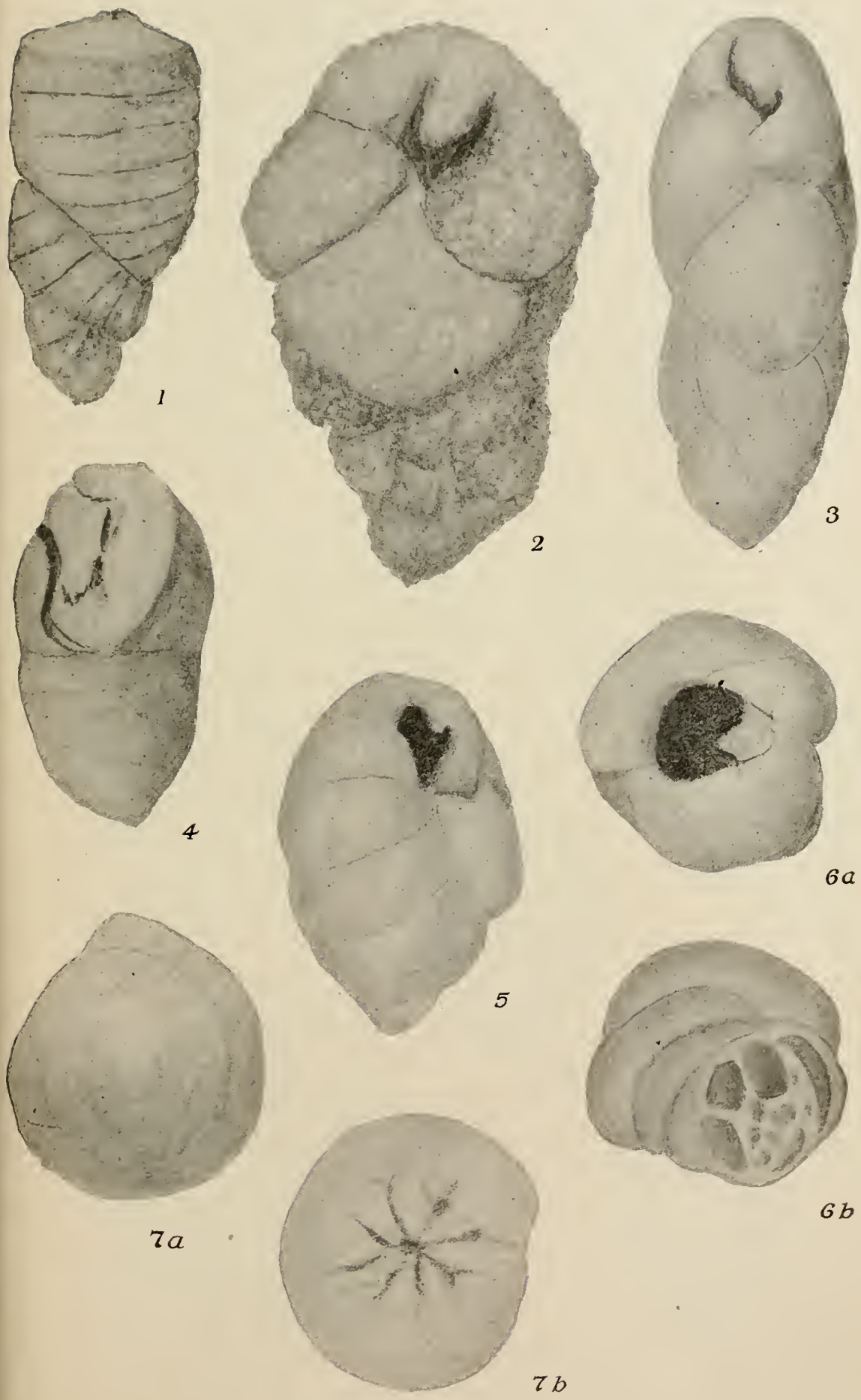

PLATE 2

EXPLANATION OF PLATE 3

Figure 1. *Truncatulina* sp. X30. 1,067 feet, Bushnell Well. *a,* dorsal view; *b,* ventral view.

Figure 2. *Nonionina* sp. X75. 380-403 feet, Okeechobee Well. *a,* side view; *b,* front view.

Figure 3. *Quinqueloculina* sp. X35. 1,720 feet, Marathon Well.

Figure 4, 5. *Massilina* sp. X50. 115 feet, Apopka Well.

Figure 6. *Alveolina* ? sp. X35. 2,320 feet, Bushnell Well. *a,* side view; *b,* edge view.

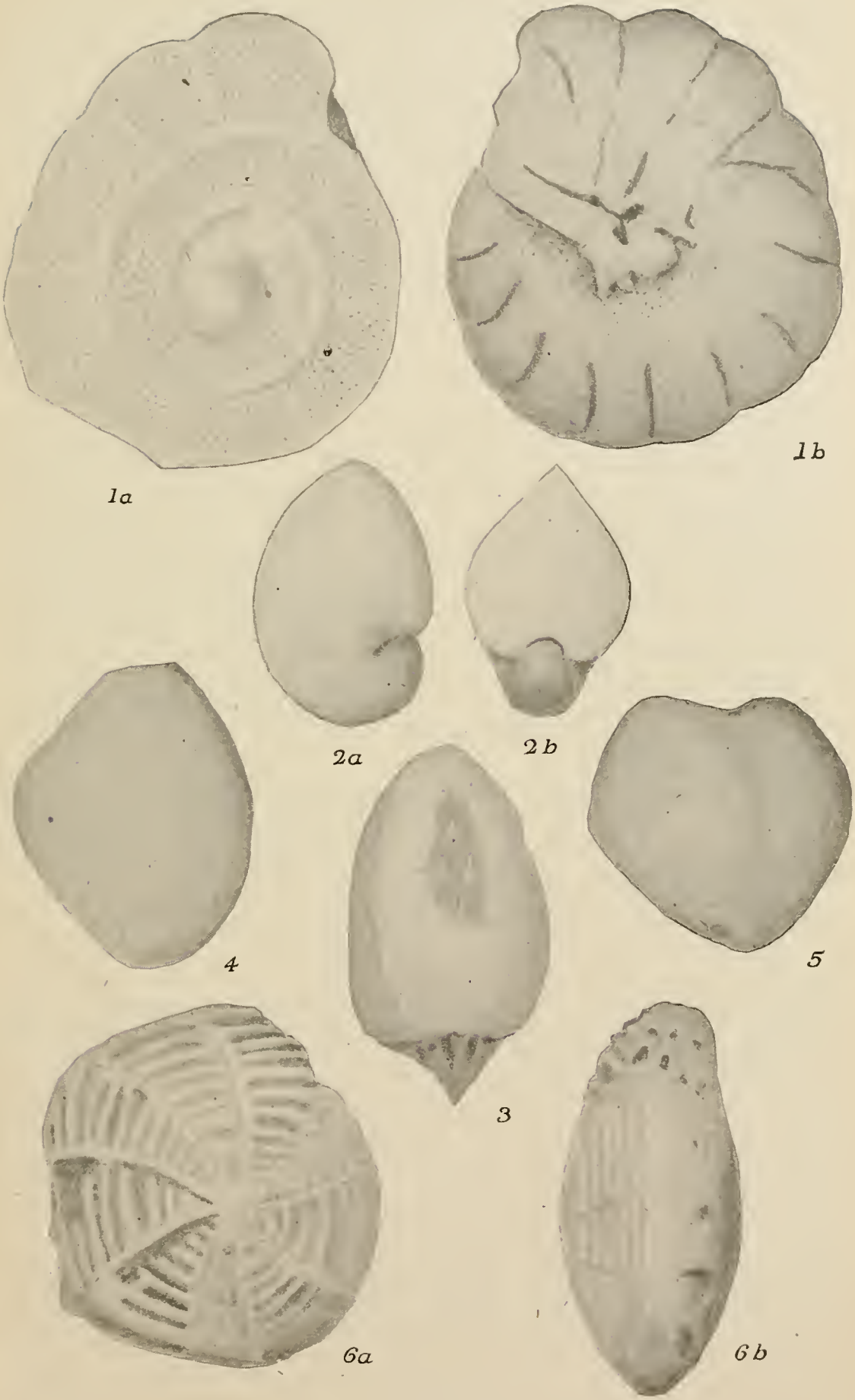

PLATE 3

INDEX TO SPECIES OF FORAMINIFERA

(Synonyms and extra-limital species in italics.)

GEOGRAPHY OF CENTRAL FLORIDA

ROLAND M. HARPER

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INTRODUCTION.

This report is a sequel to one on the geography and vegetation of northern Florida, published in the Sixth Annual Report, late in 1914, which covered that part of the state north of latitude 29°30′. The present investigation begins where the former left off and covers 15 counties on the peninsula, extending south to about latitude 27°40′. These Central Florida* counties, from Levy, Marion and Volusia on the north to Hillsborough, Polk, Osceola and Brevard on the south, cover about 13,900 square miles or 26% of the area of the state, and included 31% of its total population and 34% of its white population in 1915.

In the six years that have elapsed since the northern Florida report was written considerable additional information about the resources of the state has accumulated, or been unearthed from various publications, and at the same time a number of improvements in the methods of geographical description have been made. There are only half as many natural regions to be described in central as in northern Florida, and the regional descriptions in the present report are more condensed, especially as regards vegetation, for quantitative plant lists, although very significant to those who know how to interpret them, can probably be fully appreciated only by a small minority of readers. Much greater use than before is here made of statistics, and a multitude of fundamental facts about each region, which it would take at least ten times as long to write out in sentences, is presented in the form of tables, with enough explanation to bring out the salient features.

On the other hand the general features of the whole area are now treated much more fully than was done for northern Florida, and some interesting general principles not widely known hitherto are brought out by means of statistics and otherwise. Statistics indeed

*This part of the State is sometimes arbitrarily called "Middle Florida" by persons unfamiliar with its traditions, but Middle Florida, by long-established usage (dating from a time when the peninsula was almost uninhabited) is that part of the State between the Suwannee and Apalachicola Rivers. Central Florida is a more or less arbitrary designation, but it is now used in the same sense by the State Agricultural Department in divididng the State into five groups of counties approximately equal in area.

make rather dry reading, but besides their brevity, they have the great advantage of eliminating personal opinions, which have been rather too prominent in much that has been written about Florida heretofore. The source of most of our statistics is the state and federal censuses, and these of course are not and never can be absolutely accurate, but their errors (except in completeness of enumeration) are just about as likely to be in one direction as another, thus balancing each other to a considerable extent when sufficiently large numbers are used. And as they represent the work of a multitude of enumerators, no individual investigator can hope to approach them in completeness, or to detect errors (other than typographical, etc.) in them by merely going over the same ground once or twice.

The aim of this report is to answer as many as is possible in 200 pages or so of the questions that a prospective settler or investor might ask. There is already a vast amount of literature about this and other parts of Florida, in books and magazines and in handsomely illustrated circulars issued by boards of trade, railroads, real estate companies, etc., but most of that is devoted to some limited area, which is usually painted in the most glowing colors, so that it may not help the reader much in getting at the whole truth. Every region on earth has its advantages and disadvantages, and the well-nigh universal policy of minimizing or ignoring the latter in the effort to attract settlers is rather short-sighted, for if a newcomer finds conditions too different from what he had been led to expect he is liable to give up in despair and give the region a bad name.

The information in scientific works, soil surveys, census reports, etc., is much more likely to be accurate and impartial than that designed merely to entertain the reading public, increase the business of railroads, etc., but it is relatively inaccessible, and not easy for the average unscientific person to digest and interpret. And in spite of all that has been published about Florida, it would be difficult to find in previous works any definite statement about the prevailing soil types, commonest plants, density of population, percentage of illiteracy, leading religious denominations and foreign nationalities, percentage of white and colored farmers, owners and tenants, average size of farms, value of farm land and buildings, number of animals of various kinds per farm, cost of labor and fertilizers, leading crops and average yield of each, etc., for any of the regions

here described. But all of these points and many more are covered, and some not only with reference to present conditions but also historically, i.e., the changes that have taken place in several decades are outlined.

PLAN OF DESCRIPTION AND SOURCES OF INFORMATION

The description of each region follows as nearly as possible the outline given under General Features in the table of contents, but that of the smaller regions is necessarily less complete, on account of the lack of census statistics for areas smaller than counties.

The information about geology and underground waters is taken mostly from previous reports of this Survey, and that about soil texture from government soil surveys, which as yet however cover less than one-fourth of the area under consideration. The principal soil series and texture classes in each region sufficiently covered by soil surveys have been determined by picking them out from the maps, but it is hardly worth while to calculate their percentages until the work is more complete. Some of the chemical analyses of soils are taken from 19th century publications, and some were made for the Survey in 1915, from samples collected by the writer, by L. Heimburger, one of the assistant state chemists at that time.

The climatic factors discussed are only a few of the simpler ones, some taken direct and some computed, from publications of the U. S. Weather Bureau, chiefly Bulletins Q and W.

The descriptions of vegetation are almost wholly from the writer's own observations, on about 100 different days, mostly in the months of February, March, April and July, and in the years 1908-1910, 1914, 1915 and 1920. The importance of vegetation as an indicator of soil conditions is probably more generally recognized in Florida than in any other part of the United States; but in order to make satisfactory correlations between vegetation and soils it is necessary not merely to pick out certain species of plants supposed to be characteristic of certain soils, but to study the vegetation quantitatively, as the census does population and agriculture. The approximate relative abundance of the different species has been determined by consolidating or digesting the field notes taken in every county and region, on practically every mile of travel, whether by train, boat, automobile or on foot.

In each region described the principal vegetation types (which are discussed more fully in the general part of the report) are indicated, and the commonest large trees (i.e., those large enough to be sawn into lumber), small trees, woody vines, shrubs and herbs are listed as nearly as possible in order of abundance; which besides bringing out the general appearance of the vegetation also shows at once each region's resources in timber and other wild products of the vegetable kingdom. There are of course all gradations between trees and shrubs, and a species which is a small tree in one region may be a large tree or a shrub in another, or even in different habitats in the same region. But although no hard and fast lines can be drawn, some sort of size grouping has to be used, for it is impracticable to compare the relative abundance of plants differing greatly in size, such as trees and grasses. Mosses, lichens, fungi, etc., are omitted entirely, partly because they form such an insignificant fraction of the total bulk of vegetation, and also because only a few specialists (of whom the writer is not one) can identify them positively in the field.

It did not seem worth while to assign percentages to nearly all the species, as was done in the northern Florida report, on account of the incompleteness of the data, but in the general discussion there is a census of timber trees, giving within certain limits the proportion that each is supposed to constitute of the total forest of each region. And the percentage of evergreens in each region has been estimated, as before, for that being made up of figures for a number of species is more accurate than the percentage of any one species. The significance of evergreens is that, other things being equal, they are most abundant on the poorest soils; for a tree growing in very poor soil has difficulty in getting enough nourishment to make a complete set of leaves every year, and is almost obliged to keep each leaf two or more years (sometimes a dozen years in the case of some of the spruces of the far north, where the soil is frozen about half the year); while a tree in rich soil may take up mineral matter in solution so fast that it has to have large leaves to store the surplus in and shed them every year to get rid of it*

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*For additional notes on the relation of evergreens to soils see 6th Ann. Rep. Fla. Geol. Surv., 175-177 (footnote); Science II. 42:500-503. Oct. 8, 1915; Bull. Geog. Soc. Phila. 16:111. Dec. 1918; Geol. Surv. Ala. Special Rep. No. 11, p. 90, 1920.

To save space and avoid boring readers not interested in botanical matters the plant lists are made rather short, omitting the rarer species that one would not be likely to encounter every day, though in a few cases the lists have been extended just far enough to take in certain species that are especially characteristic. The trees listed in each case are probably only about half the number of species represented in any region, but they make up at least nine-tenths of the bulk of the forest. The shrubs and herbs are listed less completely, partly because they are less important, and partly because some of them cannot be identified any day in the year as the trees can, and the writer has not yet explored this area in the fall months, when many herbs bloom that would hardly be noticed in the spring.

For each plant there is given its technical name, its common name (if any), and its usual habitat expressed in a word or two. The technical names of evergreens are printed in bold-face type, and in the case of semi-evergreens only the specific name (second word) is thus printed. There is some uncertainty as to just which herbs should be classed as evergreens, partly because some of them have not been sufficiently observed in winter, and partly because it is impossible to draw a sharp line between evergreens and non-evergreens. Some herbs whose leaves die down completely in winter farther north are partly evergreen in the area treated and entirely so farther south; and many that are not ordinarily thought of as evergreen have rosettes of leaves close to the ground that live through the greater part of the winter.

The technical names of weeds and other plants that seem to grow only in places that have been more or less disturbed by civilization are enclosed in parentheses. Good examples of plants which are ordinarily regarded as indigenous but behave rather suspiciously are the two tall dog-fennels, *Eupatorium compositifolium* and *E. capillifolium*. The former is sometimes seen in apparently undisturbed high pine land, but it is more characteristic of roadsides or even dim trails made by log-carts, and abundant in old fields. The latter is common in lake basin prairies, etc., but may not have been there in prehistoric times, when such places were not closely pastured as they are now.* Among the trees the persimmon, a supposed native, is far more frequent in cultivated or abandoned fields than it is in swamps, which may be its natural habitat.

*See 3d Ann. Rep., Fla. Geol. Surv., p. 318.

There is doubtless much room for improvement in the treatment of common names, for the writer does not often stop long enough in one place to interrogate the residents about the names they use for wild plants. Such names enclosed in parentheses are either general terms like grass and fern, or names used in Georgia or farther north, which may or may not be in common use in central Florida. But as a large proportion of the inhabitants of this area came from other states, and some who will read this report are now living in other states, these names ought to be more intelligible than they would be in a region which has had very little immigration.

Statistics of population are taken from census reports, principally the U. S. census of 1910. It would have been interesting to carry the investigation back to 1830, when Florida first figured in census returns, but previous to 1887 the counties in central Florida were so few and large that it would be difficult to get an adequate representation of any one region from county statistics. However, some figures illustrating the growth and composition of the population in the whole area in the early days are given in the general discussion. Quite a number of additional data are taken from the state census of 1915, which however does not go into as much detail as the government censuses, and is not so free from typographical errors. At this writing the only returns of population from the U. S. census of 1920 available are the total population of all the counties and some of the cities and towns, but those have been used as far as they go. (It will probably be several months yet before a full analysis of the 1920 population by race, nativity, etc., is obtainable.)

The 1910 census is also the main source of statistical information about agricultural conditions, though others, as far back as 1850, have been utilized as far as possible. The state agricultural department took censuses of agriculture in connection with population in 1895 and 1905, and in recent years has taken censuses of crops, livestock, etc., at biennial intervals. These biennial enumerations subdivide the crops more minutely than the government censuses (which lump together most kinds of vegetables) ever did, and indicate the value of each crop in each county, but give little or no information about the number and size of farms, color and tenure of farmers, value of land, buildings and other property, and expenditures for labor, feed, fertilizers, etc. Worse still, they are marred by so many clerical or typographical errors that they have to be

used with caution. The principal use made of them here is to determine the relative importance of different crops in 1913-14 and 1917-1918. Besides returning the crops in more detail, and giving not only acreage but values by counties, another advantage of the state census is that its crop year runs from July 1 to June 30, on account of Florida's most valuable crops being harvested in winter and spring, while the government census naturally returns the crops by calendar years in Florida, for the sake of uniformity with other states, all of which have colder winters and mostly summer crops.

On account of the appropriation for the Geological Survey remaining at the same number of dollars per annum that it was when money was worth twice as much as it is now, rigid economy has had to be exercised in the selection of illustrations. Out of several hundred photographs available for the purpose, the choice has been narrowed down to 25 new half-tones and 14 old ones. This leaves without illustration such interesting physiographic features as the supposed highest hill in the state (in Polk County), the limestone caves of Marion County, the noted natural race-course of Daytona Beach, salamander hills, and several beautiful lakes and rivers; such vegetation types as grassy dunes, peat prairies and several other types of prairie, the characteristic low hammocks of the Gulf hammock and lake regions, the short-leaf pine and hickory woods of north-central Marion County, calcareous swamps of various kinds, and the flatwoods, bays, and lake shore vegetation of the lake region; and such artificial features as phosphate mines (both hard rock and pebble), the "diatomaceous earth" plants of Lake County, clay pits, sawmills, turpentine stills, roads of crushed limestone, brick, shells, or pine-straw, stone walls, rock chimneys, cattle ranches, orange groves, sugar-cane fields, truck farms, types of farm-houses, cities, towns, hotels, etc. And the counties of Sumter and Hillsborough do not happen to be represented at all in the illustrations, although many pictures have been taken in both. But some of these features or places are well illustrated in previous publications of this Survey, or in easily accessible magazines and pamphlets.

Figures 3, 7, 9, 11-13, 20-22, 29, 35, 36, 39 and 41 are from earlier reports, and the remaining 25 are new. All are made from photographs in the writer's private collection of American geographical views, except three that are otherwise credited. They

are printed in the text instead of on special paper for the sake of economy, and also to bring them as near as possible to the corresponding text and save the trouble of fitting two or three on one plate.

The map used herewith (fig. 2) is too small to show fine details, but larger maps showing the towns, railroads, etc., are easily accessible.

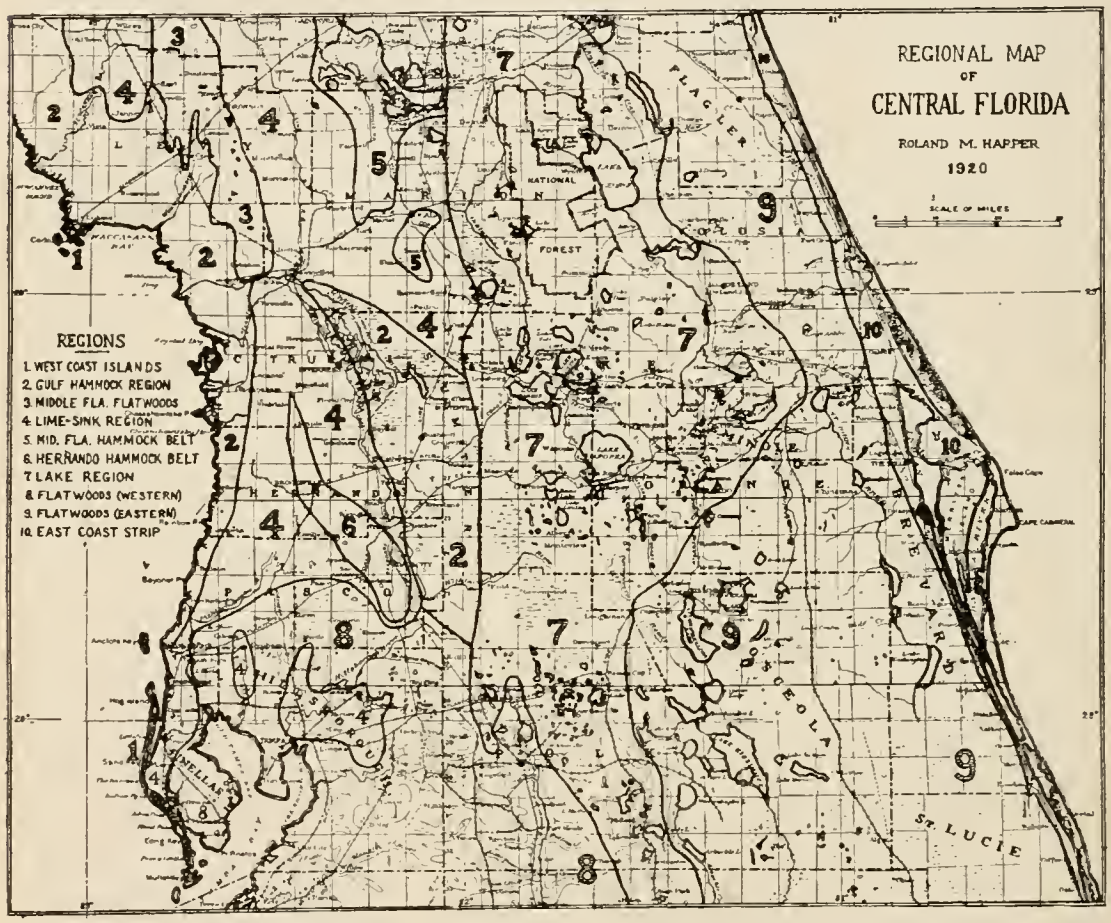

Fig 2. Map showing boundaries of the regions described herein, and various other geographical features. Scale about 1:2,500,000 or 40 miles to the inch.

For various reasons, chiefly lack of time, no bibliography has been prepared for this report, but those in the First, Third, Sixth and Twelfth Annual Reports contain references to numerous important works dealing with central Florida or the whole state, and a few other references are scattered through this report in the form of footnotes. The natural resources of an area of about 1,000 square miles around Ocala, with special reference to geology, vege-

tation and soils, were described by Dr. E. H. Sellards and others (including the present writer) in the Seventh Annual Report (1915), and that will be referred to occasionally herein, especially under the head of vegetation types.

That this report has many shortcomings the writer is well aware (and he, rather than the Survey, should be held responsible for them); but those who may be inclined to condemn it as a whole on account of a few misstatements or omissions with respect to some particular locality should bear in mind that it is impossible for one person to see all parts of such a large area in a few months or to describe it fully in 200 pages, and even if time and money were unlimited it would be impracticable to go to all the important places within a few weeks of the time of going to press. Many places indeed have not been visited by the writer since 1915, so that some conditions described in the present tense may be things of the past now, on account of the rapid development of this part of the state. Current items in daily newspapers have been of considerable assistance in keeping abreast of the times, however.

The writer (or his associates) will be glad to receive constructive criticisms from any source, so that if another edition of this work is ever called for, or if it should ever be incorporated into a geography of the whole State, it can be made as complete and accurate as possible.

REGIONAL DESCRIPTIONS

I. THE WEST COAST ISLANDS

(Figs. 3, 4, 37. Soil analyses O, P.)

This includes the Cedar Keys archipelago in Levy County, the St. Martin's Keys and other small rocky islands along the coast of Citrus and adjoining counties, and a narrow line of barrier-beach islands (the Anclote Keys, Long Key, etc.) lying from half a mile to three or four miles off shore in Pinellas County; the whole covering perhaps not more than ten or twelve square miles.

The Cedar Keys islands are mostly of sand heaped up by the wind (to a height of about 45 feet on Sea Horse Key), but there is considerable calcareous material also, in the form of shell fragments. Between them and the mainland the water is very shallow and dotted with innumerable patches of salt marsh vegetation (fig. 3), and much of the bottom is covered with oyster bars. There is a wagon road from Cedar Key to the mainland which up to a few years ago was rather unique in being submerged twice at day at high tide. There were a few bridges across the deeper places, and between them stakes were driven along the road so that it could be followed when the tide was up.

The "keys" of Pinellas County are also very sandy, but seem to have a larger proportion of shell material than the Cedar Keys group, and there is more lime-loving vegetation. Dunes are not extensively developed.

Some climatic data for Cedar Keys and Tarpon Springs are given in Table 19, in the general part of this report. The climate resembles that of the rest of central Florida in having mild winters and wet summers, but the Gulf of Mexico doubtless makes the temperature more uniform than it is in the interior. The rarity of killing frosts is indicated by the occurrence of black mangrove at Cedar Keys and red mangrove in Pinellas County.

The principal vegetation types are the sparse coarse grassy vegetation characteristic of beaches and dunes, the salt marshes and mangrove swamps (fig. 37), scrubby thickets difficult to classify, and sandy hammocks. The sequence of the following plant list cannot be regarded as very accurate, on account of the writer's

limited explorations in the region, but it ought to give a person familiar with the species named a pretty fair idea of what the vegetation looks like.

Fig. 3. Salt marshes on east side of Way Key, about ½ mile north of Cedar Key station, with oyster shells in foreground and black mangrove (*Avicennia*) bushes in middle distance. April 26, 1909.

Fig. 4. Palm savanna vegetation on stationary dunes (containing many shell fragments), on Long Key about 2 miles north of Pass-a-Grille, Pinellas Co. March 11, 1915.

COMMONEST PLANTS OF WEST COAST ISLANDS.

	LARGER TREES.	
Sabal Palmetto	Cabbage palmetto	Various situations
Pinus Caribaea	Slash pine	Various situations
Pinus clausa	Spruce pine	Stationary dunes
Juniperus Virginiana	Cedar	Hammocks
Quercus Virginiana	Live oak	Hammocks
Hicoria glabra?	Hickory	Sandy hammocks
	SMALL TREES.	
Avicennia nitida	Black mangrove	Mangrove swamps, and scattered over marshes
Rhizophora Mangle	(Red) mangrove	Mangrove swamps
Conocarpus erectus	Buttonwood	Edge of salt water
Laguncularia racemosa	White mangrove	Edge of salt water
Quercus geminata	Live oak	Stationary dunes, etc.
Persea littoralis	Red bay	Sandy hammocks
	WOODY VINES.	
Smilax auriculata		Scrubby thickets
Ipomoea Pes-Caprae		Beaches, etc.
Ernodea littoralis		Dunes
	SHRUBS	
Serenoa serrulata	Saw-palmetto	Various situations
Myrica cerifera	Myrtle	Hammocks, etc.
Yucca aloifolia	Spanish bayonet	Dunes
Coccolobis uvifera	Sea-grape	Dunes
Batis maritima		Sandy marshes
Quercus myrtifolia	(Scrub oak)	Scrubby thickets
Scaevola Plumieri		Beaches and dunes
Ilex vomitoria	Yaupon	Hammocks
Sophora tomentosa		Inner shores, etc.
Batodendron arboreum	Sparkleberry	Sandy hammocks
	HERBS	
Uniola paniculata	Sea oats	Dunes
Juncus Roemerianus	(Rush)	Salt marshes
Spartina glabra	(A grass)	Salt marshes
Opuntia sp.	Prickly pear	Old dunes, etc.
Andropogon glomeratus?	(A grass)	Dune hollows
Muhlenbergia filipes	(A grass)	Dune hollows
Chamaecrista sp.	Partridge pea	Dunes
Oenothera humifusa		Dunes
Eustachys sp.	(A grass)	Dunes
Cassytha filiformis		Thickets, etc.

Something like 98% of the trees and shrubs, but not so many of the herbs, are evergreen.

Population and Industries. Although there are no exact figures for the population of such a small area, the density is probably above the state average, owing to a world-wide tendency of people to congregate along the coast (where the climate or topography does not interfere) to engage in fishing, commerce, etc. In 1915 Cedar Key town had 800 inhabitants and Pass-a-Grille (on Long Key) 109, which together would make about 90 persons per square mile, even if there were no other settlements. About 70% of the population of both towns was white.

Fish of various kinds, oysters and sponges are important products. Cedar for pencil wood was formerly cut in considerable quantities at and near Cedar Keys, but the supply is nearly exhausted now. The cabbage palmetto is or has been utilized for fiber at Cedar Keys. A considerable part of the population makes a living by catering to sportsmen and tourists, particularly at Pass-a-Grille and other resorts in Pinellas County. There is very little agriculture, but a few cattle are raised on some of the islands, and there is said to be even a dairy on Long Key.

2. THE GULF HAMMOCK REGION

(Figs. 5-7, soil analyses 1-5.)

This extends along the Gulf coast from Wakulla County to the southern edge of Pasco, with another area, entirely disconnected from the rest but hardly distinguishable from it in any way, farther inland along the Withlacoochee River, mostly in Sumter County. Within our limits the coastal and interior portions are approximately equal in extent, together covering about 1520 square miles. There is nothing very similar farther south, or in any other state

Fig. 5. Scene on railroad (Seaboard Air Line), through the Gulf Hammock about 4 miles southwest of Ellzey, Levy County; showing out-cropping limestone, and telegraph poles braced because they are not planted very deep in the rock. April 16, 1910.

The portion northwest of the Suwannee River was described in the 6th Annual Report, pages 302-309, and a few of the vegetation types in Sumter County in the 7th.

Fig. 6. Hydro-electric power-house with 20-foot dam (built in 1911), on Withlacoochee River about 10 miles below Dunellon. March 4, 1915.

Topography and Geology. The region is mostly flat and less than 75 feet above sea-level, and is underlaid throughout with a hard limestone (Oligocene), that is exposed in innumerable boulder-like or larger outcrops.* There are occasional irregular low sandy ridges, scarcely distinguishable from parts of region No. 4, where the depth to the rock is unknown. The coast is unlike any other of equal extent in the world, as far as known, in being bordered by marshes instead of sandy beaches; the reason being apparently that the slope of the ocean bottom here is so gentle as to practically eliminate wave-action on the shore, just as if there was a barrier beach a few miles off shore. Stern-wheel steamers from the Suwannee River ply the open Gulf from the mouth of that river to Cedar Keys. The same limestone rock that characterizes the region is said to crop out on the bottom of the Gulf some distance out. Some of the rivers have rocky shoals a few miles from their mouths, and the one on the Withlacoochee is utilized for power purposes.

*See fig. 5. The soil survey of Hernando County shows one solid area of rock outcrop in the eastern end of the county covering about half a square mile.

(Fig. 6.) Several of the smaller streams have large limestone springs at their heads. (Fig. 7.)

Fig. 7. Large limestone spring at head of Homosassa River about a mile northeast of Homosassa, Citrus County. May 23, 1909.

Soils. Only a small part of this region has been covered by soil surveys (those of the "Ocala area" and Hernando County), so that it is hardly worth while to try to estimate the percentages of the different types of soil. The principal series thus far named are the "Leon", "Norfolk", "Portsmouth", "Hernando" and "Parkwood", and the texture classes, in order of area, are fine sand (about one-third of the total), swamp, sand, muck, fine sandy loam, tidal marsh, and clay loam. Rock outcrop, presumably all limestone, constitutes about one-third of 1% of the total area as mapped. Where the sand is not too deep, particularly in all the low hammocks and swamps, the influence of lime is plainly shown in the native vegetation. In a few such places there are deposits of gypsum on or near the surface. No chemical analyses of the soils of this region are available, but they are probably more calcareous than the average for central Florida.

Vegetation. The vegetation is mostly of the flatwoods type, with a few lime-loving plants, but low calcareous hammocks are more frequent and extensive in this region than in any other, with the possible exception of the east coast. (The great Gulf Hammock in Levy County, shown in fig. 5, is the most typical example.) The

hammocks often grade into swamps, which are more or less calcareous too. The coast is bordered by marshes, as already stated, and there are quite a number of shallow ponds and wet prairies, particularly in Sumter County.

The commonest plants are about as follows:

COMMONEST PLANTS OF GULF HAMMOCK REGION.

	TIMBER TREES	
Pinus palustris	Long-leaf pine	Pine lands
Sabal Palmetto	Cabbage palmetto	Low hammocks, etc.
Taxodium distichum	Cypress	Swamps and low hammocks
Pinus Caribaea	Slash pine	Low pine lands
Taxodium imbricarium	(Pond) cypress	Cypress ponds
Pinus Elliottii	Slash pine	Low pine lands
Liquidambar Styraciflua	Sweet gum	Low hammocks, etc.
Pinus Taeda	Short-leaf pine	Low hammocks, etc.
Acer rubrum	Red maple	Swamps and low hammocks
Magnolia grandiflora	Magnolia	Hammocks
Quercus Virginiana	Live oak	Hammocks, etc.
Juniperus Virginiana	Cedar	Low hammocks, etc.
Pinus clausa	Spruce pine	Scrub
Ulmus Floridana	Elm	Low hammocks
Tilia pubescens?	Lin	Hammocks
Fraxinus profunda?	Ash	Swamps
Quercus **hybrida?**	Water oak	Low hammocks
Quercus Michauxii	Swamp chestn't oak	Low hammocks
Quercus **nigra**	Water oak	Low hammocks
Celtis occidentalis?	Hackberry	Low hammocks
	SMALL TREES.	
Carpinus Caroliniana	Ironwood	Low hammocks
Salis longipes?	Willow	Edges of swamps, etc.
Quercus Catesbaei	Black-jack oak	High pine land
Magnolia glauca	Bay	Swamps
Quercus cinerea	Turkey oak	High pine land
Quercus geminata	Live oak	High pine land, etc.
Fraxinus Caroliniana?	Ash	Swamps
Persea pubescens	Red bay	Swamps
Osmanthus Americana		Hammocks
Ostrya Virginiana		Hammocks
	WOODY VINES.	
Berchemia scandens	Rattan vine	Low hammocks
Rhus radicans	Poison ivy	Low hammocks, etc.
Gelsemium sempervirens	Yellow jessamine	Hammocks
Parthenocissus quinquefolia	Virginia creeper	Hammocks
Smilax laurifolia	Bamboo vine	Swamps
Decumaria barbara		Swamps
Ampelopsis arborea		Low hammocks
	SHRUBS	
Serenoa serrulata	Saw-palmetto	Flatwoods
Myrica cerifera	Myrtle	Hammocks
Ilex glabra	Gallberry	Flatwoods
Cornus stricta?		Low hammocks
Pieris nitida	(Hurrah bush)	Swamps and flatwoods
Cholisma ferruginea		Sandy hammocks
Quercus myrtifolia	(Scrub oak)	Scrub, etc.
Myrica pumila	Myrtle	Flatwoods
Cephalanthus occidentalis	(Elbow bush)	Ponds and swamps
Asimina pygmaea?	Pawpaw	Flatwoods
Viburnum **obovatum**		Low hammocks
Vaccinium nitidum	Huckleberry	Flatwoods
Quercus minima	(Oak runner)	Flatwoods
Aralia spinosa	Prickly ash	Hammocks
Sabal glabra	Palmetto	Low hammocks, etc.
Itea Virginica		Swamps
Rosa palustris	(Wild rose)	Swamps
Hypericum fasciculatum	Sand myrtle	Ponds, etc.

HERBS

Tillandsia usneoides	Spanish moss	On trees
Aristida **stricta**	Wire-grass	Pine lands
Cladium effusum	Saw-grass	Wet prairies, etc.
Pterocaulon undulatum	Black-root	Flatwoods
Juncus Roemerianus	(Rush)	Brackish marshes
Sagittaria lancifolia		Wet prairies, etc.
Iris **versicolor**	(Blue flag)	Wet prairies, etc.
Tillandsia tenuifolia	Air-plant	Low hammocks, etc.
(Eupatorium capillifolium)	Dog-fennel	Low prairies, etc.
Saururus cernuus		Rich swamps
Spartina **Bakeri**	Switch-grass	Around prairies, etc.
(Piaropus crassipes)	Water-hyacinth	Lakes and runs
Carphephorus corymbosus		Flatwoods
Pontederia cordata	Wampee	Ponds and swamps
Nymphaea macrophylla	Bonnets	Ponds and streams
Mesosphaerum rugosum		Marly flatwoods, etc.
Polypodium polypodioides	(A fern)	On trees in hammocks
Rhynchospora miliacea	(A sedge)	Low hammocks
Mitchella repens	Turkey-berry	Hammocks
Pistia spathulata	Water-lettuce	Calcareous streams
Senecio lobatus		Rich swamps
Tubiflora Carolinensis		Low hammocks

About 75% of the large trees and shrubs, but not so many of the small trees and vines, are evergreen.

Fisheries. The shallow rock-bottomed waters of the Gulf adjacent to this region afford a favorable habitat for many kinds of fish. Besides the ordinary commercial fisheries, the region is visited in winter by many persons from outside the state who fish for sport. Homosassa is a favorite winter resort for Georgia fishermen. The sponges brought in to Cedar Keys and Tarpon Springs (which are in other regions) must also be counted among the submarine resources of the Gulf hammock region. The bird guano industry is described in the chapter on animals.

Population. This region does not cover enough of Levy, Citrus, Hernando and Pasco Counties to enable us to get any accurate statistics of the coastal portion from census reports, but the portion along the Withlacoochee River is approximately coextensive with Sumter County. Previous to 1887, when it was reduced to its present size, that county included a considerable part of the lake region also, so that census returns from it for earlier periods have little geographical value. The number of inhabitants per square mile increased gradually from 9.1 in 1890 to 14.1 in 1920. None of the population is classed as urban by the U. S. census, but 20.4% of the people were living in incorporated places at the time of the state census of 1915. In 1910 about 66% of the population was native white, 0.4% foreign white, and 33.7% of African descent. At the same time 3% of the native whites over 10 years old, none of the foreign whites, and 26.9% of the negroes were unable to read and write.

The largest towns in the Gulf hammock region in central Florida in 1915 were Crystal River, with 900 inhabitants, Center Hill, with 495, Coleman, 389, Bushnell 343, and Webster 307. In 1916 the leading religious denominations among the white church members in Sumter County were Baptist, southern Methodist, Church of God, southern Presbyterian, and Church of Christ; and among the negroes, Baptist, African Methodist, Colored Methodist, Primitive Baptist, and A. M. E. Zion.

Agriculture. For statistics of agriculture we are practically compelled to depend on the returns for Sumter County, for the same reason already given under population. The leading features of agriculture in that county in 1889-90, 1899-1900, and 1909-10 are shown in Table 1.

TABLE I.

Agricultural Statistics of Gulf Hammock Region (Sumter Co.), 1890-1910.

	1889-1890	1899-1900	1909-1910 Total	1909-1910 White	1909-1910 Color'd
Per cent of land in farms	22.8	21.8	20.5	19.4	1.1
Per cent of land improved	6.2	5.5	6.1	5.5	0.7
Improved acres per inhabitant	4.3	3.3	3.4	4.7	1.3
Inhabitants per farm	5.0	8.2	8.8	7.3	15.8
Per cent of farmers white	-----	83.6	81.0	------	------
Per cent of farmers, owners	86.3	89.7	82.4	83.4	79.0
Per cent of farmers, managers		0.9	0.4	0.5	0
Per cent of farmers, tenants	13.7	9.4	17.1	16.1	21.0
Average number of acres per farm	80.2	109.2	101.2	118.2	28.1
Average improved acres per farm	21.9	29.0	30.4	33.8	19.7
Value of farm land per acre ($)	-----	6.20	17.92	17.90	18.25
Value of farm land per farm	3450	678	1815	2121	512
Value of buildings per farm		205	409	472	138
Value of implements and machinery	30	58	123	144	34
Value of live-stock, poultry, etc.	164	338	480	------	------
Number of dairy cows per farm	1.6	2.3	8.4	10.2	0.6
Number of other cattle per farm	11.1	28.5	14.0	------	------
Number of horses per farm	1.0	1.8	1.8	1.8	1.0
Number of mules per farm	0.1	0.2	0.2	0.2	0.1
Number of hogs per farm	10.1	12.5	22.7	------	------
Number of sheep per farm	2.1	1.5	2.6	------	------
Number of poultry per farm	16.3	42.5	24.3	------	------
Expenditures per farm for fertilizer	17.00	23.80	99.00	------	------
Expenditures per farm for labor	-----	39.40	189.00	------	------
Expenditures per farm for feed	-----	------	42.50	------	------
Annual value of crops per farm	288	389	895	------	------
Annual value of animal products			88	------	------
Expend. fertilizer per acre improved	0.77	0.86	3.26	------	------
Expend. labor per acre improved	-----	1.43	6.25	------	------
Value of crops per acre improved	-----	------	29.50	------	------

The figures for dairy cows per average farm in 1910 seem rather excessive in comparison with other times and adjacent regions, and may indicate an error of some kind, or some exceptional condition not explained by the census, such as a temporary accumulation of cows on one or two large farms.

The leading crops in 1909, in order of value, as estimated from the U. S. census of 1910, were "vegetables" (about 72% of the total), corn, oranges, grape-fruit, peanuts, hay, oats, sweet potatoes, and sugar-cane (the value for the last representing the syrup made from it). In 1913-14, according to the state agricultural department, the order was cucumbers, tomatoes, oranges, cabbages, corn, (string) beans, hay, peanuts, sweet potatoes, watermelons, sugar-cane (syrup), velvet beans, and lettuce. But of course if the lime-sink portion of the county in the northeast corner, could be separated this sequence might be changed a little. (There are no data for 1917-18, because the agricultural enumerator for Sumter County failed to make a report that year.)

3. THE MIDDLE FLORIDA FLATWOODS

This region extends from north of our limits through Levy County to the Withlacoochee River a few miles west of Dunnellon, where it seems to terminate abruptly. The greater part of it is in Middle Florida (west of the Suwannee River), and it was described in the 6th Annual Report, pages 310-313. About 300 square miles of it lies within the area of the present report, and a small part of it is covered by the soil survey of the "Ocala area."

It is a level region, perhaps nowhere more than 75 feet above sea-level, with many shallow ponds and bays, and some sluggish coffee-colored creeks. The ground-water is nearly everywhere close to the surface, and there are no known outcrops of limestone, so that the soil is rather sour. Most of the soil in this region within the limits of the "Ocala area" has been classed as "Leon fine sand."

The vegetation is mostly of the palmetto flatwoods type, interspersed with numerous cypress ponds, bays, and non-alluvial swamps. The commonest plants recognizable in February, March and April seem to be as follows:

COMMONEST PLANTS OF MIDDLE FLORIDA FLATWOODS.

	TIMBER TREES	
Pinus palustris	Long-leaf pine	Flatwoods
Taxodium imbricarium	(Pond) cypress	Ponds and bays
Pinus Elliottii	Slash pine	Ponds and swamps
Pinus serotina	Black pine	Damp flatwoods
Acer rubrum	Red maple	Swamps
	SMALL TREES.	
Quercus Catesbaei	Black-jack oak	Drier spots
Magnolia glauca	Bay	Swamps and bays
	WOODY VINES.	
Smilax laurifolia	Bamboo vine	Swamps and bays
Smilax Walteri		Swamps and bays
	SHRUBS	
Serenoa serrulata	Saw-palmetto	Flatwoods, etc.
Pieris nitida	(Hurrah bush)	Damp flatwoods, etc.
Ilex glabra	Gallberry	Flatwoods, etc.
Hypericum fasciculatum	Sand myrtle	Ponds
Aronia arbutifolia	(Choke-berry)	Edges of swamps
Bejaria racemosa		Flatwoods
Quercus minima	(Oak runner)	Flatwoods
Cholisma fruticosa	(Poor grub)	Flatwoods
Vaccinium nitidum	Huckleberry	Flatwoods
	HERBS	
Tillandsia usneoides	Spanish moss	On trees
Anchistea Virginica	(A fern)	Cypress ponds
Sarracenia **minor**	Pitcher-plant	Flatwoods
Pterocaulon undulatum	Black-root	Flatwoods
Erigeron **vernus**		Flatwoods
Aristida **stricta**	Wire-grass	Flatwoods
Polygala cymosa		Cypress ponds
Andropogon scoparius?	Broom-sedge	Flatwoods
Pontederia cordata	Wampee	Ponds
Eriocaulon compressum		Ponds
Nymphaea macrophylla	Bonnets	Creeks, etc.
Centella repanda		Flatwoods
Bartonia verna		Flatwoods
Syngonanthus **flavidulus**		Flatwoods

About 80% of the trees and shrubs are evergreen, about one-third of the shrubs (both individuals and species) belong to the heath family (Ericaceae) and allied families, and leguminous plants are very scarce, as already observed in the portions of this region situated farther north.

This region does not cover enough of any one county to enable us to study it statistically, but it is evidently very thinly settled. Lumbering, turpentining and grazing seem to be the leading industries, and several of the shrubs could furnish a great deal of honey if there were enough people living near to take advantage of the fact.

4. THE PENINSULAR LIME-SINK OR HARD-ROCK PHOSPHATE REGION

(Figs. 8-11, 40. Soil analyses 6-9.)

This extends from a few miles north of the northern boundary of the state southward through the western half of the peninsula to the neighborhood of Tampa. Its southern limits are ill-defined, or at least insufficiently explored, but there is at least one area of considerable size in Hillsborough County, entirely disconnected from the rest. It reaches the coast in Pinellas County, which seems to be the only place in peninsular Florida where any high land other than dunes and shell mounds can be seen from the ocean. Its area in central Florida is about 2,400 square miles.

Geology. The greater part of the area is underlaid at no great depth by a comparatively pure limestone now regarded as of upper Eocene age, which is practically the oldest rock outcropping in Florida. Toward the southern end of the region this is supposed to dip southward and be overlaid by the Tampa limestone, of Oligocene age. Extending nearly the whole length of the region are irregular deposits or pockets of hard-rock phosphate, apparently derived mostly from a re-working of the underlying rock by geological processes, but containing many vertebrate fossils of Pliocene age, and designated by geologists as the Alachua formation. Practically the whole surface is covered by several feet of incoherent sand whose age is problematical, and there may be a stratum of clay between the sand and rock in some places, not as extensive in central Florida as farther north, however.

The underground water, tapped by many artesian wells at depths usually from 50 to 100 feet below the surface, is good to drink, but unsuited for boiler purposes on account of the large amount of limestone dissolved in it. For this reason the Atlantic Coast Line R. R. uses water-softeners at its tanks at Ocala Junction, Dunnellon and Croom, and rain water cisterns are used in some of the towns

Topography and Drainage. The highest elevations known are a little over 200 feet above sea-level. The topography is everywhere undulating, with many basins of various sizes and shapes, presumably formed by the solution of underlying limestone. Some of these have sinks or caves in their bottoms, some are sandy and always dry, some are inundated part of the time, and some contain permanent water, making ponds or lakes (fig. 10). The dry basins

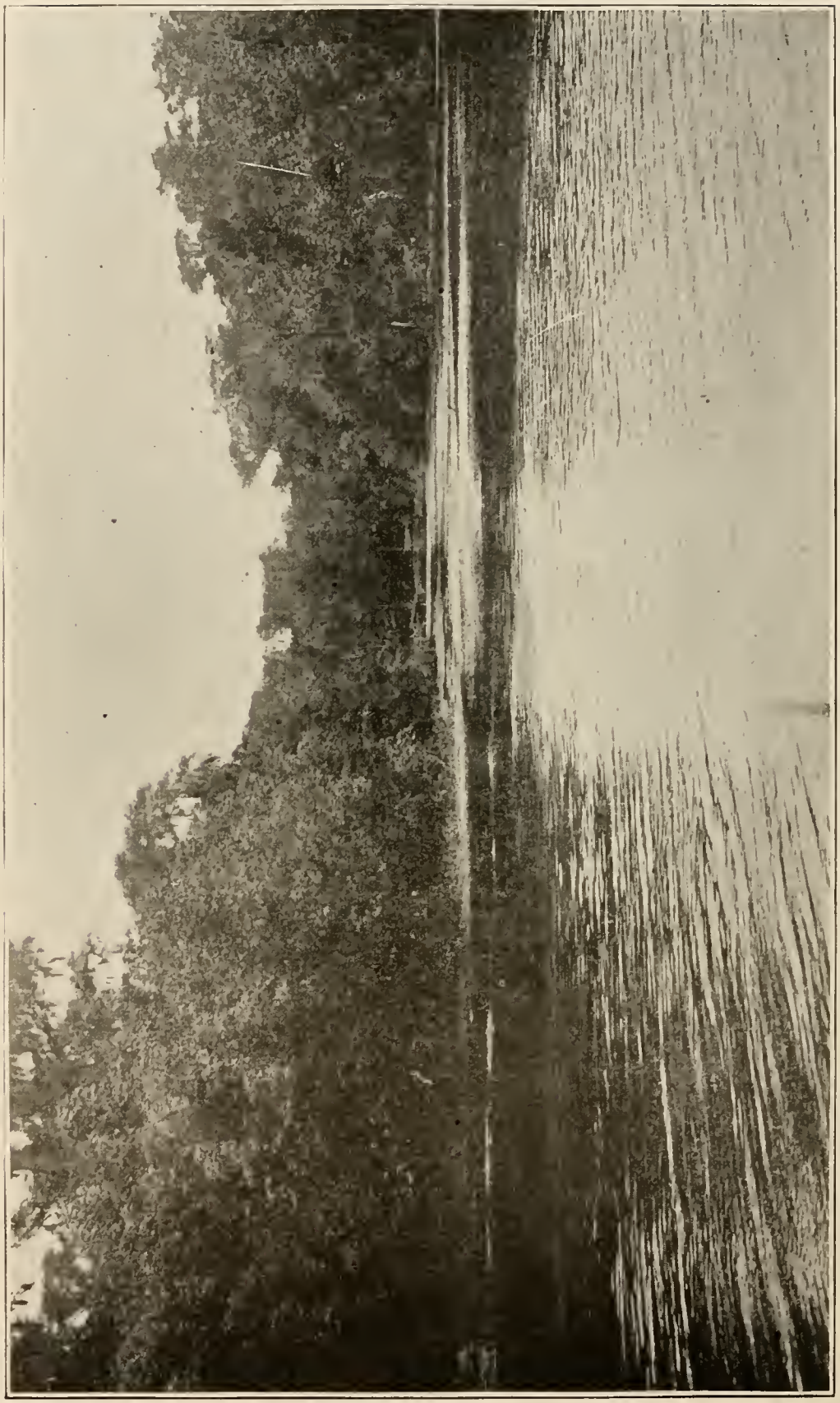

Fig. 8. Silver Spring, Marion County. By E. Peck Greene, 1908.

are commonest northward, and the lakes most numerous in Hillsborough County, where the ground-water is nearest to the surface. (This southern portion is not very different from the lake region farther east.)

Streams and swamps are rather scarce, on account of most of the drainage being subterranean, through the deep sand and cavernous limestone. There are several large limestone springs, the most noted being Silver Spring (fig. 8), a few miles east of Ocala, which is one of the largest in the world.

Soils. The greater part of the soil is a cream-colored or light buff fine-grained sand, varying toward white or brown, and usually quite uniform in texture to a depth of several or many feet. About half of this region in central Florida is now covered by soil surveys, from which it appears that by far the greater part of the soils are referable to the "Norfolk" series, with a scattering of "Gainesville," "Hernando," "Leon," "Fellowship," "St. Lucie," etc (which names however may mean little to persons not thoroughly familiar with the publications of the U. S. Bureau of Soils, to which they are at present chiefly confined). The leading texture classes are fine sand (about 75% of the total), sand, fine sandy loam,

Fig. 9. High pine land with scattered oaks (the most conspicuous one a live oak, (*Quercus geminata*), about 5 miles west of Inverness, Citrus County. March 14, 1914.

Fig. 10. Shallow basin containing water, in open pine forests about 4 miles west of Inverness. There is no fringe of bushes around this pond, a fact doubtless correlated with its considerable seasonal fluctuations, which make the edge of the area subject to fire variable. (Compare with fig. 22.) March 14, 1914.

Fig. 11. Interior of rather open scrub about 5 miles west of Inverness, taken from a point about 20 feet up a tree. March 14, 1914.

swamp, and loamy sand. Scrub, or white sand, under the various designations of "Norfolk sand with scrub oak vegetation," "Leon fine sand, scrub phase," "St. Lucie sand," and "Leon fine sand, rolling phase," makes up about 2% of the total. A few mechanical analyses are given in the general chapter on soils, but no reliable chemical analyses seem to be available yet.

Vegetation. High pine land, with or without a lower story of black-jack or turkey oak or both, makes up at least three-fourths of the total native vegetation. (See figs. 9, 10.) The oaks seem to increase in numbers wherever the pines are cut off, perhaps chiefly because that allows the ground to dry out a little more and they prefer the driest soils. There are a good many hammocks, mostly along rivers and on lake peninsulas and islands, and a few patches of scrub (fig. 11), ranging in size from a few acres to several square miles.

As there is more high pine land than all other vegetation combined, a census of plants, especially herbs, for the whole region bears considerable resemblance to that for high pine land in the "Ocala area," published in the 7th Annual Report (pages 166-167). The commonest species seem to be as follows, except that herbs that bloom in late summer and fall are probably not represented as well as they should be, for lack of observations at that time of year. The first tree listed is, or was originally, probably at least fifty times as abundant as its nearest competitor.

COMMONEST PLANTS OF PENINSULAR LIME-SINK REGION.

	TIMBER TREES	
Pinus palustris	Long-leaf pine	High pine land
Taxodium distichum	Cypress	Swamps
Liquidambar Styraciflua	Sweet gum	Hammocks, etc.
Pinus clausa	Spruce pine	Scrub
Quercus laurifolia		Sandy hammocks
Quercus Virginiana	Live oak	Hammocks, etc.
Magnolia grandiflora	Magnolia	Hammocks
Quercus falcata	Red oak	Richer uplands, northward
Sabal Palmetto	Cabbage palmetto	Low hammocks, etc.
Pinus Taeda	Short-leaf pine	Hammocks, etc.
Taxodium imbricarium	(Pond) cypress	Ponds
Persea Borbonia	Red bay	Hammocks
Acer rubrum	Red maple	Swamps
Hicoria glabra	Hickory	Sandy hammocks
Hicoria alba	Hickory	Rich uplands
	SMALL TREES.	
Quercus Catesbaei	Black-jack oak	High pine land
Quercus cinerea	Turkey oak	High pine land
Quercus geminata	Live oak	High pine land and scrub
Batodendron arboreum	Sparkleberry	Sandy hammocks
Osmanthus Americana		Sandy hammocks

Quercus Margaretta	Post oak	High pine land
(Diospyros Virginiana)	Persimmon	Old fields, etc.
Cornus florida	Dogwood	Rich uplands
Quercus **Chapmani**		Sandy hammocks
Salix longipes?	Willow	Edges of swamps
Crataegus Michauxii?	(Red) haw	High pine land, old fields, etc
Ilex opaca	Holly	Sandy hammocks, etc.
Magnolia glauca	Bay	Swamps

WOODY VINES.

Vitis rotundifolia	Muscadine	Hammocks
Rhus radicans	Poison ivy	Low hammocks
Gelsemium sempervirens	Yellow jessamine	Hammocks
Vitis aestivalis	Wild grape	Hammocks
Decumaria barbara		Swamps
Smilax auriculata		Scrub

SHRUBS

Serenoa serrulata	Saw-palmetto	Various situations
Cholisma ferruginea		Sandy hammocks
Chrysobalanus **oblongifolius**		High pine land
Myrica cerifera	Myrtle	Low hammocks, etc.
Myrica pumila	Myrtle	Pine lands
Vaccinium nitidum	Huckleberry	High pine land, etc.
Ceratiola ericoides	Rosemary	Scrub, etc.
Quercus myrtifolia	(Scrub oak)	Scrub
Ceanothus microphyllus		High pine land
Ilex glabra	Gallberry	Low pine land
Phoradendron flavescens	Mistletoe	On oaks mostly
Asimina speciosa?	Pawpaw	High pine land
Cephalanthus occidentalis	(Elbow-bush)	Ponds and swamps
Rhus copallina	Sumac	Uplands
Hypericum fasciculatum	Sand myrtle	Ponds
(Baccharis halimifolia)		Low places
Asimina reticulata?	Pawpaw	High pine land
Quercus Catesbaei (shrubby)	Black-jack oak	High pine land
Callicarpa Americana	French mulberry	Hammocks, etc.
Viburnum **obovatum**		Low hammocks
Asimina augustifolia	Pawpaw	High pine land
Rhus Toxicodendron	Poison oak	High pine land

HERBS

Aristida **stricta**	Wire-grass	High pine land
Tillandsia usneoides	Spanish moss	Hammocks, etc.
Kuhnistera pinnata	(Summer farewell)	High pine land
(Eupatorium compositifolium)	Dog-fennel	High pine land and old fields
Eriogonum **tomentosum**		High pine land
Andropogon Virginicus	Broom-sedge	High pine land
Carphephorus **corymbosus**		High pine land
Chamaecrista fasciculata?	Partridge pea	High pine land
Actinospermum angustifolium		High pine land
Eupatorium aromaticum		High pine land
Pterocaulon undulatum	Black-root	High pine land
Pteris aquilina	(A fern)	High pine land
Croton argyranthemus		High pine land
Cladium effusum	Saw-grass	Along streams, etc.
Sericocarpus bifoliatus		High pine land
Lupinus diffusus	(Lupine)	High pine land
Stillingia sylvatica	Queen's delight	High pine land
Psoralea canescens		High pine land
Spartina **Bakeri**	Switch-grass	Around prairies, etc.
Helianthus Radula		High pine land
Stenophyllus Warei	(A sedge)	High pine land
(Piaropus crassipes)	Water-hyacinth	Lakes and streams
(Eupatorium capillifolium)	Dog-fennel	Low prairies, etc.

(and about 270 others)

About 83% of the large trees and still more of the shrubs are evergreen, but Ericaceae (heath-like plants) are comparatively

scarce, and Leguminosae (leguminous plants) seem to be more abundant here than in most other parts of central Florida, which indicates that the soil is not as poor as it might look to a new-comer who had spent most of his life in clayey regions.

The long-leaf pine is, and doubtless will long continue to be, an important source of lumber, fuel, and naval stores. Near some of the phosphate mines it has been cut off pretty completely to furnish heat for drying the phosphate rock, leaving a very desolate-looking country, but it comes back as fast as it is allowed to, without any assistance. The wire-grass and other herbage of the pine lands afford an abundance of free pasturage for cattle.

Population. This region does not cover enough of any one county to enable us to estimate the density of population very accurately, but there are probably at least thirty inhabitants per square mile. It includes most of the settlements in Levy and Citrus Counties, from the statistics of which we can approximate the composition and some other characteristics of the population.

These two counties have no places with over 2,500 inhabitants, and therefore no population classed as urban by the U. S. census, but 8.7% of the people were living in the three incorporated towns in 1915. The largest towns in the region at that time were Tarpon Springs, with 1938 inhabitants, Clearwater, with 1932, Inverness, with about 1000 (but not returned separately from the precinct including the town), Dunnellon 979, Williston 800, Dunedin 429, Anthony 406, and Wildwood 385. (The 1920 census puts Clearwater ahead of Tarpon Springs, but returns for the smaller places have not been published yet).

In Levy and Citrus Counties in 1910 about 50.1% of the inhabitants were native white, 1% foreign white, and 49% negro. At the same time 5.9% of the native whites, 14.8% of the foreign whites, and 30% of the negroes were illiterate. The illiteracy percentage for foreign whites is considerably higher than it usually is in primarily agricultural regions, and probably indicates a considerable number of foreign-born unskilled laborers employed in the phosphate mines. The foreigners came mostly from Italy, Greece, England, Germany, Canada and Sweden; but of course there is no telling how many of them are fishermen and spongers, living on the coast of these two counties, and therefore entirely outside of the lime-sink region. There is a large colony of Greeks, supported

mostly by the sponge business, at Tarpon Springs in Pinellas County.

In 1916 the leading religious denominations among the whites were Baptist, Methodist (southern), Church of Christ, Episcopalian and Presbyterian; and among the negroes Baptist and African Methodist.

Agriculture. Agricultural conditions here are more like those of the typical South or cotton belt than in most other parts of central Florida. The ratio of farm land and improved land to total area is indeterminate, for the same reason as density of population, but in Levy and Citrus Counties in 1900 and 1910 there were 2.56 improved acres per inhabitant, a lower figure than in a purely agricultural region with American standards, and indicating the employment of a considerable part of the population in mining, lumbering, fishing, etc. (This is especially noticeable in the case of the negroes, who have less than one improved acre per inhabitant). Although it is impossible to get any accurate data on the subject from existing census reports, there are probably nearly as many families supported by phosphate mining as by farming, and even more may be engaged in exploiting the forests for lumber and turpentine.

The salient features of agriculture for the last three census periods previous to 1920 are shown in the following table.

The leading crops in these two counties in 1909, in order of value, were "vegetables", peanuts, corn, cotton (both kinds), sugar-cane, oats, sweet potatoes, oranges, hay, peaches, grape-fruit, pears, and Irish potatoes. Peanuts had probably increased in relative importance since 1899, judging by the increase in number of hogs per farm.

TABLE 2.

Agricultural Statistics of Lime Sink Region (Levy & Citrus Cos.) 1890-1910.

	1889-1890	1899-1900	1909-1910 Total	1909-1910 White	1909-1910 Color'd
Improved acres per inhabitant	3.83	2.56	2.56	4.4	0.64
Inhabitants per farm	10.0	12.7	17.1	10.7	45.2
Per cent of farmers white	-----	82.3	81.4	------	------
Per cent of farmers, owners	92.4	81.7	81.2	82.8	74.6
Per cent of farmers, managers		2.8	0.7	0.8	0
Per cent of farmers, tenants	7.6	15.5	18.1	16.4	25.4
Average number of acres per farm	136.3	109.0	159.0	180.0	68.7
Average improved acres per farm	38.8	32.7	43.9	47.3	28.8
Value of farm land per acre ($)	-----	5.40	7.36	7.25	8.63
Value of farm land per farm	1905	588	1170	1305	594
Value of buildings per farm		232	340	379	168
Value of implements and machinery	46	38	98	113	32
Value of live-stock, poultry, etc.	253	358	538	------	------
Number of dairy cows per farm	4.9	3.0	3.3	3.6	1.4
Number of other cattle per farm	14.7	26.6	26.5	------	------
Number of horses per farm	1.6	1.7	1.6	1.4	1.2
Number of mules per farm	0.1	0.1	0.2	0.3	0.1
Number of hogs per farm	15.2	16.9	31.4	------	------
Number of sheep per farm	1.8	3.0	1.1	------	------
Number of poultry per farm	28.2	27.3	29.8	------	------
Expenditures per farm for fertilizer	3.74	1.45	29.80	------	------
Expenditures per farm for labor	-----	25.10	49.50	------	------
Expenditures per farm for feed	-----	------	36.60	------	------
Annual value of crops per farm	272	340	620	------	------
Annual value of animal products			222	------	------
Expend. fertilizer per acre improved	.10	.04	.68	------	------
Expend. labor per acre improved	-----	.77	1.13	------	------
Value of crops per acre improved	-----	------	14.10	------	------

In 1917-18, according to the state agricultural department, the leading crops were sea-island cotton, peanuts, corn, sweet potatoes, velvet beans, (including hay thereof), sugar-cane, cucumbers, cow-peas (including hay), cabbage, oranges, (grass) hay, oats, watermelons, pecans, Irish potatoes, peaches, egg-plants, squashes, pears, castor beans (a "war crop," not raised much before or since), tomatoes, string beans, upland cotton, lettuce and plums. If we had data for the lime-sink portions of Hernando, Pasco, Hillsboro and Pinellas Counties no doubt oranges would take a much higher rank and peanuts and cotton a lower. This region leads the rest of central Florida in the relative importance of peanuts, as it does in hogs.

5. THE MIDDLE FLORIDA HAMMOCK BELT

(Figs. 12-14, 39, 41. Soil analyses 10-26, A, B, Q-U)

This has its greatest development in northern Florida, and its southern terminus in Marion County, where it covers only about 250 square miles. Unlike the portions in Alachua, Bradford, Columbia and Hamilton Counties, which occupy a slope between the high flatwoods on the east and the less elevated lime-sink region on the west, the portion south of Orange Lake has sandy lime-sink country on both sides of it, and is more or less interrupted, like a row of fertile islands in a sea of sand. The difference in elevation is not very marked, but the hammock belt averages a little higher than adjacent portions of the lime-sink region.

Geology and Topography. In this belt the Ocala limestone, of uppermost Eocene age, comes to the surface in many places, and as it is usually pure enough to dissolve readily, and considerably

Fig 12. Pit of Florida Lime Co., near Ocala. By E. H. Sellards, February, 1910.

elevated above the ground-water level, there are numerous sinks, caves, and subterranean streams. The limestone is quarried in several places (fig. 12), and mostly burned for lime. Some of the hills are partly capped by a friable sandstone of uncertain age.

Surface streams are few and small, and probably none of them connect above ground with any river. Just north of our limits there are a few large shallow lakes which become dry or nearly so at times. The highest elevations in the region seem to be about 190 feet above sea-level.

Soils. By both chemical and physical tests the soils average the best in central Florida, running pretty high in clay and in lime, as can be seen from the analyses in another chapter. In the soil survey of the "Ocala area" they are referred to the "Gainesville," "Norfolk," "Fellowship" and "Leon" series, and the texture classes, in order of area, are loamy sand, sandy loam, sand, and clay loam, the first constituting about 38% and the last about 1%. Scrub seems to be entirely absent.

Fig. 13. Semi-calcareous hammock about a mile southeast of Ocala. Feb. 13, 1915.

Vegetation. The vegetation types of the southern extremity of the region were described in considerable detail and mapped in the 7th Annual Report. In order of area the principal types seem to be high pine land, red oak woods (fig. 41), high calcareous (or semi-calcareous) hammocks (fig. 13), short-leaf pine and hickory woods (this mostly north of the "Ocala area"), sandy hammocks

(fig. 29), and low calcareous hammocks. The commonest plants are about as follows:

COMMONEST PLANTS OF MIDDLE FLORIDA HAMMOCK BELT.

	TIMBER TREES	
Pinus palustris	Long-leaf pine	High pine land
Quercus falcata	Red oak	Rich uplands
Sabal Palmetto	Cabbage palmetto	Hammocks and fields
Pinus Taeda	Short-leaf pine	Woods
Liquidambar Styraciflua	Sweet gum	Various situations
Magnolia grandiflora	Magnolia	Hammocks
Quercus laurifolia		Sandy hammocks
Persea Borbonia	Red bay	Richer hammocks
Quercus Michauxii		Richer hammocks
Hicoria alba	Hickory	Rich uplands
Quercus **nigra**	Water oak	Low hammocks, etc.
Hicoria glabra?	Hickory	Sandy hammocks
Tilia pubescens?	Lin	Rich hammocks
Quercus Virginiana	Live oak	Various situations
Fraxinus Americana	Ash	Rich hammocks
Celtis occidentalis?	Hackberry	Rich hammocks
	SMALL TREES.	
Cornus florida	Dogwood	Rich uplands
Crataegus Michauxii?	(Red) haw	Old fields, etc.
Ostrya Virginiana		High hammocks
Cercis Canadensis	Redbud	Calcareous hammocks
Carpinus Caroliniana	Ironwood	Low hammocks, etc.
Osmanthus Americana		Sandy hammocks
Ilex opaca	Holly	Sandy hammocks
Batodendron **arboreum**	Sparkleberry	Sandy hammocks
	WOODY VINES.	
Rhus radicans	Poison ivy	Low hammocks, etc.
Smilax lanceolata	(Wild smilax)	Hammocks
Vitis rotundifolia	Muscadine	Hammocks, etc.
Gelsemium sempervirens	Yellow jessamine	Hammocks, etc.
Bignonia crucigera	Cross-vine	Hammocks
Parthenocissus quinquefolia	Virginia creeper	Hammocks
	SHRUBS	
Phoradendron flavescens	Mistletoe	Hammocks
Serenoa serrulata	Saw-palmetto	High hammocks, etc.
Myrica pumila	Myrtle	High pine land, etc.
Myrica cerifera	Myrtle	Hammocks
Callicarpa Americana	French mulberry	Hammocks
Cephalanthus occidentalis	(Elbow-bush)	Swamps, etc.
Ilex vomitoria	Yaupon	Hammocks
Cornus stricta?		Low hammocks
	HERBS	
Tillandsia usneoides*	Spanish moss	On nearly all trees
Aristida **stricta**	Wire-grass	High pine land
Pteris aquilina	(A fern)	High pine land
Tubiflora Carolinensis		Calcareous hammocks
Mitchella repens	Turkey-berry	Hammocks
(Eupatorium compositifolium)	Dog-fennel	Old fields, etc.
Oplismenus setarius	(A grass)	Hammocks
Dryopteris patens?	(A fern)	Calcareous hammocks
Smilax pumila		Sandy hammocks
Eriogonum **tomentosum**		High pine land
Houstonia **rotundifolia**		High pine land, etc.
(Cassia Tora)	Coffee-weed	Roadsides, etc.
(Gnaphalium purpureum)		Cultivated fields

*About ten times as abundant as the next.

Only about 65% of the trees are evergreen, the lowest figure of any region in this latitude in Florida. Ericaceous shrubs are rather scarce, as in other calcareous regions, and leguminous plants fairly well represented, especially among the weeds. Not much use seems to be made of the native vegetation, except the pines for lumber and turpentine, almost any of the trees for fuel, and the Spanish moss for mattresses. In the early days the forest was simply an encumbrance on the land, that the farmers had to get rid of with much labor. At present it is customary in this and other hammock regions in Florida to let cabbage palmettos grow in orange groves and other cultivated ground wherever they will (see fig. 14). Some of these may be remnants of the original forest, but probably most of them have been planted by birds, and are left because they indicate hammock land and are ornamental and do not take much light and nourishment away from the crops.

Fig. 14. Cabbage palmettos in cultivated field on hillside about 2 miles south of Ocala. March 8, 1914.

Population. As this region covers only a small part of Marion County, and contains a city of considerable size, it is not possible to get any accurate information about the rural population from census reports; but in number of inhabitants per square mile and

in proportion of negroes it is unquestionably above the average for central Florida. In the whole county in 1910 there were 38% native whites, 1.3% foreign whites, and 60.7% negroes. The predominance of negroes is characteristic of many other fertile regions in the South, but in all such places the whites tend to congregate in the towns and cities, making the number of the two races more nearly equal there. In Ocala there were in 1910 and 1915 almost exactly as many whites as blacks, and in some of the smaller towns the whites are decidedly in the majority.

The incorporated cities and towns in 1915 were Ocala, with 5,370 inhabitants, Citra, with 400; McIntosh, 206; Reddick, 191; and Belleview, 182. The 1920 census showed a slight decrease in Ocala, probably due mainly to the migration of negroes from all over the South to northern manufacturing cities during the recent world war.

In 1880 (the latest year for which we have such data), when the population of Marion County was still more concentrated in the hammock belt than it is now, about 61% of the inhabitants of the county were natives of Florida, 20% of South Carolina, and 7% of Georgia, with Alabama, North Carolina and Virginia ranking next. Less than 0.7% were foreign-born, the countries most largely represented being England, Germany, Ireland, Canada and Sweden. Thirty years later the proportions had changed but little, the leading nationalities being English, German, Canadian, Scotch, Russian (mostly Jews?), Italian, Swedish, and French.

In 1910 the percentage of illiteracy in Marion County was for native whites over 10 years old 1.5, for foreign whites 1.7, and for negroes 19.6. In the city of Ocala at the same time the census enumerators found only one native white person over 10 who could not read and write, while 6.3% of the foreigners and 5% of the negroes were illiterate.

The leading religious denominations in the county in 1916 were, among the whites, Baptist, southern Methodist, northern Methodist(?)* southern Presbyterian, Episcopalian, Church of Christ, Disciples of Christ, and Roman Catholics. Among the negroes, Baptist, African Methodist, northern Methodist (?) A. M. E. Zion, and colored Methodist.

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*See explanation of statistical difficulties in the general chapter on religious denominations.

Agriculture. On account of its fertile soil this is probably the most extensively cultivated region in central Florida, although the percentage of improved land cannot be estimated, for the reasons already given. But as it probably contains most of the farms in Marion County, the statistics for the average farms in that county ought to represent conditions in the hammock belt pretty well. (If we should add to—or subtract from, as the case may be—the Marion averages the differences between them and those for Levy and Citrus Counties already given, we would probably come still nearer to the actual conditions in the hammock belt, for outside of that belt nearly all the farming in the county is done in the limesink region).

In 1850 about half the farms in central Florida were in Marion County, and the average farm (or plantation) in the county had 169 acres, of which 34.8 were improved. Its land and buildings were worth $1,055, its implements and machinery $94, and its livestock $531. In the next decade there was a great expansion, and the amount of improved land increased more than 70%. In 1860, when the ante-bellum plantation system of the South had reached its height, the average Marion County planter owned 450 acres, of which 133.7 were improved, land and buildings worth $4,620, implements and machinery $205, and live-stock $1,094. At this time considerable sugar was being produced, an industry made possible by the abundance of cheap labor, which does not exist in Florida now.* The Civil War of course made many former slaves farm proprietors, and thus reduced the average size of farms considerably; but unfortunately the census did not make any distinction between white and colored farmers until 1900. By 1880 the average farm in the county had shrunk to practically the same size as in the pioneer days of 1850, having 151 acres, with 36.8 improved. The land and buildings were then worth $903, implements and machinery $31, and live-stock $204. The expenditure for fertilizers the previous year was 86 cents per farm or a little over 2 cents per improved acre.

Agricultural conditions at the next three U. S. censuses are shown in more detail in Table 3.

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*But for this difficulty tea and silk could probably be produced here too.

TABLE 3.

Agricultural Statistics of Middle Florida Hammock Belt (Marion Co.), 1890-1910.

	1889-1890	1899-1900	1909-1910 Total	1909-1910 White	1909-1910 Color'd
Improved acres per inhabitant	3.14	2.98	3.24	6.13	1.37
Inhabitants per farm	9.6	9.7	12.5	9.2	16.3
Per cent of farmers, white	-----	49.4	53.2	------	------
Per cent of farmers, owners	89.8	82.3	86.7	87.8	85.6
Per cent of farmers, managers		3.3	2.2	3.7	0.4
Per cent of farmers, tenants	10.2	14.4	11.1	8.5	14.0
Average number of acres per farm	97.2	79.9	101.5	151.0	45.3
Average improved acres per farm	30.2	28.8	40.5	56.5	22.3
Value of farm land per acre ($)	-----	6.00	14.21	15.24	10.33
Value of farm land per farm	3925	482	1441	2295	468
Value of buildings per farm		279	462	687	206
Value of implements and machinery	43	45	104	152	49
Value of live-stock, poultry, etc.	225	206	454	------	------
Number of dairy cows per farm	4.3	2.6	2.6	3.8	1.1
Number of other cattle per farm	7.5	9.5	13.7	------	------
Number of horses per farm	1.1	1.3	1.5	1.5	1.0
Number of mules per farm	0.3	0.2	0.4	0.6	0.1
Number of hogs per farm	10.0	10.3	17.7	------	------
Number of sheep per farm	2.9	1.6	3.5	------	------
Number of poultry per farm	27.7	31.0	30.2	------	------
Expenditures per farm for fertilizer	24.30	12.55	67.60	------	------
Expenditures per farm for labor	-----	50.30	146.00		
Expenditures per farm for feed	-----	------	26.10	------	------
Annual value of crops per farm	394	376	853	------	------
Annual value of animal products			173	------	------
Expend. fertilizer per acre improved	.81	.43	1.67	------	------
Expend. labor per acre improved	-----	1.74	3.62	------	------
Value of crops per acre improved	-----	------	21.00	------	------

The leading crops in 1909 were "vegetables," corn, oranges, peanuts, hay, oats, grape-fruit, sweet potatoes, cane syrup, cowpeas, cotton (both kinds) and Irish potatoes.

In 1913-14 the order was, oranges, cantaloupes, sea-island cotton, watermelons, corn, velvet beans, lettuce, tomatoes, (string) beans, peanuts, sweet potatoes, cabbage, upland cotton, cucumbers, cowpeas, cane syrup, (grass) hay, squashes, oats, egg-plants; and in 1917-18 corn, sea-island cotton, peanuts, oranges, sweet potatoes, Irish potatoes, string beans, syrup, velvet beans, (including hay), upland cotton, watermelons, cowpeas, (and hay thereof), grass hay, tomatoes, lettuce, oats, cabbage, cantaloupes, cucumbers, and grape-fruit.

The leading animal products in 1909 were hogs, beef cattle, poultry and eggs, milk, butter, wool, and honey.

6. THE HERNANDO HAMMOCK BELT

(Figs. 15-17. Soil analyses V, W.)

In the Third Annual Report this was treated as an outlier of the Middle Florida hammock belt, but it differs from the southern extension of that in Marion County in being much less calcareous and more hilly, and in the entire absence of red oak (the commonest hardwood tree around Ocala), and it seems to merit separate treatment. It occupies high land about equally distant from the Withlacoochee River and the Gulf coast, as if it was an erosion remnant left by the deepening of the valley of that river in pre-historic times. The portions immediately north and south of Brooksville have been called Annuttalaga and Choocochattee hammocks respectively, but they are considerably larger and more diversified than typical hammocks. The area of the belt is about 200 square miles.

Geology and Topography. The Chattahoochee formation, an impure limestone of Oligocene age, is exposed around Brooksville, and may underlie the whole area. It is pretty well covered up, though, by clay (utilized for brick-making at Brooksville) and sand. The topography is decidedly hilly, for Florida. Some of the hills are among the highest in the state, though no reliable measurements of them are available yet. The Atlantic Coast Line depot at Brooksville is said to be 126 feet above sea-level, and the business portion of the town must be about 100 feet higher, and other elevations near by may be still higher. Blanton, in Pasco County, has an altitude of 106 feet by the railroad survey, and some of the hills a few miles northwest of there the writer would judge from walking over them to be nearly 200 feet higher. Mirror Lake, near the abandoned station of Lenard, a few miles northeast of Blanton, was claimed in an advertisement a few years ago to be 330 feet above sea-level; but the altitude of Lenard is given as 115 feet, and the lake does not appear to be much higher than that, probably not over 50 feet higher.

On account of the calcareous nature of the country rock, and the still purer limestone of older formations below it, much of the drainage is subterranean. There are a number of lime-sinks, the best known of which is the Devil's Punchbowl, in the woods a few miles northwest of Brooksville, a conical depression perhaps 100 feet in diameter and 50 feet deep. Apparently no streams from

this region reach the ocean by open channels. There are several small creeks and branches among the hills, but as far as known they all flow into sinks, or disappear in the sand at or near the edge of the surrounding lime-sink region. (This phenomenon recalls conditions in the arid regions of the southwestern United States, where there are many well-watered mountain ranges surrounded by deserts which no streams cross.) The permanent ground-water level is in most places far below the surface. A well about 40 feet

Fig. 15. Looking north up hill about 75 feet high, on road from Brooksville to Blanton, about a mile south of Spring Lake, Hernando County. The most conspicuous trees are short-leaf pine (*Pinus Taeda*), and sweet gum. March 9, 1915.

Fig. 16. Scene in Choocochattee Prairie, about 2 miles south-southeast of Brooksville, looking toward the sink which drains it. A few sheep can be seen grazing. Feb. 11, 1909.

below the summit of a hill a few miles northwest of Brooksville, and about 50 feet deep, was observed in March, 1915, to be dry to the bottom.

There are quite a number of lakes, some of them small and permanent, much like those in the lake region to be described presently, and others large and shallow, becoming prairie basins in dry seasons or whenever their lime-sink outlets are sufficiently free from obstructions. (Figure 16 shows the sink end of such a basin, a type more frequent in the Middle Florida hammock belt and Tallahassee red hills.*) To the former class belongs Mirror Lake, previously mentioned. It covers a few acres near the top of a hill, and if the water should rise only five feet higher than it was in April, 1920 (which was probably about the average stage), it would run over and down into a dry sandy valley about 50 feet lower. The lake doubtless has a relatively impervious stratum of clay under it.

Soils. Most of the soil seems to be above the central Florida average in fertility. In the most typical portions, within a few miles

*This type of lake basin was discussed at considerable length by Dr. Sellards in the 3rd Annual Report, pp. 43-76, pl. 6-9. (Reprinted with a few additions in the 6th Annual Report.) See also 6th Ann. Rep., p. 271.

of Brooksville, it is usually rather loamy and retentive of moisture, but in Citrus and Pasco Counties it is drier and sandier, though often brownish in color. The central portion of this belt is covered by the soil survey of Hernando County, published in 1915. In that by far the greater part of the soils are referred to the "Hernando" series (a name apparently not used elsewhere, so that it means little to the reader). Other series in order of area are the "Gainesville," "Norfolk," "Fellowship," "Portsmouth," "St. Lucie," and "Leon." The prevailing texture classes are fine sandy loam (about 60%), fine sand, loamy fine sand, and stony clay loam. The scrub, here called "St. Lucie fine sand," makes up about 3% of the total. Two chemical analyses are given in the general chapter on soils.

Vegetation. Hardwood forests, or mixed hardwood and pine cover hundreds of acres in the neighborhood of Brooksville (fig. 17), but toward the extremities of the region hammocks are chiefly confined to depressions, and the uplands are mostly high pine land. The vegetation is decidedly less tropical than that of some places farther east in the same latitude, and nearly all the plants range at least as far north as Georgia. The short-leaf or loblolly pine (*Pinus Taeda*), which is probably the most characteristic tree of

Fig. 17. Part of Choocochattee Hammock in process of clearing, about 3 miles southeast of Brooksville. Trees mostly live oak and sweet gum. March 9, 1915.

the whole South, grows nearly throughout this region, but no farther south. The reason for all this is not apparent, but may be connected with geological history in some way.* The scrub is nearly all in one patch, a few miles south of Brooksville, and has not been examined by the writer. The absence of the red oak has been mentioned above, and the species of trees seem to be fewer than in the Middle Florida hammock belt.

Nearly all the plants seem to be of fairly common and widely distributed species (as in the Tallahassee red hills of northern Florida,† and many other places where short-leaf pines abound), and the most abundant seem to be as follows:

COMMONEST PLANTS OF HERNANDO HAMMOCK BELT.

TIMBER TREES		
Pinus palustris	Long-leaf pine	High pine land, etc.
Pinus Taeda	Short-leaf pine	Hammocks
Liquidambar Styraciflua	Sweet gum	Various situations
Magnolia grandiflora	Magnolia	Hammocks
Quercus laurifolia		Hammocks
Quercus Virginiana	Live oak	Hammocks
Quercus Michauxii		Low hammocks
Hicoria glabra?	Hickory	Hammocks
Quercus **nigra**	Water oak	Various situations
Ulmus alata	Elm	Hammocks
Tilia pubescens?	Lin	Hammocks
Celtis occidentalis?	Hackberry	Hammocks
Ulmus Floridana	Elm	Low hammocks
(Diospyros Virginiana)	Persimmon	Old fields
Persea Borbonia	Red bay	Hammocks
SMALL TREES.		
Quercus Catesbaei	Black-jack oak	High pine land
Carpinus Caroliniana	Ironwood	Low hammocks
Cornus florida	Dogwood	Hammocks
Ilex opaca	Holly	Hammocks
Osmanthus Americana		Hammocks
Batodendron **arboreum**	Sparkleberry	Sandy hammocks
Quercus geminata	Live oak	Sandy uplands
Ostrya Virginiana		Hammocks
Magnolia glauca	Bay	Along streams
Serenoa serrulata‡	Saw-palmetto	Hammocks
WOODY VINES.		
Gelsemium sempervirens	Yellow jessamine	Hammocks, etc.
Vitis rotundifolia	Muscadine	Hammocks
Rhus radicans	Poison ivy	Low hammocks
(Rubus trivialis?)	Dewberry	Old fields, etc.
Bignonia crucigera	Cross-vine	Hammocks

*The similarity of Hernando County (which then included the present territory of Citrus and Pasco as well) to some places much farther north was commented on nearly forty years ago by Dr. Eugene A. Smith (Tenth Census U. S., vol. 6, p. 238. 1884).

†See 6th Ann. Rep., p. 277.

‡A form with ascending or erect trunk, sometimes ten feet tall.

SHRUBS

Serenoa serrulata	Saw-palmetto	Pine land, etc.
Viburnum semitomentosum		Hammocks
Myrica cerifera	Myrtle	Hammocks
Viburnum **obovatum**		Low hammocks
Myrica pumila	Myrtle	Pine lands
Phoradendron flavescens	Mistletoe	Hammocks
Vaccinium nitidum	Huckleberry	Pine lands
Azalea nudiflora?	Honeysuckle	Hammocks
Cholisma ferruginea		Sandy hammocks
Ilex glabra	Gallberry	Pine lands
Callicarpa Americana	French mulberry	Hammocks, etc.

HERBS

Tillandsia usneodies	Spanish moss	Hammocks, etc.
Aristida **stricta**	Wire-grass	Pine lands
Carphephorus **corymbosus**		Pine lands
Eriogonum **tomentosum**		High pine land
Tillandsia tenuifolia	Air-plant	Low hammocks
Pterocaulon undulatum	Black-root	Pine lands
Pontederia cordata	Wampee	Lakes
Helianthus Radula		Pine lands
Polypodium polypodioides	(A fern)	On trees in hammocks
Houstonia **rotundifolia**		Pine lands, etc.
Pteris aquilina	(A fern)	Pine lands
Chamaecrista fasciculata	Partridge-pea	Pine lands
(Gnaphalium purpureum)		Fields and roadsides
Tubiflora Carolinensis		Low hammocks
(Eupatorium capillifolium)	Dog-fennel	Lake prairies, etc.
Sericocarpus bifoliatus		High pine land
Salvia **lyrata**	(Sage)	Hammocks
Smilax pumila		Hammocks
Mitchella repens	Turkey-berry	Hammocks
Eryngium prostratum?		Lake shores, etc.

About 80% of the large trees and shrubs, but not so many of the small trees and vines, are evergreen. This difference is probably due to the fact that the small trees and vines are chiefly confined to hammocks with richer soil, as in regions 2 and 5.

Population. In attempting to estimate the density of population we encounter the same difficulty as in most of the regions previously described, for this belt does not cover as much as half of any one county. But there must be at least forty persons per square mile. As this is evidently the most populous part of Hernando and Pasco Counties, the figures for those counties may represent the composition of the population fairly well. In 1910 they had 56.5% of native whites, 1.6% of foreign whites, and 41.8% of negroes. The percentage of illiteracy (in the population over 10) was 3.1 among the native whites, 8.9 among the foreign whites, and 31.2 amoung the negroes. The last is the highest figure found in central Florida, and that for foreign whites is rather high, too, but both may be due to a large number of unskilled laborers in the phosphate mines of Hernando County, which are entirely outside of the hammock belt.

The largest towns are Dade City, with 1296 inhabitants in January, 1920, Brooksville, with 1011, and Zephyrhills (formerly Abbott), with 577.

In 1880 nearly one-third of the inhabitants of Hernando County were from other states, chiefly from Georgia, South Carolina, Alabama, North Carolina, and Virginia, in the order named.

The leading religious denominations among the white people in 1916 were Baptist, southern Methodist, Roman Catholic, northern Methodist (?), and southern Presbyterian; and among the negroes, Baptist, African Methodist, and northern Methodist (?). The Catholics seem to be chiefly concentrated near the western edge of the region in Pasco County, where there are several places whose names begin with "San" or "St." founded about forty years ago, and two Catholic schools.

Agriculture. The fertile soil attracted farmers at an early period, and in 1850 Benton County (which corresponds with the present Citrus, Hernando and Pasco) had 82 farms, averaging 167 acres apiece, with 32.4 improved, land and buildings worth $966, implements and machinery $82, and live-stock $802. No returns were received from this county in 1860, and those of 1870 are probably not very accurate, but by 1880 the farms had increased in number to 589, and diminished in size to 135 acres with 26.2 improved, land and buildings worth $623, implements and machinery $16.80, and live-stock $378. No fertilizer was reported as used there in 1879. The cattle and hogs probably ranged mostly in the open pine lands of the lime-sink region, as they do now.

Even yet farming in Hernando and Pasco Counties is chiefly concentrated in the hammock belt, so that the following table, based on the returns from these counties, ought to represent conditions in this region from 1890 to 1910 pretty well.

TABLE 4.

Agricultural Statistics of Hernando Hammock Belt (Hernando & Pasco Cos.) 1890-1910.

	1889-1890	1899-1900	1909-1910 Total	1909-1910 White	1909-1910 Color'd
Improved acres per inhabitant	3.05	2.24	1.74	2.72	0.37
Inhabitants per farm	6.03	10.2	12.9	8.2	64.6
Per cent of farmers white	-----	87.3	91.6	------	------
Per cent of farmers, owners	92.5	85.1	83.8	84.5	76.6
Per cent of farmers, managers		1.5	1.9	2.0	1.2
Per cent of farmers, tenants	7.5	13.4	14.3	13.5	22.2
Average number of acres per farm	97.3	74.5	76.8	77.0	72.6
Average improved acres per farm	18.5	22.8	22.4	22.3	23.6
Value of farm land per acre ($)	-----	7.92	19.65	19.75	18.45
Value of farm land per farm	2650	590	1518	1520	1340
Value of buildings per farm		290	494	523	162
Value of implements and machinery	27	46	87	87	51
Value of live-stock, poultry, etc.	189	330	473	------	------
Number of dairy cows per farm	2.7	2.5	1.6	------	------
Number of other cattle per farm	10.4	24.3	22.1	------	------
Number of horses per farm	1.0	1.4	1.5	------	------
Number of mules per farm	0.1	0.1	0.2	------	------
Number of hogs per farm	11.3	16.0	22.6	------	------
Number of sheep per farm	0.8	1.6	1.6	------	------
Number of poultry per farm	21.3	29.0	26.4	------	------
Expenditures per farm for fertilizer	7.65	9.60	32.30	------	------
Expenditures per farm for labor	-----	34.40	62.00	------	------
Expenditures per farm for feed	-----	------	36.80	------	------
Annual value of crops per farm	168	378	473	------	------
Annual value of animal products			123	------	------
Expend. fertilizer per acre improved	.42	.42	1.44	------	------
Expend. labor per acre improved	-----	1.51	2.75	------	------
Value of crops per acre improved	-----	------	21.10	------	------

The leading crops in 1909, by the U. S. census, were "vegetables," corn, oranges, sweet potatoes, cane syrup, tobacco (mostly near Dade City), grape-fruit, peanuts, and strawberries..

In 1913-14, according to the state agricultural department, sweet potatoes, oranges, corn, grape-fruit, tobacco, cowpeas, (including hay), syrup, velvet beans (and hay), peanuts, (string?) beans, and watermelons; and in 1917-18, sea-island cotton, corn, oranges, grape-fruit, sweet potatoes, syrup, peanuts, upland cotton, cowpeas (and hay), velvet beans (and hay), castor beans, watermelons, peaches, and Irish potatoes.

7. THE PENINSULAR LAKE REGION

(Figs. 18-22, 35, 36, 38. Soil analyses 37-45, C-E, J-M.)

This is the largest and in some respects the most interesting region in central Florida, with an area of about 4,000 square miles. It extends along the axis or "backbone" of the peninsula from Clay County to DeSoto County, and has no counterpart in any other state, though there is a small lake region in West Florida (described in the 6th Annual Report) that resembles it in some particulars.

Geology. Geologists have mapped most of the area as underlaid by Upper Oligocene strata, but that is largely hypothetical, for exposure of fossiliferous rock are rare. There are also patches, belts or pockets of Miocene and Pliocene formations in several places, mostly not far from the St. John's River and its tributaries. Rock Spring, in Orange County (fig. 18) is of interest as being the locality where the first Miocene fossils were found in Florida.* The vegetation in many low places near lakes and rivers seem to indicate limestone or marl near the surface, and there are a few large limestone springs in Volusia, Seminole, Orange and Lake Counties.

On the summit of Iron Mountain there is a little ferruginous sandstone or conglomerate, a kind of rock common on non-calcareous uplands in the coastal plain from New Jersey to Texas, but rare in peninsular Florida. A hard sandy clay, usually pinkish or mottled (but bright red around Lake Wales in Polk County), seems to be nearly everywhere present on the uplands, though natural exposures of it are scarce, for it is usually overlaid by a few to several feet of loose sand. This clay is used in many places for road-surfacing material, as is some of the marl. Still purer clays are used for brick-making at Whitney, and some kaolin is mined near Okahumpka. There are vast deposits of peat in all the counties (described in some detail in the 3d Annual Report), bordering the larger lakes and rivers and completely filling many of the smaller lake basins. One or two of the peat bogs in Lake County are rich in diatoms, and have been used in a small way for "infusorial earth."

Topography. The Ocklawaha and St. John's Rivers are bordered by flatwoods sometimes several miles wide, differing little from

*See E. A. Smith, Am. Jour. Sci. 121:309. April, 1881; Tenth Census U. S. 6:190. 1884; Dall & Harris, U. S. Geol. Surv. Bull. 84:125. 1892; Matson & Clapp, 2nd Ann. Rep, Fla. Geol. Surv. 114. 1909.

the flatwoods regions described elsewhere in this report; but most of the region is rather hilly, with topography something like that of the lime-sink region but on a larger scale. The highest known elevation in the State is Iron Mountain in Polk County, about 325 feet, and there are probably several other points above 300, though we

Fig. 18. Rock Spring, Orange County. The water rushes out audibly from the base of a limestone cliff about 15 feet high. Feb. 11, 1915.

Fig. 19. A small lake about a mile west of West Apopka, Lake County, in a basin over 100 feet deep among sandy hills. Surrounding vegetation all high pine land. March 9, 1914.

have no definite data on that point yet. In the southern part of Lake County there are hills that rise even higher above the lakes nearest them than Iron Mountain does. (See fig. 19.)*

There are a few dry funnel-shaped depressions, suggesting lime-sinks, in the uplands of Orange and Polk Counties, but it has not been demonstrated that they were formed by solution. There is said to be some lime-sink country on the west side of Lake George, which the writer has not yet visited. The scrub areas (described farther on) are thought by some to represent ancient dunes, like those of the east coast, but their topography is not typical dune topography at all. However, it is quite possible that the wind has moved the surface sands a little at a time through many centuries and thus rounded off the hills and hollows.

The most striking characteristic of the region, and that which contributes most to its scenic beauty, is its lakes, several thousand in number, of all sizes from a few rods to several miles in diameter. Some are traversed by or connect with rivers, while some have no

*An advertising booklet issued a few months ago by the Lake County Chamber of Commerce (and paid for by the County Commissioners), which contains a larger proportion of facts than many publications of its kind, gives the altitude of Sugar Loaf Mountain, north of Minneola, as 312 feet, which seems reasonable. (See chapter on topography, farther on.)

outlet. They are comparatively deep, and never go dry, though they may fluctuate a few feet from one year to another with the amount of rainfall. Many of the smaller ones at higher elevations bear evidence, in the shape of young pine trees around their shores, of being a little lower now than they were a generation ago. (See fig. 22). This may be due to a permanent lowering of the ground-water level by numerous artesian wells with outlets at lower levels. Unlike those in the lime-sink region and hammock belts, none of the lakes are known to have any subterranean outlets.

Streams are not very numerous, for most of the rainfall sinks almost immediately into the deep sand which covers the uplands. They are nearly all sluggish and coffee-colored. The St. John's and Ocklawaha Rivers are navigable for small steamboats all the way through the lake region, and being bordered by tropical-looking vegetation, are favorite scenic highways.

Fig. 20. Lake Alfred, a clear lake in the highlands of Polk County, showing a fringe of maiden cane and bonnets a few yards off the sandy shore and parallel with it. May 18, 1910.

Soils. The soil of the uplands is mostly a slightly loamy sand several feet deep, usually creamy or light buff in color, but varying to yellowish, brownish, and ashy gray, the last being found chiefly a few miles south of Lakeland, near the edge of the pebble phosphate country. There is probably more pure white sand (scrub) in this region than in any other, but there are no data yet for making

Fig. 21. Looking west along shore of Lake Monroe (part of the St. John's River system) about one-half mile west of Sanford, showing cabbage palmettos. May 20, 1910.

Fig. 22. Small lake near Ellsworth Junction, Lake County, showing fringe of saw-palmetto and gallberry, and long-leaf pine saplings encroaching on it. Feb. 20, 1909.

an estimate of its area, for the region has scarcely been touched by soil surveys yet.* In Marion County, northeast of Silver Springs, are some clayey flatwoods, of unknown extent, which probably belong to this region. The occurrence of marl and peat in low places has been mentioned above under the head of geology. Some of the low hammocks seem to contain gypsum deposits, as in the Gulf hammock region.

Vegetation. The prevailing vegetation type on the uplands is high pine land, very similar to that in the lime-sink region. (Fig. 19, though intended for a different purpose, shows it pretty well). Scrub (fig. 38) occurs in all sorts of situations topographically; usually not far from lakes, but often on uplands remote from any body of water. The level flatwoods bear the vegetation characteristic of such places, and peat prairies and saw-grass marshes border the larger lakes or completely fill small basins. Sandy shores of lakes have quite a characteristic growth of sedges and other comparatively small and wiry plants (as do similar places in New England), merging gradually into that of peat prairies in many places. Peninsulas jutting out into lakes are commonly occupied by sandy hammocks, and marly low places by low hammocks, much like those in the Gulf hammock region. Small and non-calcareous streams are usually bordered by non-alluvial swamps or bays, containing a large portion of evergreens.

The commonest plants in the lake region seem to be as follows:

COMMONEST PLANTS OF LAKE REGION.

TIMBER TREES

Pinus palustris	Long-leaf pine	Uplands
Sabal Palmetto	Cabbage palmetto	Low hammocks
Pinus Caribaea	Slash pine	Flatwoods, etc.
Pinus clausa	Spruce pine	Scrub
Pinus serotina	Black pine	Low pine land
Taxodium distichum	Cypress	Swamps
Pinus Elliottii	Slash pine	Bays, etc.
Taxodium imbricarium	(Pond) cypress	Around lakes and ponds
Liquidambar Styraciflua	Sweet gum	Low hammocks, etc.
Magnolia grandiflora	Magnolia	Hammocks
Acer rubrum	Red Maple	Swamps
Pinus Taeda	Short-leaf pine	Low hammocks, etc.
Gordonia Lasianthus		Swamps and bays
Quercus Virginiana	Live oak	Hammocks
Quercus **nigra**	Water oak	Low hammocks, etc.
Nyssa biflora	Black gum	Swamps and ponds
Quercus laurifolia		Sandy hammocks
Hicoria glabra?	Hickory	Sandy hammocks

*The National Forest in eastern Marion County is said to be mostly scrub.

SMALL TREES.

Quercus Catesbaei	Black-jack oak	Sandy uplands
Quercus cinerea	Turkey oak	Sandy uplands
Magnolia glauca	Bay	Swamps and bays
Quercus geminata	Live Oak	Scrub, etc.
Cholisma ferruginea		Sandy hammocks, etc.
Quercus myrtifolia	(Scrub oak)	Scrub, etc.
Persea humilis	Red bay	Scrub
Salix longipes?	Willow	Edges of swamps
Myrica cerifera	Myrtle	Hammocks, etc.
Osmanthus Americana		Sandy hammocks
Prunus umbellata	Hog plum	Hammocks, etc.
Quercus **Chapmani**		Sandy hammocks
Cornus florida	Dogwood	Hammocks
Ilex Cassine	(Cassena)	Swamps
Carpinus Caroliniana	Ironwood	Low hammocks

WOODY VINES.

Smilax laurifolia	Bamboo vine	Swamps and bays
Vitis rotundifolia?	Muscadine	Hammocks and swamps
Smilax auriculata		Scrub
Ampelopsis arborea		Low hammocks
Rhus radicans	Poison ivy	Low hammocks, etc.
Parthenocissus quinquefolia	Virginia creeper	Hammocks, etc.
Berchemia scandens	Rattan vine	Low hammocks

SHRUBS

Serenoa serrulata	Saw-palmetto	Various situations
Pieris nitida	(Hurrah bush)	Scrub, bays, etc.
Myrica cerifera	Myrtle	Low hammocks, etc.
Chrysobalanus **oblongifolius**		High pine land
Hypericum fasciculatum	Sand myrtle	Around lakes and peat prairies
Ceratiola ericoides	Rosemary	Scrub mostly
Ceanothus microphyllus		High pine land
Ilex glabra	Gallberry	Flatwoods
Bejaria racemosa		Flatwoods
Lupinus diffusus var.*	(Lupine)	High pine land
Myrica pumila	Myrtle	Flatwoods
Cephalanthus occidentalis	(Elbow-bush)	Swamps, etc.
Vaccinium nitidum	Huckleberry	Pine lands
Garberia fruticosa		Scrub
Cholisma fruticosa	(Poor grub)	Flatwoods
Prunus geniculata†	(Plum)	High sandy hills
Rhus copallina	Sumac	Hammocks, etc.
Sabal glabra	Palmetto	Low hammocks

HERBS

Tillandsia usneoides	Spanish moss	On most trees
Aristida **stricta**	Wire-grass	High pine land
Kuhnistera pinnata	(Summer farewell)	High pine land
Cladium effusum	Saw-grass	Marshes, etc.
Spartina **Bakeri**	Switch-grass	Around lakes and prairies
Pterocaulon undulatum	Black-root	Flatwoods, etc.
Pontederia cordata	Wampee	Lakes, etc.
Panicum **hemitomon**	Maiden cane	Lake margins, etc.
Anchistea Virginica	(A fern)	Bays, etc.
Eriogonum **tomentosum**		High pine land

*This species is ordinarily an herb, but in Polk County and elsewhere it grows bushy, about three feet tall, and is full of leaves and flowers in midwinter, or earliest spring.

†Apparently confined to the lake region, ranging from Lake County to DeSoto. In the original description (Torreya **11**:64-67. March, 1911) the flowers were said to be in few-flowered umbels; but they are really solitary and sessile or nearly so.

(Eupatorium compositifolium)	Dog-fennel	High pine land and old fields
Nymphaea macrophylla	Bonnets	Lakes and streams
Pteris aquilina	(A fern)	High pine land, etc.
Sagittaria lancifolia		Lakes and marshes
Osmunda cinnamomea	(A fern)	Swamps, etc.
Croton argyranthemus		High pine land
Doellingeria reticulata		Flatwoods
Actinospermum angustifolium		High pine land
(**Piaropus crassipes**)	Water-hyacinth	Lakes and rivers
Eriogonum Floridanum		High pine land
Lupinus diffusus	(Lupine)	High pine land
Saururus cernuus		Swamps, etc.
Andropogon sp.	Broom-sedge	Peat prairies, etc.
Carphephorus **corymbosus**		Flatwoods, etc.
Eriocaulon **compressum**		Lake margins, etc.
Berlandiera **subacaulis**		High pine land
Castalia **odorata**	Water-lily	Lakes, etc.
Psoralea canescens		High pine land
Acnida australis	Careless	Marshes
Aristida spiciformis	(A grass)	Low pine land
Andropogon Virginicus	Broom-sedge	High pine land
Galactia Elliottii	(Pin-down)	Flatwoods
Stenophyllus Warei	(A sedge)	High pine land
Centella repanda		Lake shores, etc.
Osmunda regalis	(A fern)	Swamps
Helianthus Radula		Pine lands
Syngonanthus **flavidulus**		Flatwoods, etc.
Fuirena scirpoidea	(A sedge)	Lake shores, etc.
(and about 300 others)		

About 85% of the trees and 95% of the shrubs are evergreen. As in many other regions with mainly non-calcareous soils, Ericaceae are relatively abundant and Leguminosae rather scarce. The species that are more abundant in the lime-sink region than here* probably prefer more calcareous or potassic or phosphatic or ferruginous soils, while those with an opposite tendency † are more characteristic of acid soils, swamps, bogs, marshes, etc.

A few of the plants in the list, such as *Persea humilis*, *Prunus geniculata*, and *Eriogonum Floridanum*, and possibly fifty other less abundant species not listed are confined to the lake region, or nearly so, while probably an equal number occur in other regions but not outside of Florida; the lake region being far ahead of other

*Such as *Taxodium distichum*, *Liquidambar*, *Quercus laurifolia*, ~~*Q. Virginiana*~~, *Q. falcata*, *Hicoria alba*, *Quercus Margaretta*, *Cornus florida*, *Cercis*, *Crataegus Michauxii*, *Vitis aestivalis*, *Asimina speciosa* (?), *Cephalanthus*, *Carphephorus corymbosus*, and *Eupatorium aromaticum*; nearly all of which are deciduous.

†Like *Pinus Caribaea*, *P. clausa*, *P. serotina*, *P. Elliottii*, *Acer rubrum*, *Gordonia*, *Nyssa*, *Magnolia glauca*, *Persea humilis*, *Smilax laurifolia*, *S. auriculata*, *Serenoa*, *Pieris nitida*, *Hypericum fasciculatum*, *Bejaria*, *Vaccinium nitidum*, *Garberia*, *Cholisma fruticosa*, *Prunus geniculata*, *Cladium effusum*, *Spartina Bakeri*, *Pontederia*, *Panicum hemitomon*, *Anchistea*, *Nymphaea*, *Osmunda cinnamomea*, and *Doellingeria*; most of which are evergreen.

parts of central Florida in the matter of local or endemic species, and contrasting especially with the hammock belts in this respect.

The pines are used for fuel, lumber, turpentine, etc., as in other regions, but have not been exploited quite so ruthlessly, whether wholly because of topographic difficulties or partly from a slight regard for the beauty of the scenery is not quite certain. Plans are just being perfected for utilizing the saw-grass, which abounds on thousands of acres of marshes, for the manufacture of paper. As in many other parts of Florida that are comparatively little cultivated, honey-yielding plants are numerous and abundant, but that fact does not seem to have been taken advantage of as fully as it might be.

Population. The statistics of population are based on the returns for Lake County, which is wholly in this region, and Seminole and Orange, most of whose population is in it. No accurate estimates can be made for periods previous to 1887, when there were great changes in county boundaries, but in 1890 there were 9 inhabitants per square mile in the area just defined. This increased, somewhat irregularly, to 19.4 in 1920. In 1910 the population was divided according to race and nativity into 57.5% native white, 3.3% foreign white, and 39.2% negro. The foreigners were mostly from England, Germany, Canada, Sweden, Scotland and Ireland. The percentage of illiteracy at the same time was 1.9 among the native whites, 1.7 among the foreign whites, and 23.0 among the negroes.

The incorporated cities and towns in 1915 were Lakeland, with 7,287 inhabitants (reported as having decreased a little by 1920, which is hard to believe); Orlando, with 6,448; Sanford, 4,998; DeLand, 3,490; Leesburg, 1,360; Winter Haven, 1,226; Eustis, 1,148; Winter Park, 787; Lake Helen, 786; Winter Garden, 648; Mt. Dora, 615; Apopka, 598; Umatilla, 527; Auburndale, 511; Orange City, 506; Tavares, 449, and Haines City, 378.

The leading religious denominations among the whites in 1916 were Southern Methodist, Baptist, Southern Presbyterian, Episcopalian, Roman Catholic, Northern Methodist, Congregationalist, Northern Presbyterian, Seventh Day Adventist, Disciples of Christ, and Primitive Baptist. Among the negroes, Baptist, African Methodist Episcopal, A. M. E. Zion, and northern Methodist.

Agriculture. Farming developed rather late in this region, and is of a more specialized type than in the regions previously described. Both in 1890 and in 1910 only about 16% of the area was in farms and 3.2% improved. The principal features of agriculture in this region since the establishment of Lake County are shown in Table 5.

TABLE 5.

Agricultural Statistics of Lake Region (Lake & Orange Cos.), 1890-1910

	1889-1890	1899-1900	1909-1910 Total	1909-1910 White	1909-1910 Color'd
Improved acres per inhabitant	2.22	2.28	1.65	2.51	0.33
Inhabitants per farm	5.97	9.13	11.3	7.55	43.0
Per cent of farmers white	-----	92.8	89.7	------	------
Per cent of farmers, owners	97.9	75.2	80.6	80.2	83.7
Per cent of farmers, managers		18.4	11.9	12.6	5.7
Per cent of farmers, tenants	2.1	6.4	7.5	7.2	10.7
Average number of acres per farm	66.7	84.0	92.8	98.9	39.5
Average improved acres per farm	13.5	20.7	18.7	19.2	14.0
Value of farm land per acre ($)	-----	19.30	41.80	41.55	46.80
Value of farm land per farm	4850	1620	3880	4110	1850
Value of buildings per farm		513	1009	1070	495
Value of implements and machinery	41	57	147	155	74
Value of live-stock, poultry, etc.	107	260	408	------	------
Number of dairy cows per farm	2.3	1.5	1.1	1.2	0.8
Number of other cattle per farm	8.0	16.0	16.5	------	------
Number of horses per farm	0.6	0.9	0.9	0.9	0.7
Number of mules per farm	0.2	0.2	0.3	0.3	0.2
Number of hogs per farm	2.2	9.3	9.8	------	------
Number of sheep per farm	0.1	0.8	0.3	------	------
Number of poultry per farm	17.7	21.4	21.7	------	------
Expenditures per farm for fertilizer	87.00	36.20	165.00	------	------
Expenditures per farm for labor	-----	77.20	190.00	------	------
Expenditures per farm for feed	-----	------	86.40	------	------
Annual value of crops per farm	381	282	926	------	------
Annual value of animal products			121	------	------
Expend. fertilizer per acre improved	6.42	1.74	8.84	------	------
Expend. labor per acre improved	-----	3.72	10.20	------	------
Value of crops per acre improved	-----	------	49.70	------	------

The census of 1910 reported two farmers in central Florida who were neither white nor negro; one in Orange County and one in Volusia. The writer has no information about the color of the former, but the one in Volusia County is a Chinaman, who lives near DeLand (therefore in the lake region), and has made something of a reputation with his oranges. By subtracting the returns for negro farmers from those for all colored farmers, it

appears that he had in 1910 115 acres, of which 20 were improved, land worth $4,000 (or $34.80 per acre), buildings worth $1,000, and implements and machinery $150. The one in Orange County was probably Chinese or Japanese and a truck-farmer, for he had only two acres, all improved, worth $100 or $50 per acre, buildings worth $750, and no implements or machinery worth mentioning.

In several places in this region corporations have acquired large tracts of land and sold it in small parcels, commonly of ten acres, to persons who may have never been in Florida at all, to be planted to oranges or other citrous* fruits. For the sum agreed upon the corporations set out the trees desired, cultivate them, market the fruit when it matures, and remit the profits (if any) to the absent owners; and this sort of business if efficiently managed may be very satisfactory to all concerned. Technically each individual holding is a farm, operated by a manager, without buildings or livestock; but practically the owners are merely stockholders in a large farming enterprise; and different interpretations of this point by the census might make a considerable difference in the per farm statistics.

The leading crops in 1909, in order of value, by United States census, were oranges (a little over half the total), "vegetables," grape-fruit, hay, corn, sweet potatoes, Irish potatoes, sugar-cane (syrup), peaches, and pears. In 1913-14, according to the State Agricultural Department, oranges (nearly half), celery, lettuce, grape-fruit, tomatoes, watermelons, (grass) hay, corn, sweet potatoes, peppers, (string?) beans, cabbage and cucumbers. In 1917-18, oranges, celery, corn, lettuce, cucumbers, peppers, tomatoes, grape-fruit, watermelons, cabbage, Irish potatoes, "native grass" hay, sweet potatoes, string beans, cowpeas (and hay), egg-plants, Natal grass hay, sea-island cotton, beets, squashes, and upland cotton. Peanuts, which constitute something like a fifth of the total crop value in the lime-sink region, make less than a thousandth in the lake region, perhaps on account of the scarcity of lime in the upland soils.

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*It is a common and apparently growing—but not altogether commendable—practice to write the noun *citrus*, the generic name of oranges, lemons, kumquats, etc., instead of the adjective *citrous*.

8. PENINSULAR FLATWOODS, WESTERN DIVISION

(Figs. 23-25. Soil analyses 27-36, H, J, X.)

Besides the flatwoods already described, there is a much larger area, covering the greater part of the peninsula south of our limits, which may be divided into several regions when it is more thoroughly explored. In the latitudes under consideration it is divided by the lake region into two parts, which may conveniently be treated separately. The western portion, which will be discussed first, has an area of about 1,700 square miles.

Geology. The strata beneath the surface sands range from Upper Oligocene to Pliocene, and are more or less calcareous and phosphatic; and although natural exposures are comparatively rare, they influence the soil perceptibly in many places. The Pliocene is represented by the Bone Valley formation, which includes the pebble phosphate deposits, and is chiefly confined to Polk County. The mining of this phosphate is perhaps the most important industry in the region. Flowing artesian wells can be had almost anywhere near the coast. There are a few mineral springs, such as Espiritu Santo near Safety Harbor and Kissingen near Bartow.

Topography. The surface is comparatively level, as implied by the name "flatwoods," but fairly "well drained." It has the appearance of having been uplifted a little in comparatively recent times, for near the coast and rivers one can in many places ascend 25 feet in less than a mile, and numerous creeks and branches have cut narrow valleys below the general level. San Antonio, at the upper edge of the region in Pasco County, is said to be 160 feet above sea-level. Shallow depressions a few acres in extent, which hold a foot or two of water in wet seasons, are very common, especially northward, but there are very few lakes, the ponds being in most cases well filled with cypress and other trees. There are more streams in proportion to area than in the other regions, but none of them are considered navigable.

Soils. The soil is nearly everywhere sand, of various colors from white to brown, but the underlying rock or marl seems to be usually within a few feet of the surface, making calcareous soils in many low places. The soil surveys of Pinellas and Hillsborough Counties (1914 and 1918) cover the greater part of the area. In those publications the soils are referred to the "Leon," "Ports-

mouth," "Parkwood," "Scranton," "Plummer," "St. Lucie" and "Fellowship" series, and the leading texture classes are fine sand (about 80%), fine sandy loam, muck, tidal marsh, swamp, "water and grass," and peaty muck." Swamp, marsh and muck together constitute about 8%, and scrub, designated as "St. Lucie fine sand," and "Leon fine sand, rolling phase," is about 3% of the total.

Fig. 23. Open flatwoods with pines mostly *Pinus Caribaea* (slash pine), about two miles west of Odessa, Pasco County. April 18, 1909.

Fig. 24. Cypress pond with no pines and very few shrubs, in flatwoods about half way between Drexel and Odessa, Pasco County. April 18, 1909.

Chemically, most of the soils seem to be pretty well supplied with phosphorus, as would be expected from the occurrence of so much phosphate rock.

Vegetation. The vegetation types include flatwoods with and without saw-palmetto (fig. 23), a little high pine land, a few patches of scrub, many cypress ponds (fig 24), wet prairies, high and low hammocks (fig. 25), various kinds of swamps and bays, and salt marshes along the shores of Tampa Bay. The cypress ponds are chiefly confined to Pasco and Pinellas Counties, the low hammocks to Hillsborough and Polk, and the high hammocks to the neighborhood of the Peace River. Swamps are not very extensive.

Fig. 25. Low hammock near Peace River about two miles southeast of Bartow, showing cabbage palmetto, dwarf palmetto, sweet gum, rattan vine, etc. March 13, 1915.

The commonest plants seem to be as follows, the first tree named being apparently about 15 times as abundant as its nearest competitor:

COMMONEST PLANTS OF WESTERN DIVISION OF FLATWOODS.

TIMBER TREES

Pinus palustris	Long-leaf pine	Flatwoods
Pinus Caribaea	Slash pine	Flatwoods
Taxodium imbricarium	(Pond) cypress	Cypress ponds
Pinus Elliottii	Slash pine	Branch-swamps, etc.
Pinus clausa	Spruce pine	Scrub

Liquidambar Styraciflua	Sweet gum	Low hammocks, etc.
Taxodium distichum	Cypress	Swamps
Acer rubrum	Red maple	Swamps
Sabal Palmetto	Cabbage palmetto	Low hammocks
Quercus Virginiana	Live oak	Hammocks
Nyssa biflora	Black gum	Swamps
Magnolia grandiflora	Magnolia	Hammocks
Quercus **nigra**	Water oak	Low hammocks, etc.
Quercus laurifolia		Hammocks
Ulmus Floridana	Elm	Low hammocks
Quercus **hybrida?**		Low hammocks, etc.
Juniperus Virginiana	Cedar	Low hammocks
Gordonia Lasianthus		Swamps and bays
	SMALL TREES.	
Magnolia glauca	Bay	Swamps and bays
Quercus cinerea	Turkey oak	Dry pine land
Quercus Catesbaei	Black-jack oak	Dry pine land
Quercus geminata	Live oak	Scrub, etc.
Salix longipes?	Willow	Edges of marly swamps
Carpinus Caroliniana	Ironwood	Low hammocks
Persea pubescens	Red bay	Swamps
Cornus florida	Dogwood	Hammocks
	WOODY VINES.	
Smilax laurifolia	Bamboo vine	Swamps and bays
Rhus radicans	Poison ivy	Low hammocks
Parthenocissus quinquefolia	Virginia creeper	Low hammocks
Gelsemium sempervirens	Yellow jessamine	Flatwoods
Vitis rotundifolia	Muscadine	Hammocks
Ampelopsis arborea		Low hammocks
	SHRUBS	
Serenoa serrulata	Saw-palmetto	Flatwoods, etc.
Asimina pygmaea?	Pawpaw	Flatwoods
Myrica cerifera	Myrtle	Hammocks
Hypericum fasciculatum	Sand myrtle	Shallow ponds, etc.
Ilex glabra	Gallberry	Flatwoods
Chrysobalanus **oblongifolius**		Dry pine lands
Myrica pumila	Myrtle	Flatwoods
Ceratiola ericoides	Rosemary	Scrub
Cholisma ferruginea		
Viburnum nudum	(Possum haw)	Swamps
Vaccinium nitidum	Huckleberry	Flatwoods
Pieris nitida	(Hurrah bush)	
Stillingia aquatica		Cypress ponds
Viburnum **obovatum**		Low hammocks
Cholisma fruticosa	(Poor grub)	Flatwoods
Quercus minima	(Oak runner)	
Baccharis halimifolia		Edges of swamps
Phoradendron flavescens	Mistletoe	On hardwood trees
Quercus pumila	(Oak runner)	
Cornus stricta?		Marly swamps, etc.
Cephalanthus occidentalis	(Elbow bush)	Swamps and ponds
	HERBS	
Tillandsia usneoides	Spanish moss	On nearly all trees
Aristida **stricta**	Wire-grass	Pine lands
(Eupatorium compositifolium)	Dog-fennel	Pine lands, etc.
Pterocaulon undulatum	Black-root	Pine lands
Cladium effusum	Saw-grass	Ponds, prairies, etc.
Pontederia cordata	Wampee	Ponds, streams, etc.
Carphephorus **corymbosus**		Flatwoods
Andropogon scoparius?	Broom-sedge	Flatwoods
Tillandsia recurvata	Air-plant	On trees
Saururus cernuus		Swamps
Tillandsia tenuifolia	Air-plant	Swamps
Juncus Roemerianus	(Rush)	Brackish marshes
Lupinus diffusus	(Lupine)	Dry pine lands
Syngonanthus **flavidulus**		Flatwoods
Panicum **hemitomon**	Maiden cane	Ponds and wet prairies
Spartina **Bakeri**	Switch-grass	Margins of ponds, etc.
Kuhnistera pinnata	Summer farewell	Dry pine lands

Tillandsia fasciculata	Air-plant	Cypress ponds mostly
Osmunda cinnamomea	(A fern)	Swamps and bays
Sagittaria lancifolia		Marshes and wet prairies
Actinospermum angustifolium		Dry pine lands
Anchistea Virginica	(A fern)	Cypress ponds, etc.
Polygala Rugelii		Flatwoods
Helianthus Radula		Flatwoods
Sporobolus gracilis	(A grass)	Pine lands

About 88% of the trees and still more of the shrubs are evergreen. Plants of the heath family are less abundant here than in some other flatwoods regions that have less fertile soils. The pines have been very largely exploited for lumber and naval stores, as usual.

Population. A rough approximation of the population conditions may be arrived at by subtracting the figures for Tampa and West Tampa from those for Hillsborough County (which included Pinellas up to 1911). On this basis there were in 1910 nearly 25 inhabitants per square mile, 12.8% of them in cities of over 2,500 population, 71.6% native white, 8.6% foreign white, and 19.7% negroes. (The foreign whites included a few hundred Greeks at Tarpon Springs, which is in a different region, and now in a different county.) In the population over 10 years old 1.7% of the native whites, 19.9% of the foreign whites, and 19% of the negroes were illiterate.

Excluding Tampa, which belongs partly to a different region, and West Tampa, which is separated only by an imaginary line, the largest cities and towns in 1915 were St. Petersburg, with 7,186 inhabitants; Bartow, with 3,412; Plant City, 3,229; Fort Meade, 2,150; Mulberry, 1,121; Port Tampa City, 1071; Largo, 552; and Bradley, 295. The returns from the 1920 census, as far as available, give these places the same relative rank, and St. Petersburg nearly double the population. But these figures should be used with some caution, for St. Petersburg is one of the most popular winter resorts in Florida, and the 1915 census was taken in July and that of 1920 in January. Oldsmar, in the eastern edge of Pinellas County, which was not on the map at all in 1915, may be larger now than some of the places listed.

Agriculture. The flatwoods region includes less than half of Pasco and Polk Counties, and Pinellas did not exist in 1910, so that the best we can do for agricultural statistics is to use the figures for Hillsborough County. A considerable part of that be-

longs to the lime-sink region, and the city of Tampa makes farming more intensive in its vicinity, but there is some very intensive farming near Plant City anyway, so perhaps the results are not very different from what they would be if we could separate the flatwoods entirely from other regions.

The percentage of land in farms increased from 2.7 in 1850 and 8.8 in 1880 to 13.4 in 1910. In the latter year 3.7% of the area of Hillsborough County was "improved," or 0.4 acres per inhabitant. (Without Tampa it would be about 0.8 acres per inhabitant.) The prevailing conditions from 1890 to 1910 are shown in the following table:

TABLE 6.

Agricultural Statistics of Southwestern Flatwoods (Hillsborough Co.), 1890-1910.

	1889-1890	1899-1900	1909-1910 Total	1909-1910 White	1909-1910 Color'd
Per cent of farmers, white	-----	94.9	94.2	------	------
Per cent of farmers, owners	98.5	88.1	89.3	89.6	84.3
Per cent of farmers, managers		3.4	4.2	4.2	5.2
Per cent of farmers, tenants	1.5	8.5	6.5	6.2	10.4
Average number of acres per farm	100.0	71.6	57.5	59.1	32.1
Average improved acres per farm	17.4	15.5	15.8	15.9	13.6
Value of farm land per acre ($)	-----	25.01	63.25	63.40	56.65
Value of farm land per farm	3810	1790	3640	3740	1820
Value of buildings per farm		405	649	670	310
Value of implements and machinery	42	52	125	128	65
Value of live-stock, poultry, etc.	294	252	440	------	------
Number of dairy cows per farm	4.9	2.7	1.6	1.6	0.6
Number of other cattle per farm	20.8	14.8	17.0	------	------
Number of horses per farm	1.1	1.0	1.0	1.0	0.9
Number of mules per farm	0.1	0.1	0.2	0.2	0.1
Number of hogs per farm	10.5	8.9	9.9	------	------
Number of sheep per farm	3.7	3.9	0.5	------	------
Number of poultry per farm	34.1	42.3	44.8	------	------
Expenditures per farm for fertilizer	17.80	34.75	108.00	------	------
Expenditures per farm for labor	-----	36.50	98.30	------	------
Expenditures per farm for feed	-----	------	117.00	------	------
Annual value of crops per farm	517	461	696	------	------
Annual value of animal products			196	------	------
Expend. fertilizer per acre improved	1.02	2.25	6.90	------	------
Expend. labor per acre improved	-----	2.37	6.25	------	------
Value of crops per acre improved	-----	------	44.25	------	------

The leading crops in 1909 were oranges, "vegetables," grapefruit, corn, hay, Irish potatoes, cane syrup, strawberries, and sweet potatoes. In 1913-14 oranges (about 45%), strawberries, toma-

toes, corn, grape-fruit, sweet potatoes, celery, beans, Irish potatoes, cucumbers, syrup, guavas, cabbage, cowpeas, watermelons, rice, peaches, egg-plants, grass, hay, pepers, and peanuts. In 1917-18 oranges (about 30%), corn, strawberries, celery, sweet potatoes, velvet beans (includin hay), Irish potatoes, syrup, cabbage, field peas (and hay), grape-fruit, string beans, peanuts, watermelons, "native grass" hay, tomatoes, lettuce, cucumbers, rice, peaches, egg-plants, grapes (scuppernongs?), Natal grass hay, plums, pecans, peppers and onions.

9. PENINSULAR FLATWOODS, EASTERN DIVISION

(Figs. 26-28. Soil analysis Y.)

The flatwoods east of the lake region cover about 3,600 square miles in the counties under consideration (since Flagler and Okeechobee were cut off from Volusia and Osceola). At the north, somewhere about the boundary between Flagler and Volusia Counties, there is a gradual transition from the peninsular flatwoods to the East Florida flatwoods (described in the 6th Annual Report). The most conspicuous difference between the flatwoods of East Florida and those of the peninsula is that the cypress ponds of the former nearly always have some slash pine in them, while in the latter the pine usually stops several yards outside of the cypress, leaving the ponds bordered by treeless strips. The cause of this difference is not yet known, but is probably connected with the soil.

Geology. The strata near the surface are so featureless that the whole area is usually mapped as Pleistocene. Considerably older formations occur at no great depth, however, the Ocala (Eocene) being encountered in wells along the east coast within 200 feet of the surface. The surface is generally covered with deep sand, but there is marl, presumably Pleistocene, in some hammocks and low spots, and peat in some of the prairies and around lakes. Flowing artesian water can be obtained near the coast and along the St. John's and Kissimmee Rivers and their lakes, but in about the latitude of Titusville the water in some of the wells is salty.

Topography. The surface is for the most part monotonously level, and seems to be nowhere more than 100 feet above the sea. Near the east coast south of Titusville, however, the general level

of the flatwoods is 10 to 25 feet above the Indian River, and there are many little ravine-like valleys carved by short streams, as if the area had been uplifted in comparatively recent times. Near the lake region the topography is often a little undulating, and the transition from one region to the other gradual, though there are also places where it is abrupt. Shallow depressions abound, ranging

Fig. 26. Prairie bordering Lake Tohopekaliga about 3½ miles east of Kissimmee, with a few cattle grazing. Abrupt transition to flatwoods with long-leaf pine and saw-palmetto in middle distance. Feb. 18, 1909.

Fig. 27. Asphalt road through flatwoods in Osceola County, about ten miles southeast of St. Cloud (the nearest town) and a mile from the nearest house. April 27, 1920.

in size from lakes covering several square miles (most of these near the lake region) to small wet prairies and cypress ponds. Streams are few and sluggish, and the rivers have extremely shallow valleys.

Soils. There are no soil surveys of this region yet, except a narrow fringe at the extreme eastern edge, but the soils are very similar in texture to those of the western division, and would presumably be classed mostly as fine sand. Chemically the average soil is probably less fertile than in the western division, especially in phosphorus (if the vegetation is a safe guide), but the Kissimmee River prairies are said to be much better than the flatwoods, and to produce some good crops without fertilizer.

Vegetation. The principal vegetation types are palmetto flatwoods, prairies of several kinds, cypress ponds, low hammocks, swamps, fresh marshes, and a few patches of scrub. The prairies are several miles wide along the two largest rivers, and those along the Kissimmee (which the writer has not yet had opportunity to explore) are said to have an abundant and varied native fauna and to be great cattle ranges, thus resembling some of the western plains Other and probably different prairies border the lakes near Kissimmee (fig. 26), and there are numerous small wet prairies in shallow depressions. The cypress ponds usually have narrow prairie-like margins, as stated in a preceding paragraph.

The commonest plants seem to be as follows:

COMMONEST PLANTS OF EASTERN DIVISION OF FLATWOODS.

	TIMBER TREES	
Pinus palustris	Long-leaf pine	Flatwoods
Taxodium imbricarium	(Pond) cypress	Cypress ponds
Pinus Caribaea	Slash pine	Flatwoods
Sabal Palmetto	Cabbage palmetto	Low hammocks
Pinus clausa	Spruce pine	Scrub
Pinus serotina	Black pine	Damp flatwoods
Acer rubrum	Red maple	Swamps
Taxodium distichum	Cypress	Swamps
Pinus Elliottii	Slash pine	Bays, etc.
Gordonia Lasianthus		Bays
Nyssa biflora	Black gum	Swamps and ponds
Quercus Virginiana	Live oak	Hammocks
Liquidambar Styraciflua	Sweet gum	Low hammocks
Magnolia grandiflora	Magnolia	Hammocks
	SMALL TREES.	
Magnolia glauca	Bay	Swamps and bays
Quercus Catesbaei	Black-jack oak	Drier spots
Quercus geminata	Live oak	Drier spots
Quercus cinerea	Turkey oak	Drier spots
Persea pubescens	Red bay	Swamps and bays
Fraxinus Caroliniana	Ash	Swamps
Ilex Cassine	(Cassena)	Swamps
Hicoria glabra?	Hickory	Sandy hammocks
Salix longipes?	Willow	Along streams

	WOODY VINES.	
Smilax laurifolia	Bamboo vine	Swamps
Rhus radicans	Poison ivy	Low hammocks, etc.
Vitis aestivalis?	Wild grape	Hammocks
	SHRUBS	
Serenoa serrulata	Saw-palmetto	Flatwoods
Hypericum fasciculatum	Sand myrtle	Ponds and wet prairies
Myrica cerifera	Myrtle	Hammocks and swamps
Quercus myrtifolia	(Scrub oak)	Scrub
Pieris nitida	(Hurrah bush)	Flatwoods, etc.
Ilex glabra	Gallberry	Flatwoods
Myrica pumila	Myrtle	Flatwoods
Cholisma fruticosa	(Poor grub)	Flatwoods
Chrysobalanus **oblongifolius**		Drier spots
Vaccinium nitidum	Huckleberry	Flatwoods
Ceratiola ericoides	Rosemary	Scrub
Quercus minima	(Oak runner)	Flatwoods
Cholisma ferruginea		Scrub
Bejaria racemosa		Flatwoods
Asimina pygmaea?	Pawpaw	Flatwoods
	HERBS	
Tillandsia usneoides	Spanish moss	On most trees
Aristida **stricta**	Wire-grass	Flatwoods
Pterocaulon undulatum	Black-root	Flatwoods
Spartina Bakeri	Switch-grass	Prairies, etc.
Cladium effusum	Saw-grass	Marshes, etc.
Tillandsia fasciculata	Air-plant	Cypress ponds
Sarracenia **minor**	Pitcher-plant	Flatwoods and prairies
Tillandsia recurvata	Air-plant	On trees
Doellingeria reticulata		Flatwoods
Polygala cymosa		Cypress ponds
Anchistea Virginica	(A fern)	Cypress ponds
Pontederia cordata	Wampee	Ponds, etc.
Dichromena latifolia	(A sedge)	Shallow ponds
Andropogon sp.	(Broom-sedge)	Flatwoods
Polygala Rugelii		Flatwoods
Syngonanthus **flavidulus**		Flatwoods
Aletris **lutea**		Flatwoods
Nymphaea macrophylla	Bonnets	Lakes and streams
Sabbatia grandiflora		Ponds and prairies
(Euthamia Caroliniana)		Flatwoods, etc.
Aristida spiciformis	(A grass)	Flatwoods
Osmunda regalis	(A fern)	Swamps
Iris **versicolor**		Swamps, etc.
Centella repanda		Flatwoods, etc.
Helianthus Radula		Flatwoods
Chondrophora nudata		Flatwoods
Galactia Elliottii	(Pin-down)	Flatwoods
Tillandsia tenuifolia	Air-plant	Swamps
Osmunda cinnamomea	(A fern)	Swamps, etc.
Carphephorus **corymbosus**		Flatwoods
Chaptalia tomentosa		Flatwoods

About 90% of the trees are evergreen, and Ericaceae are relatively numerous among the shrubs, which indicates that the average flatwoods soil is not the richest in the world. A very instructive comparison of the soil conditions in the eastern and western divisions of the flatwoods can be made by noting which species of plants are more abundant in one than in the other, as has already

been done in comparing the lime-sink and lake regions.* The species that are commoner in the western division are more characteristic of drier or more calcareous or more phosphatic soils, and nearly all of them grow in Georgia if not farther north; while those commoner eastward are more characteristic of cypress ponds, bays, scrub, and sour soils generally, and are of somewhat tropical affinities, some of them being confined to Florida and others nearly so. The former list includes more trees, vines, oaks, and leguminous plants, and the latter more evergreens, pines, palms, and Ericaceae. In fact this plant list resembles that for the lake region about as much as it does that for the western division of the flatwoods.

Fig. 28. Nearly treeless prairie in Brevard County about 7½ miles west of Melbourne and four miles from the St. John's River, looking northwest. The few scattered slash pines (*Pinus Caribaea*) are the outposts of the pine forests which extend eastward to the Indian River. Between this point and the St. John's River there are practically no trees. Feb. 5, 1915.

*The following seem to be more abundant westward: *Pinus Elliottii, Liquidambar, Taxodium distichum, Quercus Virginiana, Magnolia grandiflora, Quercus nigra, Q. laurifolia, Ulmus Floridana, Juniperus, Magnolia glauca, Quercus cinerea, Q. Catesbaei, Salix, Carpinus, Cornus florida, Rhus radicans, Parthenocissus, Gelsemium, Ampelopsis, Asimina pygmaea, Viburnum nudum, Stillingia aquatica, Viburnum obovatum, Phoradendron, Quercus pumila, Cornus stricta, Tillandsia usneoides, Eupatorium compositifolium, Pontederia, Carphephorus, Saururus, Tillandsia tenuifolia, Juncus Roemerianus, Lupinus diffusus, Panicum hemitomon, Kuhnistera, Sagittaria lancifolia, Actinospermum,* and *Sporobolus gracilis.*

The reverse is true of *Taxodium imbricarium, Pinus Caribaea, Sabal Pal-*

Population. As Osceola County is almost entirely in this region, its population is probably typical enough of the whole. The number of inhabitants per square mile ranged from 1.7 in 1890 to 3.1 in 1910 and 6.1 in 1915, since when there seems to have been a decrease, though the cutting off of Okeechobee County in 1917 makes exact comparisons between 1915 and 1920 impossible. In 1910 the proportion of native whites was 80.2%, the highest in central Florida; of foreign whites 2.9% and of negroes 16.8%. The only incorporated places in the whole region were Kissimmee, with 4,221 inhabitants, St. Cloud, with 2,080 (all white, with a considerable number of Union veterans), and Taft, with 216 (mostly negroes).

The leading religious denominations among the whites in 1916 were Baptist, Southern Methodist, Northern Methodist (?), Disciples of Christ, Northern Presbyterian, and Catholic; and among the negroes Baptist, African Methodist, Northern Methodist (?), Primitive Baptist, and A. M. E. Zion.

Agriculture. There are great variations in size and type of farms in this region, from small truck farms and orange groves such as are found all over central Florida, and larger sugar-cane plantations near the edge of the lake region, to enormous cattle ranches with very little cultivated land, these last mostly near the Kissimmee River.* On account of these variations the bare statistics for Osceola County, or any similar area that we might have data for, give a rather imperfect picture of the conditions.

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metto, Pinus clausa, P. serotina, Gordonia, Ilex Cassine, Serenoa, Hypericum fasciculatum, Quercus myrtifolia, Pieris nitida, Cholisma fruticosa, Bejaria, Spartina Bakeri, Tillandsia fasciculata, Sarracenia minor, Tillandsia recurvata, Doellingeria, Polygala cymosa, Anchistea, Dichromena latifolia, Polygala Rugelii, Aletris lutea, Nymphaea, Sabbatia grandiflora, and *Aristida spiciformis.*

*Most of the cattlemen depend mainly on free range, and own very little land, but there is one company with headquarters in the southeastern corner of Polk County that is said to have 226,000 acres fenced and to own 36,000 cattle. As in some of the grazing regions of the West, there have been some conflicts between the cattlemen and the small farmers who are gradually encroaching on the free range, with occasional bloodshed.

The farms in Osceola County average the largest in central Florida, and 4.3% of them were over 1,000 acres in extent in 1910. If free range could be counted as farm land it would swell these figures greatly. The ratio of farm land to total area in the county increased from 0.6% in 1890 to 8.2% in 1910, and of improved land from 0.16% to 0.5% in the same interval. And although the average size of owners' farms in 1910 was 244 acres and of tenant farms 234, farms operated by managers (doubtless mostly cattle ranches) averaged 2,667 acres.

The status of agriculture in Osceola County since its establishment in 1887 is summarized in the following table:

TABLE 7.

Agricultural Statistics of Southeastern Flatwoods (Osceola Co.), 1890-1910.

	1889-1890	1899-1900	1909-1910 Total	1909-1910 White	1909-1910 Color'd
Improved acres per inhabitant	0.58	1.53	1.05	1.25	0.07
Inhabitants per farm	40.7	9.73	18.3	15.6	10.3
Per cent of land in farms	0.60	4.9	8.2	------	------
Per cent of land improved	0.16	0.5	0.5	------	------
Per cent of farmers, white	-----	99.2	97.0	------	------
Per cent of farmers, owners	92.2	90.1	89.4	89.4	100.0
Per cent of farmers, managers		0.3	2.7	2.7	0
Per cent of farmers, tenants	7.8	9.6	7.9	8.2	0
Average number of acres per farm	88.0	155.7	307.0	315.6	35.3
Average improved acres per farm	23.4	14.9	19.1	19.5	7.1
Value of farm land per acre ($)	-----	7.66	21.35	21.30	33.90
Value of farm land per farm	2920	1190	6550	6720	1197
Value of buildings per farm		187	589	598	269
Value of implements and machinery	38	31	99	101	57
Value of live-stock, poultry, etc.	621	2210	2090	------	------
Number of dairy cows per farm	15.7	5.3	3.0	------	------
Number of other cattle per farm	77.9	215.7	168.0	------	------
Number of horses per farm	2.3	2.7	2.5	------	------
Number of mules per farm	0.3	0.1	0.3	------	------
Number of hogs per farm	13.9	19.0	16.3	------	------
Number of sheep per farm		13.1	9.8	------	------
Number of poultry per farm	3.0	14.9	23.1	------	------
Expenditures per farm for fertilizer	22.80	7.65	48.00	------	------
Expenditures per farm for labor	-----	13.92	118.00	------	------
Expenditures per farm for feed	-----	------	80.00	------	------
Annual value of crops per farm	380	647	593	------	------
Annual value of animal products			240	------	------
Expend. fertilizer per acre improved	.97	.52	2.52	------	------
Expend. labor per acre improved	-----	.94	6.20	------	------
Value of crops per acre improved	-----	------	31.00	------	------

The marked variations between different census periods are not easy to explain, but are probably due largely to changes in the number of orange groves and truck farms, which greatly affect the average number of cattle, etc., per farm. At all three censuses, however, this region leads all the others in number of cattle per farm.

The leading crops in 1909 were oranges, grape-fruit, "vegetables," corn, sweet potatoes, hay, and Irish potatoes; and the principal animal product beef cattle. In 1913-14 the order of value of crops was oranges, grape-fruit, corn, sweet potatoes (grass) hay, Irish potatoes, egg-plants, cane syrup, beans, celery, cabbage, velvet beans (including hay), and watermelons; and in 1917-18 oranges, corn, Irish potatoes, grape-fruit, "native" hay, sweet potatoes, syrup, cabbage, pineapples, cowpeas (and hay), and strawberries.

10. THE EAST COAST STRIP

(Figs. 29-34. Soil analyses 46-51, N, Z.)

This includes the islands and barrier beaches of the east coast, and a narrow strip of mainland averaging only a mile or two in width, a total land area in Volusia and Brevard Counties of about 500 square miles. It extends both north and south of our limits a considerable distance without much change. The boundary between this and the adjacent flatwoods is not always sharp, but is marked for a considerable part of the distance by a line of ancient dunes of white sand. Near the "head" (north end) of the Indian River the dunes are two or three miles back from salt water, with low hammocks and flatwoods east of them scarcely distinguishable from some much farther inland. And Merritt's Island, although presumably built up in comparatively recent times by the gradual shifting eastward of barrier beaches, has large areas of flatwoods very similar to those of Osceola County, except for containing no long-leaf pine (a tree which is hardly ever found on islands of any kind).

Geology and Topography. Geologically the region is very young, having probably nothing older than Pleistocene very near the surface. The material is mostly sand, but there are shells and shell fragments mixed with it in many places, sometimes predominating and hardened into coquina rock (fig. 30).

Shell mounds built up centuries ago by the aborigines are rather common along the lagoons, and many of them have been excavated for road-surfacing material (Fig 34). Flowing artesian wells, with more or less sulphurous water, can be had anywhere, and in some places the pressure is sufficient to run dynamos or other machinery.

The ancient dunes west of the Indian River (fig. 31) are in some places about 50 feet above sea-level, but this is probably due largely to an uplift in comparatively recent times, for the modern dunes next to the ocean are much lower. The outer beach in Volusia County is one of the most noted natural automobile racecourses in the world, and speeds of 156 miles an hour have been recorded there. The Indian River and other shallow salt lagoons behind the barrier beaches are navigable for small vessels, and in recent years they have been connected by dredging canals through intervening marshes and strips of sand, so that there is now an inside passage all the way up the coast to South Carolina. There is practically no tide in these lagoons, on account of the inlets being small and far apart.

Fig. 29. Scene in Turnbull Hammock, a typical low hammock, about a mile west of Daytona, Volusia County. By E. H. Sellards, May 21, 1910.

Soils. The soil survey of the "Indian River area," published in 1915, covers most of Merritt's Island and the neighboring barrier beaches, and a little of the near-by mainland, giving a very typical

Fig. 30. Looking north along rocky shore of Mosquito Lagoon, or North Indian River, about a mile north of New Smyrna, Volusia County. (The rock is coquina.) May 17, 1909.

Fig. 31. Looking east-southeast on old dunes about a mile west of Mims, Brevard County, showing spruce pines of two different ages, the younger probably having come up since the last fire. Feb. 9, 1915.

section of the soils of the east coast. Separating the Brevard County portion from that south of our limits, we find that the soils are referred to the "St. Lucie," "Portsmouth," "Palm Beach," "Parkwood," "Norfolk," and "Gainesville" series, and the prevailing texture classes are sand (over 50% without the coastal beach), fine sand, tidal marsh, fine sandy loam, coastal beach, muck, and

Fig. 32. Small pool in vast damp calcareous palm savanna near head of Newfound Harbor on Merritt's Island, showing cabbage palmettos and switchgrass (*Spartina Bakeri*), Feb. 7, 1915.

Fig. 33. Looking north along crest of outermost dunes, 15 or 20 feet high, about a mile south of Melbourne Beach, Brevard County. Vegetation mostly saw-palmetto and sea-oats. Feb. 4, 1915.

clay loam. Old dunes with scrub vegetation, mapped as "St. Lucie sand" and "St. Lucie fine sand," make up a trifle more than a third of the total. A few mechanical and chemical analyses are given in the general chapter on soils.

Fig. 34. Shell mound covered with tropical hammock vegetation and partly excavated for road material, on east side of Indian River about opposite Melbourne. The shells are nearly all *Chione cancellata,* a small clam, and there are many layers of humus in the mound. Feb. 4, 1915. (For a description and another view of the same place, taken a year or two later, see J. F. Kemp, Econ. Geol. 14:311, pl. 5 b. 1919.)

Vegetation. The flatwoods of the east coast differ from those previously described in having more slash pine than long-leaf. The old dunes (fig. 31) are generally covered with spruce pine and other scrub vegetation much like that of the lake region, passing into sandy hammocks where sufficiently protected from fire by the proximity of water-courses, etc. In marly places there are large areas of low hammock (fig. 29), passing into swamps where traversed by streams. The dunes near the ocean have vast thickets of saw-palmetto (fig. 33). Less extensive types are the palm savannas on Merritt's Island (fig. 32), and a little salt marsh and mangrove swamp. The shell mounds are commonly covered with dense hammocks of a decidedly tropical character.

The commonest plants are listed below, but on account of the indefiniteness of the inland boundary of the region in some places the sequence cannot be guaranteed as accurate.

COMMONEST PLANTS OF EAST COAST STRIP.

TIMBER TREES

Pinus Caribaea	Slash pine	Flatwoods, etc.
Sabal Palmetto	Cabbage palmetto	Low hammocks and savannas
Pinus clausa	Spruce pine	Old dunes
Pinus palustris	Long-leaf pine	Flatwoods on mainland
Pinus serotina	Black pine	Damp flatwoods
Acer rubrum	Red maple	Swamps
Juniperus Virginiana	Cedar	Edges of marshes
Quercus Virginiana	Live oak	Hammocks, etc.
Magnolia grandiflora	Magnolia	Hammocks

SMALL TREES.

Quercus myrtifolia	(Scrub oak)	Old dunes
Hicoria glabra?	Hickory	Old dunes
Quercus Catesbaei	Black-jack oak	Driest spots
Salix longipes?	Willow	Edges of swamps
Quercus geminata	Live oak	Old dunes
Quercus cinerea	Turkey oak	Driest spots
Anamomis dicrana		Tropical hammocks
Magnolia glauca	Bay	Swamps
Avicennia nitida	Black mangrove	Salt marshes
(Xanthoxylum Clava-Herculis)		Hammocks, etc.

WOODY VINES.

Smilax auriculata		Old dunes
Vitis rotundifolia?	Muscadine	Hammocks, etc.
Rhus radicans	Poison ivy	Low hammocks

SHRUBS

Serenoa serrulata	Saw-palmetto	Various situations
Myrica cerifera	Myrtle	Hammocks and swamps
Iva frutescens		Edges of salt marshes
Ceratiola ericoides	Rosemary	Old dunes
Batis maritima		Sandy salt marshes
Pieris nitida	(Hurrah bush)	Old dunes, etc.
Myrica pumila	Myrtle	Flatwoods
Ximenia Americana		Flatwoods, etc.
Chrysobalanus **oblongifolius**		Pine lands
Cholisma ferruginea		Old dunes
Vaccinium nitidum	Huckleberry	Pine lands, etc.
Bejaria racemosa		Flatwoods
Cholisma fruticosa	(Poor grub)	Flatwoods
Rhus copallina	Sumac	Hammocks, etc.
Borrichia frutescens		Salt marshes

HERBS

Spartina Bakeri	Switch-grass	Edges of marshes, savannas
Aristida stricta	Wire-grass	Flatwoods
Tillandsia usneoides	Spanish moss	Hammocks, etc.
Juncus Roemerianus	(Rush)	Salt marshes
Cladium effusum	Saw-grass	Fresh marshes
Salicornia sp.	(Samphire)	Sandy salt marshes
(Bidens **leucantha**)		Streets and vacant lots
Andropogon sp.	Broom-sedge	Flatwoods
Sagittaria lancifolia		Fresh marshes
Aristida spiciformis	(A grass)	Flatwoods
Cassytha filiformis		Old dunes, etc.
Flaveria sp.		Marly flats
Pterocaulon undulatum	Black-root	Flatwoods
Sericocarpus bifoliatus		Dry pine land
Blechnum serrulatum	(A fern)	Swamps
Erythrina herbacea		Hammocks
Acrostichum aureum	(A fern)	Edges of salt marshes
Pteris aquilina	(A fern)	Pine lands
Solidago fistulosa	Goldenrod	Damp flatwoods

Something like 96% of the vegetation is evergreen. A considerable number of the species are mainly tropical in distribution, and not found north of Florida. Comparatively little use is made of the native plants. There is some lumbering and turpentining, but that belongs more to the neighboring flatwoods, i. e., what few sawmills and turpentine stills there are along the railroad get part of most of their raw material from the flatwoods. More honey in proportion to area is produced here than in other parts of central Florida, but it may come from orange blossoms as much as from native plants.

Climate. This is the warmest part of central Florida, at least in winter, on account of the proximity of the Gulf Stream. Often a whole winter passes without frost, in the southern portions at least. As compared with other regions described herein, the total rainfall seems to be a trifle less, but the proportion of it that comes in late summer is a little greater.

Animals. Fishing is an important industry in the Indian River and other lagoons, but no statistics of it have come to the writer's notice. Titusville seems to be the principal center. Mosquitoes seem to be more abundant here than in the other regions, and on Merritt's Island they are in evidence practically every month in the year, on account of the rarity of frost. But they are more annoying than dangerous, for those of the malaria-bearing species seem to be rare or absent, being more characteristic of regions with fertile soil.*

Population. There have been some white settlements on the east coast ever since the early Spanish days; and the bringing of a colony of Greeks and Minorcans to New Smyrna by Dr. Andrew Turnbull shortly before the American Revolution is a well-known episode of Florida history. But the population remained sparse until the coming of the railroad in the '80's. There is no way of estimating the density of population accurately, but if we assume that half of the inhabitants of Volusia County and all those of Brevard are concentrated in the coast strip we will not be very far off. That would give about 13 per square mile in 1890, 16 in 1900, 26 in 1910, and 40 in 1920. These figures are considerably above the average for central Florida and the whole State, showing that not-

*See 6th Annual Report, page 288, last footnote.

withstanding the poor soil, a large part of the population gets its living from the water, as is the case on most coasts all over the world. The winter tourist business is a very important item here too, and what farming there is is very intensive, as will be shown presently.

About one-third of the population would be classed as urban by the United States census definition, but about two-thirds of the people live in incorporated places, the largest of which in 1915 were Daytona, with 4,250 inhabitants; New Smyrna, with 2,012; Titusville, 1,310; Ormond, 857; Cocoa, 807; Daytona Beach, 582, Eau Gallie, 543; Seabreeze, 443; Melbourne, 408; Holly Hill, 378; Port Orange, 296; and Hawks Park, 178. All of these are on the main line of the Florida East Coast Railway, or on the barrier beach east of it. (Stations on that railroad in central Florida average about 3½ miles apart.) They are all popular winter resorts, and their combined hotel capacity, according to the latest estimates, is over 6,000.

The composition of the population may be deduced approximately from the figures for Brevard County, although that contains less than half the total. In 1910 that county had 65.5% of native whites, 4.7% foreign whites, and 29.7% negroes. If similar figures for the eastern half of Volusia were available the proportion of foreigners (already the highest in central Florida outside of Hillsborough County) and of negroes would doubtless be increased. In the incorporated places above listed 37% of the population in the summer of 1915 was colored, and Daytona and Ormond had more negroes than whites. The leading foreign nationalities in Brevard County in 1910 were English, German, Danish, Canadian, Irish, Italian, Scotch, and Swedish, and in Brevard and Volusia together English, German, Canadian, Swedish, Italian, Irish, Scotch, Danish, Russian, Norwegian, and Swiss. Some of the native whites are descendants of Minorcans brought from the Balearic Islands by Dr. Turnbull in the latter part of the 18th century.

On account of the dense population, mostly living in towns, and the fact that a large proportion of the people (not ascertainable for any census since 1880, however) have come from other states and therefore almost necessarily learned to read before making the journey, the illiteracy percentages are low. Among the persons

over 10 years old in Brevard County in 1910, only 1.1% of the native whites, 4.5% of the foreign whites, and 17.1% of the negroes were illiterate. The figures for native whites and negroes are the lowest in central Florida.

The leading religious denominations among the whites in Brevard County in 1916 were Baptist, Southern Methodist, Northern Methodist (?), Catholic, Episcopalian, Northern Presbyterian, Advent Christian, Disciples of Christ, and Congregationalist; and among the negroes, African Methodist Episcopal Zion, Baptist, A. M. E., and Northern Methodist.

Agriculture. Dr. Turnbull's Minorcan colony was primarily an agricultural one, and it is said that in 1772 they had about 3,000 acres of hammock land planted in indigo. But the modern intensive agriculture goes back only about thirty years. On account of the rather dense population, the mild climate, and the fact that most of the farms are within a mile of a railroad that can take express shipments to New York in less than two days (with double track most of the way), farming is now more intensive and specialized here than in any other region in Florida, although the soil probably averages the poorest in the State.

The ratio of improved land to total area cannot be estimated accurately, because the region does not cover as much as half of any county, but the statistics for Brevard County illustrate agricultural conditions very well in other respects.

The specialized farming that prevails here evidently sets too fast a pace for the average negro, as shown by the considerably higher proportion of whites among the farmers than among the total population. The proportion of farms operated by managers is very large, and this probably indicates that quite a number of orange groves are owned by people who do not live in Florida at all, or spend only the winter season here. (The census of 1900 was taken in June, and that of 1910 in April.) The managers' farms in 1910 averaged 79 acres with 16.8 improved, and land and buildings worth $15,375.

TABLE 8.

Agricultural Statistics of East Coast Strip (Brevard Co.), 1890-1910.

	1889-1890	1899-1900	1909-1910 Total	1909-1910 White	1909-1910 Color'd
Improved acres per inhabitant	0.68	1.41	1.02	1.31	0.33
Inhabitants per farm	21.8	8.4	11.0	8.8	26.4
Per cent of farmers white	-----	94.1	87.6	------	------
Per cent of farmers, owners	100	80.0	76.4	79.0	58.5
Per cent of farmers, managers		16.1	19.9	18.6	28.4
Per cent of farmers, tenants	0	3.9	3.7	2.4	13.2
Average number of acres per farm	114.5	62.0	59.7	63.8	31.4
Average improved acres per farm	14.8	11.8	11.2	11.6	8.8
Value of farm land per acre ($)	-----	43.20	97.76	96.00	123.00
Value of farm land per farm	10,800	2680	5830	6125	3860
Value of buildings per farm		785	1475	1590	656
Value of implements and machinery	27	43	81	83	63
Value of live-stock, poultry, etc.	233	260	249	------	------
Number of dairy cows per farm	1.7	1.1	0.7	------	------
Number of other cattle per farm	18.5	15.8	11.1	------	------
Number of horses per farm	0.6	0.4	0.5	------	------
Number of mules per farm	0.2	0.1	0.2	------	------
Number of hogs per farm	1.8	8.3	6.9	------	------
Number of sheep per farm	0	0	0		
Number of poultry per farm	37.1	19.1	18.4	------	------
Expenditures per farm for fertilizer	54.60	62.30	148.00	------	------
Expenditures per farm for labor	-----	112.00	294.00	------	------
Expenditures per farm for feed	-----	------	81.00	------	------
Annual value of crops per farm	852	338	1355	------	------
Annual value of animal products			66	------	------
Expend. fertilizer per acre improved	3.68	5.26	13.15	------	------
Expend. labor per acre improved	-----	9.48	26.10	------	------
Value of crops per acre improved	-----	------	120.50	------	------

The number of improved acres per inhabitant is low, on account of the large town population, the importance of other industries than agriculture, and the intensive farming. The farms average the smallest in central Florida, but have the most valuable land and buildings. Live-stock is relatively unimportant, the rather large number of beef cattle per farm being probably due to a few cattle ranches in the flatwoods part of Brevard County. (It is a curious fact that neither State nor government censuses have ever found any sheep in this county.) The number of work animals averages less than one per farm, showing that some farms are worked by hand labor only. The expenditures of all kinds per farm and per acre are very high, but so are the profits, in favorable seasons.

The leading crops in Brevard County in 1909 were oranges (over half the total), grape-fruit (about one-eighth), "vegetables," sweet potatoes, Irish potatoes, pineapples, corn, cane syrup, and hay.

In 1913-14 oranges (nearly two-thirds), grape-fruit (nearly one-fourth), (string?) beans, sweet potatoes, Irish potatoes, tomatoes, watermelons, cucumbers, strawberries, cabbage, peppers, guavas, bananas, onions, Japanese persimmons, egg-plants, and lettuce.

In 1917-18 oranges (about five-sixths), grape-fruit, Irish potatoes, velvet beans, string beans, tomatoes, sweet potatoes, corn, sorghum, dasheens, cabbage, lima beans, cowpeas, onions, and grass hay.

The average farm in 1909 produced only 43.3 gallons of milk, 4.5 pounds of butter (and sold 1.5, leaving only 3 pounds per farm family per year), 25 chickens, 86.5 dozen eggs, and about one cow and one hog, but led all the rest of central Florida many times in honey, producing 72.2 pounds per farm.

GENERAL FEATURES

Under this head the various geographical features of central Florida will be discussed by topics, and each subdivided by regions as far as is possible or desirable. This naturally involves some reiteration of facts already brought out in the regional descriptions, but the two treatments supplement each other just as the ground plan and elevation of a building do, and this second part is best adapted to illustrating general principles. It will also be useful to persons who are interested primarily in one thing, such as mineral resources, water, soil, climate, timber, population or agriculture, and do not care to look through ten regional descriptions to pick out the desired information.

The treatment begins with the structure of the earth's crust, which as far as we know has not changed materially for ages, and proceeds to topography, which changes a little more rapidly—though almost imperceptibly in a human lifetime—to soil and climate, to vegetation—which is changing slowly all the time even where man does not interfere with it—and finally to such very changeable features as population and agriculture. Soil, which is the top of the earth's crust, might perhaps most logically be treated immediately after stratigraphy, but in the area under consideration its character seems to depend as much on topography as on the nature of the underlying rocks, so topography is taken up first.

A complete account would treat every topic historically as well as geographically; but the changes in stratigraphy, soil, topography and climate are so slow, and exact information about them so meager, that it is hardly worth while to speculate about them at all in a work of this kind. Vegetation changes more rapidly, and in the last 25 years there have been published hundreds of pages on the supposed trends of development, or "succession," of vegetation in various parts of the country, particularly the Middle West. But in this report vegetation is regarded as essentially static, except for the depredations of civilized man and some comparatively short cycles of succession after fire in pine lands, scrub, hammocks, etc., which will be alluded to at the proper places.

Population and agriculture have developed from almost nothing to their present stage in less than 100 years, and we have abundant

information about them in census reports, for several decades past. However, previous to 1887 most of the counties in central Florida were so large that statistics based on them give a very imperfect idea of conditions in any one region, so that the statistical tables in the foregoing pages begin with the census of 1890. But some data from earlier censuses for the area as a whole are given in the following chapters. And even if the counties had been reduced to their present size much earlier, the information in the older censuses is considerably less detailed than that in recent ones, and the remote past does not concern us as much as the recent past anyway.

Some of the tables that follow contain the same ratios and percentages already given in the eight regional tables, but they are arranged in an entirely different manner. In the preceding tables one could follow the development of any phase of agriculture in a given region through three census periods, while in the following ones conditions in different regions at the same time are tabulated side by side to illustrate the influence of different environments. There are also a number of additional tables to illustrate conditions whose historical aspects are unknown or not considered, such as soil analyses, climatic data, a tree census, illiteracy, schools, religious denominations, relative importance and yield per acre of different crops, and animal products of farms.

In all the statistical tables where different regions are contrasted the highest ratio or percentage for each feature is printed in heavier type and the lowest in italics (unless two or more numbers are so nearly equal that it is impossible to decide between them); a scheme which assists materially in picking out the salient features of each region and also in locating the best and worst places within our area for any particular thing, such as large and small farms, farm machinery, mules, sheep, bees, cotton, oranges, sugar-cane, etc.,

STRATIGRAPHY

Although a great deal of geological work has been done in this and other parts of Florida in recent years, our knowledge of stratigraphic details is still very imperfect, on account of the scarcity of outcrops of rocks that can be identified by their fossils or otherwise. And even if deep wells had been drilled on every square mile and all the strata penetrated by them identified and measured it would still be quite a problem to map the formations, because they

are in most places so nearly horizontal that they make very small angles with the comparatively level surface, so that their edges must always be ill-defined.

The oldest formations known in central Florida appear at the surface in the northwestern quarter, and dip gently southward and eastward from there. The oldest rock is a nearly pure limestone of uppermost Eocene age, known now as the Ocala formation (perhaps a continuation of the Marianna limestone of West Florida, the St. Stephens limestone of southwestern Alabama, and the Vicksburg and Jackson limestones of Mississippi), which is exposed about as far east as Ocala and Sumterville and as far south as Tarpon Springs. Most of the caves in our area are in this formation, because it is almost the only limestone pure enough and thick enough and sufficiently elevated above the ground-water to form caves. It is quarried in several places (fig. 12), either for road-surfacing material, for fertilizing purposes, or for burning into lime. The eastward dip of this formation seems to be very slight, for it has been encountered within 200 feet of the surface in wells drilled near the east coast.

Next above it is the Tampa limestone, of Oligocene age, in our area principally confined to Hillsborough County. Its exposures are very limited and more or less silicified, so that it is of little economic importance. The Miocene area of central Florida seems to be approximately co-extensive with the lake region, but exposures of the strata are very scarce. Perhaps the best one is the limestone bluff at Rock Spring (fig. 18) in the northern part of Orange County, where the first Miocene fossils in Florida were found.*

The Pliocene is represented by the Nashua marl along the St. John's River between Palatka and Sanford, and by the hard rock and pebble phosphate deposits overlying the Eocene and Oligocene in patches west of the lake region. The Pleistocene includes some shell marls near the coast and rivers, and probably much if not most of the peat and surface sand.

Most of the surface is covered by fairly homogeneous unconsolidated sand averaging several feet in thickness. A generation ago this was commonly regarded as a Pleistocene deposit, and called the Columbia formation; but the trend of opinion in recent years has

*See references on page 120.

been toward treating it as a mere product of weathering from the sandy clay or rock underlying it. There are some objections to both hypotheses, however, and the question must be regarded as still unsettled.

ECONOMIC GEOLOGY

The most important mineral resource of central Florida is phosphate rock, which is of two principal kinds, occurring in distinct regions. The "hard rock," which is the highest grade, containing usually from 77% to 80% of tricalcium phosphate, occurs in deposits of supposed Pliocene age in the lime-sink region, chiefly in Citrus County and the western part of Marion (and north of our present limits in Alachua). A variety known as "plate rock" was formerly mined near Anthony, which is in the same region but east of the Middle Florida hammock belt. A low-grade by-product known as soft phosphate was formerly discarded in mining, but is now saved in some places and used as a fertilizer in its raw state.

"Land pebble," containing usually from 65 to 77% of tricalcium phosphate, occurs in the Bone Valley formation (Pliocene), which covers considerable areas in the flatwoods south of Lakeland and Plant City. A variety known as "river pebble" was formerly dredged out of the Peace River, chiefly south of our present limits. Both the principal types of phosphate deposits are of considerable scientific interest on account of containing many well-preserved vertebrate fossils, representing sharks, crocodiles, armadillos, horses, elephants, mastodons, whales, etc.

In 1913, the last full year before the export of phosphate was interrupted by the great war, there were 14 companies mining hard rock in Florida (some of them north of the limits of this report, however), and 16 mining pebble phosphate. The total reported production for the State in that year was 489,794 long tons of hard rock and 2,055,482 of pebble, together valued at $9,563,084, or about the same as the farm crops of central Florida in 1909. The hard rock, being of higher grade, brings a higher price, and the only reason the pebble can be marketed in competition with it is probably that the latter can be mined more economically, on account of the deposits being more continuous, the use of hydraulic mining methods, etc. Much of the hard rock at present mined is below ground-water level and has to be taken out with a dredge. Nearly all the

hard rock and about half the land pebble is exported to Europe in normal times.*

Since the war the business has picked up again, and several new mines have been opened in the flatwoods or pebble district, and more attention is being paid to the soft phosphate formerly wasted in the hard rock district. Another by-product, chiefly from the pebble district, is a sandy rock containing too little phosphorus for fertilizing purposes, but making a pretty good road-surfacing material.†

Limestone is probably next in importance to phosphate in our area. It has long been quarried in several places around Ocala, and recently in southeastern Citrus County. Some of it is burned for lime and some used for road material, and in a few places it has been sawed into blocks and used for chimneys, walls, etc. A variety known as coquina, composed of shell fragments rather loosely cemented together, occurs in a few places along the east coast, and has been used locally for building purposes.

Bog iron ore is said to have been mined and smelted near Levyville in Levy County during the Civil War, for the Confederate government.

Deposits of kaolin or porcelain clay are being worked on the south side of Lake Harris in Lake County, and brick is made at Whitney in the same county, and formerly at Brooksville and a few other places. Sandy clay suitable for road surfacing is widely distributed, particularly in the lake region.

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*The exportation of so much valuable fertilizing material has been viewed with alarm by some writers, but it is a natural result of the normal working of the law of supply and demand. Substantially the same arguments might be used against shipping coal, iron or lumber from states that have them to those that lack them; but if other states or countries need these things and have something of greater present value to us to offer in exchange it is perfectly good business to make the trade. It seems to be generally true of mineral fertilizers that the soils near where they occur are pretty well supplied with that particular substance, so that they have to be transported a considerable distance to do the utmost good. By sending our phosphate to Germany, Nebraska or California in exchange for potash both sides are benefited, provided the cost of transportation, etc., is not too great.

†For a discussion of the Florida phosphates see papers by Dr. E. H. Sellards in our Fifth and Seventh Annual Reports, and U. S. Geological Survey Bulletin 604, by G. C. Matson (1915). The first and last of these contain many references to earlier papers, which need not be cited here.

Sand abounds nearly everywhere, and the pure white variety, such as characterizes the scrub, ought to be well suited for the manufacture of glass. Sand-lime brick is made at Lake Helen, in Volusia County.

The marl in low hammocks and the shell mounds are used to some extent for road-making. Gypsum is found in a few low hammocks, but apparently not in commercial quantities, unless in the western part of Sumter County.*

Peat abounds in the lake region and occurs in most of the others, but has been little used as yet. It was discussed at considerable length in the Third Annual Report, which the interested reader can consult for details.

Artesian water is easily obtained anywhere in the area, but it does not rise above the surface except near the coast and larger rivers and lakes, and at a few other places at low elevations. The highest artesian pressure found in the State is along the Indian River in southern Brevard County, where the water rises about 50 feet above sea-level, and is used in a small way for running dynamos, etc. Most of the water from deep wells contains considerable salt, lime, sulphur, etc., but hardly ever enough to make it unfit for drinking purposes, except in some places near the upper St. John's River, where the salt content is excessive. In the lime-sink region, however, the water is often too "hard" for boiler purposes, and water-softeners are used by the railroads. Rain-water cisterns for private residences are used where the water is too deep to be reached by dug wells, as in the lime-sink region, or too highly mineralized, as in some places along the east coast. Force-pumps are also frequent in the lime-sink region and the higher parts of the lake region, while ordinary suction pumps prevail in the flatwoods.

*The latest account of the Florida gypsum deposits, containing references to important earlier papers, is by R. W. Stone in "Mineral Resources of the United States for 1918" (U. S. Geological Survey), part 2, pp. 293-296.

In recent years several test wells have been put down in the hope of striking oil—one in Sumter County reached a depth of 3,080 feet before it was abandoned—but without success as yet.*

TOPOGRAPHY

The subject of topography is not very well adapted to systematic or statistical† treatment, especially in a region where so little is known of the processes that produced the configuration of the surface as is the case here. In most civilized countries the greater part of the topography is evidently the result of either glaciation or normal erosion or easily understood variations thereof, and persons skilled in such matters can trace the developmental cycles with considerable satisfaction; but surface erosion is probably an insignificant factor in our area, on account of the low altitude of some parts and the very sandy soil or subterranean drainage of other parts, and the origin of some of our topographic features is still an unsolved problem. The treatment adopted here, therefore, is necessarily somewhat empirical.

Uplands. Although the topography of central Florida seems to have been shaped mostly by other means than surface erosion, as just stated, the steepest average slopes are generally in the most el-

*It is a curious coincidence, perhaps not easily explained, however, that all or nearly all the successful oil wells in the United States are in regions where there is more rain in early summer (April to June) than in late summer (August to October), and where the native vegetation is either predominantly deciduous or treeless; a combination of conditions not found in Florida—though approached in the extreme northwest of the State—or anywhere near the coast northeast of here.

According to an article by John K. Barnes in the "World's Work" for April, 1920, the cost of drilling for oil in the United States in recent years has greatly exceeded the value of the oil produced. So apparently we would be better off financially if no oil wells had ever been drilled!

†At first thought it might seem impossible to apply any sort of statistics to topography. But in areas covered by reasonably accurate topographic maps one could at least estimate the average slope of the surface of a given region by drawing straight lines across the map in various directions, counting the number of contours crossed in a unit distance, averaging the results, and applying a factor of about three-fourths to make a correction for the fact that most of the contours will not be intersected at right angles. It would also be possible to estimate the areas lying between sea-level and 50 feet, 50 and 100 feet, etc.

evated portions, as in most other parts of the world. As far as we know at present the highest point in Florida is the summit of Iron Mountain, about two miles north of Lake Wales, in Polk County, which is said to be 324.3 feet above sea-level.* There are some very similar high steep hills in the southern part of Lake County, particularly between West Apopka and Clermont.† Clermont is 105 feet above sea-level, and some of the hills northeast of there must be 150 if not 200 feet higher; and from at least one of them one can look directly westward over three lakes at once. Col. Charles Ledyard Norton, in his Handbook of Florida (3d edition, 1891, pp. 45, 274), referring to Lake County, says: "In point of fact, the highest elevations in the State, nearly five hundred feet above tide-water, are found in this county;" but in the light of present knowledge that appears to be considerably exaggerated.

The high hills of the Hernando hammock belt have been noted in the description of that region; and there are points in the limesink region and Middle Florida hammock belt nearly if not quite 200 feet above sea-level. The Hernando hills commonly have clay near the surface, at least on their slopes (fig. 15), and Iron Mountain and some of the hills near Ocala are a little rocky on top, but those of Lake County and many others have summits and slopes alike covered with deep sand. Some of these sandy slopes are remarkably steep, about 30°, but the outlines of the hills are smooth and rounded, as if the wind slowly and imperceptibly filled up with

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*Early in 1915 the corporation owning this "mountain" and considerable adjoining land advertised it to be 385 feet high, but this seems to have been based on an erroneous assumption as to the altitude of points on the recently completed branch of the Atlantic Coast Line Railroad, which passed a little west of the property. Revised figures seem to have been obtained from the railroad a little later, and in the summer of the same year the corporation published a small topographic map of the property, giving 324.3 feet as the altitude of the summit, which seems reasonable. This was soon accepted by the U. S. Geological Survey as the highest point in the State, and so published in the annual New York World Almanac, beginning with the issue for 1917 (p. 67). About the same time, however, it became known that Iron Mountain has a close rival in a point near Round Lake in West Florida, 322 feet above sea-level. (See our 11th Annual Report, 1918, p. 81, and 12th, p. 53.)

†See E. A. Smith, Tenth Census U. S. 6:237. 1884; N. S. Shaler, Bull. Mus. Comp. Zool. Harvard Coll. 16:151. 1890; Harper, Torreya 11:65. 1911; and fig. 19 of the present report.

sand any irregularities that might tend to be formed by erosion, burrowing animals, uprooted trees, etc.*

Lake basins. The hills of the lake region are interspersed with many saucer-like basins of various sizes and depths, some dry and some containing water. Just how these basins were formed is an unsolved problem. Some have ascribed them to solution and some to the action of strong ocean currents when the land was submerged† but neither explanation fits all the facts. Basins of somewhat similar outline but usually shallower are very common in the lime-sink region, and as some of those are known to have been formed by a sudden caving in of the roof of a subterranean passage and the subsequent smoothing of the sides by rain and wind, it may be assumed that most of them originated in some such way. But in the lake region sinks, caves, and other solution phenomena are very rare, and no one seems to have ever observed the beginning of one of the basins in question. They could hardly have been scooped out by the wind or the elevations around them piled up by waves, either, for many of the hills have a hard clay substratum in them considerably above the bottom of the basins. And lakes a short distance apart often differ considerably in elevation, showing that they rest on an irregular surface of clay or some other impervious material.

Lime-sinks. This term is used for several different things. Some lime-sinks are small dry sandy basins of the kind just described, with no visible outlet, while others have rock outcropping in them and a hole at the bottom through which water escapes, and some have steep banks and are more or less permanently filled with water, which is usually bluish from dissolved limestone. The dry sandy type is most common in the lime-sink region and the

*It seems probable that the wind has had a much larger share in shaping the topography of the uplands of peninsular Florida than is commonly realized. Although the sand does not move noticeably on windy days, except in cultivated fields (and even there there is little evidence of drifting after the wind dies down), in the course of centuries any minor irregularities must be pretty thoroughly smoothed out.

†See pages 150-156 of the paper on the topography of Florida by Prof. Shaler, cited on the preceding page.

rocky type in the hammock belts. Those with permanent water in them are apparently more common in northern than in central Florida, but examples can be seen near Sumterville and Lacoochee. In the Hernando hammock belt some of the intermittent lakes or prairies have a small rocky lime-sink at one end or edge, through which the water drains off (fig. 16). There are said to be some lime-sinks on the west side of Lake George, which the writer has mapped as being in the lake region, but not yet explored.

Caves. Limestone caves are not uncommon in and near the hammock belt in Marion County, and there are a few small ones in the southeastern part of Citrus County,* hardly large enough to contain stalactites and stalagmites or to be easily entered.

Natural bridges in central Florida are of two types, which might be called wet and dry. The former is the commonest, and is caused by a stream entering a subterranean channel made by solution of limestone, which it may follow anywhere from a few rods to a few miles. It is of course impossible to go under such a bridge, and sometimes one cannot even be sure where a disappearing stream emerges again. Bridges of this type are reported near Homosassa and Tarpon Springs, and there must be many unrecognized ones made by small streams. A rarer and very different type is formed by blocks of limestone falling against each other when the ground under them settles irregularly from the slow solution of still deeper calcareous strata. A few of this kind can be seen in the neighborhood of the caves of southeastern Citrus County just mentioned.

Flatwoods. Most of the country within twenty miles or so of the coast on both sides of the peninsula is essentially level, except where shallowly dissected by streams. The dissection is most pronounced near the Peace and Alafia Rivers, and at certain points near the coast where the general level of the country is 20 or 25 feet above the sea, as at Eau Gallie, Melbourne, and St. Petersburg. The flatness is probably due to the fact that the sand and underlying materials were deposited on a nearly level ocean bottom, and have not been elevated high enough or long enough to be eroded much.

Beaches and dunes. The whole Atlantic coast of central Florida and the Gulf coast in Pinellas County, are bordered by rather

*For additional information about these see R. M. Harper, Am. Fern Journal 6:68-81. 1916; Natural History (formerly American Museum Journal) 2:201. 1919; J. K. Small, Jour. N. Y. Bot. Gard. 21:34-37. 1920.

narrow barrier-beaches, with lagoons one to five miles wide between them and the mainland. On these beaches the wind has piled up low sand dunes, rarely exceeding 10 or 15 feet in height, which seem to be moving very little at the present time. (Dunes are not as well developed in Florida, or anywhere in the tropics, apparently, as they are north of latitude 40°, perhaps because in our climate the vegetation covers the sand too quickly for the wind to disturb it much. The wind has considerable force on the east coast, however, as is indicated by the pines leaning inland at an angle of ten degrees or more in many places.)

A mile or two back from the shore, at many places along the east coast and also near Cedar Keys, Bayport, and probably elsewhere on the west coast, are old dunes of thoroughly leached white sand, which must have been formed at a time when the land stood a little lower and the peninsula was narrower, for dunes do not seem to be forming at present more than half a mile from the outermost beaches. The absence of such features farther in the interior would seem to indicate that the land has not been depressed much below its present position for a very long time; long enough for the wind to level any dunes that might have existed and for the salamanders and other animals to mix the pure sand with the darker sub-soil.*

Other shore features. The absence of barrier beaches along the Gulf hammock coast has been commented on in the description of that region. It seems to be correlated with the very gentle slope of the ocean bottom along there, which keeps the waves from beating on the shore just as if there was a barrier beach a few miles out; but just why that type of shore with a minutely irregular marshy border, should be confined to the Gulf hammock region is an unsolved problem. Very likely if there was as much wind on the Gulf coast as on the Atlantic coast the shore would be different; but there is evidently not, for the pines grow perfectly erect near the Gulf coast, instead of leaning inland as most of them do on the other side of the peninsula.

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*The many patches of scrub (described farther on under soils and also under vegetation) in the lake region are thought by some to represent old dunes, but in many or most cases their topography seems to preclude any such explanation.

The larger lakes have sandy beach ridges on their more exposed shores, and sand-bars forming across their embayments, as in lakes with sandy shores the world over, but none of our lakes are large enough to have any perceptible development of dunes around them. Wave-cut cliffs are exhibited on a small scale in the clay bluffs on the southeast side of Lake Weir, and perhaps on other lakes.

Minor topographic forms. In many places close to the Indian River, St. John's River, Tampa Bay, and other navigable waters there are shell mounds several to many feet high and usually an acre or less in extent, which are commonly supposed to be Indian "kitchen middens," though the possibility of some of them having been partly built up by raccoons or other four-footed animals does not seem to have been wholly eliminated. Some are composed chiefly of oysters and others of other mollusks, especially along rivers, where there are no oysters. One on the east side of the Indian River about opposite Melbourne (fig. 34), which is being excavated for road material (a fate shared by many others), shows about ten feet of shells, nearly all *Chione cancellata,* a small clam-like bivalve, resting on yellowish sand. There are thin layers of humus among the shells every few inches, presumably indicating that the growth of the mound was frequently interrupted long enough for a little vegetation to grow on it. Some of the mounds have more sand than shells in them, and must have been formed in a somewhat different manner; but the subject has not been sufficiently investigated.

Terraces (?). The boundary between flatwoods and uplands is sometimes gradual and sometimes rather abrupt, as for example at or near Bronson, DeLand and Lake Helen. In recent years these abrupt scarps have been regarded by some geologists as Pleistocene shore lines, or terraces,* but they do not appear to be continuous for any great distance, as terraces should be, and they lack some of the characteristic features of shore-lines, such as dunes.

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*See Matson & Sanford, U. S. Geol. Surv. Water Supply Paper 319 (1914), pp. 31-35, 210-211, and map (plate 5); and comment on same in Geog. Review 4:224-225. 1917.

HYDROGRAPHY, OR DRAINAGE

Lakes. There is perhaps no essential difference between a lake and a pond, but the former term, in Florida as elsewhere, is usually applied to the larger and more permanent bodies of fresh water. No close estimate of the number of lakes in central Florida has been made, but it is certainly in the thousands. The majority are in the lake region, as might be expected, but they are common in several other regions, particularly the eastern division of the flatwoods. The largest are Lakes George, Apopka and Kissimmee, each covering something like 100 square miles. The smaller ones, some of which are only a few acres in extent (and not as wide as some parts of the St. John's River) are approximately circular and have no visible outlets, being merely depressions extending below the ground-water level. But they can hardly be called stagnant, for the water is doubtless constantly seeping through the sandy soil in the direction of the nearest river. The larger lakes are irregularly shaped and have streams flowing into or out of them, or both, several being simply wide places in the St. John's and Kissimmee Rivers.

Few soundings have been made in our lakes, but judging from the slope of their shores the deepest may not be over 50 feet deep. As a rule they do not fluctuate more than two or three feet in the course of a year. A few which are connected with sink-holes may be lowered suddenly at long intervals in the manner described by Dr. Sellards in the 3rd and 6th Annual Reports, and those on the St. John's River of course share the fluctuations of that stream, which however are only a few feet. Lake George, being just about the head of tide-water on the St. John's, of course cannot rise much, but Lake Harney, about 200 miles by water from the mouth of the river, is said to have an extreme fluctuation of about seven feet.

Besides the seasonal variations in level, some of the lakes among the uplands are evidently lower now than they were a generation or so ago, as shown by the encroachment of young long-leaf pines on their shores.* This may be due to a permanent lowering of the ground-water level by numerous flowing artesian wells bored at lower elevations, but the matter has not been sufficiently investigated.

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*See 3d Annual Report, p. 266.

The water of most of our lakes is comparatively clear, and some in Seminole and Orange Counties are used for city water supplies in preference to the hard and sulphurous artesian water. The clearest lake of any size in central Florida is probably Lake Weir, in the southern part of Marion County. Two or three small coffee-colored branches enter its eastern end and tinge the water there a little, but its western end, which is in the lime-sink region, is so clear that one can see the bottom where it is several feet deep. This is probably correlated with a small amount of limestone in solution, for a species of mussel (*Unio Cunninghami*) is common in the western part of the lake.

Ponds and swamps. Shallow ponds, which may dry up completely in dry seasons, varying in size from perhaps one to a hundred acres, abound in the flatwoods and are fairly common in the lime-sink region. They nearly always have considerable vegetation in them, sometimes only maiden-cane, wampee, bonnets, and other herbs, but more often bushes or trees or both. (Additional details are given in the chapter on vegetation.)

The various types of marshes and peat bogs have been pretty fully discussed in the Third Annual Report, and some of them will be referred to farther on under the head of vegetation. The same might be said of swamps, which are not very extensive in central Florida.

Springs. There is perhaps no equal area in the United States that has more large springs than central Florida. Most of them are the points of emergence of subterranean creeks or rivers, which usually come up through one or more irregular openings in the bottom of bowl-like basins. They are most common in the lime-sink region and near its edges, but there are also several in the Gulf hammock region and a few in the lake region, particularly near the St. John's River and on the edges of the great Wekiva River swamp in Seminole and Orange Counties.

Silver Spring (fig. 8), a few miles east of Ocala, is one of the largest springs known, about 200 feet wide and 35 feet deep. One discharge measurement made of it gave about 150,000 gallons a minute, or 333 cubic feet a second, and another, probably some distance down stream, about twice as much. The stream or "run" issuing from it is so large that small steamers from the Ocklawaha River can come right up into the spring; and this has been a fa-

vorite trip for sight-seers for many years. The spring is also used for bathing. Blue Spring in the same county near Juliette has nearly as large a flow, but does not make a navigable stream. Other well known springs in the same region are Weekiwachee Spring in Hernando County and Sulphur Spring near Tampa. The former is rather unique in being in the midst of a large area of scrub.

In the Gulf hammock region there are large springs at the head of the Waccasassa, Crystal, Homosassa (fig. 7) and Chessahowitzka Rivers. In the lake region the best known springs are DeLeon and Blue Springs in Volusia County, Palm and Hoosier Springs in the western part of Seminole County, Clay or Wekiva Spring, the main source of the Wekiva River, Seminole Spring, near Sorrento, and Bugg Spring, near Okahumpka. Rock Spring, in the northwestern part of Orange County (fig. 18), differs from most other Florida springs, and resembles some in the Appalachian Valley, in that the water rushes out audibly from the base of a cliff, instead of welling up from the bottom of a basin.

The water of all these large springs is highly charged with calcium carbonate, and is very clear, with a slight bluish tinge. Its temperature usually ranges between 70° and 75° the year round.* Some have a very perceptible sulphurous odor too, particularly those in Seminole County. Orange, Silver, Palm, Clay and Sulphur Springs and perhaps others are used more or less for bathing pools. Silver Spring, the largest and most accessible of all, is provided with glass-bottomed boats, from which the bottom can be viewed.

The water of Green or Espiritu Santo Spring in Pinellas County and one or two smaller ones is believed to have medicinal virtues. There are a few salt springs near the St. John's River and some of its tributaries, but little is known about them.

Streams. The streams of central Florida may be divided, chiefly on a basis of size, into branches, creeks, runs and rivers. The branches, generally speaking, are those small enough to stop running in dry weather, and they are not as numerous as in the northern part of the State, where the effects of erosion are more evident. They are mostly clear or slightly coffee-colored. The creeks flow throughout the year, and vary from a few feet to several yards

*The temperature of a large spring in any part of the world, unless it is a thermal spring, is usually very close to the average annual temperature of the locality, so that it seems warm in winter and cold in summer, by contrast.

wide. They nearly all originate in and are bordered by swamps, and are decidedly coffee-colored.

The outlets of the large springs, varying in size from creeks to small rivers, are commonly called runs. They are clear and bluish like the springs, but usually do not flow more than a few miles before they lose themselves in some larger coffee-colored stream or in the ocean. Helena Run, in Lake County, is said to be transparent when it flows eastward from Bugg Spring into Lake Harris, and coffee-colored when it flows westward from the lake toward the Withlacoochee River.*

The larger rivers are all coffee-colored in their natural state, there being no naturally muddy water in peninsular Florida; but a few like the Alafia and parts of the Withlacoochee are kept turbid most of the time by washings from the phosphate mines in their vicinity. The rivers are as a rule sluggish, because the highlands of the peninsula are so narrow that streams originating in them get down into the flatwoods before becoming large enough to be called rivers.

There are, however, a few places where ledges of rock form rapids, particularly in the Gulf hammock region within a few miles of the coast. One such place on the Withlacoochee, about ten miles from its mouth, and the same distance below Dunnellon, has been made the site of a hydro-electric plant (fig. 6), with a 20-foot dam, furnishing power to Dunnellon, Brooksville, several phosphate mines, and even an orange packing house in Sumter County. There is another such plant on the Hillsborough River a few miles from its mouth (in what is regarded as a part of the lime-sink region), which however is said to be used only for emergencies, as it cannot furnish enough power for the whole city of Tampa. There is said to be a spring near Sumterville which furnishes power for a mill.†

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*See 3rd Ann. Rep., p. 281.

†According to U. S. Geol. Surv. Water Supply Paper 319, p. 406. There has been some talk of damming up other springs in central Florida for power purposes, but just why a spring should be selected for that purpose, rather than the same stream farther down where it is larger, is not clear, unless it is merely a manifestation of a mania some people have for destroying or defacing objects of natural beauty. Some attempts of this kind in West Florida are said to have had the unexpected result of merely forcing the water to find a new outlet through the cavernous limestone.

Most streams in our area are too short or too near sea-level to fluctuate much with the seasons, and besides the excess of rainfall in late summer (see chapter on climate, farther on) tends to counterbalance evaporation and thus keep their flow uniform, so that floods are practically unknown. The St. John's River, the largest, is unique in several ways. It rises in great marshes or wet prairies, resembling the Everglades, near the southern edge of Brevard County, within 25 miles of the ocean in a direct line and not over 20 feet above it at low water, and flows northward approximately parallel to the coast for over 200 miles, with a fall of only about an inch to the mile. In the latitudes under consideration it is much narrower than it is where influenced by the tide, except where it expands into lakes. Lake Monroe, between Sanford and Enterprise, is said to be five feet above sea-level, with a maximum depth (at low water?) of only eight feet. Between there and Lake Harney, the next lake above, the river is said to have an extreme fluctuation of seven feet, which is perhaps the greatest of any stream in central Florida, unless it is exceeded by the Peace or the Alafia River; but that of course is very little compared with some of the rivers farther north.

The Ocklawaha* and Withlacoochee Rivers resemble the St. John's in flowing northward most of their length, a phenomenon that deserves more attention from physiographers than it has received.

SOILS

The soils of central Florida, although prevailingly sandy, are considerably diversified within certain limits. Alluvial and red clayey soils are scarce, but we have soils ranging in chemical composition from nearly pure calcium carbonate and highly phosphatic to nearly pure silica and peat.

The correlations between soil and vegetation in this part of the country are so close, and the natural vegetation nearly everywhere so prominent, that most previous attempts to classify Florida soils

*In recent years this has often been spelled "Oklawaha," presumably by the same sort of people who write "Suwanee' for Suwannee, "Hillsboro" for Hillsborough, "Okechobee" for Okeechobee, etc., but this should especially be discouraged, for it tends to give an erroneous impression of the first syllable. (For the benefit of strangers it might be well to explain that the main accent is on the third syllable. Also that Kissimmee is accented in the middle.)

have described most of them in terms of vegetation, such as pine land, hammock, swamp, scrub, and prairie;* and it is indeed difficult to avoid mentioning the vegetation in describing our various soil types.

The leading texture classes of soils in each region, as far as known, have already been noted in the regional descriptions. In the following pages the principal soil types of the whole area will first be classified roughly by water-content, color, etc., and then some mechanical and chemical analyses presented. As in all classifications of natural objects or phenomena, there are all possible gradations between adjacent categories, so that no sharp lines can be drawn; and a few types difficult to classify are not mentioned at all.†

UPLAND (MAINLY DRY) SOILS

White sand. This consists of nearly white quartz sand, usually rather coarse, and with less than 2% of silt and clay. It varies in depth from a few inches to several feet,‡ and commonly passes rather abruptly below into yellowish sand of similar texture. It is widely distributed in central Florida, but most common in the lake region and near the east coast. In the coast strip it is chiefly confined to old dunes, but in the lake region, where it is very characteristic, no constant relation to the topography has been made out. It has been called "Norfolk sand with scrub oak vegetation" in the U. S. soil survey of the "Ocala area" (1913)§, "Leon sand, rolling phase" in that of Pinellas County (1914)§, "Leon fine sand, scrub phase"

*See for example a paper on the soils of Florida by Dr. E. H. Sellards in our 4th Annual Report (1912), pp. 1-79. This was published in more condensed form the following year in the 12th Biennial Report of the State Agricultural Department, pp. 249-299, and has been reprinted two or three times as a supplement to the Quarterly Bulletin of that department.

†Just before completing this chapter the writer had the advantage of a visit from Mr. J. Otto Veatch of the U. S. Bureau of Soils (formerly assistant on the Geological Survey of Georgia), who has been making a special study of Florida soils for the last year or two. He has made some helpful criticisms, but of course cannot be held responsible for any errors that may remain.

‡In some of the government soil surveys the white sand is stated to be a mere veneer a few inches thick, but this was probably not intended to apply generally to large areas, for in a railroad cut about four miles west of Bartow, if not elsewhere, it extends without perceptible change to a depth of at least eight feet.

§Reprinted in our 7th Annual Report, 1915.

and "St. Lucie fine sand" in Hernando County (1915), "St. Lucie sand" and "St. Lucie fine sand" in the "Indian River area" (1915), and "St. Lucie fine sand" in Hillsborough County (1918). Some of these names may indicate variations in depth or texture, however, rather than different interpretations on the part of the soil surveyors.

This sort of soil is represented in the tables a few pages farther on by mechanical analyses 37, 38, 46 and 47, and chemical analyses D and K (which unfortunately are incomplete). As compared with other soils of the area it is very poor in potash, clay, humus, and animal life, and it seems likely that in some cases at least it has been derived from the creamy sand next to be described by long-continued leaching out of soluble materials, a process which in the creamy sand seems to be constantly counteracted by animal agencies, as explained on the next page. Just what keeps these animals out of the white sand remains to be explained; but it may be that they are very slowly encroaching on it year by year.

The vegetation on the white sand on uplands is nearly always of the scrub type, described farther on in the chapter on vegetation Where it is low and flat, however, it may bear vegetation of the flatwoods type, with pines and saw-palmetto predominating; and there are various intermediate conditions. Whether the white color extends down only a few inches or several feet does not make as much difference in the vegetation as one might imagine; which seems to indicate that the top soil is more important to plants than the subsoil.

In the interior this soil is almost never cultivated, but along the east coast great quantities of citrous fruits and pineapples and even some vegetables are raised on it, of course with the aid of liberal applications of fertilizers.

Cream-colored sand. This is by far the most extensive type of upland soil in our area, especially in the lime-sink and lake regions It includes most of the "Norfolk sand," "Norfolk fine sand" and "Norfolk sandy loam" and some of the "Gainesville fine sand" of the government soil surveys, and is represented in the tables by mechanical analyses 6-9, 27, 28, 39, 40, and chemical analyses E, F, L and M.

It consists of medium to fine-grained incoherent quartz sand, with 3 to 8% of silt and clay, and is usually very homogeneous to a depth of several or many feet, so that few if any roots go all the

way through it. The prevailing color is cream or light buff, except that the uppermost inch or two is usually bleached a little by the action of vegetation. In cuts and pits where the whole thickness of the sand is exposed it rests sometimes on sandy clay and sometimes on phosphate rock or silicified limestone, the latter sometimes protruding a few inches above the surface in boulder-like outcrops without making any perceptible difference in the vegetation.*

Salamanders abound and gophers, ants, and sundry other burrowing animals are common in this type of soil, so that practically every particle of it within a foot or two of the surface must be turned over by them every few years, and this may be a sufficient explanation of its homogeneity.

The vegetation is nearly always of the high pine land type. Although the soil looks very unpromising to one accustomed to clayey soils, it is very easily cultivated, and when properly fertilized yields very satisfactory returns. Practically all the farming in the limesink region, and most of the orange groves in the lake region, are on this kind of soil.

Cream-colored sand with humus. Where the soil just described is protected from fire by being partly surrounded by bodies of water or hammocks (see chapter on vegetation), the forests become much denser (sandy hammocks), and some humus accumulates, making the top soil gray. This phase has been mapped as "Norfolk sand," "Norfolk fine sand," and "Leon sand, hammock phase;" and it is represented by mechanical analyses 41 and 42 and chemical analyses C and Q. Salamanders seem to be absent and other subterranean animals scarce, so that the soil is more leached than the typical phase; and comparatively little of it is cultivated.

Brown, rusty, and ashy sand. In many places, for example around Dade City, Brandon, Mount Dora, Montverde, and between Bartow and Fort Meade, the loose sand of the uplands is brownish instead of cream-colored. Mechanical analyses 29 and 30 and chemical analysis H, all from near Fort Meade, probably represent this type. In the vicinity of Fort Meade, where the soil is decidedly

*There is some difference of opinion as to whether this sand is a distinct formation or a residual material from the underlying Tertiary strata, as stated in the chapter on stratigraphy; but from the geographical standpoint that is a matter of little consequence.

chocolate-colored, it commonly has phosphate pebbles scattered through it, or underlying it at no great depth, and it is probable that the same sort of soil at the other localities contains more phosphorus than the common creamy sand, though those in the lake region are remote from any known phosphate deposits, and the reason for the difference in color there is not obvious.

The vegetation on the darkest phase near the Peace River is usually of the semi-calcareous hammock type, while elsewhere it is mostly high pine land, but differing from typical high pine land in having more turkey oak than black-jack—or sometimes very few oaks of any kind—and more Spanish moss on the pines than usual (especially around Dade City). This being evidently a better soil than those previously described, a good deal of it is cultivated.

In a few places in the lake region, for example in southern Polk County, the prevailing sand has a rusty yellowish color, presumably due to iron, but is similar to the creamy sand in depth, texture, and vegetation. A more remarkable type, occurring on high uplands a few miles south of Lakeland, is ashy gray in color, with considerable silt or rather very fine material in it. This is close to the pebble phosphate country but high above it, and its derivation and composition are unknown. The gray matter does not appear to be of the nature of humus.* The vegetation is mostly of the high pine land type, with turkey oaks exceptionally large and numerous. A large part of this soil has been cleared and planted to orange groves.

Semi-calcareous hammock land. This is a makeshift term used by the writer to cover a variety of upland soil that is mostly sand, but has enough limestone within a few feet of the surface or outcropping to influence the vegetation perceptibly. It is an intermediate condition between the creamy sand already described and the calcareous uplands described on the next page. It is common in the vicinity of Ocala, and has been mapped as "Fellowship sand," "Fellowship sandy loam," Gainesville loamy sand," "Gainesville sandy loam," and Portsmouth sandy loam;" and it is represented in the following tables by mechanical analyses 10-14, 17, 18, 21-24, 48-51, and chemical analyses B, G, N and S.

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*This soil in color resembles some near the center of Alachua County, mentioned incidentally in the Sixth Annual Report, p. 370; and in texture it reminds one of the loess of southwestern Mississippi, which is supposed to have been transported by the wind.

It is characterized by hammock vegetation with evergreen and deciduous trees approximately equal in numbers, as described farther on. A considerable portion of it is under cultivation. Salamanders seem to invade this soil only where it has been cleared and abandoned a short time, perhaps indicating that they do not like shady places.

Calcareous uplands. Where the soft Ocala limestone crops out, as near Ocala and in southeastern Citrus County, it grades into a black sticky soil rich in humus. One such area a little south of Ocala has been mapped as "Fellowship clay loam," and a somewhat similar soil occurs farther north near McIntosh, where no rock outcrops are in evidence, and in and around lime-sinks in the Hernando hammock belt. It is represented by mechanical analyses 15, 16 (perhaps also 17 and 18), 25 and 26, and chemical analyses T and U.

The vegetation is of the hammock type, with the great majority of the trees deciduous. The hackberry and a few other plants of the same or allied families are very characteristic. Although this is a very rich soil, it is usually too hilly or rocky to be cultivated much. Lettuce and other vegetables are raised on or near it on the west side of Orange Lake, where there is very little rock.

Clay soils. Upland soils distinctly clayey at the surface, and containing as much as one-fourth clay, are rare in peninsular Florida. The mechanical analyses farther on which show high percentages of clay are nearly all calcareous hammock soils, and the "clay" in them is probably mostly humus and marl. In the Middle Florida hammock belt, north of the "Ocala area" (e.g., around Fairfield), and in the central part of the Hernando hammock belt, there are some soils clayey enough to form clods when plowed. No mechanical analyses of these are available, but chemical analyses of two of the Hernando County soils are given under V and W. On such soils short-leaf pine, sweet gum and hickory are characteristic trees, and a good deal of corn and other staple crops are raised, with little or no fertilizer. The whole aspect of the country strongly suggests some places in Georgia and Alabama.

DAMP SOILS

Sandy. Under the head of damp sandy soils are classed most of the soils of the Gulf hammock region and the three flatwoods re-

gions, and limited areas in all the others. They vary in color from white to dark gray or nearly black, usually without any trace of red, yellow or brown. In many places shallow cuts or ditches reveal a stratum of "hardpan" (sand cemented together by some dark brown organic substance with perhaps a trace of iron) within two or three feet of the surface, and borings made by soil investigators seem to indicate that this is present in practically all our flatwoods areas, unless clay or rock takes its place. The hardpan is relatively impervious to water and not readily penetrated by tree roots, but in some places it is said to be only a few inches thick, with white sand below it, so that it can be perforated by blasting or otherwise in preparing the land for agricultural purposes.

The damp sandy flatwoods soils are classed in the government reports as "Portsmouth fine sand," "Leon fine sand," "Norfolk fine sand, flat phase," "Fellowship fine sandy loam," etc. In the following tables they are represented by mechanical analyses 19 and 20 and chemical analysis Y. Salamanders are found only in the driest spots, and other burrowing animals are scarce.

The whitest of the damp sand has a vegetation nearly all evergreen, something like that of the upland scrub, and this might be called low scrub. Most of it, however, has a low pine land or flatwoods vegetation, consisting mostly of pine and saw-palmetto. Within a few miles of the larger rivers, particularly south of latitude 29°, the pines may be absent over many square miles, making palmetto prairies; and sometimes the palmetto too is wanting or nearly so, but that probably indicates a different kind of soil, either wet or marly, or both.

A great deal of the damp sand is too wet for successful agriculture until artificially drained, but its level topography facilitates the control of irrigation water and fertilizers, and some very intensive farming is carried on in places convenient to transportation lines.

Sandy and rocky soils. In the Gulf hammock region the sand seems to be underlaid at no great depth by limestone, and the rock crops out in many places, sometimes thickly enough to interfere seriously with plowing. This type is designated in the soil surveys as "Leon sand," "Leon fine sand," Portsmouth fine sand," "Gainesville sandy loam, pine woods phase," "Hernando fine sandy loam,"

etc. The amount of lime in the soil must be comparatively small, for except where the rock outcrops are very abundant the vegetation does not differ greatly in aspect or composition from that of the non-calcareous flatwoods. Only a small part of this soil is cultivated at present, but it seems to be very well suited for vegetables of many kinds.

Sand and rock with humus. The greater part of the soil of the great Gulf Hammock of Levy County (fig 5), and perhaps many other level hammocks, seems to have been originally damp sand with limestone protruding through it, though the relative amount of sand may have been less than in the flatwoods, and indeed without extensive explorations it would be hard to say how much of it belongs to the marly type described a little farther on. Anyway, the dense forests now established in such places furnish their own protection from fire and form a great deal of humus, which differentiates the soil further from that of the flatwoods. Mechanical analyses 4 and 5 ("Parkwood fine sandy loam") represent this type pretty well. When cleared it makes a good trucking soil, like the preceding.

Clayey soils. A little north of the center of Marion County, particularly around Burbank, there are a few square miles of flatwoods with decidedly clayey soil. This type has been seen by the writer only from the train, but its vegetation seems to differ from that of sandy flatwoods chiefly in the scarcity of saw-palmetto. The land has been utilized to some extent for truck-farming. Toward Silver Spring this passes into a sort of low hammock with short-leaf pine and cabbage palmetto,* somewhat suggesting a river or creek bottom. This last, represented by mechanical analyses 44 and 45, is called "Fellowship clay" in the soil survey of the "Ocala area," though it bears little resemblance to anything around Fellowship P. O., which is on the uplands in a different region, several miles away.

Marly soils. On and near Merritt's Island there are considerable areas of damp or wet marly soils, whose texture, composition and depth are little known. The vegetation is mostly of the type designated farther on as palm savanna. Some similar vegetation, presumably indicating similar soil conditions, occurs in the Gulf hammock region within a few miles of the coast, for example be-

*Described in 7th Annual Report, pp. 178-179.

tween Crystal River and Homosassa. As most of this soil is within a few inches of sea-level, and remote from settlements, it is not utilized much if at all.

Many if not most of the low hammocks, particularly in the Gulf hammock region, are evidently on marly soil, called "Parkwood clay loam," etc. This contains a large proportion of calcium carbonate, and its texture is shown by mechanical analyses 1 to 3. A good deal of it is under intensive cultivation, for example near Coleman, and also near Lake Jessup, if that is properly classed as marly soil.

WET SOILS

Wet prairies, ponds, etc. In the Gulf hammock region and the three other flatwoods regions there are many areas depressed a few inches or feet below the general level, and filled with water in wet seasons. Some of these contain pond cypress and other woody plants, but a great many are treeless, and known as prairies, or sometimes as "sand soaks." The soil differs little from that of the surrounding flatwoods, except in being saturated with water much of the time and having a little peat or muck overlying it and more or less mixed with it. Some such areas have been mapped in the soil survey of Pinellas County as "water and grass." Their present agricultural value is almost negligible.

Peat. In the lake region and less frequently elsewhere there are many deposits of peat, often ten feet deep or more. They have been described in considerable detail in the 3rd Annual Report, which contains a table showing the ash and moisture content and a few other features of many samples from various parts of the State.* Some of our peat, particularly around Lake Panasoffkee, is quite calcareous, but all, as far as known, is low in potash. The vegetation on it may be either swamp, marsh, or prairie.

All peat needs to be drained before it can be cultivated, and very little of the deep peat in central Florida is situated so that cultivation is profitable at present. An area of several hundred acres along the Ocklawaha River southeast of Ocala was drained seven or eight years ago by diverting the river, and part of it put under cultivation. Some shallow peat or muck is both richer and more easily drained, and therefore better adapted for agricultural pur-

*This table is reprinted in the 6th Annual Report, pp. 59-62.

poses; and it is hard to draw the line between this and some of the low hammocks already mentioned.

Salt marsh muck. Along both coasts, in places protected from wave action by outlying or projecting land masses or the shallowness of the ocean bottom, are strips or patches of salt or brackish marsh, characterized by coarse grasses and rushes. The soil, a fine silt or muck, would probably be quite fertile if it could be raised a few feet above sea-level, but being saturated with salt water twice a day (or all the time in tideless lagoons), little can be done with it. And the marshes of central Florida are doubtless less fertile than those near the mouths of muddy rivers farther north, as shown by the prevalence of the evergreen rush, *Juncus Roemerianus,* rather than the marsh grass, *Spartina glabra,* which has larger leaves and renews them every year.

MISCELLANEOUS SOILS

Beach and dune sands. On the exposed portions of both coasts, except the greater part of that bordering the Gulf hammock region, the sand has been piled by waves and wind into beaches and low dunes, which are always more or less calcareous, owing to the presence of fragments of sea shells. The sand is usually rather fine, but contains very little silt or clay. Besides numerous mollusks, crustaceans, etc., that live before high tide level, a few gophers and ants make their homes in the beach sand, but salamanders are absent. The available chemical analyses (O, P, Z) seem to indicate that this soil is fairly well supplied with potash and other ingredients of fertility, but it is practically worthless for agriculture, on account of its instability, porosity, and lack of organic matter.

Shell mounds. As already indicated under the head of topography, these are found in many places along the coast and navigable rivers. They consist mostly of shells of oysters and other bivalves, one kind of shell usually outnumbering all the rest in any one mound. The shells are usually little broken, and therefore contribute little to the soil, which is usually a thin layer of humus, with no sand or clay visible, though some of the mounds have considerable sand mixed with the shells. The vegetation seems to be always hammock of some kind, and on the east coast is usually decidedly tropical in composition, south of Cape Canaveral at least.

Limestone cliffs and caves. Outcrops of tolerably pure and

hard limestone, where large enough to escape being swept by fire, and well shaded, as in hammocks and deep sinks and mouths of caves, usually have vegetation consisting mostly of ferns and mosses; but just why ferns should be partial to such places is not clear.*

Red oak uplands. A very characteristic type of vegetation around Ocala is the red oak woods (described in its proper place farther on). This is not confined to one particular type of soil, but attains its best development on a type a little different from that of the calcareous hammocks or any other above described. In the soil survey of the "Ocala area" most of it is called "Gainesville loamy sand," though it does not seem to resemble closely anything around Gainesville. Mechanical analyses 21 and 22 and chemical analysis A probably represent phases of this type, and R certainly does, for it was specially selected for that purpose. Its most remarkable feature is the high percentage of phosphoric acid, and it is also pretty well supplied with potash and iron.

Salamanders and gophers are rare or absent in this soil, perhaps because it is a little too rocky as well as too shady, but there must be other subterranean animals present, as in other fertile soils the world over. Red oak, sweet gum and hickory are the characteristic trees, and where this soil merges into the ordinary sandy uplands the long-leaf pine comes in. A good deal of it, perhaps half, is cultivated, mostly in corn, cotton or vegetables. Little or no fertilizer is used with the corn and cotton.

MECHANICAL ANALYSES

The following mechanical or physical analyses of central Florida soils and subsoils have been extracted from Bulletin 13 of the Division of Soils of the U. S. Department of Agriculture (A preliminary report on the soils of Florida, by Milton Whitney, 1898), and the soil surveys of the "Gainesville area" (1905) and "Ocala area" (1913). In the last named the localities and depths of the samples are not given, but they were obtained by correspondence with Prof. Whitney (who has been chief of the Bureau—formerly Division—of Soils since its beginning), and were used in the

*For a description of one of the finest rock fern localities in our area see the papers referred to under the head of caves on page 163.

reprint of that survey in our 7th Annual Report. The percentages of organic matter are given in most cases, and of calcium carbonate in a few cases, and the columns should total 100% without the calcium carbonate.*

The samples are grouped by regions, in the same order as in the other parts of this report. Descriptions of them follow, and the analyses constitute Tables 9 to 14.

Gulf Hammock Region

1. Clayey low hammock ("Parkwood clay loam"), Sumter Co. Average of two localities, viz., 2½ miles s. w. of Wildwood and ¾ mile s. e. of Coleman. Depth 0-5 inches. (Ocala area)

2. Subsoil of same two localities, 5-20 and 5-18 inches.

3. Lower subsoil of same, 20-36 and 18-36 inches.

4. More sandy low hammock ("Parkwood fine sandy loam"), Sumter Co. Average of two localities, viz., 2 miles n. w. of Coleman and 2 miles e. of Carlson's Ferry. Depths 0-10 and 0-12 inches. (Ocala area.)

5. Subsoil of same 10-36 and 12-36 inches.

TABLE 9.

Mechanical Analyses of Soils and Subsoils in Gulf Hammock and Lime-sink Regions. (From Soil Survey of "Ocala Area").

	Gulf hammock region					Lime-sink region, high pine land			
	Clayey low hammock			Sandy do.					
	1 Soil	2 Sub-soil	3 Sub-soil	4 Soil	5 Sub-soil	6 Soil	7 Sub-soil	8 Soil	9 Sub-Soil
Fine gravel (2-1 mm.)	.06	2.8	2.1	0.1	0.2	0.3	0.6	0.2	0
Coarse sand (1-.5 mm.)	3.4	6.0	5.2	6.0	4.3	5.5	4.1	1.4	1.7
Medium Sand (.5-.25 mm.)	6.5	6.7	4.5	20.7	16.9	17.6	10.1	8.4	9.7
Fine sand (.25-.1 mm.)	24.9	22.6	13.1	53.5	40.6	50.5	32.2	71.1	73.5
Very fine sand (.1-.05 mm.)	9.8	8.6	6.1	11.6	9.1	18.7	11.6	10.6	8.1
Silt (.05-.005 mm.)	30.2	26.3	40.9	5.6	9.3	3.3	16.2	2.5	2.3
Clay (.005-.0001 mm.)	24.6	27.2	27.9	2.4	19.4	3.9	24.8	5.7	5.0
Total	100.0	100.2	99.8	99.9	99.8	99.8	99.6	99.9	100.3
Calcium carbonate	15.75	6.00	54.79	----	14.38	----	----	----	----

*One sample reported on in Bulletin 13, representing rich heavy hammock near Altoona, has been excluded because it totals less than 95% and it has been impossible to locate the error after the lapse of so many years.

Lime-Sink Region

6. Cream-colored sand or high pine land ("Norfolk sandy loam"), Marion Co. Average of two localities, viz., 1 mile n. w. of Flemington and ¼ mile s. of Elmwood. Depths 0-18 and 0-10 inches. (Gainesville area.)

7. Subsoil of same, gray stiff sandy clay and brown sandy clay, 8-36 and 10-36 inches.

8. High pine land ("Gainesville fine sand") 6½ miles n. of Dunnellon, Marion Co. Depth 0-6 inches. (Ocala area.)

9. Subsoil of same, 6-36 inches.

Middle Florida Hammock Belt

10. "Light hammock' near Ocala. Depth 0-9 inches. (Bull. 13.)

11. Subsoil of same, 9-24 inches.

12. Lower subsoil of same, 24-36 inches.

13. Light hammock ½ mile s. of Ocala. Depth 0-12 inches. (Bull. 13.)

14. Subsoil of same, 12-30 inches.

15. Rich heavy hammock near Ocala. Depth 0-12 inches. (Bull. 13.)

16. Rich heavy hammock 2½ miles s. of Ocala. Depth 0-12 inches.

TABLE 10.

Mechanical Analyses of Soils and Subsoils in Middle Florida Hammock Belt, Marion Co. (From U. S. Soil Bulletin 13.)

	Light hammock			Light hammock		Rich heavy hammock	
	10 Soil	11 Sub-soil	12 Sub-soil	13 Soil	14 Sub-Soil	15 Soil	16 Soil
Fine gravel (2-1 mm.)	Trace	Trace	Trace	Trace	0.28	0.27	1.58
Coarse sand (1-.5 mm.)	1.59	1.80	1.45	3.07	3.30	2.16	2.62
Medium sand (.5-.25 mm.)	15.63	18.25	19.63	21.44	22.29	17.01	13.08
Fine sand (.25-.1 mm.)	62.87	65.37	62.40	53.54	55.29	40.94	46.32
Very fine sand (.1-.05 mm.)	15.70	10.07	11.65	13.30	10.64	20.26	19.83
Silt (.05-.01 mm.)	1.25	1.20	1.80	2.68	2.62	5.61	3.38
Fine silt (.01-.005 mm.)	0.48	0.55	0.62	1.33	1.64	2.23	1.50
Clay (.005-.0001 mm.)	0.61	1.39	1.26	2.39	3.06	5.55	6.86
Organic matter	1.16	0.75	0.65	1.36	0.92	4.94	2.61
Moisture, air-dry	0.35	0.22	0.30	0.49	0.32	1.61	1.39
Total	99.64	99.60	99.76	99.60	100.36	100.58	99.17

TABLE II.

Mechanical Analyses of Soils and Subsoils in Middle Florida Hammock Belt, Marion Co. (From Soil Surveys of "Ocala" and "Gainesville" areas.)

	High hammocks								Flatwoods	
	Portsmouth		Gainesville		Gainesville		Fellowship		(Portsmouth)	
	17 Soil	18 Sub-soil	19 Soil	20 Sub-soil	21 Soil	22 Sub-soil	23 Soil	24 Sub-soil	25 Soil	26 Sub-soil
Fine gravel	0.6	0.7	0.6	0.2	0.8	0.6	1.3	0.3	0.4	0.6
Coarse sand	4.6	2.3	12.9	12.8	14.0	9.3	10.2	2.6	9.7	8.6
Medium sand	13.7	4.0	26.5	25.6	23.5	14.8	12.7	5.8	23.4	24.9
Fine sand	50.0	20.9	40.1	39.4	41.4	29.7	25.1	9.5	46.9	45.6
Very fine sand	15.5	18.7	10.4	10.7	11.8	8.3	8.0	6.1	14.5	14.0
Silt	11.3	36.0	4.3	3.8	5.5	4.9	14.2	13.4	3.3	3.2
Clay	4.0	17.1	5.2	7.5	3.1	32.4	28.3	62.0	1.6	2.2
Total	99.7	99.7	100.0	100.0	100.0	100.0	99.8	99.7	99.8	99.1
Calcium carbonate	-----	1.86	-----	-----	-----	-----	-----	-----	-----	-----

17. High hammock ("Portsmouth sandy loam"*) 2½ miles s. e. of Johnson Pond, Marion Co. A black sandy loam. Depth 0-8 inches. (Gainesville area.)

18. Subsoil of same. A stiff heavy marly clay. Depth 8-36 inches.

19. High hammock (or perhaps red oak woods, the two not being satisfactorily distinguished in the report) 2 miles s. e. of Ocala ("Gainesville loamy sand"). Depth 0-10 inches. (Ocala area.)

20. Subsoil of same. Depth 10-36 inches.

21. High hammock ("Gainesville sandy loam") 5 miles s. of Ocala. Depth 0-12 inches. (Ocala area.)

22. Subsoil of same. Depth 12-36 inches.

23. High hammock ("Fellowship clay loam") 2 miles s. w. of Ocala. Depth 0-4 inches. (Ocala area.)

24. Subsoil of same. Depth 4-36 inches.

25. Flatwoods soil ("Portsmouth fine sand"†) in n. m. corner of Marion Co., 2½ miles e. of Wacahoota. Depth 0-10 inches. (Gainesville area.)

26. Subsoil of same. Depth 10-36 inches.

*This would doubtless be classified differently by the Bureau of Soils now. See 6th Annual Report, p. 255, footnote.

†Inadvertently placed in a table headed "Gainesville sand." See 6th Annual Report, p. 256, footnote.

Lake Region

27. "Etonia scrub" near Altoona (3 samples) and Orange City Junction. Depths 3, 4, 4, and 6 inches. (Bull. 13.)

28. Subsoils of same 4 samples. Depths 3-30, 6-18, 4-36, and 6-36 inches.

29. High pine land near Grand Island, Altoona (4 samples), Winter Haven (2 samples) and Eustis. Depths varying from 4 to 8 inches.

30. Subsoils of same 8 samples. Depths varying from 18 to 36 inches.

31. "Light hammock" near Winter Haven, Polk Co. Two samples, 0-8 and 0-9 inches.

32. Subsoil of same, to 36 inches.

33. "Rich heavy hammock" near Orange Bend, Lake Co. Depth 0-8 inches.

34. Clayey low hammock or short-leaf pine and cabbage palmetto bottoms ("Fellowship clay") 2 miles n. e. of Silver Spring. Depth 0-4 inches. (Ocala area.)

35. Subsoil of same. Depth 4-36 inches.

Flatwoods, Western Division. (All from Bull. 13.)

36. High pine land near Bartow (average of 2 samples). Depth 0-9 inches.

TABLE 12.

Mechanical Analyses of Soils and Subsoils in Lake Region.
(From Bulletin 13 and Soil Survey of "Ocala Area.")

	Scrub		High pine land		Light ham'k		Rich heavy hammock	Clayey low hammock	
	27 Soil	28 Sub-soil	29 Soil	30 Sub-soil	31 Soil	32 Sub-soil	33 Soil	34 Soil	35 Sub-soil
Fine gravel	0.23	0.34	2.05	2.14	Trace	Trace	0.45	0.3	0.5
Coarse sand	3.34	3.49	7.65	7.66	4.92	5.10	4.92	7.5	3.3
Medium sand	27.43	29.64	28.18	27.32	39.17	40.15	35.77	13.4	7.3
Fine sand	58.60	57.47	44.19	44.97	44.53	43.48	42.85	34.8	15.9
Very fine sand	7.60	5.85	13.73	14.37	6.17	5.82	6.49	15.9	7.4
Silt	0.55	0.74	0.98	0.96	0.79	0.90	2.33	16.4	11.3
Fine silt	0.20	0.22	0.39	0.37	0.34	0.26	0.54		
Clay	0.87	1.56	1.07	1.24	1.89	2.44	4.58	11.8	54.3
Organic matter	1.24	1.24	1.43	0.59	1.49	0.75	1.77	?	?
Moisture, air-dry	0.22	0.28	0.30	0.18	0.57	0.25	0.44	?	?
Total	100.28	100.73	99.97	99.80	99.87	99.15	100.14	100.1	100.0

TABLE 13.

Mechanical Analyses of Soils and Subsoils in Southwestern Flatwoods.
(From U. S. Soil Bulletin 13.)

	High pine land						Near Fort Meade			
	Near Bartow		1st quality		3d quality		Mulatto hammock		Heavy gray hammock	
	36 Soil	37 Sub-soil	38 Soil	39 Sub-soil	40 Soil	41 Sub-soil	42 soil	43 Sub-soil	44 Soil	45 Sub-soil
Gravel	0.26	0.17	0.52	0.52	0.10	0.11	0.78	0.70	0.33	0.38
Coarse sand	2.26	1.72	2.94	3.14	0.65	0.71	2.85	2.50	2.16	2.85
Medium sand	20.29	18.74	16.00	17.23	4.58	6.19	14.35	14.30	10.34	13.72
Fine sand	46.01	48.82	47.95	49.29	47.88	64.37	53.51	53.00	45.37	47.79
Very fine sand	23.80	24.32	24.73	23.14	40.90	24.59	23.50	24.46	33.95	27.78
Silt	1.10	0.71	0.86	0.62	0.58	0.73	0.65	0.62	0.98	0.89
Fine silt	0.40	0.23	0.38	0.30	0.23	0.40	0.44	0.34	0.50	0.20
Clay	2.94	3.87	2.62	2.62	1.68	2.15	2.07	1.58	2.76	2.30
Organic matter	2.90	1.16	3.02	2.22	1.60	0.82	1.53	1.43	2.51	2.61
Moisture, air-dry	0.68	0.45	1.54	0.48	0.47	0.30	0.62	0.47	1.16	1.05
Total	100.64	100.19	100.56	99.56	98.67	100.37	100.30	99.40	100.06	99.87

37. Subsoil of same. Depth 9-30 inches.

38. "First quality high pine land" ½ mile s. of Fort Meade. Depth 0-20 inches.

39. Subsoil of same. Depth 20-30 inches.

40. "Third quality high pine land" near Fort Meade. Depth 0-18 inches.

41. Subsoil of same. Depth 18-36 inches.

42. "Mulatto hammock" near Fort Meade. Depth 0-12 inches.

TABLE 14.

Mechanical Analyses of Soils and Subsoils in East Coast Strip near Rockledge.
(From U. S. Soil Bulletin 13.)

	Spruce pine scrub		Heavy gray hammock		Red coquina hammock	
	46 Soil	47 Sub-soil	48 Soil	49 Sub-soil	50 Soil	51 Sub-soil
Gravel	0.65	0.66	0.17	0.15	0.67	0.64
Coarse sand	12.36	9.07	4.15	4.74	10.65	10.96
Medium sand	41.42	32.58	32.16	32.25	32.67	32.26
Fine sand	41.18	52.13	60.00	59.27	38.86	44.02
Very fine sand	2.40	3.26	1.52	1.31	7.72	6.62
Silt	0.16	0.23	0.21	0.08	0.81	0.80
Fine silt	0.06	0.18	0.46	0.10	0.29	0.36
Clay	0.35	0.51	0.94	0.13	1.33	2.26
Organic matter	1.06	0.45	0.83	0.60	5.25	1.35
Moisture	0.15	0.25	0.20	0.22	1.24	0.53
Total	99.79	99.32	100.64	98.85	99.49	99.78

43. Subsoil of same. Depth not given.

44. "Heavy gray hammock" near Fort Meade (average of 2 samples). Depth 0-20 inches.

45. Subsoil of same. Depth 20-36 inches.

East Coast Strip. (All from Bull. 13.)

46. Spruce pine scrub near Rockledge, Brevard Co. Average of 2 samples. Depth 0-6 inches.

47. Subsoil of one of these. Depth 6-36 inches.

48. Heavy gray hammock near Rockledge. Average of 2 samples. Depth 0-18 inches.

49. Subsoil of same. Depth 18-36 inches.

50. Red coquina hammock near Rockledge. Average of 2 samples. Depths 0-4 and 0-6 inches.

51. Subsoils of same. Depths 4-18 and 6-36 inches.

Comments on the Mechanical Analyses

The significance of the relative proportion of the different sizes of sand grains does not seem to have been determined, except in a very general way; but other things being equal, the soils having the largest proportion of silt and clay generally have the most available plant food and support the most luxuriant (or fastest growing) vegetation, with the largest proportion of deciduous trees. The clayey low hammocks of the Gulf hammock region (analyses 1 to 3) and lake region (34, 35) lead in this respect, the former having over 50% of silt and clay, and the latter over 25% in the soil and 65% in the subsoil, probably chiefly in the form of marl. Some of the calcareous high hammocks of Marion County also stand high in this respect. The white sand or scrub of the lake region and east coast has the least clay, only about 1%, and is the poorest soil in the list, its vegetation being nearly all evergreen. The moisture capacity and organic matter (given in Bulletin 13, but not in the soil surveys) are seen to be highest in the best soils, at least as far as the determinations go.

CHEMICAL ANALYSES

No entirely satisfactory chemical analyses of the soils of our area are available, but some of varying degrees of accuracy and

completeness have been obtained from various sources. The best seem to be three in the 6th volume of the Tenth U. S. Census (pp. 201, 204, 205, 214), which leave little to be desired except the nitrogen percentages and perhaps more exact information about the topography and vegetation. The samples were collected by Dr. Eugene A. Smith in the summer of 1880, and analyzed under his direction at the University of Alabama, by John B. Durrett, by the acid digestion method (described by Hilgard in Tenth Census 5:72, Soils 340-343, and elsewhere). The localities are as follows:

A. First class pine land, 9 miles north of Ocala, with longleaf pine, red oak, hickory and wire-grass. Depth 10 inches.

B. Dark gray high hammock soil one mile south of Ocala, with live, white* and water† oaks, hickory, bay,‡ sweet and sour gum, and magnolia. Depth 10 inches.

C. Light gray hammock near Leesburg, with hickory, live and water oaks, red bay, and "evergreen." Depth 8 inches.

The analyses of these three are given in Table 15, to which sample Q (described farther on) is added for comparison with C. The first is evidently an intermediate condition between the high pine land and the red oak woods described elsewhere. The second

TABLE 15.

Chemical Analyses of Four Central Florida Soils.

	Marion Co.		Sandy ham'ks	
	Pine land	Hammock	Lake Co.	Marion Co.
	A	B	C	Q
Water and organic matter	1.884	3.583	1.675	1.29
Potash (K_2O)	.189	.112	.052	.021
Soda (Na_2O)	.038	.035	.015	?
Lime (CaO)	.072	.185	.077	.06
Magnesia (MgO)	.039	.038	.019	?
"Phosphoric acid" (P_2O_5)	.110	.110	.079	.074
"Sulphuric acid" (SO_3)	.091	.054	.053	?
Brown oxide of manganese (Mn_3O_4)	.055	.027	.032	?
Peroxide of iron (Fe_2O_3)	.321	2.048	.214	.415
Alumina (Al_2O_3)	.915	2.494	.628	
Soluble silica	1.665	1.380	.214	?
Insoluble matter	94.460	90.585	97.350	96.20
Total	99.839	100.646	100.408	------

*Doubtless *Quercus Michauxii.*

†Probably *Quercus laurifolia.*

‡Doubtless *Persea Borbonia.*

is fairly typical of what is here called semi-calcareous hammock land, and the third and fourth of sandy hammocks.

Bulletin 43 of the Florida Agricultural Experiment Station, by A. A. Persons (1897), contains many analyses of central Florida soils, made by J. P. Davies, by essentially the method recommended by the Association of Official Agricultural Chemists in 1895. These have been made the basis of several published statements about the average composition of Florida soils,* and at first glance they appear to be valuable sources of information; but closer scrutiny shakes one's faith in them. The samples were collected by several different persons, apparently mostly without previous experience or expert supervision, and some of them are not described sufficiently to make it clear just what type of soil they represent. Although the analyses cover almost every constituent that is commonly considered in such work, except manganese, and are carried out to four decimal places, they contain so many inconsistencies as to suggest either careless work or typographical erors, or both. (Prof. Persons a few years before his death informed the writer that he was unavoidably absent from the State for several weeks while this bulletin was going through the press, which may account for some of the errors.) In many cases the analyses show more humus or less potash, iron or alumina in the subsoil than in the soil, which is strange if true, and much less potash and lime than is given in analyses of somewhat similar soils in other publications. As there is no analysis from central Florida in the bulletin that is free from one or more of these defects, it has been thought best not to use any of them.

In Whitney's Bulletin 13, previously mentioned, the averages of partial analyses of four to ten samples of several types of soil are given. The method of analysis is not stated (and could not be recalled by Prof. Whitney 17 years later), but the results seem consistent with those obtained by the A. O. A. C. method (which reveals considerably less potash than Hilgard's acid digestion method). The same bulletin also gives for several types of soil the total amounts of soluble salts in the soil solution, a factor of considerable significance. The results are set forth in Tables 16 and 17. In the former, D represents "Etonia scrub" and E high

*Some of them have been quoted in our 4th Annual Report, pp. 65-71.

pine land, both from the lake region, and F "light hammock" and G "gray hammock," from various regions.

TABLE 16.

Partial Chemical Analyses of Four Types of Soil.
(From U. S. Soil Bulletin 13.)

	Scrub D	High pine land E	Light hammock F	Gray hammock G
Nitrogen	.028	.028	.042	.042
Potash (K_2O)	.003	.007	.015	.009
Lime (CaO)	.030	.060	.090	.090
Magnesia (MgO)	.013	.020	.040	.036
"Phosphoric acid" (P_2O_5)	.008	.140	.090	.320

TABLE 17.

Percentage of Soluble Salts in Several Types of Central Florida Soils and Subsoils. (From U. S. Soil Bulletin 13.)

	Soil	Subsoil
LAKE REGION		
H. Scrub near Altoona	.00095	.00094
I. High pine land near Grand Island	.00209	.00104
J. High pine land near Winter Haven	.00156	.00080
SOUTHWESTERN FLATWOODS		
K. First quality high pine land near Fort Meade	.00114	?
L. Third quality high pine land near Fort Meade	.00108	.00127
M. "Heavy hammock" near Fort Meade	.00116	.00136
EAST COAST STRIP		
N. Gray hammock near Rockledge	.00210	00100

Several samples of central Florida soils collected by the writer in 1915 were analyzed in the same year by L. Heimburger, assistant State chemist, in the same manner as those made for the 6th Annual Report, viz., the A. O. A. C. method for organic fertilizers.* These samples, which are all rather exceptional, and not typical of very large areas, are listed below, in regional order as before. The numbers in parentheses are those under which the analyses have been published in the report of the State Chemist for 1915.

West Coast Islands

O. (2136). Dry sand with considerable shell material, from palm savanna on Long Key about 4 miles north of Pass-a-Grille. Depth 12 inches.

*For further particulars see 6th Ann. Rep., p. 397.

P. (2137). Soil with larger shell fragments, near inner side of Long Key, about 2 miles north of Pass-a-Grille. Depth 6 inches.

Middle Florida Hammock Belt

Q. (2104). Cream-colored sand with humus, or sandy hammock (mapped as "Leon sand") about 6 miles south of Ocala, with vegetation nearly all evergreen (fig. 39). Depth 8 inches.

R. (2105). Red oak woods, with no evergreens, about 1½ miles e. s. e. of Ocala (fig. 41). Depth 9 inches.

S. (2106). Semicalcareous hammock with many evergreens, about a mile southeast of Ocala (fig. 13). Depth 8 inches.

T (2139). Calcareous high hammock with few evergreens, about 2½ miles south of Ocala. Depth 6 inches. This soil appeared to consist mostly of limestone fragments and black humus.

U. (2107). Hammock with trees mostly hackberry, on hillside about ½ mile south of McIntosh, Marion County. Depth 6 inches. Soil black and waxy, with many small rock fragments, though no outcrops of limestone were observed in the vicinity.

Hernando Hammock Belt

V (2134). Long-leaf pine woods with little underbrush, on hillside about ½ mile north of Brooksville. Depth 6 inches. Soil blackish, and quite different from that of typical high pine land.

W. (2135). Level forest in rather low ground about a mile north of Brooksville, with sweet gum, ironwood, etc. Depth 6 inches. This appears loamy and rather retentive of moisture, but when dry looks much like ordinary cream-colored sand.

Flatwoods, Western Division

X (2138). Rich hammock with dogwood, lin, etc., on hillside about 2 miles north of Fort Meade. Depth 9 inches. A chocolate loam, with many rock fragments presumably derived from underlying pebble phosphate beds.

Flatwoods, Eastern Division

Y (2109). Comparatively dry prairie with scattered saw-palmetto and various herbs, about 7½ miles west of Melbourne,

Brevard Co. Depth 8 inches. Soil mostly sand, but underlaid at no great depth by shell marl.

East Coast Strip

Z (2108). Crest of outermost dune, about 10 feet high, about a mile south of Melbourne Beach, Brevard Co. (fig. 33). Depth 6 inches. A fine sand with finely divided shell fragments.

The analyses of these last twelve samples are given in Table 18. The moisture is that retained by the soil after drying in the open air for several weeks in the dry season, and the volatile matter includes both organic substances (the nitrogen in which is determined separately) and carbon dioxide liberated from limestone, which amounts to considerable in some of the samples. (Any one sufficiently interested can determine approximately from the lime percentages just how much of the volatile matter is carbon dioxide.) The iron and alumina are combined, on account of the difficulty of separating them, and soda, sulphur, magnesia, manganese, etc., are omitted entirely, because they were not regarded as of sufficient importance to justify the labor of determining them.

Comments on the Chemical Analyses

In the first three analyses, made by the acid digestion method, A, from mixed red oak and pine woods, has more potash than any other central Florida soil on record (and the comparison might be extended to the whole State, as long as we have no analyses of the alluvial soils along the Apalachicola River). This soil supports a large proportion of deciduous trees, while on that represented by C, which has less than a third as much potash, the vegetation is nearly all evergreen. Sample Q is probably very similar to C, but the analysis shows considerably less potash on account of the different method used. The highest potash percentages in the analyses made by Mr. Heimburger are in the calcareous hammock soils from near Ocala and McIntosh, where deciduous trees greatly predominate.

Sample R, taken from red oak woods with no evergreens, would almost certainly show more potash than A does if analyzed by the acid digestion method, but the A. O. A. C. method does not do justice to the potash. In fact its indications with respect to this con-

TABLE 18.

Partial Chemical Analyses of 12 Samples of Soil from Central Florida, 1915.

	West coast islands		Middle Fla. Hammock Belt					Hernando hammock belt		Rich ham'k Polk Co.	Brevard Co. Prairie	Brevard Co. Dune
			Sandy ham'k	Red oak woods	High ham'k	Calcareous hammocks						
	O	P	Q	R	S	T	U	V	W	X	Y	Z
Moisture (H_2O)	.05	.10	.09	1.05	.16	3.90	3.99	.76	.26	.98	.06	.05
Volatile matter	1.495	10.20	1.20	4.09	1.62	21.63	7.58	5.25	1.96	5.78	1.36	5.31
Nitrogen	.210	.147	.180	.214	.177	.591	.412	.272	.198	.210	.206	.157
Potash (K_2O)	.049	.033	.021	.051	.029	.119	.082	.054	.047	.046	.009	.014
Lime (CaO)	1.26	.99(?)	.06	3.13	.11	7.32	1.84	.08	.14	.12	Trace	1.25(?)
Phosphoric acid	.508	.820	.074	5.35	.328	2.14	3.54	.468	.080	1.13	.032	.130
Iron and alumina	.895	1.66	.415	5.68	.81	8.52	4.77	1.82	.20	3.93	.375	.870
Insoluble matter	96.00	76.22	96.20	81.05	97.39	59.88	75.66	92.73	97.56	89.67	98.19	87.36
Total	100.36	90.02(?)	98.06	100.40	100.45	103.51	97.46	101.16	100.25	101.66	100.03	94.98(?)

stituent appear somewhat contradictory, for some of the samples in the last table show more of it than one could reasonably expect. Taking everything into consideration, however, it is safe to say that central Florida soils generally contain less potash than those of northern Florida or any equal area a few hundred miles farther inland. The reason for this is probably two-fold: first, the remoteness of this area from igneous rocks which are the main original source of potash, and second, the leaching effect of the copious late summer rains. But this lack is partly compensated by the temperature, for the plant food in any soil is liberated more rapidly in a warm climate than in a cold one.

The scrub and dune soils are low in potash, as in almost everything else.

The lime, like the potash, is as a rule most abundant in the richest soils, and vice versa, but there are some important exceptions. For example, the beach and dune sands are well supplied with calcium carbonate in the form of shell fragments, but are practically worthless for agricultural purposes, perhaps chiefly on account of the scarcity of very fine particles for plant roots to draw nourishment from (no mechanical analyses seem to be available, unfortunately), or of soil animals and bacteria. And the vegetation of the calcareous hammocks near Ocala (sample T), with over 7% of lime in the soil, does not seem as luxuriant as that near McIntosh (sample U), where there is less than 2%. However, probably the latter figure is more than sufficient, and any excess over that therefore superfluous. The least lime is in the St. John's River prairie (Y), which seems rather strange, for ditches near where the sample was taken show shell marl within two or three feet of the surface.

Although lime (or more strictly speaking any calcium compound) is not an important plant food, it is thought to improve the condition of the soil in various ways, and as it dissolves readily it liberates less soluble plant foods that may be combined or mixed with it.

The phosphorus is almost incredibly high in samples R, T, U and X, soils with more than half of one per cent of P_2O_5 being very exceptional.* The high percentage in X, which was taken

*See Hilgard, Tenth Census 5:78; 1884; Soils 355. 1906.

right in the phosphate country, is not surprising, but the still higher figures for R, T, and U are not so easy to explain. Very likely in each of these cases, however, the phosphorus is mostly combined with iron, as ferric phosphate, which is almost insoluble.*

There is nothing in the analyses of the two soils from Long Key (samples O and P) to indicate extreme sterility, and yet no attempt seems to be made to cultivate them, and the woody plants there are all evergreen.

Sample Q, from a sandy hammock, is deficient in nearly everything, and its vegetation is nearly all evergreen. In everything except potash its analysis resembles that for C about as closely as two samples from different counties and regions collected by different people about 35 years apart could be expected to; and the difference in potash illustrates the difference between the Hilgard and A. O. A. C. methods in that respect.

Sample R represents one of the richest upland soils in Florida. S is not very different from Q, but the differences are all in the direction that the vegetation indicates. T and U are rich calcareous soils, well supplied with potash and phosphorus also.

The analyses make V a better soil than W in almost every respect, though the vegetation indicates decidedly otherwise; a paradox for which no adequate explanation can be given at present.

X is a rich soil, and Y and Z are poor.

CLIMATE

The climate of central Florida differs from that of northern Florida, and still more from other parts of the eastern United States, in being warmer in winter and wetter in summer, especially late summer. The following table of climatic data for a number of stations in the area is compiled mostly from Bulletin W (Sections 83 and 84) of the U. S. Weather Bureau, and the annual climatological summary of the Florida section of the same Bureau for 1913. The data given are the average temperature for January, July and the whole year, in degrees Fahrenheit, the average length of the growing season (period between killing frosts), in days, the average annual rainfall, in inches, the percentage of the total rainfall that comes in the four warmest months (June to September) and

*See Hilgard, Soils, p. 356.

the six warmest months (May to October), and the excess of late summer (August to October) rainfall over that for early summer (April to June), in inches.*

TABLE 19.

Selected Climatological Data for Weather Stations in Central Florida, Grouped by Regions.

	Temperature			Growing Season (days)	Rainfall			
	Jan.	July	Year		An-nual	Per cent in 4 mos.	Per cent in 6 mos.	Excess in late sum'er
West Coast								
Cedar Keys	57.6	82.2	70.3	------	51.53	57.2	66.1	6.9
Tarpon Springs	58.7	80.8	70.9	------	50.27	63.1	70.8	7.8
Lime-Sink Region								
Rockwell	57.1	81.8	70.7	------	52.55	59.2	70.1	5.4
Inverness	55.8	80.4	69.5	------	51.74	59.3	69.7	3.1
Tampa	57.4	80.0	70.4	335	51.49	62.7	72.7	6.4
Mid. Fla. Hammock Belt								
Ocala	57.4	81.4	70.2	294	51.64	59.6	71.3	4.3
Hernando Hammock Belt								
Brooksville	58.0	80.8	70.8	311	55.97	62.1	72.5	4.9
St. Leo	58.3	81.5	71.5	------	58.22	60.9	71.5	3.7
Lake Region								
Orange City	58.2	82.3	71.1	------	47.33	55.9	71.4	6.4
Eustis	58.4	82.2	71.4	------	47.40	56.3	68.8	6.2
Clermont	59.9	82.8	72.6	------	48.71	58.7	71.3	5.7
Western Flatwoods								
Tampa	57.4	80.0	70.4	335	51.49	62.7	72.7	6.4
Plant City	60.0	81.0	71.4	------	55.40	61.5	74.8	6.8
Bartow	60.1	81.9	72.4	315	51.84	60.6	74.1	5.8
Fort Meade	59.2	80.6	71.2	------	58.51	62.6	76.3	6.0
Eastern Flatwoods								
Kissimmee	60.3	82.0	72.0	------	52.47	55.6	70.5	6.3
East Coast								
New Smyrna	57.9	79.8	69.7	311	50.95	49.3	68.0	9.1
Titusville	59.7	80.8	70.9	------	51.22	54.3	73.5	4.5
Merritt's Island	62.0	81.4	72.7	------	50.54	50.4	69.4	5.7

Throughout the area under consideration the average temperature for any or all months varies only a few degrees from one place to another, probably not as much as it does for the same place in different years. The growing season varies more, though, from

*For a discussion of the significance of this seasonal precipitation factor see Science II. 48:208-211. Aug. 30, 1918. Its relation to the distribution of oil wells in the United States has been pointed out in the chapter on economic geology (page 160).

294 days at Ocala (and doubtless still less a little farther north) to practically 365 on Merritt's Island and south of there, where often a whole year passes without frost. (The imaginary "frost line" lies considerably farther south, however, for there is probably no place in Florida, with the possible exception of the Keys, that has not had frost at some time within the memory of persons now living.)

Although it is not feasible to present figures on that point, the temperature of course varies from year to year, and some of these variations have made the difference between success and failure for those who are always trying to raise tender crops as far north as possible. The severe freezes of 1895 and 1899 almost wiped out the orange industry in Florida (which was then largely concentrated in the latitude of Ocala and farther north), but since then many of the larger groves have been established farther south, and more attention has been paid to locating them on high points or near lakes for protection from frost, and installing heating devices to use at critical periods, and there has been comparatively little trouble from that source in the last twenty years. The lake region has an advantage over most of the others in its abundance of hills and lakes.

Snow is of course practically unknown. The extreme variations in rainfall from place to place are not great, but the lake region seems to be a little the driest, perhaps because farthest from the coast. Although there may be considerable variation from year to year, it is hardly enough to cause any serious inconvenience, for there is nearly always enough rain to prevent drought, and at the same time the topography and soil make floods almost impossible. On the sandy uplands the heaviest rain sinks into the ground almost immediately, to appear gradually later in swamps and springs.

Over half the rain falls in the four warmest months, and over two thirds in the six warmest months, thus counterbalancing evaporation to a large extent and keeping the level of lakes and streams more constant than in most other parts of the United States. A slight correlation can be noticed between the late summer precipitation excess and soil fertility, the excess being less in the hammock belts than in the lake region and flatwoods; as if the soil itself

influenced the precipitation through the vegetation or in some other way:*

The summer rain falls mostly in the daytime, in the form of short, heavy showers.

Hurricanes visit this section occasionally, usually in late summer, the season of maximum precipitation. But they rarely do much damage except near the coast, and even there they appear to be less frequent and destructive than they are a little farther north and south, though accurate statistics are not available. Tornadoes, popularly known as "cyclones," are almost unknown here, those being chiefly confined to those parts of the United States that have considerably more rain in early summer than in late summer.

VEGETATION

The vegetation of central Florida is even more diversified than the soil, and far more than in most areas of the same size in the eastern United States. About thirty natural types are here recognized, and that number could possibly be doubled without undue duplication if one cared to go into such minute details. Just what constitutes a vegetation type is a disputed point. Some botanists have described a multitude of "plant associations," some of them consisting chiefly of a single species and occurring in strips or patches only a few feet wide; but in this work nothing less than several acres in extent is considered.

Even if there was no uncertainty about the size of the unit it would still be difficult to devise a satisfactory classification, for different types are related to each other in all sorts of ways, and two apparently quite different ones may be merely different stages of the same thing. In this work they will be taken up as nearly as possible in order of complexity, beginning with places that have no vegetation at all, and vegetation composed wholly of herbs, and proceeding through shrubby types to dense forests made up of trees, shrubs, herbs, mosses, epiphytes, parasites, etc.

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*Some of the discrepancies in this respect observable in other parts of the table may be due to records too short to be accurate enough, or even to typographical or other errors. It seems a little strange, for example, that New Smyrna should have the lowest summer percentages and the highest late summer excess at the same time.

There are interesting analogies between all these types and different stages of human society. In deserts and polar regions there is no permanent population; where conditions are a little less forbidding there are tribes with simple civilization and little education, where nearly all men have the same occupation, like the Bedouins and Eskimos; and at the other end of the series are highly civilized communities, with a very complex division of labor, and individuals varying in ability and usefulness from criminals (analogous to the parasites of the vegetable world) and loafers to geniuses and "intellectual giants," analogous to the largest trees.*

No classification of vegetation can be final or complete, for there are all sorts of intergradations between different types, and some types which may be perfectly distinct or at least not intermediate between any other two may escape observation on account of occurring only in small patches or in out-of-the-way places. But those here described probably cover at least 90% of the uncultivated land area treated, and the omission of any others will hardly be noticed by persons not intimately acquainted with the area.

Cultivated crops are not regarded as vegetation, for they do not follow natural laws but grow where they are put. There is more or less characteristic weedy vegetation in old fields, vacant lots, along roadsides, etc., but that can be studied just as well after the natural vegetation is all gone, and it is ignored for the present (except that a few of the more abundant weeds have been included in the regional plant lists). Of course it would be a matter of some interest to make a careful study of the weeds now, and again every few decades to see what changes are taking place, but limitations of time and money (if not enthusiasm) have prevented.

A good description of each vegetation type would include a list of all but the rarest species, arranged according to size and abundance (as was done for those in the "Ocala area" in the 7th Annual Report), together with notes on the prevailing times of blooming, colors of flowers, modes of dissemination, rate of growth, economic properties, etc., but to do that would increase the bulk of this report beyond reasonable limits, and consequently the descriptions have been made as brief as possible. Some of them are supplemented by

*For a rough classification of human occupations in ten grades see Scientific Monthly (former Popular Science Monthly) 10:295-296. March, 1920.

illustrations, which tell many things that cannot be put in words.

The principal vegetation types seem to be as follows:

PLACES WITH NO VEGETATION

These include bodies of water too deep for seeds to germinate in, caves too dark, small rock outcrops in pine woods swept by fire, beaches continually washed by waves, and roads, fields, and other artificial situations.

HERBS PREDOMINATING

Aquatic vegetation (fig. 35). In the deeper parts of lakes and in sluggish rivers and runs there are quite a number of herbs, either floating free like the water-hyacinth (which however is not native) and water lettuce, or with floating leaves like the water-lilies and bonnets, or all submerged except the flowers (species of *Sagittaria, Vallisneria, Potamogeton,* etc.) or with both leaves and flowers raised above the water (*Sagittaria lancifolia, Scirpus, Pontederia,* etc.). Such vegetation is found in fresh water that does not vary too much in level, in all countries that are not too cold or too dry, and consists mostly of monocotyledons and rather simple dicotyledons. It has much the same aspect in all continents, and the gen-

Fig. 35. Marshy margin of Lake Apopka near West Apopka, Lake County, showing water-lilies, wampee (*Pontederia*), etc. May 20, 1909.

era and even some of the species composing it are very widely distributed.

Marginal and shore vegetation (fig. 20). In shallow margins of lakes and along rivers where they are not subject to much fluctuation, as near their mouths, we commonly find a type of vegetation intermediate between the preceding and the saw-grass marshes (described a little farther on), and grading into both. It consists mostly of a few coarse monocotyledons with hollow or spongy stems or petioles, like maiden cane (*Panicum hemitomon*), saw-grass, wampee (*Pontederia*), and *Sagittaria lancifolia*. Then above the usual water level on sandy and peaty shores of lakes we find a greater variety of herbs, mostly monocotyledons, often with a few scattered shrubs among them. A list of characteristic plants of such places was given in the 3rd Annual Report, page 267.

Grassy dunes. On dunes where the sand is constantly moving, apparently not so much on the east coast as on the west coast, there is a sparse vegetation of coarse grasses and other herbs, chiefly sea-oats (*Uniola paniculata*) and other plants belonging to families well represented in tropical America. These renew their foliage every year, necessitating comparatively rapid growth and presumably indicating moderately fertile soil, though the bulk of vegetation per square yard or acre is not large on account of its very open structure. A little farther back from the shore, where the sand is not moving perceptibly, and much of the plant food has been leached down beyond the reach of roots, the vegetation is of a much slower-growing type, described below under the head of shrubs.

Salt marshes (fig. 3). These are characteristic of shallow bodies of salt water protected from wave action, where the vegetation builds up a foundation of muck just about to high tide level. The characteristic plants are coarse grasses and rushes, with a few scattered bushes. In warmer climates the woody plants become larger and more numerous, until the marshes are replaced by mangrove swamps (described farther on).

Saw-grass marshes (fig. 36). When a lake or a large embayment of one becomes filled with peat, especially if the water is a little calcareous, the vegetation is often composed almost wholly of saw-grass (*Cladium effusum* or *Mariscus Jamaicensis*), an evergreen sedge several feet tall. The same species also forms a fringe

Fig. 36. Large saw-grass marsh bordering Lake Harris, looking north from about a mile east of Eldorado, Lake County. Pine land in distance is over a mile away. Feb. 9, 1909.

along rivers that fluctuate little, which in favorable situations may expand into marshes of considerable width. Some of the plants commonly associated with the saw-grass have been listed on the lower half of page 270 in the Third Annual Report. Such marshes are common in the lake region, and often cover several hundred acres; and they may be important sources of peat when that substance becomes more popular than it is now. Plans are just now being perfected for manufacturing paper from saw-grass in Lake County, where there are some of the largest saw-grass marshes to be found outside of the Everglades. For such an industry to be permanent requires that the "grass" shall grow as fast as is cut, which can be determined by multiplying the annual growth per acre by the acreage available. With marsh vegetation that dies down to the ground every year, like cat-tails, it is a very simple matter to cut, dry and weigh a square yard or so of it at the end of the growing season, and convert the results to pounds or tons per acre.*

*For a study of several types of marsh vegetation on Long Island made in this way see Plant World 21:38-46. (April) 1918. The most luxuriant vegetation found there was reed-grass, *Phragmites communis*, which yielded at the rate of about 24 tons per acre when fresh and 12 tons when air-dry. Saw-grass is said to yield from 12 to 20 tons per acre (fresh) at the first cutting.

But saw-grass being evergreen, the foliage present at any one time represents more than one year's growth, so that the proper procedure would be to first mow down a small patch of it in midwinter, and then cut and weigh a measured area from the same patch a year later.

Peat prairies. These are basins reaching a few to several feet below the ground-water level which have become filled with peat, and are covered with herbaceous vegetation other than saw-grass, presumably on account of the water being purer or at least less calcareous than in the saw-grass marshes. They are more common in the lake region than elsewhere. In the course of development from lake to peat prairie the vegetation has of course undergone considerable change, beginning with none at all and passing through the aquatic and marginal types above mentioned. That growing on the surface of the peat at present is much like that of some of the lake margin prairies described on the next page, except for the frequent occurrence of dense clumps of bay (*Magnolia glauca*) and other broad-leaved evergreens, a few rods in diameter. The most characteristic plants have been listed in the Third Annual Report (pp. 274-275), and do not need to be repeated here. The herbs are mostly grasses and other monocotyledons. The peat in such places is among the purest to be found anywhere.

Basin prairies (fig. 16). The flat-bottomed lakes which drain off at intervals through subterranean outlets, in the Hernando hammock belt and farther north, are carpeted when dry with herbaceous vegetation that has not been carefully studied, but consists largely of plants whose indigeneity is under suspicion, for they grow also in places that have obviously been altered artificially. The most characteristic seem to be dog-fennel, *Eupatorium capillifolium*, and a grass, *Anastrophus paspaloides*, as stated in the Third Annual Report, page 261. The weediness of the vegetation is doubtless largely due to the fact that such areas have long been closely grazed by cattle and sheep.

Lake margin prairies (fig. 26). Some of the larger lakes that are so shallow that a small change in water level makes a great difference in the position of the shore line have the area between high and low water covered with grassy vegetation similar in aspect to that just mentioned, and containing some of the same plants and

usually a good many additional, which make nearly as good pasture. This type is commonest in the eastern division of the flatwoods, e.g., around Lakes Harney and Tohopekaliga, but there are some very interesting examples around Lake Tsala Apopka in Citrus County. There are all gradations between this type and the shore vegetation of smaller lakes already mentioned, and of course a considerable variety of flora, depending on the soil and water. For example, in the eastern part of Polk County one of the most conspicuous plants on the prairie-like margins of the smaller lakes is a prickly pear (*Opuntia ammophila?*), while in very similar, though perhaps a trifle wetter, situations in northern Osceola County a pitcher-plant (*Sarracenia minor*) is equally common. Around Lake Harney the vegetation shows a little influence of lime or salt or both.

Shallow prairies. Small shallow depressions that dry up completely in the dry seasons usually have vegetation resembling the two types last described. (See Seventh Annual Report, page 153 and fig. 57.) Such places are commonest in the lime-sink and Gulf hammock regions, and they often have a few small outcrops of flinty limestone in them. Those in the Gulf hammock region in Sumter County seem to have more dog-fennel in them than the average. Those in the eastern division of the flatwoods, which approach the next type, are known locally as "sand soaks."

Flat prairies (fig. 28). Scattered through the central portion of Volusia County, and for several miles on either side of the upper St. John's and lower Kissimmee Rivers are large areas resembling the neighboring flatwoods in soil and topography, but devoid of trees or nearly so, for no apparent reason, unless such areas are a little more subject to inundation than the flatwoods, or a little more marly. Saw-palmetto and other shrubs are often less abundant in such places than in typical flatwoods, apparently indicating more fertile soil. Going westward from Melbourne one first passes through continuous pine forests for a few miles, and then small prairies begin to appear, gradually becoming larger, and the pines between them smaller and more scattered, until at a distance of about seven miles from the Indian River or four miles from the St. John's River the trees are all left behind, and the prairie extends beyond the horizon both north and south. The writer has not yet seen the Kissimmee River prairies, on acount of their remoteness

from railroads, but the boundary between them and the pine forests is said to be pretty sharp, and they are said to have some pretty fertile spots, and more abundant animal life (both wild and domesticated) than most of our prairies.

This type of prairie is subject to fire practically every year, like the flatwoods. Its chief economic importance is as pasturage for vast herds of cattle.

SHRUBBY VEGETATION

Saw-palmetto thickets (fig. 33). The outer dunes of the east coast in the latitude of Melbourne are covered with an almost impenetrable growth of saw-palmetto about waist-high, with perhaps 1% of other shrubs* of about the same height, principally a small oak, *Quercus myrtifolia*. The palmetto leaves in such situations, instead of being yellowish green as in the interior of the State, are covered with a thin gray waxy coating, making a strong contrast with the bright green oak leaves. (This color phase of the palmetto is common within a few miles of the coast, the green type gradually replacing it farther inland, without any apparent intergradation.) Just why trees are absent there is not certain, but the strong wind probably has something to do with it. Fire must be a rare occurrence; and neither the vegetation nor the soil on which it grows seems to be utilized for anything at present.

Some of the treeless areas described on the preceding page might be classed as palmetto thickets instead of prairies, where the growth of palmetto is dense, but the other species associated with it would of course be mostly different from those on the dunes.

Scrub thickets. This term is used to cover various thickets of shrubs no higher than a man's head, widely scattered over our area, but usually of very limited extent. Those on the peninsulas of Lake Tsala Apopka were described and figured in the Seventh Annual Report (pp. 141-142, 155). Other thickets that may come under this head are found near the mouth of the beautiful Pithlachascootee River in Pasco County. Wherever typical scrub (described farther on) occurs there may be areas in it devoid of trees,

*The palmetto is not a shrub, strictly speaking, but its stiff evergreen leaves occupy about the same position that the branches of ordinary shrubs do.

and therefore to be classed as thickets. The shrubs are nearly all evergreen, and the soil very poor and seldom cultivated.

SMALL TREES

Mangrove swamps (fig. 37). On the margins of shallow quiet bodies of salt water from Brevard and Pinellas Counties southward are swamps composed of salt-loving small trees and large shrubs mainly tropical in distribution, particularly the black, red and white mangroves (*Avicennia, Rhizophora* and *Laguncularia*) and buttonwood (*Conocarpus*). The first-named extends northward in shrubby form to Cedar Keys and New Smyrna and perhaps farther. In extreme southern Florida the first two become trees of considerable size, and the red mangrove is used for tan-bark and the buttonwood for fuel.

Fig. 37. Mangrove swamp on inner side of Long Key, Pinellas County. The larger trunks at the left belong to the black mangrove (*Avicennia*), and the innumerable erect pipe-stem-like objects are its aerating organs. The seedlings and smaller crooked trunks are red mangrove (*Rhizophora*). March 11, 1915.

Tropical hammocks (fig. 34). The plants growing on shell mounds along the Indian River in southern Brevard County are nearly all of tropical species, quite different from the species of more northerly distribution on sandy soils nearby. The forests are very dense, and the trees rather small and crooked, though they all grow larger in the hammocks south of Miami, and in the

West Indies. The trees are nearly all evergreen, and most of them have small fleshy fruits, adapted for distribution by birds. Species belonging to entirely different families often look much alike, and are difficult to distinguish even when in bloom, for the flowers are rather inconspicuous. Characteristic trees are the gumbo-limbo (*Bursera*), mastic (*Sideroxylon*), rubber or wild fig (*Ficus*), and pigeon plum (*Coccolobis laurifolia*). Shrubs and herbs make up a very small part of the total bulk of vegetation. Fire is very rare, as in other hammocks, and the ground is covered with a thin layer of humus. These hammocks are too limited in extent in central Florida, and the trees in them too small, to be of any economic importance.

TALL TREES

Palm savannas (figs. 4, 32). These are of two principal types, wet and dry. The first is found principally around the head of Indian River and Newfound Harbor on the east coast, and near the Gulf coast in Citrus and Hernando Counties, where there are thousands of acres of damp and presumably marly flats close to sea-level, on which the cabbage palmetto is almost the only tree, and there are very few shrubs. On Merritt's Island the herbaceous vegetation is mostly switch-grass (*Spartina Bakeri*), but elsewhere there is greater variety. These savannas are evidently subject to fire, but probably not so often as the pine forests.

The second type occurs among the dunes of Long Key in Pinellas County, and probably elsewhere along that coast. The soil is sand with a considerable admixture of shell fragments, and the topography is diversified with miniature hills and hollows produced by the wind. The trees are all cabbage palmetto, and there is a sparse undergrowth of a few bushes and vines and many herbs, largely of the same species found in calcareous flatwoods and in meadow-like dune hollows on Anastasia Island.* Some evidences of fire were noted on Long Key, but nothing is known of its frequency. The herbage affords a little grazing.

A transition between palm savannas and low hammocks is found near the head of the Indian River and elsewhere, especially around Homosassa, where there are dense shady forests composed almost entirely of cabbage palmetto.

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*See 6th Ann. Rep., pp. 304, 339, 398.

Open flatwoods (fig. 23). In Georgia, Alabama and Mississippi the term "flatwoods" is commonly applied to rather dense hardwood forests on damp clayey soils, but in Florida it always means level forests of long-leaf or slash pine. Most of our flatwoods have a dense undergrowth of saw-palmetto or other shrubs, but in the western edge of the lake region in Marion County, and in some places in the southwestern flatwoods region, particularly in Pasco County and near the Peace River, the shrubs are scarce or absent, presumably indicating a better or at least a finer-grained soil than usual. And all through the eastern flatwoods there are patches an acre or so in extent which have little or no palmetto, and some herbs, such as the pitcher-plant, are very characteristic of such places. This latter phase is usually a little damper than the rest, and might be regarded as an approach to the shallow prairies already described.

Palmetto flatwoods. These are of two or three kinds, depending on which species of pine predominates, but all have much the same aspect: tall pines with very few other trees, and a dense shrubby undergrowth from knee-high to waist-high, consisting mostly of saw-palmetto and other evergreens. There are also many herbs partly hidden by the shrubs. This type covers the greater part of the three flatwoods regions and the Gulf hammock region, and occurs in all the others, with the possible exception of the west coast islands and the hammock belts. The pine is usually long-leaf, but near the coast and near the larger prairies, especially if the soil is a little calcareous, it may be completely replaced by slash pine (*Pinus Caribaea*). In a few damp spots in the eastern half of the area black pine (*P. serotina*) predominates. The characteristic plants of the flatwoods of Marion and Sumter Counties were listed in the Seventh Annual Report, pp. 144-146.

Fire sweeps through the flatwoods every year or two, but does not injure the pines unless they are very small or have been turpentined, and the palmettos soon send up a new crop of leaves from their thick creeping stems. The pines are an important source of lumber and turpentine, some of the shrubs yield honey, and the herbage affords pasturage for many cattle. On account of the rather damp soil, and the difficulty of grubbing out the palmetto and other shrubs, the farmers have encroached on the flatwoods very little,

probably not more than 5% being under cultivation at the present time.

"Cutthroats". In the eastern part of Polk County, about on the line between the lake region and the flatwoods, there are several examples of a little-known habitat or type of vegetation called locally by the above name. It seems to have been first made known to scientific readers by Prof. C. V. Piper about three years ago.* About two years later some of it was pointed out to the writer, who made a hasty examination while his host's automobile waited. A cutthroat seems to be a place in the flatwoods kept perpetually moist by water seeping out from slightly higher ground near by, and is almost the only thing in central Florida comparable with the boggy slopes that are a characteristic feature of the West Florida pine hills.† The trees are mostly slash pine, and the bulk of the herbage seems to consist of "cutthroat grass" (*Panicum Combsii*, also found in West Florida). According to Prof. Piper this grass is reputed to be good forage for steers but not for calves, and it is supposed to cause "salt sickness" among cattle.

High pine land (figs. 9, 10, 19). This is one of the most extensive types of vegetation in central Florida, covering perhaps nine-tenths of the lime-sink region and three-fourths of the lake region, and considerable parts of most of the others. Typically it consists of long-leaf pine, with a lower story of black-jack, turkey, and occasionally other oaks, a sprinkling of saw-palmetto and other shrubs but no woody vines, and a moderately dense carpet of wire-grass and other herbs. Either the oaks or the shrubs may be absent from many acres, though. The oaks are commonest on the highest and driest uplands, and they seem to increase in abundance after logging operations, perhaps chiefly because the removal of the pines allows the soil to become drier; but they are almost wanting in some places where nearly all the pines have been removed, as in the hard-rock phosphate country. The characteristic plants of high pine land in the lime-sink region have been listed in the Seventh Annual Report (pp. 166-167), and that in the lake region does not differ much.

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*Jour. Am. Soc. Agronomy 10:162-164. April, 1918.

†See 6th Annual Report, pp. 232-233.

As explained in the publication just cited, fire is a normal and important factor in this type of vegetation. It comes at irregular intervals, usually in early spring, but probably sweeps over each spot about once in two years, on the average. The herbs, being perennials, would probably not be injured perceptibly by fires every winter, and the shrubs also have underground stems which soon send up new sprouts after the parts above ground are burned. The long-leaf pine is practically immune to fire after it is four or five years old, and any one spot to have a continuous growth of pine would merely need to escape burning for that length of time about once or twice in a century.

The high pine land is of great economic importance. The pines yield lumber of the finest quality, fuel, naval stores, etc., and the grass furnishes pasturage for thousands of cattle. The soil is easily tilled, and much if not most of the farming in central Florida is done on what was once high pine land. Probably one-fourth of the original vegetation has been completely eradicated in this way, and the remainder considerably damaged by lumber and turpentine and phosphate men; but it restores itself pretty well when given a chance.

Scrub (figs. 11, 38). This type of vegetation is almost confined to Florida, but marked resemblances to it in one way or another can be found in the sand-hills of Georgia, the pine-barrens of New Jersey, the jack-pine plains of Michigan, the chaparral of California, the heaths of northern Germany, the scrub of western Australia, etc.; all of which have either poor soil or deficient rainfall. No accurate estimate of its area is possible at this time, but it probably covers something like 5% of the whole area under consideration, and as much as 10% of the lake region. It is nearly always on old dunes and other white sands, but occasionally on creamy sand scarcely distinguishable from that of the high pine land. Where it adjoins high pine land the boundary is often so sharp that one can go from one type into the other in one step. It has been described in many previous publications relating to Florida,* particu-

*But strange to say, two of the most complete descriptions of Florida, namely, Col. J. L. Williams' "Territory of Florida" (1837), and Dr. E. A. Smith's report on cotton production (1884), do not seem to mention the scrub at all. (For full citations of these works see 6th Annual Report, pp. 415, 416.)

larly in our Seventh Annual Report (pp. 142-144), so that little more needs to be said about it here.

Fig. 38. Typical scrub, with bare white sand in foreground, about three miles east of Tavares, Lake County. Feb. 21, 1909.

The dominant and almost the only tree is the spruce pine (*Pinus clausa*), and there is an undergrowth of evergreen shrubs and small trees, averaging about the height of a man, and very little grass or other herbage. The density of the forest varies considerably in different places. On the old dunes of the east coast, and in a few places in the interior (see Seventh Ann. Rep., fig. 62*) the pines are so close together as to make a moderately dense shade; and the U. S. Geological Survey's Ocala topographic sheet (used as a part of the base-map for the soil survey of the "Ocala area," reprinted in our Seventh Annual Report) shows an area over a mile in diameter about three miles west-southwest of Ocala, labeled "dense scrub," through which no contour lines were run. But in the lake region it is often so open that large areas of dazzling white sand can be seen, and such places are delightful to stroll through, being so bizarre in appearance and so clean and free from briers, snakes, mosquitoes, etc.

*The same cut was used previously in the Popular Science Monthly (now called the Scientific Monthly), vol. 85, p. 358, Oct., 1914.

As in the jack-pine and spruce forests of the far north, but unlike anything else in or near Florida, fire sweeps through the scrub about once in the life-time of a pine tree and kills the pines, which however soon come up again from seed. Sometimes two crops of pine of different ages can be seen close together (fig. 31).

Scrub vegetation indicates very poor soil, which is usually left uncultivated, but it is utilized along the east coast, as noted in the chapter on soils.

Cypress ponds (fig. 24). These are a characteristic feature of the pine-barren portions of the coastal plain from North Carolina to eastern Louisiana, and they extend south in Florida to Palm Beach County and the "Big Cypress" of Lee County. There seems to be nothing similar in any other country on earth. In the area under consideration they are very abundant in the flatwoods regions (except in the pebble phosphate country), rare in the lake region, and practically unknown in the others. In northern Florida and neighboring states they usually contain more or less slash pine (*Pinus Elliottii*) or sometimes black gum, but south of Flagler County the pines rarely enter the ponds, and there is commonly a treeless strip a few yards wide around each pond, where the soil is a little too dry for cypress and too wet for the common slash pine of the peninsula (*P. Caribaea*). In size the ponds may range from one to a hundred acres or so, and the water may be as much as three feet deep in the larger ones in wet seasons and disappear entirely in dry seasons. The amount of seasonal fluctuation is indicated roughly by the height of the enlarged bases of the trees.

The pond cypress (*Taxodium ascendens,* or *imbricarium*) is usually almost the only tree. Sometimes it grows so densely as to exclude nearly all other woody plants, and sometimes the cypresses are farther apart and there is a dense undergrowth of mostly evergreen shrubs and a few vines, making an approach to the bay type of vegetation. Air-plants of three or four species are often abundant on the trunks and limbs of the cypresses, making a very striking picture. In the shallow water below are a number of herbs almost confined to such situations. A list of characteristic cypress pond plants for the whole State was published in the Third Annual Report (pages 262-263), and that would not require much modification to fit central Florida alone.

In dry weather fire originating in the surrounding pine forests occasionally sweeps through a cypress pond, but the pond cypress—unlike its better-known relative in the river and lake swamps—has such thick bark that it is not usually materially injured thereby. The only economic importance of this vegetation at present seems to lie in the value of the cypress for poles, cross-ties, shingles, etc,

Bays. The same sort of depressions that ordinarily contain cypress pond vegetation often have instead a dense growth of shrubs and small trees, mostly evergreen. This sort of growth, with or without a few scattered taller trees, in shallow stagnant or slow-flowing water, is called a bay in Georgia and Florida, probably on account of the usual presence in it of bay trees (*Magnolia glauca. Persea pubescens,* or *Gordonia Lasianthus*). Whether a given depression is to be occupied by cypress pond or bay vegetation, or no trees at all, seems to be determined chiefly by the depth and seasonal fluctuation of the water, as suggested in the Sixth Annual Report (page 203); bays being in those whose water fluctuates least.

The bays in the lower parts of Middle and West Florida were described in the Third Annual Report, pp. 264-265. In central Florida they are less common, but occur in a number of places in the flatwoods and the lake region. A variation with fewer shrubs and a great deal of slash pine was described under the head of slash pine bogs on pages 256-257 of the same publication. Some of the peat prairies have dense clumps of bay-like vegetation dotting their surfaces, as indicated on a preceding page, and on pages 274-275 of the report just cited.

Typical bays are practically exempt from fire, but slash pine bogs are burned occasionally. The bays are of very little economic importance, except that some of the plants in them yield honey.

Non-alluvial swamps. Wherever water that has percolated through the surface sands without coming in contact with any calcareous strata seeps out on the surface in sufficient quantity throughout the year there is likely to be a dense shady swamp containing bay trees, maple, black gum, bamboo vines, etc. Such swamps (described in the 3rd Annual Report, pp. 258-260) differ from the bays just described chiefly in having a greater flow of water and more trees and fewer bushes. They are widely distributed through the coastal plain from Long Island to eastern Louisiana, but not very common in peninsular Florida, where they are

mainly confined to the lake region, and are sometimes called bay-heads. About half the trees in them are evergreen, and fire is rare. They are little utilized at present, but will probably be drawn upon for some kinds of timber when the country is more thickly settled.

Calcareous swamps. Swamps whose water is somewhat calcareous on account of coming from limestone springs or standing for awhile in contact with limestone or marl differ from the sour or non-alluvial swamps just described in having more deciduous and usually larger trees, particularly cypress (*Taxodium distichum*). They have been described in the Third Annual Report, pp. 271, 279-281, and Seventh, pp. 176-178. They are most common in the Gulf hammock and lime-sink regions, and in fact are almost the only kind of swamps in those regions. They also occur in the lake region, around some of the larger lakes and along the Wekiva River and its tributaries. They grade into the low hammocks to be described next, the only fundamental difference apparently being the amount of water present. In the lake region they often pass abruptly into saw-grass marshes, on which they may be gradually encroaching. Fire seems to be a negligible factor.

The cypress is valuable for timber, but the other trees are comparatively unimportant.

Low hammocks (fig. 25). Dense shady forests with soil perpetually moist, but not quite wet enough to be called swamps, are called low hammocks. Those in central Florida all seem to be more or less calcareous, and they are especially characteristic of the Gulf hammock region, but are quite common in the lake region and east coast strip, and occur in most of the others. They have been described in the 7th Annual Report, pp. 175-176. On the upland side they often pass into semi-calcareous high hammocks (described farther on), or even into sandy hammocks. Fire is very rare, as in all other hammocks.

Some of the trees are valuable for timber, and the soil is generally quite fertile, perhaps partly on account of washings from the neighboring uplands; and where it can be easily drained it is often cultivated in vegetables. Much if not most of the truck farming in Seminole and Sumter Counties is in places formerly occupied by this type of vegetation, and one of the largest orange groves in the latter is in what seems to have been a low hammock, through probably drier than the average.

In the western edge of the lake region, northeast of Silver Spring, there is a type of vegetation nearer to low hammock than anything else herein described, but resembling also the swamps of some rivers farther north. This has been described in the 7th Annual Report (pp. 178-179) as short-leaf pine and cabbage palmetto bottoms.

Fig. 39. Sandy hammock about six miles south of Ocala, with holly, saw-palmetto and other evergreens, Feb. 14, 1915.

Sandy hammocks (fig. 39). This is an interesting type of forest, widely distributed through the sandier parts of the coastal plain from North Carolina to central Florida and Alabama. In the area under consideration it seems to be best developed in the lime-sink and lake regions. The soil appears to be essentially the same as in the high pine land, except for such changes as have resulted from a slight admixture of humus, but the vegetation is entirely different, the main reason being that the hammocks are in situations partly or wholly protected from fire by lakes, streams, swamps or naturally denser forests. This point is discussed more fully in the 7th Annual Report, pp. 170-172, where a list of characteristic species can be found.

The trees are mostly broad-leaved evergreens, so that the ground is pretty well shaded throughout the year. They seem to grow

rather slowly, and many of them have crooked trunks. Shrubs and vines are abundant and herbs scarce. The vegetation on the whole is more ornamental than useful, and the soil is little used for agricultural purposes.

Calcareous high hammocks (figs. 13, 40). Where there is enough limestone near the surface to influence the soil perceptibly the uplands commonly have vegetation similar in aspect to that just described, except for having more deciduous trees and fewer shrubs. This is a very common type in the hammock belt in Marion County, and is found also in the Gulf hammock region, around some sinks in the lime-sink region and Hernando hammock belt, and (less typically) near the Peace River in the southwestern flatwoods. The characteristic plants have been listed in the 7th Annual Report, pp. 172-175.

Fig. 40. Hammock on limestone rock at the fern grottoes on the Withlacoochee River in southeastern corner of Citrus County, showing hackberry, live oak, magnolia, box elder, grape vines, etc. March 6, 1915.

An extreme phase occurs where the limestone is nearly pure and there is little or no sand on top of it, for example around caves in Marion County and among the fern grottoes of southeastern Citrus County (fig. 40). Some hammocks on the west side of

Orange Lake with black waxy soil but no visible outcrops of limestone might also be classed here. The trees in such places are mostly deciduous, and some of them are listed under the illustration. Ferns of various kinds abound on the shaded rocks, and a few herbs of the nettle family, such as *Urtica chamaedryoides* and *Parietaria,* are quite characteristic.

The soil of the calcareous high hammocks is very good for farming, but some of it is too rocky, and the expense of clearing is quite an item, too. In fields and orange groves cleared from this type (and also from low hammocks) scattered cabbage palmetto trees are a common and picturesque sight (fig. 14). They probably come up from seeds dropped by birds, and are allowed to remain for the sake of appearances and because they cast little shade and do not take much from the soil.

The tropical hammocks described on an earlier page might also be treated as calcareous hammocks, but they have been put in a different category on account of the small size of the trees.

Sweet gum woods. This is not a very distinct type, but is noteworthy on account of its strong resemblance to some forests several

Fig. 41. Red oak woods with some sweet gum, on reddish strongly phosphatic soil about a mile and a half east-southeast of Ocala, Marion County. Feb. 13, 1915.

hundred miles farther north. The sweet gum, short-leaf pine and hickory are characteristic species. This is best seen in flat-bottomed valleys with dark loamy soil around Brooksville, and on uplands northwest of Ocala, for example around Fairfield.

Such forests indicate pretty good soil for general farming, through the scarcity of running water might be a slight drawback.

Red oak woods (fig. 41). On dry uplands with somewhat clayey soil rich in potassium, phosphorus and iron, in central Marion County, the red oak is the prevailing tree, as it is in some places much farther north. Here it is commonly associated with sweet gum, hickory, and long-leaf pine. At one extreme this grades into high pine land, and at the other into high hammocks, which have neither red oak nor pine. Fire goes into the red oak woods just about as far as the pine does. Further details can be found in the 7th Annual Report, pp. 168-169.

This type of vegetation indicates a strong soil, on which staple crops can be raised for several years without fertilizer.

CENSUS OF TIMBER TREES.

In contrast with the great diversity of vegetation, the species of trees in central Florida are rather few. About two dozen that are widely distributed in the eastern United States reach their southern limits a little north of our area, while a much larger number of tropical species do not extend quite so far north.

In the following table the large trees already mentioned in the regional descriptions are brought together in a single list, with a column for each region filled with symbols showing the relative abundance of each species there. The writer's observations are hardly complete enough yet to warrant assigning percentages to every species, but those over 20 are indicated by numbers, and those under 20 by easily remembered letters corresponding to groups of percentages, as follows:—

10-20%, A (abundant)
3-10%, C (common)
1-3%, F (frequent)
0.1-1%, O (occasional)
0.01-0.1%, R (rare)

It will be noticed that these letters are in alphabetical order, so that in the table the letters nearest the beginning of the alphabet indicate the highest percentages. Where the occurrence of a given species is probable but not proved an interrogation point is used, and where it is believed to be entirely absent the space is left blank.*

The smaller and rarer trees are omitted, as are all the shrubs and herbs, because they are hardly important enough to justify taking up much space with them, and also because their relative abundance cannot be determined so accurately.

At the top of each column is given the estimated percentage of evergreens in the forests, which is believed to be pretty closely correlated with soil fertility.

*A similar scheme was used for the trees of southern Alabama in Geol. Surv. Ala. Special Report No. 11, pp. 102-104. Aug., 1920.

TABLE 20

Census of Timber Trees of Central Florida.

REGIONS	West coast	Gulf hammock region	Middle Fla. flatwoods	Lime-sink region	Middle Fla. hammock belt	Hernando hammock belt	Lake region	S. W. flatwoods	S. E. flatwoods	East coast
Percentage of evergreens	98	75	76	38	65	80	85	88	90	96
Pinus palustris (Long-leaf pine)		37	56	77	33	60	60	75	65	C
Pinus Caribaea (Slash pine)	33	C	?	R	O	?	C	C	A	36
Pinus Elliottii (Slash pine)		C	A	R		R	F	F	O	
Pinus Taeda (Short-leaf pine)		F	?	R	C	C	O			
Pinus serotina (Black pine)		R	O				C		C	F
Pinus clausa (Spruce pine)	F	O		F		?	C	F	F	A
Taxodium distichum (Cypress)		C	R	O	R		F	F	O	R
Taxodium imbricarium (Pond cypress)		C	A	R			O	C	A	
Juniperus Virginiana (Cedar)	F	O		R	R	R	?	R		O
Sabal Palmetto (Cabbage palmetto)	55	A		O	C	O	C	F	C	33
Hicoria alba ? (Hickory)		R		O	F	?				
Hicoria glabra ? (Hickory)	O	R		O	F	F	O	R	R	F
Quercus Michauxii (White oak?)		O		R	F	F	R			
Quercus Virginiana (Live Oak)	O	C	?	O	F	F	O	O	R	O
Quercus laurifolia	?	O		F	C	F	O	O	?	
Quercus **hybrida** ?		O		R	O	?	O	O	R	R
Quercus **nigra** (Water oak)		O	?	R	F	O	R	R	R	R
Quercus falcata (Red oak)		?		O	C					
Quercus Schneckii		O		R	O					
Ulmus Floridana (Elm)		F		R	?	F	O	R	R	R
Ulmus alata (Elm)		R			O	F	R			
Celtis occidentalis? (Hackberry)		O		R	F	F	R	R	R	R
Magnolia grandiflora (Magnolia)	?	F	?	O	F	C	O	O	R	R
Magnolia glauca (Bay)	?	O	O	R	R	O	F	F	O	R
Liquidambar Styraciflua (Sweet gum)		C	?	F	C	C	O	O	R	R
Acer rubrum (Red maple)		F	O	R	R	O	F	O	O	O
Acer Floridanum (Sugar maple)		O			O	?				
Acer Negundo (Box elder)		R		R	R	0	R			
Tilia pubescens? (Lin)		O		R	F	0	R	R	R	
Gordonia Lasianthus			?	R	R	R	F	R	O	R
Persea Borbonia (Red bay)	?	R		R	F	R	R	R	R	R
Fraxinus Americana (Ash)		R	?	R	R	?	O	O	R	
Nyssa biflora (Black gum)		R		R	O	R	R	?		

UTILIZATION OF NATIVE PLANTS

In central Florida, as in most other parts of the State, the most important industries based on native plants are the production of lumber and naval stores from the long-leaf pine and its near relatives. The government census reports give no statistics of these

industries for counties, but according to the report of the State Commissioner of Agriculture for 1913-14 there were in the 15 counties of central Florida at that time 102 sawmills and 51 turpentine stills. The State census of 1915 found in 13 counties (no returns on this point having been received from Osceola and Polk) 109 sawmills, with an average capital of $25,000 and 34.2 employees each, and 77 turpentine stills, with $31,500 capital and 33.9 employees each.

From a mimeographed directory of Florida sawmills made by the United Sawmills Co. of New Orleans and Atlanta early in 1915 the following statistics of the number and average capacity (in board feet per day) of the mills of central Florida, by regions, have been derived.

TABLE 21

Number and Average Daily Capacity of Sawmills in Central Florida, 1915, by Regions.

REGIONS	No.	Capacity
1. West coast islands	0	--------
2. Gulf hammock region	7	65,700
3. Middle Florida flatwoods	0	--------
4. Lime-sink region	44	31,136
5. Middle Florida hammock belt	5	20,000
6. Hernando hammock belt	7	10,000
7. Lake region	36	30,555
8. Southwestern flatwoods	20	42,500
9. Southeastern flatwoods	10	18.500
10. East coast strip	1	10,000
Whole area	130	31,962

Of course these figures should not be taken literally, for no doubt some very small mills, which would bring down the average capacity, were overlooked; and a mill near the edge of a region might get some or most of its timber from an adjoining region. But it is interesting to note that the lake region, the largest of all, has not as many sawmills as the lime-sink region, and they are a little below the average in daily capacity. The capacity seems to be roughly proportional to the density of the pine forests. Probably at least nine-tenths of the lumber is pine, but there are a few mills that specialize in cypress or hardwoods.

Besides being sawn into lumber a good deal of the pine is worked up into veneers, used in making crates and hampers to ship

oranges and vegetables in, and into crude barrels for fish or rosin, or hewed into cross-ties without ever going through a mill. Long-leaf pine is still the principal fuel in the rural districts and smaller towns, and especially at ice factories and electric light plants. A generation ago it was used on nearly all locomotives in Florida, but that custom is now almost obsolete except on a few branch lines* and logging railroads.

Cypress of both species is used largely for shingles, poles, piles, and cross-ties. Within the last few weeks a company owning a body of cypress (presumably pond cypress) near Cow Creek in Volusia County has advertised for 100 laborers to cut ties, the supply of timber being estimated to last five years. Cedar is or has been cut for pencil wood, mostly in the Gulf hammock region. There were cedar mills at Cedar Keys and Webster forty or more years ago, and more recently there has been a large mill at Crystal River and a small one at Rosewood.

Rail fences, chiefly of pine, can still be seen in some of the older settled regions, particularly the two hammock belts, but wire fences (with posts usually of pine) are much more common at present. Another important by-product of the long-leaf pine is pine straw, used for road-surfacing material in high pine land where the sand is deep and clay and rock not easily accessible, mostly in the lake region. A few years ago a pine-straw road could be constructed for about $40 a mile, but the straw has to be renewed every few years.

The terminal buds of the cabbage palmetto have been used more or less for food, and they yield a coarse fiber which is made into brushes, brooms, etc., at Cedar Keys and perhaps elsewhere. Two carloads of them are said to have been shipped north from Titusville recently to be used for ceremonial purposes on Palm Sunday. But to destroy a whole tree just for a few ounces of food or fiber is a rather wasteful practice. Its leaves are often used to make thatch roofs on fishermen's shacks and other more or less temporary structures. The hardwoods are little used as yet, except for fuel.

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*In April, 1920, the writer traveled from Tampa to Tarpon Springs behind a wood-burning engine. In the last few years the Florida East Coast Railway has run its engines with crude oil, which is almost as accessible to Florida as coal is, and incidentally less annoying to passengers.

Turning to smaller plants than trees, some of the vines and shrubs yield berries (muscadines, blackberries, huckleberries, etc.), and some may be used for decorative purposes (mistletoe, holly, wild smilax, etc.). Honey comes mostly from native shrubs and small trees, such as saw palmetto, gallberry, and black mangrove. In 1909, according to the U. S. census, the central Florida counties produced 217,757 pounds of honey and 2913 pounds of beeswax, together valued at $17,185. The corresponding figures for 1913-14, according to the State agricultural department, were 183, 305 pounds of honey and 726 pounds of wax, with a value of $19,822. The greatest honey-producing section in our area is the east coast strip, as stated in the description of that region. The industry is one that calls for very little common labor, and it would seem to be capable of great extension.

The Spanish moss is used in a small way for mattress making, mostly around Ocala and Leesburg, and it could be used a great deal more if there was enough cheap labor to be had. (The industry is much more extensively developed in Louisiana, which has no more moss than Florida, but many more illiterate unskilled laborers.) Nothing is known as to how much moss per acre can be produced annually under the most favorable conditions, but the total quantity in our hammocks and swamps is enormous, and seemingly inexhaustible.

The proposed use of saw-grass for paper-making has been mentioned on a preceding page, and a paper mill is said to be about to begin operations at Leesburg. The deer-tongue (*Trilisa odoratissima* was formerly used largely for flavoring tobacco. An old agricultural report states that 39 bales of it were shipped from Silver Springs in the fall of 1871; and some has been shipped from Volusia County within the last twenty years.

The grasses and other herbs of the pine lands and prairies afford pasturage practically all the year round for large herds of cattle and a few horses, sheep and goats, and grazing is still one of the big industries, particularly in the southeastern flatwoods, as indicated in the description of that region, and as will be further discussed under the head of agriculture. Many hogs of the "razorback" variety get most of their living from roots and acorns and other seeds in the woods.

WILD ANIMALS, OR FAUNA

No description of central Florida would be complete without some account of the native fauna, but the subject is difficult to treat satisfactorily in a few pages, especially for one who makes no pretension to being a zoologist. Although an expert ornithologist, herpetologist, ichthyologist, entomologist or conchologist might be able after careful examination of literature and specimens, or after spending a few months in the area, to prepare a fairly complete list of the animals of his particular group occurring in central Florida, there is hardly any one person in these days of specialization who is a good authority on all groups of animals. Furthermore, even if we knew exactly what species occurred in the area as a whole, existing literature and collections would be quite inadequate to show just which ones belonged in any one of the ten regions, for most animals do not stay in one place to be counted and mapped like trees, and some of the rarer or less conspicuous ones may be seen in any one region by competent observers only at long intervals. And finally, even if it was possible to get absolutely complete lists for each region, they would mean little to the layman, and those for neighboring regions might be very much alike in the absence of data on relative abundance, such as have been given in the foregoing pages for the commoner plants.

Very few botanists or zoologists as yet seem to appreciate the importance of studying wild plants and animals quantitatively after the manner of a census, and it is of course more difficult with animals than with plants, on account of the impossibility of counting those which travel rapidly or whose safety depends on concealment. And civilization increases the difficulty, for even in such a thinly settled area as ours the more conspicuous animals, such as bears, deer, alligators, wild turkeys, egrets and paroquets, have been hunted almost to the point of extermination, for their meat, hides, or plumage, or merely for "sport."* Birds are

*Among the very few quantitative studies of our animals that have been made the second and last annual report of E. Z. Jones, Game and Fish Commissioner of Florida, published in the spring of 1915, deserves special mention. It contains a table giving the estimated number of bears, deer, wildcats, coons, opossums, otters, skunks, squirrels, quail, wild turkeys, ducks, and cranes in each county; and although some of the figures may be very inaccurate, it is certainly a step in the right direction.

among the hardest of animals to apply census methods to, on account of the extensive migrations of many species, some spending their summers in Canada and their winters in South America, so that the bird population of any small area varies greatly at different seasons.† One might, however, make a distinction between those which nest in a given area and those which are merely transients.

Under the circumstances therefore the best that can be done is to guess at the number of species of mammals and birds occurring in our area and present a few random notes on them and other animals that are abundant or especially characteristic, or useful or troublesome. They will be taken up approximately in systematic order, beginning with the highest types, and with occasional references to extinct species known to have existed here in past geological epochs.‡

There are of course quite a number of scientific and popular books and articles on the animals of our area, ranging from the narratives of 18th century explorers who tried to describe everything they saw in what was to them a wonder-land, and more modern popular works on hunting and fishing, to monographs of particular families or other groups for the whole country, and short lists of mammals, birds, insects, shells, etc., for some particular neighborhood. The writer has had access to comparatively few of these zoological works, and it would be out of the question to list even those few. One of the earliest really scientific works on our fauna is that of Dr. J. A. Allen on the mammals and winter birds of East Florida.* One that covers a greater variety of animals but only a small area geographically is Prof. W. S.

†Two preliminary bird censuses of the United States, by W. W. Cooke, have been published by the U. S. Department of Agriculture, as Bulletins 187 (11 pp., Feb. 1915), and 396 (20 pp., October, 1916) but the author died before the publication of the second one, and little seems to have been done in that line since.

‡A good example of a detailed study of the fauna of a small area, but with the quantitative viewpoint almost lacking, as usual, is "An ecological survey of Isle Royale, Lake Superior," by Chas. C. Adams and others, a volume of 484 pages and numerous plates, which accompanies the Report of the Michigan Geological Survey for 1908.

*Bull. Mus. Comp. Zool. Harvard Coll. 2:161-450, pl. 4-8. 1871. Reviewed by E. Coues in Amer. Naturalist 5:364-373. 1871.

Blatchley's "A Nature Wooing at Ormond by the Sea."† Some others will be referred to farther on in connection with particular groups of animals.

Notes on the vertebrate fossils can be found in Dr. Sellards' papers on phosphate mentioned under economic geology (p. 158), and in earlier works cited therein; and numerous references to fossil shells are given in the bibliographies in the First and Twelfth Annual Reports.

Mammals. As in most other thinly settled parts of the eastern United States, bears and deer can be found in almost any county in central Florida if one goes far enough from civilization and has good luck, and stories of the latter being killed appear in the local papers almost every day in the hunting season. Rabbits, squirrels, 'coons and 'possums are probably as common here as in other parts of the South. Noteworthy papers on our mammals have been published by S. N. Rhoads in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1894, 1895 and 1902, and by Outram Bangs in the Proceedings of the Boston Society of Natural History, vol. 28, pp. 157-235, 1898.

From an annotated list of North American land mammals by Gerrit S. Miller, Jr.,‡ it appears that at least forty species (not counting sub-species) can be found in our area, including the opossum, mole, 2 shrews, 6 bats, bear, wolf, gray fox, raccoon, weasel, mink, 2 skunks or polecats, otter, panther, wildcat, 8 native mice and rats, salamander, 3 squirrels, 2 rabbits, and deer. Several of them are classed as geographical varieties or sub-species peculiar to Florida and differing slightly from the more widely distributed forms in neighboring states. These forty are only about 2% of the total number known in North America, but about 30% of the species occurring in the eastern United States.

One of our most abundant mammals, very rarely seen but easily followed up, is the "salamander" (a rodent, *Geomys Floridanus*). It travels underground in high pine land and old fields, throwing up mounds of sand every few feet, but never leaving its burrows open, at least in the daytime. This particular species is

†245 pages, 12 plates. Indianapolis, 1902.

‡U. S. Nat. Mus. Bull. 79. xiv + 455 pp. "Dec. 31, 1912."

supposed to range only from the Suwannee and St. Mary's Rivers to DeSoto County, but other forms differing very little from it range northeastward to the Savannah River in Georgia and the Warrior and Tombigbee in Alabama; and there are many other species of *Geomys* and related genera west of the Mississippi River. Like some of its western relatives, it performs an important service in stirring up the soil, as indicated in the chapter on soils; but unlike some others, it does very little damage to crops.*

The manatee or sea-cow (*Trichechus Manatus* or *Manatus Americanus*), was doubtless formerly common on our coasts, but being practically defenseless it has been hunted for sport or for curiosity until it is nearly extinct. Whales are occasionally stranded on our shores.

Among extinct mammals may be mentioned the elephant, mastodon, bison, camel, rhinoceros, tapir, sloth, armadillo, and some relatives of the horse, all of which roamed over what is now the phosphate country in Pliocene or Pleistocene time, which was only yesterday geologically speaking.

Birds. The study of birds is more popular with amateurs than is that of mammals, and it is possible to give some rather detailed information about them, culled mostly from Frank M. Chapman's Handbook of Birds of Eastern North America.† It appears from that that the number of species (not counting subspecies) that can be seen in central Florida at one season or another is between 200 and 250, or a little more than half of all that are known in eastern

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*The distribution of the southeastern salamanders, as indicated by their "hills," was discussed in Science for January 19, 1912; but up to the present time, nine years later, the writer has never seen one of the animals. The soil-making activities of one of the Great Plains species were described by Ernest Thompson Seton in the Century Magazine for June, 1904.

†There is more than one edition, but the latest seen by the writer was copyrighted in 1912, and is a duodecimo with xxix+ 530 pages, a double-page colored "life-zone" map of North America, a double-page color chart, 24 plates (some of them colored), and 136 text-figures. Toward the end there is a bibliography arranged by states, containing several references to the area under consideration.

North America. (If only nesting birds are counted we have about one-fourth.) The exact number is and always will be indeterminate, on account of differences of opinion as to what constitutes a species, if nothing else.† Another reason is that there are quite a number of birds that feed in the ocean near by but rarely if ever nest on our coasts, or which pass over in their annual migrations between North and South America and seldom stop, and some whose usual migration routes lie considerably to the eastward or westward but are occasionally blown out of their course by storms and forced to land. Then too there must be many which barely reach our limits from the north or south, and whose ranges are not yet known with sufficient exactness to indicate whether they occur within the arbitrary limits of this work or not. But all these uncertainties should not materially affect the statistical observations which follow.

The birds of North America are divided into two great groups: water birds, comprising (according to Chapman) 9 orders and 29 families, and land birds, with 8 orders and 37 families. The former are the more ancient and primitive types, and seem to be most characteristic of regions that are geologically young, while the latter have evolved so recently that there are comparatively few fossil records of them, and they are most abundant in regions that have been dry land for ages. About 46% of the birds (species, not individuals) in central Florida are water birds, as compared with 42% in eastern North America, 38% in the whole United States and Canada, and only 10 or 12% in the whole world.* But the water birds as a rule have wider ranges or migrate more than the land birds, so that even if other things were equal they should

‡As there are more bird students than species of birds in civilized countries, the temptation is strong to keep drawing finer distinctions, making slight differences the basis of subspecies, and elevating subspecies to the rank of species from time to time. Birds of widely distributed species that do not migrate much are apt to be a little smaller and darker in Florida than farther north, and already quite a number have been separated for that reason, and doubtless more will be hereafter. Some of the mammals show the same sort of variation, as was pointed out by Dr. Allen in the paper previously cited.

*This high percentage of water birds in new lands seems analogous to the high percentage of monocotyledons among flowering plants in the same areas. See a statistical method for comparing the age of different floras, in Torreya for December, 1905. Also 3d Ann. Rep. Fla. Geol. Surv., p. 357.

be relatively more numerous in species in a state or similar area than in a whole continent.

If only nesting birds were counted the results would be somewhat different. For only about 33% of our water birds, as compared with 56% of our land birds, are known to breed in the area treated; the remainder, except for a few transient or doubtful species, being found here only in winter. So that among the nesting species the land birds outnumber the water birds about two to one.

A few birds of special interest deserve a passing mention. The largest one, the wild turkey, is still found in solitudes far from the homes of mankind, like the bear and deer.

The Florida burrowing owl (*Speotyto Floridana*, first described in 1874) differs from most other birds in living in holes in the ground. It is said to be rather frequent in the Kissimmee River prairies of Osceola, Polk, Okeechobee and DeSoto Counties, and has been found also along the Caloosahatchee River and in Manatee County. The same or a very closely related form has been found in the Bahamas, and it has a near relative in Haiti and another in the western burrowing owl which is a well-known inhabitant of "prairie dog towns" in the Great Plains. Its habits have been described in a few papers referred to in Chapman's Handbook of Birds (p. 317).*

The Carolina paroquet or "parrakeet" (*Conuropsis Carolinensis*), a very showy bird that formerly ranged over a large part of the coastal plain from Virginia to Florida, is now making its last stand a little south of our limits, if it is not already extinct. Its handsome plumage caused many specimens to be caught and caged, and at the same time made it an easy mark for gunners, and there has also been some prejudice against it on account of its supposed fruit-eating propensities.

The Florida jay (*Aphelocoma cyanea,* a different genus from the common jaybird of the eastern United States and its Florida subspecies), apparently first observed by William Bartram about 1775, and first described scientifically in 1817, is said to be chiefly confined, now as formerly, to the coasts of Florida between lat-

*See also J. K. Small, Natural History 20:491, 496. "Sept.-Oct." (Dec) 1920.

itudes 27° and 30°. (The other species of *Aphelocoma*, eight or nine in number, are all western, ranging from Texas and Idaho to Central America.)

The dusky seaside sparrow (*Passerherbulus nigrescens*), although described as long ago as 1873, is still known only from marshes within a few miles of Titusville on the east coast. Chapman says of it (Handbook, p. 394): "In view of the fact that this species is abundant and that the region is in no sense isolated, but that both to the north and south there are marshes apparently similar to those it occupies, the restriction of its range to an area only a few square miles in extent makes its distribution unique among North American birds."

Besides these well-marked local species of non-migratory birds there are several other cases in which the Florida birds differ just a little from those of the same species farther north, as stated a few pages back, but it is hardly worth while to mention them in a work of this kind.

Among extinct birds there is one noteworthy record, the finding of bones identified as belonging to the great auk (*Plautus impennis*) in a shell mound near Ormond by Prof. Blatchley in 1902. This penguin-like bird was chiefly confined to the colder parts of the Atlantic ocean, and there is no record of its having been seen alive since 1842.

One avian product that deserves special mention is bird guano. The principal source of this has been a few small islands off the coast of Peru, where myriads of sea birds have roosted and nested for ages, safe from most of their enemies, and where rain is practically unknown, so that there is no leaching of the valuable fertilizing constituents of the guano. The deposits have been exploited more or less for centuries, but the industry reached its height in the third quarter of the last century.*

In recent years some artificial guano islands have been constructed near Cedar Keys, by building wooden platforms a few feet above the shallow waters of the Gulf a few miles off shore.

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*Probably the most accessible descriptions of the guano islands of Peru are those by Dr. Robert E. Coker in the Proceedings of the U. S. National Museum 56:449-511, pl. 53-69 (Sept. 1919), and in the National Geographic Magazine 37:537-566, with 28 unnumbered half-tones (June, 1920).

The writer saw one of them from a distance in 1910, but did not learn at that time whether the project was succeeding or not; but has lately been informed that other such platforms have been built near by, and that two carloads of the guano were shipped from Cedar Keys not long ago. In our climate the rain must soon leach out most of the nitrogenous compounds that give the Peruvian guano its greatest value, unless the platforms are roofed over.

Reptiles. Our largest reptile is the alligator, formerly abundant throughout Florida, and ranging over the coastal plain from North Carolina to Oklahoma. It has been so mercilessly hunted for its hide or merely for sport that it has become rather scarce and shy, and the writer has never seen one outside of captivity in the area under consideration.*

There are of course snakes of several species, but they are apparently not as abundant as in many equal areas farther north, probably because the prevailing open pine forests do not afford much food or concealment for them, and the annual fires must be an important factor in limiting their numbers.

A characteristic reptile in the high pine lands, and even occasionally on dunes, is the "gopher" (*Gopherus Polyphemus*), a turtle of strictly terrestrial habits, which digs a sloping burrow several feet deep in the sand, the entrance being marked by a mound of about the same size as the salamander hills already mentioned. Its general range is a little wider than that of the salamander, but as it is edible it has decreased in numbers with the increase of population.† According to Blatchley its burrows have quite a peculiar fauna, including a frog and several species of insects not found elsewhere.

Remains of several species of turtles and a crocodile have been found in the phosphate mines.

Fishes of many species abound in both fresh and salt water, and they afford a livelihood to many people on both coasts, particularly at Cedar Keys and Titusville. One of the largest is the

*For a scientific study of the alligator in its native haunts, somewhere south of Orlando, see A. M. Reese, Pop. Sci. Monthly 77:365-372 (with 10 half-tones.) Oct., 1910.

†The Legislature of 1909 passed a law protecting gophers in the three westernmost counties of Florida in May, June and July, and prohibiting the use of hooks and the taking of specimens less than nine inches long.

tarpon (*Tarpon Atlanticus*), which has little food value but is caught merely for sport by tourists. Important marine food fishes in central Florida waters are the mullet, red snapper, pompano and Spanish mackerel.*

There seem to be no statistics available by which the fishing business of our area can be separated from that of the rest of the State.

Sharks' teeth are common in the pebble phosphate and in some other formations.

Insects. In most parts of the world, especially in warm climates, there are more species of insects than plants, so that there must be at least a few thousand in central Florida.† A reasonably complete list of them would take years to prepare and would have little value for the general reader, but a few of the troublesome ones must be mentioned. Those of greatest popular interest are probably the mosquitoes, but to write about mosquitoes without being backed by statistics is to risk offending some local interests, so that the subject must be handled cautiously.

There are several species of mosquitoes present in some parts of our area throughout the frostless season, but probably no more individuals than in an equal area in New Jersey or Alaska. Natural conditions are not especially favorable for them in central Florida except in salt marshes, for the lime-sink region has very little water, and the lakes and streams in other regions are usually well stocked with fish that eat all the mosquito larvae within reach. Most of our mosquitoes come from artificial or accidental breeding places that could be eliminated, such as water barrels and tin cans, and the malaria-carrying species are decidedly in the minority, probably on account of the absence of muddy water which they seem to prefer. Consequently there is much less malaria in

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*See Everman & Bean, Indian River and its fishes. U. S. Senate Doc. 46. 54th Cong., 2d Session. Jan. 1897. Also in Rep. U. S. Fish Comm. 1896:227-262 (with 36 plates). 1898.

†There are said to be important papers on Florida beetles by E. A. Schwarz in Proc. Am. Phil. Soc. 17:353-469, 1878, and in Entomologia Americana 4:165-175, 1888. In recent years J. A. G. Rehn and Morgan Hebard have published taxonomic papers on some of our other insects in the Proceedings of the Academy of Natural Sciences of Philadelphia.

our area than in some places farther north. The yellow fever mosquito (*Stegomyia* or *Aedes calopus*) is believed not to be indigenous, but to breed only in artificial habitats.

The consensus of opinion seems to be that mosquitoes are most abundant on the east coast;* but even if they are that does not prevent Daytona from being a summer resort for people from the interior as well as a winter resort for northern people. A good brief summary of the mosquito situation in Florida by Clifton F. Hodge, a nature student of national reputation, appeared in the Florida Entomologist (Gainesville), for July, 1920.

Sandflies (a very small species of gnat) are said to be very annoying on the east coast at times, but the writer has never happened to encounter them there (or anywhere else).

Roaches—or cockroaches as they are called in the books—of several species are common, as in other warm climates (and in steam-heated buildings farther north), but they seem to be mostly native species, that live in decaying wood, etc., and do not ordinarily invade houses.† And the more domesticated species have at least one thing to be said in their favor, namely, they are said not to tolerate the presence of bedbugs in the same house; consequently the latter are very scarce in Florida.

Mites. A very common but inconspicuous animal, resembling an insect but belonging with the spiders, is the redbug (*Trombidium* sp., known farther north as chigger, or harvest mite). It is not peculiar to Florida, but ranges northward to Maryland and Wisconsin or thereabouts, and allied species are said to be troublesome in parts of England, France, Germany, Japan, Mexico,

*From 1824 to 1845 approximately the eastern third of central Florida was known as Mosquito County, probably taking its name from Mosquito Lagoon on the coast of what is now Volusia and Brevard Counties. In 1901 the Florida Legislature—whose jurisdiction in such matters may be questioned—decreed that the lagoon should thereafter be known as Indian River North; but Mosquito Inlet, near New Smyrna, the mouth of the lagoon, is still on the maps.

†An easily accessible pamphlet on roaches and how to deal with them is Farmers' Bulletin 658 of the U. S. Department of Agriculture, published in 1915.

etc. Being only about the size of a pin-point, it is not easy to determine its natural habitats, but it evidently frequents places that are rarely burned, like hammocks, swamps, and roadside shrubbery, and is scarce in pine lands. It is annoying but not dangerous, and its pernicious activities are chiefly confined to the warmer half of the year. The instinct that leads it to burrow into human skin is a suicidal one, for there is very little chance of such an individual having any descendants to inherit the same tastes.*

There are several species of ticks, with habits similar to those of the red bug, but being larger they are less abundant and more easily dealt with. The cattle-tick which infests the ranges and pastures has been viewed with alarm by stock-raisers in recent years, and a campaign for its extermination is now under way, with good prospects of success.†

Miscellaneous invertebrates. The scorpion, which looks just like one of the pictures among the signs of the zodiac in old-fashioned almanacs, is more or less common in South Florida, but the writer has never seen but one in central Florida, that in Lake County in 1909.

Earthworms, which abound in clayey and loamy soils in most parts of the civilized world, and are an important factor in maintaining the fertility of such soils, are scarce in the sand of peninsular Florida, but there are said to be a few native species in the humus of our hammocks, and very likely some of the European species occur in gardens.

Of the many mollusks, terrestrial and aquatic, univalves and bivalves, living and fossil, only the oyster need be mentioned here. It is common in salt water (see fig. 3), and is shipped from Cedar Keys and elsewhere. Its shells have been used extensively on roads near the coast, as stated in the chapter on roads, farther on, but they are now being gradually superseded by brick and asphalt.

Sponges grow on the rocky bottom of the shallow waters along the Gulf hammock coast, and Tarpon Springs is a great center for the sponge industry, which is carried on by Greeks. A few are also brought in to Cedar Keys.

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*See Farmers' Bulletin 671 of the U. S. Department of Agriculture, 1915. Also N. Banks, Proc. U. S. Nat. Mus. 28:30-33. 1904.

†For notes on ticks see Banks, l. c., pp. 42-49.

POPULATION

DENSITY

When the first census of Florida was taken, in 1830, the peninsular portion of the State was practically uninhabited, except for a few small settlements along the east coast. Not until about the middle of the century were there enough people or enough counties in the area under consideration to make it possible to estimate the density of population. In 1850 there was about one inhabitant to three square miles; and as at present, there were about twice as many whites as negroes. The changes in density of population since then, for the whole area and as many of the regions as we can get satisfactory data for from the census returns, are shown graphically in figure 42, which is based on both Federal and State censuses, the latter taken midway between the former, beginning in 1885.

The number of inhabitants more than doubled between 1880 and 1890, the decade when phosphate was discovered and com-

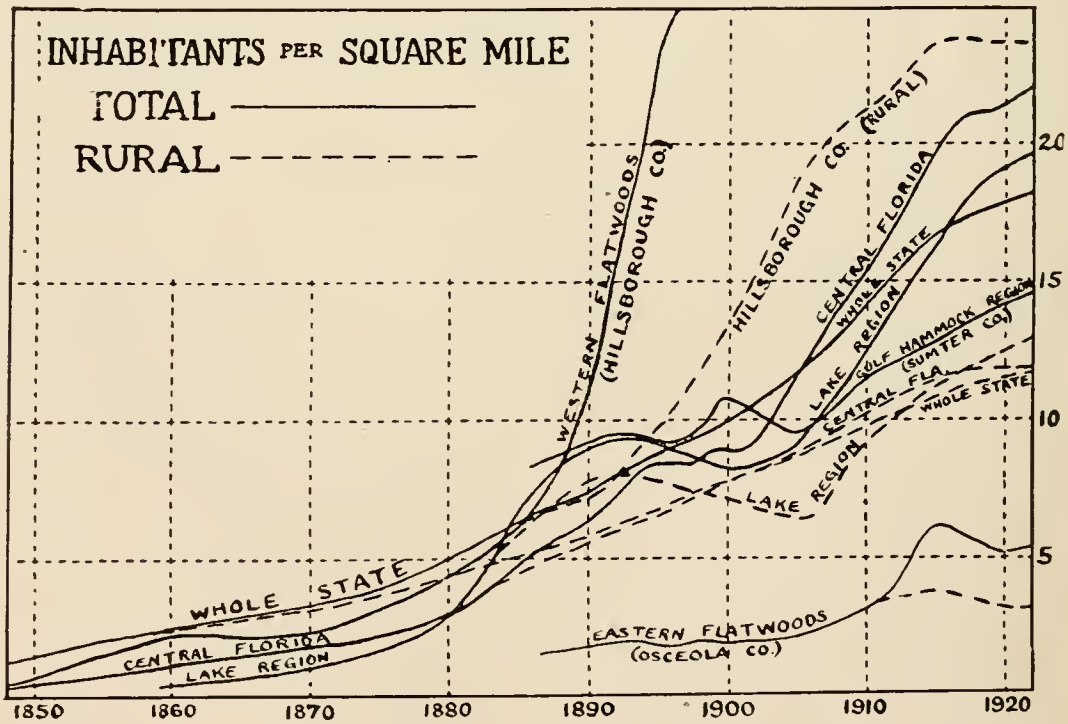

Fig. 42. Historical graph showing density of total and rural population in central Florida, some of its subdivisions, and the whole State, from 1850 to 1920, or as far as can be ascertained from the census returns.

mercial fertilizers of other kinds became available in large quantities, but almost stood still between 1895 and 1900, when two severe freezes dealt the orange industry a staggering blow.* (The lake region actually lost population during that period.) From 1900 to 1915 approximately the former rate prevailed, but the world war retarded the increase between 1915 and 1920, as it did in most other parts of the United States outside of manufacturing centers.

COMPOSITION

The percentage of negroes was lowest in 1885, only 28; but increased soon after that, when the development of farms and phosphate mines created a new demand for unskilled labor, and also at the time of the great freezes, when many white people of northern origin left the State. At this writing the racial composition for 1920 by counties has not been made public, but it is quite probable that the negro percentage is now even less than it was in 1885, on account of the great northward migration of negroes during the recent war. As in other parts of the South, negroes have always been most numerous in the most fertile regions.

The red and yellow races constituted less than 1-20 of 1% of the total population in 1910. Over half of them were Chinese, and most of the Chinese were in Tampa (and presumably in the laundry business.)

There are (or were in 1910 at least) more men than women in every region, as is the case in practically all countries that are being settled up rapidly, for men naturally precede women in seeking homes in new territory.

NATIVITY

The percentage of foreign whites in the total population ranged from 4.3 in 1850 to 1.96 in 1880, 9.1 in 1910, and 7.3 in 1915, and is highest in and around Tampa, on account of its being a seaport and a large city. The leading foreign nationalities represented in the whole area in 1880 were English, German, Swedish, Canadian, Irish, French and Scotch, all from much far-

*See Yearbook U. S. Dept. Agriculture 1895:143-174 (1896); Geographical Review 2:361-367. Nov. 1916.

ther north, it will be observed; and in 1910 Cuban, Italian, Spanish, English, German, Turkish (probably meaning mostly Syrian), Canadian, Greek, Swedish, Irish, Scotch, Russian and Roumanian. This great increase of West Indian and southern European immigration in thirty years indicates quite a deterioration in quality; but if we leave out Hillsborough County, which had over four-fifths of all the foreigners in central Florida, the percentage of foreign whites in 1910 was only 2.24, and the leading nationalities English, German, Canadian, Swedish, Irish, Scotch, Italian, Greek, Danish, Russian and French; which is not very different from the percentage or the sequence in 1880, when Tampa was a very small place. In the city of Tampa in 1910 the order was Cuban, Italian, Spanish, German, English, Canadian, Roumanian, Irish, Russian, Greek, Swedish, French, Austrian, Scotch, Mexican, Swiss, Danish. (Some religious statistics for Tampa are given farther on.)

Recent Federal censuses have not distinguished between native and foreign-born negroes, but in 1915 a little less than 1% of the negroes in central Florida were of foreign origin, doubtless mostly from the Bahamas and West Indies.

In 1880 only 59.9% of the inhabitants of central Florida were born in Florida, 14.2% in Georgia, 10.2% in South Carolina, 3% in Alabama, 1.8% in North Carolina, 0.9% in Virginia, and smaller numbers in the other states. Marion County had more South Carolinians than Georgians, strange to say.* Unfortunately there are no similar data in later censuses, either Federal or State, except for whole states and for cities with more than 50,000 inhabitants. The State census of 1915 made inquiry as to the birthplace of each individual and his or her parents, but did not publish the results, except as to the number of persons born in and out of the United States. If the data could be tabulated separately for whites and negroes, for adults and children, and for farmers and city people, some very interesting results would be obtained.

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*See Seventh Annual Report, p. 124. At present Ohioans seem to be very largely represented, especially west of the lake region, and Kentuckians in the lake region.

RURAL AND URBAN POPULATION

The percentage of the total population living in incorporated places with over 2,500 inhabitants (the arbitrary limit for urban population used by the U. S. Census Bureau) was 11.2 in 1890, 19.4 in 1895, 13.7 in 1900, 23.9 in 1905, 33.6 in 1910, 37.1 in 1915, and 40.5 in 1920. These figures are rather high, being above the average for the whole State (and in recent years for the whole South). In 1915, by the State census, 51% of the inhabitants of central Florida, and 44.2% of those in the whole State, were living in incorporated places (some of which had much fewer than 2,500 people). The percentage of urban population is a rough measure of civilization, for where there is a low state of civilization there are few or no cities; but of course it does not necessarily follow that a city is a better place to live than the country.

Some interesting comparisons between our urban and rural population in 1910 are given in Table 22. In this there are separate columns for Tampa (including West Tampa, which is incorporated separately, but for geographical purposes is as much a part of Tampa as is Ybor City on the east side), for the eight cities next in rank (listed farther on), and for the remainder of the population, which is classed as rural by the census; also for the rural and urban population of the whole State.

One who studies this table carefully can gather from it many significant facts, especially about the amount and kind of immigration to this part of the State, but it would take several pages to discuss it in detail. It will be observed however that in many respects the smaller cities resemble the rural districts more than they do Tampa, that central Florida has a larger proportion of men than the rest of the State, and that the foreigners in the smaller cities and rural districts are of a superior type to those in Tampa, where they partly take the place of negroes.

Although the foreigners constitute less than a third of the total population of Tampa proper (which includes Ybor City), they outnumber native whites and negroes combined in West Tampa (which would hardly be possible in an isolated city, but West Tampa is a mere suburb). Worse still, among the adult males the foreigners outnumber the native whites in Tampa proper, and in West Tampa they are over three times as numerous as all native

TABLE 22.

Comparisons of Rural and Urban Population of Central Florida, 1910.

	Tampa & West Tampa	Eight smaller cities	Rural	Whole State	
				Urban	Rural
Percentages of total population:					
Whites	78.0	60.3	62.5	59.5	58.8
Native white, native parents	27·5	52·0	55·7	37·2	55·0
Native white, foreign or mixed parents	19.6	5·3	3·4	11·1	2·1
Foreign white	30·9	3·0	3·4	11·2	1·7
Negroes	21.8	39.6	37.5	40.5	41.2
Males	52.3	49.1	54.8	50.8	53.1
Percentages of adult male population:					
Whites	76.8	61.2	59.9	58.7	57.5
Native white, native parents	26·5	51·4	50·0	35·3	51·2
Native white, foreign or mixed parents	6·0	4·6	2·9	6·5	2·2
Foreign white	44·3	5·2	7·0	16·9	4·1
Negroes	23.1	38.6	40.1	40.2	42.5
Illiterate	6.5	6.4	13.7	7.7	16.8
Per cent of adult males in the following groups:					
Total population	30.6	30.2	31.2	30.8	27.6
White population	30.1	30.5	29.8	30.7	26.9
Native white, native parents	29.5	29.8	28.0	29.6	25.7
Native white, foreign or mixed parents	9.3	26.0	26.2	18.1	27.7
Foreign whites	43.6	52.7	63.4	46.8	64.0
Negroes	32.4	29.3	33.4	30.9	28.3
Per cent of illiterates in population over 10:					
Native white	1.6	0.5	2.7	1.1	6.4
Foreign white	14.4	4.4	12.9	11.2	8.9
Negro	12.1	12.2	25.9	15.4	30.0

men, white and black.* (The census gives no figures for nationalities in places as small as West Tampa, but the people there are probably mostly of Latin races, as in Ybor City.) And in Tampa proper among the white children between the ages of 6 and 15 there are more with one or both parents foreign than with both parents native.

This large proportion of recent immigrants from countries with lower standards of civilization than ours is not peculiar to Tampa and vicinity by any means, but is common to practically all the larger cities of the United States. It is probably due at least

*In 1910 only 20.8 per cent of the foreign white men in Tampa and 15.4 per cent of those in West Tampa were naturalized, making the potential voters only 70.3 per cent and 35.8 per cent respectively of the adult males.

in part to the superior school facilities in cities, which by continually uplifting the native children tend to create a vacuum at the bottom of the social scale, which calls for the importation of ignorant foreigners to do the necessary menial tasks, or the monotonous routine work of semi-skilled laborers in factories. This state of affairs is accentuated by compulsory education, and is therefore more pronounced in the northern states that have had such a system much longer than Florida has.*

*The following table will indicate something of the condition of the foreign population in a few large northern cities in 1910. All except Boston and New York are noted chiefly for their textile industries.

CITIES	Boston, Mass.	Fall River, Mass.	Lawrence, Mass.	Lowell, Mass.	New Bedford, Mass.	New York, N. Y.	Paterson, N. J.
Leading foreign nationalities	Irish, Can. Russ., Ital.	Fr. Can., Engl. Irish, Austr.	Fr. Can., Ital. Irish, Engl.	Fr. Can., Irish Eng., Can.	Fr. Can., Engl. Irish, Austr.	Russ., Ital. Germ., Irish	Ital., Germ. Engl., Irish
Per cent of total population:							
Foreign white	35.9	42.6	48.1	40.9	44.1	40.4	36.1
Native white, foreign or mixed parents	38.3	43.7	37.9	39.5	33.5	38.2	40.0
Per cent of adult males:							
Foreign white	49.5	63.8	67.0	68.1	60.7	57.8	54.7
Native white, foreign or mixed parents	24.5	24.3	20.3	22.9	15.4	23.7	24.5
Per cent of foreigners illit.:							
All over 10	10.0	23.5	22.2	11.7	20.8	13.2	14.5
Adult males only	8.6	23.2	14.8	12.0	14.5	10.7	11.8

Most of the abbreviations for nationalities will be readily understood. Fr. Can. means French Canadians, and Can. all other Canadians.

CITIES AND TOWNS

The largest cities and towns, with their total population at different census periods since 1890, are shown in Table 23. They are arranged in order of size in 1915, because the 1920 figures are still subject to revision.

TABLE 23.

Total Population of Largest Cities and Towns in Central Florida, 1890 to 1920.

CITIES	1890	1895	1900 (June)	1905 (July)	1910 (April)	1915 (July)	1920 (Jan.)
Tampa	5,532	15,634	15,839	22,823	37,782	48,160	51,252
West Tampa	------	2,815	2,355	3,661	8,258	7,837	8,463
St. Petersburg	273	308	1,575	2,316	4,127	7,186	14,237
Lakeland	552	?	1,180	3,299	3,719	7,287	7,062
Orlando	2,856	2,993	2,481	3,511	3,894	6,448	9,282
Ocala	2,904	4,597	3,380	4,493	4,370	5,370	4,914
Sanford	2,016	1,517	1,450	2,822	3,570	4,998	5,588
Daytona	771	1,425	1,690	2,199	3,082	4,526	5,445
Kissimmee	1,086	1,172	1,132	1,530	2,157	4,221	2,722
DeLand	1,113	1,609	1,449	1,496	2,812	3,490	3,324
Bartow	1,386	1,931	1,983	1,950	2,662	3,412	4,203
Plant City	349	?	720	1,544	2,481	3,229	3,729
Fort Meade	267	350	261	322	1,165	2,150	2,029
St. Cloud	------	------	------	?	?	2,089	2,011
New Smyrna	287	500	543	750	1,121	2,012	2,007
Dade City	321	?	509	794	1,066	1,950	1,296
Tarpon Springs	327	562	541	740	2,212	1,938	2,105
Clearwater	------	300	343	610	1,171	1,932	2,427
Zephyrhills	------	------	------	?	423	1,450	577
Brooksville	512	608	641	709	979	1,385	1,011
Leesburg	722	805	765	844	991	1,360	1,835
Titusville	746	831	756	948	868	1,310	1,361
Winter Haven	------	------	------	375	?	1,226	1,597
Eustis	------	563	411	529	910	1,148	1,193
Mulberry	------	------	------	850	1,418	1,121	1,499
Port Tampa City	------	1,111	1,367	1,049	1,343	1,071	1,030

These actual figures should not be taken literally, for much depends on the area included in the city or town. And an extension of the city limits, which is a rather frequent occurrence, may make an abnormal apparent increase between two successive censuses. The apparent decreases in the population of Lakeland, Kissimmee and Dade City between 1915 and 1920 are hard to understand, unless the areas covered by the enumerators were smaller at the latter period, or there was some error in tabulating the returns. The increases in some popular winter resorts at the same time are doubtless due partly to the fact that the census of 1915 was taken in summer and that of 1920 in winter. For although the census is supposed to count only bona-fide residents,

many people spend about half the year in Florida and half in some other state, and are therefore entitled to be counted in either place.

But when we take several cities together such errors (except the seasonal one last named) ought to offset each other to a considerable extent. And it is safe to say that the population of the ten largest cities (which were not the same places each time, though) nearly doubled between 1890 and 1895, decreased a little in the next five years, and then more than doubled in the decades 1900-1910 and 1905-1915. The increase from 1915 to 1920 was less than 15%, but the rural population at the same time was practically stationary, as seems to have been the case in most other states. The ten cities or towns next in rank did not seem to be affected so much by the freezes of 1895 and 1899, strange to say, and they just about doubled every ten years between 1895 and 1915, but gained very little in the last five years.

WINTER RESORTS

The mild dry winters of peninsular Florida naturally attract many visitors from the colder states, and they are an important source of revenue, ranking in that respect close to the products of the phosphate mines, forests and farms. It would be very difficult to estimate the total number of "tourists" that visit central Florida in an average year, but the average maximum number that are expected at any one time in the height of the season may be guessed at by means of the hotel capacity. Of course all the hotels are not likely to be filled at the same time, and many if not most of them are open all the year for the accommodation of commercial travelers, etc. But at the same time no hotel directory is absolutely complete and up to date, and there are many winter visitors who rent cottages or even live in tents, so that the indicated hotel capacity is probably as good a measure of the tourist business as can be found.*

*The tourists are presumably all white (and mostly adults), though the negro population must be augmented a little also in the winter season by a certain number of waiters, porters, etc.

A "Guide to Florida" by Harrison Rhodes and Mary W. Dumont, published in 1912, devotes 27 pages to a hotel directory of the State. There is no explanation of how complete it is supposed to be, or whether the rates quoted are American or European plan, and in some cases either the rate or the capacity is left blank. But the towns and hotels omitted are mostly very small ones, and the rates in nearly every case are evidently American plan, and the list is useful for indicating the distribution of the tourist business and calculating the average cost of board in each region, if nothing else.

According to that there were within the area under consideration accommodations for 15,680 visitors, at an average minimum rate of $2.47 per day, American plan.* About 11% of the rooms were in the lime-sink region, mostly on the coast thereof in Pinellas County, 23.2% in the lake region, the same in the western division of the flatwoods (mostly at St. Petersburg), 35.6% on the east coast, and the rest scattering. The average rates per day were about $3.00 in the lime-sink region (one hotel on the coast contributing a large part of this), $2.21 in the lake region, $2.00 in the western division of the flatwoods, and $2.88 on the east coast. (Of course to convert these figures to present-day prices they would have to be multiplied by about two, on account of the depreciation of money during the recent war.)

A winter resort directory of the South issued by the Atlantic Coast Line for the season of 1914-15 seems to have about the same degree of completeness as that just mentioned, and the number of hotel accommodations in central Florida listed in it is about 20,000. A similar publication for 1920-21 increases the number to about 24,000, 9.7% of which are in the lime-sink region, or on the coast thereof, 34.7% in the lake region, 21.4% in the western division of the flatwoods, and 26.5% on the east coast. (In all these calculations Tampa has been divided equally between the lime-sink region and the flatwoods.) Hotels are most numerous in the lake region, but they average smaller there than on the east coast.

*This average is not simply the sum of the rates divided by the number of hotels, but a weighted average obtained by multiplying each rate by the number of rooms before adding. Where the rates given are obviously European they have been multiplied by three or four.

A list of the leading winter resorts is given below. In this all places less than two miles apart (an easy walking distance) are lumped together, and the resorts are then arranged in order of the number of hotel accommodations in the 1920 list, down to those which have only 200. The figures are not given here, because they are subject to correction and change, but they form approximately a descending geometrical progression, from 3,724 down to 200. The regions are indicated in parenthesis.

Daytona, Daytona Beach, Seabreeze (East coast).
St. Petersburg (Coast of western flatwoods).
Orlando (Lake region).*
Tampa (Coast of lime-sink region and flatwoods).
Belleair and Clearwater (Coast of lime-sink region).
DeLand (Lake region).
Ormond and Ormond Beach (East coast).
Winter Park (Lake region).
Cocoa and Rockledge (East coast).
Lakeland (Lake region).
New Smyrna (East coast).
Ocala (Middle Florida hammock belt).
Sanford (Lake region).
Winter Haven (Lake region).
Eustis (Lake region).
Plant City (Western flatwoods).
Tarpon Springs (Coast of lime-sink region).
Bartow (Western flatwoods).
Pass-a-Grille (West coast islands).
Kissimmee (Eastern flatwoods).
Tavares (Lake region).
Melbourne and Melbourne Beach (East coast).
Leesburg (Lake region).
Florence Villa (Lake region).
Mt. Dora (Lake region).
St. Cloud (Eastern flatwoods).
Lake Helen (Lake region).
Titusville (East coast).
Enterprise (Lake region).

*There are signs advertising Orlando attached to many roadside trees on Cape Cod, which is a great summer resort region.

In the last year or two there have been large numbers of so-called "tin can tourists," who come into Florida in automobiles and camp in tent colonies on the outskirts of the cities, often in special places provided for them and furnished with free water and electric lights by the accommodating municipalities. This has been going on in California in summer for several years, but it is so new in Florida that no estimate of the number of such tourists can be made.*

If the average winter visitor spends $5 a day for lodging, meals, clothes, souvenirs, railroad fare, gasoline, etc., which seems a conservative estimate at present prices, and there are 24,000 in the area throughout the three or four months of the winter season, that would make a gross income for central Florida from this source of about $12,000,000 a year. This money of course ultimately goes out in exchange for groceries, manufactured products, etc., and this explains why Florida has what some thoughtless people regard as a large "unfavorable" balance of trade. But even if all the food supply was raised within the area, the money would still have to flow out in exchange for something or other, for otherwise it would accumulate until it had very little value. The account is partly balanced, however, by the northward migation of Florida people in summer.

Just how long the average "tourist" remains in one place can hardly be guessed, but the "turnover" must be quite large. At St. Petersburg, with an estimated hotel capacity in 1914 of only 2,706, it was claimed about that time that 40,000 different tourists came there in one winter. The local Board of Trade keeps a visitor's register, and in the season of 1914-15 there were 10,830 names recorded there. The principal states from which they came, with percentages, were as follows:

Ohio 14.8, New York 12.4, Indiana 10.4, Pennsylvania 10.3, Illinois 9.5, Michigan 8.8, Massachusetts 4.7, New Jersey 3.6, Kentucky 2.5, Connecticut 2.5, Maine 2.0, Iowa 2.0, Wisconsin 1.7, West Virginia 1.6, Minnesota 1.3, Tennessee 1.3, New Hampshire 1.2, Missouri 1.0. There were also 1.1% from foreign countries (probably mostly Canada). Virginia, Alabama and

*The first such camp east of the Mississippi River is said to have been established at New Port Richey in Pasco County in the winter of 1916-17.

Mississippi were the only states east of the Mississippi River not represented. On the east coast the proportions are doubtless somewhat different, there being very likely more New Yorkers and New Englanders there.

Central Florida is not lacking in summer resorts also, such as Daytona, Pass-a-Grille, Cedar Keys, Silver Springs, Clay Springs, and Orange Springs, but no statistics of their patronage are available at this writing.

ILLITERACY

A crude measure of the educational equipment of the people is afforded by the statistics of illiteracy, which have been given by every United States census since 1840, but are not considered very trustworthy until recent decades. If the whole population, or any race or national or age group, could be graded according to education, or the number of years of schooling each individual has had, a curve could be constructed from the results, and this curve would always be steepest in its higher parts (like those for school population and size of farms given farther on), for in every city, county, state or country there are always more persons below than above the average in education (as in age, wealth, etc.), just as there are more towns than cities, more gnats than camels, more herbs than trees in the forests, more creeks than rivers, and more hills than mountains. The illiteracy count gives only one point on such a curve, and that usually near the bottom, among white people in civilized communities at least, but it is much better than no information at all on the subject.

The illiteracy percentage has been determined in different countries for adults, voters, army recruits, bridal couples, etc., but in this country the usual method is to ask of each person who has reached the age of ten years whether or not he can read and write. Formerly this was asked only of adults, but the 1910 census gives the data both for adult males and for all persons over 10, subdividing each group according to race and nativity.

Some comparisons between the urban and rural population with respect to illiteracy have already been given in Table 22. Table 24 gives for each region, the whole area and the whole State the illiteracy percentages for adult males in 1910 and for all persons over 10 at three different census periods, subdividing them by

race and nativity. The figures for 1900 are not quite as accurate as those for 1910, for the former census did not give the total number of persons over 10 in each county, and that has been estimated, on the assumption that the proportions of different age groups were the same as in 1910. The counties used in computing the regional averages are the same as already stated in the regional descriptions. Three regions are represented by two or three counties each, five by only one, and two not at all.

As in all other tables from here on in which different regions are contrasted, the highest number in each line is printed in heavy type and the lowest in italics, to show which regions lead or lag behind in any one particular.

TABLE 24.

Percentages of illiteracy in the adult male population of central Florida in 1910, and in the total population over 10 in 1900, 1910 and 1915, by regions, race and nativity.

	Gulf hammock	Lime-sink	Mid. Fla. hammock belt	Hernando hammock belt	Lake region	Western flatwoods	Eastern flatwoods	East coast	Central Florida	Whole State
ADULT MALES, 1910										
All classes	12.4	**19.5**	16.2	18.9	11.4	*7.8*	9.4	8.5	11.3	13.9
All whites	3.5	**6.3**	2.0	4.1	2.2	5.5	3.7	*1.7*	4.0	5.3
Native whites	3.6	**5.7**	1.7	3.7	2.2	*1.2*	3.8	1.4	2.2	4.9
Foreign whites	*0*	**18.9**	6.2	9.8	1.8	11.3	1.9	3.7	10.3	8.2
Negroes	27.4	30.2	26.0	34.9	25.6	*16.0*	**32.1**	21.0	24.0	25.9
PERSONS OVER 10										
1900										
All classes	15.8	21.0	21.4	21.0	12.4	11.1	12.2	*6.6*	15.0	**21.9**
All whites	4.0	**10.1**	2.6	6.1	4.3	6.9	8.2	*1.7*	5.4	8.9
Native whites, with native parents	4.2	**9.7**	2.6	6.3	4.9	2.0	8.5	*1.8*	4.3	9.0
Native whites, foreign or mixed parents	1.2	**6.9**	0.6	3.0	*0.7*	2.6	2.4	1.5	2.1	3.6
Foreign whites	*0*	**26.0**	4.3	6.7	2.4	19.1	5.7	0.9	14.7	11.6
Negroes	34.9	35.2	32.3	46.0	26.6	24.6	**39.7**	*17.9*	31.1	38.4
1910										
All classes	11.0	**18.1**	14.4	15.2	9.9	8.1	7.9	*6.3*	10.3	13.8
All whites	2.9	6.2	1.7	3.3	1.9	6.2	3.6	*1.4*	4.1	5.5
Native whites	3.0	**5.9**	1.6	3.1	1.9	1.7	3.6	*1.1*	2.2	5.0
Foreign whites	*0*	14.8	4.8	8.9	1.7	**15.3**	3.2	4.5	13.5	10.5
Negroes	26.9	**30.0**	22.9	31.2	23.0	14.7	29.1	*17.1*	21.8	25.5
1915										
All classes	14.6	14.0	17.1	13.2	?	6.8	*2.2*	4.2	9.8	14.7
White	3.3	**4.8**	2.4	2.1	1.1	4.0	*0.4*	0.6	2.5	4.4
Colored	36.6	24.2	27.8	33.4	?	18.3	*13.2*	13.3	25.2	30.6

Between 1900 and 1910 the percentages of illiteracy declined in every region, as they did nearly everywhere else in the United States, but there were apparently some increases between 1910 and 1915, perhaps due to different methods of federal and State censuses, or even to typographical errors (for the 1915 figures for negro illiteracy in Lake County are so incredibly high that they have been rejected).

The distribution of illiteracy is not altogether fortuitous, but is governed by several different factors. First, it is usually more prevalent in sparsely settled regions, where school-houses are necessarily few and far apart, than in populous communities and especially in cities. Second, it depends on the racial composition of the population, for in a given community there is always less education among the negroes than among the whites, and where they are the most numerous there is likely to be the greatest contrast between them and the whites in education, wealth, etc. (This is more evident in Georgia and Alabama than in Florida, though.) Foreigners are usually inferior to native whites in this respect in cities and in mining districts (such as the phosphate regions), but often a little superior in the purely agricultural districts of the South. (This is doubtless because the farmer type of foreigner comes mostly from northern Europe and the laborer type from Latin countries.)

Another important factor is the distance of birthplace from residence. An illiterate cannot read the advertisements of opportunities in distant states, or the time-tables used on railroad journeys, so that he is not likely to travel far unless he goes with a crowd (as many immigrants from foreign countries do). Probably nearly half the adults in central Florida were born in other states (though the census gives us no adequate information on this point), and must have learned to read before coming here. Florida has a considerably lower illiteracy percentage among native whites than other southeastern states, and central Florida is superior to the rest of the State in that respect, doubtless largely for

this reason.* The lowest white illiteracy percentage in the table is that for the east coast, which has probably the most cosmopolitan population (and also the most intensive farming, as will be shown in a later chapter), but that in the Middle Florida hammock belt is next lowest, for a different reason, namely, the large percentage of negroes available for kinds of work that require no education.

Compulsory school attendance laws, which are now in force to some degree in every state, tend to reduce illiteracy among the native population, but if unskilled laborers are still needed they are simply imported or invited from countries with low standards of living to take the place of the forcibly "uplifted" natives, as has happened on a large scale with disquieting results in many northern and western states.†

SCHOOLS.

The biennial reports of the State Superintendent of Public Instruction contain a vast amount of information about the public schools of Florida and its counties, that has never been utilized as fully as it might be. The statistical data are probably even more accurate than the average census returns, for schools and pupils are not easily overlooked, and educators have long been accustomed to keeping exact records of enrollment, attendance, expenditures, etc. Furthermore, the present State Superintendent is an experienced statistician and a stickler for accuracy, and he has probably kept the typographical errors (which mar so many other State publications) in his reports down to a minimum.

The school statistics used here are those for year 1915-16. Soon after that the world war made conditions somewhat abnor-

*Ellsworth Huntington, in his book "Civilization and Climate" (1915), noticed that Florida had a very low native white illiteracy percentage for such a supposedly "enervating" climate, and tried to explain it on the ground that "so many northern people have moved there to raise oranges." That is only a partial explanation, though, for northerners constitute only about one-eighth of the population of the whole State, and an equal number of people coming from Georgia to run sawmills or turpentine stills would have about the same effect.

†This was discussed in the comparison of rural and urban population, a few pages back. See also Geog. Review 8:274-275. "Oct.-Nov., 1919." (January, 1920.)

mal, and the passage of a compulsory attendance law in 1919 disturbed the equilibrium again, at least as regards enrollment. It would be very interesting to present comparative statistics for periods several years apart, but that would necessitate making allowance for the great changes in the value of money in recent years, and would take more time and space than can be spared at present. Another advantage of using the figures for 1915-16 instead of 1917-18 is that they can be compared closely with the population figures of the State census of 1915. The figures for 1919-20 would be equally interesting, but neither they nor the government figures for race, sex, age, etc., in 1920 have been published yet.

The State reports unfortunately do not give separate statistics for city and country schools. And although they tell how many teachers in each county have homes in other counties or states, there is no indication of how many were born in Florida or any other state, which would be equally interesting. Information about the marital condition of the teachers is likewise lacking But very likely there are few if any other states that give a greater variety of information about schools than Florida does.

Of the many kinds of school statistics available only a few can be safely used for computing regional statistics, for when only one or two counties are considered some of the numbers (e.g., of male teachers) are so small that a slight change in them would make a considerable difference in some of the ratios or averages. But some statistics of the value and size of school buildings, school expenditures, enrollment and attendance, for the two races separately, are given in Table 25 for each region treated statistically* and for the whole area and State; and Table 26 gives some additional details about schools, teachers and pupils for central Florida, the whole State, and the whole United States at the same period.

In preparing these tables a few errors in figures have been detected, but checked up pretty satisfactorily by comparison with other data in the same biennial report or corresponding figures

*There are so few negro schools in Osceola and Brevard Counties that averages based on them might be misleading; which explains the four blank spaces in Table 25.

for other years. In Table 26, as a slight aid to the reader, absolute figures are printed in heavy type, percentages in italics, and other ratios and averages in ordinary type, while in Table 25 the heavy and light figures have the same significance as in other tables in which different regions are contrasted.

TABLE 26.

Selected Public School Statistics of Central Florida and the Whole State, by Races, 1915-16.

	Cent'l Florida		Whole State		Whole
	White	Negro	White	Negro	U. S.
SCHOOLS					
Number of schools taught	581	207	2099	817	281,524
Per cent by race	*73.7*	*26.3*	*72.0*	*28.0*	--------
Average value of school property ($)	5073	1060	3350	754	5910
Per cent of buildings brick or concrete	*14.5*	*1.6*	*9.1*	*0.8*	--------
Annual expenditure per school taught	2330	550	1681	468	2280
Do. per capita of total population	6.97	1.22	6.13	0.78	6.28
Do. per pupil in average attendance	40.40	9.44	35.75	6.33	41.72
TEACHERS					
Number of positions filled	1492	378	4480	1385	--------
Average number per school	2.57	1.83	2.14	1.70	2.21
Number of teachers employed	1505	339	4598	1136	622,371
Per cent male	*18.5*	*18.6*	*24.1*	*21.9*	*19.8*
Average age of male teachers (years)	30	35	28	37	--------
Average age of female teachers (years)	29	28	26	29	--------
Av. experience of male teachers (mos.)	53	71	45	95	--------
Av. experience of female teachers (mos.)	41	54	37	55	--------
Av. monthly salary of male teachers	92.40	38.20	77.32	37.32	85.36
Av. monthly salary of female teachers	60.10	34.00	56.65	31.23	66.88
Per cent of teachers subscribing to educational journals	*60.3*	*52.0*	*47.8*	*40.8*	--------
PUPILS					
Total enrollment	43,038	16,786	135,888	62,482	20,351,687
Number per school taught	74.3	81.0	64.7	76.4	72.4
Average daily attendance	33,471	12,063	98,847	45,572	15,358,927
Number per teacher	22.4	31.9	22.1	33.0	24.7

TABLE 25.

Selected Public School Statistics of Central Florida, 1915-16, by Regions.

	Gulf hammock	Lime-sink	Mid. Fla. hammock belt	Hernando hammock belt	Lake region	Western flatwoods	Eastern flatwoods	East coast	Central Florida	Whole State
WHITE SCHOOLS										
Average value of school buildings ($)	2080	1054	2260	1767	4140	10230	1795	777	3840	2520
Number of rooms per school	2.42	1.63	1.91	2.24	2.48	5.12	2.16	1.69	2.84	2.39
Annual expenditure for schools per capita of white population ($)	4.89	6.60	6.00	8.60	7.20	5.61	4.04	7.70	6.97	6.13
Per cent of enrolled pupils white	70.0	65.8	42.5	77.9	64.4	83.7	85.1	73.4	72.0	68.5
Per cent of white population enrolled	29.3	27.5	25.4	26.0	23.6	18.3	16.4	24.4	22.2	24.1
Do. between ages of 6 and 21	85.7	81.0	80.2	83.5	79.8	61.2	62.6	86.4	74.0	76.0
Average length of term (days)	118	146	145	148	144	154	146	152	148	143
Average days attendance per pupil	91	107	111	104	115	125	101	119	116	104
Per cent of total enrollment in average daily attendance	77.3	72.7	76.8	70.5	80.0	80.8	69.7	78.4	77.8	72.8
NEGRO SCHOOLS										
Average value of school buildings ($)	210	159	516	223	434	2837	------	------	723	520
Number of rooms per school	1.60	1.13	1.59	1.37	1.90	1.69	------	------	1.81	1.66
Annual expenditure for schools per capita of negro population ($)	0.76	0.71	1.21	0.65	1.54	1.48	1.89	1.07	1.22	0.78
Per cent of enrolled pupils negro	30.0	34.2	57.5	22.1	35.6	16.3	14.9	26.4	28.0	31.5
Per cent of negro population enrolled	24.2	16.4	24.7	14.0	21.1	13.3	16.7	22.3	18.0	17.3
Do. between ages of 6 and 21	68.9	51.6	69.9	49.8	73.2	53.8	55.0	81.0	59.6	54.0
Average length of term (days)	91	105	110	97	135	121	122	79	113	101
Average days attendance per pupil	67	81	70	68	98	97	90	63	84	74
Per cent of total enrollment in average daily attendance	68.5	74.5	63.9	69.8	70.6	80.1	70.0	79.0	72.0	73.2

The differences between different regions agree pretty well with those brought out elsewhere in this report about the composition and density of population, illiteracy, agriculture, etc. The western division of the flatwoods leads in several things on account of containing our largest city, for city schools of course are usually larger and more regularly attended than country schools.

The differences between central Florida and the whole State are not very pronounced (if comparison had been made with the rest of the State instead of the whole State the contrasts would have been magnified), but they are nearly all in the direction of larger and better schools, older, more experienced and better paid teachers, better attendance records, etc. Comparisons with other states would involve considerable labor, but central Florida is evidently well up to the United States average in most respects.* The government school statistics available do not separate the races, but in the whole country about 90% of the population (and probably a still larger proportion of the school population) is white, so that figures for white schools would not differ much from those for all schools. When the sparse population of our area is considered its excellent showing in school matters is rather remarkable.

In Figure 43 the school population of central Florida and the whole State, not counting the chart or kindergarten grade, is divided by races and grades. The curves are cumulative, i.e., the distance from any point on any curve to the right hand margin indicates the percentage of pupils in the group designated that have entered or passed through the grade selected. Consequently the percentage enrolled in a given grade corresponds to the horizontal distance between the points where the curve cuts the upper and lower boundaries of the grade. The curves are all steepest in the upper grades, on account of the inevitable dropping out of pupils all along, though in some counties there are a few more in the

*In comparing Florida with the rest of the United States it should be borne in mind that most other parts of the country are colder and therefore require more substantial schoolhouses and greater expense for heating them.

fourth grade than in the third, or in the third than in the second, probably mostly on account of families moving in with children who have already been to school a few years†.

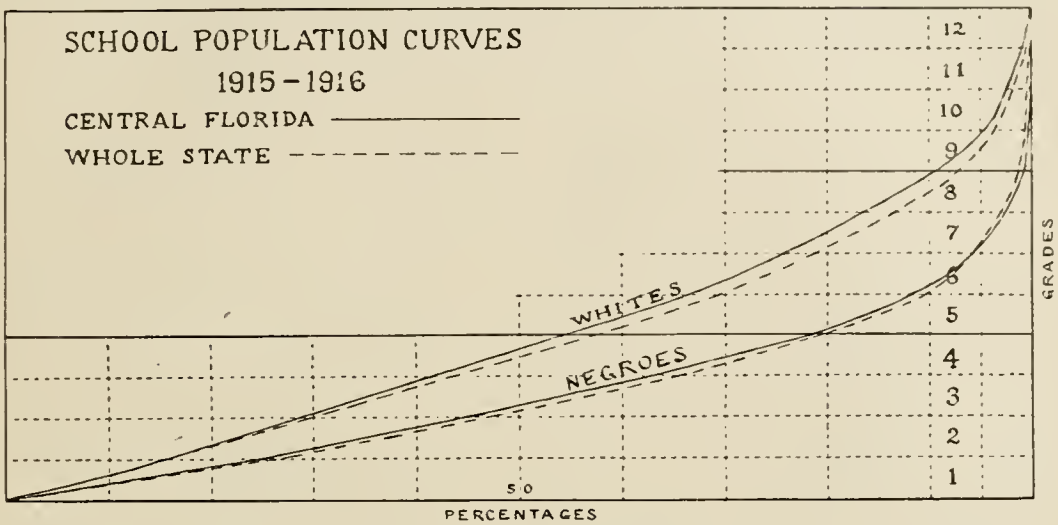

Fig. 43. Graph showing percentage distribution by grades of white and negro pupils enrolled in public schools of central Florida and the whole State, above the chart or kindergarten grade, 1915-16.

In this diagram the same superiority of whites over negroes and of central Florida over the rest of the State already brought out in several other ways is apparent. A similar curve for the whole United States would be so close to that for whites in the whole State of Florida that it could hardly be separated on the small scale used here.

Private Schools. There are quite a number of private schools, but only those of collegiate grade can be mentioned here. Very little statistical information is given about some of them in places where one would ordinarily look for it (such as recent issues of the New York World Almanac), but in order of size or reputation, or both, they seem to be as follows: John B. Stetson University (Baptist), at DeLand, with about 37 instructors and 500 students; Southern College (Methodist), at Sutherland in Pinellas County, with about 24 instructors and 210 students; Rollins College (with Congregational and southern Presbyterian affilia-

†If the entire population could be graded in this way by the census the results would be extremely interesting, but to the best of the writer's knowledge that has never been done except in Iowa.

tions), at Winter Park, with about 20 instructors and 200 students; and St. Leo College (Catholic) at St. Leo in Pasco County. All of these are located in regions of much scenic beauty, and they draw a good deal of their patronage from colder climates.

NOTED PERSONS

If "Who's Who in America" is a reliable criterion, central Florida leads the rest of the State in number of noted persons, as it does in schools and many other things. The 1920 edition of that work lists 41 persons who have homes in central Florida, which is about one to each 7,000 of the population, as compared with about one to 10,000 in the whole State, and one to 4,500 for the whole United States. If whites alone were considered the ratio would be about one to 5,000 in central Florida, one to 7,000 in the whole State, and one to 4,000 in the whole country. Just how many natives of our area are listed it would be impossible to tell without examining over 20,000 biographical sketches, as they are not indexed by birthplaces.

CHURCHES

Statistics of churches have been gathered by every United States census from 1850 to 1890, and later by special inquiry between the regular census periods, in 1906 and 1916. The information is obtained not by asking each person what church he belongs to, if any (which is done in some European countries, but would be repugnant to American ideas), but by correspondence with church officials. It is therefore hardly as accurate as most census data, but it will suffice to show the prospective settler what to expect here in that particular.

A source of considerable uncertainty is that different churches have different criteria of membership, some counting all baptized persons, including infants, and some only those who have joined the church voluntarily. (If the statistics were restricted to adults we would have a fairer basis of comparison.) Another minor difficulty is that one comparatively new denomination (which has quite a large following among persons of leisure, mostly in northern cities) refused to give any information about its membership for the enumeration of 1916, according to the census volume. For these reasons it is hardly worth while to estimate the ratio of church members to total population, but in most parts of the United States it amounts to less than half.

The data for 1916 (published early in 1920) only are used here. It would have been more or less interesting to give some 1906 figures for comparison, but the differences probably would not be pronounced enough to warrant the extra labor, and in 1906 the white and colored Baptists were not separated in the county tables. The leading denominations in each region have already been indicated in the regional descriptions, but without giving percentages, on account of the uncertainties mentioned above and below. For this reason the regions are not contrasted in the following table, which gives statistics for the whole State, central Florida with and without Hillsborough County, and the city of Tampa by itself, the last to illustrate conditions in a city with a large foreign-born population.

White and negro churches are tabulated separately, but there is some uncertainty about apportioning the Northern Methodists, both branches of Presbyterians, and some smaller denominations between the two races, for the census did not divide these according to race for areas smaller than states; but it has been assumed that the ratio between white and colored members is the same in central Florida as in the whole State. Denominations making up less than 1% of the total church membership are here grouped together under the head of "all others." The figures in the table are percentages, and should add up to about 100 in each half of each column.

TABLE 27.

Relative Strength of Leading Religious Denominations in Central Florida, 1916.

	Whole State	Central Florida		
		Total	Without Hillsborough County	City of Tampa
White Churches				
Adventist (2 branches)	1.6	1.2	1.1	1.9
Southern Baptist	30.9	29.0	31.8	20.2
Primitive Baptist	1.0	1.1	1.0	0
Church of Christ	1.5	1.4	1.4	1.0
Disciples of Christ	2.0	2.4	2.6	2.3
Congregationalist	1.5	2.1	2.5	0.7
Greek Orthodox	0.9	2.4	3.5	0
Methodist (Northern)	2.3	3.3	2.4	1.6
Methodist (Southern)	27.6	28.2	30.2	28.6
Presbyterian (Northern)	1.2	1.6	2.5	0
Presbyterian (Southern)	5.4	5.7	5.7	7.4
Protestant Episcopal	4.9	4.9	5.0	6.6
Roman Catholic	13.0	13.3	6.8	13.7
All others	6.2	3.3	3.2	15.8
Negro Churches				
National Baptist	50.5	46.9	48.0	43.6
Primitive Baptist	2.5	6.9	3.2	0
Northern Methodist	5.8	6.9	8.8	15.4
African Methodist	28.6	26.3	25.8	29.1
A. M. E. Zion	8.4	11.3	12.1	7.5
Colored Methodist	2.0	1.4	1.4	1.2
Presbyterian (Northern)	0.2	0.2	?	?
Protestant Episcopal	0.9	?	?	3.1
All others	?	?	?	?

The figures for Roman Catholics seem surprisingly small for Tampa, with its large Latin population, but if West Tampa was included the results would doubtless be different.* The only Greek church reported in central Florida in 1916 is in Tarpon Springs, and claimed 1,500 members; but it could hardly seat a third of that number at one time. Outside of Tampa and its suburbs and other cities the Catholics seem to be most numerous along the western edge of the Hernando hammock belt in Pasco County, as indicated in the description of that region. The Baptists and southern Methodists have their greatest strength in the rural districts, as elsewhere in the South.

POLITICAL PARTIES

Without going into historical details, or making allowance for inevitable periodical fluctuations, we may take the results of the presidential election of 1916 as a fair indication of the average political complexion of the white population of central Florida (for comparatively few negroes vote in Florida now) in recent years. In that election 67.3% of the votes cast in the area under consideration were Democratic, 19.7% Republican, 6.6% Socialist, and 6.2% Prohibitionist. The proportions for most of the regions vary so little from this that it is hardly worth while to tabulate them,† and those for the whole State are almost exactly the same.

In 1920, when conditions were somewhat abnormal, about 60% of the vote in central Florida was Democratic and 30% Republican, and conditions in the whole State were very similar.

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*The city of Tampa contains over half the population of Hillsborough County, but only 28.3 per cent of the Catholics, if the census figures are correct. Most of the remainder may be in West Tampa.

†The principal exception is Osceola County, where the Democrats had a safe majority in 1912, only a plurality in 1916, and a minority in 1920. (Only two other counties in the State had Republican majorities at the last election, and they were both farther south.)

AGRICULTURE

CONDITIONS PREVIOUS TO 1887

Although farming has long been one of the most important industries in central Florida, as in most other parts of the United States, it has had its greatest development only in the last few decades. In 1850, when the number and acreage of farms was first returned by the census, there were only about 600 farms in our whole area, and over half of them were in Marion County, presumably in the hammock belt, which has the richest soil. Only a little over one per cent of the whole area was in farms, and one-fifth of that improved, making 2.66 improved acres per inhabitant, which would hardly be enough to feed the population if they depended entirely on field and garden crops for their sustenance. As there were no railroads in peninsular Florida then it is not likely that any appreciable quantity of food was imported, but fish and oysters contributed something to the larder of people living near the coast, and in the interior grazing cattle and hogs in the pine woods seems to have yielded more revenue than tilling the soil. Large plantations worked with slave labor, such as were common in other southern states, were almost unknown here, except for a few in the hammock belt north of Ocala.

In the next ten years the number and average size of farms nearly doubled. Marion County still had the lion's share of the farm land and buildings, but considerably less than half the total number of farms and live-stock, showing that the farmers in other counties depended more on meat than on vegetables. The development of agriculture in central Florida as a whole from 1850 to 1880 is shown in Table 28, but the regions cannot very well be separated on account of the large size of the counties in those days, as already explained.

The number of farms more than doubled between 1860 and 1870, but their average size decreased, doubtless because the Civil War made many former slaves farm proprietors, and their holdings were naturally smaller than those of the whites. The amount of improved land fell off between 1870 and 1880, but outside of Marion County there was an increase, which would seem to indicate that the rich hammock lands were becoming impoverished

TABLE 28.

Agricultural Statistics of Central Florida, 1850-1880.

	1850	1860	1870	1880
Per cent of land in farms	1.2	3.8	5.7	7.6
Per cent of land improved	0.2	1.0	2.0	1.6
Improved acres per inhabitant	2.7	4.6	6.7	3.1
Inhabitants per farm	12.6	17.3	10.0	8.7
Total acres per farm	172.3	291.6	187.6	136.0
Improved acres per farm	33.5	79.5	66.6	27.6
Value of land and buildings per farm ($)	1195	2550	578	1354
Value of implements and machinery per farm	172	119	42	29
Value of livestock, poultry, etc., per farm	696	1149	583	278
Number of slaves per farm	4.3	7.3	------	------
Number of horses per farm	1.8	2.2	1.1	1.2
Number of mules per farm	0.5	1.5	0.7	0.2
Number of work oxen	0.9	0.7	0.3	0.7
Number of milch cows per farm	22.4	27.4	6.1	1.7
Number of other cattle per farm	74.1	102.0	50.0	26.4
Number of sheep per farm	0.8	3.2	0.4	1.4
Number of hogs per farm	37.4	43.0	13.5	13.2
Number of chickens per farm	------	------	------	16.0
Number of other poultry per farm	------	------	------	5.7
Expenditure for fertilizers, per farm	------	------	------	$2.91
Value of animals slaughtered, per farm	295.60	154.00	42.40	$285
Value of orchard products, per farm	0.26	4.09	6.17	
Value of market garden produce, per farm	0.47	0.61	0.04	
Value of staple crops, per farm	------	------	------	

from long cultivation, and the farmers were seeking fresher fields elsewhere. At the same time the number of farms nearly doubled, perhaps indicating a large immigration of small farmers from northern Florida or other states and countries. In 1880 commercial fertilizers were just beginning to be used, the expenditure for them the previous season having been at the rate of 11 cents for each acre of improved land in the whole area (only about 2 cents in Marion County, and none at all in Hernando).

CONDITIONS IN 1889-90 AND 1894-5.

The establishment of Citrus, Lake, Osceola and Pasco Counties in 1887 made it possible to use the 1890 statistics for separate regions, as shown in Table 29. But the percentage of farm land and improved land cannot be estimated accurately for those regions that cover less than half of any one county, which accounts for some blanks in the first two lines of figures.

TABLE 29.

Agricultural Statistics of Central Florida, by Regions, 1889-90.

REGIONS	Gulf hammock	Lime-sink	Mid. Fla. hammock	Hernando hammock	Lake	S. W. flatwoods	S. E. flatwoods	East coast	Central Florida	Whole State
Per cent of land in farms	22.8	------	------	------	15.7	9.1	0.6	------	10.8	10.45
Per cent of land improved	6.2	------	------	------	3.2	1.6	0.2	------	2.5	3.26
Improved acres per inhabitant	4.35	3.83	3.14	3.05	2.22	0.91	*0.58*	0.68	2.41	2.92
Inhabitants per farm	*5.05*	10.0	9.60	6.03	5.97	19.2	40.7	21.8	8.54	11.42
Per cent of owners and managers	*86.3*	92.4	89.8	92.5	97.9	98.5	92.2	100	94.6	76.3
Acres per farm	80.2	136.3	97.2	97.3	*66.7*	100.0	88.0	114.5	87.0	107.2
Improved acres per farm	21.9	38.8	30.2	18.5	*13.5*	17.4	23.4	14.8	20.5	33.5
Value of land and buildings per farm	3450	*1905*	3925	2650	4850	3810	2920	10,800	4000	2122
Value of implements and machinery per farm	30	46	43	28	41	42	38	*27*	39	34
Value of live stock, poultry, etc., per farm	164	253	225	189	*106*	294	621	233	196	208
Number of horses per farm	1.0	1.6	1.1	1.0	0.6	1.2	2.3	0.6	0.9	0.93
Number of mules per farm	0.1	0.1	0.3	0.2	0.1	*0.1*	0.3	0.2	0.2	0.28
Number of work oxen per farm	0.1	0.2	0.2	0.1	*0.1*	0.7	1.5	0	0.2	0.52
Number of milch cows per farm	*1.6*	4.9	4.3	2.7	2.3	4.9	15.7	1.7	3.4	3.31
Number of other cattle per farm	11.0	14.5	*7.3*	10.3	8.0	20.1	76.3	18.5	12.0	10.3
Number of sheep per farm	2.1	1.8	2.9	0.8	0.1	3.7	0.	*0*	1.5	2.87
Number of hogs per farm	10.1	15.2	10.0	11.2	*2.2*	10.5	13.9	1.8	7.6	10.9
Number of chickens per farm	*15.9*	26.2	25.5	20.6	17.2	33.2	39.6	35.7	18.7	26.8
Number of other poultry per farm	*0.4*	2.0	2.2	0.7	0.5	0.9	3.4	1.4	1.0	2.38
Expenditures for fertilizer per farm	7.00	*3.74*	24.30	7.65	87.00	17.80	22.80	54.60	44.10	25.00
Do. per acre improved	.77	*.10*	.81	1.42	6.42	1.02	.97	3.68	2.15	0.75
Value of products per farm	228	272	394	*168*	381	517	380	852	348	352

The expenditure for fertilizers per acre was nearly twenty times as much as in 1879-80, and the results are shown in the increased population, improved land, and value of products. By this time the Middle Florida hammock belt had lost its leadership in every particular that the table shows (but doubtless still led in improved land percentage) and the most progressive farming was in the lake region and east coast strip.

The report of the State census of 1895, although a little pamphlet of only 27 pages, and less than a third of that devoted to agriculture, gives some valuable information about conditions just after the freeze of February, 1895. (See chapter on climate.) This seems to be the first census to give the expenditures for farm labor (to which the value of board furnished laborers is added). As the expenditures and receipts are those for the year 1894, while the number and size of farms are as of the summer of 1895, when considerable acreage had been abandoned on account of the freeze, the expenditures and receipts per acre are somewhat exaggerated, as was clearly recognized at the time. But probably where a whole farm had been abandoned and there was no one to answer for it, its operations in 1894 were not counted at all, so that it did not affect the ratios per farm or per acre. The amount of improved land showed an increase over that of 1890, in spite of the calamity.

There are some omissions and inconsistencies in the returns (perhaps mostly the fault of the printers), so that it is hardly worth while to give statistics for separate regions. The next table therefore gives only the results for central Florida, the rest of the State, and the whole State. As far as statistics per farm are concerned the rest of the State is practically the northern third; but the vast uninhabited areas of South Florida of course affect the percentage of farm land and improved land.

If labor and fertilizers were the only expenses, and every farm occupied by only one family, it would appear that the difference between expenses and receipts, or the value of the labor of the average farm family in a year, was about $546 in central Florida and $553 in the rest of the State; but if we had all the facts central Florida should rank higher in this respect than the rest of the

State, on account of having a larger proportion of white farmers, if for no other reason. But as the northern Florida farms were considerably larger, many of them must have required the services of more than one family. In value of products per acre, however, central Florida was far ahead of northern Florida then, as now.

TABLE 30.
Agricultural Statistics of Central Florida and the Rest of the State, 1894-5.

	Central Florida	Rest of State	Whole State
Per cent of land in farms	10.24	10.60	10.50
Per cent of land improved	3.04	3.43	3.33
Improved acres per inhabitant	2.24	2.62	2.51
Inhabitants per farm	9.73	14.05	12.21
Average number of acres per farm	73.3	118.7	99.3
Average improved acres per farm	21.8	36.8	31.4
Value of land, fences and buildings per farm	1820	788	1155
Value of implements and machinery per farm	55.55	22.10	34.10
Expenditures in 1894, per farm, for			
Labor, including board furnished	52.20	28.00	36.80
Fertilizers	37.20	9.10	19.20
Value of products in 1894, per farm	635	590	607
Expenditure in 1894, per acre improved in 1895, for			
Labor, etc.	2.40	0.76	1.17
Fertilizers	1.71	0.25	0.61
Value of products in 1894, per acre improved in 1895	29.20	16.00	19.30

In comparing values for 1895 with those for other periods it is well to bear in mind that a year or two after that average commodity prices reached the lowest ebb ever known in the whole history of the United States, or in other words, the purchasing power of the dollar was greatest.

CONDITIONS IN 1899-1900 AND 1904-5.

For 1899-1900 we have more complete agricultural data than ever before. For the first time the farmers are divided according to race, and the value of buildings separated from that of land and fences; but there are no separate statistics for white and colored farmers for areas smaller than states, except in regard to land tenure. Goats and bees are also returned for the first time.*

*Cattle are subdivided rather minutely as to age and sex, but for our purposes that has been a drawback rather than an advantage, for it necessitates adding together several figures in the same line to get the number of cows, steers, etc., and even then the results may not be strictly comparable with those of other censuses.

TABLE 31.

Agricultural Statistics of Central Florida, by Regions, 1899-1900.

REGIONS	Gulf hammock	Lime-sink	Mid. Fla. hammock	Hernando hammock	Lake	S. W. flatwoods	S. E. flatwoods	East coast	Central Florida	Whole State
Per cent of land in farms	21.8	------	------	------	11.8	12.2	4.9	------	10.2	12.4
Per cent of land improved	5.5	------	------	------	2.9	2.6	0.5	------	2.5	4.3
Improved acres per inhabitant	3.32	2.56	2.98	2.24	2.28	------	1.53	1.41	1.87	2.87
Inhabitants per farm	*8.33*	12.76	9.70	10.20	9.10	------	9.73	8.40	12.44	12.94
Per cent of farmers white	83.6	32.3	*49.4*	87.3	92.8	94.9	99.2	94.1	81.7	66.9
Per cent of owners and part owners	89.8	81.7	82.3	85.1	*75.2*	88.1	90.0	80.0	83.1	71.0
Acres per farm	109.2	109.0	79.9	74.5	84.0	71.6	155.7	*62.0*	86.5	107.0
Improved acres per farm	29.0	32.7	28.8	22.8	20.7	15.5	14.9	*11.8*	23.2	37.1
Value of land per acre ($)	6.20	*5.49*	6.03	7.93	19.30	25.00	7.67	43.20	13.00	7.06
Value of land per farm	678	588	*482*	590	1620	1790	1190	2680	1138	756
Value of buildings per farm	205	232	279	290	513	406	*187*	785	376	242
Value of implements and machinery	58	38	44	46	57	52	*31*	43	48	48
Value of live stock, poultry, etc.	338	358	*206*	330	260	252	2210	260	362	273
Number of dairy cows per farm	2.27	3.04	2.60	2.47	*1.54*	2.74	5.28	1.09	2.36	1.93
Number of steers	7.70	5.20	*1.98*	4.72	2.25	3.22	39.40	2.46	4.96	3.89
Number of other cattle	20.8	21.4	*7.56*	19.6	13.7	11.6	176.3	13.3	21.8	12.6
Number of horses	1.85	1.66	1.25	1.40	0.86	1.04	2.70	*0.43*	1.26	1.05
Number of mules	0.16	0.12	0.17	0.15	0.18	0.10	*0.06*	0.13	0.15	0.33
Number of sheep	1.49	3.00	1.56	1.56	0.81	3.86	13.15	*0*	2.73	3.05
Number of goats	2.30	1.76	1.90	1.66	0.03	0.39	0.28	*0*	1.00	1.07
Number of hogs	12.5	16.9	10.3	16.0	9.3	8.9	19.0	*8.3*	12.1	11.1
Number of chickens and guineas	40.7	25.8	29.4	27.9	20.4	41.2	*13.9*	18.5	28.8	27.1
Number of other poultry	1.8	1.5	1.6	1.1	1.0	1.1	1.0	*0.6*	1.26	1.87
Number of colonies of bees	0.68	0.51	*0.38*	0.46	1.11	0.65	0.67	2.30	0.86	0.97
Expenditures per farm, 1899 for labor ($)	39.40	25.10	50.30	34.40	77.20	36.50	*13.92*	112.00	53.60	36.00
For fertilizer	23.80	*1.45*	12.55	9.60	36.20	34.75	7.65	62.30	23.60	18.45
Value of products per farm	389	340	376	378	*282*	461	647	338	374	396
Expenditures in 1899 per acre improved 1900.										
For labor	1.43	*0.76*	1.74	1.51	3.72	2.37	0.94	9.48	2.30	0.97
For fertilizer	0.86	*0.04*	0.43	0.42	1.74	2.25	0.51	5.26	1.01	0.50

The Middle Florida hammock belt has negroes in the majority among the farmers, as in total population. The eastern division of the flatwoods leads in live-stock, as before, and the east coast strip in value of farm land and intensity of farming, despite its rather poor soils.

The State census of 1905, under the direction of H. S. Elliot,* gave much the same sort of information about agriculture as did the federal census five years before, and under the head of live-stock made a distinction between "native" and "thoroughbred" cattle, though the oxen and dairy cows counted may be of both kinds. But the total value of livestock in each county is obtainable only by adding up the figures for several different kinds, which has not been done, as it would involve some duplication for the reason just mentioned, and besides, the live-stock values are more or less interspersed with other things in the county tables, making it rather irksome to pick them out. It would be a still greater task to get the quantity and value of various crops and animals for the whole State, for that would necessitate adding the figures for each kind for the whole 46 counties, which was not done in the census volume. In getting the total value of farm products there is still another difficulty, namely, the county totals as published seem to include not only crops and animal products, but also the value of all animals on hand, which makes a considerable exaggeration.

The number of white and colored farmers was given, but no separate statistics for the two races. As in the other State cen-

*Mr. Elliot, who died June 24, 1920, had charge of practically all the statistical work of the State agricultural department during the last thirty years of his life, and was the author of a 591-page handbook of Florida published in 1904 (see our Third Annual Report, p. 363), and of numerous short articles. He was well informed, careful and conscientious, but too modest to attach his name to his handbook and census reports, and too good-natured to insist on the printers and others who worked under his direction doing their work properly. And some of the typographical and other errors in the census reports are doubtless due to his being inadequately supplied with clerical assistance. There is a brief sketch of his life in the Quarterly Bulletin of the Agricultural Department for July 1, 1920, but it was gotten up on too short notice to do him justice.

suses, typographical errors make the figures for single counties or regions unreliable, but of course they do not affect the totals for the whole area so much. In the next table, as in that for 1895, only three columns of figures are given, one for central Florida, one for the rest of the State, and one for the whole State. St. Lucie County was cut off from Brevard shortly before this census, making the area to be included in central Florida smaller, but not materially affecting the ratios.

TABLE 32.

Agricultural Statistics for Central Florida and the Rest of State, 1904-5.

	Central Florida	Rest of State	Whole State
Per cent of land in farms	13.1	13.7	13.57
Per cent of land improved	4.25	4.75	4.62
Per cent of farmers white	83.0	64.2	68.7
Per cent of farmers owners and managers	91.0	69.1	74.2
Improved acres per inhabitant	2.38	2.73	2.64
Inhabitants per farm	17.6	12.3	13.4
Average number of acres per farm	129.5	97.0	104.6
Average improved acres per farm	41.8	33.6	37.3
Value of farm land per acre ($)	9.48	7.41	7.96
Value of land per farm	1226	721	872
Value of buildings per farm	390	193	247
Value of implements and machinery	49.00	36.80	41.50
Expenditures for labor 1904-5 per farm	58.30	40.50	46.65
Expenditures for fertilizer per farm	62.20	35.40	43.30
Expenditures for labor per acre improved	1.39	1.20	1.25
Expenditures for fertilizer per acre improved	1.49	1.05	1.16
Number of horses per farm	1.24	------	------
Number of mules	.23	------	------
Number of work oxen	.02	------	------
Number of dairy cows	0.64	------	------
Number of "native" cattle	24.20	------	------
Number of "thoroughbred" cattle	0.28	------	------
Number of sheep	3.00	------	------
Number of goats	1.02	------	------
Number of hogs	13.55	------	------
Number of chickens	40.30	------	------
Number of other poultry	3.54	------	------
Number of colonies of bees	0.22	------	------

As before, central Florida leads the rest of the State in percentage of white farmers, size and average value of farms, and intensity of farming.

CONDITIONS IN 1909-10

The federal census of 1910, supplemented by a special report on negro population published late in 1918, affords enough material for several tables, one for all farmers as before and two for whites and negroes separately, besides some for crop values, crop yields, and animal products. Statistics of a few kinds for owners, managers and tenants separately could also have been compiled from the same returns if it had seemed worth while.

The blanks near the top of the first table are due to lack of correspondence between natural boundaries and county boundaries, as before. In the negro population volume the returns from counties with less than 100 negro farmers are less complete that the others, so that some blanks had to be left in one of the tables for that reason.

As these are the most complete agricultural statistics available at this writing, they will be used to illustrate some general principles which have been passed over rather hurriedly in discussing the earlier censuses.

The percentages of farm land and improved land are doubtless highest in the most fertile region, the Middle Florida hammock belt, though there are no statistics to show it, because it covers only a fraction of one county. The number of improved acres per inhabitant is highest and the number of inhabitants per farm lowest in the Gulf hammock region (if Sumter County is a fair representative of it), indicating that agriculture is most important (relative to other industries) there, though the hammock belt would doubtless lead in this respect too if it did not contain the city of Ocala. The other extreme is in Hillsborough County, which contains the largest city.

The largest farms are in the eastern flatwoods, where there is a superabundance of "elbow room," but five-sixths of their area there is unimproved, mostly cattle range. The lime-sink region, where land is cheapest (and easy to cultivate), has the most improved acres per farm.* The east coast strip represents the other

*Conditions there resemble those in the Mississippi Valley in that low expenditures and returns per acre are compensated for by the cultivation of a large number of acres per farm; this being *extensive* as opposed to *intensive* farming.

extreme as far as central Florida is concerned, for reasons apparent after reading the description of that region.

The east coast has the most valuable land per acre, but is surpassed a little in value per farm by the eastern flatwoods, where the farms are over five times as large, on the average. The east coast strip also has the most valuable farm buildings, and therefore presumably the highest standards of living, and the lime-sink region is the other extreme, as far as the statistics show. But in value of implements and machinery the east coast is lowest, on account of the small farms worked mainly by hand labor; and the lake region ranks highest.

The eastern division of the flatwoods, being still mainly in the pastoral stage as far as agriculture is concerned, is far in the lead in the value of live-stock per farm, as well as in number of cattle, horses, and sheep. The Gulf hammock region seems to lead in dairy cows (though this may be due to some error in the census, as suggested elsewhere), the Middle Florida hammock belt (with the largest proportion of negroes) in mules and goats, the lime-sink region in hogs (as in corn and peanuts), and the east coast in bees.

The east coast has the highest expenditures for labor and fertilizers and the lime-sink region the lowest, but no region in central Florida spends as much for feed as the State average, perhaps because there is more winter pasturage here than in northern Florida. The east coast also leads in value of crops per farm and per acre, while the Hernando hammock belt is lowest in crops per farm and the lime-sink region the lowest per acre. The eastern flatwoods and the east coast strip, although adjacent, are opposite extremes as far as the value of animal products is concerned. The value of crops is roughly proportional to the value of land and buildings, and inversely to the illiteracy percentage, though if different states were compared some exceptions to this might be noticed.*

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*For some statistics of farm expenses and receipts in different regions in Florida and in several other states, with a regional map of the State and a discussion of general principles, see the Quarterly Bulletin of the State Agricultural Department, vol. 30, No. 4, pp. 14-26. (Nov.) 1920.

TABLE 33.

General Agricultural Statistics of Central Florida, by Regions, 1909-10.

REGIONS	Gulf hammock	Lime-sink	Mid. Fla. hammock	Hernando hammock	Lake	S. W. flatwoods	S. E. flatwoods	East coast	Central Florida	Whole State
Per cent of land in farms	20.5	------	------	------	------	13.4	8.2	------	12.1	15.0
Per cent of land improved	6.1	------	------	------	3.2	3.7	0.5	------	3.2	5.1
Improved acres per inhabitant	3.43	2.56	3.24	1.74	1.65	------	1.05	1.02	1.37	2.40
Inhabitants per farm	8.8	17.1	12.5	12.9	11.3	------	18.3	11.0	17.8	15.0
Per cent of farmers native white	80.5	80.5	51.1	88.1	80.5	89.5	93.7	75.3	78.8	68.0
Per cent of farmers foreign white	0.5	0.9	2.2	3.6	9.2	4.7	3.3	12.4	5.0	2.4
Per cent of farmers colored	18.9	18.6	46.8	8.4	10.3	5.8	3.0	12.4	16.2	29.6
Per cent of farmers owners	82.4	81.2	86.7	83.8	80.6	89.3	89.4	76.4	84.3	70.8
Per centof farmers managers	0.4	0.7	2.2	1.9	11.9	4.2	2.7	19.9	5.7	2.5
Per cent of farmers tenants	17.1	18.1	11.1	14.3	7.5	6.5	7.9	3.7	10.0	26.7
Average acres per farm	101.2	159.0	101.5	76.8	92.8	57.5	307.0	59.7	93.1	105.0
Improved acres per farm	30.4	43.9	40.5	22.4	18.7	15.6	19.1	11.2	24.5	36.1
Value of farm land per acre ($)	17.92	7.36	14.21	19.65	41.80	63.25	31.35	97.76	32.70	17.84
Value of farm land per farm	1815	1170	1441	1518	3880	3640	6550	5830	3040	1873
Value of buildings per farm	409	340	462	494	1009	649	589	1475	663	489
Value of implements and machinery	123	98	104	87	147	125	99	81	116	89
Value of live stock, poultry, etc.	480	538	454	473	408	440	2090	249	493	411
Number of dairy cows per farm	8.4	3.3	2.6	1.6	1.1	1.5	3.0	0.7	2.2	2.3
Number of other cattle	14.0	26.5	13.7	22.1	16.5	17.0	168.0	11.1	23.1	14.6
Number of horses	1.8	1.6	1.5	1.5	0.9	1.0	2.5	0.5	1.2	0.9
Number of mules	0.2	0.2	0.4	0.2	0.3	0.2	0.3	0.2	0.2	0.5
Number of sheep	2.6	1.1	3.5	1.6	0.2	0.5	9.8	0	2.7	2.3
Number of goats	0.8	2.0	2.4	1.7	0	1.4	1.1	0	1.1	0.9
Number of hogs	22.7	31.4	17.7	22.6	9.8	9.9	16.3	6.9	16.2	16.2
Number of poultry	24.3	29.8	30.2	26.4	21.7	44.8	23.1	18.4	29.4	26.5
Number of colonies of bees	0.26	0.39	0.39	0.44	0.67	0.47	0.68	1.17	0.60	0.78

TABLE 33—CONTINUED.

General Agricultural Statistics of Central Florida, by Regions, 1909-10.

REGIONS	Gulf hammock	Lime-snik	Mid. Fla. hammock	Hernando hammock	Lake	S. W. flatwoods	S. E. flatwoods	East coast	Central Florida	Whole State
Spent in 1909, per farm in 1910, for labor ($)	189	*50*	146	62	190	98	118	294	138	100
For fertilizers	99	*30*	67	32	165	108	48	148	96	72
For feed	43	37	*26*	36	86	117	80	81	69	36
Value of crops in 1909, per farm 1910	895	620	853	*473*	926	696	593	1355	790	723
Value of animal products, per farm 1910	88	222	173	122	121	196	240	*66*	151	144
Spent in 1909, per acre improved in 1910,										
For labor	6.25	*1.13*	3.62	2.75	10.20	6.25	6.20	26.10	5.65	2.76
For fertilizer	3.26	*0.68*	1.67	1.44	8.84	6.90	2.52	13.15	3.92	2.00
For feed	1.40	0.84	*0.65*	1.64	4.63	7.45	4.17	7.20	2.81	1.01
Value of crops in 1909, per acre improved in 1910	29.50	*14.10*	21.00	21.10	49.70	44.25	31.00	120.50	32.20	20.00

TABLE 34.

Statistics of White Farmers in Central Florida, by Regions, 1909-10.

REGIONS	Gulf hammock	Lime-sink	Mid. Fla. hammock	Hernando hammock	Lake	S. W. flatwoods	S. E. flatwoods	East coast	Central Florida	Whole State
Per cent of total	81.1	81.4	*53.2*	91.6	89.7	94.2	97.0	87.6	83.8	70.4
Per cent foreign-born	*0.7*	1.1	4.1	3.9	10.2	5.0	3.4	14.1	6.1	3.4
Per cent owners and part owners	83.5	82.9	87.8	84.5	80.2	89.6	89.1	*79.0*	84.4	79.6
Per cent managers	*0.5*	0.6	3.8	2.0	12.6	4.2	2.7	18.6	6.6	3.3
Per cent tenants	16.1	16.4	8.5	13.5	7.2	6.2	8.2	2.4	9.0	17.1
Average number of acres per farm	16.1	16.4	8.5	13.5	7.2	6.2	8.2	*2.4*	9.0	127.1
Average improved acres per farm	33.8	47.3	56.5	22.3	19.2	15.9	19.5	*11.6*	25.4	37.5
Value of farm land per acre ($)	17.90	*7.25*	15.24	18.30	41.55	63.40	21.30	96.00	33.60	18.83
Value of farm land per farm	2121	*1305*	2295	1410	4110	3740	6720	6125	3540	2390
Value of buildings per farm	472	*379*	687	523	1070	670	598	1590	740	616
Value of implements and machinery	144	113	152	87	155	128	101	*83*	128	109
Number of dairy cows per farm	10.2	3.6	3.8	------	1.2	1.6	------	------	2.7	2.84
Number of work horses per farm	1.8	1.4	1.5	------	0.9	1.0	------	------	1.1	0.94
Number of work mules per farm	0.2	0.3	0.6	------	0.3	0.2	------	------	0.3	0.51
Acres of cotton per farm	0	2.7	0.3	------	0	0	0	0	0.3	4.00
Bales per acre	------	0.2	0.2	------	------	------	------	------	0.2	0.26
Acres of corn per farm	9.8	15.0	14.2	------	2.7	3.4	------	------	6.3	11.7
Bushels per acre	12.9	10.5	12.8	------	14.5	13.9	------	------	12.9	12.0

TABLE 35.

Statistics of Colored Farmers in Central Florida, by Regions, 1909-10.

REGIONS	Gulf hammock	Lime-sink	Mid. Fla. hammock	Hernando hammock	Lake	S. W. flatwoods	S. E. flatwoods	East coast	Central Florida	Whole State
Per cent of total	18.9	18.6	46.8	8.4	10.3	5.8	3.0	12.4	16.2	29.6
Per cent owners and part owners	79.0	74.6	85.6	76.6	83.7	84.3	100	58.5	82.5	49.6
Per cent managers	0	0	0.4	1.2	5.7	5.2	0	28.4	2.5	0.7
Per cent tenants	21.0	25.4	14.0	22.2	10.7	10.4	0	13.2	15.1	49.7
Average number of acres per farm	28.1	68.7	45.3	72.6	39.5	32.1	35.3	31.4	43.5	52.2
Average improved acres per farm	19.7	28.8	22.3	23.6	14.0	13.6	7.1	8.8	19.8	32.8
Value of farm land per acre ($)	18.25	8.63	10.33	18.45	46.80	56.65	33.90	123.00	21.00	12 10
Value of farm land per farm	512	594	468	1340	1850	1820	1197	3860	915	631
Value of buildings per farm	138	168	206	162	495	310	269	656	260	177
Value of implements and machinery	34	32	49	51	74	65	57	63	49.70	40.95
Number of dairy cows per farm	0.6	1.4	1.1	------	0.8	0.6	------	------	1.0	1.08
Number of work horses per farm	1.0	1.2	1.0	------	0.7	0.9	------	------	1.0	0.66
Number of work mules per farm	0.1	0.1	0.1	------	0.2	0.1	------	------	0.1	0.34
Acres of cotton per farm	0	1.9	0.6	------	0	0	0	0	0.5	8.30
Bales per acre	-----	0.18	0.16	------	------	------	------	------	0.17	0.23
Acres of corn per farm	6.2	10.5	8.9	------	2.6	4.8	------	------	7.35	13.0
Bushels per acre	10.4	10.6	10.6	------	13.6	10.8	------	------	10.7	10.8

The tables for white and negro farmers separately present many interesting features which it would take too long to discuss, but most of them can be picked out readily enough with the aid of the bold-face and italic figures. Generally speaking, the negroes are most efficient where they are least numerous, and those on the east coast seem to have nearly as high standards as the whites in some other regions (as already indicated by the illiteracy figures).

The census tells little about the foreign white farmers except their numbers, but by doing a little adding, subtracting and dividing we can ascertain that of those in central Florida in 1910, 90.2% owned their farms, 7.3% were managers, and 2.5% tenants; while the corresponding figures for native white farmers were 84.1, 6.5, and 9.4. This agrees very well with the showing with respect to illiteracy of the rural white and foreign population brought out in an earlier chapter. The nationality of foreign farmers is not given by counties, but a little more than half of the foreign white farmers in Florida in 1910 were in central Florida, and the leading nationalities among them in the whole State were English, German, Canadian, Swedish, Irish, Scotch, and Danish.

The State census of 1915 dealt with population and manufacturing only, but for some years past the State agricultural department has been taking a census of crops, etc., every two years, going into much more detail than the federal censuses; and two of these State censuses have been used in the foregoing pages in determining the relative importance of different crops in each region. The number of acres in cultivation in each county has been given in the last few biennial crop censuses, and the report for 1917-18 gave the number and acreage of farms, but nothing about the color and tenure of farmers, the value of farm property, or the expenses of farming. On account of the limited funds available for these crop censuses the work has to be done rather hastily, and the results are further vitiated by typographical errors, so that it is not safe to use them for statistical work involving ratios and percentages.

CONDITIONS IN 1919-20

At this writing only a few preliminary returns from the federal census of Jan. 1, 1920, are available, not enough to warrant the construction of a table for the different regions; but the following results will indicate in a general way the developments of a decade in central Florida as a whole. The percentage of farm land has increased to 17.9 and of improved land to 5.4, or 1.61 acres per inhabitant. The percentage of white farmers has increased a little, to 85.4, while owners and managers together constitute 89.3% of all farmers, a trifle less than in 1910. The farms are a little larger now, averaging 106.8 acres with 32.2 improved, but this may be due entirely to the larger proportion of white farmers.

The apparent value of land and buildings per farm has more than doubled, being $8,400, but as the dollar of 1920 was probably worth less than half that of 1910, this does not necessarily indicate any increase in rural standards of living. The number of certain animals per farm is as follows: Horses 0.94, mules 0.46, cattle 13.9, sheep 0.78, hogs 12.6. This is a decrease in everything except mules, and probably indicates a further approach to the conditions prevailing in the east coast strip, where very intensive farming is done with a minimum of live-stock. Some of the horses may have been replaced by mechanical tractors, but that change is likely to be much more marked in the next ten years than in the last ten, if the supply of oil holds out. Statistics of farm expenditures and the value of crops and animal products have not yet been received, but it is altogether likely that they will show a notable increase in intensity of farming.

The amount of improved land at present is only about half enough to feed the population, and however much this may be deplored by our patriotic citizens, this part of the country will doubtless continue indefinitely to be a large importer of food; for in order to become self-supporting the farm population would have to increase faster than the city population, something that has never happened to any notable extent in the whole history of the United States, the tendency being constantly in the other direction.

VARIATIONS IN SIZE OF FARMS

All the foregoing agricultural statistics are based on average farms, and tell nothing about how many are below and above the average or how far some may depart from the average. News items about wonderful yields of one crop or another abound in local papers, and the census averages seems so small in comparison with some of these reports as to tend to give the impression that they may be inaccurate or unfair; but it must be borne in mind that it is only exceptional happenings that have much news value, and the doings of the multitudes of farmers (or any other class of people) who rank near or below the average are not likely to be mentioned often.

The U. S. census gives for every state and county, and in many cases for white and colored farmers separately, the number of farms in several different size groups, from which curves can be constructed showing the range of variation in that particular in any county or group of counties. For 1860 and 1870 the grouping was based on improved acreage, but since then on total acreage, which in most parts of Florida and other "piney woods" sections is much less significant than improved acreage, for the greater part of the farm area in this State consists of wild land which does not differ perceptibly from neighboring land that has never been appropriated by farmers.

For this reason, and also because the census does not give statistics of this kind for the two races separately for counties that have less than 100 negro farmers, no size-of-farm curves are presented here,* but some have been drawn for office use, and some of their interesting features may be mentioned briefly.

At all times and in all countries, as far as known, there are more farms below than above the average size, just as most people are below the average in age, education, wealth etc., as explained at the beginning of the chapter on illiteracy. In 1910 both in central Florida and the whole State just about 23.5% of the white farmers had farms above the average in size, while among the

*For a series of such curves for southern Alabama, perhaps the only ones of the kind ever published, see Geol. Surv. Ala., Special Report No. 11, p. 131, August, 1920.

negroes there was greater uniformity, about one-third being above the average and two-thirds below.* In central Florida about 8% of the negro farmers had larger farms than the average white man, while the corresponding figure for the whole State was about 7%, and for Marion County only about 2%. The greatest inequality in our area is in Osceola County, where only 9% of all farms (for both races, but there are so few negroes that the results would be much the same for whites alone) are above the average in size. But the largest farms are cattle ranches, with very little improved land, and if improved land alone was considered Osceola might not show up very different from some of the other counties.

If we only had similar graded figures for acreage of improved land, value of land and buildings per farm, yield of different crops, etc., the results would be very significant. But in the absence of such data we can safely assume that the resulting curves would all be steepest in their higher portions, as we already know to be the case with those for ages of the population, grades of school children (fig. 43), cities arranged in order of size, mountains in order of height, rivers in order of length, etc.

CROPS

Relative Importance

In the regional descriptions the relative importance of the principal crops for 1909, 1913-14 and 1917-18 has been indicated, without specifying how much of the total crop value is contributed by each, except sometimes in the case of one or two near the head of the list. Table 36 shows for each of the more important crops what percent it made in 1909 of the total crop value in each region for which we have statistics, as nearly as can be ascertained from the 13th U. S. census. The value of each crop in each county is not given by the federal census as it is by the State census, but it has been estimated by assuming that the value per bushel, pound,

*From these curves it can be determined that the *median* sizes of farms in the seven central Florida counties that had over 100 negro farmers in 1910 were about 43 acres for whites and 30 for negroes; that is to say, there were just as many farms above as below these sizes. But the *average* sizes for the two races, as shown in Tables 34 and 35, were 102.5 and 43.5 respectively.

or other unit is the same in each county as it is in the whole State. The federal census is also unsatisfactory in that it lumps together the two varieties of cotton and many kinds of vegetables, which are important in Florida, but that at least simplifies the table. The reasons for not using the State census figures for crop value percentages have been given elsewhere.

The percentages in this table are given to the nearest tenth, so that those below .05% are represented by zero, which does not necessarily mean that the crop in question is not raised in that region at all. Crops that do not constitute as much as 1% in any of the regions treated are omitted. The highest figure in each line is printed in heavy type, as usual, but the lowest is in many cases indeterminate. Some of the columns add up more than 100% and some considerably less, doubtless because of great variations in the value per acre of different vegetables, which are not separated by the census.

TABLE 36.

Relative Importance of Different Crops in Central Florida, by Regions, 1909.

CROPS \ REGIONS	Gulf hammock	Lime-sink	Mid. Fla. hammock	Hernando hammock	Lake	S. W. flatwoods	S. E. flatwoods	East coast	Central Florida	Whole State
"Vegetables"	**72.0**	29.5	66.8	19.3	37.6	20.7	8.1	*4.7*	30.4	17.5
Cotton (both kinds)	0.1	5.4	0.7	0	0	0	0	0	0.5	13.4
Cotton seed	----	----	----	0	0	0	0	0	----	1.8
Corn	13.2	**18.4**	13.4	16.9	3.4	5.5	7.8	*0.2*	7.4	15.8
Oats	1.3	**4.1**	3.3	0.6	0	0	0	0	1.0	1.2
Peanuts	2.1	**19.2**	6.2	2.2	0.1	0.1	0	0	2.7	5.9
Irish potatoes	*0.2*	0.3	0.4	0.7	1.8	**3.1**	1.7	0.4	1.3	2.3
Sweet potatoes	1.3	3.8	2.5	5.8	1.9	2.6	**6.6**	*0.7*	2.7	3.4
Tobacco	0	0	0.1	**3.4**	0	0	0	0	0.2	2.8
Hay and forage	1.5	1.3	5.1	0.5	3.7	3.4	**5.6**	0.1	3.4	2.3
Sugar cane (syrup)	1.0	**5.2**	2.5	4.6	0.3	2.7	1.5	0.2	1.9	2.9
Strawberries	0	0	0	1.4	0.1	**2.7**	0	0	1.1	0.8
Oranges	8.2	*3.7*	8.6	16.7	51.8	43.2	**54.3**	51.9	32.5	11.9
Grapefruit	3.3	*0.3*	2.8	3.0	9.9	**18.7**	10.6	12.5	9.8	5.3

Average Yields

The average yield per acre of the leading crops in 1909, which is readily ascertained from the census reports, except for vegetables and orchard fruits, is given by regions in the next table, except that in a region where a given crop is relatively insignificant

its yield has not been computed because the chances of error are too great. For example, if only one or two farmers in a region raise a certain crop their yield in the census year might easily be below or far above the normal, in accordance with the principle set forth a few pages back, so that averages based on them might be very misleading.

"Vegetables" are left out of this table, because so many different kinds, measured in different units, are lumped together in the government census reports. Both federal and State censuses give the number instead of acreage of fruit trees, apparently because some farms have only a few scattered trees whose acreage cannot be measured; but the average number of orange and grapefruit trees per acre is commonly reckoned at 70, and the acreage has been computed on that basis.

TABLE 37.

Average Yield per Acre of Certain Crops in Central Florida, 1909.

CROPS \ REGIONS	Gulf hammock	Lime-sink	Mid. Fla. hammock	Hernando hammock	Lake	S. W. flatwoods	S. E. flatwoods	East coast	Central Florida	Whole State
Corn (bushels)	16.0	*10.6*	12.0	13.3	14.6	13.7	12.4	15.7	11.5	11.6
Oats (bushels)	12.2	13.9	12.8	12.1	13.9	17.7	----	10.0	13.1	14.0
Rice (bushels)	----	----	17.7	17.5	----	23.5	----	----	22.7	19.8
Peanuts (bushels	14.2	22.1	16.3	19.2	15.7	11.9	----	----	18.5	18.4
Hay (tons)	1.0	1.6	*1.0*	1.2	1.1	1.2	1.1	1.5	1.2	1.0
Irish potatoes (bushels)	51.0	72.3	*52.4*	57.4	92.3	87.0	90.8	95.4	84.6	100.8
Sweet potatoes (bushels)	85.7	82.3	*70.8*	101.5	100.1	85.8	105.0	120.0	90.4	94.7
Sugar cane (tons)	*4.0*	7.7	4.4	13.5	7.4	13.9	21.2	13.4	9.4	11.1
Sugar cane (gals. syrup)	164	221	199	*145*	171	155	179	294	178	196
Oranges (boxes)	*81*	138	115	103	119	176	153	115	122	123
Grapefruit (boxes)	152	----	129	146	103	144	121	*98*	129	112
Strawberries (quarts)	----	----	----	----	2130	*680*	1737	----	----	1611	1777

The yield of any crop of course fluctuates from year to year with the weather, etc., but should not change much from one decade to another, except for a slight increase as the population becomes denser, land more valuable, and farming more intensive. Natural fertility of soil seems to have little to do with crop yields, probably because differences in that respect are so easily eliminated by the use of a few dollars' worth of labor or fertilizer, or both. The Middle Florida hammock belt is unquestionably the

most fertile in the area under consideration, but it does not have the highest yield of any crop shown in the table; and the averages for central Florida are close to the State averages, although the soil is doubtless below the State average in fertility.* Density of population has more effect, for the western flatwoods and the east coast strip each lead in three crops.

ANIMAL PRODUCTS

In several of the foregoing tables the number of animals per farm in different regions at different times has been given, but little has been said about the amount of meat, milk, wool, eggs, honey, etc., produced by them. Such information was gathered more completely by the census of 1910 than by any preceding one, and the results as far as they apply to central Florida are shown in Table 38, which as usual has a column for each region, one for the whole area, and one for the whole State.

The census does not give the total production and value of every animal product, but sometimes only the total or only the surplus sold; and the different kinds are lumped together more or less in the returns of values. The results are computed on a per farm rather than a per acre basis, for animals bear no close relation to either total farm land or improved land.

The amount of milk, butter, poultry and eggs sold is roughly proportional to the urban population, and is therefore highest in the western division of the flatwoods, represented by Hillsborough County. Hogs (and therefore animals slaughtered, which are mostly hogs), are most important in the lime-sink region, which raises the most corn and peanuts. Animals sold on the hoof, which are mostly beef cattle, of course lead in the eastern flatwoods. Although that region has the most sheep per farm, they must be raised mostly for mutton, for the Middle Florida hammock belt exceeds it in wool per farm. The east coast leads in honey, but is lowest in most other animal products, on account of the intensive farming which prevails there.

*The value of crops per acre is a different matter, though. In this respect central Florida is over 60 per cent above the State average, as shown in Table 33, not by producing larger yields, but by raising a larger proportion of more valuable crops and less cotton, corn, oats, peanuts, etc.

TABLE 38.

Animal Products per Farm in Central Florida, 1909, by Regions.

REGIONS	Gulf hammock	Lime-sink	Mid. Fla. hammock	Hernando hammock	Lake	S. W. flatwoods	S. E. flatwoods	East coast	Central Florida	Whole State
QUANTITIES										
Milk produced (gallons)	111.0	98.6	180.0	62.1	144.0	309.0	205.0	43.3	162.0	153.4
Milk sold (gallons)	4.2	6.0	14.9	13.7	30.5	214.0	24.2	6.1	60.0	27.8
Butter made (pounds)	25.4	25.8	46.3	15.9	40.4	22.2	58.2	4.5	30.6	34.1
Butter sold (pounds)	2.0	6.0	7.5	4.3	8.4	6.7	2.4	1.5	6.1	6.2
Poultry raised (number)	44.8	47.0	59.8	34.4	35.2	47.1	29.4	25.3	42.0	41.8
Poultry sold (number)	11.9	19.9	18.7	14.0	12.2	24.8	14.6	7.1	16.7	14.6
Eggs produced (dozen)	91.6	139.0	123.0	102.0	98.5	226.0	161.0	86.5	134.0	111.0
Eggs sold (dozen)	29.3	69.8	60.0	59.5	47.2	163.0	44.0	49.7	76.8	56.1
Honey produced (pounds)	1.6	4.4	4.4	3.0	12.4	8.6	9.3	72.2	17.6	15.0
Wool, fleeces shorn	1.3	0.9	2.0	0.8	0.1	0.3	1.5	0	1.3	1.5
Cattle sold or slaughtered	0.9	3.9	2.1	2.8	2.1	1.8	8.0	1.0	2.6	1.7
Hogs sold or slaughtered	2.9	16.6	8.0	6.2	2.9	1.5	4.4	1.2	5.3	7.1
Sheep and goats sold or slaughtered	0	0.7	0.6	0.3	0	0.5	1.3	0	0.4	0.2
VALUES										
Dairy products (excluding milk and cream used at home)	9.70	9.82	20.00	8.75	25.70	80.50	27.80	3.64	29.90	19.45
Dairy products sold	1.93	4.04	8.66	4.79	14.25	75.00	10.12	2.73	21.70	11.55
Poultry and eggs produced	39.00	50.50	51.15	37.90	46.10	79.60	58.00	37.80	45.50	41.00
Poultry and eggs sold	11.86	23.80	22.40	18.95	21.60	52.30	17.70	18.70	27.80	18.75
Honey and beeswax produced	0.18	0.42	0.52	0.39	1.23	0.99	1.17	4.71	1.39	1.21
Wool and mohair produced	0.83	0.62	1.62	0.60	0.08	0.15	1.00	0	1.00	1.27
Animals sold on the hoof	20.00	60.00	41.60	31.30	30.30	24.80	134.60	7.22	39.00	27.00
Animals slaughtered	18.10	101.00	58.20	43.50	17.35	10.10	18.35	12.60	34.20	53.90
All animal products (except home milk, hides feathers, etc.)	88	222	173	123	121	195	240	66	151	144

By comparing the number of animals of various kinds sold or slaughtered in a year with the number living on the average farm at the time of the census we can get a rough approximation of the annual birth and death rate of each species, which in central Florida in 1909-10 was about 10% for cattle, sheep and goats, 33% for hogs, and 143% for poultry.

The difference between the amount of milk, butter, chickens and eggs produced and that sold is approximately that consumed by the average farm family in a year, if none of these products are bought by the farmers, and therefore gives some indication of the standard of living. The farmers of the east coast, however, although they have the most expensive land and buildings and therefore presumably a pretty high standard of living, must buy considerable groceries with the money received for their vegetables and oranges, for otherwise the average family would have only about 37 gallons of milk, 3 pounds of butter, 18 chickens, and 57 dozen eggs to eat in a year, as compared with 92.6 gallons of milk, 19.8 pounds of butter, 27 chickens, and 69 dozen eggs in the lime-sink region, which probably really has the lowest standards. (Very likely the east coast farmers eat more fish and oysters than those in the interior, though.) If such data could only be obtained for whites and negroes separately we would doubtless find considerable differences

MANUFACTURING

The United States census has not published returns of manufacturing for single counties for several decades; and although the State agricultural department has taken censuses of manufacturing at several different periods, and published the returns by counties, omissions and typographical errors make the reports of doubtful value for statistical purposes.* Consequently it is not feasible to treat the subject statistically at this time, but some random observations can be given.

Central Florida is too remote from coal mines and waterfalls for manufacturing to rank high among its industries, though at some future time its vast stores of peat may be utilized as a source of power. (Some notes on water-power were given in the chapter on topography.) The most common kinds of manufacturing establishments are sawmills and turpentine stills, which put the raw products of the pine forests through one or two of the first stages in their preparation for use; and these get their power from pine wood, which is a by-product of the same industries and therefore costs them very little. A few statistics of sawmills have been given in the chapter on vegetation.

Every city has various necessary establishments supplying local needs, such as laundries, bakeries, ice factories, printing offices, and plants supplying water, gas and electricity, and these are classed as factories by the census, but unlike real factories they bring in little or no wealth to the region because their products are not shipped out to any appreciable extent, and it is hardly possible to expand such industries any faster than the population immediately around them grows. (There are of course a few exceptions, such as the plant in DeLand where this report is printed.)

There are quite a number of crate factories, which have a somewhat wider circle of patronage, and a few brick-yards. Cigar boxes are made in Tampa to supply the factories there, and there

*For example in the 1915 census no returns of manufacturing were received from Osceola County, and none of sawmills and turpentine stills from Polk County; and the published figures made it appear that the cigars made in Hillsborough County were worth about six cents apiece and those in Orange County only about half a cent apiece.

is more or less building of ships and boats along the coast. Preserves and other fruit products are made on a small scale in a few places, and the list of small manufacturing industries might be extended considerably if there was any convenient way of getting information about them.

Among factories in the accepted sense of the word, those that employ skilled or semi-skilled labor in large buildings and make finished products to be consumed in other states, the best known are the cigar factories, which are chiefly concentrated in the outskirts of Tampa and operated by Cubans. They use little or no machinery, and fuel and power constitute only about 1/6000 of their total expenses (as compared with more than ¼ in the case of ice factories).*

There is a large fertilizer factory at Inglis, near the mouth of the Withlacoochee River in Levy County, where much of the hard-rock phosphate is exported; and a tractor factory at Oldsmar. Plants for the manufacture of automobile cushions from Spanish moss and of paper from saw-grass are said to be nearing completion at Leesburg.

The U. S. census of 1910 gives a few meager details for all manufacturing industries in Tampa combined, from which the following figures have been extracted. In 1909 there were 215 "factories" (nearly twice as many as in Jacksonville), with a combined capital of $11,610,421, employing about 10,000 persons (over four times as many as Jacksonville). The total expenses were $16,281,003, and the value of products $17,653,021.

TRANSPORTATION

WATERWAYS

The St. John's and Ocklawaha Rivers are navigable for most of their length. Passenger steamers are operated throughout the year on the St. John's as far up as Sanford, and during the tourist season small steamers and launches have for many years carried sight-seers up the Ocklawaha and its tributary, Silver Spring Run.

*A number of original statistics on the efficiency of Tampa cigar-makers under different weather conditions can be found in Ellsworth Huntington's "Civilization and Climate" (1915).

to Silver Springs. There is occasional freight traffic, perhaps less now than formerly, still farther up the Ocklawaha to the large lakes of central Lake County. The Kissimmee River together with lakes and canals affords navigation all the way from Kissimmee to Lake Okeechobee, but as the river is very crooked and the population near it very sparse, there has never been much traffic on it. Much of the phosphate exported from the hard rock district travels a few miles on the Withlacoochee River, from Inglis, the terminus of a short railroad, to its mouth. The lagoons along the east coast have been connected up by short canals, and the shallower stretches deepened, so that boats drawing not more than three or four feet have an "inside passage" the whole length of the coast.

RAILROADS

Central Florida is well supplied with railroads, considering its sparse population, and it is one of the few parts of the United States that has had any railroad building in the last five or six years. In 1880 apparently the only railroads in this area were lines connecting Cedar Keys and Ocala with Jacksonville, and an isolated line from Astor on the St. John's River to Fort Mason on Lake Eustis: about 83 miles in all. By 1891 the mileage had increased more than ten-fold, to 1,026, or about one mile to every 100 inhabitants.

At the beginning of 1920 there were about 1,875 miles of track on which passenger service was operated, making about one mile to every 7.7 square miles or every 160 inhabitants. None of the lines are double-tracked, and the average number of passenger trains is about two each way a day (four or five on some lines in winter, though). Nearly half the present mileage belongs to the Atlantic Coast Line and its subsidiaries, and next in order are the Seaboard Air Line (including Tampa Northern, Tampa & Gulf Coast, etc.), with 28.6%, Florida East Coast, 15.2%, Tavares & Gulf 2%, Ocklawaha Valley, Charlotte Harbor & Northern, and Tampa & Jacksonville.

The mileage of railroads for 1920 is shown by regions in Table 39, which gives also for each region the percentage of the total area, population, and railroad mileage which it has, as nearly as can be estimated.

TABLE 39.

Railroad Mileage in Central Florida, 1920, by Regions, Compared With Area and Population.

Regions	Mileage	Per cent of total		
		Area	Population	Mileage
1. West coast islands	2	0.1	0.3	0.1
2. Gulf hammock region	127	10.3	4.8	6.8
3. Middle Florida flatwoods	25	2.2	?	1.3
4. Lime-sink region	365	15.5	24.6	19.6
5. Middle Fla. hammock belt	43	1.4	4.0	2.3
6. Hernando hammock belt	28	1.3	2.6	1.5
7. Lake region	547	27.5	24.6	29.5
8. Western flatwoods	390	13.5	27.5	21.0
9. Eastern flatwoods	225	25.8	4.8	12.0
10. East coast strip	121	2.8	6.7	6.5

ROADS

In the early days in central Florida, as in other long-leaf pine regions, roads cost practically nothing, for wagons could be driven almost anywhere through the open pine forests. Where small streams had to be crossed it was necessary merely to cut a right of way through the swamp, and if the bottom was soft a layer of poles could easily be put down. In the flatwoods and other low places ditches are often dug on both sides of the road to carry off the water from heavy rains faster than it would flow naturally, and the earth from them used at the same time to elevate the roadbed a little. Little-used roads through the flatwoods are often carpeted with a fine turf of a small sedge, *Eleocharis Baldwinii,* which is more agreeable for both pedestrians and vehicles than the bare sand.

On the uplands where the sand is deep and dry it soon becomes loosened up by the wheels and rather difficult to pull through. The simplest way of getting around this is to start a new trail a little to one side, where the sand has not been stirred up. From this practice there often results a maze of approximately parallel roads, rather confusing to a stranger, who may have no way of knowing whether a fork in the road indicates a junction or a mere siding. (This of course is not peculiar to Florida, but can be seen also in Michigan and elsewhere.)

Where it is not practicable to make new tracks, as for example where there are fences on both sides of the road (for wherever

forests or prairies are much more extensive than cultivated fields it is cheaper to fence the crops and give the cattle and hogs free range than it would be to confine the cattle, and the law gives the animals this freedom in most parts of Florida), some method of improving the road must be adopted if there is much traffic on it. The cheapest road-surfacing material is pine straw (said to have cost about $35 a mile by 1915 prices), which has been used to a considerable extent where there is neither clay nor rock within easy reach. This is ordinarily renewed every year or two. Near sawmills and planing mills sawdust and shavings are often used in the same way.

In many places, particularly in the lake region, sandy clay occurs within a few feet of the surface, and when spread out to the proper thickness and rolled it makes a very good roadbed. In several other regions limestone rock is available, and gives still better results. In the pebble phosphate country a sandy rock that forms part of the overburden in the mines is sometimes used in the same way. Even in the eastern flatwoods and the lake region there are a few deposits of marl near the surface, and that makes as good a road as clay. Near the coasts oyster shells, either from living reefs or from shell mounds, have long been utilized by road-makers, as have other species of shells occurring in the mounds. Before the days of automobiles the shells were usually simply spread out over the surface of the road from time to time and left to be ground up and compacted by wagon wheels.

Since automobiles became common there has been a great development of permanent roadways, and where local supplies of rock, clay, etc., are inadequate, brick and asphalt (fig. 27) have been imported from other states or countries in large quantities. At the present time there is perhaps no equal area in the world that has better roads in proportion to population than central Florida. But in the building of highly improved roads in recent years there has been a regrettable tendency to locate them as much as possible along section lines or parallel thereto. This practice doubtless simplifies negotiations with land-owners and requires less mental exertion than adapting the roads to the topography, but it makes them more expensive to build and maintain and wastes the time of people using them (for two sides of a square are over 40%

longer than the diagonal), to say nothing of the extra wear and tear on tires and steering gear at the numerous square turns, and the danger of accident.

On Sept. 30, 1918, according to the Second Biennial Report of the State Road Department, there were over 1,500 miles of roads classed as improved in the 15 central Florida counties, making 31.9% of the State total, or about one mile to every 200 inhabitants. By kinds of material used they were divided as follows: Marl and sand-clay 25%, asphalt 22.9%, brick 19.3%, shells 16.8%, plain macadam 10.7%, surface-treated macadam 5.24%, concrete 0.14%. About two-thirds of the brick roads in the State are in central Florida, and about two-thirds of the asphalt roads in Polk County alone. Shell roads are confined to the coast counties, or nearly so. There has of course been some road-building since 1918, but later figures are not yet available.

AUTOMOBILES

Central Florida is naturally as well supplied with automobiles as it is with good roads. On March 2, 1920, according to the State comptroller, there were 24,604 cars registered in our 15 counties, which was about 40% of the State total and about one to every 12 inhabitants. The license records as published do not indicate how many of the cars belong to winter visitors who get Florida licenses at the beginning of the year and use them in some northern state all summer, and do not even separate the races; but probably neither tourists nor negroes constitute more than 10% of the total. In the lake region there was about one automobile to every nine inhabitants (and probably about 1 to 6 or 7 among the white population, which means that the majority of white families own at least one, and compares favorably with the figures for Iowa and Kansas, which are often cited as extremes.)

NEWSPAPERS AND OTHER PERIODICALS

From a 1920 newspaper directory of the United States it appears that there are in central Florida about 14 daily, 3 semi-weekly and 46 weekly newspapers (some of the weeklies being weekly editions of dailies, however, and not independent enterprises), besides 10 special publications (mostly weekly) for agriculturists, college students, ministers, motorists, labor unionists, Cubans or negroes. Their average circulation cannot be estimated closely, because the individual figures are not given in some cases, some papers are printed only part of the year, some have a larger circulation in winter than in summer, etc. But there must be about 450,000 papers printed each week, enough to give every family, white and black, a paper every day. This is doubtless above the State average, for in 1909, according to the census, the aggregate circulation of all periodicals printed in Florida was about 700,000 per week, or four a week per family.* Of course many copies, especially of Tampa papers, go outside of central Florida, but this must be much more than counterbalanced by publications coming in from other sections and states, and the total number of papers read may be as much as two a day per family, or three a day per white family.

It is hardly worth while to give statistics by regions, for probably no paper has its circulation confined to one region; but outside of Tampa those of largest circulation are in the western division of the flatwoods, averaging about 5,700 per week normally. Those in St. Petersburg claim a doubled circulation in the tourist season, and one of them distributes its whole edition gratuitously on days when the sun does not shine previous to the hour of printing.

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*In the whole United States at the same time the number of papers printed was about eleven a week per family, but the number read may be much less, for the number coming in from foreign countries must be less than the number exported to Canada, etc.

ADDITIONS AND CORRECTIONS.

Pages 75-76. The statistical tables (Nos. 1-8, 20-22, 24-39) contain over 2,000 percentages, averages and other ratios, about nine-tenths of them new and the remainder copied from census reports, etc.

Page 82. In footnotes and elsewhere there are references to about fifty papers relating to the area treated and thirty others.

Pages 111, 161. A news item from Brooksville a few weeks ago mentioned incidentally a Snow Hill, five miles from there (direction not specified), 368 feet above sea-level. This is probably an exaggeration, but it deserves investigation.

Page 121. Last line of text. For connect read connected.

Page 129. The raising of asparagus "ferns" under partial shade (like tobacco and pineapples) is said to be an industry of some importance around Pierson and Leesburg.

Page 136. There are a few typographical errors in the first paragraph, most of them easily detected.

Page 141. The sanguinary conflicts mentioned in the footnote are probably not so much between stockmen and small farmers as between cattlemen and others who own and fence large areas and those who own little or no land and cut the fences that interfere with the ranging of their animals.

Page 159. Diatomaceous "earth" should have been mentioned after peat. See page 119, also 3d Ann. Rep., pp. 290-291.

Page 160. In second paragraph of first footnote, for April read May. (The article cited was published in April, though.)

Page 165. An important paper on the shell mounds along the St. John's River is that by Dr. Jeffries Wyman in the American Naturalist 2:393-403, 449-463, 1868. Clarence B. Moore has published several articles on the Indian mounds of Florida and other southern States in the Journal of the Academy of Natural Sciences of Philadelphia.

Page 171, first footnote. Fairly typical of most 19th century classifications of Florida soils on a basis of vegetation is a paper (presumably by H. S. Elliot) in the Quarterly Bulletin of the State Agricultural Department for July 1, 1909, pp. 25-36, reprinted in the 11th Biennial Report of the same department, pp. 36-49. 1911.

Page 200, line 3. For "In" read "On."

Page 219, in first line of figures, for 38 read 83.

Page 224, second footnote. Two other noteworthy treatments of animals in geological reports, both published about three years ago, are a 30-page chapter by Howard Cross in Bulletin 27 of the Oklahoma Geological Survey (Geography of Oklahoma by L. C. Snider and others), and S. S. Visher's Geography of South Dakota (S. D. Geol. Surv. Bull. 8). In the latter both plants and animals are classified by habitat.

Page 244. About 30,000 visitors are said to have registered at St. Petersburg in the season of 1920-21, with Ohioans in the lead, as before.

Page 245. The size-of-farm curves mentioned here were not published, for reasons explained on page 274. The 1915 State census of Iowa grades the whole population according to education, as stated on page 253.

INDEX

This index is intended to include references to all important topics in the whole volume (though at least nine-tenths of it pertains to pages 71-288, on the Geography of Central Florida) that are not sufficiently indicated by the tables of contents or common to all the regional descriptions or several or many of the statistical tables, except the species of foraminifera, which are indexed separately on page 70. Numbers in parentheses indicate pages on which the topics in question are referred to indirectly or under different names.

Technical names of plants (about 230 species) and animals are italicized. Where only a generic name is given it means either that there is only one species of that genus in central Florida, or that the identity of the one mentioned is uncertain, or else that the statement referred to applies to several or all of the species of the genus. In order to find all the references to some of the commoner species it may be necessary to look up both technical and common names in the index. The number of references to different species will give some idea of their relative importance in the area treated, which might not always be apparent otherwise.

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