FLORIDA GEOLOGICAL SURVEY

EIGHTEENTH ANNUAL REPORT

FLORIDA STATE GEOLOGICAL SURVEY

HERMAN GUNTER, *State Geologist*

EIGHTEENTH ANNUAL REPORT

1925-1926

ADMINISTRATIVE REPORT
MINERAL INDUSTRIES
NATURAL RESOURCES OF SOUTHERN FLORIDA

PUBLISHED FOR

THE STATE GEOLOGICAL SURVEY

TALLAHASSEE, 1927

LETTER OF TRANSMITTAL

To His Excellency, Hon. John W. Martin, Governor of Florida:—

Sir:- In accordance with the law establishing the State Geological Survey there is submitted herewith the Eighteenth Annual Report of the State Geologist. The report contains the administrative section briefly setting forth the activities of the Survey, detailed statement of expenditures, and statistics of mineral production for 1925. The main paper of the report is one entitled "Natural Resources of Southern Florida" which it is believed will give authoritative and useful data on this important section of Florida.

The interest you have shown in the work of this Department and the cordial co-operation given has been appreciated.

HERMAN GUNTER,
State Geologist.

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ADMINISTRATIVE REPORT

HERMAN GUNTER, *State Geologist*

Establishment.—The Florida Geological Survey has been functioning for twenty years, having been created by an Act of the Legislature of 1907, approved June 3, 1907. The act establishing the Survey provides for the appointment of a State Geologist by the Governor, specifies his duties and place of office. The objects of the Survey were also outlined and a continuing appropriation of $7,500 a year was made for its maintenance. Other provisions of the law are that the State Geologist shall make to the Governor annually a report of the progress made by the Survey.

Publications.—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. The reports of the 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.

Those annual reports followed by an asterisk (*) are no longer available for distribution as a whole volume, owing to exhaustion of the 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 (†).

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 Geological 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 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 re sources 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, 1921, 307 pp., 3 pls., 43 figs.*

This report contains: (1) Oil prospecting in Florida; (2) statistics of mineral production, 1918; (3) foraminifera from deep wells†; (4) geography of central Florida.

Fourteenth Annual Report, 1922, 135 pp., 10 figs., one map.

This report contains: (1) statistics on mineral production, 1919 and 1920; (2) on the petroleum possibilities of Florida, including a geologic map.

Fifteenth Annual Report, 1924, 266 pp., 2 pls., 55 figs.

This report contains: (1) Administrative report and statistics on mineral
This report contains: (1) Administrative report and statistics on mineral
production, 1921 and 1922; (2) a contribution to the late Tertiary and Quaternary paleontology of northeastern Florida; (3) a preliminary report on the clays of Florida.

Sixteenth Annual Report, 1925, 203 pp., 52 figs., two maps.

This report contains: (1) Administrative report and statistics on mineral production, 1923; (2) a preliminary report on the limestones and marls of Florida.

Seventeenth Annual Report, 1926, 275 pp., 5 figs., two maps.

This report contains: (1) Administrative report and statistics on mineral production, 1924; (2) History of Soil Investigation in Florida and Description of New Soil Map; (3) Generalized Soil Map of Florida (in colors); (4) Elevations in Florida; (5) Review of the Structure and Stratigraphy of Florida.

Eighteenth Annual Report, 1927. (this volume)

This report contains: (1) Administrative report and statistics on mineral production, 1925; (2) Natural resources of southern Florida.

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 anaylses 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.

No. 12. Phosphate Industry of Florida during 1920, May 9, 1921.

Personnel.—During the fiscal year the Survey force, in addition to the State Geologist, consisted of D. Stuart Mossom, Assistant Geologist, Roland M. Harper, temporary assistant, and Mrs. Mary H. Carswell, stenographer. Mr. Mossom prepared the paper entitled "A Review of the Structure and Stratigraphy of Florida with Special Reference to Petroleum" which appeared in the Seventeenth Annual Report and Dr. Harper contributed to that report the paper on "History of Soil Investigation in Florida and Description of the New Soil Map." The paper on "Natural Resources of Southern Florida," in this volume, is by Dr. Harper and is a continuation of his geographical studies of northern Florida (Sixth Annual Report) and central Florida (Thirteenth Annual Report).

Co-operation.—A fund of $5,000 made available by Act of the 1925 Legislature provided for co-operation with the Bureau of Soils, United States Department of Agriculture. As a result field work was begun in December, 1925, on the detailed mapping of the soils of Polk County. In addition co-operation has been carried on with the United States Geological Survey in revising a report of the geology of Florida to be accompanied by a geologic map. This work was carried on by Dr. C. Wythe Cooke of the Federal Survey and Mr. D. Stuart Mossom of the Florida Survey, field work being completed in March, 1927. As in former years co-operation was continued with the United States Bureau of Mines

and the Bureau of Census in the collection of statistics on mineral production in Florida. This co-operation has been found mutually advantageous since it avoids duplication of work and possible discerpancies in statements which might occur if statistics were collected by each individual agency.

It is regretted that funds asked for co-operation in topographic mapping and in water resources investigations, in successive budgets of the Geological Survey, have not been granted. The topographic map is an essential in developmental work and would prove of untold value to the State in the construction of roads, canals, drainage, flood control, and industrial lines. The water resources are one of the most valuable assets that the State possesses and while the Survey has some data much is yet needed and a special fund for detailed investigations should be made and is urgently recommended.

Appropriation.—The law establishing the Survey has in no wise been changed. The appropriation for the maintenance of the Survey was increased by the Legislature of 1923 to $10,345 annually for the fiscal years July 1, 1923 to June 30, 1924, and July 1, 1924 to June 30, 1925. For the biennium 1925 to 1927, the appropriation was increased and apportioned as follows:

Salary of State Geologist	$3,300	
Salary of Assistant Geologist	2,200	
Temporary Assistant	1,200	
Stenographer	1,500	
Traveling Expenses and Field Equipment	2,500	
Printing, Stationery and Engraving	2,500	
Postage	400	
Auto truck for field work	600	
Co-operation U. S. Bureau of Soils, for the two years		$5,000

The following itemized list shows the expenditures of the Survey from July 1, 1925 to June 30, 1926. All 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.

LIST OF WARRANTS ISSUED FROM JULY 1, 1925 TO JUNE 30, 1926

JULY, 1925

Herman Gunter, State Geologist, salary	$ 275.00
D. Stuart Mossom, Asst. Geologist, salary	183.33
D. Stuart Mossom, Asst. Geologist, expenses	103.40
R. M. Harper, Assistant, salary	183.33
Mary H. Carswell, Stenographer, salary	125.00

W. H. May, Postmaster, stamps	50.00
The Record Company, publishing 16th Annual Report	1,301.00
Dixon's Transfer, hauling 6 boxes reports	2.50
James Messer, automobile truck	600.00
Southern Telephone & Construction Co.	3.25
H. E. Bierly, 2 vols. Palaeontology, Nicholson & Lydekker	8.00
Underwood Typewriter Company, 1 No. 5 typewriter	60.53
A. Hoen & Company, 100 copies State base maps	24.96
D. A. Dixon Company, supplies	9.65
Stanley Rule & Level Plant, 4 hammers	5.54
Orlando Potteries, display pottery	5.35
Underwood Typewriter Company, 1 portable typewriter	40.50
Middle Florida Ice Company	2.70
American Railway Express Company	1.41
W. H. May, Postmaster, stamps	50.00
H. H. Bohler, lettering Ford	8.00

AUGUST, 1925

Herman Gunter, State Geologist, salary	$ 275.00
D. Stuart Mossom, Asst. Geologist, salary	183.33
D. Stuart Mossom, Asst. Geologist, expenses	39.15
R. M. Harper, Assistant, salary	183.33
R. M. Harper, expenses	54.23
Mary H. Carswell, Stenographer, salary	125.00
Southern Telephone & Construction Company	3.25
Middle Florida Ice Company	2.60
American Railway Express Company	.75
W. S. Tyler Company, sieves	26.73
G. E. Stechert & Company, 1 book	8.08
Natural History, subscription	3.00
Dixon's Transfer, freight and drayage	.85

SEPTEMBER, 1925

Herman Gunter, State Geologist, salary	$ 275.00
Herman Gunter, State Geologist, expenses	65.32
D. Stuart Mossom, Asst. Geologist, salary	183.33
D. Stuart Mossom, Asst. Geologist, expenses	7.35
Mary H. Carswell, Stenographer, salary	125.00
Southern Telephone & Construction Co.	3.25
D. A. Dixon Company, supplies	1.60
Seaboard Air Line Rwy. Co., fare to Washington and return	72.74
American Railway Express Company	1.88
Middle Florida Ice Company	2.60
P. C. Keesee, lettering signs, American Legion Exhibit	10.00
Empire Printing & Box Company, paper trays	12.00
N. B. Davis, printing and developing films	3.88

OCTOBER, 1925

Herman Gunter, State Geologist, salary	$ 275.00
Herman Gunter, State Geologist, expenses	144.29
D. Stuart Mossom, Asst. Geologist, salary	183.33
D. Stuart Mossom, Asst. Geologist, expenses	4.50
Mary H. Carswell, Stenographer, salary	125.00
Southern Telephone & Construction Company	3.25
Middle Florida Ice Company	2.70
Manufacturers Record, subscription	10.00
The American Fertilizer, subscription	3.00

Engineering & Mining Journal Press, subscription	5.00
D. A. Dixon Company, 3 chairs	35.60
Service Print Shop, printing	20.50
Standard Oil Company, coupon book for gasoline	19.60

NOVEMBER, 1925

Herman Gunter, State Geologist, salary	$ 275.00
D. Stuart Mossom, Asst. Geologist, salary	183.33
D. Stuart Mossom, Asst. Geologist, expenses	27.32
Mary H. Carswell, Stenographer, salary	125.00
Southern Telephone & Construction Co.	3.25
Middle Florida Ice Company	2.40
McGraw-Hill Book Company	3.00
Chas. G. Stott Company, 2 I. P. Sheet Holders	4.00
L. B. Marshall, copying mineral statistics	4.44
Hills Book & Jewelry Company, fixing kodak	7.50
James Messer, grinding valves etc., on Ford	5.15
Gulf Publishing Company, subscription to Oil Weekly	8.00
D. A. Dixon Company, supplies	10.70
American Railway Express Company	3.45
Tallahassee Variety Works, making chest of drawers	50.00
Rhodes Hardware Company	1.70

DECEMBER, 1925

Herman Gunter, State Geologist, salary	$ 275.00
Herman Gunter, State Geologist, expenses	5.82
D. Stuart Mossom, Asst. Geologist, salary	183.33
D. Stuart Mossom, Asst. Geologist, expenses	10.95
Mary H. Carswell, Stenographer, salary	125.00
R. M. Harper, Assistant, salary	183.33
James Messer, field car and equipment	514.15
Western Union Telegraph Company	2.37
James Messer, car and equipment for soil survey work	514.15
H. H. Bohler, lettering cars	33.00
Southern Telephone & Construction Company	3.25
C. H. Ellacott, lettering index map	2.50
Tophams, 2 leather note book cases	12.00
American Railway Express Company, 1 box maps	3.66
Dixon's Transfer, freight and drayage	12.65
Newell B. Davis, photographs	14.40
Rock Products, 3 years' subscription	5.00
H. A. O'Leary, books and magazine articles	3.38
Florida Real Estate Bureau, Florida Old and New	1.00
Wrigley Photo-Engraving Corp., zinc etching index maps	6.20
Artcraft Printers, letter heads, receipts and envelopes	48.75
A. Hoen & Company, 5,000 soil maps, 200 black maps	427.63
W. H. May, Postmaster, stamps and box rent	26.50
James Messer, repair work on truck	3.50

JANUARY, 1926

Herman Gunter, State Geologist, salary	$ 275.00
Herman Gunter, State Geologist, expenses	79.22
D. Stuart Mossom, Asst. Geologist, salary	183.33
D. Stuart Mossom, Asst. Geologist, expenses	41.62
R. M. Harper, Assistant, salary	183.33
Mary H. Carswell, Stenographer, salary	125.00

E. W. Knobel, Soil Specialist, December expenses	78.08
F. R. Lesh, Junior soil surveyor, December expenses	34.08
The Western Union Tel. Company	3.58
H. & W. B. Drew Company, 2 Paragon scales	8.08
Southern Telephone & Construction Company	3.25
Florida Historical Society, Brevard's History of Florida	27.50
H. H. Bailey, Birds of Florida	20.00
H. & W. B. Drew Company, 500 cloth tags	3.15
D. A. Dixon Company, supplies	7.20
W. L. Marshall, fixing store room	81.65
Economic Geology, subscription	4.00
Charles E. Decker, annual dues to Assn. Petroleum Geologists	15.00

FEBRUARY, 1926

Herman Gunter, State Geologist, salary	$ 275.00
D. Stuart Mossom, Asst. Geologist, salary	183.33
D. Stuart Mossom, Asst. Geologist, expenses	38.93
R. M. Harper, Assistant, salary	183.33
Mary H. Carswell, Stenographer, salary	125.00
E. W. Knobel, Soil Specialist, January expenses	97.20
F. R. Lesh, Junior soil surveyor, January expenses	82.55
Samuel W. Phillips, Soil Specialist, January expenses	113.67
Adonis L. Gray, Junior soil surveyor, January expenses	74.40
The Southern Telephone & Construction Company	3.25
The Western Union Telegraph Company	1.75
Messer Brothers, recharging battery	1.00
James Messer, work on Ford, 3 bulbs	7.30
Line-A-Time Mfg. Company, one Line-A-Time No. 159836	20.29
American Railway Express	5.60
S. McL. Estes, Inc., repairing Ford, soil work	42.68
D. A. Dixon Company, supplies	8.80
W. H. May, Postmaster, stamps	25.00
M. L. Bath Company, 100 well log forms	5.98

MARCH, 1926

Herman Gunter, State Geologist, salary	$ 275.00
Herman Gunter, State Geologist, expenses	59.24
D. Stuart Mossom, Asst. Geologist, salary	183.34
D. Stuart Mossom, Asst. Geologist, expenses	77.53
R. M. Harper, Assistant, salary	183.34
Mary H. Carswell, Stenographer, salary	125.00
Samuel W. Phillips, Soil Surveyor, February expenses	99.09
E. W. Knobel, Soil Specialist, February expenses	123.07
F. R. Lesh, Junior Sil Surveyor, February expenses	84.00
Adonis L. Gray, Junior Soil Surveyor, February expenses	84.00
The Western Union Telegraph Company	2.63
C. G .Metcalf Central Garage, oil and gas	27.66
Messer Brothers, adjustment on tire	6.00
Seaboard Air Line Railway Company, fare to Memphis	32.21
Southern Telephone and Construction Company	3.25
W. H. May. Postmaster, envelopes and box rent	45.46
American Railway Express Company	1.07
Service Print Shop, 200 business cards	3.00
D. A. Dixon Company, 5,000 second sheets	4.50

APRIL, 1926

Herman Gunter, State Geologist, salary	$ 275.00
D. Stuart Mossom, Asst. Geologist, salary	183.34
D. Stuart Mossom, Asst. Geologist, expenses	11.45
R. M. Harper, Assistant, salary	100.01
Mary H. Carswell, Stenographer, salary	125.00
Samuel W. Phillips, Soil Surveyor, March expenses	114.41
F. R. Lesh, Junior Soil Surveyor, March expenses	94.00
Adonis L. Gray, Junior Soil Surveyor, March expenses	102.62
E. W. Knobel, Soil Specialist, March expenses	141.23
G. C. Metcalfe Central Garage, oil and gas	23.12
Western Union Telegraph Company	2.43
Disb's'g Officer, U. S. War Dept. Engrs. blue prints Kissimmee River	4.45
The Southern Telephone & Construction Company	4.05
D. A. Dixon Company, supplies	3.75
G. C. Mecalfe Central Garage, oil and gas	32.57
S. W. Phillips, Soil Surveyor, April expenses	100.98
E. W. Knobel, Soil Specialist, April expenses	135.47
F. R. Lesh, Junior Soil Surveyor, April expenses	95.00
Adonis L. Gray, Junior Soil Surveyor, April expenses	84.00

MAY, 1926

Herman Gunter, State Geologist, salary	$ 275.00
D. Stuart Mossom, Asst. Geologist, salary	183.34
D. Stuart Mossom, Asst. Geologist, expenses	30.37
Mary H. Carswell, Stenographer, salary	125.00
D. A. Dixon Company, supplies	4.50
T. J. Appleyard, Inc., folder and proof map	8.00
Wrigley Photo-Engraving Corp., zinc etching	41.18
Journal of Geology, subscription	5.40
Ceramic Industry, subscription	3.00
James Messer, repair work on Ford 3X	11.25
James Messer, repair work on Ford 2X	8.62
Samuel W. Phillips, Soil Surveyor, May expenses	20.88
F. R. Lesh, Junior Soil Surveyor, May expenses	24.31
C. H. Ellacott, drafting base map	42.00
The Western Union Telegraph Company	9.67
Capital Office Supply Company, supplies	1.85
The Southern Telephone & Construction Company	3.25

JUNE, 1926

Herman Gunter, State Geologist, salary	$ 275.00
D. Stuart Mossom, Asst. Geologist, salary	183.34
D. Stuart Mossom, Asst. Geologist, expenses	31.46
Mary H. Carswell, Stenographer, salary	125.00
The Southern Telephone & Construction Company	3.25
Hoffberger Motor Company, repair to Fords	4.25
American Railway Express Company	2.63
W. H. May, Postmaster, stamps and box rent	26.50

STATISTICS OF MINERAL PRODUCTION IN FLORIDA DURING 1925

HERMAN GUNTER

COLLECTED IN CO-OPERATION WITH THE UNITED STATES BUREAU OF MINES AND THE U. S. BUREAU OF CENSUS

With an output totaling $17,522,303 during 1925 the mineral industries of Florida continued to show progressive development. With one exception, the year 1920, this is the largest mineral production that Florida has ever recorded, increases being reported in every industry. The value of the output for 1924 was $13,939,289, thus indicating an increase of $3,583,014, or a little more than 25 per cent. The percentage of increase for the several industries over that for 1924 is as follows: Phosphate 9½%; Clay, including fuller's earth and kaolin, 3%; Clay products 30 %; Lime and limestone 40%; Crushed flint 50%; Sand and gravel 192%; Sand-lime brick 61%; Mineral waters 12%; Peat, ilmenite, rutile, zircon and monazite 66%.

CLAY

Four plants were engaged in mining the white sedimentary kaolin in Florida during 1925. These were located in Putnam and Lake Counties, although deposits are known to occur in other sections.

PRODUCERS

The Edgar Plastic Kaolin Co., Metuchen, N. J., and Edgar, Fla.
Florida China Clay Co., Inc., Leesburg, Fla.
Lake County Clay Co., Metuchen, N. J., and Okahumpka, Fla.
United Clay Mines Corporation, Trenton, N. J., and Hawthorne, Fla.

CLAY PRODUCTS

There was a 30 per cent increase in value of clay products over that of 1924, although there was a decrease in value of common brick and of pottery. There was, however, a decided increase in value of face brick. The total value of common and face brick,

pottery and other clay products for the year was $327,389. The following firms reported production:

PRODUCERS

Barber Brothers, Cottondale, Jackson County.
Build-With-Brick Company, Molino, (Plant at Brickton, Escambia County).
J. M. & J. C. Craber, Campville, Alachua County.
E. M. Davis, Ocklocknee, (Plant at Lawrence, Gadsden County).
Dolores Brick Company, Molino, Escambia County.
Florida Industrial School for Boys, Marianna, Jackson County.
Gamble & Stockton Company, 210 St. James Bldg., Jacksonville,(Plant at Dixston, Clay County).
Georgia-Carolina Brick Company of Florida, Stockton St. & A. C. L. R. R., Jacksonville, (Plant at Callahan, Nassau County).
Glendale Brick Works, Glendale, Walton County.
G. C. & G. H. Guilford, Blountstown, Calhoun County.
W. J. Hall & Son, Chipley, Washington County.
Keystone Brick Company, Whitney, Lake County.

POTTERY PRODUCERS

The Florida Pottery, 2107 Fourth St., St. Petersburg, Pinellas County.
Los Manos Pottery, C. R. Crandall, Prop., Palm Beach County.

FULLER'S EARTH

Fuller's earth is a clay differing from other clays chiefly in that it possesses to an exceptional degree the property of absorbing coloring matters from mineral, animal and vegetable oils and fats and some other liquids. This bleaching or decolorizing property, which gives to the earth its value, can be determined only by actual filtration test. In general appearance it is frequently difficult to distinguish fuller's earth from some other ordinary clays. In color, when dry, it may vary from rather light greenish-white to gray, buff or brown. Fuller's earth is ordinarily described as non-plastic, and this may be true of some earths, but others possess sufficient plasticity to be classed as semi-plastic. When this earth is placed in water it usually disintegrates readily but this characteristic too is shared by some other clays. The final criterion of a good fuller's earth is its capacity for removing coloring matters from oils as determined by filtration tests.

In 1925 the production of fuller's earth in the United States amounted to 206,574 short tons with a valuation of $2,923,965. As compared with 1924 these figures indicate an increase of 16 per cent in quantity and 11 per cent in value. This increase is

accounted for not only by the fact that every state reporting production in 1924 and 1925 showed an increase but also by California and Nevada re-entering the list of producting states for 1925. The following states reported production: Georgia, Florida, Texas, Illinois, Massachusetts, California and Nevada. The commercial production of fuller's earth in the United States began at Quincy, Gadsden County, in 1895, and from that year until 1924 Florida continuously held first place. Beginning with 1924, however, Georgia's production increased to such an extent as to replace Florida in this rank, so that Georgia now is the leading state, Florida second and Texas third. The production of these three states amounted to 85 per cent of the total for 1925. The average per ton value in 1925 was $14.15 indicating a slight average decrease as compared with 1924 of $14.79 per ton. The production from Florida cannot be given separately without disclosing individual operations, but it is included in the total mineral production of Florida. The following companies reported production in 1925:

PRODUCERS

Attapulgus Clay Company, Ellenton, Manatee County.
The Floridin Company, Quincy and Jamieson, Gadsden County.
The Fuller's Earth Company, Midway, Gadsden County.

ILMENITE, MONAZITE, RUTILE AND ZIRCON

The recovery of ilmenite and monazite from the beach sands at Mineral City about 5 miles south of Jacksonville Beach (formerly Pablo Beach) began in 1916 and has continued, with some interruptions, until Florida is now the leading state in the production of ilmenite. The first commercial production of zircon was reported in 1922 and that of rutile in 1925. Production of monazite has not been reported since 1916 until 1925. The occurrence of these so-called rare earths in the beach sands is unique and they have formed the basis of an important mineral industry. Operations at Mineral City are conducted under the name of Buckman and Pritchard, Inc., owned by the Titanium Pigment Co., Inc., 94 Fulton St., New York, a subsidiary of the National Lead Company. Statistics of output and value cannot be given separately without disclosing individual operations but such figures are included in the total for the State.

LIMESTONE, LIME AND FLINT

The output of limestone for 1925 amounted to 3,795,420 tons with a valuation of $4,348,234 As compared to the value of this product for 1924 these figures indicate an increase of 60 per cent. The various purposes for which the limestone is reported as used were: Road material, concrete, asphalt filler, railroad ballast, riprap, building stone and agricultural. The large increase again shows the continued progress Florida is making in the way of permanently surfaced highways, in general construction and industrial lines. To the figures on limestone should be added those for crushed flint or miscellaneous stone and lime which brings the total production of limestone, crushed flint, miscellaneous stone, quick and hydrated lime to 4,044,583 tons with a total valuation of $4,873,757, an increase of 35 per cent in output and of 57 per cent in value over 1924.

COMPANIES REPORTING LIMESTONE PRODUCTION

Atlantic Coast Line Railroad, (Quarried by A. M. Cook, Levy and Marion Counties).
Blowers Lime & Phosphate Company, Ocala.
Camp Concrete Rock Company, Ocala.
Commercial Lime Company, Ocala.
The Coquina Company, Daytona Beach.
Cummer Lumber Company, Jacksonville.
Crystal River Rock Company, Leesburg.
Dixie Lime Products Company, Ocala.
Florida Lime Company, Ocala.
Florida Rock Products Company, Brooksville.
Gainesville Lime Rock Company, Gainesville.
The Maule Ojus Rock Company, Ojus.
Marion County Lime Company, Ocala.
Marion County Road Department, Ocala.
Naranja Rock Company, Naranja.
Ocala Lime Rock Company, Ocala.
Oakhurst Lime Company ,(Florida Lime Company) Ocala.
The George H. Palmer Company, P. O. Box 4117, Miami.
W. T. Price, Miami.
Standard Hard Rock Company, Morriston.
T. A. Thompson, Branford.
Volusia Coquina Rock Company, Volusia.
Williston Lime Rock Company, Williston.
Williston Shell Rock Company, Williston.

COMPANIES REPORTING FLINT OR MISCELLANEOUS STONE PRODUCTION

Baird Flint Rock Company, P. O. Box 388, Ocala.
Cummer Lumber Company, Jacksonville.
Florida Shell Rock Company, Williston.

Long-Pasley Lumber Company, Williston.
Tampa Rock Company, Tampa.
A. T. Thomas Company, Ocala.

COMPANIES REPORTING LIME PRODUCTION

Commercial Lime Company, Ocala.
Dixie Lime Products Company, Ocala.
Florida Lime Company, Ocala.

MINERAL WATERS

The total sales of waters in Florida in 1925 as shown by returns from the owners of springs and wells amounted to 1,680,-895 gallons valued at $151,366.85. Production was reported from the following springs or wells:

Brack's Panacea Soft Water Springs, Bradenton, Manatee County.
Chumuckla Springs, McDavid, Escambia County.
Crystal Springs, Crystal Springs, Pasco County.
Crystal Mineral Springs, Whitehouse, Duval County.
Egret Water Company, Fort Pierce, St. Lucie County.
Espiritu Santo Springs, Inc., Safety Harbor, Pinellas County.
Good Hope Mineral Springs, Jacksonville, Duval County.
Flamingo Water Company, Orange City, Volusia County.
Hampton Springs, Hampton Springs, Taylor County.
Purity Springs Water Company, Tampa, Hillsborough County.
St. Nicholas Springs, South Jacksonville, Duval County.
So-No-Wa Springs, Bryceville, Nassau County.
Ultrafine, Miami, Dade County.

PEAT

Production of peat in 1925 increased 31 per cent in quantity and 51 per cent in value over that for 1924. The peat marketed in Florida is sold principally as a nitrogenous fertilizer filler. The following companies reported production:

Ammoniate Products Corporation, 2 Rector St., New York and Fellsmere, Indian River County, Fla.
Dundee Fertilizer Company, I. Berner, Lessee, 1407 Marion St., Tampa and Dundee, Polk County, Fla.
Florida Humus Company, 14 Wall Street, New York and Zellwood, Orange County, Fla.

PHOSPHATE

The output from the hard rock field increased 20 per cent, a marked improvement as compared to 1924. There was an increase of 20 per cent in quantity and of 10 per cent in value of output over 1924. Of the total amount marketed in the United States Florida is credited with 84 per cent. Other states reporting

production in 1925 were South Carolina, Tennessee, Kentucky, Idaho and Wyoming. Significant gains were made by the Western States in phosphate rock output for 1925 and another feature was the re-entry of South Carolina into the column of producing states after making no report for 1923 and 1924. The reported total production for Florida for 1925 was 2,929,964 long tons valued at $8,789,070.

The output from the hard rock field increased 20 per cent in quantity and 12 per cent in value over 1924. This is taken to indicate better European conditions since practically all the hard rock phosphate is exported. The increased costs of production and the competition of the North African phosphates is, however, seriously affecting the high grade phosphate industry. No new mines were reported being developed during the year.

Of the total output of phosphate from Florida in 1925 the land pebble rock constituted 94 per cent. The marketed output from this field for 1925 increased a little over 20 per cent and the value about 9½ per cent. European conditions do not so directly affect the land pebble district since the greater part of this rock is used domestically. It is also true that some of the phosphate producers are manufacturers of fertilizers, thus consuming a large percentage of the output from such mines.

The following table gives the production and value of Florida phosphate rock from 1900 to 1925. Since the beginning of phosphate mining in 1888 to 1925 inclusive, Florida has produced 51,988,717 long tons with a total valuation of $200,963,215. These figures are in accordance with statistics collected by the United States Geological Survey, the United States Bureau of Mines and the Florida Geological Survey.

PRODUCTION AND VALUE OF PHOSPHATE ROCK IN FLORIDA, 1900-1925.

(Long Tons)

Year	Land Pebble		Hard Rock		River Pebble		Soft Rock		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1900	221,403	$ 612,703	424,977	$ 2,229,373	59,863	$ 141,236	.....	$.....	706,243	$ 2,983,312
1901	247,454	660,702	457,568	2,393,080	46,974	105,961	.....	.....	751,996	3,159,473
1902	350,991	810,792	429,384	1,743,694	5,055	9,711	.....	.....	785,430	2,564,197
1903	390,882	885,425	412,876	1,988,243	56,578	113,156	.....	.....	860,336	2,986,824
1904	460,834	1,102,993	531,081	2,672,184	81,030	199,127	.....	.....	1,072,951	3,974,304
1905	528,587	1,045,113	577,672	2,993,732	87,847	213,000	.....	.....	1,194,106	4,251,845
1906	675,444	2,029,202	587,598	3,440,276	41,463	116,000	.....	.....	1,304,505	5,585,578
1907	675,024	2,376,261	646,156	4,065,375	36,185	136,121	.....	.....	1,357,365	6,577,757
1908	1,085,199	3,885,041	595,743	4,566,018	11,160	33,480	.....	.....	1,692,102	8,484,539
1909	1,266,117	4,514,968	513,585	4,026,333	.....	.....	.....	.....	1,779,702	8,541,301
1910	1,629,160	5,595,947	438,347	3,051,827	.....	.....	.....	.....	2,067,507	8,647,774
1911	1,992,737	6,712,189	443,511	2,761,449	(a)	(a)	.....	.....	2,436,248	9,473,638
1912	1,913,418	6,168,129	493,481	3,293,168	(a)	(a)	.....	.....	2,406,899	9,461,297
1913	2,055,482	6,575,810	489,794	2,987,274	(a)	(a)	.....	.....	2,545,276	9,563,084
1914	1,829,202	5,442,547	309,689	1,912,197	(a)	(a)	.....	.....	2,138,891	7,354,744
1915	1,308,481	3,496,501	50,130	265,738	.....	.....	.....	.....	1,358,611	3,762,239
1916	1,468,758	3,874,410	47,087	295,755	.....	.....	(b)	(b)	1,515,845	4,170,165
1917	2,003,991	5,305,127	18,608	159,366	.....	.....	(b)	(b)	2,022,599	5,464,493
1918	1,996,847	5,565,928	62,052	377,075	.....	.....	8,331	147,103	1,067,230	6,090,106
1919	1,360,235	5,149,048	285,467	2,452,563	.....	.....	14,498	196,318	1,660,200	7,797,929
1920	2,955,182	14,748,620	400,249	4,525,191	.....	.....	13,953	190,551	3,369,384	19,464,362
1921	1,599,835	8,604,818	175,774	1,806,671	.....	.....	4,419	20,153	1,780,028	10,431,642
1922	1,870,063	7,035,821	188,084	1,308,201	.....	.....	446	3,500	2,058,593	8,347,522
1923	2,348,137	7,987,752	199,516	1,071,675	.....	.....	.....	.....	2,547,653	9,059,427
1924	2,289.466	7,387,897	143,115	629,579	.....	.....	.....	.....	2,432,581	8,017,476
1925	2,758,315	8,081,137	171,649	707,933	.....	.....	.....	.....	2,929,964	8,789,070

(a) Included in land pebble.
(b) Included in hard rock.

PHOSPHATE MINING COMPANIES REPORTING PRODUCTION IN 1925

American Agricultural Chemical Co...2 Rector Street, New York City, and Pierce, Florida.
American Cyanamid Company .....511 Fifth Avenue, New York City, and Brewster, Florida.
J. Buttgenbach & Company .....22 Ave. Marnix, Brussells, Belgium, and Dunnellon, Florida.
Coronet Phosphate Company .....99 John Street, New York City, and Plant City, Florida.
C. & J. Camp .....Ocala, Florida.
Dunnellon Phosphate Company .....106 East Bay Street, Savannah, Georgia, and Dunnellon, Florida.
Florida Phosphate Mining Corp. .....P. O. Box 1118, Norfolk, Virginia, and Bartow, Florida.
The Holder Phosphate Company .....Inverness, Florida.
Independent Chemical Co., Inc. .....33 Pine Street, New York City, and Bowling Green, Florida.
International Agricultural Corp. .....61 Broadway, New York City, and Mulberry, Florida.
Mutual Mining Company .....102 East Bay Street, Savannah, Georgia, and Floral Ciy, Florida.
Morris Fertilizer Company .....801 Citizens & Southern Bank Building, Atlanta, Georgia and Bartow, Florida.
Phosphate Mining Company .....110 Williams Street, New York City, and Nichols, Florida.
Southern Phosphate Development Co...Inverness, Florida.
Southern Phosphate Corp. .....25 Broad Street, New York City, and Lakeland, Florida.
Swift & Company .....Union Stock Yards, Chicago, Illinois, and Bartow, Florida.

SAND AND GRAVEL

The output of sand and gravel in Florida during 1925 was the largest ever recorded in the State and amounted to 1,515,529 short tons with a valuation of $1,089,215. These figures indicate an increase of 135 per cent in quantity and 192 per cent in value over 1924. The various uses for which the sand and gravel were reported were: Building, engine, railroad ballast and paving.

The sands of the State are produced from various sources, large quantities coming from deposits fairly uniform in physical characteristics, others dredged from lake or stream bottoms, while large tonnages of by-product sands from the mining and washing of kaolin and pebble phosphate are now placed on the market. The Florida gravel comes principally from the Apalachicola River and from the Escambia River, although deposits of clayey-gravel occur in other sections of western Florida and have been used for

surfacing highways in that part of the State. Excellent sands are also dredged from the rivers along with the siliceous gravel.

SAND AND GRAVEL COMPANIES REPORTING PRODUCTION IN 1925

Acme Sand Company, Eustis.
Alafia Sand and Shell Company, P. O. Box 2933, Tampa.
American Cyanamid Company, Brewster.
Cummer Lumber Company, Newberry.
Diamond Sand Company, Lake Wales.
Duo Sand and Rock Comany, P. O. Box 1687, West Palm Beach.
Escambia Sand and Gravel Corp., Flomaton, Ala. (Plant at Tarzan, Fla.)
Florida Gravel Company, Chattahoochee.
Hesperides Washed Sand Company, Lake Wales.
Interlachen Sand and Gravel Company, Interlachen.
Lake Wier Crystal Sand Company, Ocala.
Leesburg Sand and Supply Company, Leesburg.
Maule Ojus Rock Company, Ojus.
Phosphate Mining Company, Nichols.
Tallahassee Pressed Brick Company, Havana.
Tampa Sand and Shell Company, P. O. Box 921, Tampa.

SAND-LIME BRICK

The sand-lime brick industry enjoyed a satisfactory business year during 1925 since the reported output increased 44 per cent and the value 61 per cent over that of 1924. All companies operating in past years reported increased production and one new company, namely the Lakeland Brick and Tile Manufacturing Company, Lakeland, made its first report on production. According to the returns from the several producers the total output during 1925 was 26,993,000 brick valued at $323,385, or an average of $11.98 per thousand.

PRODUCERS

Bond Sandstone Brick Company, Lake Helen.
Lakeland Brick and Tile Manufacturing Company, Lakeland.
Palm Beach Brick and Supply Company, West Palm Beach.
Plant City Brick Company, Plant City.

Two additional sand-lime brick plants have recently been established as follows: George E. Dunan, P. O. Box 1494, Bradenton and the DeSoto City Brick Company, DeSoto City. The demand for building materials in the State is such as to induce additional manufacturing plants.

SUMMARY

From the statistics of mineral production for 1925 it is seen that on the whole a prosperous condition existed. As compared with former years the total output was the largest ever recorded except for 1920. Exceptional conditions existed, however, which caused an abnormal output and value for that year, as large quantities of phosphate held in storage during certain years of the war were marketed thus accounting for the unusual total for 1920.

The table on the next page summarizes the value of mineral products in the State for each year from 1916 to 1925 inclusive, and the graph following it shows some of the same data expressed in percentages of the State total. This method eliminates the great fluctuations in prices during the World War period, but does not show the increase in true values, which amounted to about 100% in nine years (while the population of the State increased less than 50%).

The curves for phosphate show the depression caused by the war in the hard rock field, and the effects of the strike of 1919 in the land pebble field. (A different sort of graph in our 15th Annual Report, page 20, shows the total production of different kinds of phosphate in Florida, in tons, for each year from 1888 to 1922, and the table on page 20 of the present volume shows both production and value of the same from 1900 to 1925.) The decline of phosphate and fuller's earth in the last few years is not absolute but relative, and is due mostly to the great increase in the production of limestone, sand and gravel, caused by the enormous road-building activities throughout the State.

VALUE OF MINERAL PRODUCTION OF FLORIDA, 1916-1925.

MINERAL PRODUCTS	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Phosphate										
Land Pebble	$ 3,874,410	$ 5,305,127	$ 5,565,988	$ 5,149,048	$14,745,620	$ 8,604,818	$ 7,035,821	$ 7,987,752	$ 7,387,897	$ 8,081,137
Hard Rock	295,755	159,366	377,075	2,452,563	4,525,191	1,806,671	1,308,201	1,071,675	629,579	707,933
Soft Rock	...	...	147,103	196,318	190,551	20,153	3,500	...	...	...
Total Phosphate	4,170,165	5,464,493	6,090,106	7,797,929	19,464,362	10,431,642	8,347,522	9,059,427	8,017,476	8,789,070
Ball Clay, Fuller's Earth, Peat, Zircon, Ilmenite Monazite, Rutile	784,799	897,118	1,241,437	2,190,258	2,700,082	1,504,574	1,666,260	1,782,718	1,860,847	1,968,119
Lime, Limestone and Flint	529,373	713,018	365,293	296,594	569,097	638,272	857,913	1,572,768	3,097,703	4,873,757
Common Brick, Pottery, Tile, and Sand-Lime Brick	317,156	324,564	238,276	340,215	557,542	286,522	368,149	393,323	452,053	650,774
Sand and Gravel	42,352	145,579	48,768	164,101	117,601	97,324	147,924	290,082	375,853	1,089,215
Mineral Waters	15,676	9,850	12,883	12,062	27,120	28,365	57,305	131,781	135,357	151,367
Total	$ 5,859,521	$ 7,554,622	$ 7,996,763	$10,801,159	$23,435,804	$12,986,699	$11,445,073	$13,230,099	$13,939,289	$17,522,302

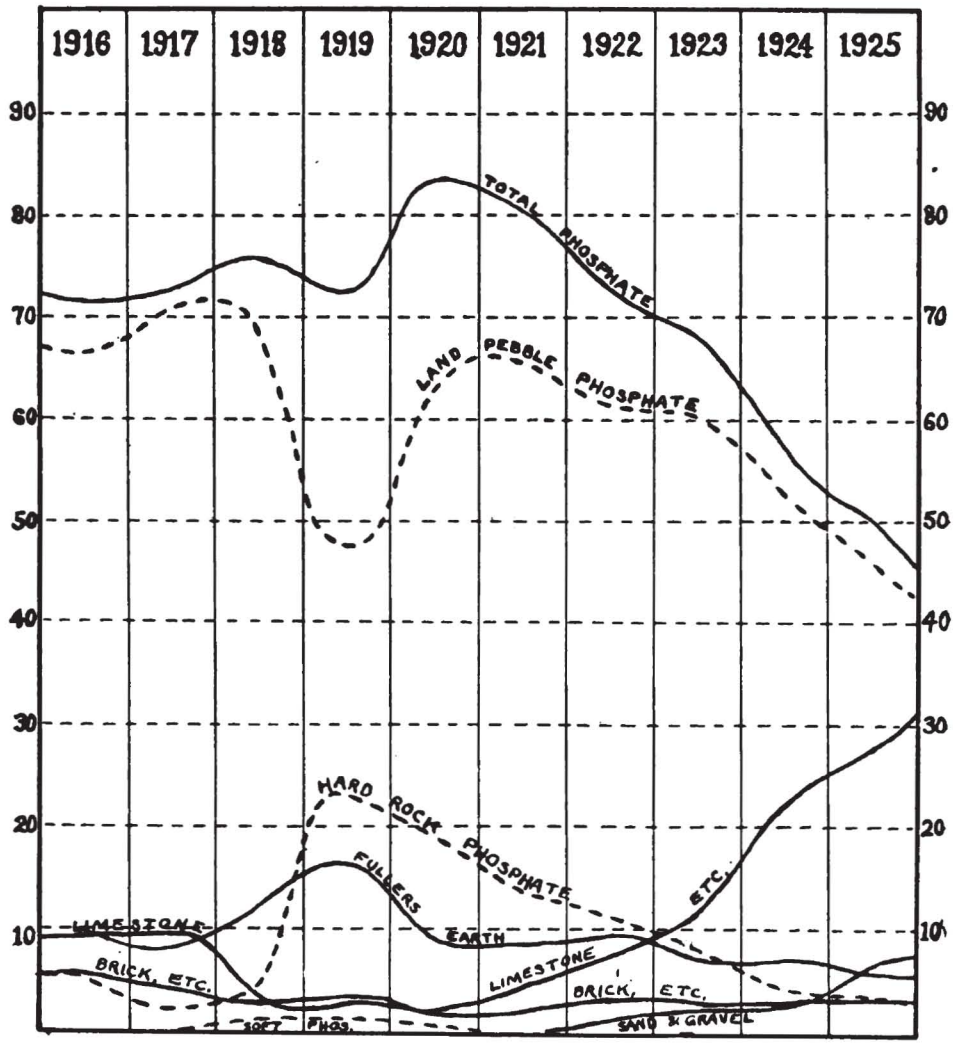

FIG 1. Graph showing values of the principal mineral products of Florida, 1916 to 1925, expressed as percentages of the total. For absolute values see the table on the preceding page.

NATURAL RESOURCES OF SOUTHERN FLORIDA

ROLAND M. HARPER

From the Eighteenth Annual Report of the Florida State Geological Survey, 1927.

FLORIDA STATE GEOLOGICAL SURVEY

HERMAN GUNTER, *State Geologist*

EIGHTEENTH ANNUAL REPORT

TALLAHASSEE, FLORIDA

1927

NATURAL RESOURCES OF SOUTHERN FLORIDA

ROLAND M. HARPER

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INTRODUCTION

The main object of geography is to describe and classify the surface of the earth, by means of the things or features found thereon. These features are of two principal kinds: inanimate, such as soil, topography, water and climate; and organic, such as vegetation, fauna, population and industries. In the second group it is customary to make a distinction between the plants and lower animals on the one hand, and the human population or civilization on the other, on account of the extreme complexity of the latter. Physical geography deals with the natural features, including all the inanimate and the plants and lower animals; and human geography with the rest, which may be classed as artificial features, because they are developed or modified by thinking beings.

The natural or physical features constitute the environment of civilization. They are supposed to have existed much longer than the human race, and to change much more slowly than civilization does, except where man himself changes them, by cutting down forests, damming up streams, killing wild animals, etc. The artificial or human features may change very rapidly, though, especially in an area like that covered by this report; and in order to describe them adequately it is necessary to use a great variety of statistics, for density and composition of population, acreage and yield of crops, kind and value of manufactures, etc., etc. Physical geography is indeed also capable of some statistical treatment, in the way of soil analyses, weather records, stand of timber, etc., but such statistics are usually much simpler than those used in human geography.

The present report seeks to describe the physical features or natural resources of South Florida, from the northern boundaries of Manatee and Indian River Counties to the south end of the State, an area of about 17,000 square miles, not counting lakes and salt water. At present people all over the United States are looking toward this section, and many doubtless have very hazy ideas about the soil, water supply, climate, vegetation, fauna, etc., all of

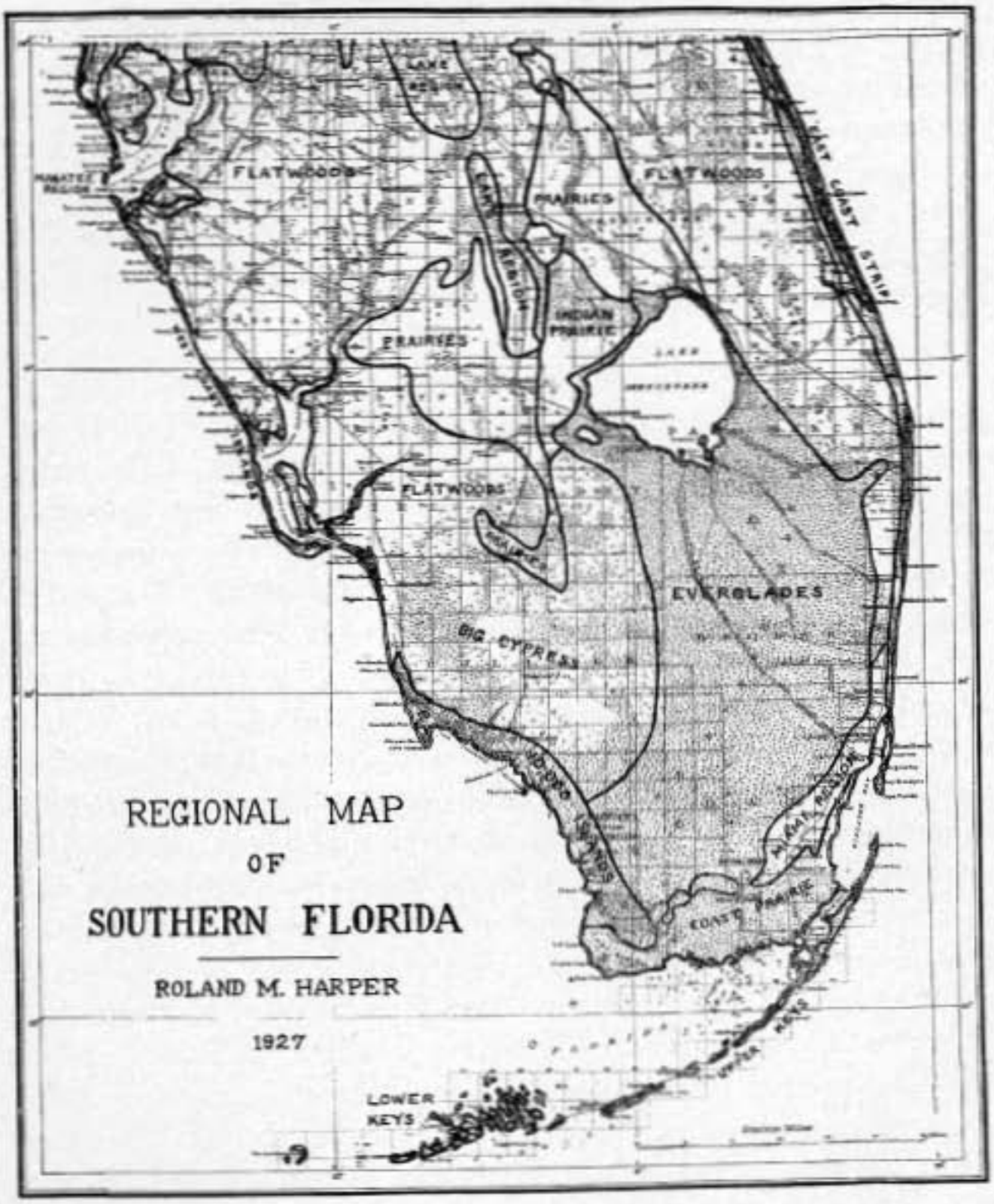

FIG. 2. Map showing location of regions described in text, together with rivers, railroads, counties, townships, etc. The regional boundaries are only approximate in some places, and those of the Big Cypress are not shown at all, because too little known at present. The dotted line northeast of Lake Okeechobee, in Martin County, indicates a low scarp or terrace, which may some time be treated as a regional boundary. (See regional descriptions.) Scale about 3,040,000, or 48 miles to the inch.

which are treated in the following pages. It is of course also important to a home-seeker or investor to know something about what kind of neighbors he may expect to have, as well as about agriculture, manufacturing, commerce, etc., but information about the population and industries can be given better at some future time, after the results of the federal agricultural census of January, 1925, and the state population census of February, 1925, have been more fully analyzed or digested.

In this report, in conformity with the established policy of this department (and practically all other state geological surveys) we have tried to present the important truths impartially, not overlooking the fact that some of the soils are below the average in fertility, some of the water is hard, the weather is not always perfect, some of the trees are crooked or otherwise of little use, mosquitoes are occasionally seen, etc. Absolute accuracy is not claimed, for there are still large areas in South Florida that have never been seen by any one competent to write a scientific description of them, and even with the best of intentions mistakes sometimes occur. And of course a complete description of an area of this size cannot be given in 160 pages. But if there are any errors or serious omissions they are unintentional, and just as likely to be on the good as on the bad side. We believe that the whole truth, or an approximation to it, will be more useful to prospective settlers and investors than merely the better half of it; and to ignore the disadvantages would be as inexcusable as for a newspaper to omit all mention of fires, floods, hurricanes, earthquakes, accidents, crimes, epidemics and deaths. Constructive criticisms will always be welcomed, and if important enough they can be incorporated into future publications of this office.

In order to avoid making this report too bulky and delaying it indefinitely, no notice is here taken of publications, explorations and occurrences subsequent to the Spring of 1926, except that some information obtained by correspondence and reading since then has been incorporated.

SOURCES OF INFORMATION

One of the first steps in any scientific investigation is to ascertain what has already been published on the subject, and then build up on the foundations already laid. A great deal has been written about the geology, scenery, and other natural features of South Florida, especially in the last decade or two; but at the present writing lack of time and library facilities forbid attempting a complete bibliography. However, even a partial bibliography may be very helpful to future investigators of the same field, and such a one is given below. It includes about 165 titles (by 94 authors), two-thirds of them published since 1900.

In order to economize time and space as much as possible, several kinds of publications are arbitrarily excluded, but exceptions are sometimes made for works of special interest or importance. The excluded classes are as follows:

1. Previous reports of this Survey; for they are not very numerous yet, and they ought to be accessible in the same libraries that have this volume.

2. Publications covering the whole State or a larger area, particularly monographs of families, genera, etc., unless they contain descriptions of several new species from the area treated.

3. Papers devoted to only one species of plant or animal, unless it is a new species from South Florida.

4. Works fully cited in later ones referred to below, or in the bibliographies in our First, Third, Sixth and Twelfth Annual Reports.

5. Books and articles written more with a view of interesting a large number of readers, or inducing people to come to Florida, than of presenting fundamental facts. This sort of literature is very abundant at present, and of course it contains some important truths (and scientific works may contain unintentional errors), but if one should start citing popular works one would never know where to stop.

6. Relatively inaccessible publications, such as old newspapers, ephemeral magazines, and little-known scientific serials of limited circulation.

7. Works dealing almost entirely with human or artificial features, such as census reports, and descriptions of cities.

In order to illustrate the development of scientific knowledge concerning this area the bibliography is arranged as nearly as possible in chronological order.* A reader who wishes to know what works of any particular author have been cited here or in footnotes can locate them by means of the index.

On account of the Geological Survey's limited library facilities, many of the bibliographic references have had to be obtained by correspondence†, and some errors may have crept into the citations; but if so they can easily be straightened out by any one who has access to a good library.

A few publications not listed in the bibliography are mentioned in footnotes, to illustrate some particular point.

BIBLIOGRAPHY

1851

Michael Tuomey. Notice of the geology of the Florida Keys, and of the southern coast of Florida.—Am. Jour. Sci. 61: 390-394.

1856

J. C. Ives. Memoir to accompany a military map of the peninsula of Florida, south of Tampa Bay, compiled by Lieut. J. C. Ives, Topog'l Engineers, under the general direction of Capt. A. A. Humphreys, Topog'l Engineers, by order of the Hon. Jefferson Davis, Secretary of War. April, 1856—(U. S. War Dept.) New York, M. B. Wynkoop (publisher). 1856. 42 pp. and 2 folded maps.

The main map measures 32x42 inches, begins a little north of latitude 28°, and shows many details of vegetation, etc., pretty accurately for that early date. One or two later vegetation maps seem to have been based on it. The same map is reproduced on a smaller scale, with a few quotations from the text, in U. S. Senate Document 89, 1911 (see below).

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*The month of publication is usually not given in books, or in scientific serials which appear annually or at irregular intervals, and it is often mis-stated in periodicals, and the error overlooked or soon forgotten, and this state of affairs sometimes causes injustice in cases of disputed priority. (See under *Ilex cumulicola*, farther on.)

†For valuable assistance in this matter the writer is indebted to Francis Harper of the Boston Society of Natural History (for references on birds and mammals), C. W. Johnson of the same institution (mollusks), Dr. M. A. Howe of the New York Botanical Garden (plants), J. T. Nichols of the American Museum of Natural History (fishes and reptiles), J. A. G. Rehn of the Philadelphia Academy of Natural Sciences (insects), E. G. Vanatta of the same (mollusks), Lee R. Dice of the University of Michigan (mammals), Prof. W. S. Blatchley, former state geologist of Indiana, and for several years past a winter resident of Florida (insects), and a few others.

1869

R. E. C. Stearns. Rambles in Florida.—American Naturalist 3: 281-288, 349-356, 397-405, 455-470. Aug.-Nov., 1869.

Mostly conchological, but contains interesting notes on the geography, flora, fauna, etc. Some of the Keys are described in the last five pages.

1872

C. J. Maynard. Catalogue of the mammals of Florida, with notes on their habits, distribution, etc.—Bull. Essex Institute 4: 135-150. Sept. and Oct., 1872. (Also reprinted with pages numbered 1 to 16.)

Based on three winters' travel in Florida, with two or more companions each time, some of them scientists. The Everglades and Keys were visited on the second trip, and the third took the party as far south as Jupiter. Lists 36 species, including one introduced, the brown rat. (The common mouse was not seen in Florida at that time.)

1874

Frederick Brendel. Notes on the flora of southern Florida.—American Naturalist 8:449-452. Aug. 1874.

1875

(Capt.) *F. Trench Townsend.* Wild life in Florida, with a visit to Cuba.—xiv + 319 pp., frontispiece and map. London, 1875.

1877

L. F. DePourtales. Hints on the origin of the flora and fauna of the Florida Keys.—American Naturalist 11:137-144. March 1877.

1878

A. W. Chapman. An enumeration of some plants—chiefly from the semi-tropical regions of Florida—which are either new, or which have not hitherto been recorded as belonging to the southern states.—Botanical Gazette 3:2-6, 9-12, 17-21. 1878.

W. W. Calkins. Marine shells of Florida.—Proc. Davenport (Iowa) Acad. Nat. Sci. 2:232-252. 1878.

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A. P. Garber. Ferns in South Florida.—Botanical Gazette 3:82-85. Oct. 1878.

1880

W. W. Calkins. Winter herborizations on Indian River, Florida.—Botanical Gazette 5:57-58. May, 1880.

G. H. Horn. Coleoptera from the Florida Keys collected by W. H. Ashmead.—Proc. Entom. Sec. Phila. Acad. Sci. (Trans. Am. Entom. Soc.) 8:xvii. 1880.

1881

Jerome Cochran, M. D. Sketches of yellow fever on the Gulf Coast of Florida.—Trans. Med. Assoc. Alabama 34:451-484. 1881.

Key West described on pages 454-457, and Manatee and vicinity on pages 465-466.

J. Cosmo Melvill. List of the mollusca obtained in South Carolina and Florida, principally in the island of Key West, 1871-1872.—Jour. Conchology (Leeds, England) 3:155-173. 1881.

Samuel C. Upham. Notes from Sunland, on the Manatee River, Gulf coast of South Florida.—83 pp., 2 plates. Published by the author, Braidentown and Philadelphia, 1881.

1883

Felipe Poey (y Aloy). List of food fishes brought from Key West, Fla., into the markets of Habana.—Bull. U. S. Fish Comm. 2:118. 1883.

W. H. Dall. On a collection of shells sent from Florida by Mr. Henry Hemphill.—Proc. U. S. Nat. Mus. 6:318-342, pl. 10. Dec., 1883.

1884

J. Cosmo Melvill. List of the phanerogams of Key West, South Florida, mostly observed there in March, 1872.—Mem. Manchester (England) Lit. & Phil. Soc. III. 8:138-154. 1884.

David Starr Jordan. The fishes of the Florida Keys.—Bull. U. S. Fish Comm. 4:77-80. 1884.

James A. Henshall. Camping and cruising in Florida.—248 pp., Cincinnati, 1884. (Largely about South Florida.)

1885

D. S. Jordan & C. H. Gilbert. Descriptions of ten new species of fishes from Key West, Florida.—Proc. U. S. Nat. Mus. 6:24-32. 1885.

David Starr Jordan. List of fishes collected at Key West, Fla., with notes and descriptions.—Proc. U. S. Nat. Mus. 7:103-150. 1885.

Joseph Swain & S. E. Meek. Notes on the pipe fishes of Key West, Fla., with description of *Siphostoma mckayi*, a new species.—Proc. U. S. Nat. Mus. 7:237-239. 1885.

W. H. Dall. Notes on some Floridian land and fresh-water shells, with a revision of the Auriculacea of the eastern United States.—Proc. U. S. Nat. Mus. 8:255-289, pl. 17, 18. July, 1885.

1886-7

Angelo Heilprin. Explorations on the west coast of Florida and in the Okeechobee wilderness. With special reference to the geology and zoology of the Floridian peninsula. A narrative of researches undertaken under the auspices of the Wagner Free Institute of Science of Philadelphia.—Trans. Wagner Inst. 1:iii-vii, 1-134, with plates 1-19 (of animals and fossils) and two of landscape drawings not numbered. 1887. (Pages 65-127 also published in advance, in 1886.)

One of the earliest scientific descriptions of the Caloosahatchee River and Lake Okeechobee, with notes on the geology, flora and fauna, and the first account of the rich molluscan fauna of the Caloosahatchee formation. Also covers the Gulf coast from Cedar Keys to the mouth of the Caloosahatchee River.

1887

W. E. D. Scott. The present condition of some of the bird rookeries of the Gulf coast of Florida. The Auk 4:135-144, 213-222, 273-284. 1887.

1887-1889

Chas. T. Simpson. Contributions to the mollusca of Florida.—Proc. Davenport Acad. Nat. Sci. 5:45-72, 63*-72*. 1887 and 1889.

1888

E. A. Schwarz. The insect fauna of semi-tropical Florida with special regard to the Coleoptera.—Entom. Amer. 4:165-175. 1888.

A. H. Curtiss. How the mangrove forms islands.—Garden & Forest 1:100. April 25, 1888.

A. H. Curtiss. The flora of the Florida Keys.—Garden & Forest 1:279-280. Aug. 8, 1888.

Points out the differences between the Upper and Lower Keys, and the similarity of the latter to the mainland around Miami. Mentions the occurrence on the Lower Keys of slash pine, two species of thatch palm, cabbage palmetto, saw-palmetto, and myrtle *(Myrica cerifera)*, which are rare or absent on the Upper Keys.

1888-1890

W. E. D. Scott. A summary of observations on the birds of the Gulf coast of Florida.—Auk 5:373-379. 1888; 6:13-18, 152-160, 245-252, 318-326. 1889; 7:14-22, 114-120. 1890.

1889

Robert Grant. Tarpon fishing in Florida.—Scribner's Magazine 6:154-168. (Illustrated.) Aug., 1889.

Describes some of the coast between Punta Gorda and Punta Rassa.

1889-1903

W. H. Dall. A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the southeastern coast of the United States, with illustrations of many of the species.—U. S. Nat. Museum Bull. 37. 74 plates. Reprinted in 1903, with 232 pages and 95 plates.

Contains a bibliography of 12 pages.

1890

David Starr Jordan. List of fishes collected in the waters of southern Florida by Dr. James A. Henshall, under the direction of the U. S. Fish Commission.—Bull. U. S. Fish Comm. 8:371-379. 1890.

J. H. Simpson. Florida plants.—Rep. Sec. Agr. (U. S.) 1889:389-393. 1890.

Mostly from the vicinity of Manatee.

W. E. D. Scott. On birds observed at the Dry Tortugas, Florida, during parts of March and April, 1890.—Auk 7:301-314. 1890.

Lists 80 species.

1891

A. C. Adams & W. C. Kendall. Report upon an investigation of the fishing grounds off the west coast of Florida.—Bull U. S. Fish. Comm. 9:289-312. (Illus.) 1891.

James A Henshall. Report upon a collection of fishes made in southern Florida during 1889.—Bull. U. S. Fish Comm. 9:371-389. 1891.

L. M. Underwood. The distribution of tropical ferns in peninsular Florida.—Proc. Indiana Acad. Sci. 1891:83-89.

Deals largely with central Florida, but states that the most interesting part of the State botanically is south of Lake Worth (a region which had no railroads in those days). Mentions among other things that the mail was then brought to Miami once a week, by a carrier who walked along the beach from Lake Worth, a distance of about 60 miles, and crossed the intervening inlets by ferries, when the weather permitted.

1892

W. E. D. Scott. Notes on the birds of the Caloosahatchee region of Florida.—Auk 9:209-218. 1892.

Lists 259 species.

H. W. Wiley. The muck lands of the Florida peninsula.—(In report of Chemist) Rep. U. S. Sec. Agriculture, 1891:163-171. Reprinted in U. S. Senate Document 89, 1911. (See below.)

Deals with the vicinity of Lakes Tohopekaliga and Okeechobee. On page 166 is a list of a few plants growing on muck around Lake Okeechobee, most of them identified only generically.

1893

C. S. Sargent. The mangrove tree.—Garden & Forest 6:97-98, 101, 103, with 2 figures. March 1, 1893.

John M. Holzinger. List of plants new to Florida.—Contr. U. S. Nat. Herb. 1:288. Oct., 1893.

Lists 17 species, all but one collected in the southern part of the State by J. H. Simpson.

1894

C. R. Dodge. Subtropical Florida.—Scribner's Magazine 15:345-362, with 12 half-tone sketches. March, 1894.

Frank M. Chapman. Remarks on certain land mammals of Florida, with a list of the species known to occur in the State.—Bull. Am. Mus. Nat. Hist. 6:333-346. 1894.

Samuel N. Rhoads. Contributions to the mammalogy of Florida.—Proc. Acad. Nat. Sci. Phila. 1894:152-160.

1894-5

John Hamilton. Coleoptera taken at Lake Worth, Fla.—Canadian Entomologist 26:250-256. 1894; 27:317. 1895.

1895

Einar Loennberg, Ph. D. Notes on reptiles and batrachians collected in Florida in 1892 and 1893.—Proc. U. S. Nat. Museum 17:317-339. 1895.

Lists 15 turtles, 7 lizards, 30 snakes, 5 salamanders, and 10 toads and frogs, all from the peninsular part of the State, but mostly north of the limits of this report.

(The same author also published some notes on Florida plants in Botaniska Notiser, a Swedish magazine, in December, 1894, and a paper on Florida fishes in another Swedish periodical in the same year.)

1896

Alexander Agassiz. The Florida elevated reef. (With notes on the geology of southern Florida by L. S. Griswold.)—Bull. Mus. Comparative Zoology of Harvard College, 28:29-62, pl. 1-26. Oct., 1896.

1897

Barton W. Evermann & Barton A. Bean. Indian River and its fishes.—U. S. Senate Misc. Doc. No. 46, 54th Cong., 2nd session. 26 pp., 7 plates. Jan., 1897. Also in Rep. U. S. Fish Comm. 1896:227-262, with 36 plates 1898.

Lists 106 species of fishes occurring in the Indian River, mostly collected by the writers in January, 1896.

1898

(Lieut.) *H. L. Willoughby.* Across the Everglades. A canoe journey of exploration.—192 pp. and numerous half-tone illustrations. Philadelphia, 1898 (and later editions).

J. A. Allen. The mammals of Florida.—American Naturalist 32-433-436. 1898.

1899

Samuel N. Rhoads. Annotated list of land and fresh-water shells collected in the vicinity of Miami, Florida.—Nautilus 13:43-48. Aug., 1899.

C. L. Pollard. Notes on some South Florida ferns.—Fern Bulletin 7:88-90. Oct., 1899.

1902

Chas. T. Simpson. A visit to the royal palm hammock of Florida.—Plant World 5:4-7. Jan., 1902.

This does not refer to the now well known Royal Palm Hammock, in Dade County (formerly called Paradise Key, and now a State park), but to a much less accessible one near the Gulf coast, in what is now Collier County.

C. L. Pollard. Plant agencies in the formation of the Florida Keys.—Plant World 5:8-10, pl. 4. 1902.

Mostly about mangroves.

John K. Small & George V. Nash. Report upon a trip to Florida.—Jour. N. Y. Bot. Gard. 3:29-35. Feb., 1902.

Vicinity of Miami mostly.

A. S. Hitchcock. A list of plants collected in Lee County, Florida.—Proc. Iowa Acad. Sci. 9:189-225. 1902.

1903

(Mrs.) *E. C. Anthony.* Notes on the ferns of the Florida east coast.—Fern Bulletin 11:21-23. Jan., 1903.

O. P. Phillips. How the mangrove adds new land to Florida.—Jour. Geography 2:10-21, with 12 half tones. 1903.

M. A. Howe. Report . . . . on a trip to Florida.—Jour N. Y. Bot. Gard. 4: 44-49. 1903

1904

Oakes Ames. A contribution to our knowledge of the orchid flora of southern Florida.—Contr. Ames Bot. Lab., No. 1. 23 pp., 12 plates. Feb., 1904.

John K. Small. Report on exploration in tropical Florida.—Jour. N. Y. Bot. Gard. 5:49-53. March, 1904.

A. A. Eaton. A preliminary list of pteridophyta collected in Dade County, Florida, during November and December, 1903.—Fern Bulletin 12:45-48. "April" [May], 1904.

Oakes Ames. Additions to the orchid flora of Florida.—Proc. Biol. Soc. Wash. 17:115-117. May, 1904.

N. L. Britton. Explorations in Florida and the Bahamas.—Jour. N. Y. Bot. Gard. 5:129-136. July, 1904.

John K. Small. Report upon further exploration of southern Florida.—Jour. N. Y. Bot. Gard. 5:157-164, figs. 24-26. Aug., 1904.

M. A. Howe. Collections of marine algae from Florida and the Bahamas.—Jour. N. Y. Bot. Gard. 5:164-166. Aug., 1904.

George V. Nash. The palms of Florida.—Jour. N. Y. Bot. Gard. 5:194-199. Oct., 1904.

Bradford Torrey. Nature's Invitation.—Boston, 1904.

Pages 83-160 devoted to Florida, mostly the southern part.

1905

J. A. G. Rehn & Morgan Hebard. A contribution to the knowledge of the Orthoptera of southern and central Florida.—Proc. Phila. Acad. Nat. Sci. 57:29-55. 1905.

M. A. Howe. New Chlorophyceae from Florida and the Bahamas.—Bull. Torrey Bot. Club 32:241-252, pl. 11-15. May, 1905.

Describes two new species of green algae, *Halimeda scabra* and *Siphonocladus rigidus*, from various localities in South Florida and the Bahamas.

H. A. Pilsbry. Land shells of the Florida Keys.—Nautilus 19:37-41. August, 1905.

Forty species listed, including some from Cape Sable and the Ten Thousand Islands, with notes on distribution. One new, *Succinea floridana*, from Big Pine Key, etc.

M. A. Howe. New Chlorophyceae, new Rhodophyceae and miscellaneous notes.—Bull. Torrey Bot. Club 32:563-586, pl. 23-29. Nov., 1905.

Includes descriptions of *Sarcomenia filamentosa*, n. sp., washed ashore at Cape Florida and elsewhere, and *Acetabulum Farlowii* (Solms) Howe, from Key West, Miami, etc

1906

John Gifford. The Florida Keys.—Nat. Geog. Magazine 17:5-16. Jan., 1906.

M. Foslie & M. A. Howe. New American coralline algae.—Bull. N. Y. Bot. Gard. 4:128-136, pl. 80-93. June, 1906.

Includes descriptions of two new species from Sands Key (Dade County), namely, *Goniolithum accretum* and *Lithophyllum bermudense* (the former growing also in the Bahamas and the latter in Bermuda).

H. W. Fowler. Birds observed in June in the Florida Keys.—Auk. 23:396-400. 1906. (33 species.)

1907

John K. Small. Exploration of southern Florida.—Jour. N. Y. Bot. Gard. 8:23-28. Feb., 1907.

C. F. Millspaugh. Flora of the sand keys of Florida.—Field Columbian Museum, Pub. 118. (Bot. Series, vol. 2, No. 5), pp. 189-245. March, 1907.

An account of a very detailed study of the vegetation of all the small islands west of Key West, by O. E. Lansing, Jr., with maps; intended primarily for comparison with studies that may be made of the same areas in future years.

H. A. Pilsbry. Origin of the tropical forms of the land molluscan fauna of southern Florida.—Proc. Acad. Nat. Sci. Phila. 59-193. 1907.

M. A. Howe. Further notes on Halimeda and Avrainvillea.—Bull. Torrey Bot. Club 34:491-516, pl. 25-30. Oct., 1907.

Discusses among others *Halimeda discoidea* and *Avrainvillea nigricans,* coralline algae from South Florida and the tropics.

1908

E. G. Vanatta. List of the land shells of Lee County, Florida.—Nautilus 21: 99-104. Jan., 1908.

Specimens collected by Clarence B. Moore, mostly along the coast from Pine Island to Chokoloskee.

Ernst A. Bessey. The Florida strangling figs.—Rep. Missouri Bot. Gard. 19:25-33, pl. 1-9. 1908.

Frank M. Chapman. Camps and cruises of an ornithologist.—New York, 1908.

Part 3 (pp. 83-154) deals with Florida.

1909

M. A. Howe. The genus Neomeris and notes on other Siphonales.—Bull. Torrey Bot. Club 36:75-86, pl. 1-8. Feb., 1909.

Includes notes on three marine algae from South Florida and the tropics, namely, *Neomeris annulata, Udotea conglutinata,* and *Udotea cyathiformis.*

John K. Small. Exploration in the Everglades.—Jour. N. Y. Bot. Gard. 10: 48-55. March, 1909.

T. Wayland Vaughan. The geological work of mangroves in southern Florida. —Smithsonian Miscellaneous Collections 52:461-464, with 7 plates and 2 text-figures. 1909.

Written because the subject had not been treated much in geological literature. (Three or four botanical papers on the same subject are cited above.)

Chas. T. Simpson. Collecting in the Everglades.—Fern Bulletin 17:38-41. "April" [May], 1909.

E. P. Van Duzee. Observations on some Hemiptera taken in Florida in the spring of 1908.—Bull. Buffalo Soc. Nat. Sci. 9:149-230. 1909.

Many new species, mostly from southern Florida.

M. A. Howe. Report on an expedition to Jamaica, Cuba, and the Florida Keys.—Jour. N. Y. Bot. Gard. 10:115-118. 1909.

1910

Winthrop Packard. Florida Trails.—300 pp., 40 plates. Boston, 1910.

One of the best of the popular books on Florida. Some of the chapters were previously published in the Boston Transcript.

R. M. Harper. Tramping and camping on the southeastern rim of the Everglades.—Florida Review (Jacksonville) 4:44-49, 51-55, 147-157. 1910.

1911

Everglades of Florida. Acts, reports, and other papers, state and national, relating to the Everglades of the State of Florida and their reclamation.—U. S. Senate Doc. 89, 62nd Congress, 1st Session. 208 pp., 2 folded maps, 6 plates. 1911.

Contains among other things reproductions of Lieut. Ives' map (1856), and Dr. Wiley's article on muck lands (1892), referred to above.

John K. Small. Exploration in southern Florida.—Jour. N. Y. Bot. Gard. 12:147-156, figs. 26-31. July, 1911.

Describes Miami Beach, the Keys, etc. Notes the occurrence of a deer on the lower Keys (described as a new variety by Barbour and Allen in 1922).

Ernst A. Bessey. The hammocks and Everglades of southern Florida.—Plant World 14:268-276, figs. 1, 2. "Nov.". 1911.

Describes among other things the relation of hammocks to fire.

George H. Clapp. Land shells of Garden Key, Dry Tortugas, Fla.—Nautilus 25:91-92. Dec., 1911.

1912

W. E. Safford. Notes of a naturalist afloat. II. The Florida Keys.—American Fern Journal 2:1-12. (Illust.) "Jan." [Feb.], 1912.

John W. Harshberger. South Florida: a geographic reconnoissance.—Bull. Geog. Soc. Phila. 10:235-245. 1912.

H. A. Pilsbry. A study of the variation and zoogeography of Liguus in Florida.—Jour. Acad. Nat. Sci. Phila. II. 15:427-471, pl. 37-40. (3 colored plates and a map). 1912.

Deals with the tree-snails of the southern mainland and Keys.

1912-1914

J. A. G. Rehn & Morgan Hebard. On the Orthoptera found on the Florida Keys and in extreme southern Florida.—Proc. Acad. Nat. Sci. Phila. 64:235-276, figs. 1-21. 1912; 66:373-412, figs. 1-7. 1914.

1912-1923

E. G. Vanatta. Land shells of southern Florida.—Nautilus 26:16-22, pl. 2. June, 1912; 26:31-34. July, 1912; 33:18. July, 1919; 34-9395. Jan., 1921; 37:65-69. Oct., 1923.

1913

Nelson C. Brown. The tropical or Antillean region of Florida.—Forestry Quarterly 10:673-678, 1 plate. "Dec., 1912" [Jan., 1913].

The plate contains three half-tones made from photographs by the present writer.

John K. Small. Report on exploration of tropical Florida.—Jour. N. Y. Bot. Gard. 14:81-86. April, 1913.

John K. Small. Flora of Miami. Being descriptions of the seed-plants growing naturally on the Everglade Keys and in the adjacent Everglades, southern peninsular Florida.—xii + 206 pp. New York (published by the author), 1913.

John K. Small. Flora of the Florida Keys. Being descriptions of the seed-plants growing on the islands of the Florida reef from Virginia Key to Dry Tortugas.—xii + 162 pp. New York (published by the author), 1913.

1914

John K. Small. Exploration in the Everglades and on the Florida Keys.—Jour. N. Y. Bot. Gard. 15:69-79, pl. 129-131. April, 1914.

Describes the Everglades canals, Lake Okeechobee, etc.

Florida Everglades. Report of the Florida Everglades Engineering Commission to the Board of Commissioners of the Everglades Drainage District and the Trustees of the Internal Improvement Fund, State of Florida.—U. S. Senate Doc. 379, 63d Cong., 2nd Session. 148 pp., with several unnumbered text-figures, half-tone plates, folded maps and diagrams. Washington, 1914.

J. A. G. Rehn & Morgan Hebard. Records of Dermaptera and Orthoptera from west central and southwestern Florida, collected by William T. Davis.—Jour. N. Y. Entom. Soc. 22:96-116. June. 1914.

John W. Harshberger. The vegetation of South Florida, south of 27° 30' north, exclusive of the Florida Keys.—Trans. Wagner Free Inst. Sci. 7:49-189, with folded map, 2 text-figures and 10 pplates. Philadelphia, "Oct." [Dec.], 1914.

1915

Frederic H. Kennard. On the trail of the ivory-bill [ed woodpecker, in the Big Cypress country].—Auk 32:1-14, pl. 1-3. Jan., 1915.

Frederic H. Kennard. The Okaloacoochee Slough.—Auk 32:154-166, pl. 13-15. April, 1915.

Morgan Hebard. Dermaptera and Orthoptera found in the vicinity of Miami, Florida, in March, 1915.—Entom. News 26:397-408, 457-469, pl. 18-20. 1915.

1915-1916

Charles N. Mooney & Mark Baldwin. Soil survey of the Indian River area, Florida.—Field Operations U. S. Bureau of Soils, 1913: 675-717, pl. 4, and large soil map. 1916. (Also issued as an advance chapter, with 47 pages, plate and map, dated July 31, 1915.)

The area described is a narrow strip along the coast from Titusville to Palm Beach.

1915-1919

Mark Baldwin & H. W. Hawker. Soil survey of the Fort Lauderdale area, Florida.—Field Operations U. S. Bureau of Soils, 1915:751-798, pl. A. B., (folded maps), 26-29, and large soil map. 1919. (Also issued as an advance chapter, with 52 pages and the same illustrations, dated July 31, 1915.)

The area described is a strip about five miles wide along the North New River Canal through the Everglades from Lake Okeechobee to Fort Lauderdale.

1916

Morgan Hebard. Spring Orthoptera found on the islands in the vicinity of Charlotte Harbor, Florida.—Entom. News 27:14-21. Jan., 1916.

John K. Small. Exploration in southern Florida in 1915.—Jour. N. Y. Bot. Gard. 17:37-45, pl. 166-168. March, 1916.

Mentions the desecration of Royal Palm Hammock, among other things.

F. S. Collins & M. A. Howe. Notes on species of Halymenia.—Bull. Torrey Bot. Club 43:169-182. April, 1916.

Includes description of *H. Gelinaria*, n. sp., a marine alga from North Carolina and South Florida.

John K. Small. Royal Palm Hammock [in Dade County].—Jour. N. Y. Bot. Gard. 17:165-172, pl. 179-182. Oct., 1916.

T. E. Snyder. Notes on horse-flies as a pest in southern Florida.—Proc. Entom. Soc. Washington 18:208. 1916.

John K. Small. A cruise to the Cape Sable region of Florida.—Jour. N. Y. Bot. Gard. 17:189-202, pl. 183-188. Nov., 1916.

Reprinted with some additions and alterations, as an independent pamphlet entitled "The Cape Sable region of Florida," with 27 pages and 6 plates, in 1919.

1917

John K. Small. Botanical explorations in southern Florida in 1916.—Jour. N. Y. Bot. Gard. 18:98-111, pl. 195-199. May, 1917.

Harden F. Taylor. Mortality of fishes on the west coast of Florida.—U. S. Bur. Fisheries, Document 848. 24 pp. 1917.

Roland M. Harper. (Review of) Matson & Sanford's "Geology and ground waters of Florida."—Geog. Review 4:224-226. Sept., 1917.

1918

John K. Small. Ferns of tropical Florida.—Amer. Museum Jour. 18:126-134, with 7 half-tones. "Feb.", 1918.

A sort of preface to a book with the same title. (See next.)

John K. Small. Ferns of tropical Florida.—ix + 80 pp. New York (published by the author), 1918.

John K. Small. Ferns of Royal Palm Hammock.—vii + 38 pp. New York. (published by the author), 1918.

J. T. Nichols. Bird-notes from Florida. [Along the coast from Miami to Sanibel.] Abstr. Proc. Linn. Soc. N. Y. 30:20-27. pl. 1. Sept., 1918.

John K. Small. Botanical exploration in Florida in 1917.—Jour. N. Y. Bot. Gard. 19:279-290, pl. 219-222. Nov., 1918.

Describes his first visit to the Big Cypress, among other things.

1918-19

W. S. Blatchley. Some new or scarce Coleoptera from western and southern Florida.—Can. Entom. 50:416-424. 1918; 51:28-32, 65-69. 1919.

1919

John K. Small. Narrative of a cruise to Lake Okeechobee.—Am. Museum Jour. 18:684-700, with 14 illustrations. "Dec., 1918."

W. E. Safford. Natural history of Paradise Key and the nearby Everglades of Florida.—Smithsonian Rep. 1917:377-434, with 32 text-figures, 64 plates, and folded map. (Smithsonian Publ. 2508). Washington, 1919.

A. H. Howell. Description of a new seaside sparrow from Florida.—Auk 36:86-87. Jan., 1919.

Thryospiza mirabilis, from Cape Sable.

C. A. Mosier & T. A. Snyder. Notes on the seasonal activity of Tabanidae [horse-flies] in the lower Everglades of Florida.—Proc. Entom. Soc. Wash. 21: 186-197. 1919.

A. H. Howell. Notes on the fox squirrels of southeastern United States, with description of a new form from Florida.—Jour. Mammalogy, 1:36-38. Nov., 1919.

The new form is *Sciurus niger avicennia,* from near Everglade, in Lee (now Collier) County.

John K. Small. Coastwise dunes and lagoons. A record of botanical exploration in Florida in the spring of 1918.—Jour. N. Y. Bot. Gard. 20:191-207, pl. 236-238. Oct., 1919.

Paul Bartsch. The bird rookeries of the Tortugas.—Smithsonian Rep. 1917: 469-500, with 38 plates. Washington, 1919.

1920

A. H. Howell. Description of a new race of the Florida water-rat *(Neofiber Alleni).*—Jour. Mammalogy 1:79-80. Feb., 1920.

Var. *nigrescens,* from the south shore of Lake Okeechobee.

John K. Small. Of grottoes and ancient dunes. A record of botanical exploration in Florida in December, 1918.—Jour. N. Y. Bot. Gard. 21:25-38, 45-54, pl. 241-244. Feb. and Mar., 1920.

Describes his first visit to what is now Highlands County, among other things.

W. S. Blatchley. Notes on the winter Coleoptera of western and southern Florida, with descriptions of new species.—Can. Entom. 52:42-46, 68-72. 1920.

Describes the Cape Sable country, among other things.

G. M. Allen. An insular race of cotton rat from the Florida Keys.—Jour. Mammalogy 1:235-236. Nov., 1920.

Sigmodon hispidus exsputus, from Big Pine Key.

Chas. T. Simpson. In lower Florida wilds. A naturalist's observations on the life, physical geography, and geology of the more tropical part of the State.—xv + 404 pp., 64 unnumbered plates, 2 maps. New York, 1920.

Reviewed in Geog. Review 4:635. Oct., 1921.

John K. Small. A botanical excursion to the Big Cypress.—Natural History (formerly Am. Museum Jour.) 20:488-500, with 8 half-tones. 1920.

1921

George H. Clapp. Land shells of Chokoloskee Key and Cape Sable, Florida.—Nautilus 34:108. Jan., 1921.

John K. Small. Old trails and new discoveries.—Jour. N. Y. Bot. Gard. 22:25-40, 49-64, pl. 253-256. 1921.

Describes some cactus hammocks on Big Pine Key, and Indian Prairie. among other things.

Richard F. Deckert. Amphibian notes from Dade County, Florida.—Copeia 92:20-23. March, 1921.

A. H. Howell. A list of the birds of Royal Palm Hammock, Florida.—Auk 38:250-263. April, 1921.

Lists 31 water birds and 97 land birds.

Clarence B. Moore. Liguus at Marco, Florida.—Nautilus 34:139-140. April, 1921.

Chas. T. Simpson. Florida west coast Liguus. [A reply to article by C. B. Moore cited above.]—Nautilus 35:20-22. July, 1921.

John K. Small. Historic trails by land and water.—Jour. N. Y. Bot. Gard. 22:193-222, pl. 263-266. 1921.

Mentions a submerged cave southwest of Royal Palm Hammock, among other things.

1922

Chas. T. Simpson. A search for Liguus.—Nautilus 35:65-73. Jan., 1922.

Reprinted in his "Out of Doors in Florida" (see below).

W. S. Blatchley. Some new and rare Coleoptera from southwestern Florida.—Can. Entom. 54:9-13, 27-33. 1922.

Relates to the vicinity of Fort Myers and Chokoloskee.

Thomas Barbour & Glover M. Allen. The white-tailed deer of eastern United States.—Jour. Mammalogy 3:65-78. May, 1922.

Contains description of *Odocoileus virginianus clavium,* a new subspecies from Big Pine Key.

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Oliver P. Hay. The Pleistocene of North America and its vertebrated animals from the states east of the Mississippi River and from the Canadian provinces east of longitude 95°.—Carnegie Inst. Wash., Publ. 322. 499 pp., 64 text figs. (mostly full-page maps between text and index), 2 folded maps. Feb. 24, 1923.

South Florida fossils referred to on pages 38-40, 122-124, 145-146, 159-160, 163-164, 197-200, 208, 222, 225, 233, 263-264, 379-384, 412-415, 426-427, 430-437, 440-451, 458-459.

W. S. Blatchley. Notes on the Coleoptera of southern Florida with descriptions of new species.—Can. Entom. 55:13-20, 30-36. 1923.

Mostly about Moore Haven and Lake Okeechobee.

Chas. T. Simpson. An expedition that failed.—Nautilus 36:109-115. April 1923.

Discusses the distribution of tree snails *(Liguus* and *Oxystyla)* in the vicinity of Cape Sable.

John K. Small. Green deserts and dead gardens.—Jour. N. Y. Bot. Gard. 24:193-247, with 4 half-tones in text. 1923.

1923-1925

William J. Clench. The marine shells of Sanibel, Florida.—Nautilus 37:52-56. Oct., 1923. Additions to the list in same, 38:93-95. Jan., 1925.

1924

Charles T. Simpson. Out of doors in Florida. The adventures of a naturalist, together with essays on the wild life and the geology of the State.—xii + 408 pp., with several unnumbered half-tone plates. Miami, "1923."

Similar in treatment to his 1920 book above cited. Almost wholly devoted to the southern half of the State.

W. S. Blatchley. New Coleoptera from southern Florida, with notes on other interesting species.—Can. Entom. 56:164-170. 1924.

John K. Small. The land where spring meets autumn. A record of exploration in Florida in December, 1921.—Jour. N. Y. Bot. Gard. 25:53-94, pl. 285-287. 1924.

W. H. Schroeder. Fisheries of Key West and the clam industry of southern Florida.—U. S. Bur. Fisheries Doc. 962, or Appendix 12 to Report of the Commissioner of Fisheries for 1923. 74 pp., 29 figs., mostly half-tone plates. 1924.

Contains a pretty good bibliography, of 6 pages.

John K. Small. Plant novelties from Florida.—Bull. Torrey Bot. Club 51: 379-393. Sept. 1924.

Describes several new genera and species, mostly from Highlands County and southeast of there.

1925

W. R. Taylor. The marine flora of the Dry Tortugas.—Revue Algologique (Paris) 2:113-135. June, 1925.

Lists about 200 species of algae.

FIELD WORK

The writer's field work in the area under consideration up to the end of 1925 amounted to about twelve weeks, mostly in 1909 and 1924, distributed by months as follows: January, 10 days,

February 3, March 30, April 16, July 6, August 14, November 5; and by counties, using their present boundaries, about as follows: Dade, 42 days, Lee, 6, Manatee and Monroe, 5 each, Highlands and Okeechobee, 4 each, Palm Beach, 3, Hardee, DeSoto, Glades, Indian River, St. Lucie and Broward, 2 each, and all others 1 or less.

Besides traveling on nearly all the railroads, and making several short trips by boat, on both fresh and salt water, he has also traversed some country remote from railroads by automobile, for example from Zolfo to Avon Park, Lake Childs to Okeechobee, Venice to Punta Gorda and Olga, Arcadia to Berman and Olga, Fort Myers to Caxambas, Fort Myers to Immokalee, Fort Myers to Moore Haven, Moore Haven to Okeechobee, Okeechobee to Fort Pierce, Okeechobee to Jupiter, and Homestead to East Cape Sable.

Over 300 miles have also been covered on foot, distributed by counties approximately as follows: Dade, 80 miles, Okeechobee, 35, Highlands, DeSoto, Lee and Palm Beach about 25 each, Indian River, Hardee and Manatee about 20 each, St. Lucie, Glades, Charlotte and Monroe about 15 each, and the rest only a mile or two. Notes have been taken on nearly every mile, whether riding or walking, and these form the basis of the descriptions of vegetation in the following pages.

The largest areas that remain to be explored are in the Everglades and west thereof, bounded roughly by Caxambas, Immokalee, West Palm Beach and Cape Sable.

Except for one or two contributed by other persons (and duly credited) the half-tone illustrations are all from the writer's own photographs. It happens that all my Florida negatives previous to 1920 are inaccessible at this writing, and although I have a complete set of prints, many of the older ones are faded or otherwise unsuitable for reproduction, so that some excellent pictures, especially of the tropical hammocks near Miami (some of which have since been obliterated by the growth of the city) have to be omitted for this reason. Nearly every vegetation type described, however, is illustrated by one or more views, and there are also other views for the various natural regions, to illustrate topography, etc.

GEOLOGY

Geological mapping in South Florida is rather difficult, on account of the generally flat surface, mostly covered with sand or muck, and vegetation. And even if we had satisfactory well records with abundant fossils from every township it would still be quite a problem to locate the edges of the various formations, for the strata are very nearly horizontal.

The oldest strata in our area that are near enough to the surface to be identified in natural exposures are along the Manatee River not far from its mouth, and have been referred to the Alum Bluff group, of Miocene age. They contain important deposits of fuller's earth, which has long been mined near Ellenton, and some limestone which has been used locally for building stone. Strata of similar age have been assumed to underlie the lake region in Highlands County, but no rock outcrops are known there, and the aspect of the country is very different from anything in Manatee County.

From the northern edge of our area the strata seem to dip very gently southeastward, with successively younger formations appearing at or near the surface. Next above the Miocene is the Pliocene, represented by the Bone Valley and Caloosahatchee formations. The former includes the important pebble phosphate, which as far as workable deposits is concerned is chiefly confined to Polk County, just north of our limits. But a form known as river pebble, washed down into streams, was formerly dredged out of the bed of the Peace River as far south as Arcadia. The vegetation along many of the smaller streams in Hardee and DeSoto Counties seems to indicate calcareous or phosphatic marl not far from the surface, which may be of this formation.

The Caloosahatchee marl, noted among conchologists the world over for its great variety of finely preserved shells (over 600 species having been listed), is exposed along the river of that name near LaBelle, and along the Peace River and some of its tributaries below Arcadia, and presumably underlies a considerable area between those rivers.

Nearly everywhere else in South Florida north and west of the Everglades, drainage ditches only a few feet deep cut into beds

of shell marl which are presumably Pleistocene, as nearly all the shells are identical with species now living. Quite a number of extinct vertebrates, such as the mammoth and mastodon, have been found in similar situations, especially near the east and west coasts. In the northwest corner of Collier County, near Bonita Springs, there are several acres (and perhaps a much larger area away from the road) in which a soft, sandy limestone comes right to the surface in the flat pine woods, and forms a series of platter-like bodies with rounded and slightly upturned edges, each a few square feet in area, separated by hollows a few inches deep filled with grass and other vegetation. These "platters," which also resemble some of the lichens that grow on rocks, or fungi that grow appressed to rotten logs, magnified many times, appear to be still in process of formation, like the tufa and sinter terraces around hot springs in the Rocky Mountain region. The northern edge of Monroe County is said to be so rocky that it is difficult to blast out enough material to build up a roadbed across it. That rock is probably the Lostmans River limestone, of Pleistocene age.

In many places in the flatwoods of Manatee and Charlotte Counties shallow ditches expose a yellowish sandy clay or marl beneath a foot or two of whitish sand.

Passing over a few little-known Pleistocene formations of limited extent and thickness, we come to the most important formation southeast of the Everglades, namely, the Miami oolite. This is said to occur as far north as Delray, but it is hardly noticeable north of Fort Lauderdale. There it makes a narrow belt and is mostly concealed by the surface sand, but southward and southwestward it gradually widens and the sand thins out. Southwest of Coconut Grove there is practically no more sand, and in the neighborhood of Homestead the visible area of oolite is about ten miles wide. It is believed to extend at least half way from Homestead to Cape Sable, but south and west of Paradise Key (Royal Palm Hammock) it is mostly covered by the marl of the coast prairies. (See additional details in the chapter on soils.)

The Miami oolite is often called coral rock locally, but that is a misnomer, for coral makes up only a very small part of it. It is a more or less sandy limestone, often cross-bedded, especially

northward. North of Miami it is full of vertical pot-holes a foot or two in diameter, filled to the top with quartz sand, and with the partitions between them often less than a foot thick, so that when the sand is dug out the rock looks like a honeycomb. (See fig. 47.) Southwest of Coconut Grove, however, the pot-holes are smaller and more irregular. A few large buildings in Miami have been constructed of this rock, dressed into blocks, but its greatest use at present is for road material and railroad ballast. Several quarries are operated in Dade County, and the rock has been shipped as much as 200 miles northward. It is said to be very similar to some of the rock in the Bahamas and Bermuda.

The Key West oolite, which makes up all the lower Keys, is supposed to be of about the same age as the Miami oolite, but it differs in appearance, having very few pot-holes. The upper Keys are composed of genuine coral limestone, which is also Pleistocene.

The coast prairie, between the Miami oolite and the Keys, is covered with a soft gray marl, which is probably Recent in age, being practically a soil formation. The still more recent deposits, such as sand and peat, will be discussed under the head of soils.

Besides the use of sand and peat as soils for growing crops in, a few attempts to utilize the latter commercially have been made. Many people have wondered why the vast deposits of peat in the Everglades have not been used for fuel or fertilizer. The chief difficulty is probably the labor cost. The same amount of labor expended in a coal mine or a pine forest will produce much more fuel than in a peat bog, and the difference in cost is great enough to pay the freight for several hundred miles on what little coal is used in South Florida. At the present time there is a factory in the drained marshes about five miles west of Fellsmere, making fertilizer filler from peat, which is shipped out by rail.*

The sand along the east coast and perhaps elsewhere is used locally in mortar and cement.

A few rarer minerals deserve brief mention. About twelve miles south of Fort Myers, near a small creek, there is a deposit of red ocher on the surface, in flat sandy pine woods. Vivianite, or blue iron earth, a phosphate of iron, has been found in small

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***For additional details about peat see our Third Annual Report.**

quantities recently near Citrus Center in Glades County. Ilmenite, an oxide of titanium, occurs in the form of small shiny black grains among the beach sands of the Atlantic coast at least as far south as Fort Pierce, and has been mined for several years in Duval and St. Johns Counties. A few other heavy minerals are usually associated with it.

UNDERGROUND WATERS

Over the greater part of South Florida water can be found near enough to the surface to be brought to the surface by suction pumps, and larger supplies are obtainable from deep wells, which overflow nearly everywhere within 50 feet of sea-level, except in the Miami limestone region and south thereof. The water from shallow wells in the more elevated portions is pure enough, but that from deep wells nearly always contains enough lime, sulphur or salt to be perceptible to the taste. The amount of salt is hardly ever enough to make the water from the shallow wells undrinkable, except on the Keys. Key West still depends on rain-water for most of its domestic supply (and that is not any too abundant, for Key West has less rain than any other place in Florida), but some people there have shallow wells, and the railroad brings water for its locomotives and hotels in tank cars from Homestead, 126 miles away. Plans are on foot for laying water mains along the railroad from Homestead to Key West, the project having been authorized by a special session of the Legislature in November, 1925.

Some cities on the east coast which formerly got pretty good water from deep wells have grown so rapidly that prolonged pumping has lowered the water enough for a little salt water from the ocean to filter in, and consequently large quantities of bottled water are shipped in from springs farther north for drinking purposes, and considerable distilled water is used also. Sulphur in the water seems to be more prevalent near the coast than in the interior. It is not liked by some people who are unaccustomed to it, and its compounds rust iron pipes, but otherwise it does little harm. The lime is unobjectionable to the taste, but makes the water "hard."

In some places even shallow wells yield water that is hard or

unpalatable, and private houses outside of the cities in such localities, as for example in Manatee and Lee Counties, have rainwater cisterns instead of wells.* The city of Moore Haven gets its water from Lake Okeechobee, Okeechobee City is just installing a pumping plant for the same purpose, and there has been some talk of supplying West Palm Beach and Miami from the same source.

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*Cisterns are also very common in southern Louisiana and southeastern Texas, and there are some even in the thinly settled portions of New York City, and in southern Ontario. (Fertile soil and good water hardly ever occur together.)

TOPOGRAPHY

Generally speaking, the surface of South Florida is flat. Outside of Highlands County there is probably no point in the area treated more than 125 feet above sea-level, and perhaps none over 100 feet south of Hardee County. In the flat portions some of the streams have cut narrow valleys, which may be as much as 50 feet deep along the Peace River and some of its tributaries in Hardee and DeSoto Counties, but are usually much less. The flat areas away from the streams are dotted with shallow basins usually a foot or two in depth and several acres in extent, whose origin has never been satisfactorily explained.

The lake region in Highlands County, often called the "Ridge," is apparently all more than 100 feet above sea-level, and the highest points in South Florida, near Avon Park, are probably about 175 feet. The descent from this upland to the flat country around it is rather abrupt in many places, so that railroads passing from one region to the other have a long cut through the upland and a long embankment in the lowland, each as much as a mile long in some cases. This is especially noticeable on the Seaboard Air Line north of Avon Park and east of Sebring, and on the Atlantic Coast Line south of Venus. (On the latter road the elevation of Venus is given as 118 feet, and that of Palmdale, the next station south, as 52 feet.)

This abrupt transition has been regarded by some observers as a marine terrace, and by others as evidence that the sandy uplands are ancient dunes; but neither explanation seems to fit all the facts. The hills of the lake region (at least in Polk County, where they are very similar in appearance to those of Highlands County) are underlaid by a pinkish sandy clay, which stands higher than the flatwoods, and could not have been heaped up by the wind, unless in a very dry climate. And most of the deep sand in the region is more loamy than any known dune sand, and furthermore its topography is different from that of any known dune area. It is not improbable, though, that the sandy hills, however they were formed, have been gradually and imperceptibly smoothed off by the wind, and that process may be going on today.

The lake region, as its name implies, is dotted with lakes of

various sizes, ranging from a few acres to five or six square miles in extent. (The larger lakes, such as Istokpoga and Okeechobee, are entirely outside of the lake region, and surrounded by flat country.) Just how the lake basins were formed is still an unsolved problem. There does not seem to be any limestone under them thick enough and pure enough and near enough to the surface to make lime-sinks, and the hills around them could hardly have been piled up by the wind, as stated above. But whatever their origin, the combination of smooth hills and lakes is very pleasing to the eye, and causes the whole lake region to be a favorite winter resort.

The only other elevations of any consequence in South Florida are the old dunes along the east and west coasts. Modern or active dunes, such as are found along the coast of Georgia, and still better farther north, hardly exist in South Florida, the wind hardly ever piling up the beach sands to more than five or six feet above high tide in our latitudes; possibly because in this warm climate the vegetation spreads over the sand more quickly and holds it in place better than in higher latitudes, or else because of the large proportion of shell fragments in our beach sands.

But at some time in the past, perhaps a few thousand years ago, the wind must have been stronger or the climate colder or drier, for there is a nearly continuous line of steep-sided old dunes just west of the Indian River and other coastal lagoons, from about St. Augustine to Fort Lauderdale. They are said to reach a height of 63 feet above sea-level at Olympia (formerly Hobe Sound) and 47 feet at West Palm Beach, and some of those near Jensen must be at least 50 feet high. (See fig. 44.) These dunes usually extend about half a mile inland from the shores of the lagoons, but outlying areas of them are found in a few places five or six miles from the coast.

High old dunes are much scarcer on the Gulf coast. One might imagine from the map that they would be well developed on Sanibel Island, on account of its exposed position, but apparently no part of that island is more than ten feet above sea-level. Possibly the great abundance of shells there has something to do with the absence of dunes. The most remarkable old dunes on the west coast are at Caxambas, at the southeast end of Marco

Island, in Collier County. The highest elevation there is variously estimated at from 60 to 85 feet. (See fig. 34.)

The old dunes along the east coast apparently indicate an uplift of a few feet in comparatively recent times.* For they are not only higher above sea-level than any modern dunes in Florida, but also sometimes too far inland for the wind to have much influence on them. They must have been formed when the Indian River was part of the open ocean, and the barrier beach east of it a submerged sand-bar.

Toward Cape Sable, however, there is evidence of a recent sinking of the land. Some years ago a dredge piling up an embankment for the road through the coast prairie to Cape Sable is said to have cut into a cave with stalactites, at or below sea-level, and filled with water.† There is no known way in which stalactites can form under water, so the cave must have been dissolved out of the rock when it stood above the ground-water level. The very irregular and dissected outline of the lower Keys, and the occurrence there of several species of plants and animals known on the mainland but not on the Upper Keys, also point to a recent submergence. But the upper Keys, being an old coral reef, must have been formed under water and then elevated, perhaps at the same time with the old dunes of the east coast.

Other evidence of submergence on the west coast is found in the wide estuaries at the mouths of the Manatee, Peace, Caloosahatchee and other rivers, which appear to be typical "drowned valleys," and have no counterpart on the east coast.

MINOR TOPOGRAPHIC FORMS

In the Miami limestone region there are numerous examples of topographic forms produced by solution, besides the small potholes found on nearly every square yard of the surface. Among the most conspicuous of these are the natural bridge over Arch Creek (crossed by the main highway at the settlement of Arch Creek), and several lime-sinks in Brickell's and other hammocks. The Miami pine land is intersected at right angles by a considerable

*See Geog. Review 4:225. 1917.
†See Small, Jour. N. Y. Bot. Gard. 22:203-204. 1921.

number of "glades," which are elongated approximately straight depressions from a few inches to a few feet in depth, and from about fifty yards to half a mile in width. (See fig. 30.) Some of these extend all the way across from the Everglades to the coast prairie, while some open out only into the latter. They were presumably formed mostly by solution, for near their edges in some places there are fantastically shaped pillars and arches of limestone, with very jagged surfaces. (Fig. 49.) Smaller pillars of the same sort are so abundant around Paradise Key, where the Everglades and coast prairie meet, that any one walking across the prairie can hardly avoid stepping on them.

The inner edges of some of the Upper Keys have been undercut in a curious manner (see fig. 56), probably mostly by the solvent action of the water, but perhaps assisted by the gentle lapping of the waves. The resulting overhanging edges may project as much as two feet, with a vertical thickness of about the same amount.

Where the Miami oolite approaches Biscayne Bay there are a few wave-cut cliffs, apparently dating back to a time when the land stood a little lower than at present. The most accessible of these are at Silver Bluff (which probably takes its name from them), but they are now pretty well built over.

SOILS

There are no detailed soil surveys for South Florida yet, except a narrow strip along the east coast, from Palm Beach northward, surveyed by the U. S. Bureau of Soils in 1913, and another along the North New River Canal through the Everglades from Lake Okeechobee to Fort Lauderdale, surveyed in 1915. Consequently the present treatment of the subject must be rather superficial.

North of the latitude of Miami and outside of the Everglades most of the surface is covered with fine sand several feet deep. In the flat areas it is commonly grayish in color from finely divided organic matter, but in the lake region it is prevailingly yellowish or cream-colored, or in places nearly white. The old dunes, especially along the east coast, usually have white sand at the surface, but at a depth of a foot or two that sometimes passes abruptly into a rusty yellowish and slightly indurated sand. The whiteness of the surface there and in spots in the lake region and flatwoods is probably due to long-continued leaching by summer rains, where there are few or no burrowing animals to keep the soil stirred up.

The gray sand of the flatwoods is sometimes underlaid by calcareous or phosphatic marl, and sometimes by "hardpan," a sandy material cemented together by organic matter or iron oxide, or both. The marl is sometimes near enough to the surface to influence the vegetation perceptibly, but where the sand is deeper it would take extensive prospecting with a soil auger to determine the distribution of marl and hardpan subsoils.

The Miami oolite is important as a soil material in Dade County. Although outcrops of it are recognizable along New River, its influence on the vegetation is hardly noticeable north of Ojus, at the north edge of Dade County. There it is mostly covered by quartz sand, as stated in the chapter on geology, but the sand thins southward, and is scarcely seen below Coconut Grove. From Coconut Grove to Homestead the bare limestone is exposed nearly everywhere, but there is enough humus in its innumerable cavities to support considerable vegetation. For several miles around Homestead, in the so-called Redlands district, the inter-

stices of the rock are filled with a reddish clay. That looks as if it might be residual from the weathering of the limestone, like the red clay of the Shenandoah Valley of Virginia and the Tennessee Valley of Alabama, and one would expect it to be very fertile. No chemical analysis of it has ever come to the writer's notice, but he ventures the guess that it is similar to the laterite of India, which is not at all noted for fertility, being very deficient in potash, one of the essential elements. For the vegetation of the red lands differs very little from that of the bare rock between Homestead and Coconut Grove, or the sand-covered rock between Coconut Grove and Ojus; and some of the differences that do exist may be due to climate as much as to soil.

West of Royal Palm Hammock there are disconnected areas of rocky pine lands, Long Key* and other so-called Everglades Keys, similar to those northeast of Homestead, except that the surface is a little more jagged. Limestone rock seems to come to the surface in a considerable area in southern Collier and northern Monroe Counties, but that is too little known yet to map accurately. The Keys proper, both upper and lower, are of solid limestone, with very little soil in the ordinary sense.

The surface of all the oolite country is essentially flat, but elevated a few feet above average ground-water level. As a geological formation the Miami oolite extends out into the Everglades on the north and the coast prairie on the south; but as a soil type its boundaries are very sharp, except at the north end where it gradually disappears under the sand. All around the edges of the visible rock, or Biscayne pine land, and in the numerous narrow intersecting glades, there is a soil of soft gray marl. Northwestward this soon passes beneath the Everglades muck, but southward it is exposed over hundreds of square miles. Analyses of the marl from near Cape Sable show it to be nearly all calcium carbonate, which is very unusual for a soil. Somewhat similar marl occurs around the Keys, mostly below sea-level, and a good deal of it has been dredged up to make railroad embankments.

The road from Fort Pierce to Okeechobee goes through a few

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*Sometimes called Long Pine Key, to distinguish it from Long Key in Monroe County (which is one of the coral reef upper keys), and an island of the same name which is a sandy barrier beach in Pinellas County.

miles of damp marly soil, which presumably makes a belt a few miles wide parallel to the coast, but it has a somewhat loamy appearance, and is probably much less calcareous than that in the coast prairie. Similar-appearing material occurs beneath a foot or two of surface sand in Manatee and Charlotte Counties. There are probably other marly spots scattered over the flatwoods, which have not been sufficiently explored.

The scarcity of siliceous soils south of Coconut Grove is illustrated by the fact that on the Keys and at Cape Sable what look like ordinary sandy beaches, covered with sea-oats and other common beach plants, are composed of grains of limestone and shell fragments instead of quartz sand.

The greater part of the Everglades, and many smaller marshes and swamps, is covered with peat or muck, ranging in thickness from a feather-edge to several feet. This sort of soil is much prized for certain crops, particularly vegetables, but has to be drained before it can be cultivated, and that is an expensive process. The work of cutting drainage canals through the Everglades has been going on for about 18 years, but it seems that at present not more than 2% of the area is under cultivation.

SOIL FERTILITY

Extravagant claims have been made about the fertility of the soil in all parts of South Florida, but without much scientific foundation. It is difficult, however, to find standards for estimating fertility in an area so different from the rest of the United States. Very few chemical analyses of our soils are available, and there are differences of opinion on their interpretation. The vegetation is nearly all evergreen, and in temperate regions evergreens generally mean soil too poor to allow the trees to make a complete new crop of leaves every year. But in South Florida the trees may be evergreen because the climate allows them to carry on vegetative activity throughout the year. On the other hand, many or most of the tropical trees have crooked trunks and hard heavy wood, indicating slow growth.

Perhaps the best test of soil fertility afforded by native vegetation is the amount of vegetable matter produced by a given area

in a year.* That would be easy enough to determine on an Illinois prairie, where one could simply cut and weigh a measured area of herbage at the end of the growing season. But in South Florida most of the vegetation is not only evergreen but woody, so that there is no obvious way of measuring a year's growth.

When other things are equal the value of farm land ought to be proportional to its fertility, but other things are usually not equal. For several years past farm land has commanded a higher price in South Florida than in the rest of the State ($65.90 per acre in 1920 and $135.35 in 1925, as compared with $35.78 and $70.00 in the whole State), and even higher than some of the extremely fertile prairies and bottoms in the Mississippi Valley; but these values must be largely psychological or speculative, especially the increase in the last five years, when prices of nearly everything else were going down. But the proximity of much of the South Florida farm land to railroads and high-priced residential property, and the possibility of its soon being in demand for a town-site, tends to boost its value. (Within the past two or three years the production of oranges and grapefruit in South Florida is said to have fallen off considerably on account of the cutting down of many groves to make room for houses.)

The value of the crops per acre in South Florida is high, far above the United States average in fact.† But the intrinsic fertility of the soil has much less to do with that than the amount of labor and fertilizer applied to it.

Probably the best statistical measure of soil fertility, except in regions where the utilization of the soil is hindered by an excess of water, or a climate too cold or too dry, or inaccessibility, or the proximity of cities, is the proportion of the land that is under cultivation. In South Florida the ratio of improved farm land to total area was about 1.3% in 1920 and 2.1% in 1925, as

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*See Plant World 21:38-46. 1918.

†In 1919-20, according to the U. S. census figures, the value of all crops, per acre of improved land, was $114.20 in South Florida, $34.80 in the whole State, and $33.35 in the whole United States. At the same time the expenditures per acre in South Florida included $23.54 for labor (including board) $23.00 for fertilizer, and $9.37 for stock feed.

compared with 6.5% for the whole State and 26.4% for the whole United States (80.5% in Iowa, and still more in the blue-grass region of Kentucky).

Another good measure of the fertility of a cultivated soil ought to be the length of time that crops can be raised on it with little or no fertilizer. By this standard the Keys ought to be pretty rich, for in Monroe County the expenditure for fertilizer in 1919, per improved acre in 1920, was only 27 cents, which was far below the State average; and five years later no fertilizer at all was purchased. And around Moore Haven the farmers in the Everglades, or some of them, seem to be still getting some results without fertilizers.*

In the Moore Haven district the muck that bears a dense growth of elder seems to be regarded as best, and that opinion is probably justified, for elder is a fast-growing shrub which elsewhere prefers rich soils, and it makes a remarkably dense growth in some parts of the Everglades, and presumably a large amount of new vegetable matter every year. Dr. H. W. Wiley, in his paper on Florida muck soils cited in the bibliography (written about 20 years before Moore Haven appeared on the maps, and often referred to by promoters in recent years) states that although muck is generally very deficient in mineral matter, that around Lake Okeechobee ought to be better than the average, on account of the limestone underlying it.

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*The following extracts from an article by H. F. Button, on "Some land booms in southern Florida," in the Rural New Yorker for Dec. 18, 1920, are of interest in this connection. It refers particularly to the vicinity of Moore Haven.

"Like all muck soils this region is very rich in nitrogen, and produces a few very large crops, particularly of giant pigweeds, which grow to a height of 12 to 15 feet. Cabbage, lettuce and tomatoes have all been raised here with great profit, but on the soils where as many as three crops have been removed the fields showed by the growth of the truck that something was wrong. A careful study of the growth of plants, particularly some fall-planted white potatoes, showed clear evidence of potash hunger, which we learned to identify during the time when our supplies of fertilizer were limited by the war. The peanuts, which are raised extensively here, showed the need of more phosphoric acid, just as one might expect who has had experience with muck soils in other places. When these needs were suggested to the real estate men they were at first indignantly denied, and when the matter was further pressed and evidence offered, three different men came back with the same argument, namely: That it was undoubtedly true, but that it would never do to acknowledge that this soil lacked for anything. In other words, they considered that it would be treason to their business to begin the use of fertilizers, as one of the great claims of the place has been the richness of the soil."

After all is said, however, it is a fact that neither soil nor climate have much to do with a farmer's profits, for in the long run those depend almost entirely on his own efficiency, together with a certain amount of luck in the way of weather, etc. Any impartial student of the subject will admit that Florida has poorer soils on the average than any other State in the Union; and yet the yield of crops per acre here is above the United States average as already stated. And within the State both the value of property per farm and of crops per acre are almost inversely proportional to soil fertility, some of the highest yields being on the white sands near the east coast.* But whether the yield per acre is high or low, any farmer who is ambitious enough can cultivate enough acres to bring in whatever income he desires.

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*In this connection see also articles by the present writer on productivity of Florida soils (Quarterly Bull. Fla. Dept. Agr., vol. 30, No. 4, pp. 14-26. Nov., 1920), and agricultural conditions in Florida in 1925 (Economic Geography 3:340-353. July, 1927).

CLIMATE

As the differences between South Florida and the rest of the United States are probably due as much to climate as to anything else, that subject warrants an extended treatment. The map (fig. 3) shows the average annual temperature and rainfall throughout the area, and the following table illustrates some of the salient features of climate for the principal weather stations. Tampa, which is a little outside the area under investigation, is included because its records are longer and presumably more accurate than those of most of the stations farther south.

The data given (mostly obtained from the 1924 summary of the Florida section of the U. S. Weather Bureau) are the average temperature for the whole year and January and July, in degrees Fahrenheit; the average annual rainfall, the percentage of it that comes in the four warmest months (June to September inclusive) and the six warmest months (May to October), and the excess of late summer (August to October) over early summer (April to June) rainfall in inches. The significance of these arbitrary rainfall factors will be discussed farther on.

TEMPERATURE

This is the southernmost part of the United States proper, (the southern tip of Texas being in about the same latitude as Miami), and also the warmest in winter, though higher maxima in summer are found in many western states, even as far north as Montana.

The average annual temperature in the area under consideration ranges from about 71° to 77°. (See map, fig. 3). It varies considerably from year to year, as shown in Fig. 6, which gives the average annual temperature at the principal stations in South Florida from 1905 to 1924, taken from the annual summaries of the Florida section of the U. S. Weather Bureau. Some years were noticeably cooler than the average, and some warmer, throughout the area, but we have no reason to believe that the climate is becoming progressively colder or warmer.

As is the case nearly everywhere else near the Atlantic coast, the isotherms have a northeast-southwest trend, probably largely on account of the Gulf Stream. The east coast is therefore warmer

Selected Climatic Data for South Florida.

	Length of Record (Yrs.)	Temperature			Rainfall			
		Annual	January	July	Annual	Percent June-Sept.	Percent May-Oct.	Late Summer Excess
Tampa	35	71.7	60.1	81.2	53.13	63.4	72.7	5.86
Bradenton	41	71.7	60.8	80.9	55.47	62.4	73.5	6.49
Fort Myers	62	73.3	63.5	81.0	51.57	63.5	77.0	4.08
Arcadia	22	—	62.7	81.8	50.04	57.8	70.8	3.40
Avon Park	27	72.6	62.4	81.3	51.92	59.3	75.4	2.50
Fellsmere	12	72.1	63.0	80.5	48.90	53.4	72.5	6.48
Fort Pierce	24	73.3	64.1	80.9	53.03	46.1	64.6	4.63
Jupiter	27	73.9	64.3	81.0	54.33	51.0	77.2	10.67
Hypoluxo	30	74.5	66.3	81.4	60.39	44.9	70.6	6.47
Fort Lauderdale	12	75.0	68.2	81.4	59.89	40.6	69.6	6.83
Miami	23	75.4	67.3	81.9	65.50	49.4	75.3	10.90
Homestead	14	—	67.4	80.6	62.75	53.0	75.9	3.20
Key West	54	76.9	69.5	83.5	38.66	50.0	72.6	7.95

than the west coast in the same latitude, and the distribution of many tropical plants corresponds with that.

The seasonal variations of temperature for the same stations are shown in Fig. 4. It will be noticed that there is more differ-

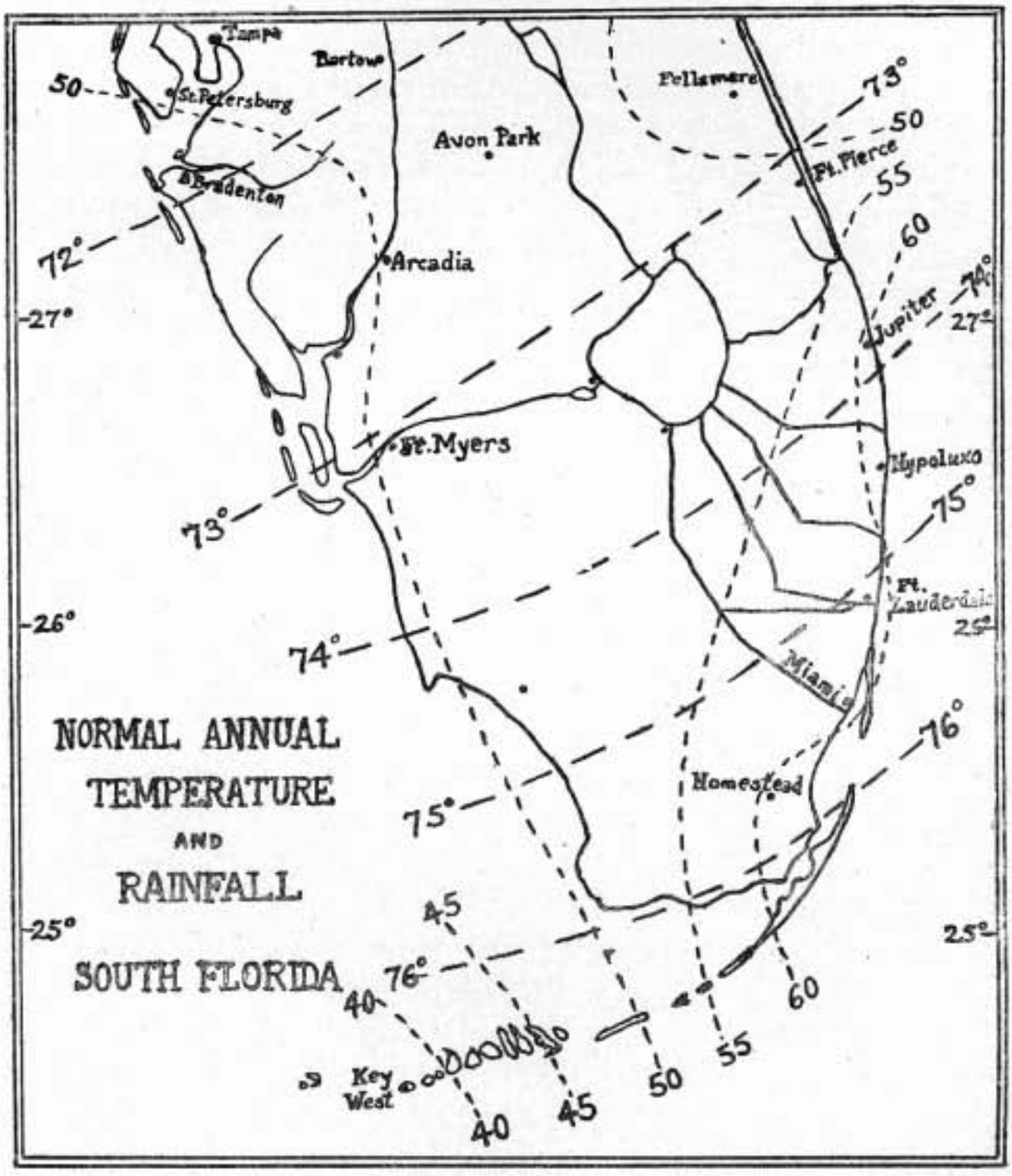

FIG. 3. Map showing normal mean temperature and annual rainfall for southern Florida. Temperature (in degrees Fahrenheit) is indicated by the lines of long dashes, and rainfall (in inches) by the short dashes. When weather stations in this area are more numerous, and the records have been kept for a longer period, the lines can be drawn more accurately, and they may then be more crooked than here shown.

The 60-inch rainfall line was inadvertently drawn east instead of west of Miami.

ence between the different stations in winter than in summer. As a rule the nearer the equator one goes the less is the seasonal variation of temperature. The difference between the January and July averages is only 14° at Key West*, as compared with 21.1° at Tampa (and about 50° in Michigan). Our coldest weather is usually about the middle of January, and the warmest about the first week in August. The points where the temperature equals the annual averages are marked by crosses on the curves and it will be noticed that at nearly every station the temperature is above the average just about half the year, from late April to late October (lagging about a month behind the solar seasons).

On account of the comparatively small annual range of temperature, spring of course comes on much more slowly in this

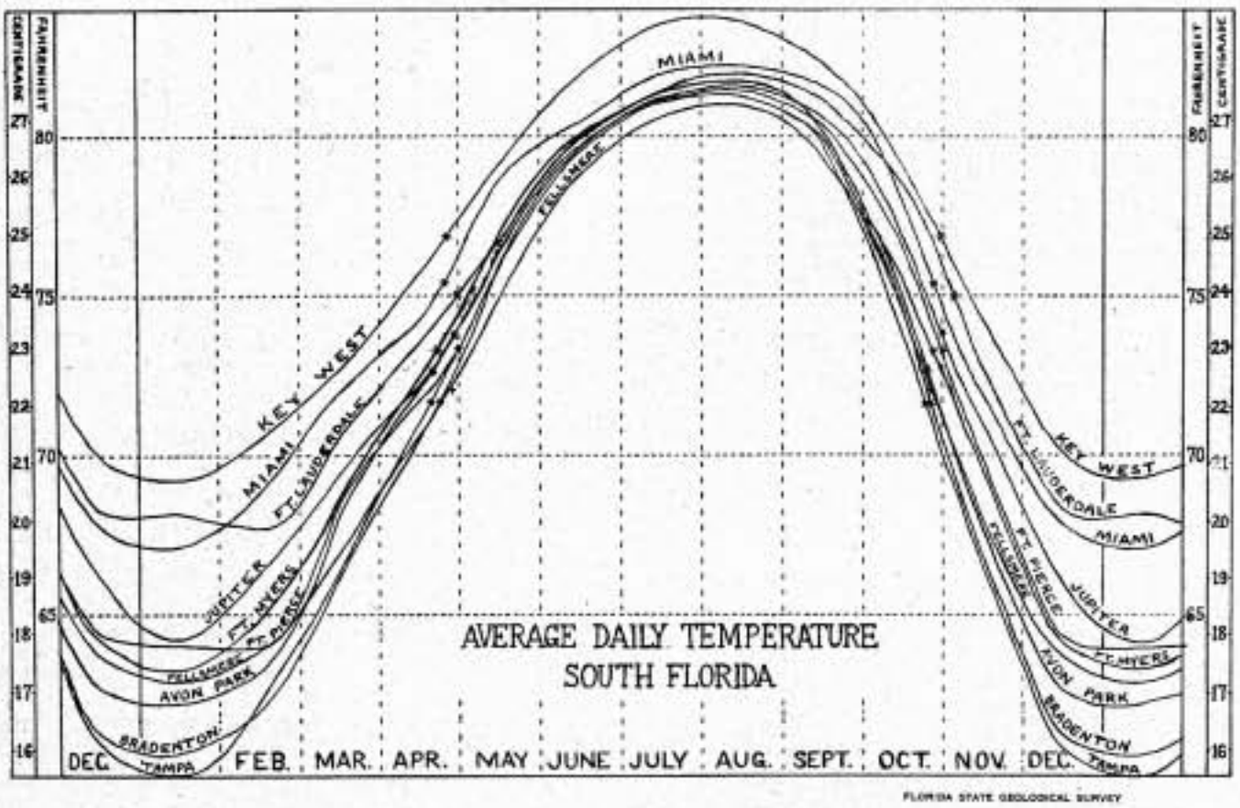

Fig. 4. Daily temperatures for various South Florida weather stations throughout an average year. These curves have been constructed from monthly averages (drawing them a little below the indicated points in the middle of the coldest months and above in the hottest), but are believed to represent the average conditions for every day in the year (disregarding diurnal variations) as accurately as the published records will permit. The average points on each curve are indicated by crosses.

***At Havana the January and July temperatures are said to be 69° and 80°, only 11° apart.**

climate than farther north. The maximum rate of warming up in April and May ranges from about 3.5 degrees per month at Key West to 4.4 at Tampa (as compared with about 13° in Michigan). The rise of temperature from day to day during the spring and early summer (in the average of ten or more years, but not necessarily in any one year) is pretty uniform, and the decline in the fall still more so (and a little more rapid besides).

These curves are smoothed for 24-hour intervals; i. e., any point represents the average temperature for 12 hours before and after the time indicated. We have no adequate data on diurnal variations, but in South Florida there is about as much difference in temperature between day and night as between winter and summer (or even more at Key West and in the tropics).

EXTREMES OF TEMPERATURE

The absolute maximum temperature very rarely reaches 100° F. anywhere in South Florida. As the summer days are shorter there than they are farther north, that partly balances the more nearly vertical position of the sun.

A considerable part of the area was once thought to be below the "frost line," i. e., to have a minimum temperature above 32° F. But more accurate records in recent years have demonstrated the fallacy of that belief. Key West is the only weather station in the United States that has no "official" record of freezing temperature, the minimum there having been given for many years past as 41°. But weather instruments are usually several or many feet above the ground, and on cold nights a difference of a few feet in elevation may make a difference of a few degrees in temperature. The writer has seen photographs taken near Miami just after a December frost in 1906, showing foliage killed up to about three feet from the ground, and uninjured above that.* An official publication of the Cuban government states that on December 24, 1906, ice was formed on standing water at several places in Cuba, while the official temperature at Havana was 54° F. Old-time residents of Key West assert that they have seen frost there, so

*Further details are given a few pages farther on.

there is probably no point in Florida, or in the United States, absolutely free from it. But a glance at that city shows that temperatures too cool for comfort must be very infrequent there, for the houses have no chimneys. (Cooking is done mostly with charcoal.) Miami also has very few chimneys.

The northern parts of our area have freezing temperatures nearly every winter, averaging about three times a year at Bradenton, but even that does not necessarily injure vegetables or fruit. The lowest temperatures on record for various stations are said to be as follows: Tampa 19°, Bradenton 19°, Arcadia 21°, Avon Park 21°, Fort Myers 24°, Fort Pierce 24°, Jupiter 24°, Hypoluxo 26°, Miami 27°, Ritta (on Lake Okeechobee) 29°, Marco 30°, and Flamingo 29°. But some of these stations have records too short to be of much value, and besides the minimum temperatures on the ground are probably lower, as already stated.

PRECIPITATION

Practically all the atmospheric precipitation in South Florida consists of rain. (A few hail storms have been recorded in the northern portions.) The annual average for the whole area is not very different from that of the whole eastern United States, but it varies considerably in short distances, from over 65 inches at Miami to less than 40 at Key West. (See map, fig. 3). The latter is the driest point on record in Florida, in spite of being closely surrounded by salt water. The variations from year to year are more irregular than in the case of temperature, as shown by Fig. 7, which covers very nearly the same stations as the corresponding temperature graph above it, and brings out the wet and dry years in the last two decades pretty well.

The seasonal distribution of our rainfall is rather interesting. Throughout Florida there is more rain in summer than in winter, and the difference is more pronounced in the southern part of the State than at the other end. The dry winters make Florida much more desirable as a winter resort than it would be if most of the rain came in winter, as it does in all the Pacific coast states. From December to April inclusive practically none of our stations have more than 4 inches of rain in a month.

The percentage of the total rainfall coming in the four and

six warmest months have been given in the table a few pages back, and these may be compared with similar figures for northern and central Florida, given in our 6th and 13th annual reports. The excess of late summer over early summer rain, given in the same table, has been found to be correlated pretty well with soil, vegetation, tornadoes, hurricanes and oil wells, in the United States, if not in other parts of the world.* Regions with a considerable late summer excess commonly have poor soils, vegetation mostly evergreen, more hurricanes than tornadoes, and no oil wells But variations in this respect within short distances may not mean much, or may be due to imperfect records.

Fig. 5 shows that in South Florida there is a tendency to two

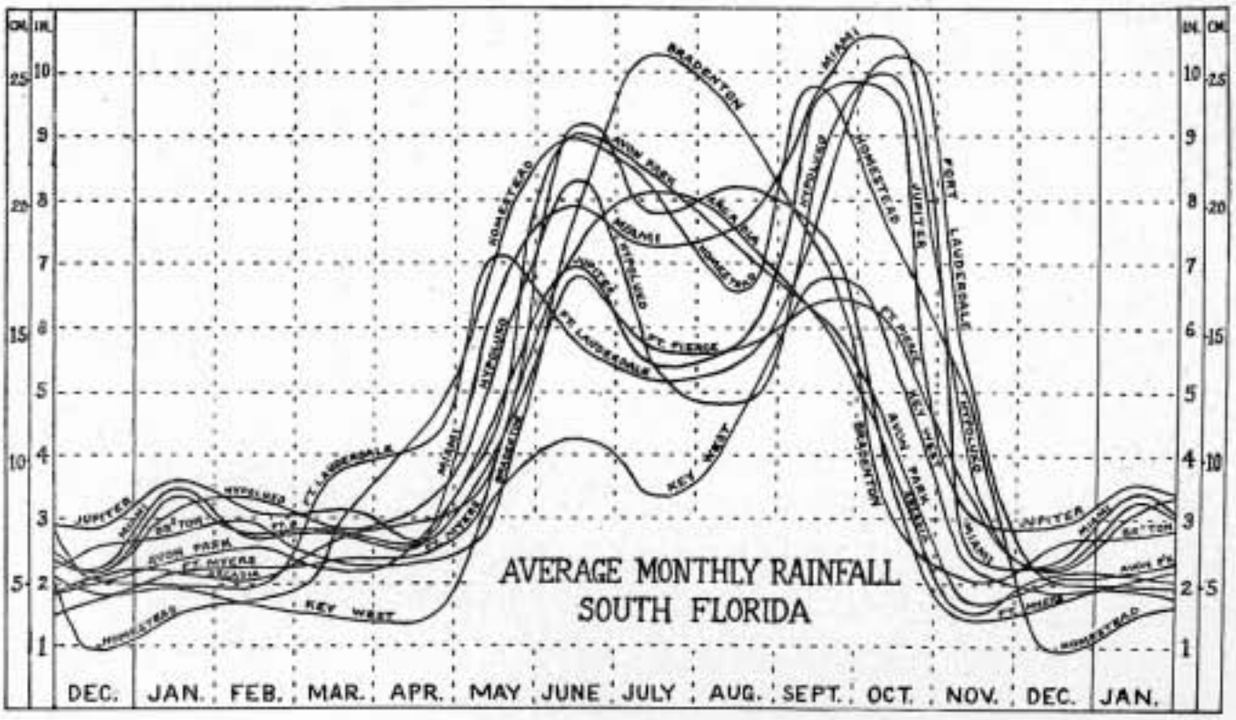

Fig. 5. Monthly rainfall for various South Florida stations throughout an average year. Every point on any curve is intended to represent the average rainfall for half a month preceding and half a month following the date indicated. The average figures for each month have been plotted in the middle of the month and the smoothest possible curves drawn through them. If the averages for every day in the year were available the maximum and minimum amounts would not necessarily come in the middle of a month, but there seem to be no such data published, and even if there were the curves resulting from them might be so irregular as to be confusing.

In this graph and the preceding January and December appear twice, so as to show changes during the winter better than if they were cut off abruptly at the ends of the calendar year, as is commonly done.

*See Science II. 48:208-211. Aug. 30, 1918; 13th Ann. Rep. Fla. Geol. Surv., pp. 194-197. 1921; Engineering & Mining Jour. 112:693-694. Oct. 29, 1921.

rainy periods, a lesser one in early summer and a heavier one in late summer. Generally speaking, the west coast has its heaviest rain in June or July, and the east coast and Keys in September or October. But even the west coast has more rain in August, September and October together than in April, May and June. Several of the stations have two maxima, with less rain in August than in July or September.

Data on the diurnal distribution of rainfall are not very complete, but most of the rain in South Florida falls in the day-time, in heavy showers of short duration. Very heavy downpours in short periods have been recorded at many stations, some of the most noteworthy being mentioned in the chronology a little farther on.

RELATIVE HUMIDITY

Only a few stations keep records of relative humidity. It is about 80% over most of South Florida, and does not vary much with the seasons, for the heavier precipitation in summer tends to balance the heat of the sun. Consequently droughts are rare.

WIND

The average velocity of the wind is about 10 miles per hour at Jupiter and Key West, and probably less in the interior. There is nearly always some breeze, on account of the proximity of the ocean. Although South Florida is hundreds of miles from the main tornado belt of the United States, such a phenomenon occurred in Dade County on the afternoon of April 5, 1925, and a few small ones farther up the east coast in the spring of 1926. (For details see below.)

Hurricanes occur somewhere on the coast every few years, usually in the fall, at about the time of maximum rainfall. The damage they do seldom extends more than a few miles inland. There is a chapter on hurricanes in Simpson's "Out of Doors in Florida," pp. 214-232, and some of the noted ones of the last twenty years are mentioned in the following chronological summary. It is quite likely that hurricanes during many centuries have been the means of bringing many plant seeds, insects, etc., from the West Indies to Florida.

SOME EXTREMES OF WEATHER

Some of the unusual extremes of weather in South Florida in the last twenty years or so will be mentioned below. The items are taken from U. S. Weather Bureau publications and contemporary newspaper clippings. Of course no one should get the impression from this that bad weather is frequent in that part of the State. These are merely the extremes that attracted special notice; and most of the time the weather is delightful. It would be hard to find a more agreeable climate for the year round anywhere in the world. Much has been written about the alleged enervating effects of warm climates, but Ellsworth Huntington, in his book "Civilization and Climate" (1915), states that people from the Bahamas, in very nearly the same latitude, after a short visit to Florida usually feel invigorated and refreshed.

1905. January 26, a cold wave, with freezing temperatures nearly throughout the State, except at Key West, which reported a temperature of 44°. November dry, December wet.

1906. A hurricane on Oct. 18 did considerable damage between Miami and Key West, and killed over 100 men working on the F. E. C. Ry. extension.

Less than an inch of rain in December. Cold wave Dec. 24-26. Minimum temperatures recorded, 14° at Fort Meade (a little north of our limits), 28° at Tampa, 23° at Manatee, 24° at Avon Park, 30° at Jupiter and Hypoluxo, 31° at Fort Myers, 32° at Miami, 33° at Flamingo, and 47° at Key West. This cold wave seems to have been exceptional, at some places at least, in hugging the ground very closely. At Havana, Cuba, at the same time, ice is said to have formed on small pools, while the official temperature (doubtless several feet above the ground) was 54°.

Dr. Ernst A. Bessey, who was then stationed at the Subtropical Laboratory of the U. S. Department of Agriculture at Miami, showed the writer soon afterward some photographs taken in low places in the vicinity, showing foliage killed within a few feet of the ground and uninjured higher up; and in a recent letter he has given some of his recollections of the occurrence, after a lapse of 19 years. He says that a thermometer at the laboratory, in a low place, recorded a temperature of 19° just before sunrise, and remained below 25° for perhaps two or three hours. The cold air seemed to flow in depressions something like a stream of water, and was dammed up in some places by roads crossing such depressions, but did little or no damage on higher ground.

1907. January warm and dry, and March likewise, with less than an inch of rain. The whole year rather dry and warm, with no killing frost anywhere in South Florida.

1908. Frost in every county on Jan. 15th. March and April warm. Heavy rain in October, causing a flood at Fort Lauderdale, and considerable damage to crops.

1909. A hurricane on Oct. 11th killed 15 or 20 people on the Keys, and damaged property to the extent of over a million dollars. At Key West the wind velocity reached nearly 100 miles an hour, and 6.13 inches of rain fell in two hours and 15 minutes. Cold wave Dec. 30-31, freezing as far south as Miami.

1910. January and early February cold. April cool and dry. Between Oct. 14th and 19th a hurricane did considerable damage all along the coast, and Miami was without mail for a week, but very few lives were lost. During that time 16 inches of rain fell in two days at Hypoluxo, and 27.81 inches during the month. The year was cooler and drier than usual, though.

1911. Warmer than the average. June hot, but July cooler. September and October hot, and November wetter than usual. Frost as far south as Fort Myers on Jan. 6th, but no damage to crops.

1912. June a wet month. Rainfall for the month 25.62 inches at Bradenton, 26.91 at Fort Myers, 25.19 at Hypoluxo. Miami had 10.67 inches on Nov. 21st and 22nd. The whole year was wetter than usual.

1913. A rather dry year. January warm, October and November dry.

1914. March cold and dry. Killing frost nearly to Miami on the 3d. May and June warm and dry. Nov. 21st the coldest day of fall, with a little frost.

1915. January wet. March cold, with killing frost at Miami on the 18th. October and November warm. Frost in several places on Dec. 15th. The year cooler and wetter than usual.

1916. January mild and sunny. February dry. March cold and dry, with frost in northwest portions on the 5th. April likewise, with killing frost in Broward County on the 10th. Same county had frost again on Nov. 20th. November and December wet. A little frost on Dec. 17th.

1917. January dry. Frost on Feb. 3rd at most stations, but not as damaging around Lake Okeechobee as at Miami. Temperature of 37° recorded on that date at Long Key, Monroe County. May dry. The 27th was the hottest day of the year at Arcadia, with a temperature of 98°. Drought at Miami from July to December. October to December cold. The year cooler and drier than usual.

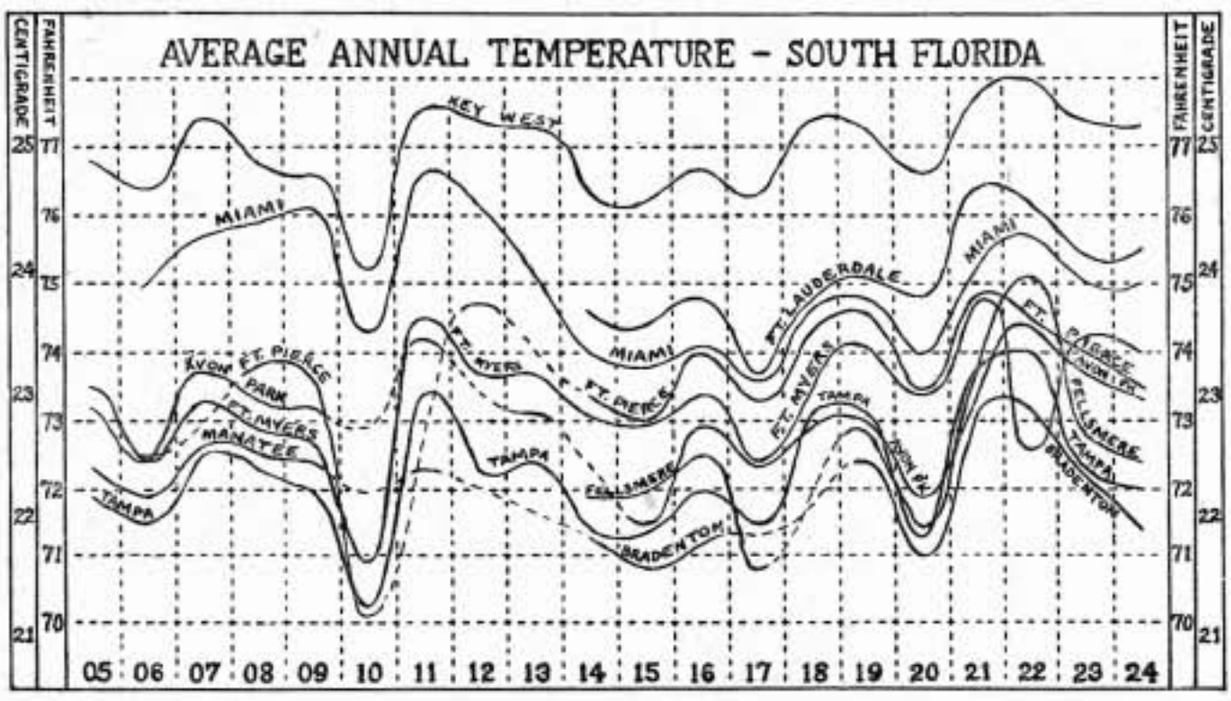

FIG. 6. Average annual temperature for various South Florida weather stations from 1905 to 1924. Every point on any curve is intended to represent the average temperature for six months preceding and six months following the date indicated. (But see explanation under next figure.)

1918. January cold, especially the first week, when there was frost at most stations. February warm and dry; October warm and wet.

1919. January cool and dry, with freezing temperature at Miami on the 5th. February wet. Heavy rains at Fort Lauderdale and Miami on March 14th. May wet. Hurricane Sept. 9-10, doing about two million dollars' damage at Key West. At the same time a tornado about 600 feet wide passed through Goulds, in Dade County. October and November warm. Frost in Broward County on Dec. 30th. The year warmer and wetter than usual.

1920. Frost at Miami first week in January. February cold and wet. March cold. Frost south of Miami on the 2nd, which was the coldest day of the year. April and September wet. Cold wave on Dec. 17th, with a little frost. A cool dry year.

1921. January to March mostly mild and dry, but light frost on Jan. 16th. May cool and wet. June and July pretty dry at Miami. Hypoluxo recorded a temperature of 100° on June 20th. September hot and dry. October cool and wet. Fort Lauderdale had 31.34 inches of rain during that month. On the 24th to 26th a hurricane swept across the peninsula from about Sanibel to Titusville, and Sanibel Island is said to have been completely submerged for a short time.

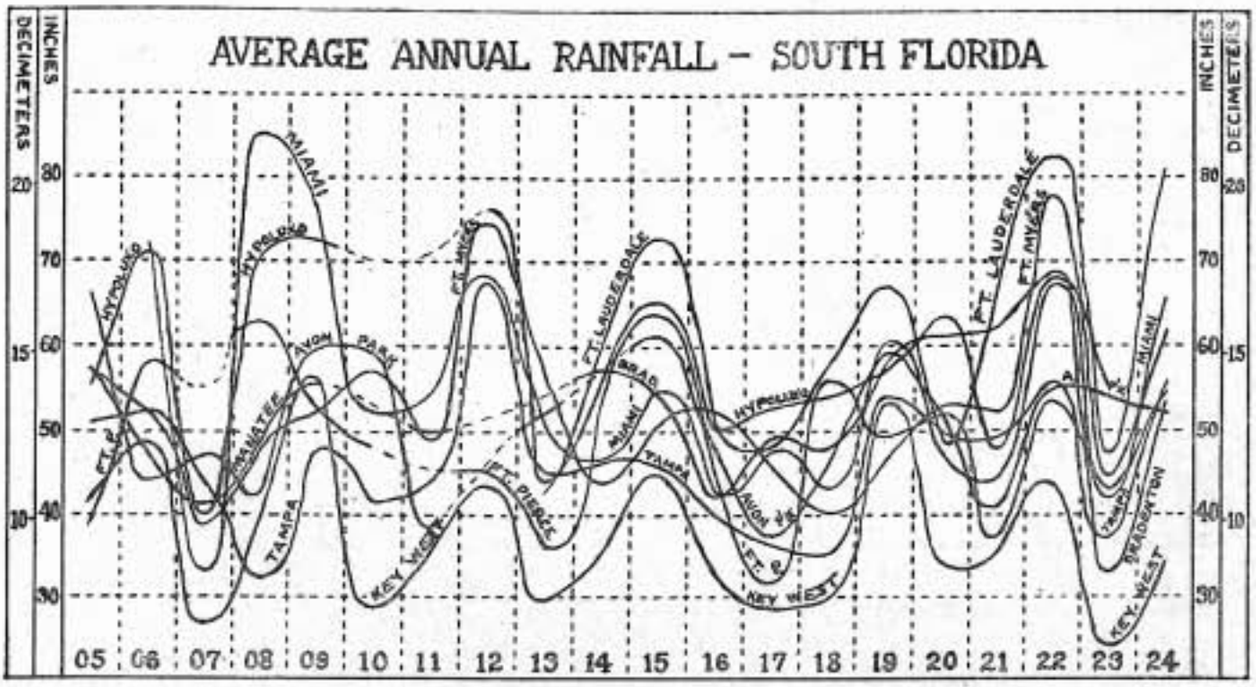

FIG. 7. Average annual rainfall for various South Florida weather stations from 1905 to 1924. Every point on any curve is intended to represent the total rainfall for six months preceding and six months following the date indicated. (But see below.)

In both of these graphs portions of some of the curves are dotted. That indicates gaps in the records, which have been filled in by guess. Both kinds of curves have been constructed by putting the annual averages in the middle of the space allotted for each year, and drawing the smoothest possible curves through those points. That makes it appear as if the twelve-month maxima and minima always come at or near the middle of the year, which cannot be true in general. If the figures for every month in these twenty years had been studied, the maximum and minimum points could have been located more accurately, but that would have taken much longer, and might have made the curves so irregular as to confuse the reader.

Damage of about three million dollars and a few lives lost, but mostly north of the area under consideration. December mild and dry, with no freezing temperature in the whole State.

1922. January very dry. February mostly warm and dry. March and April also dry. June wetter than usual at Fort Myers, but drier elsewhere. Bradenton had 19.35 inches of rain in August. Heavy rains in latter part of September, causing Lake Okeechobee to overflow. Moore Haven had 14.93 inches of rain during the month. Rains continued in October, putting the Everglades two or three feet under water, which remained for several weeks. Homestead had 23.89 inches of rain that month. Considered a wet year.

1923. February and March warm and dry. May wet with heavy rain and hail storm in Hardee County and northward on the 3d. The worst hail on record in South Florida, causing a little damage to crops. June rainy. October and November cool and dry. December warm, wih no frost south of Arcadia. A rather dry year.

1924. January and February cold, damp and cloudy. March cooler than usual. Frost at Moore Haven in January, February and March, the last March 13th. May 30th the warmest day of the year at Arcadia and Avon Park, with temperatures of 98° and 99° respectively. June warm; July wet; August warm and dry. Hurricane in northwest portion on the night of Oct. 20-21, accompanied by very heavy rains, breaking several records, and flooding a large area around Lake Okeechobee. Sands Key had 2.79 inches of rain in an hour, and Miami 4.66 inches in two hours. November started warm, and ended cold and dry. Frost at Arcadia on the 30th. December warmer than usual.

1925. January warm and wet. Average temperature for the month 75° at Key West. Davie, in Broward County, had 7.55 inches of rain on the 24th and 13.08 inches during the month; and Lake Okeechobee overflowed again. Frost as far south as Miami on Feb. 13th, killing many vegetables. March mostly dry, but heavy rain at Miami on the 23d did a little damage. On the afternoon of April 5th the first tornado ever seen in South Florida by most of the present inhabitants struck Hialeah, killed five people, injured 35, and did about $300,000 damage to property. May wetter than usual. Davie had 5.60 inches of rain on the 6th, and Miami 18.74 inches during the month. October warmer and drier than usual. Very heavy rain at Miami on Nov. 30th, flooding the streets; 15.10 inches fell in 24 hours. Considerable damage by wind at the same time, at various places on the coast. (In spite of the frost, tornado and cloudburst in and near Miami, that city, like most other places in South Florida, had the greatest boom in its whole history during 1925.)

VEGETATION

In an area with so little diversity of topography as South Florida, and so little land cultivated yet, the native vegetation is in most places the most conspicuous feature of the landscape. At the same time a great deal of the South Florida vegetation differs considerably from that of the rest of the United States, and also from that of the tropics, and it is very diversified besides. Furthermore, the "developers" are trying to destroy the vegetation as fast as possible, to make room for cities and farms,* and some that was studied by the writer in 1909, 1910, or even later, is already gone forever. All these circumstances make it desirable to put on

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*In this connection the following quotation from Simpson's "Out of Doors in Florida" (pp. 136-137) is very appropriate:

"We advertise the beauties and attractions of Florida; we send out agents and literature to call the people of the northland to come and spend their winters or to be permanent residents with us. Then we destroy every vestige of its natural beauty, we cut down the hammocks, drain the lakes and mutilate the rivers. We clear out the mangrove borders which nature created to guard our shores from the destruction by the sea during hurricanes and in their places build hideous sea walls. The only attraction belonging to the State that we do not ruin is the climate, and if it were possible to can and export it we would do so until Florida would be as bleak and desolate as Labrador. What natural beauty will we have left for another generation? What right have we to waste and destroy everything that nature has lavishly bestowed on the earth?" (And there is more along the same line there and elsewhere in the book.)

That this spirit of commercial vandalism is by no means peculiar to Florida is shown by the following passages from an article by Struthers Burt on "The Crime Against the West," in Harper's Magazine for April, 1926. It relates to a valley in Wyoming, whose natural beauty is being despoiled by various kinds of "improvements."

"At the head of the valley . . . . is a lake eighteen miles long which . . . . is [was] one of the most beautiful lakes in the world. . . . . A private irrigation company built a dam across the outlet. . . . . Today the lake is ruined beyond repair. Thousands of feet of standing timber have been killed, and as the water is drawn off, there are mud banks . . . . millions of trout are killed annually. . . . .

"Not long ago there was a plan to turn the . . . . country into a lumbering country. . . . . You no doubt know lumbered countries as we lumber in America, ... and you know what a logging stream looks like. Still later, a very definite attempt, indorsed by many of the local people, was made to introduce sheep into the valley. You also no doubt know what happens to a country when sheep are introduced as we introduce them in America. . . . . .

"The valley . . . . is becoming more and more a mecca for motorists . . . . But the local Forest Service, instead of taking advantage of the two old roads on either side of the valley, which, like all old roads, followed natural contours and possessed some beauty, have built a thing diagonally across the valley and twenty miles long that looks like a railway track. . . . . For a mile on either side of the lake there are now gas stations, 'hot dog' stands, lunch counters, and tent colonies. . . . . Wherever there is a lake it will meet the fate of this lake, wherever there is a view it will some day have a signboard."

record a pretty full acount of the vegetation, for the benefit of future generations, who will not have such good opportunities to study it as there are at present.

This more or less unique vegetation has naturally attracted the attention of quite a number of botanists, and numerous papers on South Florida plants have been cited in the preceding bibliography. But none of them give quite the sort of information that we ought to have. Many of them are mere lists of plants, or narratives of expeditions, which tell very little about what the vegetation really looks like, except in a few spots that happen to be illustrated by photographs. The most pretentious paper on the subject, that of Harshberger (1914) classifies the vegetation by habitat, and lists many of the characteristic species of each habitat, but with no adequate indication of relative abundance, which is very important. Furthermore, that paper does not cover the Keys, and does not always identify the species correctly or distinguish between native plants and weeds. Millspaugh's paper on the sand keys (1907) gives many minute details, mapping the location of individual plants, but covers only a very small area, and it would be quite out of the question to apply the same methods to the whole of South Florida.

In the following pages the principal vegetation types observed by the writer will be described, and as many as possible illustrated. There are of course all sorts of graduations between different types, so that it is often difficult to decide just where to draw the line between them, and no two persons might agree exactly on the subject; but this difficulty is inherent in all classifications of natural phenomena. More thorough exploration or careful study might increase the number of types considerably, but it is just as well not to attempt too much the first time.

Some ecologists like to see in every area they study tendencies for every type of vegetation (except the assumed ultimate or "climax") to develop gradually into some other type by a process of "succession." Undoubtedly the vegetation everywhere is different now from what it was several thousand years ago, but in South Florida the evidence of such changes, except in a few instances, is so slight that it seems futile to speculate about them, and we may as well assume that almost every vegetation type will remain

the same indefinitely, unless forced to change by physiographic or climatic changes or the encroachments of civilization.

It is very likely that the various hammocks are tending to encroach on the pine lands and other open types of vegetation that border them, as the trees at the edges make more humus, as has been explained by the writer for areas a little farther north*; but there are some who believe that our hammocks were once more extensive, and have been reduced in area by fire or some other cause.

In the following descriptions of vegetation the order is necessarily somewhat arbitrary, but as far as practicable that of the driest, coolest inland habitats will be discussed before that of wet, tropical and marine habitats, and weeds last.

Under each type the plants are divided first into large and small trees, vines, shrubs, herbs, etc., and the species in each group arranged as nearly as possible in order of abundance, as determined by counts in the field. The size classification is more difficult in South Florida than in the northern states, for there are all possible graduations between trees and herbs, and even the same species may be either a tree or a shrub, or a shrub or herb, in different places. And some of our cycads and small palms and cacti do not fit the definition of either shrub or herb.

The rarer plants are omitted in every case, for there is too much possibility of their being accidental or temporary invaders from other types, or wrongly identified, and they constitute such a small fraction of the total vegetation that their names would take up more space than they are worth. In rapid reconnoissance work it is not possible to take specimens of all unfamiliar plants for subsequent identification; and besides the flora of South Florida is not as well known yet as that of most other parts of the eastern United States, so that some plants which appear at first glance to belong to well-known species may later be described as new. Consequently there are many interrogation points scattered through the plant lists, to be eliminated by future study, if the

*See our 7th Annual Report, pp. 170-171. Also a paper by E. A. Bessey (1911) cited in the bibliography.

"developers" do not work faster than the botanists and destroy too many plants before they can be sufficiently studied.

The names of evergreens are printed in italics,* but in this mild climate where almost any plant can keep growing throughout the year the distinction between evergreen and deciduous-leaved plants is not as sharp as it is farther north. However, any plant with stiff leaves that live more than a year is regarded as evergreen, and herbs which die down to the ground in winter in the neighboring states are regarded as deciduous, even if some of them are green in mid-winter in South Florida.

In nomenclature and classification the various floras by Dr. J. K. Small are followed in most cases, but those do not agree exactly with each other, as they were published at different times, and our knowledge is constantly increasing and our ideas changing. Common names are given where known, but many of the plants listed have such limited distribution, and no known use, that persons other than botanists have never had any occasion to give them any names.

It is the aim of this report to describe every type of vegetation as it was before civilized man damaged it; but in a few cases where weeds have become pretty well established among the native plants their names have been inserted in the proper places, but in parentheses. After the descriptions of native vegetation there is a chapter on weeds; a weed being defined as a plant that is wholly or mainly confined to unnatural places like roadsides, railroads, vacant lots and cultivated fields. These are bound to increase in number of individuals and species as the country is settled up, and therefore an account of their present status ought to be interesting to refer to a generation hence, when they will probably be much more numerous than at present.

In the discussions of vegetation some attention will be paid to the prevailing modes of dissemination (seed dispersal), which vary considerably in different types. Many trees and shrubs and a few herbs have berries or other fleshy fruits, which are eaten by birds, and their seeds thus carried considerable distances;

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*For the last twenty years or so the writer has been using heavy type to distinguish evergreens in vegetation lists, but the present printers were not equipped for that.

while others have nuts or acorns, transported mainly by squirrels. Many herbs and a few woody plants have seeds or fruits bearing wings or a parachute-like tuft of hairs, which adapts them to travel with the wind.

Another common seed-dispersal contrivance among herbs and shrubs is a sort of catapult device, known to botanists as the tonobole. It has dry seeds which lie loose in involucres, calyxes or capsules borne on stiff stems which stand upright through the winter, and when the stems are shaken by the wind, or an animal brushing against them, the seeds fly out. (This type is scarce in the far north, where the deep snow hinders its operation.) A few herbs, especially weeds, have burrs or barbed fruits which stick to the hair of animals or human clothing.

Still others which grow in or near water have seeds or fruits adapted to floating. There are also a few very specialized contrivances, like the large spindle-shaped seed of the red mangrove, which attains a considerable growth before it leaves the tree, and is ready to take root as soon as it touches the bottom of shallow salt water. But in a surprisingly large number of cases, including some of the commonest weeds, we do not know yet just how the seeds are transported.

It might be desirable also to tell something about the prevailing colors of flowers, blooming seasons, etc., but in this warm climate the blooming season for many species is rather indefinite, and most of the woody plants have rather inconspicuous flowers.

THE SCRUB

(Fig. 8.)

The driest and poorest soils in South Florida, consisting almost entirely of white quartz sand, are usually occupied by a type of vegetation known as scrub. It is most extensively developed in the lake region in the middle of the peninsula, especially around Lake Stearns; but it makes a nearly continuous narrow strip just west of the narrow lagoons along the east coast as far south as the northern edge of Dade County, and there are patches of it along the west coast as far south as Naples, or even a little on Marco Island, and in a few places in the flatwoods.

The scrub is characterized especially by an abundance of spruce pine, though there are considerable areas in Highlands County where that is wanting or nearly so. The rest of the vegetation is mostly large crooked evergreen shrubs, with only a few grasses or other herbs. On account of the scarcity of grass, a small ground fire cannot run through the scrub as it does in the long-leaf and slash pine forests described farther on, but about once in the lifetime of a spruce pine a combination of wind and dry weather may cause a fire to sweep through the tops of the trees and kill them. The pine cones soon afterward open and drop seeds for a new crop, and the shrubs sprout up again from the roots.*

Farther north in the peninsula the transition from high pine land to scrub is often complete in a few feet, corresponding with an equally abrupt change in soil from cream-colored to white sand (though the long-leaf pine sometimes grows on white sand, or the spruce pine on cream-colored sand); but in Highlands County the two types often intergrade in a perplexing fashion.

There are some slight differences between the scrub of the

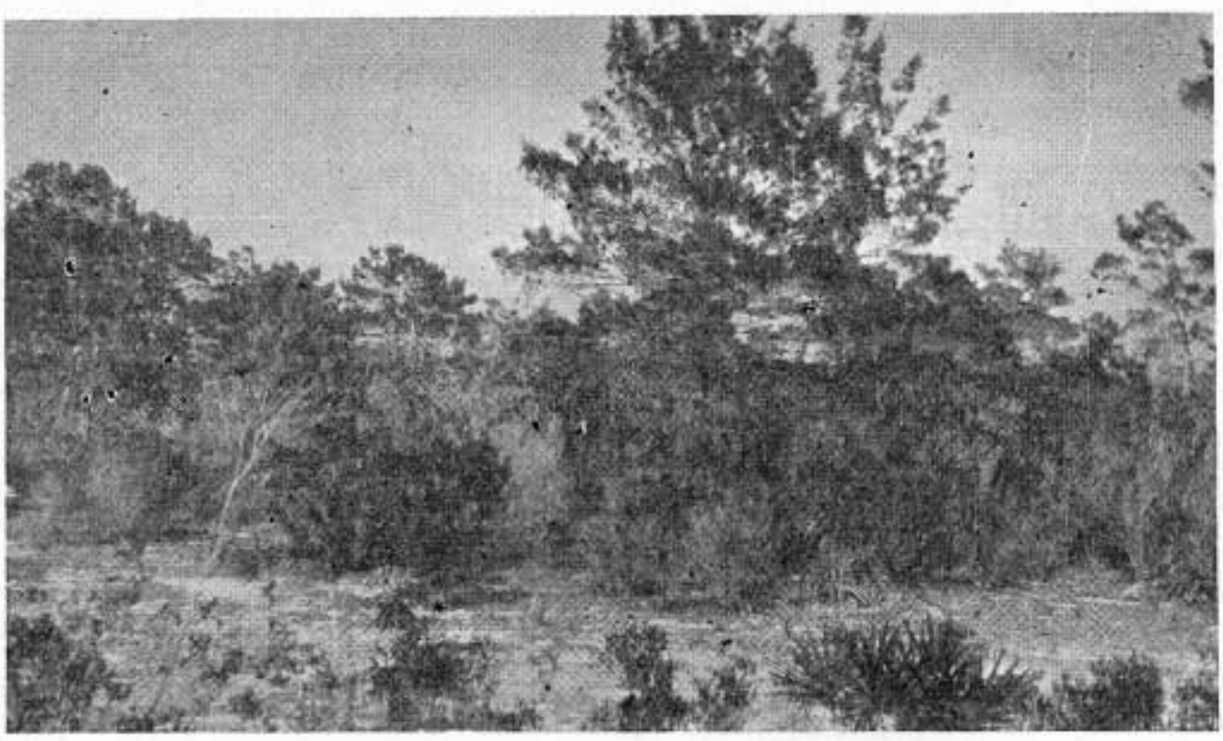

FIG. 8. Scrub vegetation on white sand near the coast about 4 miles north of Naples, Collier County. The most conspicuous plants are *Pinus clausa*, *Ceratiola*, and *Serenoa*. March 12, 1924.

*See our 7th Annual Report, pp. 142-144. 1915.

interior and that of the old dunes near the east coast, but it hardly seems worth while to separate them at present. The commonest scrub plants in our territory are about as follows:

TREES—
- *Pinus clausa* (spruce pine)

SMALL TREES—
- Hicoria Floridana (hickory)
- *Quercus myrtifolia* (an oak)
- *Quercus geminata* (live oak)
- Quercus Chapmani (an oak)
- *Ilex opaca* (?)* (holly)
- Quercus Catesbaei (black-jack oak)

VINES—
- *Smilax auriculata*

SHRUBS—
- *Serenoa serrulata* (saw-palmetto)
- *Ceratiola ericoides* (rosemary)
- *Quercus myrtifolia* (an oak)
- *Cholisma fruticosa* (poor grub)
- *Quercus geminata* (live oak)
- *Pieris nitida* (hurrah bush)
- *Sabal Etonia* (a palm)
- *Palafoxia Feayi*
- *Chrysobalanus oblongifolius*
- *Conradina puberula?*
- *Garberia fruticosa*
- Prunus geniculata (a plum)
- *Ximenia Americana?*
- *Vaccinium nitidum* (huckleberry)
- *Polygonella polygama?*
- Asimina speciosa? (pawpaw)

HERBS—
- *Tillandsia usneoides* (Spanish moss)
- Cassytha filiformis
- *Opuntia ammophila?* (prickly pear)
- *Tillandsia recurvata* (air-plant)
- Lechea sp.
- *Selaginella arenicola?*
- *Rhynchospora dodecandra* (a sedge)
- Petalostemon Feayi
- Warea cuneifolia
- *Nolina Brittoniana*
- Cnidoscolus stimulosus
- Thysanella robusta

MOSSES, ETC.—
- *Cladonia sps.* (reindeer moss)

Most of the trees and herbs and nearly all the shrubs are evergreen. The seeds of the pine are transported by the wind, but most of the smaller trees have nuts or acorns, and about half the shrubs have berries. A few of the herbs and one of the shrubs have wind-borne seeds, but for about half the herbs we do not know exactly how the seeds travel.

This vegetation is of very little use for either timber or forage, but a good deal of it has been destroyed to make room for orange groves in the interior, and for pineapple fields and houses on the east coast.

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*This is a stunted form, described in September, 1924, by Small as *Ilex cumulicola* and by Ashe as *I. arenicola*.

HIGH PINE LAND
(Figs. 9, 37.)

This is a very common type of vegetation in northern and central Florida, but in South Florida it is almost confined to the lake region of Highlands County, with a few small patches on slightly elevated spots in the flatwoods, where they can usually be recognized from a distance by the presence of oaks. (Fig. 38.)

The topography is rolling, and the soil is nearly always a deep dry cream-colored sand, essentially uniform as far down as most roots go. Water falling on this soil sinks in immediately, even in the heaviest rains. Gophers and salamanders are fairly common, and doubtless play an important part in keeping the soil stirred up, which does not happen to any appreciable extent in the scrub just described.

The dominant tree is the long-leaf pine, and one or more species of medium-sized oaks are nearly everywhere in sight. Shrubs are much less abundant than in the preceding and following types, but herbs are generally more so, though one occasionally finds patches of bare sand a few square feet in extent. Fire is a frequent and important factor of the environment. In pre-historic times the fires must have been started mostly by lightning, and although that may not have happened very often on any one square mile, a fire once started might run for many miles, so that every spot in the high pine land must have been burned over something like once in two years, on the average. With the multiplication of roads, orange groves, etc., any one fire cannot spread as far now as formerly, but there are more chances of starting fires, so that the frequency of fire at any one spot may not have changed much.

The frequency of fire tends to keep the oaks and vines in check, but does not injure the pine perceptibly after it is a few years old (except when turpentined). It also limits the shrub and herb population almost entirely to species with underground roots, which can send up new sprouts after the tops are burned (which usually happens in winter or early spring). For that reason annual plants and vines are scarce, except in spots where the vegetation is too open for fire to travel through.*

*For additional notes on the effects of fire see our 7th Annual Report, pp. 147, 148, 165, and various earlier papers there referred to.

The most typical high pine land plants are as follows:

TREES—

Pinus palustris (long-leaf pine)

SMALL TREES—

Quercus Catesbaei (black-jack oak)
Quercus geminata (live oak)
Quercus cinerea (turkey oak)

VINES—

Smilax auriculata

SHRUBS—

Serenoa serrulata (saw-palmetto)
Chrysobalanus oblongifolius
Prunus geniculata (a plum)
Lupinus diffusus (lupine)
Sabal Etonia (a palm)
Quercus myrtifolia (an oak)
Garberia fruticosa
Palafoxia Feayi
Ceanothus microphyllus
Asimina speciosa? (pawpaw)
Ximenia Americana?

HERBS—

Aristida stricta (wire-grass)
Tillandsia usneoides (Spanish moss)
Polygonella gracilis
Petalostemon Feayi
Opuntia ammophila? (prickly pear)
Stenophyllus Warei (a sedge)
Actinospermum angustifolium
Thysanella robusta
*Chrysopsis graminifolia?**
Eriogonum tomentosum
Paronychia herniarioides
Kuhnistera pinnata
Sisyrinchium solstitiale
Cracca chrysophylla
Chamaecrista sp. (partridge pea)
Gibbesia Rugelii?
Froelichia Floridana
Chrysopsis gossypina?
Aristida virgata
Warea cuneifolia
Lechea sp.
Laciniaria tenuifolia
Afzelia pectinata
Yucca filamentosa (bear-grass)
Andropogon Virginicus (broom-sedge)
Chapmania Floridana

FIG. 9. High pine land in lake region about 5 miles E. S. E. of Avon Park, Highlands County, showing *Pinus palustris, Quercus Catesbaei* (at right), *Serenoa, Aristida stricta,* etc. Jan. 28, 1924.

*Stouter and more leafy than it usually is farther north.

Most of the shrubs are evergreen, but among the trees and herbs there are more deciduous species than in most other parts of South Florida, which presumably indicates that the soil is richer than it looks. Other indications of pretty good soil are that none of the shrubs listed belong to the Ericaceae (heath family), and that there is a considerable proportion of leguminous plants among the herbs. Most of the shrubs have berries. Among the herbs more of the seeds are carried by the wind than in any other way, but in about half the cases we do not know just what method of dissemination operates.

The pine is a very important source of lumber and naval stores, and the wire-grass affords some forage for cattle. Something like twenty per cent of this type in Highlands County has been cleared away to make room for settlements and citrus groves, and that process is still going on.

FLATWOODS

(Figs. 10, 11, 25, 38, 42.)

This is probably the most extensive type of vegetation in South Florida, covering at least a third of the area. It consists of vast open forests of pine (either long-leaf or slash), with hardly any other tree, and a rather dense undergrowth of saw-palmetto and other low shrubs, with about an equal number of herbs. The soil is usually a fine grayish sand, but limestone or marl may approach closely to the surface without making much difference in the vegetation. Fire is as frequent as in the high pine land.

The pines are usually nearly all of one species, in a given area, the two not mixing much. Generally speaking, the long-leaf pine seems to prefer the higher and drier and cooler portions, and the slash pine the more tropical and marly places; but often there is no visible difference in the soil, or in the rest of the vegetation. In order to determine if possible the cause of the predominance of one pine or the other, a careful analysis has been made of the long-leaf and slash pine types separately, and the results are here presented in parallel columns:

FIG. 10. Long-leaf pine flatwoods about 3 miles south of Fort Drum, Okeechobee County. Trees all *Pinus palustris*, mostly under a foot in diameter. Undergrowth of *Serenoa* conspicuous. This is one of the few remaining virgin stands of long-leaf pine, and it may not remain long, on account of its accessibility. Aug. 9, 1925.

FIG. 11. Slash pine flatwoods about a mile north of Bonita Springs, Lee County. The pines (all *Pinus Caribaea*) are smaller and farther apart, and the saw-palmetto less abundant, than is usual in this type of vegetation, but still more so than in the long-leaf pine flatwoods. March 12, 1924.

Long-leaf pine

TREES

Pinus palustris (long-leaf pine)

SMALL TREES

Quercus geminata (live oak)

SHRUBS

Serenoa serrulata (saw-palmetto)
Cholisma fruticosa (poor grub)
Ilex glabra (gallberry)
Vaccinium nitidum (huckleberry)
Myrica pumila (myrtle)
Pycnothymus rigidus
Asimina reticulata (pawpaw)
Pieris nitida (hurrah bush)
Bejaria racemosa
Quercus minima (oak runner)
Ascyrum tetrapetalum
Chrysobalanus oblongifolius
Hypericum aspalathoides
Gaylussacia dumosa (huckleberry)

HERBS

Aristida stricta (wire-grass)
Pterocaulon undulatum (black-root)
Syngonanthus flavidulus
Tillandsia usneoides (Spanish moss)
Aristida spiciformis (a grass)
Carphephorus corymbosus
Elephantopus nudatus?
Sericocarpus bifoliatus
Laciniaria tenuifolia?
Xyris flexuosa
Chrysopsis graminifolia?
Actinospermum angustifolium
Trilisa odoratissima (deer-tongue)
Zamia integrifolia (coontie)
Xyris sp.
Galactia Elliottii (pin-down)
Petalostemon carneus?
Kuhnistera pinnata (summer farewell)
Andropogon sp. (broom-sedge)
Aster adnatus
Lachnocaulon Beyrichianum?
Pinguicula lutea (buttercup)
Stillingia sylvatica?
Eryngium aromaticum
Chamaecrista sp. (partridge pea)
Sophronanthe hispida
Polygala Rugelii
Polygala setacea

Slash pine

TREES

Pinus Caribaea (slash pine)
Sabal Palmetto (cabbage palmetto)

SMALL TREES

Quercus geminata (live oak)
Quercus myrtifolia (an oak)

SHRUBS

Serenoa serrulata (saw-palmetto)
Cholisma fruticosa (poor grub)
Quercus minima (oak runner)
Pycnothymus rigidus
Vaccinium nitidum (huckleberry)
Myrica pumila (myrtle)
Bejaria racemosa
Chrysobalanus oblongifolius
Ilex glabra (gallberry)
Asimina reticulata (pawpaw)
Gaylussacia dumosa (huckleberry)

HERBS

Aristida stricta (wire-grass)
Pterocaulon undulatum (black-root)
Sabbatia Elliottii?
Polygala Rugelii
Syngonanthus flavidulus
Carphephorus corymbosus
Aristida spiciformis (a grass)
Eryngium aromaticum
Litrisa carnosa
Elephantopus nudatus?
Sericocarpus bifoliatus
Cassytha filiformis
Xyris flexuosa?
Galactia Elliottii (pin-down)
Rhynchospora fascicularis (a sedge)
Helianthella sp.
Pteris aquilina (a fern)
Helianthus sp. (sunflower)
Trilisa odoratissima (deer-tongue)
Polygala setacea
Panicum sp. (a grass)

Considering first the two lists together, all the trees and nearly all the shrubs are evergreen, but most of the herbs are not classed as evergreens in Georgia. A little more than half the shrubs have

berries, and most of the others belong to the class of "tonoboles." About half the herbs have wind-borne seeds. Something like a third of the shrubs belong to the Ericaceae and allied families, and only about one-tenth of the herbs to the Leguminosae, which does not speak very well for the soil.

In contrasting the two lists, although the sequence indicated cannot be guaranteed as absolutely accurate, for only a small fraction of the area has been examined, it is pretty safe to say that *Ilex glabra, Vaccinium nitidum, Pieris nitida, Aristida stricta, Tillandsia usneoides, Laciniaria tenuifolia, Chrysopsis graminifolia, Actinospermum, Trilisa odoratissima,* and *Kuhnistera* are more abundant in the long-leaf pine type, and *Quercus myrtifolia, Pycnothymus, Sabbatia Elliottii, Polygala Rugelii, Eryngium aromaticum, Litrisa, Cassytha* and *Helianthella* in the slash pine type. Those in the former category seem to prefer cooler climates, or drier or more acid soils, and the latter seem to be a little more tropical, though some of them range at least as far north as Georgia. But we evidently do not know the whole story yet.

Both pines are used extensively for lumber, and for turpentine as far south as the Caloosahatchee River, but apparently not yet beyond that latitude. The huckleberries are sometimes picked for market, even as far south as Palm Beach County. Several of the shrubs have flowers that yield honey, and the wire-grass and other herbs are eaten by cattle. Probably not more than five per cent of the flatwoods area has been cultivated, up to the present time.

DRY PRAIRIES
(Figs. 12, 40.)

On both sides of the Kissimmee River, and extending westward with some interruptions nearly to Arcadia and Fort Ogden, are vast level comparatively dry treeless prairies, covered with grasses and low bushes, averaging about two feet in height. Prairies of similar aspect are found also in Collier, Manatee and Brevard* Counties, and in smaller patches as far north as Volusia and Wakulla Counties; and their aggregate extent in Florida must be two or three thousand square miles.

The vegetation differs from that of the flatwoods just de-

*See our 13th Annual Report pp. 138, 140, 203-204.

scribed in hardly any way except the absence of trees, and the reason for that is obscure. The soil seems to be the same fine gray sand as in the flatwoods, and no more subject to inundation, but it may be that there is hardpan or something of the sort near enough to the surface to interfere with the roots of trees. The fact that the prairie soil is hardly one per cent cultivated would seem to indicate that it is inferior to that of the flatwoods in some way.

Until the building of railroads to Okeechobee and Moore Haven, ten or fifteen years ago, the prairies were rather inaccessible and little known, except to cattlemen. But now there are three or four railroads through the prairies, and one traveling on them can get views strongly suggestive of the Great Plains.

Almost anywhere in the prairies one can see a few scattered slash pines, cabbage palmettoes or live oaks, averaging less than one tree to the acre; but the great bulk of the vegetation is of shrubs and herbs, in approximately equal proportions. It is subject to frequent fires, like the flatwoods, although there is no pine straw to add fuel to the flames. Consequently practically all the plants have large underground parts, which enable them to send up new shoots after a fire, as in the pine forests.

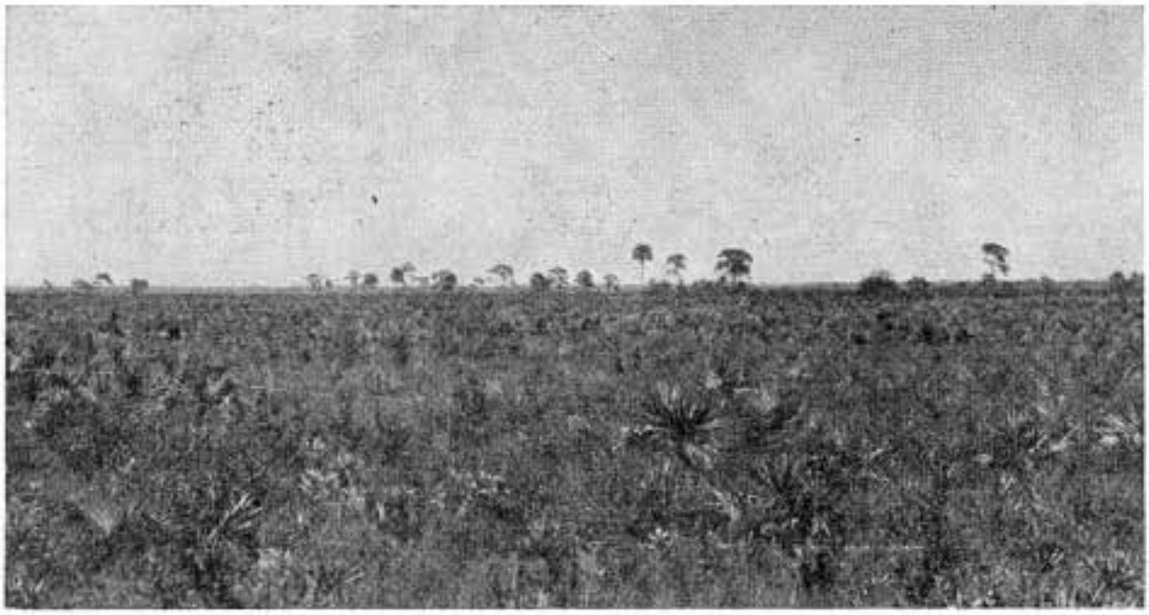

FIG. 12. Scene in dry prairies about two miles northwest of Okeechobee, with a few slash pines and cabbage palmettoes in the distance. Aug. 8. 1925.

The commonest species seem to be as follows:

SHRUBS—

Serenoa serrulata (saw-palmetto)
Quercus minima (oak runner)
Ilex glabra (gallberry)
Cholisma fruticosa (poor grub)
Vaccinium nitidum (huckleberry)
Ascyrum tetrapetalum
Asimina reticulata (pawpaw)
Hypericum aspalathoides
Pieris nitida (hurrah bush)
Myrica pumila (myrtle)
Gaylussacia dumosa (huckleberry)

HERBS—

Aristida stricta (wire-grass)
Syngonanthus flavidulus
Pterocaulon undulatum (black-root)
Litrisa carnosa
Polygala Rugelii
(Eleocharis Baldwinii) (road-grass)
Carphephorus corymbosus
Agalinis sp.
Elephantopus nudatus?
Eupatorium Mohrii?
Lechea sp.
(Anastrophus paspaloides) (a grass)
Sophronanthe hispida
Panicum Combsii? (a grass)
Aristida spiciformis (a grass)
Helianthella sp.
(Euthamia sp.)
Xyris pallescens
Fimbristylis puberula (a sedge)
Rhynchospora fascicularis (a sedge)
Lachnocaulon Beyrichianum?
Hyptis radiata
Podostigma pedicellata
Solidago fistulosa (goldenrod)

Being composed mostly of the same species, this vegetation has about the same characteristics as that of the flatwoods, as regards proportion of evergreens, modes of dissemination, etc. But if there is any difference, the proportion of leguminous plants is still smaller. The saw-palmetto makes up about half the shrubbery and the wire-grass about half the herbage. Most of the herbs have no common names, and no known use except for forage, and in that respect they have more quantity than quality.

MIAMI PINE LAND

(Figs. 47, 48.)

The pine lands on the Miami oolite, covering a few hundred square miles, have much the same aspect as the slash pine flatwoods farther north, except for the trees being a little smaller and more crooked, but the undergrowth is quite different. This is probably due partly to the warmer climate, but more to the very different soil, which is mostly pitted limestone instead of sand. In other states the vegetation on limestone is usually totally different both in composition and in aspect from that on sand, but the South Florida limestones do not seem to influence vegetation as much as most other kinds do; perhaps because they are deficient in potash, which is a more important soil constituent than lime.

Several characteristic plants of the sandy flatwoods extend into the Miami region just about as far as the sand does (i. e., to the neighborhood of Miami), while the plants peculiar to that region gradually disappear northward, and go no farther than the visible outcrops of limestone, or to about the northern edge of Dade County.

The soil is practically always dry, for the rain that falls quickly disappears unto the porous limestone.

Fire seems to be as frequent in the Miami pine lands as in the flatwoods, if not more so. It is said that fire sometimes runs up into a pine tree and singes all its leaves off without killing it. A few of the herbs, especially the ferns, grow mostly in little pot-holes, which give them pretty good protection from fire.

This vegetation includes a considerable number of endemic species, which grow neither farther north nor in the tropics, and many of these have been discovered by Dr. Small and his associates in the last 25 years. Some are chiefly confined to the southwestern portion of the region, perhaps because it is a little too cold for them at Miami.

In the following list the names of plants chiefly confined to the north end of the region, on sandier soils, are preceded by N, and the more tropical species of the southwest end by S.

TREES—

Pinus Caribaea (slash pine)

SMALL TREES—

Dipholis salicifolia (bustic)
N *Quercus geminata* (live oak)
S *Coccothrinax argentea* (silver palm)

VINES—

Smilax auriculata
Rhabdadenia corallicola?

SHRUBS—

Serenoa serrulata (saw-palmetto)
N *Sabal Etonia* (a palm)
N Quercus pumila (oak runner)
S *Guettarda scabra*
N *Chrysobalanus oblongifolius*
Coccothrinax argentea (silver palm)
Croton linearis?
Quercus minima (oak runner)
N *Myrica pumila* (myrtle)
N *Vaccinium nitidum* (huckleberry)
N *Cholisma fruticosa* (poor grub)
N *Pycnothymus rigidus*
S Metopium toxiferum (poison-wood)
Pithecolobium Guadalupense
S *Byrsonima lucida*
Rhus copallina? (sumac)
S *Tetrazygia bicolor*
Morinda Roioc
Lantana depressa
N Amorpha herbacea
N *Quercus myrtifolia*
N Asimina reticulata?
Dodonaea Jamaicensis

HERBS—

Zamia Floridana (coontie)
Aristida stricta (wire-grass)
Cassytha filiformis
Aneimia adiantifolia (a fern)
Pteris longifolia (a fern)
Jacquemontia Curtissii
Chamaecrista brachiata? (partridge pea)
Opuntia sp. (prickly pear)
N *Chrysopsis graminifolia?*
Chamaesyce pinetorum?
Tithymalopsis polyphyllus
Crotalaria pumila?
Buchnera elongata
Stillingia angustifolia?
Afzelia pectinata
Dichromena colorata? (a sedge)
N Polygonella gracilis
Pteris caudata (a fern)
Melanthera sp.
Polygala coralicola?
Borreria sp.
Andropogon sp. (broom-sedge)
S Cassia Bahamensis?
N Petalostemon Feayi
Petalostemon carneus?
Asclepias verticillata
Aldenella tenuifolia
N *Eryngium aromaticum*
N Actinospermum angustifolium
N Rhynchospora Grayii (a sedge)
Elephantopus nudatus?

Most of these plants look about the same in winter as in summer, though some of the herbs that range as far north as Georgia are not evergreen there. The pine and a few of the herbs have wind-borne seeds, most of the shrubs as usual have berries, and among the herbs there seem to be more tonoboles than anything else, though in about half the cases we do not know just how the seeds travel. Among the shrubs the only Ericaceous ones are confined to the sandy northern portion. The proportion of Leguminosae among the herbs is greater than in the sandy flatwoods just described, and about the same as in the high pine land.

The pine is used locally for lumber and fuel, but not for

turpentine. For lumber it is inferior to the larger and straighter slash pines farther north, and still more to the long-leaf pine, but for some purposes it is more economical to use it than to pay freight on better material. The coontie is an important source of starch, and one or two starch factories have operated in this region at various times. The wire-grass could be eaten by cattle, but the honeycombed surface of the limestone makes this out of the question as a grazing region, and Dade County has long had a stock law, prohibiting cattle from running at large, as in regions farther north that have more cultivated land than forest.

Something like one-tenth of the area is occupied by settlements, and groves of various tropical fruits, and the clearings would doubtless be much more extensive if it were not for the difficulty of working the very rocky soil.

There are some slash pine forests somewhat similar to those around Miami on the lower Keys, especially Big Pine Key. These have not been studied much, but they seem to differ from those just described in having fewer species of plants, which is a natural consequence of their small area and remoteness from other pine forests. And the absence of pot-holes on the Keys probably also tends to make the vegetation less diversified.

Where the limestone comes to the surface in the flatwoods of Collier County, the vegetation includes a few of the characteristic Miami species, but it is more like that of the sandy flatwoods in the same neighborhood. It has not yet been investigated sufficiently, however.

BEACHES AND DUNES

(Figs.13-15, 46.)

On sandy beaches and low dunes within a few yards of the Atlantic Ocean and Gulf of Mexico, and on a few beaches of calcareous sand on the Keys, above high tide but within reach of salt spray, and exposed to intense light as long as the sun shines, we find a rather sparse vegetation, similar in aspect to that of northern sea beaches, except for having more woody plants and more ever-

greens. It sometimes grades into the scrub vegetation already described, but more often into cactus thickets, mangrove swamps, or hammocks, which are described farther on. Fire is almost impossible, on account of the openness of the vegetation. The characteristic species are about as follows:

TREES—
- *Sabal Palmetto* (cabbage palmetto)
- *(Cocos nucifera)* (cocoanut)

SMALL TREES—
- Bursera Simaruba (gumbo limbo)
- *Persea littoralis?* (red bay)
- *Quercus geminata* (live oak)

WOODY VINES—
- Vitis Munsoniana (muscadine)
- *Smilax auriculata*

SHRUBS—
- *Scaevola Plumieri*
- *Coccolobis uvifera* (sea-grape)
- *Serenoa serrulata* (saw-palmetto)
- *Suriana maritima*
- *Yucca aloifolia* (Spanish bayonet)
- *Opuntia austrina?* (prickly pear)
- *Ernodea littoralis*
- *Conocarpus erecta* (buttonwood)
- *Iva imbricata*
- *Chamaesyce buxifolia*
- *Chrysobalanus Icaco* (cocoa plum)
- *Tournefortia gnaphalodes*
- *Avicennia nitida* (black mangrove)
- *Jacquinia Keyensis* (Joe-wood)
- Lycium Carolinianum
- *Laguncularia racemosa* (white mangrove)
- *Rhizophora Mangle* (red mangrove)
- Sophora tomentosa
- *Chrysobalanus oblongifolius*

HERBS—
- Uniola paniculata (sea-oats)
- Sesuvium Portulacastrum
- *Ipomoea Pes-Caprae*
- Canavalia lineata
- Cassytha filiformis
- Croton maritimus
- Helianthus debilis
- Sporobolus Virginicus? (a grass)
- Panicum amarulum (a grass)
- Cenchrus macrocephalus? (sand-spur)
- Muhlenbergia filipes? (a grass)
- Oenothera humifusa (evening primrose)
- Coreopsis Leavenworthii?
- Calonyction Tuba? (moon-flower)
- (Monarda punctata) (horse-mint)

A large proportion of the species are tropical; and in this area where frost is almost unknown they look much the same in winter as in summer, though most of the herbs would not be called evergreen if they grew in the northern states. The herbs are mostly of rather rank growth, which apparently indicates much more soil fertility than in the scrub. Several of the herbs, such as *Ipomoea, Canavalia, Cassytha,* and *Calonyction,* are vines, and some of them grow to remarkable lengths, which would not be possible in a habitat subject to fire. Most of the grasses have long root-stocks which grow just beneath the sand and send up shoots every few inches.

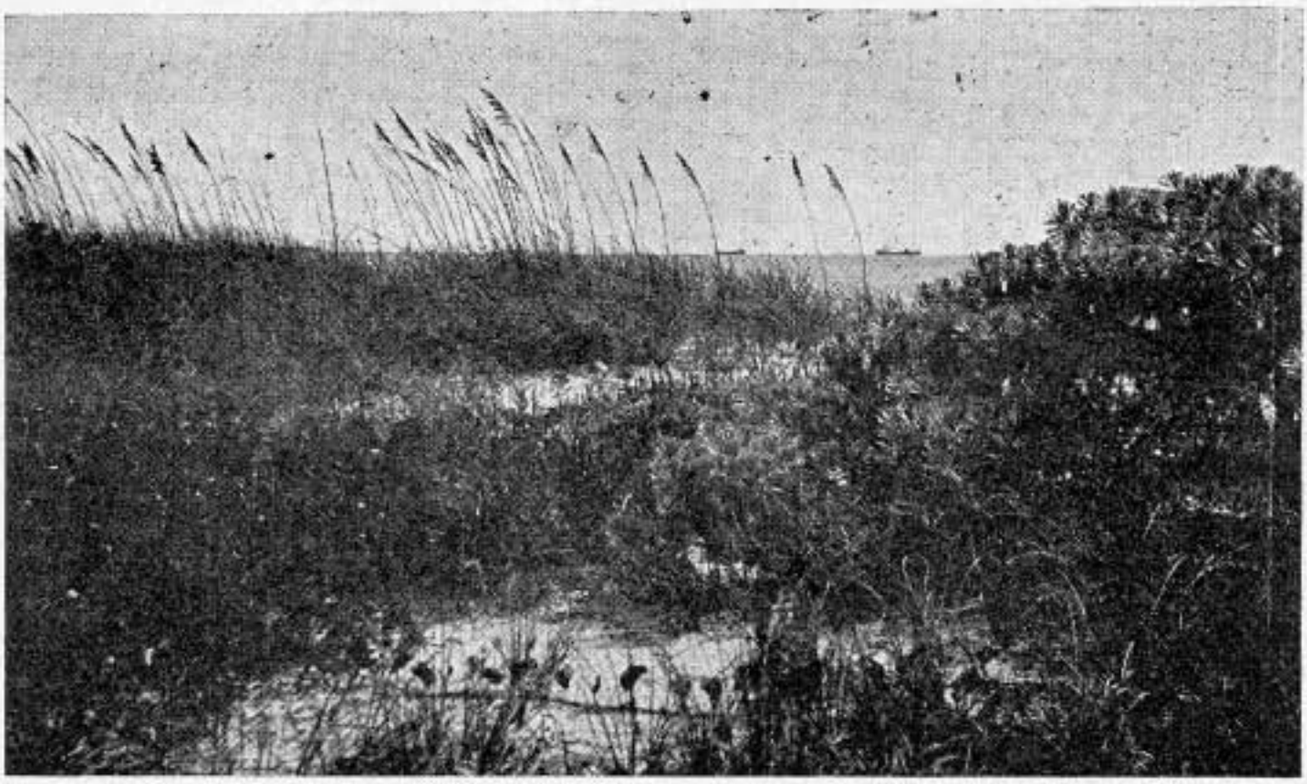

FIG. 13. Dune vegetation on east coast near Boynton, Palm Beach County, looking east. Shows *Tournefortia* (right), *Scaevola* (lower left), *Ipomoea Pes-caprae* (foreground), and *Uniola paniculata* (upper left). Aug. 21, 1923.

FIG. 14. Gulf beach on Gasparilla Island near South Boca Grande, Lee County, showing steep wave-cut scarp about six feet high. Vegetation mostly *Ipomoea Pes-caprae* in foreground, and *Uniola paniculata* farther off. Nov. 21, 1924.

The cocoanut and live oak are propagated by nuts, and most of the other woody plants have berries. The exact method of dispersal of most of the herbs is unknown; but the sand-spur has burrs, the grasses probably depend more on continuous horizontal growth than on propagation by seeds, and the seeds of several others are doubtless carried up and down the coast by wind and waves. The fruit of the cocoanut is well adapted for floating, and it is thought that some may have been carried long distances in that way; though the species is supposed to be native of the South Sea Islands, and could not have been in Florida before the discovery of America.

Ericaceous shrubs seem to be wanting, but a member of the Leguminosae ranks fourth among the herbs.

Several of the species are cultivated for ornament, and the fruit of the sea-grape is said to be edible when cooked.

FIG. 15. Beach vegetation (mostly *Uniola paniculata*) on nearly pure calcareous sand on Upper Matacumbe Key, looking south. (Tea-table Key seen at left, Indian Key near center.) July 26, 1910.

SALT FLATS

(Figs. 16, 17.)

On the west coast from Tampa Bay to the Keys there are many flat expanses of firm sand or limestone rock close enough to sea-level to be inundated at high tide, but protected from waves, with a rather sparse and peculiar vegetation. As in the case of the beaches, the plants are mostly too far apart for fire to run from one to another. This is the nearest approach in South Florida to the salt marshes which border the coast in all the other coast states. It often grades into beaches and dunes or cactus thickets on higher ground, or into mangrove swamps where the surface is lower.

The commonest species are about as follows:

TREES—
- *Sabal Palmetto* (cabbage palmetto) (very scattered)

SMALL TREES OR LARGE SHRUBS—
- *Conocarpus erecta* (buttonwood)
- *Laguncularia racemosa* (white mangrove)
- *Rhizophora Mangle* (red mangrove)
- *Avicennia nitida* (black mangrove)
- *Coccolobis uvifera* (sea-grape)

SMALLER SHRUBS—
- *Batis maritima*
- *Borrichia frutescens*
- Lycium Carolinianum
- *Borrichia arborescens?*

HERBS—
- *Salicornia ambigua* (samphire)
- *Sporobolus Virginicus?* (a grass)
- *Dondia linearis*
- Fimbristylis castanea? (a sedge)
- *Monanthochloe littoralis* (a grass)
- Sesuvium Portulacastrum
- Spartina juncifoimis? (a grass)
- *Juncus Roemerianus* (a rush)
- Panicum virgatum (a grass)
- Limonium Nashii? (sea-lavender)
- Philoxerus vermicularis

Both Ericaceous and Leguminous plants seem to be absent here, but grasses are relatively numerous, as in typical salt marshes. The *Salicornia, Dondia,* and *Monanthochloe* are especially characteristic of the salt flats. The last-named is not known on the east coast at all, but occurs also in southern Texas and Mexico.

A few of the woody plants have fleshy fruits, but practically nothing is known about how the seeds of the herbs are transported. They probably float from place to place at high tide, though.

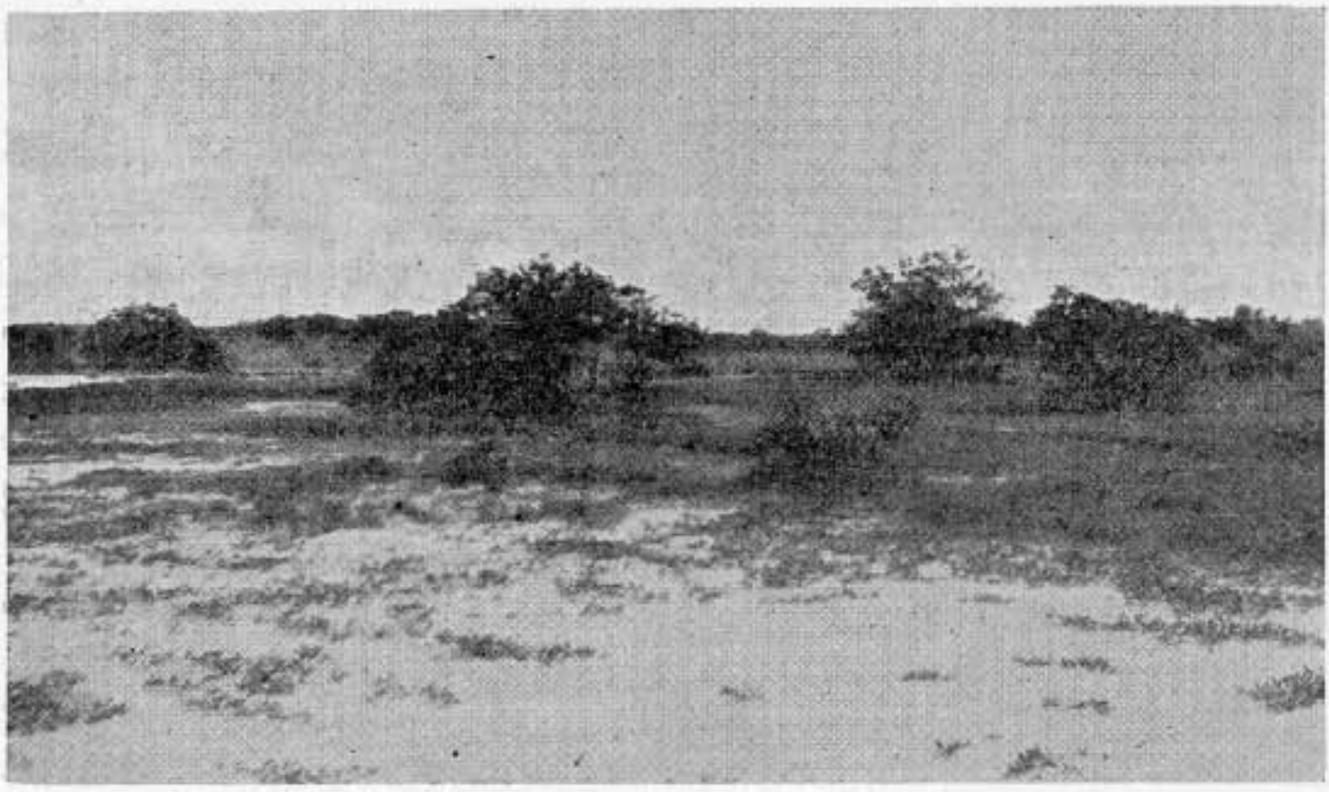

FIG. 16. Sandy salt flat near south end of Pine Island, Lee County. Bushes mostly *Avicennia* and *Conocarpus*. *Sesuvium* in foreground. Jan. 23, 1924.

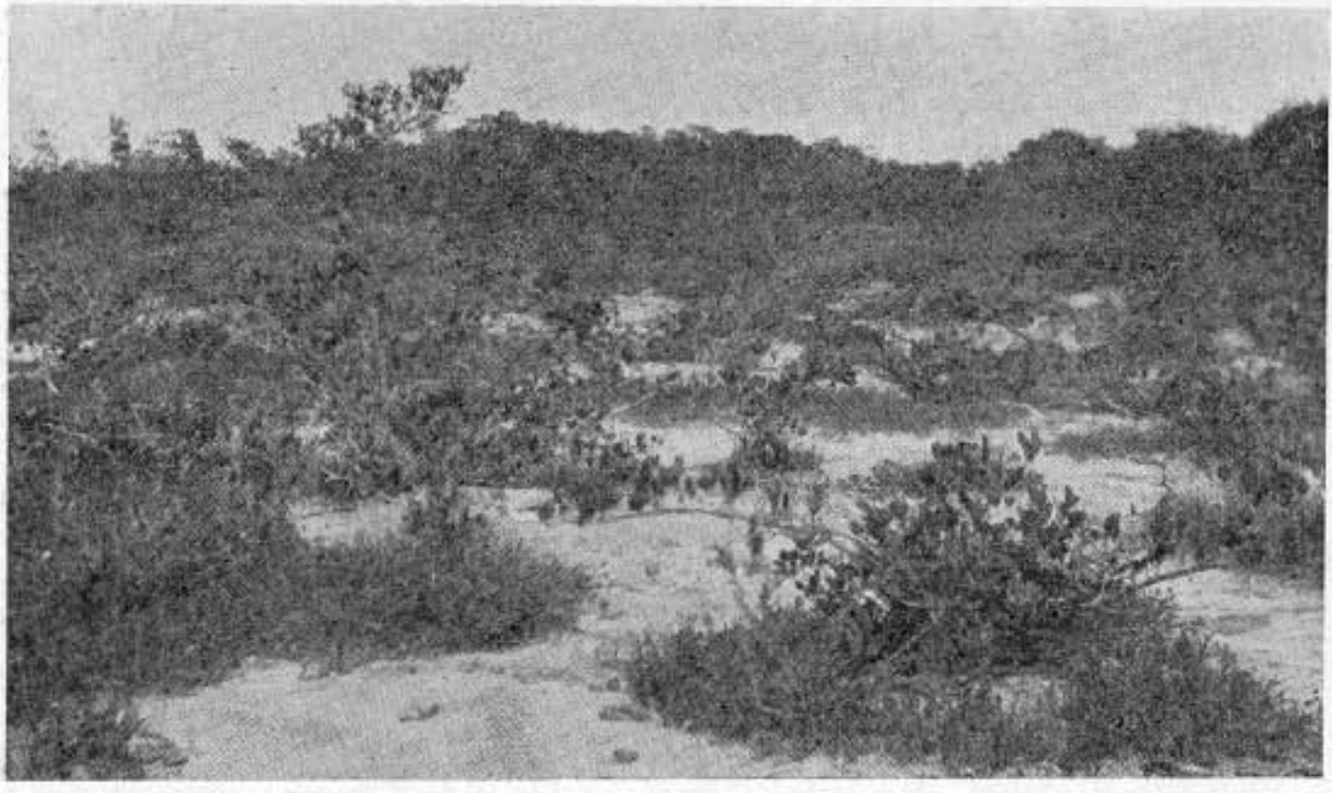

FIG. 17. Salt flat on limestone rock on Summerland Key, Monroe County (one of the Lower Keys). Vegetation mostly *Laguncularia*, *Avicennia*, *Batis*, *Salicornia*, and *Monanthochloe* (the latter plainly visible in foreground). March 20, 1924.

CACTUS THICKETS OR SHORE HAMMOCKS

(Fig. 18.)

On the west coast from about the mouth of the Manatee River to the lower Keys there are many examples of a type of vegetation consisting largely of stiff crooked spiny shrubs. It is usually intermediate in position between the sandy beaches and the denser hammocks a little farther inland, but contains several species not characteristic of either. The soil may be either sand, shells, marl or rock, but even the sand probably has considerable lime in the form of shell fragments. Fire must be very rare.

Such vegetation is very sparingly represented on the east coast, unless on a few shell mounds, and at the south end of Merritt's Island,* but it is said to be common on some of the drier Bahama Islands, but some of the same or very similar species are found also in Mexico. The characteristic species are about as follows. (The distinction between trees and shrubs is rather arbitrary.)

FIG. 18. Shore hammock or cactus thicket near inner shore of Sanibel Island, about ½ mile east of Sanibel P. O. *Agave decipiens* prominent in foreground, and *Opuntia Dillenii* (?) visible in center, a little farther back. The small trees are mostly *Pithecolobium* and *Conocarpus*. Jan. 24, 1924.

*See Simpson, Out of Doors in Florida, pp. 206-208; Small, Jour. N. Y. Bot. Gard. 28:12. 1927.

TREES—
Sabal Palmetto (cabbage palmetto)

SMALL TREES OR LARGE SHRUBS—
Yucca aloifolia (Spanish bayonet)
Conocarpus erecta (buttonwood)
Bursera Simaruba (gumbo limbo)
Coccolobis uvifera (sea-grape)
Erythrina arborea (coral bean)
Xanthoxylum Fagara
Ichthyomethia piscipula (Jamaica dogwood)
Bumelia angustifolia
Avicennia nitida (black mangrove)
Laguncularia racemosa (white mangrove)
Sideroxylon foetidissimum (mastic)
Forestiera porulosa
Ficus aurea (wild fig, or rubber)
Chiococca racemosa?
Rhizophora Mangle (red mangrove)
Pithecolobium Guadalupense?

WOODY VINES—
Guilandina Crista?
Dalbergia Ecastophyllum?
Pisonia aculeata

SHRUBS—
Opuntia austrina? (prickly pear)
Acanthocereus pentagonus? (cactus)
Gossypium hirsutum (wild cotton)
Lycium Carolinianum
Borrichia frutescens
Chamaesyce buxifolia
Lantana involucrata?

HERBS—
Sesuvium Portulacastrum
Agave decipiens?
Uniola paniculata (sea-oats)
Verbesina laciniata
Philoxerus vermicularis
Canavalia lineata
Ipomoea Pes-Caprae
Panicum amarulum
Iresine paniculata
Tillandsia utriculata (air-plant)
Tillandsia Balbisiana? (air-plant)
Cassytha filiformis (Capraria biflora)
Epidendrum Tampense (an orchid)
Tillandsia fasciculata? (air-plant)

The spiny plants in the above list are *Yucca, Erythrina, Xanthoxylum, Bumelia, Guilandina, Pisonia, Opuntia, Acanthocereus,* and *Agave.* The vegetation has some of the characteristics of the southwestern deserts, but just what causes this is not certain, for the climate is not at all arid, except on the lower Keys. As usual, most of the woody plants are evergreen, but some of the herbs probably renew their foliage every year. About half the woody plants have fleshy fruits. The air-plants (including orchids) all have wind-borne seeds, but just how the other herbs, with one or two exceptions, are disseminated is still a mystery.

As in the case of the beaches and dunes, there are no plants of the Ericaceae; but two of the small trees, two of the woody vines, and one of the herbaceous vines belong to the Leguminosae.

PALM SAVANNAS

(Figs. 19-21.)

In some places in the interior of the peninsula, particularly in the Indian Prairie northwest of Lake Okeechobee, there are vast level prairies plentifully dotted with cabbage palmetto trees, either singly or in clumps or groves, and the herbaceous vegetation consisting mostly of clumps of tall grass. Vegetation of similar aspect is found also on Merritt's Island in Brevard County,* and at various places near the Gulf coast from Franklin County to Lee County; and its general appearance is much like that of some tropical savannas. In Indian Prairie, on Merritt's Island, and on the Gulf coast north of Tarpon Springs, the soil of the savannas is pretty well saturated with water most of the time; but on the west coast islands from Long Key in Pinellas County† to Sanibel the savannas are usually on an undulating surface of dry sand mixed with shell fragments.

The vegetation of the savannas contains several species which are supposed to be rather partial to calcareous soil, and the correlation is obvious enough on the west coast islands, where the sand is full of shell fragments; but the Indian Prairie drainage

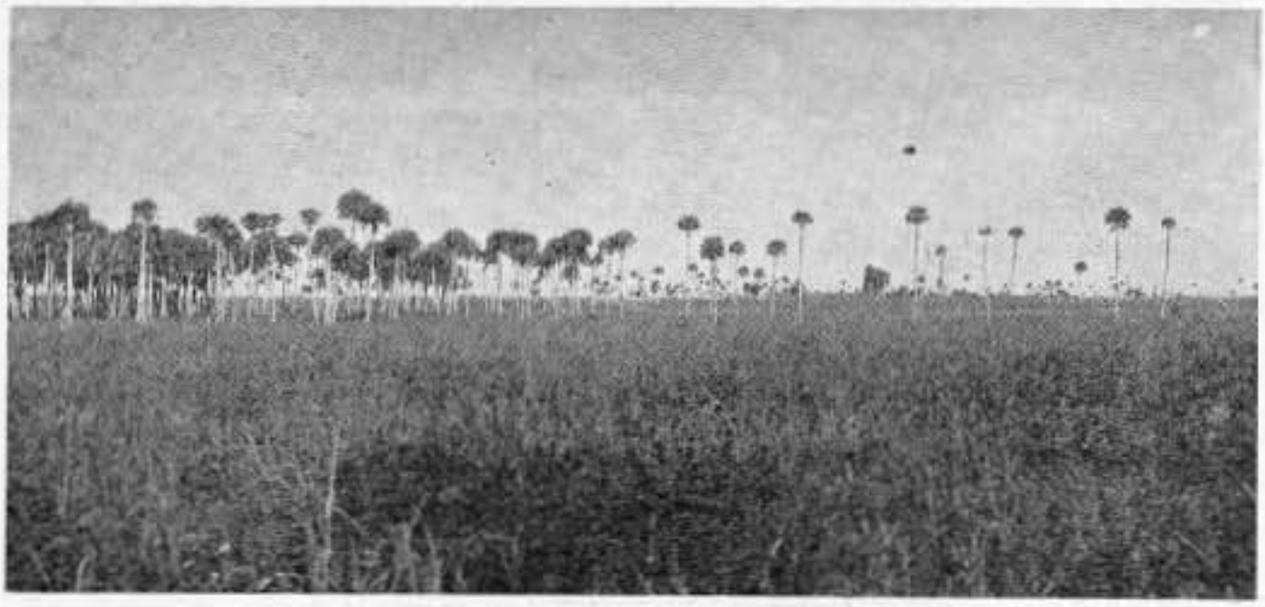

FIG. 19. Palm savanna vegetation in Indian Prairie about 14 miles west of the Kissimmee River on road from Arcadia to Okeechobee. Aug. 10, 1925.

*See our 13th Annual Report, p. 146, fig. 32.
†Ibid., p. 85, fig. 4.

canal, where the road from Moore Haven to Okeechobee crosses it, exposes nothing but sand, with little or no trace of calcareous material.

The Indian Prairie and other wet palm savannas differ enough from the drier and more undulating ones on the west coast to warrant separate treatment. The plant lists for the two types will therefore be given below in parallel columns:

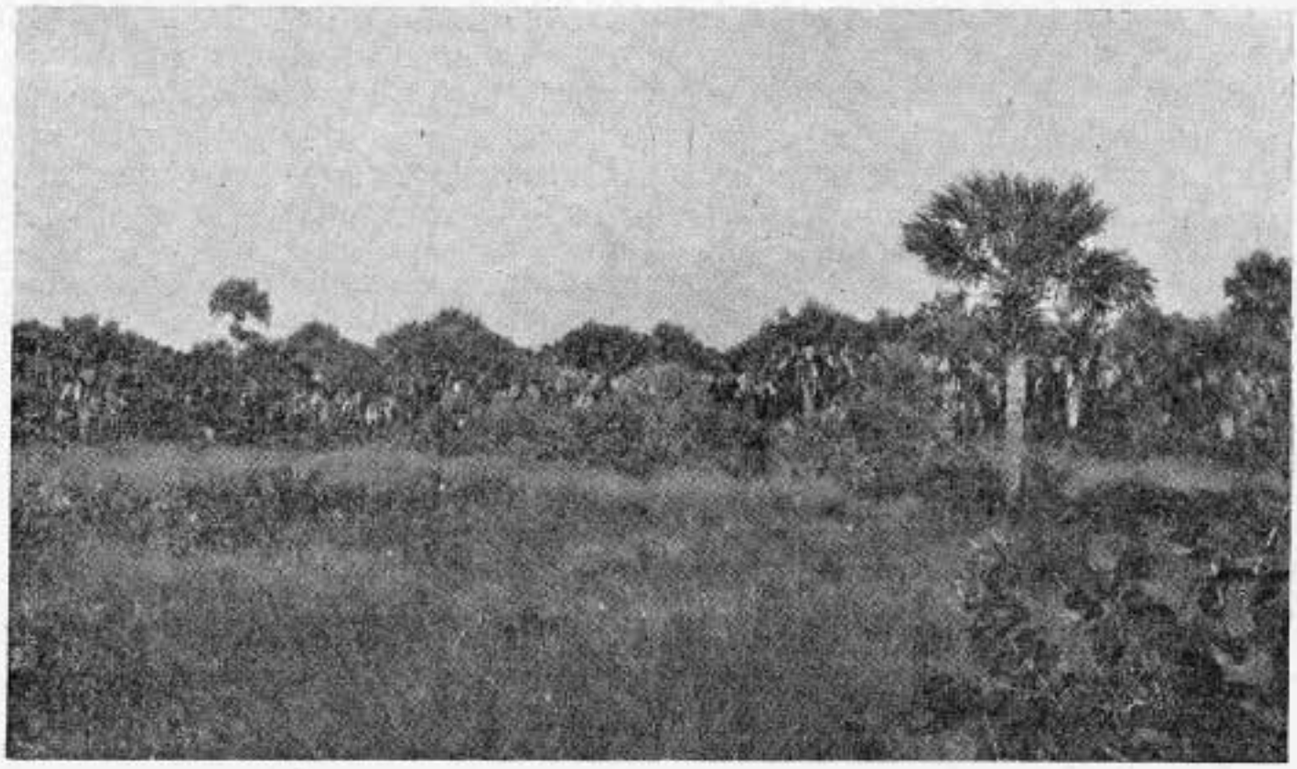

FIG. 20. Palm savanna on Gasparilla Island near South Boca Grande, Lee County. Soil of shell fragments and quartz sand in approximately equal proportions. *Sabal Palmetto* in background, *Coccolobis uvifera* at right, and *Muhlenbergia* in foreground. Nov. 21, 1924.

Wet savannas

TREES

Sabal Palmetto (cabbage palmetto)
Quercus Virginiana (live oak)
Pinus Caribaea (slash pine)

VINES

Smilax laurifolia (bamboo vine)

SHRUBS

Serenoa serrulata (saw-palmetto)
Baccharis halimifolia
Myrica cerifera (myrtle)
Hypericum fasciculatum
Stillingia aquatica
Ilex glabra (gallberry)

HERBS

Spartina Bakeri (switch-grass)
(Eupatorium capillifolium?) (dog-fennel)
Tillandsia utriculata (air-plant)
Andropogon glomeratus? (broom-sedge)
Cladium effusum (saw-grass)
Coreopsis Leavenworthii
Blechnum serrulatum (a fern)
(Euthamia sp.)
(Eleocharis Baldwinii) (road-grass)

Dry savannas

TREES

Sabal Palmetto (cabbage palmetto)

SMALL TREES

Coccolobis uvifera (sea-grape)

SHRUBS

Sophora tomentosa
Myrica cerifera (myrtle)
Ernodea littoralis
Jacquinia Keyensis
Opuntia sp. (prickly pear)

HERBS

Spartina junciformis? (a grass)
Muhlenbergia filipes? (a grass)
Flaveria sp.
Salicornia ambigua
Samolus ebracteatus
Solidago sempervirens (goldenrod)
Mikania scandens
Carduus spinosissimus? (thistle)
Andropogon glomeratus? (broom-sedge)
Sesuvium Portulacastrum
Melanthera sp.

Nearly all the woody plants are evergreen, but most of the herbs would not be so classed in a cooler climate. Most of the

FIG. 21. Palm savanna near west edge of Summerland Key. Trees all *Thrinax* sp. Undergrowth *Spartina* (?), *Borrichia*, etc. March 20, 1924.

woody plants, especially in the dry savannas of the west coast, have fleshy fruits, while at least half the herbs are disseminated by the wind. There seem to be no representatives of the Ericaceae, but one of the shrubs, and at least one herb, not abundant enough to be listed here, in the dry savannas, belongs to the Leguminosae.

The grasses furnish some forage for cattle, and some Seminole Indians are still living in some of the palmetto groves in the Indian Prairie, where they have small patches of corn and vegetables.

A still different type of palm savanna occurs on some of the Keys. The following plant list is based on a brief examination of one at the western edge of Summerland Key, near the railroad, one day in March, 1924.

TREES—
Thrinax sp. (thatch palm)

VINES—
Echites sp.?

SHRUBS—
Borrichia frutescens
Pithecolobium sp.
Morinda Roioc

HERBS—
Spartina sp.? (a grass)
Panicum virgatum? (a grass)
Andropogon glomeratus (a grass)

The shrubs are inconspicuous and the grasses abundant, as one can infer from the illustration.

LOW HAMMOCKS

(Figs. 22, 36.)

In northern and central Florida there are many hammocks which seem to owe their existence to protection from fire, for their soil seems to be essentially the same as that of near-by pine lands, except for the addition of humus contributed by the plants themselves.* But in South Florida, outside of the Miami region and the immediate vicinity of the coast, that condition is rare, and hammock vegetation seems to be practically confined to spots where there is limestone or marl near the surface, and such places are usually low and damp.

The hammocks of South Florida might be divided also into

*See our 7th Annual Report, pp. 170-171. 1915.

non-tropical and tropical, according to the species of trees composing them. Those of the Miami region and close to the coast farther north are of the tropical type, and also are in comparatively dry situations, while the remainder, being in damp places as above stated, are very similar to the low (calcareous) hammocks of central Florida.†

Such hammocks are common near the mouth of the Manatee River, and frequent in the prairie region of Glades and Okeechobee Counties. Like most other hammocks, they are dense and shady, and not much subject to fire. The trees are mostly tall and straight, indicating fairly rapid growth. There are hardly any small trees, but many vines. There are about as many herbs growing as epiphytes on the trees as on the ground.

The commonest species are about as follows:

TREES—
- *Sabal Palmetto* (cabbage palmetto)
- *Quercus Virginiana* (live oak)
- *Quercus obtusa?* (water oak)
- Acer rubrum (red maple)
- *Persea Borbonia* (red bay)
- Ulmus Floridana (elm)
- Hicoria sp. (hickory)
- Taxodium distichum (cypress)

VINES—
- Rhus radicans (poison ivy)
- Vitis aestivalis? (wild grape)
- Vitis Munsoniana (muscadine)
- Smilax rotundifolia?
- Ampelopsis arborea
- Parthenocissus quinquefolia (Virginia creeper)
- Berchemia scandens (rattan vine)
- *Gelsemium sempervirens* (yellow jessamine)

SHRUBS—
- *Psychotria undata* (wild coffee)
- *Rapanea Guyanensis*
- *Psychotria Sulzneri* (wild coffee)
- *Icacorea paniculata*
- *Myrica cerifera* (myrtle)
- *Viburnum obovatum*
- Cornus stricta
- *Serenoa serrulata* (saw-palmetto)
- *Lantana involucrata*
- Sophora tomentosa
- Callicarpa Americana (French mulberry)

HERBS—
- *Tillandsia tenuifolia* (air-plant)
- *Tillandsia utriculata* (air-plant)
- *Tillandsia usneoides* (Spanish moss)
- Oplismenus setarius (a grass)
- *Rhynchospora miliacea* (a sedge)
- *Polypodium aureum* (a fern)
- *Vittaria lineata* (a fern)
- Saururus cernuus
- *Centella repanda*
- *Tillandsia fasciculata* (air-plant)
- *Nephrolepis exaltata* (Boston fern)
- Uniola laxa (a grass)
- Metastelma sp.

MOSSES—
- *Syrrhopodon Floridanus*

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†Ibid., p. 175.

This vegetation type probably has a smaller proportion of evergreens that any other in South Florida, which indicates pretty good soil. Only two of the trees listed, the palmetto and red bay, seem to have leaves that last two or more seasons, but those of the live oak last about a year, or a little more, and those of the water oak nearly as long. Only one of the vines is completely evergreen, and that the last one on the list. Most of the shrubs are evergreen, but some of them probably would not be in a colder climate, on account of their thin leaves. Among the herbs the epiphytes (four *Tillandsias* and three ferns) are evergreen, for an epiphyte, having no connection with the soil, cannot possibly get enough mineral food for a new crop of leaves every year; but the other herbs, which grow in the ground, would hardly be classed as evergreen, though in this climate the leaves of some might be green most of the winter.

FIG. 22. Hammock on north side of Caloosahatchee River in Glades Co., a few miles above LaBelle, near Coffee Mill Hammock. Trees mostly *Sabal Palmetto* (old and young), *Quercus Virginiana*, *Q. obtusa*, and *Acer rubrum*. March 14, 1924.

Among the trees the number with berries, nuts, and winged fruits is about equal All the vines but one and all the shrubs but one have berries. Among the herbs the epiphytes have seeds or spores transported by the wind, but the mode of dissemination for most of the terrestrial species is unknown.

All the trees and vines listed can be found also in Georgia, but the first four shrubs and most of the epiphytes do not range north of Florida. Probably the interior of these hammocks is sufficiently protected from frost to allow these tropical species to thrive.

Not much use is made of any of these plants, but the soil is excellent for vegetable growing, and a great deal of the vegetation has been destroyed for that reason, especially in the Manatee region.

TROPICAL HAMMOCKS

(Fig. 43.)

These seem to be confined to places where the temperature inside of them rarely or never gets below freezing. They are commonest southwest of Miami, but there are narrow strips close to salt water north of there, as far up the coast as Brevard County. A very interesting tropical hammock borders the Indian River for a few miles south of Fort Pierce, and averages only about 100 feet wide. On a large shell mound on Snead's Island, at the mouth of the Manatee River, there is a hammock of which the western half, nearest to the Gulf, is tropical and the eastern or inland half more like the low hammocks just described.

Below Miami the largest hammock (Brickell's) borders Biscayne Bay, but there are many smaller ones scattered through the rocky pine lands of the same region. Those in the Miami region nearly all have live oaks around their edges, and as that species can stand considerable frost, it may be that it serves to protect the more tender plants within from occasional freezes, as well as from fire.

The northernmost tropical hammocks seem to be all on shell mounds.* That just south of Fort Pierce is on a bluff of coquina,

*See our 13th Annual Report, pp. 205-206.

and those in the Miami region and on the Keys are on limestone.

In the Miami region the hammocks seem to be tending to encroach on the pine forests which border or surround them, or were doing so before civilized man came along to interfere. It appears as if the smaller ones may have started in the distant past, around small sink-holes, or in spots too rocky to be much subject to fire, and gradually spread as the hardwood trees deposited humus and paved the way for more of their descendants.*

In a typical tropical hammock most of the trees have crooked trunks, hard heavy wood, and stiff evergreen leaves, indicating slow growth, in spite of the limestone and abundant humus. (Potash is probably very deficient in the soil.) They make a dense shade, and there are very few herbs growing on the ground, but often a great profusion of air-plants on limbs and leaning trunks of the live oak and other rough-barked trees.

When a clearing is made in such a forest by the axe or fire, a considerable number of weeds, both woody and herbaceous, spring up rapidly, and if there is no further disturbance they flourish until the slow-growing native trees have time to re-establish themselves. This phenomenon is paralleled in the coniferous forests of the northern states and Canada, where after a fire the ground is soon occupied by a brushy growth of birch and aspen and various briers and fire-weeds.* The most characteristic fire-weeds of the tropical hammocks are two small trees, *Trema*† and *Carica*, a shrub or large woody herb, *Solanum verbascifolium*, and one or more of the Lantanas.

The different areas of tropical hammock, although much alike in general appearance, vary considerably in floristic composition, and almost every one contains a pleasant surprise for the botanist visiting it for the first time, in the shape of one or more rare plants not found in the others. Nearly all the species occur also in the West Indies, but a few seem to have been separated from their tropical relatives long enough to develop slight differ-

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*See the chapter on the origin of the hammocks, in Chas. T. Simpson's "In Lower Florida Wilds," (1920), pp. 190-209. Also E. A. Bessey, Plant World, 14:271-273. 1911.

*See Pop. Sci. Monthly 85:341. Oct., 1914.

†One or two other species of *Trema* are said to function in the same way in the tropics.

ences. A complete list of the plants would be a long one, perhaps running into the hundreds. The following list represents only a part of the flora, perhaps not more than a third or fourth, but probably nine-tenths of the bulk of the vegetation. There are many rare plants which the writer has never seen, and others which he has not been able to identify at sight when they are not in bloom, especially among the orchids. Even some of the trees are difficult to identify without flowers, for some belonging to very different families may have similar bark and foliage.

As in some of the types already described, there are all gradations between trees and shrubs, sometimes even in a single species, so that the following size classification is necessarily somewhat arbitrary.

LARGER TREES—

Bursera Simaruba (gumbo limbo)
Sabal Palmetto (cabbage palmetto)
Coccolobis laurifolia (pigeon plum)
Quercus Virginiana (live oak)
Sideroxylon foetidissimum (mastic)
Eugenia confusa (ironwood)
Ficus aurea (wild fig, or rubber)
Persea Borbonia (red bay)
Ichthyomethia piscipula (Jamaica dogwood)
Lysiloma Bahamensis
Hicoria sp. (hickory)*
Ficus brevifolia (wild fig)
Swietenia Mahagoni (mahogany)†
Sapindus Saponaria (soapberry)
Roystonea regia (royal palm)
Krugiodendron ferreum

SMALL TREES—

Simaruba glauca (paradise tree)
Ocotea Catesbyana
Xanthoxylum Fagara
Metopium toxiferum (poisonwood)
Exothea paniculata
Citharexylum fruticosum (fiddlewood)
Laurocerasus myrtifolia
Chrysophyllum olivaeforme (satin-leaf)
(Trema mollis)
Morus rubra (mulberry)
Ilex Krugiana
(Carica Papaya) (papaw)

WOODY VINES—

Rhus radicans? (poison ivy)
Vitis Munsoniana (muscadine)
Parthenocissus quinquefolia (Virginia creeper)
Dalbergia Ecastophyllum?
Vitis Caribaea? (wild grape)
Pisonia aculeata
Ampelopsis arborea

SHRUBS—

Psychotria undata (wild coffee)
Icacorea paniculata
Rapanea Guyanensis
Acanthocereus pentagonus (a cactus)
Callicarpa Americana (French mulberry)
Serenoa serrulata (saw-palmetto)
Psychotria Sulzneri (wild coffee)
(Lantana Camara?)
(Solanum verbascifolium)
Panicum divaricatum (a grass)
Erythrina arborea
Rhus copallina? (sumac)
Chiococca racemosa?
Guettarda scabra

HERBS—

Nephrolepis exaltata (Boston fern)
Tillandsia utriculata (air-plant)
Tillandsia tenuifolia (air-plant)
Campyloneuron Phyllitidis (a fern)
Tillandsia fasciculata (air-plant)
Tillandsia Valenzuelana (air-plant)
Tillandsia usneoides (Spanish moss)

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*In St. Lucie Co., not in Dade.
†Observed only in Monroe County.

SMALL TREES—(cont'd)

Tetrazygia bicolor
Picramnia pentandra
Calyptranthes sp.
Guettarda elliptica
Eugenia sp. (stopper)
Chrysobalanus pellocarpus? (cocoa plum)
Dipholis salicifolia
Amyris elemifera?
Drypetes crocea?
Gymnanthes lucida
Conocarpus erecta (buttonwood)
*Capparis Jamaicensis**
Annona sp. (custard apple)
Eugenia sp.? (stopper)
Xanthoxylum Clava-Herculis

HERBS—(cont'd)—

Polypodium polypodioides (a fern)
Tillandsia sp. (air-plant)
Pteris caudata (a fern)
Polypodium aureum (a fern)
Tillandsia recurvata (air-plant)
Metastelma Blodgettii?
Vittaria lineata (a fern)
Dryopteris normalis? (a fern)
Catopsis sp.? (air-plant)
Tillandsia Balbisiana (air-plant)
Blechnum serrulatum (a fern)
Tectaria trifoliata (a fern)
(Bryophyllum pinnatum)
Epidendrum Tampense? (an orchid)
Epidendrum nocturnum (an orchid)
Peperomia spatulifolia
Epidendrum cochleatum? (an orchid)
Epidendrum rigidum (an orchid)

This vegetation is nearly all evergreen, though some of the shrubs and herbs have tender foliage that may be renewed every year, or oftener. The great majority of the woody plants have fleshy fruits, while nearly all the herbs have very small seeds, or spores, adapted to be carried by the wind. In either case it is a comparatively simple matter for the supply to be constantly renewed from the West Indies, by natural agencies.

Not much use is made of these plants, and the density of the forests and the hardness of the wood has prevented farmers from making much use of the seemingly rich soil. But roads have been cut through some of the finest hammocks, and near Miami much of Brickell's Hammock and a few others has been "developed" into very valuable building sites. The very interesting hammock along the Indian River south of Fort Pierce, although only about 100 feet wide, has the main east coast highway running through it for its whole length (see fig. 43, p. 174), and it will probably soon be still further damaged to make room for houses.†

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*Observed only in St. Lucie County.

†Several months ago there was talk of widening the highway through this hammock, and even adding sidewalks and other improvements; which if carried out will just about complete the destruction.

CAPE SABLE HAMMOCKS

Near Cape Sable, especially in what is known as the Madeira Hammock, there is a variation of the tropical hammock type growing on marl near sea-level, without any neighboring pine land or live oak fringe, and grading into mangrove swamps. The commonest plants there, as determined by very limited observations in March, 1924, are about as follows:

TREES—
- *Swietenia Mahagoni* (mahogany)
- *Coccolobis laurifolia* (pigeon plum)
- *Sabal Palmetto* (cabbage palmetto)
- *Ficus aurea* (wild fig)
- Ichthyomethia piscipula (Jamaica dogwood)

SMALL TREES—
- *Conocarpus erecta* (buttonwood)
- *Xanthoxylum Fagara*
- Colubrina sp.
- Carica Papaya (papaw)

VINES—
- Pisonia aculeata

SHRUBS—
- *Icacorea paniculata*
- *Acanthocereus pentagonus* (a cactus)
- *Panicum divaricatum* (a grass)

HERBS—
- *Vittaria lineata* (a fern)
- *Tillandsia utriculata* (air-plant)
- *Tillandsia fasciculata* (air-plant)
- *Campyloneuron Phyllitidis* (a fern)
- *Epidendrum rigidum* (an orchid)
- Iresine paniculata
- Philoxerus vermicularis
- Diapedium assurgens?
- *Cyrtopodium punctatum* (an orchid)
- *Tillandsia* sp. (air-plant)

These hammocks resemble those near Miami in the abundance of evergreens, epiphytes, fleshy-fruited woody plants, and wind-borne seeds. But the commonest tree, the mahogany (or madeira as it is called locally) has a hard woody fruit, which may possibly be adapted to floating in salt water, like the cocoanut.

The mahogany is a very valuable wood, and some of it has been cut from the Cape Sable region, but its relative scarcity and inaccessibility has prevented its being the basis of an important industry. The commonest small tree, the buttonwood, is in constant demand as one of the sources of charcoal for Key West.

KEY HAMMOCKS

(Fig. 23.)

Another variation of the tropical hammock type is the hammocks on the Keys. They occur on dry limestone rock, but differ from those in the Miami region in having the trees averaging smaller, and usually so close together that one cannot penetrate such a forest without cutting a path, as in the proverbial tropical jungles. This may be partly due to the drier climate of the Keys, or to the fact that since the building of the railroad the hammocks on the Keys have suffered a great deal from fire, which must have been a rare occurrence originally. Many of the trees grow so slowly that their wood is hard and heavy. Ferns, air-plants, orchids and other herbs are much scarcer than on the mainland.

The species of plants are fewer than on the mainland, but the following list is doubtless far from complete, as it is made up

Fig. 23. Dense scrubby hammock on Lower Matacumbe Key (one of the Upper Keys), showing especially *Coccolobis laurifolia* and *Thrinax*, with stems only a few inches in diameter. July 27, 1910.

mostly from car-window notes. It covers both upper and lower Keys (which are described separately farther on). The distinction between trees and shrubs is even more difficult than on the mainland.

TREES—

Bursera Simaruba (gumbo-limbo)
Ichthyomethia piscipula (Jamaica dogwood)
Metopium toxiferum (poison-wood)
Thrinax sp. (thatch palm)*
Lysiloma Bahamensis
Ficus aurea? (wild fig)
Sideroxylon foetidissimum (mastic)
Swietenia Mahagoni (mahogany)
Coccolobis laurifolia? (pigeon plum)
Eugenia confusa (ironwood)
Hippomane Mancinella (manchineel)

SMALL TREES—

Metopium toxiferum (poison-wood)
Mimusops emarginata
Pithecolobium Guadalupense?
(Trema mollis)
(Carica Papaya) (papaw)
Simaruba glauca (paradise tree)

VINES—

Vitis Munsoniana (muscadine)
Guilandina sp.
Parthenocissus quinquefolia (Virginia creeper)

SHRUBS—

(Solanum verbascifolium)
Genipa clusiifolia (seven-year apple)
Acanthocereus pentagonus (a cactus)
Pithecolobium sp.
Eugenia sp. (stopper)
Bumelia sp.?
Panicum divaricatum (a grass)
Rapanea Guyanensis

HERBS—

(Too scarce to mention)

Woody plants with compound and deciduous leaves seem to be more abundant than in the tropical hammocks of the mainland, and this may indicate richer soil. The proportion of fleshy fruits is almost as large as in the hammocks near Miami. The thatch palms have been used locally for covering small buildings, and the mahogany would be important if there was enough of it. The poison-wood is more or less poisonous to the touch, and the manchineel is said to be still more dangerous.

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*There are probably two species of *Thrinax*, but from the train it is difficult to tell which is which.

LAKES AND PONDS

(Fig. 24.)

Lakes are less numerous in South Florida than farther north, although Lake Okeechobee is the largest one in the southeastern states. The aquatic vegetation of the area under consideration has been little studied, but it seems to present no peculiar features, and the description of this type for the whole State in our Third Annual Report (pp. 269-270) will apply pretty well to South Florida. Floating plants, like *Pistia* (water-lettuce), and the water-hyacinth, a recently arrived pest, are frequent, and plants with floating leaves, such as *Castalia* (water-lily) and *Nymphaea* (bonnets) still more so, where the water is not too deep. In shallow water protected from wave action we find also several reed-like plants, such as *Cladium* (saw-grass) and *Sagittaria,* indicating a transition to the saw-grass marshes described farther on.

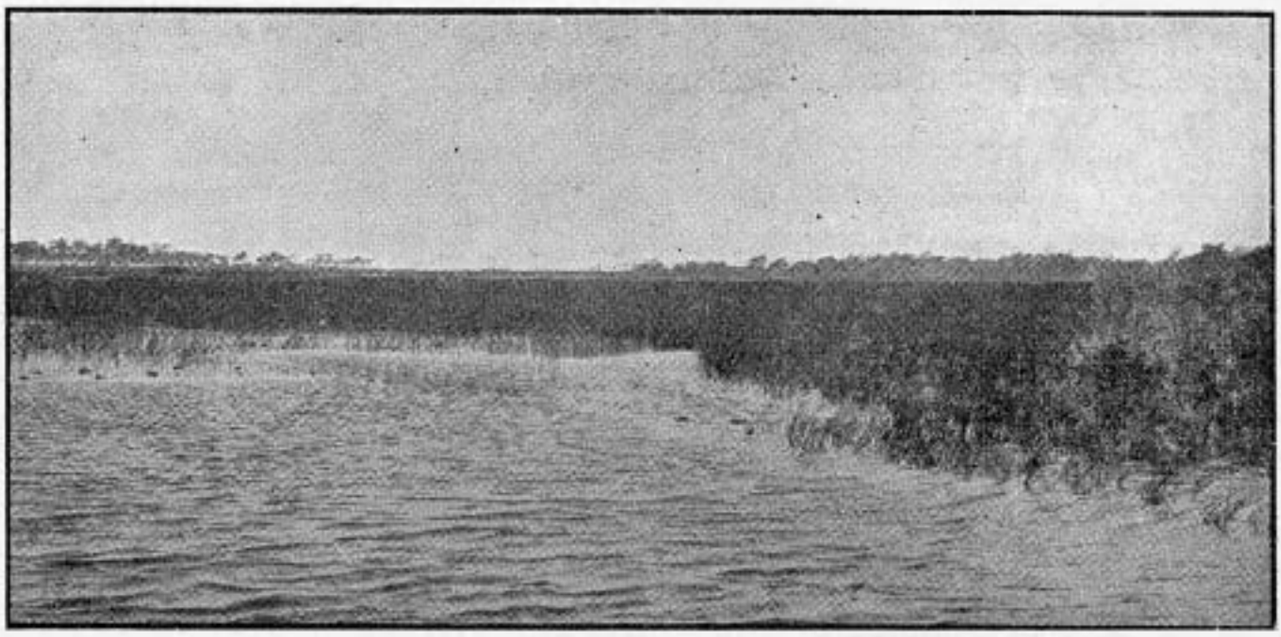

FIG. 24. Clear Lake, about a mile west of West Palm Beach, looking south. April 13, 1909. (From 3d Ann. Rep., p. 273, where a description of the vegetation can be found. The place is doubtless greatly changed by this time, on account of the growth of the city.)

WET PRAIRIES AND SHALLOW PONDS

(Fig. 25.)

Scattered through the flatwoods and prairies, and less frequently in the lake region, are innumerable shallow approximately circular depressions, varying in extent from one to many acres,

which may hold a foot or two of water in wet weather, and become entirely dry in spring. Occasionally they are full of cypress trees, constituting the cypress ponds (described farther on); but more frequently they have a few other trees, scattered shrubs, or nothing but herbs. When treeless they are sometimes called "sand soaks."

The soil is nearly always sandy, but there may be limestone or marl not far from the surface, and a little muck in the deeper portions.

The vegetation of the treeless depressions varies considerably with the depth and permanence of the water, and tends to be aranged in concentric zones, so that it is difficult to make a satisfactory quantitative study of it.* Any list that might be gotten up, unless minutely divided according to depth zones, would include some plants that grow only in the deeper parts and some confined to the edges, so that they would never be together. But the following list is believed to be fairly representative of the shallow ponds of South Florida, other than cypress ponds.

Fig. 25. Small wet prairie in long-leaf pine flatwoods about two miles south of Hilolo, Okeechobee County. The numerous light spots are the heads of *Marshallia graminifolia*. Aug. 9, 1925.

*See our 3d Annual Report, pp. 266-268.

TREES—
- *Sabal Palmetto* (cabbage palmetto) (very scattered)

SMALL TREES—
- Fraxinus Caroliniana (pop-ash)
- Salix amphibia? (willow)

SHRUBS—
- *Hypericum fasciculatum* (guinea cypress. or sand myrtle)
- *Hypericum myrtifolium*
- Cephalanthus occidentalis (elbow bush)
- *Myrica cerifera* (myrtle)
- *Ascyrum tetrapetalum?*

HERBS—
- Marshallia graminifolia (in very shallow basins)
- Pontederia cordata (wampee) (in permanent water)
- *Cladium effusum* (saw-grass)
- Anastrophus paspaloides (a grass)
- Thala divaricata? (in permanent water with marly subsoil)
- Sagittaria lancifolia (in water)
- *Spartina Bakeri* (switch-grass)
- Rhynchospora Tracyi (a sedge)
- *Centella repanda* (mostly toward edges)
- Litrisa carnosa (in very shallow basins)
- Polygala Baldwinii (usually over marl)
- Flaveria sp. (usually over marl)
- (Lathamia sp.)
- Andropogon sp. (broom-sedge)
- Hyptis radiata
- *Juncus repens* (a rush)
- Dichromena latifolia (a sedge)
- *Eleocharis cellulosa* (round-grass) (in permanent water)
- Scleria sp. (a sedge)
- Polygala cymosa (in water)
- Panicum erectifolium (a grass)
- Bidens coronata?
- Eriocaulon decangulare
- *Erigeron vernus*

Both of the small trees and a few of the herbs have seeds transported by the wind, but in the majority of other cases the mode of dissemination is unknown. Most of the shrubs are evergreen, but the small trees and the great majority of the herbs are not. *Hypericum fasciculatum*, sometimes known as "sand myrtle," or "guinea cypress," is especially characteristic of this habitat, and is more abundant than all the other woody plants combined. Two of the other shrubs belong to the same family. Among the herbs five sedges and four grasses are listed. Both ericaceous and leguminous plants are rare or wanting.

About the only use made of any of these plants is as forage for cattle.

CYPRESS PONDS

(Fig. 26.)

Just why some of the shallow wet depressions should be treeless and others full of trees is an unsolved problem, but it may be due to the same soil conditions that are responsible for the difference between flatwoods and prairies; for cypress ponds are very rare in the prairie areas, and also in the lake region. The depth and fluctuation of the water may have something to do with it too, for a cypress pond must have water in it most of the time. If the water is too deep, though, there are no trees, except around the edges. The level of the water in a cypress pond may fluctuate two or three feet with the seasons, but not much more than that. **And if the fluctuation is less than a foot or so, and the water shallow enough, we find a bay instead of a cypress pond.**

In South Florida the cypress ponds (also called "cypress heads") are most common in the flatwoods of Lee and Palm Beach Counties, and are absent from large areas where one might expect to find them, as for example in Manatee, Sarasota, Hardee, DeSoto and Charlotte Counties. The Big Cypress in Collier County is probably largely of this type, but that has not yet been visited by the writer.*

The soil under a cypress pond is usually sand, though limestone may be very near the surface, as in Lee County, and the same species of cypress is common in the coast prairie of Dade County, where there is no sand at all.

The cypress trees in a cypress pond usually have very abruptly enlarged bases, the enlargements reaching up just about to high-water mark; and "knees" are scarce. In the northern parts of the State the trees around the edges are usually about as large as those in the middle, and the pines in the surrounding pine forests grow pretty close to the cypresses, and the slash pine (*Pinus Elliottii*) often goes right into the ponds with the cypress. But in South Florida a cypress pond usually has no pines in it, and is bordered by a treeless strip a few yards wide, and the trees at the

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*For notes on the Big Cypress see Kennard, Auk 32:1-14. 1915; Small, Jour. N. Y. Bot. Gard. 19:287-289. 1918; Natural History 20:488-500. 1920.

edges are generally much smaller than those in the middle, sometimes no taller than a man. Any one seeing such a pond for the first time might imagine that the small trees at the edges were young ones, and that the cypress growth was spreading. But the cypress never voluntarily invades dry land, and there is no reason to suppose that the climate is becoming wetter or the water deeper. The little trees at the edges have probably had just as much time to grow as the large ones in the middle, but they must be dwarfed by some unfavorable soil condition. The reason for all this, however, is not known. Fire gets into the cypress ponds occasionally in dry seasons, but does not seem to do much damage.

The flora of cypress ponds in South Florida does not seem to be as diversified as it is in the northern parts of the State.* The following seem to be the commonest species:

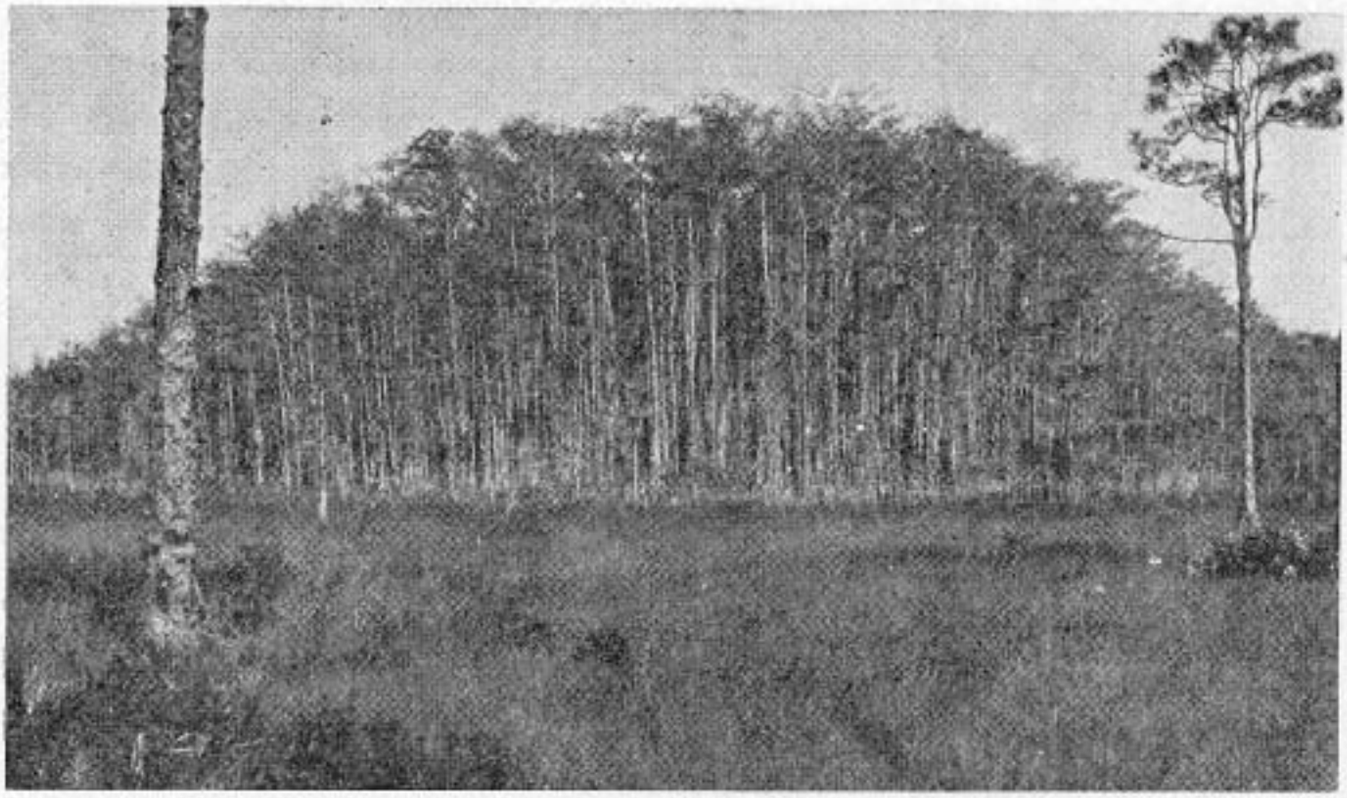

FIG. 26. Cypress pond or "head" in slash pine flatwoods in Lee County, about half way between Fort Myers and Immokalee. *Pinus Caribaea* in foreground. Note the dwarfed cypresses toward the edges of the pond, and the treeless zone around it. March 13, 1924.

TREES—
- Taxodium imbricarium (pond cypress)
- *Pinus Caribaea* (slash pine) (rare)

SHRUBS—
- *Myrica cerifera* (myrtle)
- Stillingia aquatica
- *Hypericum fasciculatum*

HERBS—
- *Tillandsia fasciculata* (air-plant)
- *Blechnum serrulatum* (a fern)
- Chondrophora nudata
- *Eleocharis cellulosa* (round-grass)
- *Cladium effusum* (saw-grass)
- *Tillandsia usneoides* (Spanish moss)
- *Tillandsia recurvata* (air-plant)
- Eriocaulon decangulare
- Phragmites communis (reed-grass)
- Heliotropium Leavenworthii
- Polygala cymosa
- Eriocaulon compressum
- Panicum erectifolium? (a grass)
- Hyptis radiata
- Leptopoda Helenium
- Oxypolis filiformis

The cypress is probably at least 100 times as abundant as the pine. The first air-plant listed is very abundant, some ponds having several bunches of it on nearly every tree, usually six or eight feet from the ground; and its bright red flowers in spring are very striking. There are also a few other showy flowers, mostly yellow. The cypress being deciduous, makes evergreens in the minority, and most of the herbs are deciduous too.

The seeds of the cypress are adapted for floating, and in very wet seasons when the flatwoods are inundated some of them may float from one pond to another. They may be also carried by squirrels, for the cypress ponds among the rolling pine lands of West Florida could never have been supplied by floating seeds. Most of the herbs have seeds transported by the wind, and the remainder by agencies as yet unknown.

The cypress, on account of its durable wood, is valuable for poles, posts, crossties, shingles, etc. One of the shrubs, *Stillingia aquatica,* which seems to have no common name, has wood lighter than cork, and if that was generally known some use might be made of it.

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*See our 3d Annual Report, pp. 262-264.

RIVER-BANKS

South Florida has nothing corresponding to the muddy rivers of the states farther north, which rise several or many feet in wet weather, and deposit mud over their flood-plains. Even the largest rivers, the Peace and Caloosahatchee, have coffee-colored water with very little inorganic sediment, although they may fluctuate as much as ten feet with the seasons, near the middle of their courses. (A river obviously cannot rise much either near its head or near its mouth.)

The plants growing on the banks and in the flood-plains of these rivers have not been studied in detail. The following list is based mostly on observations along the Peace River near Arcadia and Fort Ogden, and on the Caloosahatchee near LaBelle.

TREES—
- Taxodium distichum (cypress)
- *Sabal Palmetto* (cabbage palmetto)
- *Quercus Virginiana* (live oak)
- Acer rubrum (red maple)
- Hicoria aquatica (swamp hickory)*
- Gleditsia triacanthos (honey locust)
- *Quercus obtusa?* (water oak)
- Ulmus Floridana? (elm)
- Liquidambar Styraciflua (sweet gum)

SMALL TREES—
- Fraxinus Caroliniana (pop-ash)
- Salix nigra? (willow)

VINES—
- Rhus radicans (poison ivy)

SHRUBS—
- *Serenoa serrulata* (saw-palmetto)
- *Viburnum obovatum*
- *Myrica cerifera* (myrtle)
- Cornus stricta?
- Cephalanthus occidentalis (elbow-bush)

HERBS—
- *Tillandsia usneoides* (Spanish moss)
- *Tillandsia tenuifolia* (air-plant)
- *Nymphaea macrophylla* (bonnets) (in sloughs)
- *Tillandsia utriculata* (air-plant)
- (Glottidium vesicarium)
- *Polypodium polypodioides* (a fern) (on trees)
- *Pistia spathulata* (water-lettuce) (in sloughs)

This list has a good deal in common with that for the low hammocks, previously mentioned. But some of the species, such as *Hicoria aquatica, Gleditsia, Liquidiambar,* and *Salix nigra,* are seldom if ever seen elsewhere in South Florida. (Several species of trees seem to extend farther south along and near the Peace River than anywhere else.)

Most of the trees and vines are deciduous, and another in-

*The hickories on the Caloosahatchee River have been described by Prof. C. S. Sargent as a variety, *australis.*

dication of pretty good soil is the scarcity or absence of Ericaceae and the presence of one tree and one large herb belonging to the Leguminosae, and perhaps some rarer species of that family not listed. The small trees and most of the herbs have wind-borne seeds.

Some of the trees have useful wood, but they are not abundant enough in this habitat to be of any commercial importance.

We also have a few rivers whose water fluctuates very little with the seasons, but they have been investigated botanically even less. A good example of this class is New River in Broward County. The following plants were noted while ascending it in a launch from Fort Lauderdale to the Everglades on April 12, 1909:

TREES—
- Taxodium imbricarium? (cypress)
- Acer rubrum (red maple)
- *Sabal Palmetto* (cabbage palmetto)
- Taxodium distichum (cypress)
- *Quercus Virginiana* (live oak)

SMALL TREES—
- Salix amphibia? (willow)
- *Chrysobalanus Icaco?* (cocoa plum)
- *Annona palustris?* (custard apple)
- *Persea pubescens* (red bay)
- *Ilex Cassine*

VINES—
- Vitis Munsoniana (muscadine)

SHRUBS—
- *Myrica cerifera* (myrtle)
- Cephalanthus occidentalis (elbow-bush)

HERBS—
- *Nymphaea macrophylla* (bonnets)
- *Acrostichum aureum* (a fern)
- *Sagittaria lancifolia*
- Saururus cernuus
- *Tillandsia fasciculata* (air-plant)
- Hymenocallis sp.? (spider-lily)
- *Tillandsia usneoides* (Spanish moss)
- Phragmites communis (reed-grass)
- *Cladium effusum* (saw-grass)
- Pontederia cordata (wampee)
- Osmunda regalis (a fern)
- Crinum Americanum?

Although this locality is in about latitude 26°, and considerably farther south than some tropical hammocks, few of the species can be regarded as tropical.

Some of the rivers and creeks in prairie regions, such as the Kissimmee west of Okeechobee, and Fisheating Creek west of the lake region, meander through marshes, and have few or no trees near them. And the same is true of some streams farther north, such as the St. John's River in southern Brevard County, and some rivers and creeks in southern Louisiana and northeastern Illinois.

CREEK AND BRANCH SWAMPS

(Fig. 27.)

Small streams which do not have enough water in them to fluctuate much are generally bordered by dense swamps of varying width. These are commonest in the flatwoods west of the lake region, and the vegetation often suggests the presence of calcareous or phosphatic material a little below the muck and sand.

The characteristic plants are about as follows:

TREES—
- Acer rubrum (red maple)
- Nyssa biflora (black gum)
- Taxodium distichum (cypress)
- *Sabal Palmetto* (cabbage palmetto)
- *Quercus obtusa?* (water oak)
- *Quercus Virginiana* (live oak)
- Liquidambar Styraciflua (sweet gum)
- Ulmus Floridana (elm)

SMALL TREES—
- *Magnolia glauca* (bay)
- Salix amphibia? (willow)
- Fraxinus Caroliniana (pop-ash)
- *Ilex Cassine*

VINES—
- *Smilax laurifolia* (bamboo vine)
- Vitis Munsoniana (muscadine)

SHRUBS—
- *Myrica cerifera* (myrtle)
- Viburnum nudum (possum haw)
- Cornus stricta
- *Phoradendron flavescens* (mistletoe)

HERBS—
- *Tillandsia usneoides* (Spanish moss)
- Pontederia cordata (wampee)
- *Blechnum serrulatum* (a fern)
- *Tillandsia tenuifolia* (air-plant)
- Saururus cernuus
- *Tillandsia utriculata* (air-plant)
- *Dryopteris unita* (a fern)
- Osmunda regalis (a fern)
- *Tillandsia fasciculata* (air-plant)
- *Nymphaea macrophylla* (bonnets)
- Thalia sp.
- Cyperus articulatus (a sedge)
- *Pistia spathulata* (water-lettuce)
- Osmunda cinnamomea (a fern)
- *Tillandsia recurvata* (air-plant)
- *Polypodium polypodioides* (a fern)
- *Cladium effusum* (saw-grass)
- Bidens coronata
- *Epidendrum Tampense* (an orchid)
- Rhynchospora corniculata (a sedge)
- Lorinseria areolata (a fern)

These swamps are somewhat intermediate between the river-swamps previously mentioned, and the bays to be described next, but seem to have more species than either, perhaps simply because examples of this type of swamp are more numerous than the others. The trees are pretty tall and straight, not over half the vegetation is evergreen, and Ericaceous shrubs are scarce, all of which indicates fairly good soil conditions. Ferns are rather numerous.

About half the trees and all the vines and shrubs listed have berries, but the great majority of the herbs are disseminated by the wind.

This vegetation is not very tropical, for at least three-fourths of the species can be found also in Georgia.

The wood of some of the trees would be useful if it occurred in sufficient quantities, but the creek and branch-swamps constitute probably not more than 5% of the total area, so they are relatively unimportant.

FIG. 27. Looking down Fisheating Creek from railroad bridge just south of Palmdale, Glades County. Trees nearly all *Taxodium distichum* (leafless at this season). Jan. 27, 1924.

BAYS AND NON-ALLUVIAL SWAMPS

(Fig. 28.)

A shallow depression or other perpetually wet area whose water does not fluctuate more than a foot or so during the year,* if not entirely treeless like the wet prairies previously described, is likely to be filled with a dense forest known as a bay, presumably from the abundance of bay trees. The water is usually stagnant, as in the cypress ponds, but it may seep out from an adjoining gentle slope and circulate very slowly.† On account of the dense shade and moisture, these bays are just about the coolest spots in South Florida. They are found in the lake region, in the flatwoods, and among old dunes near the east coast, usually on

*See our 6th Annual Report, pp. 203, 351.
†See 3d Annual Report, pp. 253-260.

sour sandy soil; and they are probably most frequent in DeSoto, Highlands and Glades Counties.

The following are the commonest species:

TREES—
- *Magnolia glauca* (bay)
- Nyssa biflora (black gum)
- Acer rubrum (red maple)
- *Gordonia Lasianthus* (red bay)

SMALL TREES—
- *Ilex Cassine*

VINES—
- *Vitis Munsoniana* (muscadine)
- Parthenocissus quinquefolia (Virginia creeper)
- *Smilax laurifolia* (bamboo vine)

SHRUBS—
- Itea Virginica
- *Myrica cerifera* (myrtle)
- Viburnum nudum (possum haw)
- *Phoradendron flavescens* (mistletoe)

HERBS—
- *Blechnum serrulatum* (a fern)
- Saururus cernuus
- Peltandra Virginica
- Peltandra sagittifolia?
- *Dryopteris unita* (a fern)
- Osmunda cinnamomea (a fern)
- Arisaema triphyllum (Indian turnip)
- *Nephrolepis exaltata* (Boston fern)
- *Tillandsia tenuifolia* (air-plant)
- *Tillandsia fasciculata* (air-plant)
- *Tillandsia usneoides* (Spanish moss)
- Lorinseria areolata (a fern)

MOSSES, ETC.—
- *Sphagnum cuspidatum*
- *Pallavicinia Lyellii*
- *Sphagnum sps.*

The proportion of evergreens here is probably a little greater than in the branch-swamps, indicating poorer soil. Leguminous plants seem to be entirely absent. Most of the woody plants have berries, and most of the herbs have wind-borne seeds or spores.

FIG. 28. Bay in prairie region about a mile northwest of Palmdale. Trees nearly all *Magnolia glauca*, with somewhat crooked trunks. Jan. 26, 1924.

All the species listed except some of the ferns and air-plants range at least as far north as Georgia, and a few of them to Canada.

CUSTARD-APPLE SWAMPS

The custard-apple, *Annona glabra,* or *palustris,* is said to have once formed extensive forests on the south shore of Lake Okeechobee,* but the writer has never seen them, and if there were ever any near Moore Haven they must have been cut away. The same species grows also along the edges of the Everglades and streams running out of them farther south, and in some of the clumps of small trees in the Everglades. These Everglade clumps might be regarded as constituting a distinct type of vegetation, but they are not so treated here. Lists of their component species can be found in the descriptions of the saw-grass marshes and marl prairies, farther on.

SAW-GRASS MARSHES

(Figs. 29, 41.)

The largest saw-grass marsh in the world is the Everglades, but there are many smaller ones, down to an acre or so in size, scattered over peninsular Florida, especially around lakes, and about the head of the St. John's River. Their vegetation is saw-grass and other reed-like plants, with floating-leaved aquatics in the more open places, where the water is deepest, and clumps of bushes and small trees in firmer soil. The soil is typically a few feet of peat, with water over it varying in depth with the seasons; but either peat or water may be absent, or nearly so.

The following list is made up chiefly from observations around Lake Okeechobee, and may not be typical for the middle of the Everglades. The woody plants perhaps should not be included in the marsh vegetation, but they are closely associated with it, either on its edges, or in clumps out in the marshes. Some of the plants listed are chiefly confined to areas that have been partly drained. Their names are put in parentheses, and the

*For illustrations of them see Harshberger, Trans. Wagner Free Inst. Sci. 7: pl. 10. 1914; Small, Jour. N. Y. Bot. Gard. 15: pl. 129, 131. 1914; 19: pl. 219. 1917; Am. Museum Jour. 18:684, 688. 1919.

reader who wishes to picture to himself the primeval condition of the Everglades should ignore them:

TREES—
- Taxodium distichum (cypress)
- Acer rubrum (red maple)

SMALL TREES—
- Salix amphibia? (willow)
- *Annona palustris?* (custard apple)
- *Magnolia glauca* (bay)
- *Persea pubescens* (red bay)
- *Myrica cerifera* (myrtle)
- *Chrysobalanus pellocarpus?* (cocoa plum)

VINES—
- Calonyction aculeatum? (moon-flower)

SHRUBS—
- (Sambucus sp.) (elder)
- *(Baccharis halimifolia)*
- Cephalanthus occidentalis (elbow-bush)
- (Ricinus communis) (castor-bean)
- Decodon verticillatus

HERBS—
- *Cladium effusum* (saw-grass)
- Typha latifolia (cat-tail)
- *Pistia spathulata* (water-lettuce)
- *Sagittaria lancifolia*
- (Eupatorium serotinum)
- Phragmites communis (reed-grass)
- *(Piaropus crassipes)* (water-hyacinth)
- (Jussiaea Peruviana)
- Pontederia cordata (wampee)
- Acnida australis (careless)
- (Eupatorium capillifolium) (dog-fennel)
- Andropogon sp. (broom-sedge)
- Peltandra Virginica
- *Scirpus validus* (bulrush)
- *Nymphaea macrophylla* (bonnets)
- (Chaetochloa magna) (fox-tail grass)
- *Blechnum serrulatum* (a fern)
- *Centella repanda*
- *Eleocharis cellulosa* (round-grass)
- Oxypolis filiformis
- Hymenocallis sp. (spider-lily)
- (Syntherisma sanguinale) (crab-grass)
- Dryopteris Thelypteris (a fern)
- (Capriola Dactylon) (Bermuda grass)
- Monniera Caroliniana

FIG. 29. Reed-like vegetation, mostly *Phragmites*, in Everglades about a mile west of head of Miami River. April 9, 1909. (From 3d Ann. Rep., p. 286. This is somewhere near where the city of Hialeah now stands.)

There are more grasses and sedges in this list than in most of the others. Except for the saw-grass, which is more abundant than all other vegetation combined in a typical undisturbed saw-grass marsh, evergreens are in the minority, which might be interpreted as meaning pretty good soil. And even the saw-grass might not take more than a year or so to renew its foliage completely, though one could hardly determine this without cutting a small patch of it and watching it for a year. Ericaceous shrubs are entirely absent, but Leguminous herbs are too, unless represented among the weeds. A few of the herbs have wind-borne seed, or spores, but more of them probably depend on water transportation.

Paper has been made from the saw-grass at Leesburg, in central Florida, but the venture does not seem to have been a commercial success. The peat, composed of the remains of all the plants listed, could be used for fuel, fertilizer filler, etc., if it were not for the cost of labor. Possibly 2% of the Everglades area, and other saw-grass marshes, has been cultivated in recent years. But in wet seasons it is difficult to get rid of the water, and in dry seasons the drained peat sometimes catches fire, and the soil then goes up in smoke.

MARL PRAIRIES

(Fig. 30.)

The south end of the Everglades has a limestone or marl substratum instead of sand, and the same is true of the numerous narrow glades that intersect the Miami pine land, and the coast prairie south of it. The vegetation of these places is similar in aspect to that of the northern part of the Everglades, and other saw-grass marshes, but differs in composition, on account of the calcareous soil, and also because the water is shallower, and absent about half the time. Besides the regular marsh vegetation there are clumps of small trees and bushes in drier spots, and some aquatics in small pools, commonly known as 'gator-holes.

There are many univalve shells in such places, chiefly *Ampullaria* and *Planorbis*, and some fresh-water sponges. In dry weather the ground and bases of the plants are covered with a soft thick calcareous deposit, which is seldom seen elsewhere.

The following list is made up from observations in some of the transverse glades between Miami and Royal Palm Hammock, and the edges of the Everglades and coast prairie close by, and the clumps and 'gator-holes are included:

SMALL TREES—

Annona palustris? (custard apple)
Chrysobalanus pellocarpus? (cocoa plum)
Salix amphibia? (willow)
Persea pubescens (red bay)
Myrica cerifera (myrtle)
Magnolia glauca (bay)
Rapanea Guyanensis

SHRUBS—

Cephalanthus occidentalis (elbow-bush)
Rhizophora Mangle (red mangrove)

HERBS—

Cladium effusum (saw-grass)
Centella repanda
Spartina Bakeri (switch-grass)
Phragmites communis (reed-grass)
Schoenus nigricans (a sedge)
Eleocharis cellulosa (round grass)
Blechnum serrulatum (a fern)
Crinum Americanum?
Aletris bracteata?
Hyptis radiata
Nymphaea macrophylla (bonnets)
Potamogeton lucens?
Polygala Baldwinii
Monniera Caroliniana
Pluchea purpurascens?
Typha latifolia (cat-tail)
Sagittaria lancifolia
Oxypolis filiformis
Aeschynomene pratensis
Dichromena colorata? (a sedge)
Lippia sp.
Rhynchospora Tracyi (a sedge)
Sisyrinchium sp. (blue-eyed grass)
Ludwigia microcarpa?
Cassytha filiformis
Peltandra Virginica
Thalia divaricata?
Pontederia cordata (wampee)
Samolus ebracteatus
Heliotropium Leavenworthii?
Flaveria sp.
Polygala coralicola?
Mesadenia lanceolata

FIG. 30. Looking north in one of the transverse glades of the Miami pine land about ½ mile west of Larkin (now South Miami). *Spartina Bakeri* in foreground, *Pinus Caribaea* at left, hammock at right. Aug. 19, 1923.

Nearly all the small trees are evergreen, but few of the herbs would be classed as such. There are no Ericaceae, and only one leguminous plant is listed. Two grasses are included (both near the head of the list) and five sedges. (Saw-grass and round grass belong to the sedge family, in spite of their names.) Among the plants which are commoner in the marl prairies than in the typical saw-grass marshes, presumably on account of the more calcareous soil, are *Spartina Bakeri, Phragmites, Crinum, Aletris, Hyptis, Potamogeton, Polygala Baldwinii, Aeschynomene, Dichromena, Lippia, Sisyrinchium, Ludwigia, Thalia, Samolus,* and *Flaveria.*

As in several other vegetation types, most of the woody plants have fleshy fruits, and most of the herbs whose mode of dissemination is known have wind-borne seeds, but in most cases we do not know just how the seeds are transported.

Very little use is made of any of these plants, but some of the soil they occupy is cultivated, especially for early tomatoes.

MANGROVE SWAMPS

(Figs. 31-33.)

This is a very characteristic type of vegetation in South Florida, being present all along both coasts, wherever there is shallow salt or brackish water not too much subject to wave action. The finest development is probably in the Ten Thousand Islands of the west coast. It does not seem to make much difference to the mangroves whether the soil is sand, marl or muck; and there are even a few of them growing on the rocky outer shores of some of the Keys.

Much has been written about the function of mangroves as land-builders,* but the amount of land that has been added to the area of Florida by them in the last thousand years cannot amount to more than a few square miles, or a very small fraction of one per cent of the total. At the inland edge of a mangrove swamp the trees often appear to be actively putting out new aerial roots as if invading the land, but they never get up on dry land; and their advance out into the water must be extremely slow too, for they cannot grow in water that is too deep.

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*Several papers on the subject in the bibliography can be located by looking up mangrove in the index.

FIG. 31. Outer edge of mangrove swamp bordering Biscayne Bay near Lemon City (on Chas. T. Simpson's place). Trees all *Rhizophora* (red mangrove). April 3, 1909.

FIG. 32. Interior of same swamp looking out toward the bay. *Conocarpus* (buttonwood) at right. July 31, 1910.

A list of mangrove swamp plants, based on a single locality in Dade County, was published in the Third Annual Report (p. 233). The following list is more complete, and is probably the most accurate analysis of such vegetation ever published, though it could doubtless be improved upon if the Ten Thousand Islands could be explored more. Large and small trees are not separated, for few of them grow large enough for lumber.

TREES—

Rhizophora Mangle (red mangrove)
Conocarpus erecta (buttonwood)
Avicennia nitida (black mangrove)
Laguncularia racemosa (white mangrove)
Sabal Palmetto (cabbage palmetto)
Coccolobis uvifera (sea-grape)
Ficus aurea (wild fig, or rubber)

VINES—

Rhus radicans? (poison ivy)
Rhabdadenia biflora?
Dalbergia Ecastophyllum

SHRUBS—

Batis maritima
Borrichia frutescens
Opuntia austrina? (prickly pear)
Lycium Carolinianum
Acanthocereus pentagonus (a cactus)
Harrisia sp.? (a cactus)

HERBS—

Acrostichum aureum (a fern)
Tillandsia fasciculata (air-plant)
Juncus Roemerianus (a rush)
Tillandsia utriculata (air-plant)
Cladium effusum (saw-grass)
Catopsis sp.? (air-plant)
Spartina glabra? (a grass)
Tillandsia Balbisiana? (air-plant)

FIG. 33. Mangrove swamp just north of Miami Beach, in process of clearing for building sites. Trees all or nearly all *Rhizophora*. Aug. 17, 1923. This view shows the shape of the taller trees better than one of an undisturbed swamp could.

This vegetation sometimes grades into salt flats, cactus thickets, or tropical hammocks. It is one of the few types of vegetation in South Florida that has trees but little or no Spanish moss. All the trees and most of the other plants are evergreen. Most of the species are tropical, and there are no Ericaceae among them (or very close to a mangrove swamp anywhere); but one of the vines belongs to the Leguminosae, and possibly a shrub or herb of that family could be found.

About half the woody plants have fleshy fruits, but most of the herbs have seeds or spores carried by the wind.

The red mangrove has been used more or less for tan-bark, and the buttonwood is the favorite source of charcoal for the cooks of Key West. The black mangrove and perhaps some of the others yield honey. Some of the mangrove swamps contain considerable peat.*

The mangrove soil is never cultivated, but in recent years a good deal of mangrove swamp near east coast cities has been converted into building sites by pumping sand into them, killing the trees if they have not been cut away previously.

SUBMARINE VEGETATION

In warm shallow salt water around the Keys, and perhaps near the neighboring mainland, the bottom is said to be covered in places with flowering plants belonging to some of the simpler monocotyledonous families. The writer has had no opportunity to study this vegetation, but it seems from the available literature that the most characteristic plants are *Ruppia maritima, Cymodocea manatorum* (manatee grass), *Halodule Wrightii, Halophila Engelmanni,* and *Thalassia testudinum* (turtle grass), all belonging to the orders Naiadales and Hydrocharitales, which precede the grasses in the classification now most commonly used. There are also many seaweeds, including some containing so much lime that they resemble corals and no doubt contribute to the building of coral reefs.†

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*See our 3d Annual Report, p. 304.

†See papers by M. A. Howe and W. R. Taylor in the bibliography; also Science II. 35:387-842. May 31, 1912. Dr. Small has published brief notes on the same type of vegetation in Jour. N. Y. Bot. Gard. 24:211. 1923; 25:73-74. 1924.

According to Simpson,† the manatee grass and turtle grass are very important as sources of food for fish, and some species of fish root them out like pigs, eat the stems, and then the leaves float ashore in countless numbers. No doubt other marine animals feed on them too.

This completes the treatment of the native vegetation of South Florida for the present. There are probably several other types in the large areas still scientifically unexplored, and those already mentioned could be described more accurately if one could spend more time with them; but of course perfection is seldom attained in the first attempt. We will now consider the weeds, which are supposed to have come in in modern times, most of them perhaps within fifty years.

WEEDS

Natural vegetation is so abundant and diversified in South Florida that previous botanical explorers have paid little attention to the weeds.* Although only two or three percent of the area is cultivated at the present time, weeds already constitute at least 10% of the flora; and they will undoubtedly increase in numbers as time goes on, even if the cleared area does not increase. The one that is now most abundant of all, the Natal grass, was not noticed by the writer in South Florida in 1909 and 1910, and is not mentioned in Small's Flora of Miami; but some time between 1913 and 1923 it came in in vast numbers. It is therefore high time to take stock of the weed population; and the same should be done again every generation or so.

As in other parts of the world, our weeds are found mostly in fields, yards, vacant lots, waste places, and along roads and railroads (all of which are not often burned over). It is sometimes difficult to decide just what plants are weeds, for some

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†Out of doors in Florida, pp. 275-276.

*In Small's floras of Miami and the Keys (1913) weeds are often not distinguished from natives, and in most cases they are assigned to one or more natural habitats, such as hammocks and pine lands, as if they were actually invading the native vegetation, instead of being chiefly confined to roadsides and other clearings. But the Miami flora contains about 20% of weeds, and that of the Keys about 30%.

species which must certainly have been here in prehistoric times have developed a decided fondness for unnatural habitats (and perhaps undergone slight changes at the same time, so that they are no longer exactly like their aboriginal ancestors). But all those listed below are solely or mainly confined to weedy places, and some of them are well known to be recent immigrants from foreign countries.

A few, like the guava, were first brought to this country to be cultivated for food or ornament, and have escaped from cultivation to some extent. But the writer does not believe in going to the extreme that some botanists do, of counting as a wild plant any cultivated species that persists for a few years after the field in which it was cultivated is abandoned, or the house around which it was planted burns down, just to claim as many species as possible for the flora. For many such alleged escapes, like the banana, pineapple, date and watermelon, cannot perpetuate themselves very long without human assistance in planting the seeds or keeping wilder plants from choking them out.

We have as yet very few trees that can be called weeds. The cocoanut, a native probably of Polynesia, is common along our coasts, often planted for ornament or its fruit, and some of the trees may be self-sown. The "Australian pine" (*Casuarina*), commonly planted along roads around Miami, occasionally comes up spontaneously. And the chinaberry (*Melia*), a common shade tree, especially around negro houses a little farther north, and often planted by birds in old fields, fence-rows, river-bottoms, etc., has been seen growing wild once or twice in South Florida, but seems to do better in cooler climates and richer soils.

The following weed list includes no large trees, but a few small trees, shrubs and vines, and many herbs. The rarer species are omitted, as in the descriptions of natural vegetation, and for the same reasons. Their common names (if any) and usual habitats are given in a few words, but of course it is not always possible to do the matter justice in a single line.

SMALL TREES	
Trema mollis	Burned and cleared tropical hammocks
Carica Papaya (papaw)	Burned and cleared tropical hammocks
Psidium Guajava (guava)	Around settlements
Ricinus communis (castor bean)	Around settlements
VINES	
Vitis Munsoniana (muscadine)	Old fields, roadsides, etc.
Calonyction sp. (moonflower)	Partly drained swamps
Rubus trivialis? (dewberry)	Fields and roadsides, northward
SHRUBS	
Baccharis halimifolia	Partly drained swamps, etc.
Sambucus sp. (elder)	Swamps and canal banks
Solanum verbascifolium	Clearings in tropical hammocks
Tournefortia gnaphalodes	R. R. embankments on the Keys
Lantana Camara?	Roadsides, etc.
Solanum Blodgettii?	Along railroad on the Keys.
Suriana maritima	R. R. embankments on the Keys
Daubentonia punicea	Low grounds near Peace River
HERBS	
Tricholaena rosea (Natal grass)	Sandy fields and roadsides, especially in lake region and along east coast
Bidens leucantha (Spanish needles)	Roadsides, cultivated grounds, etc.
Ammocallis rosea (periwinkle)	Around settlements, especially along east coast
Piaropus crassipes (water-hyacinth)	Lakes and streams
Cenchrus sp. (sand-spur)	Roadsides, railroads, etc.
Anastrophus compressus (carpet-grass)	Damp sandy roadsides, etc.
Cyperus Surinamensis (a sedge)	Roadsides, railroads, etc.
Jussiaea Peruviana	Partly drained swamps
Ambrosia artemisiifolia (ragweed)	Roadsides, etc.
Urena lobata	Roadsides and waste places
Eupatorium capillifolium (dog-fennel)	Drained swamps and prairies
Euthamia sp.	Damp roadsides in flatwoods, etc.
Eupatorium compositifolium (dog-fennel)	Dry sandy roadsides, northwestward
Leptilon Canadense	Fields, etc., mostly eastward
Eleocharis Baldwinii (road-grass)	Roads and trails in damp flatwoods and prairies
Sporobolus Indicus (a grass)	Roadsides, etc.
Poinsettia heterophylla	Roadsides, etc., mostly eastward
Capriola Dactylon (Bermuda grass)	Roadsides, railroads, etc.
Chaetochloa magna (fox-tail grass)	Partly drained muck
Phytolacca rigida (poke-berry)	Roadsides, etc.
Syntherisma sanguinale (crab-grass)	Fields, etc.
Polypremum procumbens	Along railroads, etc.
Juncus effusus (rush)	Damp ground, northwestward
Carduus spinosissimus? (thistle)	Sandy fields, etc.
Eupatorium serotinum (bone-set)	Drained muck, etc.
Philoxerus vermicularis	Near salt water
Anastrophus paspaloides (a grass)	Low prairies
Scoparia dulcis	Roadsides, etc.
Chamaesyce pilulifera	Roadsides and railroads
Lepidium Virginicum (pepper-grass)	Fields and roadsides
(and over 100 others)	

Only a few of these would ordinarily be classed as evergreens, though in this warm climate most of them are growing all the time. *Bidens leucantha,* for example, a tender-looking plant, which strays occasionally up to the northern edge of the State, where it is cut down by every killing frost, in South Florida blooms every day in the year.

A few of our worst weeds have burrs, which are very rare in the native flora. Some have wind-borne seeds, and most of the woody plants have berries, but in the majority of cases we have not yet learned how the seeds travel from place to place.

These weeds belong to many different families, and the only families represented by more than two species in the foregoing list are the grasses and composites. If the list was extended possibly the Euphorbiaceae, Leguminosae, Cyperaceae and Malvaceae would rank next.

Of those whose origin is known probably the majority came from the tropics, but there are a few from Europe and Asia (some of which grow as far north as Canada), and quite a number which have generally hitherto been treated as native American species, even though they are known only in weedy places, which could not have existed as such in pre-historic times.*

Being weeds and outcasts, few of these plants have any useful properties, except those which are mostly cultivated and only occasionally wild, like the papaw, guava, and castor bean. The muscadine and dewberry have edible fruit, but do not seem to bear very abundantly in South Florida. Ten years ago it was thought that the Natal grass would be a fine hay crop, on account of its rapid growth on dry sandy soils, and a great deal of it was planted in central Florida for that purpose, but one hears little about it now. Some of the other grasses make hay or pasture, too.

***See discussion of native weeds in Bull. Torrey Bot. Club 35:347-360. July, 1908.**

FLORISTICS

In the foregoing pages the aspect and composition of the various vegetation types has been discussed, with little regard to the relationships of the species and their geographical distribution. Some study of these matters too will be of interest, in a region so different from most other parts of the world.

The total number of species of flowering plants represented in the area, including weeds, must be well over 1,000, perhaps 1,500. About 870 are described in Small's Flora of Miami and 630 in his Flora of the Keys, and the two areas together must have about 1,000;* but the distinctions between species in those works are drawn pretty finely, and a more conservative botanist might recognize fewer species. However, the number has been increased by additional discoveries since 1913, so that 1,000 may be a pretty close estimate.

Of ferns there are perhaps 50 species, mostly tropical. The mosses, liverworts, lichens, fungi, algae and lower orders of plants are numerous, but have been so little studied that one can hardly guess at the number of species at present.

The vegetation lists on the preceding pages include only about 400 species of ferns and flowering plants (and a few mosses, etc.). Of the flowering plants about 28 might be classed as large trees, 52 as small trees, 19 as woody vines, 83 as shrubs, and the rest as herbs. A complete list for the area treated might include twice as many woody plants and four or five times as many herbs. Just about 10% of the species listed are weeds, introduced by man, but a complete list would doubtless have relatively more weeds in it. About 25% of the angiosperms are monocotyledons, a slightly lower figure than for most other parts of the coastal plain.† The families of flowering plants most largely represented (using their names in the broadest sense) seem to be Compositae,

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*The sandy islands just east of Miami, namely, Key Biscayne, Virginia Key, etc., are included in both floras, though they belong properly to neither, but are the south end of the east coast strip.

†See Torreya, 5:207-210. Jan. 1906; 3d Ann. Rep. Fla. Geol. Surv., p. 357. Small's Flora of Miami has 30.5% of monocotyledons, and his Flora of the Keys 23.4%.

Gramineae, Leguminosae, Cyperaceae, Euphorbiaceae, and Rubiaceae, in the order named. Most of these families in other parts of the world include a considerable number of lime-loving plants, and it is an interesting coincidence that they are all well represented in the cedar glades of Middle Tennessee, which are always on limestone outcrops.* The family Cyperaceae (sedges) is less calciphile than the others mentioned, though. The species belonging to it constitute less than 6% of the Miami flora and less than 4% of the flora of the Keys, as compared with over 12% of the species of flowering plants listed in our Third Annual Report as growing on peat. (In that family the large genus *Cyperus* is much more calciphile and tropical, and much better represented in South Florida, than the still larger genus *Carex*.)

The genus most largely represented in the foregoing vegetation lists is *Quercus* (the oaks), with nine species, most of them small trees. (Only one of them has decidedly lobed leaves like most of the northern oaks.) *Tillandsia* (air-plants) is a close second. Other genera with five or more species are *Rhynchospora, Panicum* and *Polygala*. Most of the genera are represented in the vegetation lists by only one species; and the ratio of species to genera is about 1.4, which is about the same as in the central Florida list in our 13th Annual Report, but less than in the northern Florida list in the 6th Annual Report, which has 1.6 species per genus. Of course in all these lists the rarer species are excluded, but the ratios for complete lists might not be very different. Completeness was attempted in Small's floras of Miami and the Keys, and the ratio of species to genera in those is 1.67 and 1.54 respectively. This ratio of course varies with different authors, who may have different conceptions of genera and species, but still more with the area or number of species involved, being larger in the larger floras (4.26 in Small's Flora of the Southeastern United States, 1903).

Among the genera represented by three or more common species in northern Florida (and farther north) and fewer or none in southern Florida are *Eleocharis, Carex, Xyris, Juncus, Sarracenia, Crataegus, Prunus, Baptisia, Meibomia, Viola, Rhexia,*

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*See Ecology 7:51. Jan. 1926.

Ludwigia, Nyssa, Asclepias, Viburnum and *Laciniaria.* Terrestrial orchids, and the families Umbelliferae and Ericaceae, show the same tendency.

Broadly speaking, the native flora can be divided into northern, tropical, and endemic elements. Some of those here called northern range as far north as Canada, and others no farther than Georgia. They are mostly plants of sandy pine lands, swamps and marshes. A considerable number of trees and shrubs, such as *Pinus Elliottii, Hicoria aquatica, Quercus obtusa, Q. Catesbaei, Magnolia grandiflora, Itea, Liquidambar, Gleditsia, Cornus florida,* and *Nyssa biflora,* seem to reach their southern limits in the neighborhood of the Peace River, perhaps mostly because that is practically the coolest part of South Florida, or else because the soil there is more like that in the northern parts of the State. A few others extend nearly or quite as far south in the lake region or central prairies.

Such counties as Okeechobee, Glades and Charlotte have comparatively few species of trees, being too far south for most of the northern species, and too cool for most of the tropical ones.

The strictly tropical species are chiefly confined to the Miami limestone region and southward, and to very narrow strips along both coasts farther north; and nearly all of them extend farther north on the east coast than on the west, just as the isotherms do. (See the climatic map, fig. 3.) Only a few are found in the interior north of Miami, the commonest ones perhaps being *Nephrolepsis, Rapanea, Icacorea,* and *Psychotria undata.*

The endemic element, comprising species peculiar to Florida, is chiefly confined to the lake region and the Miami pine lands. They are generally rarer than the more widely distributed species, so that only a few of them appear in the foregoing vegetation lists. Many of them are confined to single counties, principally Highlands and Dade. Some of our lake region endemics range north into Polk County or farther, but several are known at present only from Highlands, which up to about 1912 had no railroads and was practically a *terra incognita* to the scientist. Dr. Small began to visit that region in 1918, and most of its endemics were discovered and described by him. One of the commonest shrubs there, however, *Prunus geniculata,* was discovered by the writer

in Lake County, in 1909, and described in 1911.* In 1924† Dr. Small described two new genera and about half a dozen supposed new species in other genera, known only from Highlands County; and there are at least as many others in that region which are confined to Florida but not to that county or region.

Several herbs which are characteristic of dry sandy pine lands in southern Georgia and northern Florida, when they get as far south as Highlands County, where the climate allows them to keep growing nearly throughout the year, become more robust, and look almost like different species. One of the most striking cases is *Lupinus diffusus,* which in northern Florida is a prostrate herb, blooming in spring, but in Polk and Highlands Counties grows about three feet tall and often does not branch within a foot of the ground, blooms in winter, and is practically an evergreen shrub. The botanists apparently have not yet made any distinction between these two extremes,§ but a few other species have been described as new for similar reasons and with apparently less justification.

On the other hand, some trees which have their southern limits in Highlands County are more stunted there than farther north, probably on account of the poorer soil. A good example is the common holly, *Ilex opaca,* which is represented in the scrub near the south end of the lake region by a stunted form, described in September, 1924, by Small as *Ilex cumulicola** and by Ashe as *Ilex arenicola.*†

In the flatwoods and dry prairies east of the lake region there are a few plants of limited range, which escaped attention until recently, on account of the comparative inaccessibility of that territory. Probably the most abundant of these is *Litrisa carnosa,* a composite related to *Carphephorus* and*Trilisa,* which was unknown to science until Dr. Small found it in the eastern

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*Torreya 11:64:67. March, 1911.

†Bull. Torrey Bot. Club 51:379-393. Sept., 1924.

§Since the above was written Dr. Small has segregated the lake region form, under the name of *Lupinus cumulicola.*

*Bull. Torrey Bot. Club 51:384. Sept., 1924.

†Jour. Elisha Mitchell Sci. Soc. 44:40. "Aug." [Sept.], 1924.

part of Highlands County in August, 1922.‡ It is common in both flatwoods and prairies, in Highlands, Okeechobee, Indian River and St. Lucie Counties, but it blooms in late summer, when very few botanists are working in Florida. Other rather local plants of the same general region are *Hymenocallis Palmeri* and *Laciniaria Garberi*. A new shrub, *Deeringothamnus pulchellus*, related to the pawpaws, has recently been described by Dr. Small from the flatwoods of Charlotte County.

In Small's Flora of Miami, which includes flowering plants only, there are about 120 species, or more than one-eighth of the total, which are not known outside of Florida, the others ranging northward to Georgia or beyond, or southward to the West Indies, or both. Of these 120 about one-fourth are known only in the Miami region, and nearly as many range southward to the Keys. Among the endemics of that region in the strictest sense there are 5 or 6 species of Euphorbiaceae (mostly of the genus *Chamaesyce*), 5 Compositae, 3 Leguminosae, 2 Verbenaceae, and 2 Polygalaceae, but no endemic genera. Of course future explorations may change all these numbers somewhat, by extensions of known ranges and discovery or description of additional species, but the distinctions between some of the alleged species are perhaps already too fine, and probably few of these supposed endemics are so distinct that a botanist familiar with their nearest relatives would see the differences immediately.* (Some of the recently discovered endemics in the lake region and east of there are much more distinct, and two or three of them have been made the types of new genera.)

Classified by habitat, more than half the endemics of the Miami region, whether we consider those confined to that region or those more widely distributed in Florida, are assigned by Small to the pine lands, about one-fourth to "Everglades" (meaning mostly the marly glades intersecting the pine lands, rather than

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‡The writer found it near Fort Pierce in August, 1923, and immediately recognized it as something undescribed, and soon sent specimens to Dr. Small, but they were not mentioned in his description, published over a year later.

*This may indicate that the country south of Lake Okeechobee is not old enough geologically to have developed any endemic genera or very distinct species yet.

the Everglades proper), and somewhat less than one-fourth to hammocks.

On the Keys the number of endemics is smaller. Only about 42 species, or 6% of all the flowering plants listed from there by Small, are supposed to be confined to Florida; though a few more (mostly cacti) have been described by him since. Fifteen of those are known only from the Keys, 12 others range northward to the vicinity of Miami, and 15 others farther north. Ten of the true endemics are known only from the lower Keys, two from the upper Keys, and three from both. The families most largely represented are Euphorbiaceae (mostly *Chamaesyce*), Cactaceae, Compositae and Cyperaceae.

Of the species listed by Small as growing on the Keys and in the tropics, but not in the Miami region, there are 137, of which 20 are known on the upper Keys, 79 on the lower, and 38 on both. But many of them are introduced weeds. (There are also several species, mostly weeds, which grow on the Keys and farther north or west, but are not yet known in the Miami region.) As weeds are not very well separated from natives by Small, these numbers do not mean much, but we may note in passing that the families most largely represented among the 137 tropical species are Gramineae (24), Leguminosae (15), Amarantaceae (9), Cyperaceae (8), Convolvulaceae (7), Compositae (5), Euphorbiaceae (5), and Malvaceae (5). The reason that Key West has more weeds than Miami is doubtless that it has been settled much longer, and has been a seaport from the start, while the shipping at Miami has been insignificant until within the last few years.

Without a reasonably complete list of South Florida plants it is hardly possible to estimate the proportion of northern and tropical species in the flora, or how many extend to Georgia, Virginia, Canada, etc. But it is obvious that the proportion of tropical species is much greater in the hammocks, mangrove swamps, salt flats, and sea beaches than in the pine lands and scrub, which have practically no counterpart in the tropics; so that it is not a matter of climate entirely.

The weeds seem to be mostly of West Indian origin, but quite a number are supposed to be natives of the United States, and there are a few from Europe, Asia and Africa.

FAUNA

It is much more difficult to give a satisfactory account of the fauna than of the flora of a region, even if one were thoroughly familiar with all groups of animals; because so many of the animals are small or elusive or migratory, and the larger ones have been greatly reduced in numbers by the depredations of hunters and the encroachments of civilization.

About all that can be done with this subject at present is to compile from the best accessible sources a few notes on the principal groups of animals, as was done for central Florida in our 13th Annual Report (pp. 223-233), to which the reader is referred for a fuller discussion of the difficulties.

MAMMALS

As nearly as one can judge from the latest check-list of North American mammals,* and other literature,† there are about forty species of land mammals to be expected in South Florida, besides a few varieties, "races" or subspecies. Among them are the opossum, mole, two shrews, several bats, bear, raccoon, weasel, otter, two skunks, gray fox, wolf, wildcat, panther, three squirrels, salamander‡, nine or ten native mice and rats, two rabbits and deer. Some of them, however, are very rare, and one cannot be certain from the statements about their ranges, in a work covering the whole of North America, whether they have actually been seen south of Tampa and Sebastian or not. In addition to those just mentioned, the manatee and few species of whales, porpoises and dolphins are occasionally seen in salt water along the coasts.

Quite unlike the plants, the relationships of all our land mammals are with the north instead of with the tropics, doubtless because none of them can cross the wide expanse of water between Florida and the West Indies. A few, however, are races confined to Florida, of species rather widely distributed in the eastern

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*List of North American recent mammals, by Gerrit S. Miller, Jr. U. S. National Museum Bull 128. xvi+673 pp. 1924.

†Particularly a paper by Outram Bangs on the land mammals of peninsular Florida and the coast region of Georgia, in Proc. Boston Soc. Nat. Hist. 28:157-235. 1898. A few other papers on mammals are cited in the bibliography of this report.

‡Geomys: see fig. 37 (page 158).

United States. For example, our bear, *Euarctos Floridanus* (originally described from Key Biscayne, one of the sand islands opposite Miami), ranges northward about to the northern limits of the State, and probably does not differ much from the common black bear (*E. Americanus*), which ranges from Georgia to Labrador. A fox squirrel from the Ten Thousand Islands was found by Mr. Howell a few years ago to differ a little from the ordinary southern fox squirrrel, and was named by him *Sciurus niger avicennia*. *Oryzomys palustris coloratus*, one of the rats, is known from Lake Okeechobee to Cape Sable, but there is another variety, *O. palustris natator*, in central Florida, and the typical *O. palustris* ranges nearly throughout the coastal plain east of the Mississippi River. Another rat, *Sigmodon hispidus*, which ranges through the coastal plain from North Carolina to Louisiana, has one variety (*littoralis*) known only from the vicinity of the upper St. John's River, one (*spadicipygus*) only from Cape Sable, and still another (*exsputus*) only from Big Pine Key. The rodent genus *Neofiber*, with one species, *N. Alleni*, confined to Florida and extreme southern Georgia, is represented in South Florida by the variety *nigrescens*, from the southern shores of Lake Okeechobee.

A deer from Big Pine Key has been found to differ a little from the common deer of the eastern United States (*Odocoileus Virginianus*), and in 1922 was given the subspecific name *clavium* (meaning "of the keys") by Barbour and Allen.

The trapping of fur-bearing animals, principally the raccoon and otter, is still an important industry in some of the wilder sections, such as the Big Cypress; and it is said that several hundred thousand dollars' worth of skins are marketed annually at Okeechobee, Arcadia, LaBelle, Fort Myers, and perhaps other places.

BIRDS

It is even more difficult to enumerate the birds than the mammals, on account of their extensive migrations. Many species which migrate up and down the Gulf Stream close to our shores every year never set foot in Florida unless they are driven ashore by a storm or something of the kind. Many others belong mostly

farther north or south than the limits of this work, and enter it only rarely, as when driven southward by extreme cold or northward by hurricanes. And furthermore, the splitting of species by ornithologists has been carried to such an extreme that it is difficult to decide just how many species there are.

The sources of information mentioned in the 13th Annual Report have recently been supplemented by a large quarto book on the birds of Florida by H. H. Bailey, published in December, 1925.* From that and other works it appears that between 250 and 300 species of birds may be seen in South Florida at one time or another.† Of the two great groups of birds, water birds (with long bills or legs, and usually with webbed feet) and land birds, about 40% belong to the former group, a figure a little above the average for the United States, but below that for central Florida.

The number of birds which breed or build nests in our area, however, is less than half the total, perhaps not over 125. The proportions of land and water birds seem to be nearly the same among the breeding species as among the total. The water birds may be divided roughly into those of fresh and salt water, though some species seem to be equally at home in both kinds of water; and we seem to have more breeders among the fresh-water than among the salt-water species. More specifically, most of the terns, cranes, bitterns, herons, egrets, rails, doves, owls, woodpeckers, whippoorwills and jays nest with us, and most of the gulls, ducks, geese, sandpipers, swallows, warblers and thrushes do not. (This list includes both water and land birds).

As most birds have no trouble in flying across many miles of ocean, we have quite a number of tropical species, seldom if ever seen farther north. The most striking of these is probably the flamingo, which was once found in the neighborhood of Cape Sable; but it was such a conspicuous mark for hunters that it has been greatly reduced in numbers, and none have been recorded from Florida since 1921, or nesting since 1907. Two other

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*Reviewed in the Auk 43:105-106. Jan. 1926.

†Prof. W. E. D. Scott in 1892 listed 259 species from the vicinity of the Caloosahatchee River alone. (See bibliography.)

bright-colored birds, the roseate spoonbill and the paroquet, are said to be extinct or nearly so.

There are a few supposed endemic species, such as *Thryospiza mirabilis*, a sparrow recently described from Cape Sable by Mr. Howell. The burrowing owl, *Speotyto Floridana*, which is almost confined to the prairies near the Kissimmee River, has near relatives in the West Indies and in the Great Plains.*

REPTILES

One who had no information on the subject might imagine that in the almost tropical climate of South Florida reptiles would be very abundant, if not dangerous; but the ordinary traveler sees very few species or individuals, and from the available literature it appears that the number of species is not large, and there are only a few which are not found farther north. Reptiles have the same difficulty in crossing over from the tropics that mammals do, and the number of species in our area is only a little greater than that of mammals, and their geographical relationships are about the same as in the case of mammals.

The earliest paper known to the writer which is wholly devoted to Florida reptiles is one by Loennberg (1894), cited in the bibliography. That author, a Swedish scientist, was in Florida from September, 1892, to July, 1893, mostly in Orange County. He says of many species, "common in South Florida," when he means Orange County, which is outside the limits of the present report;† but he also includes several records from Key West. Works of wider scope, such as Cope's Crocodilians, lizards and snakes of North America (U. S. National Museum Report for 1898), and Ditmars' Reptile Book (1907 and later editions), have furnished some additional records, though they are not as specific about localities in Florida (or any other state) as one might wish. Some unpublished notes on reptiles and amphibians have been contributed by Mr. Richard F. Deckert of Miami.

From these sources it appears that the reptile fauna of South

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*See our 13th Annual Report, p. 228.

†A generation and more ago the State was commonly divided into West, Middle, East and South Florida, the last being applied to almost everything south of Ocala.

Florida includes the crocodile, alligator, about 9 lizards, 30 snakes, and 14 turtles; which is about the same number that can be found in almost any other southeastern state. Reptiles not ranging much farther north are the crocodile, reef gecko (on the Keys), the lizards *Plestiodon egregius* and *Rhineura Floridana*, the water-snakes *Natrix compressicauda* and *Seminatrix pygaea*, another snake *Liodytes Alleni*, the turtle *Kinosternon Baurii*, and three or four large sea-turtles found among the Keys. (Some of the latter, however, occasionally wander several hundred miles up the Atlantic coast.) The first two and the sea-turtles are tropical species, and the others are confined to Florida, or nearly so, with relatives farther north, except in the case of *Liodytes*, which is a monotypic genus with its nearest relatives in South America. Some of the sea-turtles are shipped from Key West to the markets, and one of them, *Eretmochelys imbricata*, the hawksbill turtle, is the source of the tortoise-shell formerly used largely for combs, etc.

AMPHIBIA, OR BATRACHIANS

Not much literature on this group (frogs, toads, salamanders, etc., formerly classed with the reptiles) is available at the present writing, but they are probably fewer in number than the reptiles, and represented by the common southern species. It is thought by some that amphibians are less numerous in limestone regions than elsewhere, and there is plenty of limestone in South Florida. Mr. Deckert has found one species of salamander and about a dozen toads and frogs in Dade County.

FISHES

The finny tribe is well represented in South Florida and adjacent waters, but they have not been studied as much as they should be. Lake Okeechobee is noted for its catfish, and about a million dollars' worth of that and a few other species are shipped every year from Okeechobee City, where there are several fish warehouses on Taylor's Creek, with railroad connections. Many salt-water fish are shipped from Fort Pierce, Punta Gorda, Key West, and other coast cities. Cortez in Manatee County and Gasparilla in Charlotte County are villages inhabited almost entirely by fishermen and their families. There was formerly

a small plant for the manufacture of shark leather on Sanibel Island, but it moved a few years ago to Big Pine Key.

Tourists get much sport from fishing with hook and line, especially on the west coast. The tarpon is the favorite with them, on account of its large size, but it is seldom eaten. On January 23, 1924, while waiting for a steamer on the dock at St. James City, Lee County, the writer watched a fisherman pulling in a mackerel every few minutes, and the next day on Sanibel Island, a few miles away, the same thing was being done with sheepshead weighing several pounds apiece.

A pamphlet by W. C. Schroeder (1923) cited in the bibliography, describes the fisheries of Key West. An investigation made in 1918 (which must have been an off year, on account of the war) showed 458 persons engaged in the fisheries of Monroe County at that time. The various fishery products (including turtles, lobsters, clams, sponges, etc., as well as fish) totaled 3,752,355 pounds, for which the fishermen received $290,170 (about eight cents a pound, or $620 per man per year). Most of the fishing was done in winter, and some of the fishermen may have had other sources of income at other seasons. Most of the fish brought into Key West are shipped to Cuba,§ some northward, and some used locally.

Schroeder states that "the variety of fish sold in Key West is probably greater than in any other locality in the United States." He lists 83 species of commercial importance, the principal ones being Spanish mackerel (*Scomberomorus maculatus*), kingfish (*Scomberomorus regalis* and *S. cavalla*), groupers (*Mycteroperca Bonaci*), grunts (*Haemulon Plumieri* and others), mullet (*Mugil*, two species), porgies (*Calamus* species), yellowtail (*Ocyurus chrysurus*), mutton-fish (*Lutianus analis*), bluefish (*Pomatomus saltatrix*), jewfish (*Promicrops itaiara*), mangrove snapper (*Lutianus griseus*), pork-fish (*Anisotremus Virginicus*), and red snapper (*Lutianus Aya*).

Besides these edible species there are a great many others noted for their grotesque appearance, beauty or rarity, and in the last year or two large shipments have been made from Key West

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§See Poey (1883) in bibliography.

to aquariums in New York‡ and Philadelphia. One of the handsomest small fishes of our tropical waters rejoices in the curious name of *Abudefduf saxatilis*.*

A strange phenomenon which occurs every few years on the west coast, and interferes with the fishing for a time, is known as "poison water." It has never been explained, but it causes millions of fish to die. The U. S. Fish Commission published a bulletin about it in 1917;† and in August, 1925, a steamer plying between Tampa and Key West encountered so many dead fish in a space of about twenty miles near Boca Grande that it was delayed several hours.

INSECTS

Insects are numerous in South Florida, as in other warm humid countries, though some entomologists who have written on the subject report finding fewer species than they expected. Only a few of the important species can be mentioned here, for the writer has not had access to much of the literature.

Mosquitoes can be found nearly throughout the year, but they are very scarce at some times and places where they might be expected. They seem to be most abundant along the Indian River and on the Keys, and least so in the Everglades and pine lands. The commonest mosquito in South Florida is a small black one (probably *Aedes niger*), whose bite is less annoying than that of most other species. Although it belongs to the same genus as the yellow-fever mosquito, it is not known to carry any disease germs. The malaria mosquito (*Anopheles*) has been reported from a few places, but malaria has never been very prevalent in South Florida, and it is much more easily dealt with now than a generation ago, when the manner of infection was unknown.

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‡The director of the New York Aquarium has furnished a list of 87 species of Key West fishes which he says are kept on exhibition there most of the time.

*See Simpson's "In Lower Florida Wilds," pp. 301-316, for notes on this and associated species.

†See H. F. Taylor in bibliography. An item in the daily papers in August, 1927, stated that millions of dead fish were floating in the Gulf off the coast of Yucatan, supposedly on account of a submarine volcanic eruption.

Horse-flies (*Tabanus*) and deer-flies (*Chrysops*) are common below Miami in summer, and are rather annoying, especially to horses.* Bees, wasps and ants are common enough, but no more troublesome than they are farther north. Notes on various other insects can be found in Safford's paper on Paradise Key (1919).

ARACHNIDS AND CRUSTACEANS

Scorpions (*Centrurus* and *Mastigoproctus*) are probably commoner in South Florida than farther north, but the writer has never seen a living specimen of the latter, and not more than half a dozen of the former, and one very rarely hears of a person being stung by them. Spiders are fairly common, and a large one, sometimes mistaken for a tarantula, often comes into dwellings.

A large crawfish (*Cambarus fallax*) in the Everglades is sometimes used for food. The salt-water crawfish or spiny lobster (*Paliurus argus*), which occasionally attains a weight of eight pounds, is an article of commerce on the Keys, over $30,000 worth having been marketed in Key West in 1918. Another important marine crustacean in the same neighborhood is the stone crab, *Menippe mercenaria*. It sometimes weighs a pound, but usually only its claws are eaten. The Key West fishermen in 1918 brought in about 18,000 pounds of them, valued at $2,750.

A quite different crab, which is somewhat of a pest, is the land crab, *Cardisoma Guanhumi*. It is a West Indian species, and is represented by a related species on the Pacific coast. It is common along the east coast between Palm Beach and Miami, if not farther, and often wanders a mile or so inland, and climbs up into trees and houses. It sometimes does considerable damage to cultivated plants, apparently from pure wantonness (for it does not seem to eat them); and the Miami papers occasionally carry advertisements of substances to poison it with, illustrated by pictures of the animal. A few other crabs occur along the coast.

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*See T. E. Snyder, Proc. Entom. Soc. Wash. 18:208. 1916.

MOLLUSKS

Mollusks are probably more abundant in South Florida than in any equal area in the United States. Almost every drainage ditch in the flat sandy areas, within forty or fifty miles of the coast, cuts into beds of shells, which are mostly of species still living ,and modern shells are washed up on the coasts, especially the Gulf coast, by the million. Sanibel Island is one of the most noted localities for marine shells,* but apparently they are not as numerous now as in former years, possibly because there has been some change in ocean currents that lessened the number annually washed ashore, or merely because there are now more tourists to pick up the best ones. Shells are also abundant on the shores of Gasparilla Island (where many of them are tinged with red or orange), and in the warm marl-bottomed waters around the Keys.

In wet places with calcareous subsoil, as in the southern part of the Everglades, the coast prairie, and the narrow glades between, there are many fresh-water shells, the commonest being species of *Ampullaria* and *Planorbis*. In the tropical hammocks of both mainland and Keys there were formerly many tree-snails (*Liguus*), but many have been destroyed by the clearing or burning of some of the hammocks, and near cities and highways they are often taken by tourists, for they are conspicuous and handsome objects. They represent several species and an indefinite number of varieties, often differing in neighboring hammocks or keys, and they present many interesting problems for the evolutionists.†

The digging of clams (*Venus mercenaria Mortoni*) is an important industry in the neighborhood of the Ten Thousand Islands. Just off the coast, beginning within a mile of the shore, in water four to seven feet deep, there is said to be a bed of them about five miles wide and forty miles long, probably the largest

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*See page 83 of Miss Julia Rogers' "Shell Book" (New York, 1908 and later editions), and page 7 of Simpson's "Out of Doors in Florida."

†See Pilsbry (1912) in bibliography, also pages 328-350 of Simpson's "Out of Doors in Florida."

bed of hard clams in the waters of the United States, and almost the only one in the South. Including the shell, the weight of these clams averages nearly a pound, but sometimes exceeds two pounds. They were formerly dug by hand and taken mostly to Key West, but now machinery is used, and they are taken to two canneries at opposite ends of Marco Island in Collier County.*

The large conch, *Strombus gigas*, found along the Keys is used to some extent for food, and its shells for ornamental purposes. The shell with living animal weighs from one to five pounds, and in 1918 about 2,000 pounds or $100 worth of them were sold in Key West.

SPONGES

Sponges were formerly a very important article of commerce at Key West, but the beds in that neighborhood have become depleted, and the center of the industry has been transferred to the coast of the Gulf hammock region, in central Florida. From 1849 to 1891 Key West had almost a monopoly of the sponge business of the United States. In 1888 there were 238,038 pounds of sponges marketed there, representing 94% of the United States total. By 1918 the Key West sponge business was less than half that of 1888, and less than one-fourth of the United States total, the other principal market being Tarpon Springs, at the south end of the Gulf hammock region. This decline of the sponge business may be partly responsible for the recent decrease of population in Key West.

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*One of these factories (at least in March, 1924) gave the address of its New York office on the labels of its cans, with no indication that the product came from Florida; perhaps because it was imagined that persons accustomed to buying New England clams might be prejudiced against those from so far south.

REGIONAL CLASSIFICATION

In the foregoing discussions of the geology, soil, vegetation, etc., certain natural regions, such as the lake region and the Miami limestone region, have been mentioned incidentally, but without defining them. The map (fig. 2) shows the writer's present interpretation of all the natural regions of South Florida, and brief descriptions of them will be given in the following pages. As vegetation is pretty closely correlated with soil, topography, etc., and there is still an abundance of natural vegetation in this area, that has been depended on very largely for differentiating the regions where topographic contrasts are lacking. Most of the counties are still too large and diversified to be used satisfactorily for statistical purposes, but at some future time, when the population is denser and counties more numerous, it will be very interesting to fit statistics of population, agriculture, etc., to the boundaries shown on this map, and see what contrasts can be found.

In the regional descriptions the principal emphasis will be placed on vegetation, for that is the most conspicuous feature of most of them at present. The plant lists will be made up in the same way as those for the vegetation types, with the most abundant species listed first, but these lists will be less complete than those already given, the herbs being omitted in most cases.

WEST COAST ISLANDS

(Figs. 14, 18, 20, 34, 35.)

This includes the islands and barrier beaches along the west coast from the mouth of Tampa Bay to Cape Romano, except Pine Island and one or two others, which do not differ in any important particular from the neighboring mainland. The writer has visited only Anna Maria Key, Gasparilla, Sanibel and Marco Islands, but those are probably typical enough of the whole group. They are mostly barrier beaches of sand and shells, rising only a few feet above sea-level, except that the highest point on Marco Island has an elevation of 60 feet or more. Their total area is probably not over 100 square miles.

Besides the universal sand and shell fragments, there are a few deposits of muck in mangrove swamps, etc. The water

from artesian wells is rather hard and sulphurous, and in some places a little salty; and in most of the settlements rain-water cisterns are used.

The vegetation comprises that of beaches and dunes, cactus

FIG. 34. Looking west over village of Caxambas from old hotel on top of highest dune on Marco Island, Collier County. A few cocoanut trees (planted) in middle distance. March 12, 1924.

FIG. 35. Vegetation on shelly inner shore of Sanibel Island, about a mile from its eastern end. Most conspicuous plants are *Scaevola*, *Suriana*, *Coccolobis*, and *Sesuvium*. Jan. 24, 1924.

thickets, salt flats, palm savannas, mangrove swamps, and a little tropical hammock. There are some slash-pine flatwoods on Marco Island and more on Pine Island, but those are not essentially different from those on the mainland. The commonest woody plants of the region, excluding the flatwoods, are about as follows:

TREES—
- *Sabal Palmetto* (cabbage palmetto)

SMALL TREES—
- *Rhizophora Mangle* (red mangrove)
- *Avicennia nitida* (black mangrove)
- *Coccolobis uvifera* (sea-grape)
- *Conocarpus erecta* (buttonwood)
- *Laguncularia racemosa* (white mangrove)
- Bursera Simaruba (gumbo-limbo)
- Xanthoxylum Fagara
- Erythrina arborea
- *Ficus aurea* (wild fig)
- Bumelia angustifolia?
- Ichthyomethia piscipula (Jamaica dogwood)
- *Sideroxylon foetidissimum* (mastic)
- *Quercus geminata* (live oak)
- Pithecolobium sp.
- *Persea littoralis* (red bay)

VINES—
- Vitis Munsoniana (muscadine)
- Rhus radicans? (poison ivy)
- *Smilax auriculata*
- Guilandina Crista

SHRUBS—
- *Opuntia austrina?* (prickly pear)
- *Batis maritima*
- *Scaevola Plumieri*
- *Serenoa serrulata* (saw-palmetto)
- *Yucca aloifolia* (Spanish bayonet)
- *Ernodea littoralis*
- *Jacquinia Keyensis*
- *Acanthocereus pentagonus* (a cactus)
- Erythrina arborea
- *Myrica cerifera* (myrtle)
- Sophora tomentosa
- *Suriana maritima*
- *Borrichia frutescens*
- *Chamaesyce buxifolia*
- *Lycium Carolinianum*
- *Lantana involucrata*
- Forestiera porulosa
- *Cholisma fruticosa* (poor-grub)
- *Chiococca racemosa?*
- *Chrysobalanus Icaco* (cocoa plum)
- Maytenus phyllanthoides
- *Palafoxia Feayi*
- *Baccharis halimifolia*

Not much use is made of the native vegetation. Fisheries are probably more important than agriculture, but there is a little truck-farming on some of the islands, such as Sanibel. The tourist business is important in winter, and several of the islands have been connected with the mainland by bridges since automobiles became common. Sanibel Island and to a lesser extent Gasparilla are noted for the variety of marine shells on their shores.

MANATEE HAMMOCK REGION

(Fig. 36.)

Around the mouth of the Manatee River there is an area of perhaps 50 square miles, with rather indefinite boundaries, characterized by rather rich marly soil and hammock vegetation, which deserves to be treated as a distinct region. It contains com-

mercial deposits of fuller's earth, and limestones that have been used for building purposes. The ground-water is hard, as in many other fertile regions, and rain-water cisterns are commonly used outside of the cities.

Much of the area, perhaps half, is now under cultivation. The natural vegetation that still remains is mostly of the non-tropical low hammock type, and a plant list for the whole region would be essentially the same as that already given for that type, with a few weeds added.

On account of its fertile soil, and ready accessibility by boat, this region has been settled since the middle of the last century, and the population is now pretty dense. The cities and towns of Bradenton (formerly spelled Braidentown), Manatee, Palmetto and Ellenton are all in this region, and have considerable tourist business in winter. Farming is very intensive, the value of crops in Manatee County in 1919 having been about $245 per improved acre, as compared with $35 for the whole State and $29.35 for the whole United States. Among the leading crops are grape-fruit, celery, tomatoes, egg-plants and peppers (the last three all belonging to the nightshade family).

FIG. 36. Old clearing in the big hammock south of Manatee. Trees mostly oaks and red maple. Jan. 21, 1924.

FLATWOODS, WESTERN DIVISION

(Figs. 11, 26, 37, 38.)

This covers approximately the northwestern quarter of the area under consideration, perhaps 4,000 square miles. Its surface, except in the vicinity of the larger streams, is essentially flat, rising gradually from sea-level to about 150 feet above in northern Hardee County. The surface soil is mostly fine sand mixed with more or less vegetable matter, but often, perhaps usually, there is some phosphatic material or shell marl within a few feet of the surface.

The greater part of the vegetation is of the flatwoods type, including approximately equal areas of long-leaf and slash pine flatwoods, which could be separated pretty well on the map if one could explore the area thoroughly enough to trace out their boundaries. Generally speaking, the slash pine (*Pinus Caribaea*) predominates south of the Caloosahatchee River, and also near the coast, and the long-leaf pine elsewhere.*

There are also many swamps and low hammocks along streams, cypress ponds (mostly south of Punta Gorda), shallow grassy ponds, and a few patches of scrub. The "Sugar-bowl"

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*See the agricultural map of Florida by Dr. Eugene A. Smith opposite page 187 of the 6th volume of the Tenth U. S. Census, drawn in 1880 and published in 1884. The slash pine was there called pitch or Cuban pine, because it grows in western Cuba, and was not at that time distinguished from *Pinus Cubensis*, which is confined to eastern Cuba. At the same time the Georgia slash pine, *Pinus Elliottii*, which grows mostly in wet places, was confused with the long-leaf pine by nearly everybody. (*Pinus Elliottii* occurs in our area too, mostly near the Peace River in Hardee and DeSoto Counties, and in bays in the northern part of Okeechobee County.)

Some of Dr. Smith's comments on the pines of South Florida are worth reprinting. One page 205 of his work on Florida just mentioned he says: "The pitch pine grows all along the Gulf coast, and has been designated as *Pinus Elliottii* Engelmann, in the northern portion of its area of occurrence, while southward it is named *Pinus Cubensis* Grisebach, by Professor Sargent, who considers it identical with the Cuban pine." On page 207 he continues: "South of latitude 27°, as we have seen . . . the pitch pine replaces in part or wholly the long-leaf species. Through the courtesy of Professor C. S. Sargent I am enabled to give other localities of this tree north of that parallel along the coast. [Shown on his map.] . . . In Manatee and Brevard Counties [which were then much larger than at present and met along the Kissimmee River] the flatwoods, which, alternating with prairies and savannas, make up the country, are timbered with pitch pine, and wherever the prairies, savannas and marshes prevail this tree is characteristic. The area is little cultivated, being used almost exclusively as grazing grounds for vast herds of cattle."

country, in Manatee or Sarasota County, and the Devil's Garden, Okaloacoochee Slough, and Big Cypress, in Hendry and Collier Counties, have not been visited by the writer, and are rather inaccessible, but might deserve separate treatment. The "Sugar-bowl" seems to be practically unknown botanically, but some accounts of the others can be found in Dr. Small's narratives, cited in the bibliography.

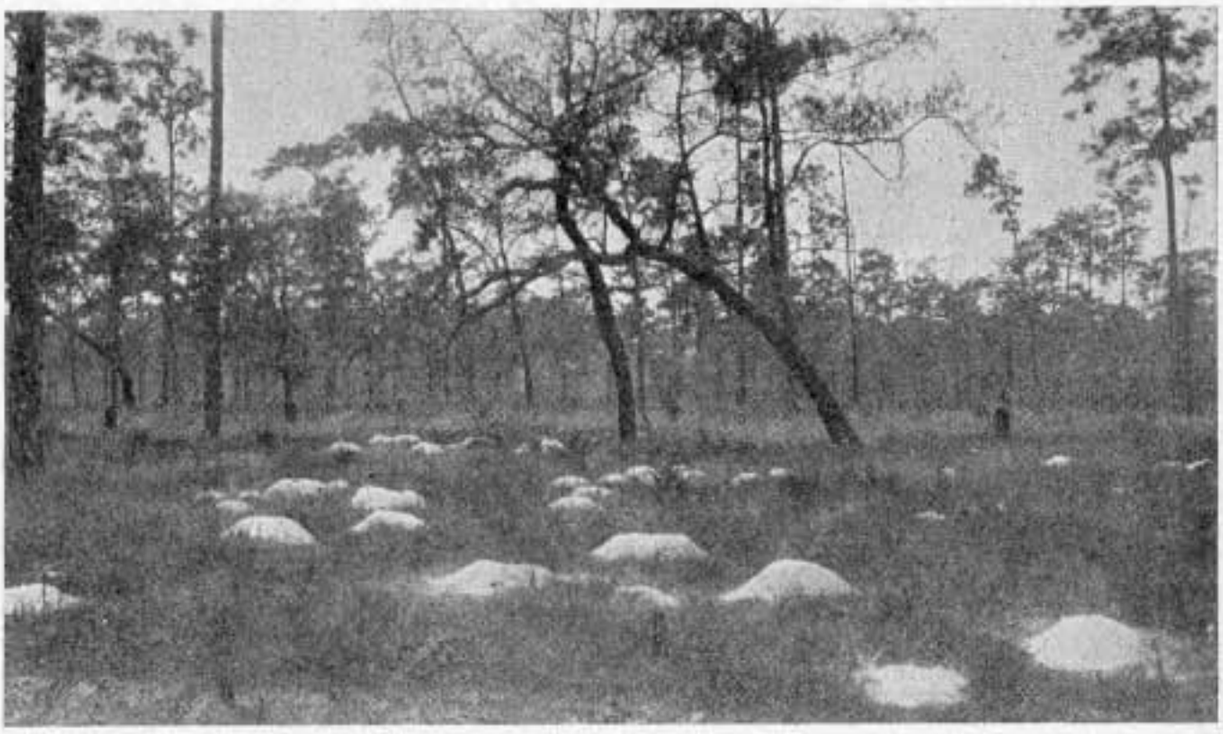

FIG. 37. Salamander (*Geomys*) hills of white sand in rather high but level forest of *Pinus palustris, Quercus Catesbaei, Serenoa, Aristida stricta,* etc., about two miles north of Wauchula (now in Hardee County). March 14, 1915.

On account of the predominance of flat pine woods the plant list for the whole region is not very different from that of the flatwoods vegetation type already given, especially as regards the herbs. The following list includes the woody plants only, and it should be borne in mind that the first two pines are more abundant than all the rest of the vegetation combined, and the saw-palmetto more abundant than all the rest of the shrubs.

TREES—

Pinus palustris (long-leaf pine)
Pinus Caribaea (slash pine)
Sabal Palmetto (cabbage palmetto)
Taxodium imbricarium (pond cypress)
Acer rubrum (red maple)
Quercus Virginiana (live oak)
Nyssa biflora (black gum)
Pinus Elliottii (slash pine)
Taxodium distichum (cypress)
Liquidambar Styraciflua (sweet gum)
Pinus clausa (spruce pine)
Gordonia Lasianthus (red bay)
Quercus obtusa? (water oak)
Ulmus Floridana (elm)
Hicoria aquatica (hickory)

SMALL TREES—

Magnolia glauca (bay)
Quercus Catesbaei (black-jack oak)
Quercus geminata (live oak)
Salix amphibia? (willow)
Quercus cinerea (turkey oak)
Fraxinus Caroliniana (pop-ash)
Quercus myrtifolia (an oak)
Quercus Chapmani (an oak)
Ilex Cassine

VINES—

Smilax laurifolia (bamboo vine)
Vitis Munsoniana? (muscadine)
Rhus radicans (poison ivy)
Parthenocissus quinquefolia (Virginia creeper)

SHRUBS—

Serenoa serrulata (saw-palmetto)
Ilex glabra (gallberry)
Myrica cerifera (myrtle)
Cholisma fruticosa (poor-grub)
Asimina reticulata (pawpaw)
Hypericum fasciculatum (sand myrtle)
Ceratiola ericoides (rosemary)
Myrica pumila (myrtle)
Vaccinium nitidum (huckleberry)
Quercus minima (oak runner)
Pycnothymus rigidus
Stillingia aquatica
Bejaria racemosa
Chrysobalanus oblongifolius
Rhus copallina (sumac)
Pieris nitida (hurrah bush)
Viburnum nudum (possum haw)
Ascyrum tetrapetalum?
Viburnum obovatum
Cephalanthus occidentalis (elbow-bush)
Baccharis halimifolia
Phoradendron flavescens (mistletoe)
Hypericum aspalathoides (sand-myrtle)

The first two pines are being cut for lumber as fast as possible, but there is a vast amount of pine still standing away from the railroads, though not of as good quality as most of that formerly obtained in the northern parts of the State. The long-leaf pine is bled for turpentine almost throughout its range, but the slash pine has apparently not yet (or at least up to two years ago) been turpentined south of the Caloosahatchee River. Not much use is made of the other plants yet, except that several of the shrubs are good sources of honey.

Probably not over 5% of the area has been cleared for farming, and the population is sparse, except near the coast and rivers, where the rapidly growing cities of Fort Myers, Sarasota, Wauchula, Arcadia and others are located.

FIG. 38. Long-leaf pine flatwoods after the turpentine and lumber men have finished their destructive exploitation, about 4 miles east of Arcadia, DeSoto County. Jan. 22, 1924. (Thousands of square miles in Florida have been devastated like this in the last decade or two.)

LAKE REGION

(Figs. 9, 39.)

In South Florida this is confined to Highlands County. It extends all the way through the county from north to south, with an average width of six or eight miles, and it is known locally as the Ridge section. Its boundaries are pretty sharp in most places, though there are a few low sandy ridges east of it separated from the main body by flatwoods.

Generally speaking, it is a rolling upland, with many lakes and very few streams. The soil is everywhere sand (except where overlaid by muck), varying in color from yellowish to white. The writer has not seen any cuts in Highlands County deep enough to reach the bottom of the sand, but there must be clay under it, as there is in the very similar country in Polk County.

The natural vegetation is mostly high pine land and scrub, with various gradations between. Some flatwoods areas belong to this region, and there are numerous bays, swamps, and wet prairies or shallow ponds, and a few areas corresponding to the

"cutthroats" of Polk County.* Along the Atlantic Coast Line R. R., which traverses the region from end to end, the long-leaf pine prevails from the northern edge of the county to DeSoto City, and then is not seen again for nearly twenty miles. In the first ten miles south of DeSoto City slash pine and spruce pine are about equally common, the former mostly in flatwoods; but between Lake Stearns and Childs and a little farther the spruce pine is the only pine in sight, and sometimes it too is absent from considerable areas.

For a few miles east of Childs the road to Okeechobee crosses some rather steep "choppy" hills of white sand covered with scrub vegetation, strongly suggesting the old dunes of the east coast, and some explorers have regarded this as evidence that the whole lake region of Highlands County is an old dune area. But there is no reason to suppose that its geological history has been essentially different from that of the same region in Polk County, where the hills are higher and underlaid with clay.

The commonest woody plants in the lake region are about as follows:

FIG. 39. Small lake about 4 miles southeast of Avon Park, with *Pinus Caribaea* in foreground, *Myrica cerifera* at left, and *Pontederia* in edge of water. Jan. 28, 1924.

*See our 13th Annual Report, p. 208.

TREES—

Pinus palustris (long-leaf pine)
Pinus clausa (spruce pine)
Pinus Caribaea (slash pine)
Nyssa biflora (black gum)
Gordonia Lasianthus (red bay)
Sabal Palmetto (cabbage palmetto)
Acer rubrum (red maple)

SMALL TREES—

Quercus Catesbaei (black-jack oak)
Quercus geminata (live oak)
Quercus myrtifolia
Hicoria Floridana (hickory)
Magnolia glauca (bay)
Quercus cinerea (turkey oak)
Quercus Chapmani (an oak)
Persea humilis (red bay)

VINES—

Smilax auriculata
Smilax laurifolia (bamboo vine)
Vitis Munsoniana (muscadine)

SHRUBS—

Serenoa serrulata (saw-palmetto)
Pieris nitida (hurrah bush)
Lupinus diffusus (lupine)
Prunus geniculata (a plum)
Sabal Etonia (a palm)
Chrysobalanus oblongifolius
Garberia fruticosa
Cholisma ferruginea
Ceratiola ericoides (rosemary)
Ceanothus microphyllus
Ximenia Americana
Vaccinium nitidum (huckleberry)
Phoradendron flavescens (mistletoe)
Palafoxia Feayi
Hypericum fasciculatum
Asimina speciosa? (pawpaw)
Myrica cerifera (myrtle)

It is hardly worth while to list the herbs, but as there are comparatively few herbs in the scrub, the herb list for the high pine land, given on an earlier page, would represent the whole region pretty well.

The long-leaf and slash pines have been used for lumber and turpentine, as usual, but that business seems to be on the decline. Something like 10% of the area, including both high pine land and scrub, but hardly any of the flatwoods areas, has been cleared and planted in grapefruit and oranges, and that sort of development is still actively in progress.

Avon Park and Sebring are winter resorts, and a few smaller ones are developing.

THE PRAIRIE REGION

(Figs. 12, 22, 28, 40.)

The dry prairies of South Florida are mostly in two parts, separated by the palm savannas between Lake Istokpoga and Lake Okeechobee, with smaller areas in Manatee and other counties, but there seem to be no important differences between the eastern and western portions. The region as a whole, in its natural features, differs little from the flatwoods except in the scarcity of pines, but there are certain economic differences which may become either more or less pronounced as the country is settled up.

The topography is almost perfectly flat except for slight depressions along streams and a few very shallow ponds and wet prairies. But there are also a few unexplained elevations. The headquarters of a cattle ranch in the prairie about seven miles northwest of Okeechobee are on a low swell a few feet higher than the surrounding country, and for a mile or two southeast of there the water runs swiftly in the roadside ditches after a heavy rain.

The soil is mostly sand, probably underlaid with hardpan in most of the area, but the vegetation in some places seems to indicate a marly subsoil.

Besides the prairie vegetation proper, which is much like that of the flatwoods with pines left out, there are a few scattered pines and cabbage palmettoes, and many oases of hammock vegetation, these usually bordering ponds or streams which afford partial protection from fire. Shallow depressions have either marsh, wet prairie or bay vegetation, depending probably on the depth and permanence of the water.

Some of the streams, like Prairie Creek in DeSoto County, have a fringe of trees along them, while others, like the Kissimmee River, are bordered by extensive treeless marshes. The reason for this difference has not been sufficiently investigated.

The following plant list includes trees and vines only, the shrubs and herbs being practically the same as already listed under the head of prairie vegetation.

TREES—
- *Sabal Palmetto* (cabbage palmetto)
- *Pinus Caribaea* (slash pine)
- *Quercus Virginiana* (live oak)
- Taxodium distichum (cypress)
- Acer rubrum (red maple)
- Nyssa biflora (black gum)
- *Quercus obtusa?* (water oak)

SMALL TREES—
- *Magnolia glauca* (bay)
- Fraxinus Caroliniana (pop-ash)
- Salix amphibia? (willow)
- *Ilex Cassine?*

VINES—
- Rhus radicans (poison ivy)
- Vitis aestivalis? (wild grape)
- Smilax rotundifolia?
- *Smilax laurifolia* (bamboo vine)
- Vitis Munsoniana (muscadine)

There are quite a number of animals in this region, besides the domestic cattle which range all over it at the rate of 15 or 20 per square mile. The burrowing owl (see references in the chapter on birds) is said to be especially characteristic, and the sandhill crane, now a rather rare bird, can be seen oftener in the prairies than elsewhere.

As there are not enough trees for a lumber industry, and not 1% of the soil is cultivated, the main industry in the prairies is cattle raising; and this has long been the principal grazing region of South Florida. There are several large cattle ranches in the region, mostly near the Kissimmee River. The grass makes up in quantity what it lacks in quality, and in this climate the cattle need little or no protection from the weather.

Before DeSoto County was divided into five counties (in 1921), it had an area of about 3750 square miles, about half of which was prairie. The U. S. Census of 1900 reported 82,183 cattle from the county, or over 10 per inhabitant, 21.9 per square mile, or one to every 29 acres. (The State census of 1905 reported 477,056 cattle from the same area, but that must have been a misprint, for it would mean 127 per square mile or one to every five acres.) By 1920 the cattle had decreased to 53,192, which was 14.2 per square mile or 2.1 per inhabitant, and over 95% of them were beef cattle, valued at about $20.75 each. The 1925 figures for the five counties, however, show an increase of cattle in spite of the increase of farms, the total at that time being 70,459; but their value averaged only $12.75 each.

During the World War the treelessness of the area was taken advantage of by the government in the establishment of two avia-

tion fields (Carlstrom and Dorr) in the edge of the prairie a few miles east of Arcadia.

There are no settlements of any consequence in the prairie region yet, except the growing city of Okeechobee at its edge, and that is supported mostly by the muck farms bordering Lake Okeechobee, the lake fisheries, and the tourist traffic passing through between the east and west coasts.

FIG. 40. Cattle grazing in dry prairies about 5 miles north of Immokalee, Collier County. March 13, 1924.

INDIAN PRAIRIE

(Fig. 19.)

West of the Kissimmee River, between Lakes Istokpoga and Okeechobee, is a region of beautiful palm savannas, covering apparently a few hundred square miles.

The surface is flat and usually damp, and unimproved roads through this region have several inches of water over them much of the time. As far as known the soil is all sand, with a little muck at the surface, and yet the abundance of cabbage palmetto would seem to indicate marl or something of the sort within reach of the tree roots.

To a traveler entering this region for the first time the abundant palmettoes and tall grass are a wonderful sight, hardly matched anywhere else in the United States, except for small areas of palm savanna near the coasts of Florida. Dr. Small* calls this the most remarkable growth of cabbage palmetto in existence.

Besides the ubiquitous palm savanna vegetation, there are many islands or oases of pine woods and hammock, and the region grades off toward both lakes into saw-grass marshes much like the Everglades.

The plant list would be much the same as that already given for inland palm savannas (page 103, first column), with the addition of a small proportion of flatwoods and low hammock. Birds of various kinds are numerous.

There is almost no permanent population in this region as yet, but some of the hammocks are inhabitated by Seminole Indians, of whom there are estimated to be about 150 in Glades County. They have a few garden patches in the hammocks, but doubtless get much if not most of their food by hunting. There is also some grazing in the area, but practically no farming in the ordinary sense.

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*Jour. N. Y. Bot. Gard. 22:57. 1921.

THE EVERGLADES

(Figs. 29, 41.)

This vast area of marsh land, about 4,000 square miles in extent, has attracted a great deal of attention ever since it was known to civilized man; but except for its size it does not differ much from hundreds of other saw-grass marshes in Florida. It includes a narrow strip around the west side of Lake Okeechobee, and an area forty or fifty miles wide extending from the lake to the mangrove swamps of the Ten Thousand Islands. Lake Okeechobee itself may be regarded as a part of the Everglades, in which the water is a little too deep for saw-grass to grow.*

The surface of the Everglades is essentially flat, i. e., it conforms to the curvature of the earth, and if it were not for the accumulation of muck the greater part of the area would be a large shallow lake. The muck or peat varies in depth from a featheredge to several feet, and it rests mostly on sand northward and

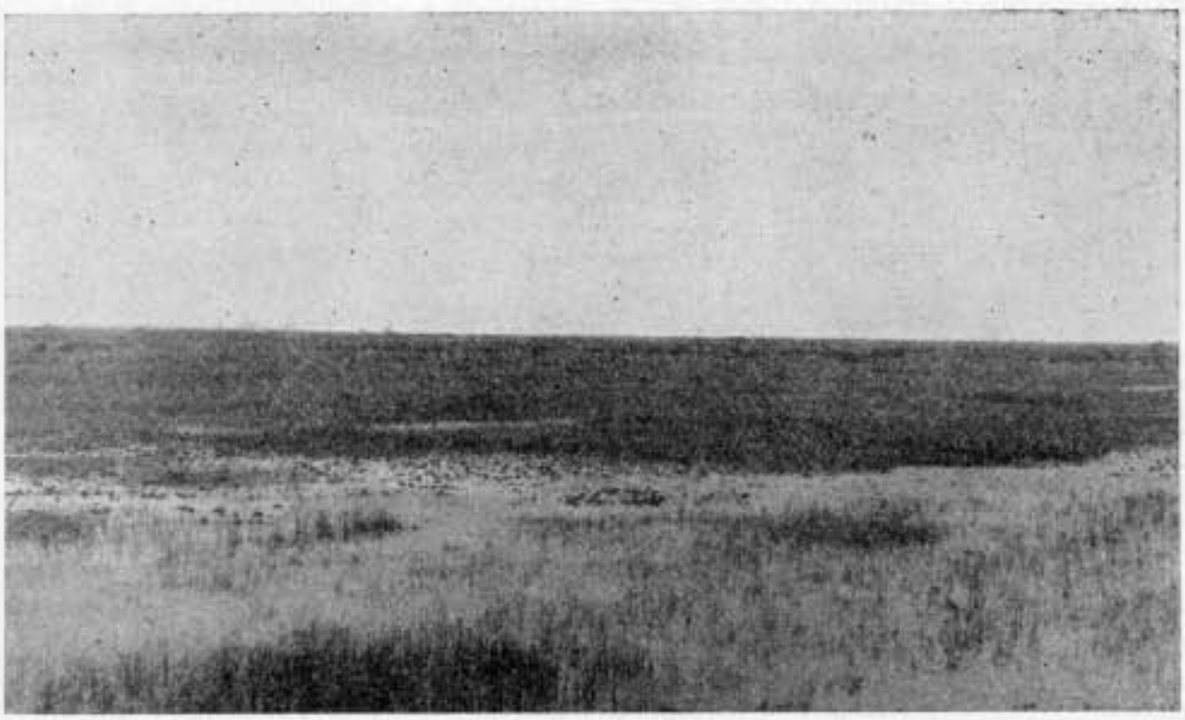

FIG. 41. Looking west in Everglades from dredge in North New River Canal about 13 miles northwest of Fort Lauderdale (now in Broward County). April 12, 1909.

*For more detailed descriptions of the Everglades see the two U. S. Senate Documents (1911 and 1914) and the soil survey of the "Fort Lauderdale area" (1915). cited in the bibliography.

on marl or limestone southward, though the two kinds of substrata may be more or less mixed.

The prevailing vegetation has already been described under the head of saw-grass marshes, and the southern part of the Everglades is largely of the marl prairie type. There are also many clumps of trees and bushes, and strips of taller timber near Lake Okeechobee and the edges of the Glades.

There are many birds, especially water birds.

The supply of peat in the Everglades is practically unlimited, and many people have wondered why it is not used for fuel or fertilizer. The answer is probably that there is not enough cheap labor in Florida to dig out the peat and market it in successful competition with coal or wood. And any material used for fertilizer generally has to be transported several hundred miles at least to reach soils deficient in that particular substance.

The cutting of several canals through the Glades in the last fifteen years or so has made small areas available for cultivation, but it is difficult to say how much, for no available statistics separate the Everglade farms from those on terra firma in the same counties. Possibly two per cent of the total area would be a reasonable estimate. A considerable variety of crops has been tried, mostly vegetables, but it is probably too early yet to say just which crop is best adapted to such soil.

FLATWOODS, EASTERN DIVISION

(Figs. 10, 25.)

The flatwoods on the east side of South Florida are separated from those on the west side by the lake region, prairies and Everglades, occupying a space forty miles wide or more, but they are very similar in most respects. The most conspicuous differences perhaps are that the eastern division is less elevated and has fewer streams, and its pine is nearly all slash pine, the long-leaf species not being known south of Okeechobee on that side of the State. The soil is mostly a grayish fine sand; but there is a clayey or marly belt of unknown extent a few miles west of Fort Pierce, and as usual many areas of muck or peat, and a few strips or patches of white sand.

This region might be divided into two parts by a line approximately parallel to the coast and about twenty miles back from it. The division is most marked perhaps at Indiantown, where there seems to be a low seaward-facing scarp, rising ten feet in a mile or two, possibly an old shore-line. The country east of there in Martin and Palm Beach Counties, called "Hungry Land" in some of Dr. Small's botanical narratives,* is low and wet, and has about as much pond cypress as slash pine, and many pretty flowers,† especially in summer; while westward of Indiantown the country is a little higher and drier, with denser forests, fewer flowers, and little or no pond cypress, but some river cypress (*Taxodium distichum*) along Lake Okeechobee and the creeks flowing into it.

Farther north, in St. Lucie County, the escarpment is hardly noticeable, but the country corresponding to that east of Indiantown has a somewhat marly soil, and a rather open growth of pond cypress. In Indian River County there are many wet prairies east of Fellsmere, and west of there some large marshes something like the Everglades, constituting the head-waters of the St. John's River.

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*See Jour. N. Y. Bot. Gard. 22:30, 206. 1921; 23:139-140. 1922. "Hungry Land" probably has no definite boundaries, and some persons acquainted with that area locate it south rather than east of Indiantown.

†In this connection see pages 98-212 of C. T. Simpson's "Out of Doors in Florida" (1924).

For the present the whole area will be treated as a unit. Its prevailing vegetation types are about the same as those in the flatwoods on the west side of the State, namely, flat pine woods, swamps, bays, cypress ponds, marshes, low hammocks, and scrub. The following plant list includes woody plants only; for the herb list would be practically the same as that already given for the slash-pine flatwoods type of vegetation.

TREES—
Pinus Caribaea (slash pine)
Pinus palustris (long-leaf pine) (northward only)
Sabal Palmetto (cabbage palmetto)
Taxodium imbricarium (pond cypress)
Taxodium distichum (cypress)
Pinus clausa (spruce pine)
Acer rubrum (red maple)

SMALL TREES—
Magnolia glauca (bay)
Salix amphibia? (willow)
Quercus geminata (live oak)
Gordonia Lasianthus (red bay)
Ilex Cassine
(Psidium Guajava) (guava)

VINES—
Smilax laurifolia (bamboo vine)
Rubus trivialis? (dewberry)
Vitis Munsoniana (muscadine)

SHRUBS—
Serenoa serrulata (saw-palmetto)
Hypericum fasciculatum (guinea cypress?)
Cholisma fruticosa (poor-grub)
Myrica cerifera (myrtle)
Ilex glabra (gallberry)
(Baccharis halimifolia)
Quercus minima (oak runner)
Pieris nitida (hurrah bush)
Stillingia aquatica
Myrica pumila (myrtle)
Ceratiola ericoides (rosemary)
Chrysobalanus oblongifolius
Pycnothymus rigidus
Bejaria racemosa
Vaccinium nitidum (huckleberry)
Hypericum aspalathoides (sand myrtle?)
Asimina reticulata (pawpaw)
Quercus myrtifolia (an oak)
Cephalanthus ocicdentalis (elbow bush)
Ascyrum tetrapetalum?
Gaylussacia dumosa
Hypericum opacum

The first tree listed probably makes up more than half the total.

If we compare this list with that for the western division of the flatwoods, to discover what differences there are in the vegetation, and why, we find that among the woody plants *Pinus palustris, Acer rubrum, Quercus Virginiana, Nyssa biflora, Pinus Elliottii, Liquidambar, Quercus obtusa, Ulmus Floridana, Hicoria aquatica, Magnolia glauca, Quercus Catesbaei, Q. cinerea, Fraxinus Caroliniana, Quercus Chapmani, Rhus radicans, Ilex glabra, Asimina reticulata, Stillingia aquatica, Rhus copallina, Viburnum nudum, Viburnum obovatum, Cephalanthus* and *Phoradendron* are commoner in the western division (which also has a greater

variety of trees), and *Pinus Caribaea, Hypericum fasciculatum, Cholisma fruticosa* and *Pieris nitida,* in the eastern.

The former group contains many more species, and most of them do not range much farther south, so that the reason for the difference may be largely climatic; the east side of the peninsula being warmer than the west side in the same latitude. Soil may have something to do with it too, for the three shrubs in the latter group are characteristic of acid soils.*

The pines are being cut for lumber, but at present there is probably more virgin pine timber in this region than in any other equal area in the eastern United States, on account of the sparse population. And there is little or no turpentining as yet south of the St. Lucie canal in Martin County. Very little of the area is cultivated, perhaps not one percent, and there is practically no grazing south of the canal, and not as much north of there as in the western division of the flatwoods.

EAST COAST STRIP

(Figs. 13, 33, 42-46.)

As in central Florida, the east coast strip consists mostly of a narrow sandy barrier beach, a lagoon (Indian River, Lake Worth, Biscayne Bay, etc.) averaging about a mile wide back of it, and a narrow strip of old dunes on the mainland, sometimes with a mile or so of flatwoods between the dunes and the lagoon. The southern extremity of the region is Key Biscayne or Cape Florida, a few miles southeast of Miami.

About half the area, from Palm Beach northward, was mapped and described in the U. S. soil survey of the "Indian River area," in 1915. The principal soil texture types found in that area were sand (55.6%), fine sand (17.4%), tidal marsh, muck, coastal beach, fine sandy loam, and a few others that made

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*A similar comparison of the flatwoods west and east of the lake region in central Florida was made in our 13th Annual Report, pp. 140-141.

less than 1% each. (These figures are for the whole area, which is partly in central Florida, and the proportions would doubtless be a little different for the South Florida portion alone, if one took time to estimate that separately.)

The vegetation types include some flatwoods differing very little from those farther inland, beach and dune vegetation, scrub, mangrove swamps, low hammocks, tropical hammocks, bays, and a few others not easily classified. The commonest woody plants are about as follows. The size classification is necessarily somewhat arbitrary, on account of the intergradation of trees and shrubs. The first three trees are far more abundant than the others.

TREES—

Pinus clausa (spruce pine)
Pinus Caribaea (slash pine)
Sabal Palmetto (cabbage palmetto)
Quercus Virginiana (live oak)
Hicoria sp. (hickory)
Persea Borbonia (red bay)
Acer rubrum (red maple)
Sideroxylon foetidissimum (mastic)

SMALL TREES—

Hicoria Floridana (hickory)
Quercus myrtifolia (an oak)
Laguncularia racemosa (white mangrove)
Magnolia glauca (bay)
Rhizophora Mangle (red mangrove)
Quercus geminata (live oak)
Salix amphibia? (willow)
Bursera Simaruba (gumbo-limbo)
Gordonia Lasianthus (red bay)
Xanthoxylum Fagara
Simaruba glauca (paradise tree)
Ficus aurea? (wild fig)
Coccolobis uvifera (sea-grape)
Chrysophyllum olivaeforme (satin leaf)
Laurocerasus myrtifolia
Coccolobis laurifolia (pigeon-plum)
Quercus Chapmani (an oak)
Exothea paniculata

VINES—

Vitis Munsoniana (muscadine)
Smilax auriculata
Dalbergia Ecastophyllum
Rhabdadenia biflora
Smilax laurifolia (bamboo vine)
Pisonia aculeata?

SHRUBS—

Serenoa serrulata (saw-palmetto)
Ceratiola ericoides (rosemary)
Cholisma fruticosa (poor grub)
Quercus myrtifolia (an oak)
Quercus geminata (live oak)
Myrica cerifera (myrtle)
Palafoxia Feayi
Erythrina arborea
Pieris nitida (hurrah bush)
Conradina puberula?
Hypericum fasciculatum
Rhus copallina (sumac)
Myrica pumila (myrtle)
Chrysobalanus oblongifolius
Psychotria undata (wild coffee)
Lantana Camara?
Acanthocereus pentagonus (a cactus)
Icacorea paniculata?
Scaevola Plumieri
Yucca aloifolia (Spanish bayonet)
Tournefortia gnaphalodes
Batis maritima
Aster Carolinianus?
(Carica Papaya) (papaw)
Bejaria racemosa
Iva imbricata?
Rapanea Guyanensis
Chrysobalanus Icaco (cocoa plum)
Suriana maritima
Baccharis halimifolia

Little use is made of the native vegetation, except the slash pine and a few ornamental plants. A good deal of the scrub has been destroyed and supplanted by pineapples and citrous fruits, and some of nearly all types to make room for houses, roads, etc., for this is now one of the greatest winter resort regions in the world. An asphalt road now runs the whole length of it on the mainland, and for a considerable distance there is an equally good road parallel to it on the barrier beach, with bridges connecting them at every town of any size. A dozen years or more ago there was considerable traffic on the inland waterway, a canal having been dredged through the mangrove swamps between the lagoons; but the improvement of highways has made that mode of transportation seem too slow in comparison, and one hears little about the canal now.

Besides the tourist business, and intensive farming, the fisheries are of considerable importance. Fort Pierce seems to be the principal shipping point for fish.

Fig. 42. Flatwoods (marly?) between old dunes and Indian River, about a mile north of Quay (now in Indian River County). Trees *Pinus Caribaea* and *Sabal Palmetto*. Aug. 23, 1923.

FIG. 43. Looking north along asphalt road through narrow tropical hammock bordering Indian River about ½ mile south of Ankona, St. Lucie County. Aug. 22. 1923. The proposed widening of this road (perhaps already accomplished) will destroy some very interesting vegetation.

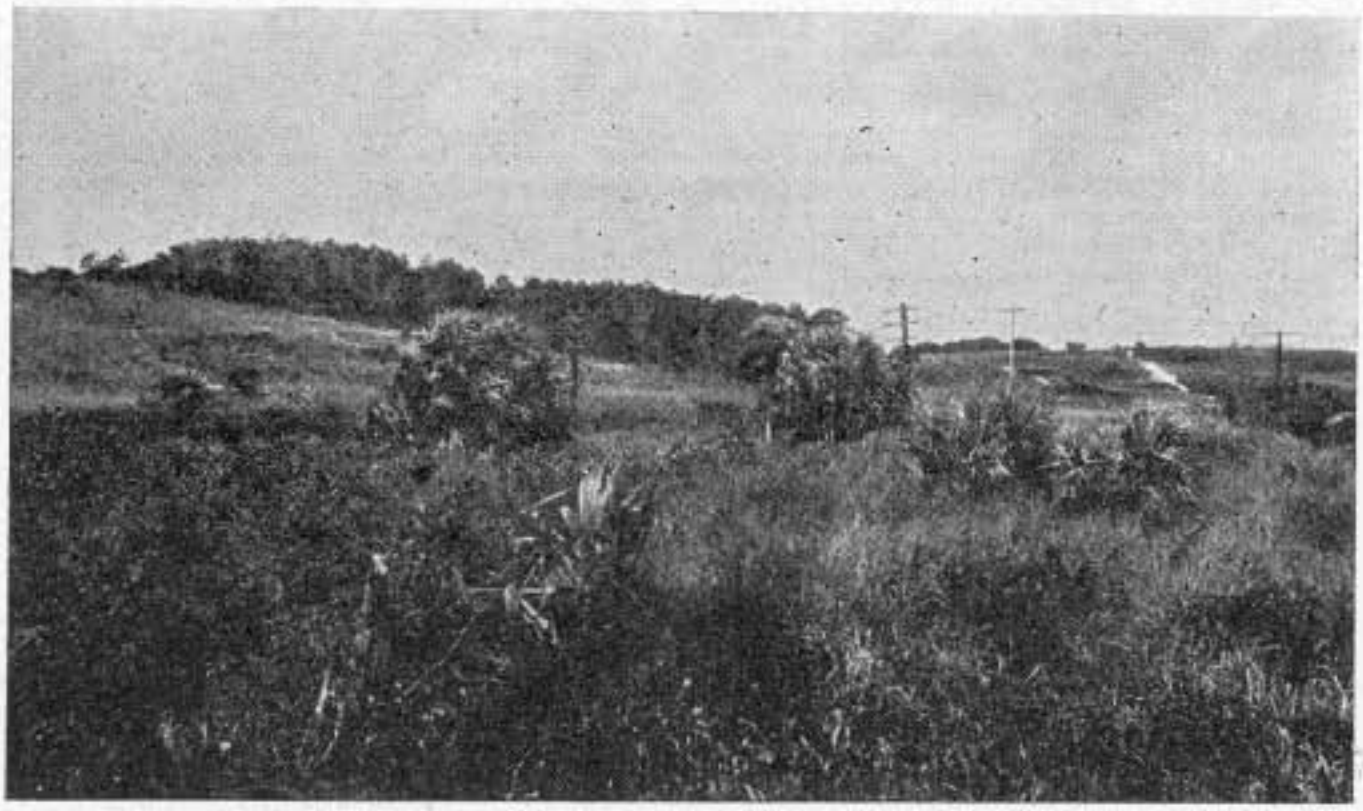

FIG. 44. High old dunes, possibly 75 feet above sea-level, near Jensen (now in Martin County). Forest of *Pinus clausa* near center. The cleared areas on the dunes were presumably once cultivated in pineapples, but are now lying fallow. Aug. 22, 1923.

FIG. 45. Old field, formerly cultivated in pineapples, and now covered with Natal grass, between Boynton and Delray, Palm Beach County, looking west from the 316 mile-post (now about 297 miles from Jacksonville) on the Florida East Coast Ry. The crest of the old dunes, with a thin fringe of pines, is seen in the background, about ½ mile away. Aug. 21, 1923.

FIG. 46. Looking south along shore at Miami Beach. *Ipomoea Pes-caprae* in foreground, *Uniola paniculata* and cocoanut trees at right. Aug. 17, 1923.

MIAMI LIMESTONE REGION

(Figs. 30, 47-49.)

This region, which is without a close counterpart anywhere else in the world, has already been pretty well described under the heads of geology, soil and vegetation. Excluding the portions where the Miami oolite is covered by sand, marl or water, it extends from about the northern edge of Dade County near Ojus to the western edge west of Homestead, and has an area of about 500 square miles. In some botanical works it has been called the Biscayne pine land, or Everglade keys.

It is essentially flat, and perhaps nowhere more than 25 feet above sea-level, with a surface of honeycombed limestone, whose cavities are mostly filled with sand north of Cocoanut Grove and with red clay in the Redlands district, around Homestead. It is dred feet wide, some of which extend all the way through from intersected by numerous transverse glades, averaging a few hun-

FIG. 47. Scene in Miami pine land on right-of-way of F. E. C. Ry., about two miles north of the center of Miami, showing some of the geological peculiarities. The sand has been removed from the foreground for railroad ballast, exposing the peculiar honeycombed surface of the oolitic limestone, with vertical pits a foot or two in diameter. March 22, 1909. (The city limits of Miami now extend far beyond this spot, and the population has multiplied about 30 times since the picture was taken, so that the locality is probably no longer recognizable.)

the Everglades to the coast prairie, while others open only into the latter. These glades are a few inches or feet lower than the pine lands, and are inundated in the wettest seasons. The rock of the region is used extensively for road material and railroad ballast, and locally for buildings.

The prevailing vegetation is that of the dry pine lands. Next in order of area are the marly glades and the tropical hammocks. The commonest woody plants are about as follows, the pine being more abundant than all the others combined. Species chiefly confined to the northern or southern portions are designated by N or S, as in the plant list for the Miami pine land.

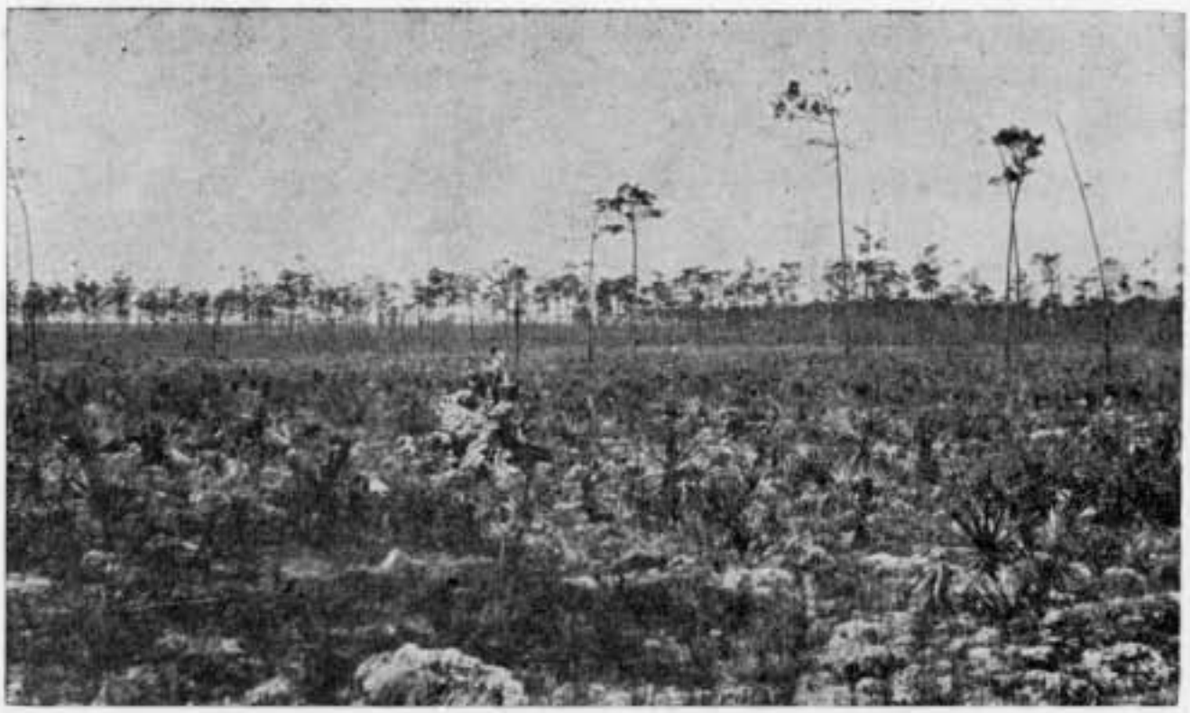

FIG. 48. View in pine land near Cutler, Dade County, after lumbering. A recent fire has removed some of the vegetation temporarily, exposng the rough surface of the limestone rock, which here has no sand over it, and has much smaller and more irregular cavities than those shown in the preceding figure. March 17, 1924.

TREES—

Pinus Caribaea (slash pine)
Quercus Virginiana (live oak)
Sabal Palmetto (cabbage palmetto)
Bursera Simaruba (gumbo-limbo)
Ocotea Catesbyana
Eugenia confusa (ironwood)
Sideroxylon foetidissimum (mastic)
Ficus aurea (wild fig, or rubber)
Taxodium distichum (cypress)
S Lysiloma Bahamensis
Coccolobis laurifolia (pigeon-plum)
Metopium toxiferum (poison-wood)
Ichthyomethia piscipula (Jamaica dogwood)

SMALL TREES—

(Trema mollis)
Simaruba glauca (paradise tree)
Salix amphibia? (willow)
S *Coccothrinax argentea* (silver palm)
Rapanea Guyanensis
Coccolobis laurifolia (pigeon-plum)
S *Tetrazygia bicolor*
Cithharexylum villosum (fiddle-wood)
Metopium toxiferum (poison-wood)
Chrysobalanus pellocarpus? (cocoa-plum)
Ilex Krugiana
Icacorea paniculata
Morus rubra (mulberry)
Dipholis salicifolia
Chytraculia sp.
(Carica Papaya) (papaw)
Annona palustris (custard-apple)
Guettarda elliptica?
Picramnia pentandra
Persea pubescens (red bay)
Laurocerasus myrtifolia
Chrysophyllum olivaeforme (satin-leaf)
Persea Borbonia (red bay)
Ilex Cassine

VINES—

Rhus radicans? (poison ivy)
Parthenocissus quinquefolia (Virginia creeper)
Vitis Munsoniana (muscadine)
Vitis Caribaea? (wild grape)
Echites sp.?
Pisonia aculeata

SHRUBS—

Serenoa serrulata (saw-palmetto)
N Quercus pumila (oak runner)
S *Guettarda scabra*
Cholisma fruticosa (poor grub)
Coccothrinax argentea (silver palm)
N *Sabal Etonia* (a palm)
Metopium toxiferum (poison-wood)
Psychotria undata (wild coffee)
Rhus copallina? (sumac)
Baccharis halimifolia
N *Chrysobalanus oblongifolius*
Croton linearis?
N *Quercus myrtifolia* (an oak)
Myrica pumila (myrtle)
Myrica cerifera (myrtle)
Quercus minima (oak runner)
N *Vaccinium nitidum* (huckleberry)
S *Lantana depressa*
S *Tetrazygia bicolor*
Byrsonima lucida
Pithecolobium Guadalupense

The pine has been used a good deal for lumber, but not for turpentine yet. Its wood is rather hard and brittle, and inferior to that of the long-leaf pine, but for some purposes it is more expedient to use it than to haul long-leaf pine lumber from points

150 to 200 miles away. Possibly 5% of the pine land has been cleared and planted in grapefruit and other subtropical fruits, and a similar amount utilized for residential purposes. As it is almost impossible to use a plow in the rocky pine land, tree crops have a decided advantage over annual crops. But the transverse glades are relatively free from rock, and vegetables, especially tomatoes, are raised in them in the dry season, as in the coast prairie adjoining.

On account of its unsurpassed winter climate, and the increasing number of people in other states who can afford to take long vacations, this region is rapidly filling up with houses, apartments and hotels.

FIG. 49. Curiously water-worn pillars of limestone about three feet tall, in eastern edge of the transverse glade near Larkin (shown in fig. 30). Photograph from Dr. S. Graenicher, April, 1924.

THE COAST PRAIRIE

(Figs. 50-53.)

Southeast and south of the Miami limestone region, extending to the shores of Biscayne Bay and the Bay of Florida, is a perfectly flat area, nearly all subject to inundation by high tides and in the rainy season, but dry enough in winter and spring. This has been confused with the Everglades by some writers, and its inland edge does not differ much from the southern edge of the Everglades; but the Everglades are never touched by salt water, and the mangrove and two species of cypress, which are common in the coast prairie, seem to be wanting in the Everglades, except at the extreme southern end, and there are various other differences. The main body of the coast prairie terminates on the northeast at Silver Bluff, but there is a narrow strip of what appears to be the same thing in Broward County, between Ojus and Fort Lauderdale, east of the railroads.

The soil is everywhere a gray marl, mostly calcium carbonate, with rock near the surface at the inland edge, and some muck over it southward. The vegetation is quite diversified, and not

FIG. 50. Stunted cypresses (*Taxodium imbricarium*) in coast prairie a few miles west of Paradise Key or Royal Palm Hammock, Dade County. March 18, 1924.

FIG. 51. Mangrove (*Rhizophora*) bushes in coast prairie several miles southwest of Paradise Key. Clump of small trees of various species (including *Paurotis*) in right background. March 18, 1924.

FIG. 52. Looking west along marly shore near East Cape Sable, Monroe County, at medium tide. The trees are all *Avicennia* (black mangrove). March 18, 1924.

easy to describe. At the inland edge it is mostly prairie with scattered clumps of trees, much like the transverse glades of the Miami pine land, and the southern edge of the Everglades. Going south or east from Florida City (formerly called Detroit) to where the influence of salt water becomes apparent, one soon comes to multitudes of red mangrove bushes, a few feet tall. These look vigorous and not at all stunted, and at first sight one might think they were young trees which would soon grow taller; but they and their ancestors have probably been there hundreds if not thousands of years, without ever growing any larger than they are now. A plant cannot live long without growing; so there must be something (perhaps fire?) that kills these mangrove bushes every few years and makes them start all over again. Nearer the coast the mangroves are larger, and where their roots are in salt water all the time they are medium-sized trees, as usual.

Going southwestward from Royal Palm Hammock toward Cape Sable there is first a great deal of stunted pond cypress (*Taxodium imbricarium*) scattered through the prairie, and dense clumps of trees with large river cypresses (*Taxodium distichum*) can be seen off to the south, probably mostly along the course taken

FIG. 53. Sticks of *Conocarpus* (buttonwood) piled up to be burned for charcoal, near Flamingo, on the mainland of Monroe County. Living trees of same species in backgorund. March 18, 1924.

by the water discharged from the Everglades in the rainy season. Elsewhere the pond cypress seems to prefer sandy soils, but here it is in a soil of nearly pure calcium carbonate. It extends southward only a few miles from the pine land, and then for a similar distance there are no woody plants in the prairie except an occasional clump of shrubs and small trees, some of them containing among other things the rare palm *Paurotis Wrightii*. Then bushes of red mangrove and buttonwood and other salt-loving species appear, partly replacing the saw-grass. Beyond the Monroe County line the mangrove and buttonwood reach tree size, and the vegetation is mostly mangrove swamp for a few miles, with mahogany hammocks in the drier spots.

About Flamingo open prairies of considerable extent appear, and there are a few cactus thickets near the shore. Near East Cape Sable the shore is fringed with black mangroves, and by moonlight the place looks much like some shores hundreds of miles farther north, there being no pines or palms in sight. (Fig. 52.) The Cape Sable country might be treated as a distinct region if it was better known.

The commonest woody plants of the coast prairie, including the hammocks and mangrove swamps, are about as follows:

TREES—

- Taxodium imbricarium (pond cypress)
- *Sabal Palmetto* (cabbage palmetto)
- Taxodium distichum (cypress)
- *Ficus aurea* (wild fig)
- *Swietenia Mahagoni* (mahogany)
- *Ichthyomethia piscipula* (Jamaica dogwood)
- *Rhizophora Mangle* (red mangrove)

SMALL TREES—

- *Conocarpus erecta* (buttonwood)
- *Avicennia nitida* (black mangrove)
- *Rhizophora Mangle* (red mangrove)
- *Persea pubescens* (red bay)
- Metopium toxiferum (poison-wood)
- *Paurotis Wrightii* (a palm)
- *Magnolia glauca* (bay)
- *Chrysobalanus Icaco* (cocoa-plum)
- *Myrica cerifera* (myrtle)
- *Laguncularia racemosa* (white mangrove)
- Salix amphibia? (willow)

VINES—

- Rhus radicans? (poison ivy)
- Parthenocissus quinquefolia (Virginia creeper)
- *Smilax laurifolia* (bamboo vine)
- *Rhabdadenia biflora?*

SHRUBS—

- *Rhizophora Mangle* (red mangrove)
- *Chrysobalanus Icaco* (cocoa-plum)
- *Borrichia frutescens*
- *Batis maritima*
- *Myrica cerifera* (myrtle)
- Gossypium hirsutum (wild cotton)
- *Serenoa serrulata* (saw-palmetto)
- *Opuntia austrina?* (prickly pear)
- *Acanthocereus pentagonus* (a cactus)
- *Yucca aloifolia* (Spanish bayonet)
- *Rapanea Guyanensis*
- *Conocarpus erecta* (buttonwood)
- Erythrina arborea
- Cephalanthus occidentalis (elbow-bush)

The list of herbs would be essentially the same as that already given under the head of marl prairies.

Some mahogany (known locally as madeira) has been cut from this region at various times, and Madeira Hammock, on the south shore, takes its name from that species. Here, as nearly everywhere within 100 miles of Key West, charcoal making is an important industry, and the buttonwood is preferred for that purpose.

Somewhere near the southwestern corner of Dade County there was once a noted bird rookery, Cuthbert Rookery, much visited by gunners in quest of egret plumes, even long after the killing of egrets was prohibited by law, for laws of course are not very effective in uninhabited regions.

There is practically no farming in the coast prairie at present except at its inland edge, where there are vast fields of vegetables, especially tomatoes, in spring. Considerable sugar-cane was once raised near Flamingo, for syrup, but too frequent inundations by salt water seem to have discouraged the growers. There is said to be a large plantation of cocoanuts near Cape Sable.

THE TEN THOUSAND ISLANDS

(Fig. 54.)

Along the Gulf coast from Naples nearly to Cape Sable is located the largest mangrove swamp in the United States. Inland it grades into the Everglades and coast prairie, and its boundaries, even the shore line, are ill-defined in many places. It is divided by tidal channels into a multitude of islands, whence its name; and the channels are so crooked and shallow and the distinction between land and water so difficult to make that it has never been accurately mapped. (But now that aeroplanes are coming into use for map-making purposes the task ought to be simpler.) Between Cape Romano and Cape Sable or Whitewater Bay the mangrove swamp is said to front directly on the Gulf, but north of Cape Romano, Marco Island and a sandy peninsula extending southward from Naples separate it from the Gulf. (Most maps of Florida represent this northern extension of the Ten Thousand Islands as dry land.)

The region is rather remote from railroads at present, but there is a pretty good road from Naples to Marco ferry, and the following plant list is made up from observations along that road in March, 1924. From all accounts the most abundant tree must be still more so in the more typical and central portions of the region.* Large and small trees are here combined:

TREES—
- *Rhizophora Mangle* (red mangrove)
- *Avicennia nitida* (black mangrove)
- *Laguncularia racemosa* (white mangrove)
- *Conocarpus erecia* (buttonwood)

SHRUBS—
- *Batis maritima*

HERBS—
- *Juncus Roemerianus* (a rush)
- *Salicornia ambigua?*
- *Acrostichum aureum* (a fern)

At one time the red mangrove was exploited to some extent for tan-bark. A variety of the fox-squirrel, known only from this region, and the clam industry of neighboring waters, have been mentioned in the chapters on fauna.

This region seems to be inhabited at present only by a few fishermen, but plans are now on foot to develop a winter resort on the coast, just about in the latitude of Miami.

FIG. 54. Salty savanna or marsh with *Avicennia* (about 20 feet tall), and *Juncus Roemerianus*, about two miles north of Marco, Collier County. March 12, 1924.

*See Sargent (1893) in bibliography.

THE UPPER KEYS

(Figs. 15, 23, 55, 56.)

The Florida Keys are divided into two groups, differing considerably in geology and vegetation.* The upper Keys extend from Soldier Key, about ten miles south of Miami, to the south end of Big Pine Key and a little beyond, a distance of about 100 miles. They average less than a mile wide, and are divided into several separate islands, with the gaps between them usually less than a mile wide. The highest elevation on them is said to be 18 feet above sea-level.

The rock is a coral reef of comparatively recent age (Key Largo limestone), and there is very little soil in the ordinary sense. There is said to be no fresh water on any of the upper Keys, and the few inhabitants therefore depend on rain-water, and water brought from the mainland in tank cars.

The vegetation is mostly tropical hammock (rather scrubby) and mangrove swamp. Air-plants are much less abundant than

FIG. 55. Rocky outer shore of Lower Matacumbe Key at low tide. Cocoanut trees at left. July 27, 1910.

*For notes on the differences between the upper and lower Keys see Curtiss, Garden & Forest 1:279-280. 1888; Sanford, Ann. Rep. Fla. Geol. Surv. 2:196-198. 1910; Small, Jour. N. Y Bot. Gard. 12:153-156. 1911; 18:104. 1917; 22:52. 1921.

in the hammocks of the Miami region, probably largely on account of the greater exposure to wind and salt spray. And several plants which are common to the mainland and the lower Keys, such as the slash pine, saw-grass, cabbage palmetto, and myrtle (*Myrica cerifera*), are rare or absent on the upper Keys.

The following plant list is based mostly on car-window notes, and is doubtless far from complete, for many of the tropical trees and shrubs look so much alike that it is difficult to identify them from a moving train. The distinction between trees and shrubs is necessarily somewhat arbitrary, and some species appear under more than one head.

TREES—

Bursera Simaruba (gumbo-limbo)
Ichthyomethia piscipula
(Jamaica dogwood)
Metopium toxiferum (poison-wood)
Thrinax (2 species) (thatch-palm)
Lysiloma Bahamensis
Ficus aurea? (wild fig)
(Cocos nucifera) (cocoanut)
Sideroxylon foetidissimum (mastic)
Swietenia Mahagoni (mahogany)
Eugenia confusa (ironwood)

SMALL TREES—

Rhizophora Mangle (red mangrove)
Avicennia nitida (black mangrove)
Conocarpus erecta (buttonwood)
Metopium toxiferum (poison-wood)
Coccolobis uvifera (sea-grape)
(Carica Papaya) (papaw)
(Trema mollis)
Coccolobis laurifolia (pigeon plum)
Simaruba glauca (paradise tree)
Laguncularia racemosa
(white mangrove)

VINES—

(Vitis Munsoniana) (muscadine)
Guilandina Crista
Parthenocissus quinquefolia
(Virginia creeper)

SHRUBS—

Batis maritima
(Solanum verbascifolium)
(Tournefortia gnaphalodes)
(Solanum sp.)
Borrichia frutescens
Opuntia Dillenii? (prickly pear)
Acanthocereus pentagonus (a cactus)
Gossypium hirsutum (wild cotton)
Chamaesyce buxifolia?
Pithecolobium Guadalupense?
Iva imbricata
Borrichia arborescens
Mimusops emarginata
Genipa clusiifolia
(seven-year apple)
Panicum divaricatum (a grass)

HERBS—

Uniola paniculata (sea-oats)
(Bidens leucantha)
(Spanish needles)
(Tricholaena rosea) (Natal grass)
Flaveria linearis
Sporobolus Virginicus? (a grass)
Sesuvium Portulacastrum
Dondia linearis
Spartina junciformis? (a grass)
Monanthochloe littoralis (a grass)
Ipomoea Pes-Caprae
(morning-glory)
Philoxerus vermicularis
Chloris sp.? (a grass)
(Cenchrus sp.) (sand-spur)
Agave decipiens
Salicornia ambigua

Besides these should be mentioned the rare palm, *Pseudophoenix Sargentii,* known from Elliott's Key, Long Key, and some of the West Indies, but now nearly exterminated in Florida, just because of its rarity. Practically all the plants listed grow also in the tropics, and there are no very distinct endemic species on the upper Keys. Among the herbs the grasses are pretty well represented, but some of them are mere weeds, which may not have been there 100 years ago.

Some mahogany has been cut from the upper Keys, but it has never been the basis of an important industry, because there is not enough of it, and the cost of getting it to market is too great. And since the building of the railroad the forests on Key Largo have been burned so much that they are practically worthless at present.

The principal agricultural enterprise is the growing of limes, which are seldom seen elsewhere in Florida, and that business expanded considerably between the writer's two visits to the Keys, in 1910 and 1924. As it is practically impossible to use a plow or hoe in the rock, the lime groves are generally full of weeds,

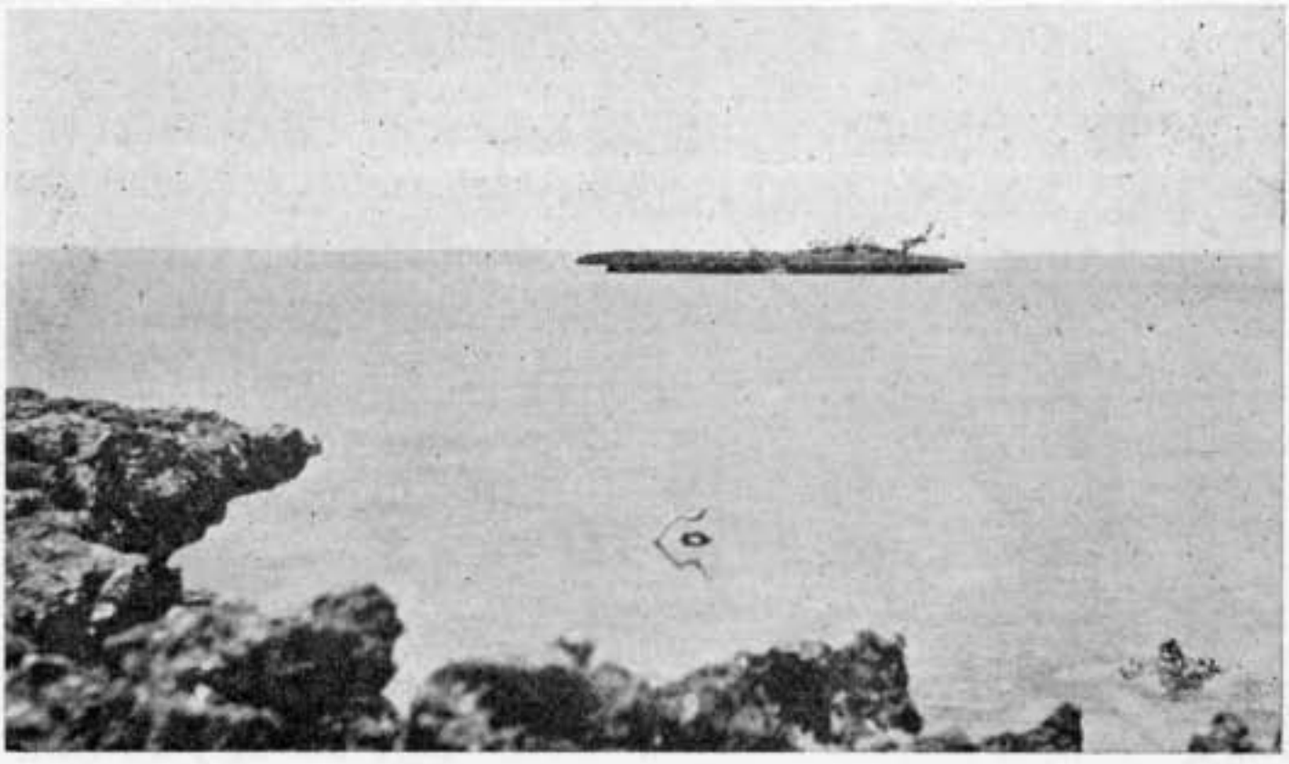

FIG. 56. Inner shore of Key Vacca at Marathon, showing small rocky island about 100 yards off shore, with edges deeply undercut all around by the solvent action of the water, combined with wave action. July 28, 1910.

which if left alone for a year or two would almost hide the little trees; and a person who had never seen a lime grove before might pass one on the train without noticing it.

On account of the scarcity of soil and water, the population is sparse; but within the past year or two much land on Key Largo has been sold at fancy prices for winter resort purposes, and there is now a newspaper there, and a highway bridge connecting with the mainland.

THE LOWER KEYS

(Figs. 17, 21, 57, 58.)

This group of islands extends from about Little Pine Key to Key West, a distance of about forty miles, and may be regarded as including also some small low islands farther west, the Marquesas Keys and Dry Tortugas. The islands are very irregular in outline, as every map shows, and only a few feet above sea-level, and it is a reasonable supposition that they are the remnants of a land-mass that once (several thousand years ago, perhaps) stood higher and was continuous, and perhaps connected with the mainland.

FIG. 57. Thicket vegetation on limestone rock on Ramrod Key. showing *Conocarpus, Coccolobis uvifera, Byrsonima, Andropogon tener* (?), etc. March 20, 1924.

The lower Keys are composed of a Pleistocene limestone which is supposed to be of the same age as the Miami oolite, but it is more solid, without the honeycomb effect so noticeable in Dade County. It has been called the Key West oolite, and on Big Pine Key it joins the coral rock of the upper Keys. On some of the lower Keys there are small sinks or pot-holes, which hold enough fresh water to afford a suitable habitat for the saw-grass and a few other plants not known on the upper Keys, but the water is hardly fit to drink. At Key West a little fresh water is obtained from shallow wells, but all deep wells so far yield water too salty to drink. Consequently the city depends mostly on rain-water, and artesian well water hauled in tank cars from Homestead, over 100 miles away.

On a few of the Keys, notably Ramrod Key, there is enough loamy soil for a few gardens, but farming as one of the assets of the region is negligible. What little soil there is seems to be quite fertile, though.

The vegetation is more diversified than that of the upper Keys. Big Pine Key has extensive forests of slash pine, and there are a few pines on some of the smaller keys nearby. There are thatch-palm savannas on Summerland Key and elsewhere, hammocks in protected places, a few cactus thickets, and many salt flats and mangrove swamps. The trees are all rather stunted, and the forests were probably never as tall and dense as on the mainland, for this is not only the driest part of Florida, but is also subject to hurricanes every few years.

The following plant list is based on notes taken from the train in March, 1924, and while walking from Cudjoe to Big Pine on the 20th of that month. Many additional species are listed in Small's Flora of the Florida Keys (1913), but without indication of relative abundance. The vegetation of some of the small islands west of Key West has been described in detail by Millspaugh (1907).

TREES (mostly small)—

Conocarpus erecta (buttonwood)
Avicennia nitida (black mangrove)
Thrinax (2 species?) (thatch-palm)
Metopium toxiferum (poison-wood)
Pinus Caribaea (slash pine)
Rhizophora Mangle (red mangrove)
Ichthyomethia piscipula (Jamaica dogwood)
Coccolobis uvifera (sea-grape)
Coccothrinax argentea (silver palm)
Pithecolobium sp.
Mimusops emarginata
Sabal Palmetto (cabbage palmetto)

VINES—

Smilax auriculata

SHRUBS—

Rhizophora Mangle (red mangrove)
Borrichia frutescens
Batis maritima
Ernodea littoralis
Serenoa serrulata (saw-palmetto)
Morinda Roioc
Byrsonima lucida
Bumelia angustifolia
Erithalis fruticosa
Borrichia arborescens
Myrica cerifera (myrtle)
Sophora tomentosa
Suriana maritima
Opuntia Dillenii?
Eugenia sp.?
Rapanea Guyanensis
Genipa clusiifolia?
Croton linearis?

The herbs other than weeds make up almost too small a proportion of the vegetation to be worth mentioning here, but there are several endemic species among them, as noted in the chapter on floristics. The buttonwood and a few other trees are used extensively for charcoal for Key West, but the other native plants are not used much. Several of the trees have very hard wood (e. g. lignum-vitae), and might be important if they occurred in sufficient quantity.

FIG. 58. Sacks of charcoal awaiting shipment on Cudjoe Key. In the center can be seen a narrow opening where boats come in through the mangrove fringe to get the charcoal. March 20, 1924.

The many varieties of fish, sponges, etc., marketed at Key West should be counted among the resources of this region. Big Pine Key has a deer* and a rat supposed to differ a little from their nearest relatives on the mainland, as noted previously under the head of mammals, and it is a reasonable assumption that these differences (and perhaps also those exhibited by the endemic species of plants) have developed since the Keys were separated from the mainland by the sinking of the ocean floor.

There are very few inhabitants on the lower Keys outside of Key West, and even that city had about 5,000 fewer inhabitants in 1925 than in 1920, in spite of the unprecedented boom in the peninsular part of the State. Key West grew pretty steadily up to 1890, and then remained about stationary until 1920, in spite of the coming of the railroad in 1912.† The sudden drop of about 20% between 1920 and 1925 has never been satisfactorily explained, but the decline of the sponge business (see chapter on sponges, page 151) probably had something to do with it.

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*See Small, Jour. N. Y. Bot. Gard., 12:155. 1911. Barbour & Allen, Jour. Mammalogy 3:73. 1922.

†See Bull. Am. Geog. Soc. 44:90-93. 1912.

ADDENDA

The following bibliographical reference was obtained too late for insertion in its proper place on page 36:

1879

Maurice Thompson. The witchery of archery.—xii+269 pp. New York, 1879.

Largely devoted to birds, and said to contain a chapter (pp. 100-126) on Lake Okeechobee and vicinity, which antedates Heilprin's account (see p. 37) by several years.

INDEX

This index is for the whole volume, though nearly all the entries in it pertain to the paper on southern Florida which makes up the greater part of the volume. The references cover mineral resources, economic products, vegetation types, authors cited, plants, animals, and a few other topics, but not names of mining companies, counties, cities. lakes, rivers, etc. Technical names of plants and animals (including families) are italicized, and a few synonyms and cross-references are included, for genera or species whose names have been changed recently.

Where there is only one species in the area treated, or in Florida, or the identity of some species is uncertain. the specific name is usually omitted to save space. (About 315 genera and 440 species of plants. and 100 genera or larger groups of living animals, are mentioned in the paper on southern Florida. About 400 species of plants are listed under the head of vegetation, and the rest in the bibliography or in the regional descriptions.)

As some species are referred to in one place by common name only and in another by technical name only, any one wishing to find everything that is said about a given species should look up both sames. (Most of the animals are mentioned by common names only.) But in many such cases the pages where a plant is mestioned under a different name are given in parentheses; and the same device is used for other indirect references.

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