CHAPTER I

PHYSICAL DESCRIPTION OF THE EVERGLADES

1. Geological Background

The Everglades of Florida occupy an irregularly marked shallow slough thirty-five to fifty miles wide and a hundred miles in length. They comprise an area of approximately four thousand square miles, all south of the twenty-seventh parallel of latitude with the exception of a small strip bordering the shores of Lake Okeechobee.[1] The soil of the Everglades is of organic origin.

Bounded on the eastern side by a coastal fringe of sand dunes and on the western side by the Ocaloacoochee Slough and the Big Cypress Swamp, the Everglades extend to the southern and southwestern coast of the state, where the salt-water marshes and the mangrove swamps form the southern border.

The Everglades constitute the third or downstream unit of the watershed of the interior of the Florida peninsula below the twenty-eighth parallel. The first or tributary section of this drainage area, the Kissimmee-Everglades water-

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1 Samuel Sanford, "The Topography and Geology of Southern Florida," Florida State Geological Survey, Second Annual Report (1909), 189; C. Wythe Cook and Stuart Mossom, "The Geology of Florida," Florida State Geological Survey, Twentieth Annual Report (1928), 43; E. H. Sellards, "Geologic Sections Across the Everglades," Florida State Geological Survey, Twelfth Annual Report (1919), 67-68; J. C. Stephens and C. C. Schrontz, "The Principal Characteristics of the Kissimmee-Everglades Watershed," The Soil Science Society of Florida, Proceedings, IV-A (1942), 14, 24.

shed, comprises some five thousand square miles.[2] The drainage elements of the first area are the Kissimmee River, which drains about two-thirds of the area, and numerous smaller streams such as Fisheating Creek and Taylor's Creek. The second or middle unit of this watershed is Lake Okeechobee, a shallow body of fresh water of seven hundred and twenty square miles whose surface elevation is regulated between fourteen and eighteen feet. The composite area of the three units approaches ten thousand square miles. Under natural conditions, prior to the advent of artificial drainage, the outflow of the waters of the first two units passed onto the third unit.[3]

> Taken as a whole the topography of the /southern/ Florida mainland has all the aspects of infancy. Drainage is defective, sloughs, shallow ponds and lakes abound. Most of the interior is a swamp, there are no well-defined river systems nor stream valleys. . . . [4]

These infantile aspects are due, insofar as the Everglades are concerned, to the gradient of one-tenth of a foot per mile over the hundred miles from the southern shore of Lake Okeechobee to the Gulf of Mexico. This vast basin, forty miles wide, has been the scene of the growth and slow decay of vegetation in an area of low elevation enjoying a warm climate and heavy rainfall. Inside the basin is a wide and

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2 J. C. Stephens and C. C. Schrontz, "The Principal Characteristics of the Kissimmee-Everglades Watershed," loc. cit., 14.

3 C. Wythe Cook and Stuart Mossom, "The Geology of Florida," loc. cit., 43-44.

4 Samuel Sanford, "The Topography and Geology of Southern Florida," loc. cit., 179.

flat plain, flanked by natural drainage ways which have imperceptibly divided the area into a saw-grass plain bordered by a series of ridges and sloughs. In general, surface water flow and vegetative accumulation are in opposition,

> . . . but the gradient would have to be greatly increased before running water would begin to cut down the gradually thickening mass of plant remains that makes up the organic soils of the Everglades. 5

The vegetative accumulation, or soil, varies from an average thickness of eight feet at Okeechobee's shores to the thinnest of deposits at the sides of the Everglades.

The line of demarcation between the glades and adjoining areas is extremely irregular: along this line extends a stretch of grass land that may be under two feet of water at the end of the rainy season, but in most years is dry enough for the cultivation of a winter vegetable crop. The actual boundary between the Everglades and the adjoining prairie is where the sedges of the glades are met by true grasses, cypress, salt marsh, or mangroves.[6]

Scientific interest in the geology of the Everglades began after the middle of the nineteenth century. The first state geologist of Florida, E. H. Sellards, brought together the geological investigations of the peninsula prior to 1908 in a section of his first report. In 1825 James Pierce

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5 Garald G. Parker, "Notes on the Geology and Ground Water of the Everglades in Southern Florida," The Soil Science Society of Florida, Proceedings, IV-A (1942), 52.

6 Samuel Sanford, "Topography and Geology of Southern Florida," loc. cit., 181.

visited south Florida and observed a great savanna which he estimated to be a hundred miles in circumference, but, "The existence of a large permanent lake located by maps in the southern part of the peninsula is doubted."[7] The publication of Buckingham Smith's documentary report on the Everglades in 1848 established the existence and general location of the area.

Smith believed the geology of the southern portion of the state to be similar to that of the sea-coasts of Georgia and South Carolina. "Oolitic lime-rock, filled with the shells and corals of species that still exist, forms the great geological feature of the country."[8] Smith found the rock to be porous and susceptible of easy excavation; exposure to air hardened the rock and made it useful for building purposes.

> The same rock forms the bottoms of the openings through the rim of the Ever Glades to an unknown depth. It composes the floor of Biscayno /sic/ Bay, and of the other bays and sounds, and of the rivers along the coasts on both sides of the peninsula, and also the basin of the Ever Glades. [9]

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7 E. H. Sellards, "Geological Investigations in Florida Previous to the Organization of the Present Geological Survey," First Annual Report of the Florida State Geological Survey (1908), 56.

8 Thomas Buckingham Smith, "Report of Buckingham Smith, Esquire, on His Reconnaissance of the Everglades, 1848," Senate Documents, The Reports of the Committees, Number 242, 30 Congress, 1 Session, 15. Hereinafter cited as "Buckingham Smith Report."

9 Ibid.

In 1851 Michael Toumey examined the limestone at the falls of the Miami River leading into the Everglades. These rocks, he found, were of the same age as those he had seen at Key West, and were identical with living shells in the surrounding waters. Toumey regarded the glades as resting on a basin of what he termed Miami limestone, clearly distinguished from the Tertiary limestone at Tampa Bay. The contour of the ridge surrounding the Everglades, together with its structure and the embedded remains, led Toumey to the conclusion that the elevation of the Florida Keys by twenty feet would produce a similar ridge shutting out the sea between the Florida reef and the mainland. Such an elevation, Toumey believed, would produce another basin similar to that of the Everglades, differing only in greater comparative length.[10]

Because of their accessibility the fossil-bearing beds of the Gulf Coast and the Calcosahatchee River aroused the interest of geologists before 1900. The geologic formation of the southern part of the peninsula, however, remained obscure for another generation on account of the difficulties of making observations.

> . . . The combination of low, flat terrain with few and very shallow river cuts, the difficulty of transportation, the lack of cuttings from deep or

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10 E. H. Sellards, "Geological Investigations in Florida Previous to the Organization of the Present Geological Survey," loc. cit., 58-59.

> shallow wells, and the mantle of muck, marl, sand, water, and vegetation that covers the underlying rocks . . . [11]

caused the investigations of early workers to be restricted to the seacoasts and river banks.

Since the beginning of drainage operations in 1882, the cutting of canals and channels in South Florida has added an abundance of geological information. Other sources of data were found in the excavations made for roads, ditches, and dikes, as well as the samplings of material through which numbers of drills have passed in the sinking of water and oil wells. Had the mass of data now handy for modern geologists been available to Louis Agassiz in 1851, or to Joseph LeConte in 1878, they would never have subscribed to a coralline theory of growth for the southern part of the state.[12]

The name "Floridian Plateau" has been applied to the great projection southeastward of the continent of North America. This projection separates the deep water of the Gulf of Mexico from the deep water of the Atlantic Ocean.[13] This Floridian Plateau has been in existence since very ancient times, and appears to have lain east of the epicontinental seas during the Palezoic era. The plateau probably

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11 Garald G. Parker, "Notes on the Geology and Ground Water of the Everglades in Southern Florida," loc. cit., 53.

12 Ibid.

13 C. W. Cook and Stuart Mossom, "The Geology of Florida," loc. cit., 39.

remained dry land during the Triassic, Jurassic, and Lower Cretaceous epochs, but was covered by the seas during the Upper Cretaceous times. In the Cenozoic era the plateau underwent many shiftings, but the water was never very deep, nor the land high above the sea level.[14] At the western edge of the Everglades, fifty miles from Miami, sedimentary rock exists to a depth of at least ten thousand feet. An examination of the cuttings of an exploratory well for oil showed that the drilling ended in Lower Cretaceous strata, ". . . comparable to the Fredericksburg group of Texas and southern Oklahoma, and suggests that this area is underlain by still older sedimentary rocks."[15]

In a resume of the structure and stratigraphy of Florida, Stuart Mossom outlined the sedimentary formations of the state. He found these formations to describe an anticline in a southeasterly direction from the Ocala limestone dome of the Eocene Age. From surface level at Ocala, the Eocene limestone dips to a depth of twelve hundred feet as the Everglades give way to the Gulf. Atop the Ocala formation are the younger groups of Oligocene and Miocene ages which become thicker as they approach the coast lines. The Pliocene and Pleistocene formations do not extend more than one hundred

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14 C. W. Cook and Stuart Mossom, "The Geology of Florida," loc. cit., 39.

15 Garald G. Parker, "Notes on the Geology and Ground Water of the Everglades in Southern Florida," loc. cit., 54.

and sixty feet under the surface.[16]

The Eocene, Oligocene, and Miocene formations extend to a depth of twelve hundred feet in the Miami area, dipping to the sea in every direction. On account of this anticline and the permeability of the rocks, they are excellent artesian aquifiers. "The waters of these formations are not only highly mineralized . . . but are corrosive, rendering them unsatisfactory for most needs."[17] The formations of the Pliocene and Pleistocene, flanking the Miocene, are exposed in many places in and around the Everglades.

Angelo Heilprin, exploring the Caloosahatchee and Lake Okeechobee in 1886 found no evidence to support a coralline theory of growth of Florida; he decided that the growth had been through accessions of organic and inorganic material in the usual methods of sedimentation and upheaval.[18] Matson and Clapp expressed the joint belief that the deposition of the Pliocene rocks began with an encroachment of the sea which extended beyond the latitude of Lake Okeechobee. Following the deposition of the Pliocene the land emerged

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16 Stuart Mossom, "A Review of the Structure and Stratigraphy of Florida," Florida State Geological Survey, Seventeenth Annual Report (1926), 171-254.

17 Garald G. Parker, "Notes on the Geology and Ground Water of the Everglades in Southern Florida," loc. cit., 71.

18 Angelo Heilprin, Explorations on the West Coast of Florida and in the Okeechobee Wilderness, 65. Hereinafter cited as Okeechobee Wilderness.

to a probable greater height than at present, and "It was during this period that the major features of the present topography were produced."[19]

Two Pliocene formations are located in the Everglades, the Caloosahatchee marl and the Tamiami limestone. The Caloosahatchee marl, exposed in the banks of the river of the same name, consists chiefly of fine sand and shells. Its color ranges from white to light gray, blue, or yellow. It appears to underlie a large part of Florida south of the twenty-seventh parallel. Deposited in a warm and shallow sea, this marl contains a large proportion of unbroken shells. Water from the marl has a high chloride content, due in part to Pleistocene sea invasions, and in part to the Miocene rocks underneath it.[20]

The Tamiami limestone, coming to the surface in the lower reaches of the Big Cypress and appearing as far north as Fort Lauderdale on the east coast, is a wedge-shaped formation, inclining toward the coast, and the main source of water for the cities of the east coast. "The calcareous sandstones and sandy limestones of this formation are among the most permeable rocks ever investigated by the Federal

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19 George C. Matson and Frederick C. Clapp, "A Preliminary Report of the Geology of Florida with Special Reference to Stratigraphy," Florida State Geological Survey, Second Annual Report (1909), 167.

20 C. W. Cooke and Stuart Mossom, "The Geology of Florida," loc. cit., 152-153.

Geological Survey."[21] These rocks were deposited in a warm shallow sea, followed by an elevation above sea level when erosion and solution took place, and a subsequent lowering under the sea brought about a deposition of the Miami oolite on the Tamiami.

The close of the Pliocene epoch witnessed a great change in the climate of the earth. This change brought about the formation of glaciers that covered a third of the northern hemisphere. "The Pleistocene epoch has been divided into four major glacial stages and a minor one . . ."[22] during which the sea level fell in producing the massive fields of ice. In the interglacial stages the seas rose again, as the ice melted, and the lower lands of the world were covered by the seas. These successive inundations were accompanied by the deposition of marine materials and were followed by the recessions of the waters which gave the land its approximate present appearance in lower Florida by building up the lands on the north, east, and west of the Okeechobee-Everglades depression. Longshore currents swept sands from the north, along both coasts, which merged with the lime deposits in

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21 Garald G. Parker, "Notes on the Geology and Ground Water of the Everglades in Southern Florida," loc. cit., 71.

22 Garald G. Parker and Nevin D. Hoy, "Additional Notes on the Geology and Ground Waters of Southern Florida," The Soil Science Society of Florida, Proceedings, V-A (1943), 37.

the south. These mergers built up the edges of the Floridian Plateau and produced the large slough in the area under study.[23]

The first of the Pleistocene formations to be laid down was the Miami oolite, present in the southern and eastern parts of the Everglades. The oolite varys in thickness from the merest deposit to thirty feet and is overlain by sand, muck, and marl, and cut through by sandy channels in many places. It is a white or light yellow limestone of very high porosity, easily quarried, and used for rough constructional purposes. Because of its outcroppings along the east coast and in the banks and rapids of the short rivers, it was the first of the south Florida rocks to be noted.[24] Modern geologists believe the oolite was formed as a shallowly submerged bar which, as has been suggested, shut off a wide shoal, now the Everglades, from deeper water of the Atlantic. It is possible that Lake Okeechobee marks a deeper part of the sea, as its present bottom is fifteen feet lower than the neighboring Everglades.[25]

That part of the Everglades soils not underlain by Miami

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23 Garald G. Parker and Nevin D. Hoy, "Additional Notes on the Geology and Ground Waters of Southern Florida," loc. cit., 41-42, 54-55.

24 C. W. Cook and Stuart Mossom, "The Geology of Florida," loc. cit., 204-205.

25 Garald G. Parker, "Notes on the Geology and Ground Water of the Everglades in Southern Florida," loc. cit., 68.

oolite and Tamiami limestone is generally underlain by the Ft. Thompson deposits, also of Pleistocene age. This formation averages ten feet in depth over the northern part of the glades and includes freshwater, marine, and brackish-water limestones and marls. Found at the surface near Ft. Thompson on the Caloosahatchee River, the formation covers the area occupied by Lake Okeechobee when that body of water extended from the present site of the town of La Belle to the present eastern border of the Everglades and south to the Tamiami Trail.[26] The alternation of marine and brackish water deposits combined with fresh water shells provides a clear record of the several inundations of the seas. Ground water in the Ft. Thompson formation is found in the shallow wells in the vicinity of Lake Okeechobee, where it is sought for domestic use. "The fact that the Ft. Thompson is relatively low in permeability makes it a valuable asset in areas of ditching and diking for water control."[27]

The Anastasia and Pamlico formations, found in the coastal ridge on the Atlantic and along the eastern borders of the Everglades, are composed of sand, sandy limestone, and calcareous sandstone. In the strip bordering the Everglades where the sands of these formations are mixed with glades

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26 C. W. Cook and Stuart Mossom, "The Geology of Florida," loc. cit., 211-212.

27 Garald G. Parker and Nevin D. Hoy, "Additional Notes on the Geology and Ground Water of Southern Florida," loc. cit., 51.

organic soils the lands are valuable for cropping and grazing. Water wells developed in these deposits are of relatively indifferent quality.[28]

The most recent geological formation in the Everglades is the Lake Flirt marl, composed of soft gray marl or calcareous mud almost universally present under the deeper muck of the upper Everglades. Flirt marl is of value because of its impermeability, which prevents the percolation of ground waters in the organic soils of the region. "Where it is present under sufficient thickness of soil that ditches do not cut through it, the water table can be controlled even in areas of permeable underlying rocks."[29] The top fifty feet of rock strata in the northern half of the Everglades is relatively impermeable and subjects this half to water control. In the lower half of the Everglades the strata become looser and highly water-bearing as the rim is approached. Canals cut through permeable strata drain adjacent lands to the limit of the canal; contrariwise, the success of water control by dikes and pumps depends on impermeability.

Lacking modern geological information, yet seeking the truth, John R. Mizell in 1902 compared the Okeechobee-Everglades formations to a large bowl with two rims. The inner

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28 Garald G. Parker and Nevin D. Hoy, "Additional Notes on the Geology and Ground Water of Southern Florida," loc. cit., 50.

29 Ibid., 49-50, 55.

basin he likened to the big lake, a small sea within itself. The outer basin he likened to the Everglades, with the rock rim on the east and swamps and sloughs on the west. Mizell believed the normal condition of the glades to be unaffected by the inner basin until the lake was taxed beyond its capacity to relieve itself through the Caloosahatchee Canal. The short streams on the Atlantic side of the Everglades were produced by the head of water from the lake overflow being unable to force its way down the Caloosahatchee, and seeking its way across the low spots in the outer rim.[30]

2. The Soil Deposits of the Everglades

The topography of the rock foundation on which the cumulative deposits have been built is, in reality, not similar to a basin, but more comparable to a broad and open trough fifty miles wide and a hundred miles long. The Everglades are a component of an immense hydrologic unit consisting of the Kissimmee River Valley as the watershed, Lake Okeechobee as the storage basin, and the Everglades as the overflow area. Seen in this light,

> The Everglades are the result of slow vegetative decay in an area having low elevation, warm climate, and heavy rainfall, and would continue

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30 Cited in, "Message of Governor W. S. Jennings to the Legislature of Florida Relating to the Reclamation of the Everglades," April 7, 1903, Senate Documents, Number 89, 62 Congress, 1 Session, 88.

> to build up on a surface having even a steeper gradient than that now existing were it not for the drainage systems man has installed. 31

The northern and eastern sections of the Everglades are nearly devoid of trees, being covered with saw grass (Mariscus jamicensis), a sedge growing in dense tussocks to heights of ten and twelve feet. Although saw grass covers most of the glades, bushes and trees of myrtle, willow, and bay often appear in sporadic clumps or little islands. On the eastern and western edges many islands or hammocks appear in close proximity to the mainland. These hammocks consist of a dense growth of broad leaved trees and shrubs and appear as true islands during periods of high water.[32]

This rank growth of herbaceous vegetation has occupied this large trough through the center of southern Florida, and from its decay and settlement has built up the ground level at the southern shore of Lake Okeechobee to fourteen feet above bed rock. This thickness of the cumulative soils at Okeechobee gradually thins out to a feather edge at the sides of the Everglades.[33] Charles T. Simpson, a naturalist

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31 Garald G. Parker, "Notes on the Geology and Ground Water of the Everglades in Southern Florida," loc. cit., 52.

32 John K. Small, From Eden to Sahara: Florida's Tragedy, 14; M. H. Gallatin and J. R. Henderson, "Progress Report on the Soil Survey of the Everglades," The Soil Science Society of Florida, Proceedings, V-A (1943), 95-104.

33 Samuel Sanford, "The Topography and Geology of Southern Florida," loc. cit., 190-191; Charles Torrey Simpson, In Lower Florida Wilds, 119.

who spent a good many years in southern Florida, believed that "The southern part of the glades was recently elevated and there has not been sufficient time as yet . . . to form any great depth of vegetable deposits. In fact the rock appears on the surface over extensive areas in the newer part. . . ."[34]

The publicity attending the progress of canal excavation and land sales in 1912 gave rise to a demand for information as to the chemical composition and productiveness of the soils of the Everglades. The examination of thirty-five samples of soils taken from Lake Okeechobee to Miami was the first scientific analysis of these soils. Previous to that time examinations of Florida muck soils had been on the basis of other localities in the state, principally in the Kissimmee-St. Cloud area. The analyses of the glades soil showed an exceedingly high nitrogen content with comparatively small quantities of potash and phosphates.[35] In 1913 State Chemist Rufus E. Rose reported that the soil would grow large crops of foilage plants without fertilization, but would need the addition of potash and phosphate for a satisfactory yield of

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34 C. T. Simpson, In Lower Florida Wilds, 119-120.

35 R. E. Rose, "Analyses of Everglades Soils," Florida Department of Agriculture, Florida Quarterly Bulletin, XXXIII (January, 1913), 11.

grain or sugar.

A survey of the Everglades soils from the site of the rock rim at the head of the north branch of the New River at Ft. Lauderdale to the south shore of Lake Okeechobee was made in the winter of 1915, under the auspices of the United States Department of Agriculture. This soil survey covered a strip two and a half miles wide on each side of the North New River Canal. The surveyors reported that "From the rock rim to the shores of Lake Okeechobee the soils mapped in this survey are composed largely of organic matter in various stages of disintegration and decay."[36] Grouping the soils according to the percentage of mineral constituents and the stage of decomposition of the vegetable tissue, the survey located three classes of Everglades soils.

Near Lake Okeechobee, bordering the shore for a width of one to two miles, the material was found to be black and well decomposed, and averaged sixty percent ash content. The inorganic matter consisted of fine sand, silt, and clay, and gave the soil a heavy silty texture. Because of the growth of the custard apple tree on this type of soil, it has been called the custard apple muck.[37] "The best land in the Everglades is where the custard apple grows. Some claim

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36 Mark Baldwin, H. W. Hawker, and Carl F. Miller, Soil Survey of the Fort Lauderdale Area, Florida, 16. Hereinafter cited as Baldwin, Hawker, and Miller, Soil Survey.

37 Ibid., 17, 31.

the custard apple is there because the soil is naturally better, others that the soil is better because of the custard apple."[38] Silting, bird rookeries, depth, and age have all had a part in the development of this band at Okeechobee's edge. Baldwin and his associates measured the depth of the muck and noted that it averaged from forty to seventy-five inches, and that it was underlain with peaty-muck to the limestone at one hundred twelve to one hundred and fifty inches. The surface was flat with a very gentle slope away from an elevation of twenty-one feet above sea level at the water's edge.[39]

Twenty-five years later, in 1940, the Soil Conservation Service of the federal government began mapping the Everglades soils, and found the most valuable to be the Okeechobee muck, known locally as custard apple. Bordering the shore of the big lake on the eastern and southern exposures for a distance of one to three miles, this earth measured from thirty to sixty inches and lay on brown fibrous peat which in turn rested on rock at a depth of five or more feet. A heavy, black, organic material with a high mineral content of from thirty to sixty per cent, this belt is highly desirable for the growth of sugar cane and vegetable

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38 John C. Gifford, The Tropical Subsistence Homestead, 89.

39 Baldwin, Hawker, and Miller, Soil Survey, 32.

crops.[40]

South of the area of the custard apple muck, Baldwin and his associates surveyed a gradational belt of less decomposed material with a smaller percentage of mineral matter which they called Peaty Muck. Known throughout the Everglades as "Willow and Elder Land," because of this characteristic growth on a belt of two to four miles to the south and east of the Okeechobee muck, it consisted of a transition strip between the lake border soils and the Everglades Peat at its rear. With from six to eighteen inches of finely fibrous and partially rotted matter lying on a stratum of Okeechobee muck varying in thickness from two to thirty or more inches, it is underlain with peat to a depth of from five to eight feet before reaching the bed rock.[41] Mapped by the 1940 survey as Okeelanta Peaty Muck, this soil has been found to be very desirable from the standpoints of both location and quality.[42]

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40 Charles B. Evans and R. V. Allison, "The Soils of the Everglades in Relation to Reclamation and Conservation Operations," The Soil Science Society of Florida, Proceedings, IV-A (1942), 43.

41 Ibid.

42 "As usually mapped this soil has three distinct layers: (1) the surface 6 to 12 inches of finely fibrous, decomposed peat, (2) a layer of plastic, sedimentary muck which varies in thickness from 2 to 30 or more inches, and (3) another layer of fibrous, brown peat." M. H. Gallatin and J. R. Henderson, "Progress on the Soil Survey of the Everglades," loc. cit., 99.

Approaching the interior of the Everglades away from Lake Okeechobee the material becomes less decomposed and is nearly pure organic matter. The 1915 survey came upon the soil which occupies the majority of the Everglades within two or three miles of the lake and mapped it as brown fibrous peat. The surveyors determined that this material averaged from eighty-five to ninety-three per cent combustible, and to comprise over sixty per cent of their mappings.

> . . . a remarkably uniform body of material, typically it consists of brown fibrous to dark brown semifibrous, slightly decomposed organic matter, underlain by limestone at depths varying from about 36 to 140 inches. 43

In 1915 the depth of this region of Everglades Peat varied from 110 to 130 inches 10 miles south of the lake to 50 inches at the 32 milepost below the lake.

> The surface of the upper part of the large area of this type is flat and nearly level. No natural drainage channels are apparent and the flatness is broken only by infrequent alligator holes and runways. 44

The 1940 Soil Survey identified the Everglades Peat as the most extensive soil type in the area. It found the top six to eighteen inches to be a fine, black, fibrous material containing up to fifteen per cent mineral matter, lying over rock or sand.[45]

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43 Baldwin, Hawker, and Miller, Soil Survey, 35.
44 Ibid., 39.
45 Charles B. Evans and R. V. Allison, "The Soils of the Everglades in Relation to Reclamation and Conservation Operations," loc. cit., 44.

The agriculturally important types of organic soils surveyed in the Everglades to 1943 were: Okeechobee muck, deep and very deep phases, 25,000 acres; Okeelanta peaty muck, deep and very deep phases, 30,000 acres; Everglades peat, deep and very deep phases, 350,000 acres; and Everglades peat over sand, 130,000 acres.[46]

In the portion north of the Hillsboro Canal and west of the Lake Worth Drainage District dikes, roughly the far northeastern corner of the Everglades, the 1940 Soil Survey mapped 165,000 acres of Loxahatchee peat. Found in the more inaccessible portions of the glades, this soil is a soft, felty, brown, fibrous material which is spongy in character, and in general has been laid down from tenderer plants than the saw grass. This earth loses three-fourths of its volume on drying and is not considered particularly desirable for agricultural purposes. Since it is covered with water during the greater part of the year it has become a refuge for frogs, fish, alligators, and ducks. Attempts to bring the Loxahatchee peat into cultivation have been generally unsuccessful.[47]

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46 Separation into phases on the basis of depth was made as follows: more than 96 inches, very deep phase; 60 to 96 inches, deep phase; 36 to 60 inches, shallow phase; less than 36 inches, very shallow phase. M. H. Gallatin and J. R. Henderson, "Progress Report on the Soil Survey of the Everglades," loc. cit., 97-100.

47 Charles B. Evans and R. V. Allison, "The Soils of the Everglades in Relation to Reclamation and Conservation Operations," loc. cit., 45.

Local classification of the soils of the Everglades has been according to the native vegetation growing upon them. The custard apple is a true muck of a sedimentary nature, while the saw grass is a true peat of an accumulative nature. The elderberry and willow is not distinct, but a combination of the other two.[48]

Between 1940 and 1943, 5,800 of the 7,000 square miles in the Everglades and Everglades Drainage District had been surveyed and mapped by the United States Soil Conservation Service. The information obtained indicated that some 435,000 acres of the land examined was "suitable for long time use for crop production."[49] Non-agricultural organic soils, marls, sands, rockland, tidal marsh, and dredged land made up the remainder of the soils found in the Everglades and the district. The non-agricultural organic soils included Everglades peat of the shallow and very shallow phases and peat over shallow marl, as well as every phase of Loxahatchee peat. While a small percentage of the marls and sands have been brought into agricultural production, their most extensive use has been for dry weather grazing and wildlife and water conservation.[50]

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48 Harold E. Hammar, "The Chemical Composition of Florida Everglades Peat Soils, with Special Reference to their Inorganic Constituents," Soil Science, (July, 1929), 1-13.

49 M. H. Gallatin and J. R. Henderson, "Progress Report on the Soil Survey of the Everglades," loc. cit., 104.

50 Ibid., 100-104.

3. The Flora and Fauna of the Everglades

The Everglades are situated in a semi-tropical climate. The average yearly rainfall varies from sixty inches at Miami to fifty inches at Okeechobee.[51] The yearly variation is considerable, and even the distribution within the year produces wet and dry seasons. Temperatures vary from the summer high of 98° F. to winter temperatures as low as 9° F. under conditions of very low water in the open glades.[52] "The region is . . . remarkable for the fact that it is a meeting place for many temperate and tropical types of plants and animals."[53]

> It is by definition, and by the usual boundaries applied to it, a region without many trees and dominated by grasses, sedges, reeds, rushes, and other herbs growing on peat, marl, or even sandy soils that are nearly level, and which are flooded or wet nearly to their surface most of the year. . . . From the point of view of the plant ecologist, these marshes are like "low moors" which are similar in some respects to bogs because peat does accumulate in them. 54

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51 J. C. Stephens and C. C. Schrontz, "The Principal Characteristics of the Kissimmee-Everglades Watershed," loc. cit., 24.

52 R. V. Allison, "The Soil and Water Conservation Problem in the Everglades," The Soil Science Society of Florida, Proceedings, I (1939), 38.

53 W. E. Safford, "Natural History of Paradise Key and the Nearby Everglades of Florida," Annual Report of the Smithsonian Institution, 1917, 377. Hereinafter cited as, "Everglades Natural History."

54 John H. Davis, Jr., "Vegetation of the Everglades and Conservation from the Point of View of the Plant Ecologist," The Soil Science Society of Florida, Proceedings, V-A (1943), 105.

The plant ecologist has divided the vegetation of the Everglades into six broad types, with the general areas covered by them as follows: (1) custard apple and willow-elderberry zone along the eastern and southern shores of Lake Okeechobee- 140,000 acres; (2) saw grass marsh plains of the northern and central glades- 1,000,000 acres; (3) saw grass and wax myrtle or bay-berry thicket areas, along the sides of the central plain- 240,000 acres; (4) slough and tree-island areas north of the Hillsboro Canal and west of the Miami Canal- 775,000 acres; (5) mixed marshes and wet prairies east and west of the central plain sough of the Tamiami Trail- 300,000 acres; and (6) bordering prairies with scattered hammocks and stands of trees along the borders of the Everglades- 145,000 acres.[55]

A majority of the plants in this great partially submerged bog stem from aquatic families. Covering the larger part of the Everglades, the saw grass has been the predominent growth which has impressed every traveler in the area. Mismamed a grass, this luxuriant growth is in fact a sedge whose leaves are armed on their edges with teeth like a rip saw and ". . . attain a length of seven feet and in the spring or early summer the plant sends up a nearly round flower stem to a height of ten feet or more."[56] The water

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55 John H. Davis, Jr., "Vegetation of the Everglades and Conservation from the Point of View of the Plant Ecologist," loc. cit., 105-112.

56 Charles T. Simpson, In Lower Florida Wilds, 121.

hyacinth, a naturalized plant, has become as predominant on the canals of the Everglades as the saw grass on the soils.[57] Introduced into Florida just before the turn of the nineteenth century, the hyacinth has completely outstripped its floating cousin, the water lettuce, which Heilprin noted in the Taylor's Creek swamps in 1886.[58]

In the sloughs and deeper waters of the glades, where not crowded out by the saw grass, are found other grasses and water plants. Hugh Willoughby encountered great masses of an underwater grass similar to that used in aquaria, and to which he attributed the clarity of lower Everglades waters.[59] Gama grass, oftimes cultivated for ornament in gardens, with its twelve-foot-long flowering stems, cattails and their accompanying reeds, giant foxtail similar to domesticated millet, common reeds, boneset, elegant thalia, bullrushes, and maiden cane form but a part of the prolific plant life in the grassy water.[60] ". . . handsome blue nama and two charming pond lilies, one . . . with yellow and the other . . . with white flowers;"[61] arrowheads with lance shaped leaves; pickerel weed, with spikes of blue flowers; water arums, like jacks-in-the-pulpit; and spider lilies all contribute to the twelve hundred species of native and natural-

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57 Charles T. Simpson, In Lower Florida Wilds, 121; R.V. Allison, "The Soil and Water Conservation Problem in the Everglades," loc. cit., 51.
58 Angelo Heilprin, Okeechobee Wilderness, 45.
59 Hugh L. Willoughby, Across the Everglades, 40.
60 Charles T. Simpson, In Lower Florida Wilds, 124-126.
61 Ibid., 125.

ized flowering plants growing on the lower mainland of Florida, many of which are located on the glades and island hammocks below Lake Okeechobee. With the advent of artificial drainage and the creation of spoil banks came a rank growth of poke-weed, pickerel weed, pig-weed, and water hemp. The amazing growth of these annual plants to a height of twenty feet may lead the unsuspecting to mistake them for a real forest.[62]

Through the length and breadth of the Everglades, and especially near the eastern and western edges, marsh shrubs and trees grow in isolated clumps or on the islands. Among them, the amphibian willow, elderberry, wax myrtle, swamp bay, cocoa plum, and the custard apple predominate. For many years the eastern and southern shores were bordered with a two to three mile belt of the custard apple, flanked to the rear by the elderberry.[63] In 1911 a traveler made the first note of the moonvine covering the custard apple growth almost in its entirety, like a green mantle.[64] Growing on the small islands on the edge of the glades and forming a dense green foliage on the streams, the cocoa plum with its insipid purple and white fruit was used by the

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62 W. S. Blatchley, In Days Agone, Notes on Fauna and Flora of Sub-Tropical Florida in the Days when Most of its Area Was a Primeval Wilderness, 102. Hereinafter cited as In Days Agone.

63 Charles T. Simpson, Out of Doors in Florida, 233.

64 W. S. Blatchley, In Days Agone, 101.

Seminole as a part of his diet.[65]

On the larger islands or keys in the area, as well as on the eastern and northern shores of Lake Okeechobee, many large trees were found. Here grew the live oak, cypress, maple, bay, and a few of the long leaf pine.

> Of special interest is the strangling fig which begins life somewhat like a mistletoe, sprouting from a tiny seed dropped on the limb of a tree. It soon sends down threads which take root when they reach the ground, and which grow together wherever they touch one another, forming a meshwork about the trunk of the host which is slowly strangled to death. 66

Among the climbing plants, always indigenous to tropical climes, W. E. Safford catalogued many interesting specimens. Wild grapes, hunter's vine with the sap filled stem for drinking, cockspur, and the climbing brambles caught his attention among the myraid plants of the hammocks and glades. In the limbs of the trees and amidst the vines encompassing them he located many modest and inconspicuous orchids and other epiphytes. Of these the creeping, spider, shell, chintz-flowered, and marsh orchids he believed attractive for their odd forms and fragrance. Included among the other air plants collected were the resurrection fern, Spanish

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65 John C. Gifford, The Reclamation of the Everglades with Trees, 22.

66 W. E. Safford, "Everglades Natural History," loc. cit., 383.

moss, the pineapple-like bromelaids, and a number of tree ferns.[67]

One of the most utilitarian members of the plant life of the Everglades is the cabbage palm or sabal palmetto. This palm grows to a majestic height on the islands of the glades and adjoining prairies. Its trunk is used for building purposes, its leaves for thatch, and the tender bud at the heart of the uppermost end of the trunk is a succulent food when properly cooked. It is known locally as swamp cabbage. The royal palm, found on Paradise Key, grows only in hammock or wet soil. These palms, with a clean, gray, and smooth trunk, crowned by ten or twelve shining and deep, dark green leaves, rise as high as a hundred and twenty feet. Describing the royal palms on Paradise Key in 1921, Charles T. Simpson wrote:

> Viewed from a distance of half a mile or more this forest is one of the most beautiful my eyes have rested on. The whole forms a superb emerald island decorated with splendid palms which everywhere cut the skyline with unsurpassed effect, and it is set in a sea of green everglades. [68]

The animal life of the region of the Everglades is equally as varied as the plant life. Safford in his paper on the natural history of Paradise Key and the surrounding glades

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67 W. E. Safford, "Everglades Natural History," loc. cit., 385-386.

68 Charles T. Simpson, Out of Doors in Florida, 241.

wrote that "the insect fauna alone must certainly include thousands of species. . . ."[69] Charles T. Simpson, in one of his many fascinating books on the flora and fauna of southern Florida, commented that one hundred twenty-eight species of birds had been sighted on or near the same locality and a considerable variety of small mammals, fish, and frogs.[70]

Of great interest to naturalists, the shell life of the Everglades has produced many specimens of crustacea and gastropada. The tree snails found on the trees of the islands are among the most attractive of their species, with their shells of varying and beautiful colors.[71] The marsh snails thrive in the grassy waters and furnish a large food staple to the bird life in the area. Crawfish abound throughout the grassy waters and likewise form a part of the diet of the marsh birds. Centipedes and scorpions are found on the islands in large numbers around rotting logs and other vegetable matter.

In his study of the insect life of the Key and its environs, Safford was able to collect and classify a large number of spiders, white ants or termites, dragon flies, roaches, grasshoppers, beetles, moths, butterflies, ants, wasps, bees, hornets, and flies.

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69 W. E. Safford, "Everglades Natural History," loc. cit., 390.

70 Charles T. Simpson, Out of Doors in Florida, 241.

71 W. E. Safford, "Everglades Natural History," loc. cit., 391; Charles T. Simpson, Out of Doors in Florida, 243.

> The Diptera of Paradise Key include many groups zoologically related but with very diverse habits: mosquitoes; horseflies and deer flies, which not only attack animals but even pursue automobiles for miles; robber flies, which catch their insect prey on the wing; flower flies, which feed on nectar and pollen; parasitic tachina flies, which lay their eggs on living insects; and carrion-eating flesh flies. 72

The mosquitoes of Florida, and especially southern Florida, are renowned for their painful bite. Simpson related an incident where the insects covered the exposed parts of his body until the skin could not be seen. With cheeks swollen and eyelids puffed from the poisoning, he could scarcely see, and felt stupid with a desire to lie down and sleep. One of his companions, not so badly affected, was able to find some wild limes, the juice of which he applied to the swollen parts, and relieved Simpson almost instantly. He noted that there were well authenticated instances in Florida and elsewhere of death occuring from the attack of mosquitoes. 73

Equally blood-thirsty are the Florida horsefly and deer fly. Zane Grey, on a hunting and fishing trip through the Ten Thousand Islands and Shark River waters in 1924, reported the following experience:

> Suddenly something bit me fiercely through my shirt. . . . I slapped my shoulder. A huge black fly dropped to the floor of the launch. He had brought the blood. . . . He resembled the common horsefly I had observed in the west, yet he appeared more vividly colored. 74

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72 W. E. Safford, "Everglades Natural History," loc. cit., 408.
73 Charles T. Simpson, In Lower Florida Wilds, 107.
74 Zane Grey, Tales of Southern Rivers, 67.

The several varieties of horseflies in South Florida can become the most annoying of pests, "often flying after automobiles and railway trains; so annoying . . . to painters and other workmen that they have to protect . . . themselves by means of portable smudges."[75] Simpson pointed out the curious nuptial flights of the males, in which they swarmed in millions, "making an almost deafening noise."[76] Several members of the deer fly family, smaller and more brightly colored than the horseflies but just as blood thirsty, have been found throughout the area. Other types of flies thriving in the glades include the soldier fly, the Midas fly, the tachina fly, and the screw-worm fly. The last, a terrible little fly, lays its eggs in wounds or in the nostrils of living animals. "It has even been known to deposit its eggs in the nostrils of human beings sleeping out of doors, but this is a rare occurence."[77] The larvae from the hatched eggs, known as screw worms, eat the flesh of the host, and stock owners must be ever alert to arrest the ravages of this insect.

Lake Okeechobee and the Everglades have been near perfect homes for fish, especially in times of high water. During these periods the fish go into the weedy sections border-

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75 W. E. Safford, "Everglades Natural History," loc. cit., 409.

76 Charles T. Simpson, Out of Doors in Florida, 242.

77 W. E. Safford, "Everglades Natural History," loc. cit., 410.

ing the lake and the glades to enjoy new feeding grounds. Without doubt, the most interesting species of fish in the region is the predatory alligator gar. It looks for all the world like a freak of prehistoric ages and ichthyologists find it is a direct descendant. John C. Gifford, pioneer Miami resident, related an incident in which he had been attracted by a great stench in the glades during a season of low water. Approaching a great pool of water, he saw garfish by the thousands in the slowly falling water.

> The fringe was lined by thousands of birds fighting, squawking, and gorging themselves on these dying fish. We returned a few days later. The slough was dry and covered with a layer of guano. 78

The vertebrae of the garfish are similar to ball and socket joints, and the head may move independently. The scales, arranged in diagonal rows, are fitted together by a system of hooks and do not lap each other. Simpson declared the scales to be so hard that fire could be struck from them with the use of steel.[79]

The black or big-mouthed bass roamed the length and breadth of the Everglades prior to the beginning of drainage operations. The black bass is the pluckiest of Florida fresh-water game fish and when feeding will strike at any likely moving object. Specimens of twenty pounds or over

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78 John C. Gifford, The Tropical Subsistence Homestead, 61.

79 Charles T. Simpson, In Lower Florida Wilds, 128.

have been taken from the peninsular waters. While in the lower glades in 1896, Hugh Willoughby crossed many pools ten feet wide and five feet deep which, he said, were inhabited by black bass up to a foot in length.[80] Bass that jumped into the boats of the Ingraham expedition furnished the men with a part of their bill of fare when they crossed the middle glades in 1892.[81] Other fish found in the Everglades include the gamy and voracious mud or dogfish, which is "one of the hardest fighters that ever took the hook."[82] Catfish, shiners, kill fish, sunfish, bluegill bream, and numerous minnows are found in the lakes, pools, and sloughs of the Everglades.

Perhaps the fauna which most quickly come to mind at the mention of the Everglades are the reptiles, the largest of which are alligators. "These huge animals are not at all dangerous, but will flee at the sight of a man and will not show fight unless brought to bay."[83] Heilprin noted an instance of a gator feeding in the Okeechobee-Hicpochee Canal by grabbing a turtle and pulling it under the water. Naturalists have found that the alligator feeds on practically any animal that passes within its reach. On his trip through

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80 Hugh L. Willoughby, Across the Everglades, 119.

81 W. R. Moses, (MSS), "The Everglades Exploring Expedition," 27. Typescript copy in Albertson Library, Orlando, Florida.

82 W. E. Safford, "Everglades Natural History," loc. cit., 411.

83 Ibid., 415.

the very southern end of the glades Zane Grey came upon a Seminole encamped at the headwaters of Lostman's River with a catch of eleven gators for a night's work.[84]

The Everglades are well supplied with a great variety of snakes. The cottonmouth or water moccasin, a lover of wet and swampy lands, is perhaps the most unpopular and predominant of the snake population. The snake is very poisonous and dreaded by all travelers in the glades. The diamond back and ground rattlesnakes are encountered occasionally, but both these rattlers prefer a drier habitat. Garter, water, black racer, gopher, coachwhip, and green tree snakes are additional members of the family encountered in the glades.[85]

> The bird fauna of southern Florida is especially rich, not only on account of the mild climate, favorable to many subtropical species, but also because Florida is a highway for migratory species which spend their winters in the West Indies. 86

Practically all of the birds which frequent the states of the eastern seaboard are found in or near the Everglades at some time of the year. The distinctive members of the feathered animals in the glades are those who frequent a watered plain for a natural habitat. Of these, the roseate spoonbill and the flamingo have almost disappeared from the Everglades.

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84 Zane Grey, Tales of Southern Rivers, 75-76.
85 W. E. Safford, "Everglades Natural History," loc. cit., 416-418.
86 Ibid., 419.

As late as 1887, several flocks of the spoonbill, a rose tinted heron with a shovel shaped bill, were found in the Everglades. The snowy egret and the white ibis, once the prey of plume hunters and threatened with extinction but now protected by the wardens of the law, are present in large flocks throughout the area.[87]

Angelo Heilprin found the swampy prairie from Fort Thompson to Lake Okeechobee a virtual paradise for birds; at Taylor's Creek he observed several flocks of parakeets.[88] Other visitors to the area observed teeming bird life over all the territory. Heron, crane, bittern, grebe, water turkey, duck, turkey vulture, limpkin, hawk, osprey, rail, gallinule, coot, dove: veritably ad infinitum, the list grows with scarce mention of songbirds like the thrush and cardinal. Before passing on, mention should be made of the kite, a bird of prey. Zane Grey ably described it as follows:

> Opportunity was afforded to watch an Everglade kite, a rare bird I had not seen before. This one soared above us, round and round swooping down to the treetops. It was about the size of a pigeon, only more slender, a little longer, and possessed a remarkable build. It was a giant swallow. The wings were perfectly bowed. . . . The tail was wide with a deep fork. Its head

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87 Frederick A. Ober, The Knockabout Club in the Everglades; The Adventures of the Club in Exploring Lake Okeechobee, 143; Charles T. Simpson, In Lower Florida Wilds; Angelo Heilprin, Okeechobee Wilderness, 35.

88 Angelo Heilprin, Okeechobee Wilderness, 46.

> appeared small. Perhaps its most striking feature was the color. The underside of the wings was half black, half white, and the tail had the same beautiful markings. . . . In beauty, grace, and wildness this Everglade kite equalled the frigate bird of the keys. 89

The mammals which are found in the Everglades proper are very few in number. Deer graze in open spots on the tender grass. An occasional wildcat will make his home on one of the islands in order to prey on rats and mice. Possum and raccoon are found along the borders and sometimes on the islands. Perhaps the mammal best adapted to the glades is the Florida otter, whose trails Willoughby saw by the thousands. Constant hunting for the valuable pelts has reduced this animal to a veritable rarity in his natural habitat.[90] Other than birds, fish, and reptiles the center of the Everglades is nearly devoid of life. In the tall saw grass, inundated for a large part of the year, the lack of life is not hard to understand.[91]

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89 Zane Grey, Tales of Southern Rivers, 66-67.

90 Charles T. Simpson, In Lower Florida Wilds, 128; W. E. Safford, "Everglades Natural History," loc.cit., 423-424.

91 Hugh Willoughby, Across the Everglades, 160; W. R. Moses, "The Everglades Exploring Expedition," 27-30.