# FLORIDA GEOLOGICAL SURVEY

## EIGHTH ANNUAL REPORT

# FLORIDA STATE GEOLOGICAL SURVEY

E. H. SELLARDS, PH. D., STATE GEOLOGIST

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PUBLISHED FOR

THE STATE GEOLOGICAL SURVEY

TALLAHASSEE, 1916.

## LETTER OF TRANSMITTAL

To His Excellency, Hon. Park Trammell, Governor of Florida:

Sir:—In accordance with the Survey law I submit herewith my Eighth Annual Report as State Geologist of Florida. The report contains the statement of expenditures by the Survey for the year ending June 30, 1915, together with those investigations by the Survey that have progressed far enough to be available for publication.

Very respectfully,

E. H. SELLARDS,
State Geologist

THE E. O. PAINTER PRINTING CO. DE LAND, FLA. № 11252

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The bill by which the Florida Geological Survey was established was introduced into the Legislature of the State by Dr. E. S. Crill, who after repeated efforts secured its passage by the Legislature of 1907. Dr. Crill was born in Oneida County, New York, December 25th, 1843, moved to Florida in 1874, and thereafter gave largely of his time to the public service of his adopted State. Trained as a physician he gave twenty years of his life, 1865 to 1885, to the practice of medicine. In 1880 he was elected State Senator, an office which he held until 1885, when he resigned and accepted the office of State Treasurer in Governor Perry's Cabinet. On the completion of his term as State Treasurer he returned to private life, but in 1897 was again called to public service as State Senator, and after serving twelve years declined re-election and returned again to private life. His public service is notable for the constructive and progressive legislation which he originated and supported. His relations to his fellowman in private life were marked by such a spirit of cordial helpfulness as to endear him to all with whom he came in contact. His death occurred at his home in Palatka, October 23, 1915, at the mature age of 72, thus closing a life full of good works.

# ADMINISTRATIVE REPORT.

E. H. SELLARDS, STATE GEOLOGIST.

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The Survey is fortunate in having had during the past year the co-operation of a number of persons who have assisted in various ways. Some of these have contributed important specimens to the Survey collection, while others have given important information relating to formations, well records, minerals or fossils. In the text of the report which follows, the names are given of many of those who have generously assisted in the Survey work.

### MORE OFFICE AND LABORATORY SPACE NECESSARY.

The statement in the Sixth Annual Report, 1914, in regard to the overcrowded condition of the Geological Survey applies more forcibly now than at that time. The Survey has in fact far outgrown the accommodations that are available and additional office and laboratory space is very much needed. The library shelves are full, and it is now and for some time has been quite impossible to care for the publications that are being received. Many of these new publications represent the results of investigations by the neighboring State Surveys or by the National Survey, and are very necessary for comparative purposes to the Florida Survey. Other publications being received from various sources are for reference purposes and are necessary to the determination of fossils or mineral specimens, or of geological formations, or other matters in connection with the Survey work.

The Survey at present is practically without a work room. There is no table or desk room available to store or to handle the maps, charts, and drawings that are constantly being used in the Survey work. It is impossible from lack of space to properly open up and study the collection of mineral and fossil specimens that have been obtained by the Survey. The store room space is too small to accommodate even the current issues of the Survey's own publications which must be cared for temporarily awaiting their distribution.

In connection with the work of the Survey there is a constant accumulation of notes, records, photographs, manuscripts, plates and cuts, as well as the general correspondence of the office which must be cared for. The present limited office space affords no room for storing, filing or properly caring for these records, nor for exhibiting the Survey collections of rocks, minerals, and fossils which should be made available to the public.

In the present quarters there is constant danger of loss by fire. The Survey collections now contain some very valuable material for scientific purposes, particularly in regard to the early history of man on the American Continent. These collections cannot be duplicated and it is very much to be hoped that a fire-proof building including adequate facilities may be provided for the Survey and the other Scientific Departments of the State.

## TOPOGRAPHIC AND SOIL MAPS.

Detailed topographic and soil maps of the State are very much needed. The topographic maps should be made on a scale of about an inch to the mile and should show contour lines at 10-foot intervals of elevation. When accurately made these maps serve as a base for soil maps as well as for many other useful purposes, particularly for road building. In the preparation of these maps cooperation may be secured by the State Geological Survey with the United States Geological Survey and with the United States Bureau of Soils, and it is very much to be hoped that an appropriation may be made by the Legislature to carry on the State's part of this work, for which at least $5,000 per annum should be available.

## PUBLICATIONS ISSUED BY THE STATE GEOLOGICAL SURVEY.

The following is a list of the publications issued by the State Geological Survey since its organization:

### ANNUAL REPORTS.

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 and 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, and 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) the relation between the Dunnellon formation and the Alachua clays of Florida; (4) geography and vegetation of northern Florida.

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

This report contains: Statistics on mineral industries; pebble phosphates of Florida; natural resources of an area in Central Florida, including a part of Marion, Levy, Citrus and Sumter counties; soil survey of Bradford County; and soil survey of Pinellas County.

Eighth Annual Report (this volume).

## BULLETINS.

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

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

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

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

## PRESS BULLETINS.

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 Imbedded in the Earth, January, 1915.

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

## DISTRIBUTION OF REPORTS.

The reports issued by the State Geological Survey are distributed upon request, and may be obtained without cost by addressing the State Geologist, Tallahassee, Florida. Requests by those living outside of the State of Florida should be accompanied by postage, or if desired the reports will be sent express collect.

## EXPENDITURES OF THE GEOLOGICAL SURVEY FOR THE YEAR ENDING JUNE 30, 1915.

The total appropriation for the State Geological Survey is $7,500 per annum. No part of this fund is handled direct by the State Geologist, as all survey accounts are paid upon warrants drawn upon the Treasurer by the Comptroller as per itemized statements approved by the Governor. The original of all bills and the itemized statements of all expense accounts are on file in the office of the Comptroller. Duplicate copies of the same are on file in the office of the State Geologist. The warrants when paid are on file in the office of the State Treasurer.

List of warrants issued during the year ending June 30, 1915.

JULY, 1914.

| | |
|---|---|
| Herman Gunter, assistant, expenses, July, 1914 | $ 60.36 |
| R. M. Harper, Salary, July, 1914, $125.00; expenses, $20.65 | 145.65 |
| A. G. Seiler, publications | 12.00 |
| Groover-Stewart Drug Co., supplies | 4.20 |
| E. W. Clark, supplies | 1.25 |
| W. Wellborn, clerical asst | 2.88 |

AUGUST, 1914.

| | |
|---|---|
| Herman Gunter, expenses, August, 1914 | 107.70 |
| R. M. Harper, Salary | 125.00 |
| W. E. Knibloe, services, August, 1914 | 86.60 |
| H. & W. B. Drew Co., supplies | 28.84 |
| Southern Express Company | 1.26 |

SEPTEMBER, 1914.

| | |
|---|---|
| E. H. Sellards, State Geologist, salary for quarter ending September 30, 1914 | 625.00 |
| Herman Gunter, assistant, salary for quarter ending September 30, 1914 | 375.00 |
| R. M. Harper, salary | 125.00 |
| W. E. Knibloe, services, September 1-15 | 62.50 |
| Laura Smith, services | 75.00 |
| Ed Lomas, janitor services | 30.00 |
| E. H. Sellards, expenses, July, August, September | 134.26 |
| Herman Gunter, expenses, September | 11.61 |
| H. & W. B. Drew Co., supplies | 12.25 |
| Maurice-Joyce Engraving Co., engravings | 30.90 |
| Richard Brown, Bureau of Standards, drayage | 9.50 |

OCTOBER, 1914.

| | |
|---|---|
| E. H. Sellards, expenses, October, 1914 | 51.95 |
| Herman Gunter, expenses, October, 1914 | 22.07 |
| Alex McDougall, postage | 25.00 |
| Southern Express Company | 4.68 |
| Dan Allen, drayage | 3.74 |
| The Letter Shop, supplies | 2.52 |

NOVEMBER, 1914.

| | |
|---|---|
| E. H. Sellards, expenses, November, 1914 | 71.91 |
| Herman Gunter, expenses, November, 1914 | 67.25 |
| Dan Allen, freight and drayage | 9.09 |
| Southern Express Company | 6.07 |

DECEMBER, 1914.

| | |
|---|---|
| E. H. Sellards, State Geologist, salary for quarter ending December 31, 1914 | 625.00 |
| Herman Gunter, assistant, salary for quarter ending December 31, 1914 | 375.00 |
| R. M. Harper, salary | 70.00 |
| Laura Smith, services | 75.00 |
| Ed Lomas, services | 30.00 |
| Southern Express Company | 13.74 |
| Richard Brown, drayage | 2.25 |
| Pa. R. R. Co., freight on clay samples | 1.31 |
| Alex McDougall, postage | 2.74 |
| Snyder and Black, soil maps | 175.00 |
| Wrigley Engraving Co., engravings | 7.50 |
| A. Hoen & Co., maps | 200.00 |
| Maurice Joyce Engraving Co., engravings | 79.33 |

JANUARY, 1915.

| | |
|---|---|
| E. H. Sellards, expenses, December, 1915 | 77.26 |
| S. A. L. Ry., freight | 88.38 |
| R. M. Harper, services, January, 1915 | 150.00 |
| Alex McDougall, postage | 133.80 |
| American Journal of Science, subscription | 6.00 |
| Southern Express Company | 4.63 |
| T. J. Appleyard, printing | 49.25 |
| Dan Allen, freight and drayage | 23.65 |

FEBRUARY, 1915.

| | |
|---|---|
| E. H. Sellards, expenses, February, 1915 | 101.38 |
| Herman Gunter, expenses, February, 1915 | 95.90 |
| R. M. Harper, salary | 150.00 |
| R. M. Harper, expenses, February, 1915 | 54.69 |

| | |
|---|---|
| Dan Allen, freight and drayage | 12.59 |
| Arthur H. Thomas Co., supplies | 18.20 |
| H. & W. B. Drew Co., supplies | 14.11 |
| Southern Express Company | 13.24 |
| The Letter Shop, supplies | 4.50 |
| Alex McDougall, postage | 125.78 |

MARCH, 1915.

| | |
|---|---|
| E. H. Sellards, State Geologist, salary for quarter ending March 31, 1915 | 625.00 |
| E. H. Sellards, expenses, March, 1915 | 115.83 |
| Herman Gunter, assistant, salary for quarter ending March 31, 1915 | 375.00 |
| Herman Gunter, expenses, March, 1915 | 90.61 |
| R. M. Harper, salary | 150.00 |
| R. M. Harper, expenses, March, 1915 | 30.57 |
| Laura Smith, services | 137.00 |
| Ed Lomas, janitor services | 30.00 |
| Southern Express Company | 7.76 |
| Eastman Kodak Co., supplies | 2.44 |
| Economic Geology, subscription | 3.00 |
| Dan Allen, freight and drayage | 3.39 |
| Alex McDougall, postage | 45.00 |

APRIL, 1915.

| | |
|---|---|
| H. & W. B. Drew Co., supplies | 5.69 |
| Arthur H. Thomas Co., supplies | 9.32 |
| R. M. Harper, salary | 150.00 |
| Dan Allen, freight and drayage | 3.36 |

MAY, 1915.

| | |
|---|---|
| Herman Gunter, expenses, May, 1915 | 26.80 |
| Alex McDougall, postage | 17.20 |
| Southern Express Company | 9.66 |
| Dan Allen, freight and drayage | 3.69 |
| University of Chicago Press, subscription | 3.60 |

JUNE, 1915.

| | |
|---|---|
| E. H. Sellards, State Geologist, salary for quarter ending June 30, 1915 | 625.00 |
| Herman Gunter, assistant, salary for quarter ending June 30, 1915 | 375.00 |
| Laura Smith, services | 115.00 |
| Ed Lomas, janitor services | 30.00 |
| Total | $8,101.19 |

| | | |
|---|---|---|
| Appropriation for the year | $7,500.00 | |
| Balance from the preceding year | 608.68 | |
| | | $8,108.68 |
| Total expenditures for the year ending June 30, 1915 | | 8,101.19 |
| Balance | | $ 7.49 |

## EXCHANGE LIST OF THE FLORIDA GEOLOGICAL SURVEY.

The following is a list of the libraries to which the State Survey reports are regularly sent, in which they are permanently preserved and may be consulted by those interested. Those institutions or libraries indicated on the list by a star (*) issue or distribute publications copies of which are sent to the Florida Geological Survey Library.

Academy of Natural Sciences of Philadelphia, 19th and Race Sts., Philadelphia, Pa.

Academia Nacional de Ciencias, Cordoba, Argentina, S. A.*

Academy of Science of St. Louis, 3817 Olive St., St. Louis, Mo.*

Agricultural and Mechanical College of Texas, Office of State Forester, College Station, Texas.

Alabama Geological Survey, University, Ala.*

Alfred T. Gwynne Institute, Fort Myers, Florida.

American Geographical Society of New York, Broadway and 156th St., New York, N. Y.*

American Institute of Mining Engineers, New York.

American Museum of Natural History, West 77th St., New York, N. Y.*

American Philosophical Society, 104 South Fifth St., Philadelphia, Pa.*

American Society of Civil Engineers, 220 West 57th St., New York, N. Y.

Arizona Geological Survey, Tucson, Ariz.*

Arizona State Bureau of Mines, University of Arizona, Tucson, Arizona.

Arkansas Geological Survey, Fayetteville, Ark.*

Barnard College Library, New York, N. Y.

Bartow Public Library, Bartow, Fla.

Beloit College Library, Beloit, Wis.

Bibliotheek der Rijks-Universiteit te Groningen, Groningen, Holland.*

Bodleian Library, Oxford, England.

Boston Society of Natural History, Boston, Mass.

British Museum, Cromwell Road, London, S. W., England.

Brown University Library, Providence, R. I.

Bryn Mawr College Library, Bryn Mawr, Pa.

Buffalo Society of Natural Sciences, Buffalo, N. Y.*

Bureau of Economic Geology and Technology, Austin, Texas.*

California Academy of Sciences, San Francisco, Cal.*

California Agricultural Experiment Station Library, Berkeley, Cal.*
California State Mining Bureau, Ferry Bldg., San Francisco, Cal.*
Carnegie Library of Pittsburgh, Pittsburgh, Pa.
Carrabelle High School Library, Carrabelle, Fla.
Case School of Applied Science, Geological Library, Cleveland, Ohio.
Catholic University of America Library, Washington, D. C.
Charleston Museum, Charleston, S. C.*
Chicago Academy of Sciences, Lincoln Park, Chicago, Ill.*
Chicago Public Library, Chicago, Ill.
Citrus Experiment Station, Riverside, California.
Cleveland Public Library, Cleveland, Ohio.
Cocoa High School Library, Cocoa, Fla.
Colgate University Library, Hamilton, N. Y.
Colorado School of Mines Library, Golden, Colo.*
Colorado State Geological Survey, Boulder, Colo.*
Columbia University Library, New York, N. Y.
Columbia University, Geological Department Library, New York, N. Y.
Commission of Conservation, Ottawa, Canada.*
Connecticut State Library, Hartford, Conn.*
Cornell College Library, Mount Vernon, Iowa.
Cornell University Library, Ithaca, N. Y.
Cornell University, Department of Geology, Library, Ithaca, N. Y.
Danmarks Geologiske Undersogelse, 14 Gammelmont, Kjobenhavn, K., Denmark.*
Dartmouth College, Department of Geology, Hanover, N. H.
Davenport Academy of Natural Sciences, Davenport, Iowa.*
David S. Walker Library, Tallahassee, Fla.
Daytona Public School Library, Daytona, Fla.
Delaware College Agricultural Experiment Station Library, Newark, Del.*
Department of Commerce Library, Washington, D. C.
Department of Mines, Melbourne, Victoria, Australia.*
Department of Mines, Ottawa, Canada.*
Department of Mines, Sydney, New South Wales, Australia.*
Des Moines Public Library, Des Moines, Iowa.
Elisha Mitchell Scientific Society, Chapel Hill, N. C.*
Emory College Library, Oxford, Ga.
E. M. Museum Library, Princeton, N. J.
Fairchild Geological Library, University of Rochester, Rochester, N. Y.
Free Library of Philadelphia, Philadelphia, Pa.
Free Reading Library, West Palm Beach, Fla.
Free Public Library, St. Augustine, Fla.
Field Museum of Natural History, Chicago, Ill.*
Florida Agricultural Experiment Station Library, Gainesville, Fla.*
Florida Agricultural and Mechanical College Library, Tallahassee, Fla.
Florida State College for Women, Tallahassee, Fla.
Geographical Library, Oronoque, Conn.
George Wetmore College Library, 404 Alhambra Bldg., Milwaukee, Wis.
Geological Department of the State of Georgia, Atlanta, Ga.*

Georgia State Library, Atlanta, Ga.

Geological Society of America, care F. R. Van Horn, Librarian, Cleveland, Ohio.

Geological Society of South Africa, Johannesburg, Transvaal, South Africa.*

Geological Survey of Canada, Ottawa, Canada.*

Geological Survey and Museum, Jermyn Street, London, England.*

Geological Survey of New Zealand, Wellington, New Zealand.*

Geological Survey of Western Australia, Beaufort St., Perth, W. A.*

Grand Rapids Public Library, Ryerson Public Library Bldg., Grand Rapids, Mich.

Grinnell College Library, Grinnell, Iowa.

Hamilton College Library, Clinton, N. Y.

Harvard University Library, Cambridge, Mass.

Hampton Institute Library, Hampton, Va.

Hopkins Library, Lake Helen, Fla.

Illinois Agricultural Experiment Station Library, Urbana, Ill.*

Illinois State Geological Survey, Urbana, Ill.*

Illinois State Museum of Natural History, Springfield, Ill.*

Imperial Institute, South Kensington, London, S. W., England.*

Indiana Academy of Science, Indianapolis, Ind.*

Indiana Agricultural Experiment Station Library, Lafayette, Ind.*

Indiana Department of Geology and Natural Resources, Indianapolis, Ind.*

Indiana State Library, Indianapolis, Ind.*

Indiana University Library, Bloomington, Ind.

Instituto de Geologia y Perforaciones, Montevideo, Uruguay, S. A.*

Iowa Academy of Science, Des Moines, Ia.*

Iowa Geological Survey, Iowa City, Ia.*

John Crerar Library, Chicago, Ill.*

Johns Hopkins University Library, Baltimore, Md.

Justus Perthes' Geographische Anstalt, Gotha, Germany.*

Kongl. Universitets-Biblioteket, Lund, Sweden.*

Kansas Academy of Science, Topeka, Kan.*

Kansas Agricultural College Library, Manhattan, Kan.*

Kansas State Geological Survey, Lawrence, Kan.*

Kentucky Geological Survey, Frankfort, Ky.*

Laval University Library, Quebec, Canada.

Lehigh University Library, South Bethlehem, Pa.

Leland Stanford Junior University Library, Stanford University, Cal.

Library of Congress, Washington, D. C.

Live Oak Free Public Library, Live Oak, Fla.

Los Angeles Public Library, Los Angeles, Cal.

McGill University Library, Montreal, Canada.

Manatee High School Library, Manatee, Fla.

Margaret Carnegie Library, Mills College, P. O., Cal.

Maryland Agricultural College Library, College Park, Md.*

Maryland Geological Survey, Baltimore, Md.*

Massachusetts Agricultural College Library, Amherst, Mass.*

Massachusetts Institute of Technology Library, Boston, Mass.
Michigan Geological and Biological Survey, Lansing, Mich.*
Mills College, Geological Library, Mills College, P. O., Cal.
Milwaukee Public Library, Milwaukee, Wis.
Minneapolis Public Library, Minneapolis, Minn.
Minnesota Geological Survey, Minneapolis, Minn.*
Minnesota School of Mines Library, University of Minn., Minneapolis, Minn.
Mississippi State Geological Survey, Jackson, Miss.*
Missouri Botanical Garden, St. Louis, Mo.*
Missouri Bureau of Geology and Mines, Rolla, Mo.*
Missouri School of Mines Library, Rolla, Mo.
Missouri State Fruit Experiment Station Library, Mountain Grove, Mo.
Missouri State Historical Society, Columbia, Mo.
Montana State School of Mines Library, Butte, Mon.
Mount Dora Library, Mount Dora, Fla.
Mount Holyoke College Library, South Hadley, Mass.
Museum of Comparative Zoology, Cambridge, Mass.*
Museo Goeldi de Historia Natural e Ethnographia, Belem, Para, Brazil, S.A.*
Museo Nacional de Historia Natural, Buenos Aires, Argentina, S. A.*
National Academy of Science, Washington, D. C.
Natural History Society of Glasgow, Glasgow, Scotland.
Natural History Society of New Brunswick, Saint John, N. B.*
Nebraska Geological Survey, Lincoln, Nebr.*
Newark Free Public Library, Newark, N. J.
New Jersey Agricultural Experiment Station Library, New Brunswick, N. J.*
New Jersey Geological Survey, Trenton, N. J.*
New York Academy of Sciences, 77th Street and Central Park West, New York, N. Y.
New York Botanical Garden Library, Bronx Park, New York, N. Y.*
New York Public Library, 476 Fifth Ave., New York, N. Y.
New York State Library, Albany, N. Y.*
New York State College of Forestry, Syracuse, N. Y.
New York State Museum, Geological Department, Albany, N. Y.*
North Carolina Experiment Station Library, West Raleigh, N. C.*
North Carolina Geological and Economic Survey, Chapel Hill, N. C.*
North Dakota Agricultural and Economic Geological Survey, Fargo, N. D.*
North Dakota Geological Survey, Grand Forks, N. D.*
Northwestern University Library, Evanston, Ill.
Oberlin College Library, Oberlin, Ohio.
Ohio Agricultural Experiment Station Library, Wooster, Ohio.*
Ohio Geological Survey, Columbus, Ohio.*
Ohio State Library, Columbus, Ohio.
Ohio State University Library, Columbus, Ohio.
Oklahoma Geological Survey, Norman, Okla.*
Orange City Library, Orange City, Fla.
Oregon Agricultural College Library, Corvallis, Oregon.*
Oregon Bureau of Mines and Geology, Corvallis, Oregon.*
Orlando Sorosis Library, Orlando, Fla.

Oshkosh Normal School Library, Oshkosh, Wis.
Peabody Institute of the City of Baltimore, Library, Baltimore, Md.*
Peabody Museum Library, New Haven, Conn.
Pennsylvania Department of Mines, Harrisburg, Pa.*
Pennsylvania State Museum, Harrisburg, Pa.
Pennsylvania Topographical and Geological Survey Commission, Beaver, Pa.*
Philadelphia Free Public Library, 13th and Locust Sts., Philadelphia, Pa.
Pomona College Library, Claremont, Cal.
Public Library of Cincinnati, Cincinnati, Ohio.
Public Library, Des Moines, Iowa.
Public Library, Jacksonville, Fla.
Public Library, Minneapolis, Minn.
Public Library, St. Louis, Mo.
Public Museum of the City of Milwaukee, Milwaukee, Wis.*
Purdue University Library, Lafayette, Ind.
Queens University Library, Kingston, Ontario, Canada.
Real Academia de Ciencias exactas, Fisicas y Naturales, Valveroe, Madrid, Spain.
Rensselaer Polytechnic Institute Library, Troy, N. Y.
Rhode Island Natural Resources Survey, Providence, R. I.*
Riggs Memorial Library, Georgetown University, Washington, D. C.
Rochester Academy of Science, Rochester, N. Y.
Rollins College Library, Winter Park, Fla.
Royal Society of Tasmania, Hobart, Tasmania.*
Royal Society of Queensland, Brisbane, Queensland, Australia.*
Royal Technical College, Copenhagen, Denmark.
Royal Society of Victoria, Melbourne, Australia.
Rutgers College Library, New Brunswick, N. J.
School of Mining, Kingston, Ontario, Canada.
St. Lawrence University, Canton, N. Y.
Science College, Tokyo Imperial University, Tokyo, Japan.
Seattle Public Library, Seattle, Wash.
Smithsonian Institution, Washington, D. C.* Bureau of International Catalog of Scientific Literature.
Societe de Geographie de Quebec, Quebec, Canada.*
Sorosis Library, Orlando, Fla.
South African Association for the Advancement of Science, Cape Town, South Africa.
South Carolina Experiment Station Library, Clemson College, S. C.*
South Dakota Geological Survey, Vermillion, S. D.*
South Dakota State College of Agriculture and Mechanic Arts Library, Brookings, S. D.*
South Dakota State School of Mines Library, Rapid City, S. D.*
State Agricultural College Library, Fort Collins, Colo.
State Historical Society of Missouri, Columbia, Mo.
Stetson University Library, DeLand, Fla.
Summerlin Institute, Bartow, Fla.

Sveriges Geologiska Undersokning, Stockholm, Sweden.*
Syracuse University Library, Syracuse, N. Y.
Tennessee State Geological Survey, Nashville, Tenn.*
Tuskegee Normal and Industrial Institute Library, Tuskegee Institute, Ala.
U. S. Bureau of Census, Washington, D. C.*
U. S. Bureau of Mines, Washington, D. C.*
U. S. Bureau of Soils, Washington, D. C.*
U. S. Coast and Geodetic Survey, Washington, D. C.*
U. S. Department of Agriculture, Forest Service, Washington, D. C.*
U. S. Department of Agriculture Library, Washington, D. C.
U. S. Geological Survey Library, Washington, D. C.*
U. S. National Museum Library, Washington, D. C.*
U. S. Office of Public Roads, Washington, D. C.
U. S. Weather Bureau, Publication Division, Washington, D. C.
University of California, College of Agri. Library, Berkeley, Cal.*
University of California Library, Exchange Department, Berkeley, Cal.*
University of California, Citrus Experiment Station, Riverside, Cal.
University of Chicago Library, Chicago, Ill.
University of Chicago, Department of Geology, Chicago, Ill.
University of Cincinnati Library, Cincinnati, Ohio.
University of Colorado Library, Boulder, Colo.*
University of Florida, Department of Agronomy, Gainesville, Fla.
University of Florida Library, Gainesville, Fla.
University of Florida Museum Library, Gainesville, Fla.
University of Georgia Library, Athens, Ga.
University of Glasgow Library, Glasgow, Scotland.*
University of Illinois Library, Urbana, Ill.
University of Iowa Library, Iowa City, Ia.
University of Kansas Library, Lawrence, Kan.
University of Louisville Library, Louisville, Ky.
University of Maine Library, Orono, Me.
University of Michigan, Ann Arbor, Mich.*
University of Minnesota Library, Minneapolis, Minn.
University of Minnesota Library, Dept. of Agri., St. Paul, Minn.
University of Missouri Library, Columbia, Mo.
University of Nebraska Library, Lincoln, Nebr.
University of North Dakota Library, University, N. D.
University of Notre Dame, Leomonnier Library, Notre Dame, Ind.
University of Oregon Library, Eugene, Ore.
University of Pennsylvania Library, Philadelphia, Pa.
University of Pittsburgh Library, Pittsburgh, Pa.
University of Tennessee Library, Knoxville, Tenn.
University of Texas Library, Austin, Texas.
University of Washington Library, Seattle, Wash.
University of Wisconsin Library, Madison, Wis.
University of Wyoming, Agri. College Exp. Station Library, Laramie, Wyo.*
Vanderbilt University Library, Nashville, Tenn.
Vassar College Library, Poughkeepsie, N. Y.

Vermont Geological Survey, Burlington, Vt.*
Virginia Polytechnic Institute Experiment Station Library, Blacksburg, Va.
Virginia Polytechnic Institute Library, Blacksburg, Va.
Virginia State Geological Survey, Charlottesville, Va.*
Virginia State Library, Richmond, Va.
Virginia Truck Experiment Station Library, Norfolk, Va.
Wagner Free Institute of Science, Montgomery Avenue and 17th St., Philadelphia, Pa.*
Walker Museum Library, Chicago, Ill.
Washington Biological Society, Washington, D. C.
Washington Geological Survey, University Station, Seattle, Wash.*
Washington University Library, Skinker Road and Forsythe Blvd., St. Louis, Mo.
Wellesley College Library, Wellesley, Mass.
Wesleyan University Library, Middletown, Conn.
Western Society of Engineers, 1735 Monadnock Block, Chicago, Ill.*
Western Reserve University Library, Cleveland, Ohio.
West Virginia Geological and Economic Survey, Morgantown, W. Va.*
Williams College Library, Williamstown, Mass.
Wisconsin Geological and Natural History Survey, Madison, Wis.*
Woman's Club Library, Miami, Fla.
Wyoming Agricultural College and Experiment Station Library, Laramie, Wyo.*
Wyoming Geological Survey, Cheyenne, Wyo.*
Yale University Library, New Haven, Conn.*

# MINERAL INDUSTRIES OF FLORIDA DURING 1915.

E. H. SELLARDS.

CONTENTS.



The value of the minerals produced in Florida during 1915 was less than that of the preceding year, the decline being due to the unfavorable market condition. The total mineral production during 1914 is valued at $8,621,688, while that for 1915 is valued at $5,035,010.

A new industry in the State as well as in the United States is the production of a dye or stain made from a bituminous material. The deposit of bitumen as found in the earth is mixed with sand. The company making this new product is the Gulf Reduction Company, Pensacola.

## BALL CLAY OR PLASTIC KAOLIN.

Three plants were engaged in mining ball clay in Florida during 1915. These were the Edgar Plastic Kaolin Company, Edgar; The Lake County Clay Company, Okahumpkee; and the Richmond China Clay Company, Okahumpkee. The ball clays of Florida are white burning, refractory clays notable for their plasticity. They occur in association with sand from which they are separated by washing. The value of the ball clay produced, although not separately given, is included in the total mineral products of the State.

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Statistic on production collected in cooperation with the U. S. Geological Survey.

## BRICK AND TILE.

The total number of common brick manufactured in Florida during 1915 was 31,019,000, valued at $182,149. The production for the year 1915 shows a reduction as indicated by these figures over that of the preceding year, the decrease being due to the unfavorable conditions. The quantity and value of tile, and other brick products is not separately given, but is included in making up the total mineral products of the State. The total value of brick and tile products for the year 1915 exceeded $200,000.

The following firms in Florida were engaged in the manufacture of brick or tile during 1915:

Barrineau Brothers, Quintette.
Campville Brick Company, Campville.
Clay County Steam Brick Company, Green Cove Springs.
Florida Brick Company, Brooksville.
Florida Industrial School for Boys, Marianna.
Gamble and Stockton Company, 108 West Bay St., Jacksonville.
Glendale Brick Works, Glendale.
Guilford Brick Company, Blountstown.
Hall and McCormac, Chipley.
Keystone Brick Company, Whitney.
McMillan Brick Company, Molino.
O. O. Mickler Brick Company, Callahan.
Lee Miller, Whitney.
Ocklocknee Brick Company, Ocklocknee.
Platt Brothers, South Jacksonville.
Tallahassee Pressed Brick Company, Havana.

## FULLER'S EARTH.

The total production of fuller's earth in the United States during 1915 was 47,901 short tons, an increase over the preceding year of 6,920 tons. In addition to that produced there was imported into the United States, 19,441 short tons. Some fuller's earth is exported from the United States, although the amount can not be determined owing to the fact that this product is not listed separately from other clays.

The States producing fuller's earth at present are Arkansas, California, Florida, Georgia, Massachusetts and Texas. Of these Florida is the chief producer, the output from this State amounting to

approximately three-fourths of the whole output for the United States. The value of the fuller's earth produced in the United States during 1915 was $489,219. The production in Florida, although not separately listed, is included in making up the total mineral production of the State.

The following companies are engaged in mining fuller's earth in Florida: The Atlantic Refining Company, Ellenton; the Floridin Company, Quincy and Jamieson; the Florida Fuller's Earth Company, Ellenton, and the Fuller's Earth Company, Midway.

## LIME, LIMESTONE AND FLINT-ROCK.

The total quantity of quick and hydrated lime made in Florida during 1915 amounted to 15,306 tons, valued at $78,240, an increase over the production for the preceding year of 2,930 tons. The lime produced in Florida is chiefly quick lime, although some hydrated lime is being made.

The total amount of limestone and flint-rock produced in Florida for all purposes except that of burning for quick lime, including building, road making, railroad ballast and agricultural limestone is valued at $354,673. The following companies in Florida have reported the production of lime or limestone for the year 1915. The first four companies named produced both lime and limestone, the remaining companies of the list produced limestone, or limestone and flint-rock:

Florida Lime Company, Ocala.
Marion Lime Company, Ocala.
Standard Lime Company, Kendrick.
Virginia-Florida Lime Company, Ocala.
Blowers Lime and Phosphate Company, Ocala.
Brooksville Stone and Lime Company, Brooksville.
Crystal River Rock Company, Crystal River.
Live Oak Limestone Company, Live Oak.
Florida Crushed Rock Company, Montbrook.
Florida Lime Company, Ocala.
Manatee Limestone Company, Manatee.
E. P. Maule, Ojus.
R. L. Nunn, Brooksville.
George Sykes Company, Miami.
A. T. Thomas and Company, Ocala.

## OIL PROSPECTING.

Prospecting for oil and gas has been carried on in Florida at intervals for many years and at the present time drillings are being made near Tallahassee, Chipley and Kissimmee.

Oil and gas may occur in any rocks which are sufficiently porous to retain them, but are found in commercial quantities only where favorable structural conditions exist. There must in all cases be a capping of impervious rock to retain the oil so that it may not escape to the surface. Large quantities of oil probably are not found except where there are particularly favorable structural conditions. The simplest structure probably is an arch or upward fold in the rock. The oil and gas being lighter than water, rise to the top of the fold and are retained there by the overlying impervious stratum. This simple upward fold is known as an anticline, and the theory of the accumulation of oil in a fold of this kind is known as the anticlinal theory, which was first proposed in 1892 by Dr. I. C. White, State Geologist of West Virginia. Dome structure in rocks affords equally favorable conditions, and involves the same principles, the oil rising in the porous stratum to the top of the dome. Rock strata dipping in one direction only, thus forming a monocline, may by slight alterations in the rate of dip produce basins or other structures which are capable of retaining oil. In fact any structural feature in the rocks which permits the storage of a quantity of oil may afford a commercial supply.

Structure, however, is not the only requisite, and it is not to be assumed that where the structure is favorable, oil and gas are necessarily present. The origin of oil and gas is not fully understood. The theory that more nearly meets general acceptance than any other, perhaps, is that the oil and gas are derived from an organic source, either animal or vegetable matter imbedded in the rocks of the earth. An alternate hypothesis is that of an inorganic origin, it being assumed that the oil and gas originate through chemical reactions which take place deep within the earth. In either case the oil and gas move upward and are collected where the conditions are favorable in the rocks above. It thus follows that structural conditions favorable to the accumulation of oil may and frequently do exist without any oil being present. On the other hand, oil and gas probably form in the earth without having an opportunity, owing to lack of favorable structure, to accumulate in commercial quantities.

The structural conditions to which reference has been made may or may not show at the surface. Thus a country that is monotonously level may in fact have pronounced folding of the rock beneath the surface. Conversely a country may be very hilly owing to surface erosion and yet having underlying formations that present few if any of the structural features favorable to oil. One cannot, therefore, select a hill or ridge as indicating the location of a fold or a dome. It is true, however, that ridges and hills may indicate structural features beneath the surface, and hence should receive consideration with respect to oil possibilities.

A study of the geology of a region frequently affords important information as to the most favorable place at which to locate oil wells. These studies, however, must be made in detail and should cover large areas, so as properly to correlate the structural features that are observed. That which is especially needed to further this work in Florida is first of all accurate topographic maps by which all surface features may be definitely located, and exact well records by which the location, depth and thickness of formations may be determined. In connection with the well records it is to be noted also that the records should be based on the samples of the drillings taken at frequent intervals as often at least as every ten feet. The driller's log and notes are of value, but they should be supplemented in all cases by the actual rock samples.

## SURFACE INDICATIONS.

In a locality where oil occurs surface indications may or may not exist. Those which are found frequently are in the form of the escape of oil through leaks into springs, streams or other openings in the earth. The channels of streams not infrequently cut into a rock formation that contains oil. In this case oil may show on the stream, or the excess of oil having passed away may be detected only by the stain in the rock or by a test by which the remaining oil is dissolved from the rock and is thus detected. All such surface indications which seem possibly to indicate the location of oil or gas should receive careful investigations.

## DEPTH OF WELLS.

The depth at which oil and gas are found varies from a few feet to such depth as is practicable to drill. A small supply has frequently been obtained from very shallow wells, and large sup-

plies from wells of moderate depth. In California at the present time oil and gas wells are not infrequently carried to a depth of 5,000 feet. When drilled to such a depth the cost is necessarily very great, but is justified from the results that have been obtained.

Of the wells drilled as test wells for oil in Florida that of the Pierson Oil Company, four and a half miles south of Sumterville in Sumter County, is reported to have reached a depth of 2,002 feet and to have given showings of oil. A second well drilled by this company near Crystal River in Citrus County reached a depth of 1,900 feet, and as completed flows salty water which rises several feet above the surface. A well drilled for oil by the Southern States Lumber Company between Muscogee and Cantonment in Escambia County reached a depth of 1,462 feet. No indications of oil are reported at this well. A well drilled near Orange Hill in Washington County about six miles south of Chipley is reported to have reached a depth of 1,250 feet and to have afforded indications of oil.

## LOCATION OF OIL AND GAS WELLS.

The location of oil and gas wells is by no means a simple matter even for those who have the best training and are thoroughly acquainted with the geology of the region. For this reason it is well not to be over-confident of the accuracy of the reports of those who purport to know the exact location of oil in advance of drilling. This is particularly true with regard to reports made by those who come without recommendation other than that they are from some previously known oil field and who without any previous knowledge of the geology of the State and who are themselves without accurate or recognized geologic training, purport upon slight investigations and in advance of drilling to locate definitely large bodies of oil. In a recent issue of Economic Geology (June, 1916), Dr. Ralph Arnold, a recognized oil geologist of international reputation, has said: "It is impossible for anyone to say definitely from surface evidence whether oil does or does not exist below the surface of the earth at any particular spot; the drill is the final arbiter of this question, and even the drill does not always tell the truth."* With this statement the most experienced geologist with little doubt will agree.

* Paper read at the Second Pan-American Scientific Congress at Washington, December, 1915.

While the geologist cannot encompass the impossible, it is well to recognize that there is an important part of the work that he may do, namely, to select on the evidence of the structural features of the rock as well as upon surface indications, if there are such, the place most favorable for the location of a test well.

## PEAT.

Peat is being produced at Beswick, Florida, by the Ranson Humus Company. This being the only plant in operation in the State, the production is not separately listed. The peat produced by this company is placed on the market in the form of prepared humus and peat litter.

## PHOSPHATE ROCK.

The mining of phosphate rock in Florida during 1915 has been very much interfered with by the European war, for while there is a demand for the rock in the European countries transports have not been available to make shipment and the freight rates have been excessive. The output for 1913 was 2,584,794 long tons, while during 1914 the output, as reported by the producers, was 2,097,864 long tons, a decrease of 486,930 tons. The production during 1915 was 1,455,874 long tons, a further decrease of 641,990 tons, or a total decrease over normal production of over a million tons.

The total shipment of phosphate rock for 1915 as reported by the producers was 1,358,611 long tons of which 1,308,481 tons were land pebble and 50,130 tons were hard rock phosphates. Of the total shipments only 229,160 tons were exported, whereas, under normal conditions more than a million tons are exported. The export shipments include land pebble 185,846 tons, and hard rock 43,314 tons. The domestic shipment include land pebble 1,122,635, and hard rock 6,816 tons.

Summary of Production and Shipment of Phosphate in Florida for the Year 1915, Based on Data Supplied by the Producers:

| Pebble Phosphate. | Long tons. |
|---|---|
| Production | 1,416,422 |
| Consigned for export | 185,846 |
| Consigned for domestic shipment | 1,122,635 |
| Total shipments | 1,308,481 |

Hard Rock Phosphate.

| | |
|---|---|
| Production | 39,452 |
| Consigned for export | 43,314 |
| Consigned for domestic shipment | 6,816 |
| Total shipments | 50,130 |

Pebble and Hard Rock Phosphate Combined.

| | |
|---|---|
| Production | 1,455,874 |
| Consigned for export | 229,160 |
| Consigned for domestic shipment | 1,129,451 |
| Total shipment | 1,358,611 |

The value of the phosphate shipped from Florida during 1915 was as follows: Land pebble, $3,496,501; hard rock $265,738; total $3,762,239. The value of the phosphate rock shipped from Florida during the preceding year was $7,354,744, a decrease of $3,592,505.

SUMMARY OF PRODUCTION AND SHIPMENT OF FLORIDA PHOSPHATE FOR THE YEARS 1908, 1909, 1910, 1911, 1912, 1913, 1914 and 1915 (long tons).

| | 1908. | 1909. | 1910. | 1911. | 1912. | 1913. | 1914. | 1915. |
|---|---|---|---|---|---|---|---|---|
| Pebble Rock— | | | | | | | | |
| Production | 1,150,000 | 1,334,569 | 1,637,709 | 2,020,478 | 2,043,486 | 2,107,256 | 1,787,597 | 1,416,422 |
| Exported | 470,270 | 509,341 | 606,110 | 703,589 | 732,651 | 887,398 | 625,821 | 185,846 |
| Domestic | 421,781 | 819,701 | 995,728 | 1,274,056 | 1,204,502 | 1,168,084 | 1,203,381 | 1,122,635 |
| Total shipments | 892,051 | 1,329,042 | 1,601,838 | 1,977,645 | 1,937,153 | 2,055,482 | 1,829,202 | 1,308,481 |
| Hard Rock— | | | | | | | | |
| Production | 768,011 | 527,582 | 392,088 | 474,094 | 536,379 | 477,538 | 310,267 | 39,452 |
| Exported | 631,001 | 496,645 | 461,353 | 462,072 | 470,354 | 476,898 | 303,172 | 43,314 |
| Domestic | 9,900 | 17,456 | 18,745 | 16,723 | 15,425 | 12,896 | 6,517 | 6,816 |
| Total shipments | 640,901 | 514,101 | 480,098 | 478,795 | 485,779 | 489,794 | 309,689 | 50,130 |
| Pebble and Hard Rock Combined— | | | | | | | | |
| Production | 1,918,011 | 1,862,151 | 2,029,797 | 2,494,572 | 2,579,865 | 2,584,794 | 2,097,864 | 1,455,874 |
| Exported | 1,101,271 | 1,005,986 | 1,067,463 | 1,165,661 | 1,203,005 | 1,364,296 | 928,993 | 229,160 |
| Domestic | 431,681 | 837,157 | 1,014,473 | 1,290,779 | 1,219,927 | 1,180,980 | 1,209,898 | 1,129,451 |
| Total shipments | 1,532,952 | 1,843,143 | 2,081,936 | 2,456,440 | 2,422,932 | 2,545,276 | 2,138,891 | 1,358,611 |

Total phosphate produced in Florida 1908 to 1915, inclusive ..... 17,022,928
Total phosphate exported 1908 to 1915, inclusive ..... 8,065,835
Total domestic shipments 1908 to 1915, inclusive ..... 8,314,346
Total recorded shipments 1908 to 1915, inclusive ..... 16,,380,181
Total amount of phosphate produced in Florida from the beginning of mining in 1888 to 1915, inc.. 29,418,659

The following is a list of the phosphate mining companies of Florida. Of the companies on this list a few were idle in 1915, most of these, however, carried rock in stock from which sales were made, and will continue operations when conditions are favorable.

LIST OF PHOSPHATE MINING COMPANIES OF FLORIDA.

| | |
|---|---|
| Acme Phosphate Co | Morriston, Fla. |
| Amalgamated Phosphate Co | 25 S. Calvert St., Baltimore, Md., and Brewster, Fla. |
| Armour Fertilizer Works | Bartow, Fla., and Union Stock Yards, Chicago, Ill. |
| P. Bassett (Successor to Central Phosphate Co.) | Newberry, Fla. |
| Peter B. and Robert S. Bradley | 92 State St., Boston, Mass., and Floral City, Fla. |
| J. Buttgenbach & Co | Holder, Fla. |
| C. & J. Camp | Ocala, Fla. |
| Charleston, S. C., Mining and Manufacturing Co. | Richmond, Va., and Ft. Meade, Fla. |
| Coronet Phosphate Co | Lakeland, Fla., and 99 John St., New York. |
| Cummer Lumber Co | Jacksonville and Newberry, Fla. |
| Dominion Phosphate Co | Bartow, Fla. |
| Dunnellon Phosphate Co | Rockwell, Fla. |
| Dutton Phosphate Co | Gainesville, Fla. |
| Export Phosphate Co | Mulberry, Fla., and 55 State St., Boston, Mass. |
| Florida Mining Co | 165 Broadway, New York, and Mulberry, Fla. |
| Florida Phosphate Mining Corporation | Norfolk, Va., and Bartow, Fla. |
| Franklin Phosphate Co | Newberry, Fla. |
| Holder Phosphate Co | Ocala and Inverness, Fla. |
| International Phosphate Co | 27 State St., Boston, Mass., and Ft. Meade, Fla. |
| Interstate Chemical Corporation | Charleston, S. C., and Bowling Green, Fla. |
| Istachatta Phosphate Co | Istachatta, Fla. |
| Lakeland Phosphate Co | Lakeland, Fla. |
| Leland Phosphate Co | Croom, Fla. |
| Mutual Mining Co | Savannah, Ga., and Floral City, Fla. |
| Meredith-Noble Phosphate Co | Romeo, Fla. |
| Palmetto Phosphate Co | Baltimore, Md., and Tiger Bay, Fla. |
| Pebbledale Phosphate Co | Mulberry, Fla. |
| Phosphate Mining Co | 55 John St., New York, and Nichols, Fla. |
| Pierce Phosphate Co | 2 Rector St., New York, and Pierce, Fla. |
| Prairie Pebble Phosphate Co | 165 Broadway, New York, and Mulberry, Fla. |
| Schilmann & Bene | Ocala, Fla. |
| Societe Franco-Americaine des Phosphates de Medulla (Successor to Standard Phosphate Co.) | Christina, Fla |
| Societe Universelle de Mines, Industries Commerce et Agriculture | Paris, France, and Pembroke, Fla. |
| Southern Phosphate Development Co | Ocala and Inverness, Fla. |
| Swift & Co | Bartow, Fla. |
| T. A. Thompson | Ft. White, Fla. |

## ROAD MATERIALS.

The materials available in Florida for making improved roads include crushed stone, marl, shell, sand, gravel and sand-clay. In addition cement, asphalt and vitrified brick are being imported into the State for this purpose. The kind of road constructed depends largely upon the materials available that are cheap enough to be economically used. Sandy clays suitable for country roads are widely distributed and at the present time the mileage of roads built of sand-clay in the State equals the mileage of roads built of all other materials combined. Marl, limestone and shell are the next most widely distributed materials, while flint, bog ore, gravel and phosphate rock are more restricted. While it is impossible to get complete statistics on road materials it is known that more than $56,000 worth of rock was produced in Florida during 1915 for the purpose of road construction.

In the following table the rocks that are found in Florida are classified according to their origin. A second table is added in which the rocks are classified according to their chemical composition. The rocks of the State as may be seen from the lists given in these tables are all of sedimentary or of sedimentary-chemical origin, as no igneous or highly metamorphic rock are known in the State.

ROCKS OF FLORIDA CLASSIFIED ACCORDING TO ORIGIN.

| | |
|---|---|
| Mechanical origin | Sandstone,<br>Shales,<br>Clays. |
| Organic origin | Shell limestone,<br>Infusorial earth,<br>Muck, peat, lignite. |
| Chemical origin | Bog iron ore,<br>Oolitic limestone,<br>Flint or chert,<br>Crystallized limestone,<br>Phosphate rock. |

Disregarding mode of origin and placing the rocks according to chemical composition, the classification may be arranged as follows:

## ROCKS OF FLORIDA CLASSIFIED ACCORDING TO CHEMICAL COMPOSITION.

| | |
|---|---|
| Siliceous rocks | Flint and chert,<br>Sandstone,<br>Infusorial earth. |
| Calcareous rock | Shell limestone,<br>Crystallized limestone,<br>Oolitic limestone,<br>Marl. |
| Argillaceous rock | Clay and shale, |
| Carbo-Hydrates | Muck, peat, lignite. |
| Ferruginous rocks | Bog iron ore. |
| Phosphatic rocks | Pebble and rock phosphate. |

### SILICEOUS ROCKS:—FLINT, CHERT AND GRAVEL

Flint is chemically an oxide of silica, $SiO_2$, with more or less accompanying impurities. It is a variety of the mineral quartz, occurring massive and non-crystallized or more accurately very imperfectly crystallized (crypto-crystalline.) The term "chert" is often used interchangeably with flint. Properly chert is an impure flint or flinty rock. Flint and chert are lacking in cleavage. They break, as do the other varieties of quartz, with conchoidal fracture. A flint rock when crushed breaks into sharp cornered pieces of varying size. The mineral quartz, of which flint is a variety, has a hardness of seven on a scale in which the hardest mineral, diamond, is ten. The varieties of quartz vary in hardness slightly according to the impurities that they contain. Silica is one of the least soluble of minerals and among the most resistant to decay.

Flint and chert occur mostly as masses or "horsebacks" in the limestone formations. A good illustration of the manner of occurrence may be seen in phosphate pits or in some of the lime pits at Ocala. In some of the sinks on Thompson's farm two miles east of Sumterville will be seen flint masses exposed by the natural decay of the limestone. The flint masses appear to conform to no rule as to size and extent. Flints may form a ridge running through the limestone; or again they occur as rounded or elongated masses. Occasionally the flint forms as a thin stratum lying horizontally. This flint bearing limestone lies at no great distance from the surface

throughout all of the central peninsular section of the State from Columbia County on the north to Sumter County on the south and from the Suwannee River and the Gulf coast to east Alachua and Marion counties. Much of the hard rock phosphate rests upon this flint-bearing limestone, and from the phosphate pits great quantities of the flint may be obtained. This flint-bearing limestone is known as the Ocala formation. It is not to be inferred that no other Florida formation contains silica for, on the contrary, many of the formations are highly siliceous. The Ocala limestone, is, however, the chief flint-bearing formation of Florida.

The flint masses were clearly not present in the limestone as originally formed. This formation when not affected by chemical change consists typically of a mass of calcareous shells varying in size from minute foraminifera to larger bivalves and gastropods with which are interbedded coral and other fossils, along with a limited amount of siliceous material supplied principally by sponge spicules. Originally, without doubt, the limestone consisted largely of the remains of these calcareous shells, the flint masses having been subsequently deposited through the agency of underground water. Water in its round of circulation through surface and deeper formations takes silica as well as other substances into solution. In the course of its circulation through the limestone, the silica in solution in the water replaces the calcium carbonate of the limestone. The direct evidence that the flint masses are formed by the replacement process is to be had from the examination of a piece of flint. In this it will be seen that the foraminifera and other shells which were originally calcareous have been changed to silica. The replacement process is by no means confined to the formation of flints. As already mentioned, chemical changes are constantly going on among the minerals making up the rock formations, and replacement of one mineral by another is one of the important phases of chemical change.

Siliceous gravels are widely scattered over the State and in a few localities occur in sufficient abundance to be used as a road material. Gravel pits have been opened at Interlachen and at Grandin in Putnam county and in Escambia and Jackson counties.

## CALCAREOUS MATERIAL.

Calcareous road materials occur in the form of shells, shell and coral limestones, oolitic limestone, and marls. All of these rocks consist essentially of calcium carbonate or of the double carbonate of calcium and magnesium, and have certain features in common. They are much less resistant to wear than is quartz. When pure and crystallized the mineral calcite ($CaCO^3$) has a hardness of only three in the scale in which quartz is seven. It is thus much softer than the steel tires of wagons. In fact a chief item in the repair of calcareous roads arises from the fact that steel tires cut holes in the soft material. On the other hand, an advantageous property of calcareous material is the readiness with which it re-cements itself. Calcium carbonate dissolves to an appreciable extent in water containing $CO_2$ gas or weak organic acids. Chemical re-adjustment is therefore rapid in a mass of crushed or broken calcareous rock, the dissolved calcium carbonate acting as a cementing material.

In practical application, the physical condition in which these materials occur must be taken into consideration. In the case of recent shells, the calcium carbonate is in a compact amorphous condition. The shells of a shell limestone are usually brittle and often crumble easily. The oolitic limestone is made up of innumerable round concretions barely large enough to be readily visible to the eye. These are held together by a calcareous cement. After crushing, the particles re-cement more or less perfectly. The marls are calcareous deposits which are sufficiently soft to be applied to roads without previous crushing. More or less perfectly crystallized limestone occurs locally in the State. Its formation is probably due to a replacement process similar to that described for flint and chert. The chemical changes in this case involve a rearrangement of the constituent molecules; as a result of which the non-crystallized material of the rock assumes a definite form. When partly crystallized the limestone becomes compact and close grained.

*Distribution and Amount of Calcareous Rocks.*—The calcareous rocks are widely distributed in the State. The Ocala limestone, as already stated, is found near the surface over much of central Florida. Oolitic limestones make up an extensive formation running north and south from Miami and forming the east border of the Everglades. Coral and oolitic limestones form the foundation of the keys from Miami to Key West. Shell limestone occurs exten-

sively along the Caloosahatchee River. Tampa Bay affords a compact limestone which often carries much silica. The Chattahoochee series of compact limestones occurs extensively in parts of West Florida. The marls are usually of local occurrence and are restricted to no part of the State. Shells, thanks to oyster industry of the present, and to the shell mound builders of the past, occur in inexhaustible quantities.

The term "marl" in connection with road making is applied to any calcareous material that is sufficiently soft to admit of direct application to roads without previous crushing. The marls as a rule are taken direct from the pits to the roads. With the soft marls, traffic over the road serves to crush, smooth, and pack the material, although the harder marls after being spread on the road are broken up by hand or crushed with a roller. A characteristic of marl is that after being thus packed the material re-cements itself, forming a uniform surface. The marls used for roads include several varieties. A form frequently used is an amorphous marl found usually in old swamps. Marls of this character were formerly used extensively in Orange County, being obtained in the western part of the county. Marls used in Brevard County, west of Titusville, are of a similar character. The swamp marls are usually of local occurrence and may be expected in almost any part of the State. Some of the limestones of the State are sufficiently soft to serve as marls. Thus the extensive formation known as the Ocala limestone is, as a rule, comparatively soft, and is extensively used for road making, being commonly classed as a marl. The marl roads of Marion County are made from this limestone, numerous pits being opened in the county for this purpose.

Crushed stone is being used somewhat extensively for roads. For this purpose hard limestone, flint, or phosphate rock is used. After crushing, the coarser material is spread on the road, making a secure foundation, on which the fine siftings are used thus filling in and making a top dressing, giving a smooth surface and a very durable road.

## SHELL ROADS.

Shell deposits are less uniformly scattered over the State than marl and limestone and are less extensively used for roads. The principal shell deposits are the oyster shells found near the coast or along inlets from the coast, and the chief supply of these is afforded by the shell mounds accumulated in the past by the Indians, al-

though modern oyster canning factories give an important added supply. Aside from the shell mounds of the coast there is a notable series of shell mounds along the St. Johns River, which consists chiefly of small univalve shells with some mussels. These were likewise accumulated by the Indians. Aside from the shell accumulated by human agencies the shell deposits accumulated by natural agencies should be mentioned. Among these are coquina rock and other marine shell deposits. The coquina accumulated as beach deposits and subsequently became more or less cemented, forming in places hard rock. Elsewhere masses of uncemented shells occur, such as those previously mentioned at DeLand. These are usually classed as shell marls.

## SAND-CLAY.

Sand-clay, because of its widespread occurrence, is the most extensively used road material in the State. Almost every county has sandy clays suitable for road making, or the clay suitable to mix with or cover the sands of the natural sandy roads. These roads, while not all that could be desired, are a vast improvement over the ordinary sand roads and their cheapness recommends them to general use.

Fine grained clay mixed in proper proportion with coarse, angular quartz, makes a road that has been found useful where cheapness of construction is necessary, and where the roads have light travel. In mixing sand and clay for road purposes the proportion should be so adjusted that there is enough clay in the mixture to fill the voids or interstices between the grains of sand. If too little clay is added the sand grains will lack bonding power and not make a solid roadbed. If too much clay is added, and the sand grains are widely separated, the road behaves much as though the sand were not present at all. The amount of clay necessary to mix with a given volume of any particular sand should be determined by some one experienced in this work.

Since all clay contains more or less sand, it may be expected that certain localities will supply clay that contains the right admixture of sand and clay to form a natural sand-clay road, or so nearly the proper admixture that it will serve that purpose satisfactorily. Fortunately for Florida, almost every county is supplied with an abundance of clay which serves admirably the purpose of road-making. With this material at hand, road construction in country sections is carried on at a minimum expense. These roads

find their greatest usefulness in country sections where cheapness in road-making is necessary.

The road-making clays are of a red or yellowish color, indicating a high percentage of iron compounds which probably assist in the bonding power of the material. In texture the clay is rather coarse and breaks up readily.

## BOG IRON ORE.

Bog iron ore occurs in various parts of the State, but is usually in thin deposits and of local extent. It has been stated by Shaler (U. S. Geological Survey, 15th Ann. Rept., p. 272, 1895), that where the surface of a limestone road can be covered with iron ore the firmness of the mass is much increased. An iron oxide, such as bog iron ore, serves as a cementing material, and this is doubtless the explanation of its usefulness for this purpose.

Low grade phosphate may serve in some localities as a useful road rock. The hard rock phosphate is harder than limestone and is reported to have better cementing qualities. Phosphate screenings have been used to some extent and have proved satisfactory.

## SAND-LIME BRICK.

Four companies were actively engaged in the manufacture of sand-lime brick in Florida during 1915 as follows: The Bond Sandstone Brick Company, Lake Helen, Fla.; The Composite Brick Company, 425 St. James Bldg., Jacksonville, Fla.; The Plant City Composite Brick Company, Plant City, Fla., and The Valrico Sandstone Company, Valrico, Fla.

The total production of sand-lime brick in Florida during 1915 including common, front and fancy brick, was valued at $77,575.

## SAND AND GRAVEL.

The sand produced in Florida is used for building and paving and for railroad ballast. The gravel produced finds its chief use for road making and for road ballast. The total production of sand and gravel for 1915 was 123,548 tons, valued at $34,055.

The companies reporting the production of sand and gravel in Florida during 1915 are the following:

Atlantic Coast Line Railroad Company.
Florida Sand and Shell Company, Tampa.
Interlachen Gravel Company, Interlachen.

Lake Wier Sand Company, Ocala.
Logan Coal and Supply Company, Jacksonville.
W. E. Long, Orlando.
Walter L. Westcott, Orlando.
Woodmar and Company, Ocala.

## WATER.

The springs of Florida are famous for their large volume of flow as well as for the clearness and beauty of their waters. Many of these springs are used as health resorts, while from others the water is sold for medicinal or table use. The total sales of mineral and spring water in Florida during 1915, as shown by the returns from the owners of springs and wells, amount to 118,920 gallons, valued at $12,516. The average price thus approximates ten cents per gallon.

The following is a list of some of the mineral springs of Florida:

Chumuckla Mineral Springs and Hotel Company, Chumuckla Mineral Springs, Chumuckla, Florida.
Espiritu Santo Springs Company, Espiritu Santo Springs, Safety Harbor, Florida.
Lackawanna Water and Ginger Ale Company, Lackawanna Springs, Jacksonville, Florida.
L. H. McKee, Quisiana Spring, Green Cove Springs, Florida.
Magnesia Spring Water Company, Magnesia Spring, Grove Park, Florida.
Magnolia Springs Hotel Company, Magnolia Spring, Magnolia Springs, Florida.
Nathaniel Brewer, Jr., Newport Springs, Newport, Florida.
Orange City Mineral Springs Company, Orange City Mineral Springs, Orange City, Florida.
Panacea Springs Company, Panacea Springs, Panacea, Florida.
Ponce de Leon Springs Corp., DeLeon Springs, DeLeon Springs, Florida.
Purity Springs Water Company, Purity Spring, Tampa, Florida.
Silver Springs, Ocala, Fla.
Tampa Kissengen Wells Company, Stomawa Mineral Well, Tampa, Florida.
Vincent Bros., Wekiva Springs, Apopka, Florida.
Wakulla Springs, Wakulla County, Florida.

## SUMMARY STATEMENT OF MINERAL PRODUCTION IN FLORIDA DURING 1915.

| | |
|---|---|
| Common or building brick, 31,019 M., valued at | $ 182,149 |
| Lime, including quick and hydrated lime, 15,506 tons, valued at | 78,240 |
| Limestone, including ground limestone for agricultural use and crushed rock for railroad ballast, concrete and road material | 354,673 |
| Mineral waters, 118,920 gallons, valued at | 12,516 |
| Phosphate rock, 1,358,611 long tons, valued at | 3,762,239 |
| Sand and gravel, including building and moulding sand and gravel, 123,548 short tons, valued at | 34,055 |
| Sand-lime brick, including common and front brick, 13,078 thousand, valued at | 77,575 |
| Mineral products not separately listed, including ball clay, drain tile, and fuller's earth | 533,563 |
| Total mineral production valued at | $5,035,010 |

# DESCRIPTIONS OF SOME FLORIDIAN FOSSIL VERTEBRATES, BELONGING MOSTLY TO THE PLEISTOCENE.

BY OLIVER P. HAY.

RESEARCH ASSOCIATE OF CARNEGIE INSTITUTION OF WASHINGTON.

PLATES 1-9.

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# DESCRIPTIONS OF SOME FLORIDIAN FOSSIL VERTEBRATES, BELONGING MOSTLY TO THE PLEISTOCENE.

Plates 1-9.

OLIVER P. HAY.

RESEARCH ASSOCIATE OF THE CARNEGIE INSTITUTION OF WASHINGTON.

The greater part of the vertebrate materials described in the present paper belongs to the collection of the Florida State Geological Survey and was put into my hands by Dr. E. H. Sellards for examination. However, the portion of the upper jaw of *Hipparion plicatile* was given me, on a visit to Ocala, Florida, by Mr. William M. Dale, to be transferred to the U. S. National Museum. The interesting little land tortoise herein described is the property of Dr. Henry G. Bystra, of Brooksville, Florida. The part of a plastron which is referred to *Terrapene antipex* belongs to Mr. Fred R. Allen, of St. Augustine.

Florida is extremely rich in the bones and teeth of extinct vertebrate animals; and the efforts of Dr. E. H. Sellards, the State Geologist, to secure and preserve these for science ought to receive the encouragement and assistance of all citizens of the State. Finders of fossil teeth and bones ought to send them to the office of the State Geologist, at Tallahassee, instead of bestowing them on transient visitors who esteem them only as curiosities.

## MAMMALIA.

### FAMILY EQUIDAE.

#### *HIPPARION PLICATILE* LEIDY.

Plate 2, fig. 8.

From Mr. William M. Dale, Gainesville, Florida, vice-president of the Dunnellon Phosphate Company, the National Museum has received a part of the palate of this species. It has received the number 8265. The specimen was found in a phosphate mine at Juliette, about three miles north of Dunnellon, in a bend of the

Withlacoochee river, at a depth of 60 feet under ground. This fragment contains the second, third and fourth premolars of the right side. The teeth are in fine condition. The fragment is illustrated on plate 2, figure 8, of the natural size. The following measurements have been secured:

Measurements of premolars in millimeters.

| Dimensions taken | Height | Length | Width |
|---|---|---|---|
| $Pm^2$ | 24 | 26 | 21 |
| $Pm^3$ | 24 | 22 | 22 |
| $Pm^4$ | 24 | 21 | 23 |

In the second premolar the protocone comes into pretty close contact with the anterior intermediate column (protoconule). In the other teeth it is well removed from the adjacent columns.

### *PARAHIPPUS?* SP. INDET.

Plate 8, figs. 1-2.

In the collection of the Florida Geological Survey are five lower teeth which seem to belong to the genus *Parahippus*. No. 1634 is a right molar with a part of the front end missing and with a long hinder root; No. 1635, the anterior end of a right molar; No. 1636, the crown of a left molar; No. 1637, the crown of a left molar; No. 1638, the crown of another left molar. These teeth were all found at Newberry, Alachua county, Florida, and were presented by the Franklin Phosphate Company.

The following table presents the measurements of some of these teeth.

Measurements of lower teeth of *Parahippus* sp. indet., in millimeters.

| Dimensions taken | No. 1636 | No. 1637 | No. 1638 | No. 1634 |
|---|---|---|---|---|
| Length | 13.5 | 13.5 | 12 | 13.5 |
| Width of front lobe | 10 | 10.5 | 10 | 10 |
| Width of hinder lobe | 11 | 11.5 | 9.5 | 8.5 |

No. 1635 appears to have been a larger tooth than the others, inasmuch as the width of the front lobe is 12 mm.

In these teeth there is an internal cingulum which continues

across the front and rear of the crown. The mesostyle is marked off from the metaconid by a very shallow groove. While the crowns of all the other teeth are very black, that of No. 1637 is brownish yellow. It may be a milk tooth. Although these teeth probably belong to an undescribed species of *Parahippus* it seems to be better not to apply to them a systematic name until after better materials, especially upper molars, shall have been found. Figure 1, of plate 8 represents No. 1638; figure 2, No. 1636, both one-half larger than the natural size.

The writer has studied a fragment of an upper jaw, with molars of a *Parahippus,* which was found in phosphate deposits near Charleston, S. C. This jaw belonged to a much larger species than that which is represented by the teeth here described from Newberry, Florida.

## FAMILY CERVIDAE.

### *ODOCOILEUS OSCEOLA* (BANGS).

Plate 8, figs. 3-5.

In the collection of the Florida Geological Survey are some teeth which belong to *Odocoileus* and perhaps to the species now existing in Florida, *O. osceola.* By many this form is regarded as only a subspecies of *O. virginianus.* Of these teeth there are an upper right second molar (No. 1443), an upper left probably first molar (No. 1439), a lower right second molar (No. 1379), two lower left third molars (Nos. 1446, 1448), and a lower right third molar (No. 1424).

All of these teeth were found near Dunnellon, Marion county, in the "Cullens river mine," and were presented by Messrs. Schilmann and Bene.

For purposes of comparison measurements have been secured from two skulls of the deer now living in Florida. These belong to the Biological Survey of the Department of Agriculture. One, No. 167764, is that of a doe which was obtained at St. Vincent; the other, No. 58292, that of a buck which was secured in Osceola county. The basilar length of the doe's skull is 221 mm.; that of the buck, 270 mm. The length of the teeth is taken near the middle of the width, while the width is taken across the front lobe and at the base of the crown.

Measurements of teeth of *Odocoileus osceola* in millimeters.

| Upper Teeth. | | | | Lower Teeth. | | | |
|---|---|---|---|---|---|---|---|
| | 167764 | 58292 | 1439 1443 | | 167764 | 58292 | 1379 1446 |
| $Pm^2$ length---- | 12.5 | 12.5 | -- | $Pm_2$ length---- | 9.5 | 7.5 | -- |
| width---- | 10 | 10 | -- | width---- | 5.5 | 4.5 | -- |
| $Pm^3$ length---- | 10 | 10 | -- | $Pm_3$ length---- | 12 | 10.5 | -- |
| width---- | 11 | 11 | -- | width---- | 6.5 | 6.5 | -- |
| $Pm^4$ length---- | 9.5 | 9.5 | -- | $Pm_4$ length---- | 12 | 11.5 | -- |
| width---- | 12 | 12 | -- | width---- | 8.5 | 8 | -- |
| $M^1$ length---- | 13.5 | 13.5 | 13 | $M_1$ length---- | 14 | 13.5 | -- |
| width---- | 13 | 14 | 14 | width---- | 9 | 9.2 | -- |
| $M^2$ length---- | 14 | 14.5 | 14 | $M_2$ length---- | 15 | 15 | 15 |
| width---- | 15 | 15.5 | 14 | width---- | 10 | 10.5 | 9.5 |
| $M^3$ length---- | 13.5 | 14.5 | -- | $M_3$ length---- | 20.5 | 20.5 | 20 |
| width---- | 15 | 15.5 | -- | width---- | 10 | 10 | 10 |

It will be observed that the two individuals of *O. osceola* agree closely in the measurements. The fossil teeth are not greatly different. However, in the tooth No. 1443 (pl. 8, fig. 3) the width across the hinder lobe is 12 mm.; while in the doe examined the width is 14 mm.; in the buck, 14 mm. In the molar No. 1439 (pl. 8, fig. 4) the hinder lobe is only 12 mm. wide. It is found too that the third lobe, or talon, of the hinder molar of the fossil teeth is 6 mm. wide; while in the existing deer in Florida it is only 5 mm. However, in the last lower molar, No. 1446, (pl. 8, fig. 5) the talon is 5 mm. wide. In the fossil molar No. 1379 the greatest width, 10 mm., is at the second lobe; while in the doe this width is found in the front lobe. The fossil upper molars seem, therefore, to have a narrower hinder lobe; while the talon of the hinder lower molar is wider than in the existing deer. On the other hand, the lower last molar, No. 1424, is about 1 mm. narrower in all parts than the other two third molars. One would hardly be justified in proposing at present a new name for the Pleistocene remains of *Odocoileus* found in Florida, but the differences need to be noted.

The finding of the antlers of deer in the Pleistocene deposits in Florida and South Carolina is not at all uncommon.

# REPTILIA.

## FAMILY TESTUDINIDAE.

### *TESTUDO OCALANA*, NEW SPECIES.

Plate 3, figs. 1-4; Plate 9, figs. 1-3.

*Type-specimen.*—Left half of the epiplastron, No. 4299 of the Florida Geological Survey.

*Type locality and formation.*—Ocala, Florida. Pleistocene.

*Diagnosis.*—Epiplastral beak closely resembling that of *T. crassiscutata.* Thickest part of border behind the beak distant from free edge less than the thickness. In *T. crassiscutata* the thickest part equal to only one-half its distance from the free edge.

In a considerable collection of tortoise remains, including more than one, probably three or four species, which was presented by the Florida Lime Company and made near Ocala, Marion county, are some parts which belong apparently to an undescribed form. To this is given the name *Testudo ocalana.* As type of the species is taken the left half of the epiplastral beak, No. 4299 (pl. 3, fig. 1). This resembles closely the corresponding bone of a specimen which was found in Hillsboro county and which, after being referred provisionally to *T. crassiscutata,* was figured in three positions (Foss. Turtles N. A., p. 461, figs. 622 *a-c*). These figures are here reproduced (pl. 9, figs. 1-3) and will serve to illustrate the Ocala specimen. The latter measures from the midline in front to the outer hinder angle 79 mm.; the greatest thickness of the epiplastral lip is 34 mm., somewhat less than in the one figured. The greatest thickness at the end which articulated with the hypoplastron is 18 mm. It seems necessary to refer this specimen from Hillsboro county to this species.

In the collection is a large part of a hyoplastron, No. 4292, (pl. 3, fig. 2) which belonged to a slightly larger individual, inasmuch as the greatest thickness at the hyo-epiplastral suture is 22.5 mm. The form of the thickened border in this region is identical in the two specimens.

The bone extends to the midline and includes 28 mm. of this border behind the entoplastron. From this fact it is determined that the front lobe, measuring from where the humeropectoral sulcus crosses the border, had a width of 160 mm. The entoplastron was 66 mm. wide and was rounded behind. The sulcus mentioned passed close behind the entoplastron. The length of the pectoral

scutes at the midline was 17 mm. As usual, they expanded greatly behind the axillary notch. The bone is of moderate thickness, 12 mm. at the midline, about 8 mm. where it joined the hypoplastron.

The epiplastral and hyoplastral bones described differ from those of *T. crassiscutata* in having the thickest part of the bone, at the hyo-epiplastral suture relatively nearer the free border. In *T. crassiscutata* the greatest thickness is hardly equal to one-half of the distance from the free border to the summit of the slope on the upper surface. In *T. ocalana* the corresponding fraction is four-fifths or more.

A right first costal bone present (No. 4288) is referred provisionally to this species (pl. 3, fig. 3). Only a part of the hinder inner angle is missing. It presents borders for articulation with the first neural, the nuchal, the first, second, third, and fourth peripherals, and the second costal. From the outer angle to the border for the neural it measures 133 mm. The thickness at the neural is 10 mm. The border for union with the nuchal and the first and second peripherals is very irregular and jagged; that for union with the third and fourth peripherals is smooth. The first vertebral scute had a width in front of 94 mm. in addition to the width of the neural. At its hinder end the width was 48 mm. in addition to that of the neural.

A hinder peripheral, apparently the left eighth, is referred to this species. Its number is 4311. Figure 4 of plate 3 presents a view of its front borders.

### *TESTUDO INCISA*, NEW SPECIES.

Plate 3, figs. 5-8.

*Type specimen.*—The xiphiplastral of the left side, No. 4287 of the collection of the Florida Geological Survey.

*Type-locality and formation.*—Ocala, Marion county, Florida. Pleistocene.

*Diagnosis.*—Xiphiplastron thick and heavy, with a deep and rounded notch at the rear, between the two acute terminal processes. Anal scutes very short at the midline.

In a lot of bones presented by the Florida Lime Company, at Ocala, is the xiphiplastral bone here described. Whether any of the other bones in the collection belong to the same species it is impossible to say. The bone here described and figured (pl. 3, fig. 5) indicates a tortoise fully as large as the existing so-called

gopher of Florida. The width at the front of the bone is 60 mm.; the length along the midline, 38 mm. From a line at right angles with the midline and proceeding from the front of the notch the lateral processes extended backward 29 mm. This is, therefore, the depth of the notch. Its width behind was 60 mm. At the inner front angle of the bone the thickness is 8 mm. This increases rapidly, especially near the outer border, where the thickness is 20 mm. From the top of the ridge thus formed the outer border descends steeply. At the furrow between the femoral and the anal scutes the border is acute and the wall slopes less steeply and has a height of 11 mm. The terminal process is triangular. Its lower face is convex. On its upper surface a sharp ridge runs from its base to its apex. From the summit of the ridge the surface slopes in each direction to the free borders of the process. The greatest thickness at the base is 12.5 mm. The area for the anal scute is 43 mm. wide, 39 mm. along the outer border and 8 mm. at the midline. This scute differed from that of the existing gopher (*Gopherus polyphemus*) in being much shorter at its median end.

With this xiphiplastral are associated provisionally the following specimens found at Ocala: A left seventh peripheral and a part of an eighth, No. 4286; a right seventh peripheral, No. 4297; a hinder right peripheral, No. 4305; a part of a left sixth costal, No. 4295; and a part of a bridge peripheral of the left side. The peripherals are remarkable because of their lack of curvature from the upper to the free border. As the xiphiplastral bone is suggestive of relationship with *Gopherus polyphemus,* so too are the peripherals. However, these peripherals are in one way quite different from those of the existing land tortoise of Florida. In this species the free border is prolonged somewhat where crossed by the intermarginal furrows; while in the peripherals here assigned to *T. incisa* the border is there notched. In both species the border is scalloped, but in *T. incisa* the notches are in the peripherals; in *Gopherus polyphemus,* between them.

The height of the left seventh peripheral, taken in front, is 75 mm.; taken behind, 65 mm. The thickness at the front and near the upper end is 8 mm. As will be seen from the illustration (pl. 3, fig. 6), the lower border is notched where crossed by the intermarginal furrow. This indicates that the hinder free border of the carapace was scalloped. The furrow just mentioned, as it ascends, comes nearer and nearer to the front border of the bone.

The outer face of the bone is nearly flat, as is too that of the preserved part of the eighth peripheral. On the inner face of the seventh peripheral is seen the ridge against which rose the hypoplastral buttress. This buttress appears to have been ankylosed to the peripheral.

The right seventh peripheral (pl. 3, fig. 7) belonged to a younger individual. On the plate its lower border is directed upward and the inner face is shown. A fragment of the hypoplastral buttress remains attached. The outer surface is nearly flat. The lower border is hardly notched. What appears to be a ninth, possibly an eighth, right peripheral is represented as showing its front border (pl. 3, fig. 8). The individual was of about the same size as that of figure 7. The outer surface is convex from front to rear, but plane from above downward. There is a quite deep notch in the free border.

### *TESTUDO DISTANS*, NEW SPECIES.

Plate 3, fig. 9.

*Type-specimen.*—An entoplastron, No. 4289, in the collection of the Florida Geological Survey.

*Type-locality and formation.*—Ocala, Florida. Pleistocene.

*Diagnosis.*—Rear of entoplastron largely occupied by the pectoral scutes.

In the collection made at Ocala and presented by the Florida Lime Company is a large entoplastron which is different from any known to the writer. A description of it may eventually lead to the discovery of other parts of the species. It is represented by figure 9 of plate 3. The remarkable feature of the bone is the fact that the pectoral scutes extended forward on its area; whereas in nearly all other species of the genus these scutes have their front border just behind it.

The length of the bone along the midline is 128 mm.; the greatest width, 145 mm. The thickness near the midline and 80 mm. behind the front is 15 mm. As will be observed, the gular scutes extended backward on the entoplastron about 20 mm. The length of the humerals on the entoplastron is about 80 mm. but the left one is the shorter. The humero-pectoral sulcus entered the area of the bone nearest its widest part and swept forward and inward, then backward and inward to the midline.

This bone cannot belong to *T. crassiscutata;* because the ento-

plastron of the type, while not twice as wide as the bone here described, is nearly five times as thick. The entoplastron of that species has likewise a different shape; and the gulars seem to have occupied more of its anterior end. The bone cannot belong to *T. ocalana;* because in this species, as usual, the pectorals do not infringe on the entoplastron.

### *TESTUDO SELLARDSI,* NEW SPECIES.

Plate 8, figs. 6-8.

*Type-specimen.*—A part of the xiphiplastron, accompanied by parts of the carapace, of a large tortoise, No. 1831 of the Geological Survey of Florida.

*Type-locality and formation.*—Vero, St. Lucie county, Florida. Pleistocene.

*Diagnosis.*—In size and structure resembling *T. crassiscutata,* but having the outer face of the anterior part of the thickened xiphiplastral border flat or concave, instead of convex; the thickness of the anterior end of the border contained in the distance to the bottom of the xiphiplastral notch 3.6 times, instead of 3 times.

In the paleontological collection at Tallahassee are various remains of this species regarded as hitherto undescribed. They were obtained in the canal of the Indian River Farms Company, near Vero, St. Lucie county, south of the Florida East Coast Railway. The fragments have the number 1831. As far as possible the fragments have been brought together. It is found that there are present a part of the second neural plate and all of the fourth, most of the fifth and all of the sixth, seventh and eighth; also the proximal ends of the right fourth, fifth, and seventh costals; and of the left fifth and seventh; also various other fragments of costals; also the left side of the xiphiplastron. These parts indicate a very large animal. Some of them are represented by figures 6-8 of plate 8.

The following are the dimensions of the neurals measured, the length being taken at the middle, the width where greatest, and the thickness at the middle of the costal border.

Measurements of neurals in millimeters.

| No. | Length | Width | Thickness |
|---|---|---|---|
| 4 | 108 | 185 | 38 |
| 5 | 115 | 150 | 30 |
| 6 | 87 | 157 | 27 |
| 7 | 78 | 134 | 27 |
| 8 | 75± | 110 | 24 |

From the length of these neurals it is calculated that the carapace had a length of about four feet. Along the midline of the fourth neural there is a broad deep groove. The upper surface of the fifth neural slopes from both ends toward the scutal furrow which crosses it. That of the seventh is concave. The eighth neural is crossed by a scutal furrow. From the scutal furrow which crosses the fourth costal it is ascertained that the third vertebral scute had a width of 300 mm. The fourth vertebral scute extended back on the eighth neural plate.

It is especially in the hinder lobe of the plastron where are found differences which distinguish this species from *Testudo crassiscutata*. Some of these differences are brought out in the following table of measurements. In the third column are given the dimensions that the bone of *T. crassiscutata* would have in case the first measurement were the same as in *T. sellardsi*, 238 mm.

Measurements of xiphiplastra of *Testudo crassiscutata* and *T. sallardsi*, in millimeters.

| Dimensions taken | T. sellardsi | T. crassiscutata | |
|---|---|---|---|
| | | Actual | Reduced |
| From outer end of hypo-xiphiplastron to bottom of xiphiplastral notch | 238 | 255 | 238 |
| Greatest thickness of xiphiplastron at suture just named | 66 | 85 | 80 |
| Thickness of xiphiplastron at suture named and 80 mm. from border | 40 | 35 | 33 |
| Thickness of xiphiplastron at midline and 40 mm. in front of notch | 35 | 32 | 30 |
| Fore-and-aft extent of horn-covered portion of upper surface of xiphiplastral lobes | 63 | 83 | 77 |
| From tip of xiphiplastral lobes to bottom of notch, along the border of the bone | 84 | 120 | 112 |

When we compare closely the xiphiplastron of the two species we find various differences which show themselves to the eye. The outer face of the wall running along the outer border of the bone is, at the anterior end, perpendicular in both species. Further backward, about one-third the distance to the extremity of the bone, the outer face of the wall in *T. crassiscutata* has become slightly convex fore-and-aft (pl. 8, fig. 8, a, a) and quite convex (pl. 8, fig. 8, c, c) from below to its upper border; whereas, in *T. sellardsi* it has become concave from front to rear (pl. 8, fig. 8, b, b) and only slightly convex (pl. 8, fig. 8, d, d) up and down.

From the summit of the wall mentioned its inner face falls off much more rapidly in *T. crassiscutata* than in *T. sellardsi,* so that at a distance of 80 mm. from the outer border of the bone, measured on the lower surface, the thickness is greater in the latter (40 mm.) than in the former species (35 mm.). At a point about halfway along the inner face of the wall the upper surface of the bone has sunken so much that a sort of wide pit is produced. In *T. sellardsi* this pit is much shallower.

The upper surfaces of the lobes of the xiphiplastron which were covered with horn are disproportionately broader in *T. crassiscutata* (85 mm.) than in *T. sellardsi* (65 mm.). The lower surface of the xiphiplastron of the type of *T. crassiscutata* is smooth; that of *T. sellardsi* are provided with vermiform grooves, from 3 mm. to 5 mm. in width and of varying depth. These continue on the horn-covered parts of the upper surface. This feature may have been individual.

The lack of common parts makes it practically impossible to compare the carapaces of the two species here mentioned. In the U. S. National Museum are two neural bones, found near Tampa, Florida, which the writer has figured (Foss. Turtles N. A., p. 460, fig. 618). It is, however, not wholly certain that they belonged to *T. crassiscutata.* One of these is the fourth neural and may, therefore, be compared with the fourth of *T. sellardsi* (pl. 8, fig. 6). It will be seen that they differ somewhat in outline; but this may not be important. The length of that of *T. crassiscutata* is 130 mm.; its width, 200 mm. The length is, therefore .65 of the width. In *T. sellardsi* the length is .53 of the width. In both species the width of the third vertebral scute was about 300 mm.

At present, it appears that parts of the carapace, not found with the rear portions of the plastron, belonging to *T. crassiscutata, T. sellardsi* and *T. hayi,* can hardly be distinguished, the one species from the other.

A comparison of text-figure 6 with that of a large land tortoise figured by Dr. Sellards, but without a systematic name (Seventh Ann. Rep. Fla. Geol. Surv. 1915, p. 70),* shows at once that the animals represented belonged to quite distinct species. In the species figured by Sellards only the second neural bone had taken on the octagonal form. Indeed, the neurals in general had attained a stage of differentiation representing that of the Oligocene genus *Stylemys.* The fourth neural is hexagonal; whereas, in *T. sellardsi* it is octagonal. The fifth neural has quite different forms in the two species.

### *TESTUDO LUCIAE,* NEW SPECIES.

Plate 9, fig. 5.

*Type-specimen.*—Part of the right hypoplastral bone, No. 1807 of the Florida Geological Survey.

*Type-locality and formation.*—Vero, St. Lucie county, Florida. Pleistocene.

*Diagnosis.*—A species perhaps as large as *T. crassiscutata,* but differing in having a thinner wall along the border of the base of the hinder lobe.

Among the materials in the Florida paleontological collection is a part of a very large species of *Testudo* which appears not to have been hitherto recognized. This fragment has the number 1807 and is recorded as having been obtained from the canal of the Indian River Farms Company, east of the Florida East Coast Railway, near the Indian river, at Vero, St. Lucie county. There can hardly be any doubt that the animal lived during the Pleistocene.

The part present and forming the type of the species belongs to the right side and hinder part of the hypoplastron. It is therefore a part of the base of the hinder lobe of the plastron. It extends backward nearly, but not quite, to the suture with the xiphiplastron. The animal was about the size of *T. crassiscutata* Leidy. It appears, however, to differ from that species sufficiently. As in

* Subsequently described as *Testudo hayi.* American Journal of Science, Vol. xlii, Sept., 1916.

the latter, the outer border of the hinder lobe formed a high wall, perpendicular on its outer face. Between the furrow separating the abdominal and the femoral scutes and the hypo-xiphiplastral suture the height of the wall is 90 mm. The summit of the wall is narrower than in Leidy's species. The outline figures (figs. 4, 5, pl. 9) represent sections taken at the hypo-xiphiplastral suture of the two species at the place described. It will be seen that in *T. crassiscutata* (fig. 4) the bone is everywhere thicker. Toward the midline of the lobe, 90 mm. from the outer border, the thickness in Leidy's species is 36 mm.; in the one here described, only 26 mm.

The furrow between the abdominal and femoral scutes descends from the summits of the wall mentioned to the lower surface of the bone. After passing inward and forward about 40 mm. it turns and passes inward and backward, making an angle of about 60° with the outer border. On the lower surface of the bone it is a very broad, illy defined groove.

### *BYSTRA*, NEW GENUS.

*Diagnosis.*—Like *Testudo,* but small and with heavy shell, anterior end of plastron not emarginate at the ends of the gulo-humeral sulci. These sulci running nearly straight across the plastron and lying wholly in front of the entoplastron. Supercaudal scute single. Type *Bystra nanus.* Named in honor of the discoverer of the type specimen.

### *BYSTRA NANUS*, NEW SPECIES.

**Plate I.**

*Type-specimen.*—A complete and only slightly injured shell belonging to Dr. Henry G. Bystra, of Brooksville, Fla.

*Type-locality and formation.*—Holder, Florida. Found in a phosphate mine and belonging probably to the Miocene or Pliocene.

*Diagnosis.*—Besides the characters given under the definition, the plastron of the type has a truncated and much thickened beak; a rather deeply notched hinder lobe, which is thick in front; and vertebral scutes of moderate width.

This specimen (pl. I) was found in the operations of mining for phosphate rock. It was enclosed in a mass of silicious sand, most of which was cemented into a hard mass. The left side of

the shell was somewhat crushed so that a few of the neurals are slightly injured, as well as some of the peripheral plates above the left bridge. No essential part of the structure of the shell is obscured.

The shell shows no indications of youth. The bones are closely apposed, so that it is sometimes difficult to discover the sutures. Nevertheless, the animal was a small one. The length from the front of the plastron to the rear of the carapace is only 100 mm. On account of the great convexity of the plastron it is believed that the shell belonged to a female. The following measurements have been secured:

| Measurements in millimeters. | |
|---|---|
| Length from front of plastron to rear of carapace | 100 |
| Length from front of carapace to rear thereof | 105 |
| Height from bottom of carapace | 60 |
| Width over hinder limbs | 75 |
| Length of plastron along midline | 88 |
| Length of plastron to rear of hinder lobe | 93 |
| Width of front end of anterior lobe | 24 |
| Width at base of front lobe | 44 |
| Length of bridge | 46 |
| Width at base of hinder lobe | 55 |
| Width of notch at rear of hinder lobe | 22 |
| Length of epiplastra along midline | 10 |
| Length of entoplastron | 18 |
| Width of entoplastron | 17 |
| Length of hyoplastron along midline | 20 |
| Length of hypoplastron along midline | 30 |
| Length of xiphiplastron along midline | 15 |

The structure of the carapace is identical with that of various species of *Testudo*. The costal plates about the bridges are alternately wide above, with narrow distal ends, and narrow above, with wide distal ends. Those costals which are wide above articulate each with three neurals, the middle one of which is slightly smaller than the others. Behind the series of neurals there are two suprapygals and a pygal. The last suprapygal has a width of 21 mm.; the pygal a width of 27 mm. The disturbed condition of the neurals precludes measurements of all of them. The first and the fifth have a width of 13 mm. The peripheral bones above the bridges have a height, from their lower borders, of 21 mm.; while the costals joining them have a height of 32 mm.

The vertebral scutes are of moderate width, the third being 21 mm. wide, the fourth, 23 mm.; the fifth 29 mm.

The supracaudal scute is not divided. The front of the an-

terior lobe of the plastron is cut off squarely. The edge is acute, but on the upper surface the bone thickens backward for a distance of 14 mm., attaining a thickness of 10 mm. At the rear of the plastron there is a notch 22 mm. wide and 7 mm. deep. From the hinder extremities of this lobe the border thickens forward to the femoral notch, attaining there a thickness of 10 mm.

The gular scutes form a strip across the front of the anterior lobe their hinder borders being nearly parallel with the front. They measure along the midline 7.5 mm. Along the midline the humeral scutes measure 19 mm.; the pectorals, 6 mm.; the abdominals, 37 mm.; the femorals, 15 mm.; the anals, 5 mm.

### *GOPHERUS PRAECEDENS*, NEW SPECIES.

Plate 4, figs. 1-2.

*Type-specimen*—A left xiphiplastral bone, No. 5463, of the Florida Geological Survey.

*Type-locality and formation.*—Vero, St. Lucie county. Pleistocene.

*Diagnosis.*—Resembling *Gopherus polyphemus,* but having a relatively broader xiphiplastron, which is also more deeply notched on the lateral borders.

In the collection of fossil remains made near Vero, by Dr. Sellards, is a left xiphiplastral bone which appears to belong to an undescribed species. It belonged evidently to a broad and heavy-shelled animal which had a somewhat greater size than the Florida "gopher," *Gopherus polyphemus.* Upper and lower views of the bone are here given (pl. 4, figs. 1, 2).

The bone lacks only a small fragment lost from the upper surface of the outer anterior angle. The width of the bone in front is 79 mm., making the width of the whole hinder lobe at this part 158 mm. The length of the suture between this bone and its fellow is 58 mm. It will be seen that the outer border is deeply notched at the crossing of the femoro-anal sulcus. The distance from the bottom of this notch to the median suture is 48 mm. At the rear of the hinder lobe there was a notch about 80 mm. wide and 20 mm. deep. The parts of the right and left bones included between this notch and the lateral notches stand forth like a pair of ears.

The close resemblance to *Gopherus polyphemus* makes it necessary to refer the new species to *Gopherus.* For the same reason

the species called *Testudo atascosae* (Hay, Foss. Turtles N. A., p. 464, figs. 627-628) must be known as *Gopherus atascosae.*

This xiphiplastral bone resembles that of *G. atascosae.* There are, however, numerous differences. The width of the xiphiplastral part of the hinder lobe in the types of the two species is nearly the same, 158 mm. and 168 mm. In *G. praecedens* the distance from the bottom of the posterior notch to the outer end of the hypo-xiphiplastral suture is 92 mm.; in *G. atascosae* it was about 110 mm. This comes about from the fact that the xiphiplastron of the former species, including the ear-like lobules, is shorter. In the type of *G. atascosae* it had a length of 100 mm.; that of *G. praecedens* is only 83 mm. long. In *G. praecedens* there is a wall-like thickening of the bone along the outer border not greatly unlike that of *G. atascosae* (op. cit. fig. 628a); but while this is 30 mm. high in the last named species, in *G. praecedens* it was only 21 mm. The section taken through the ear-like lobule of the bone appears to have been about the same in the two species (op. cit. fig. 628b) and the thickness seems to be closely the same, 22 mm.

The thickness of the bone forming the type of *G. praecedens,* measured at the middle of the anterior border, is 8.5 mm. The portion which forms the hinder lobule and which on the lower side is occupied by the anal scute appears swollen downward, projecting several millimeters below the rest of the bone. This anal area is finely pitted, while the surface of the remainder of the bone is smooth.

*Gopherus praecedens* probably resembled the species yet existing in Florida more than it did the extinct Texas species referred to above. The males of *G. polyphemus* have the lobules of the rear of the plastron swollen on the under surface, as they were in *G. praecedens.* The xiphiplastral bone of *G. polyphemus* is, however, somewhat narrower, as compared with the length; its lateral border is far less deeply notched; the outer face of the border of the bone, at the suture with the hypoplastral is perpendicular, even overhanging, instead of sloping upward and inward, as it does in *G. praecedens;* and the border of the bone in the hinder notch is much more acute than in the fossil species here described.

No other bones are present which can be with certainty referred to this species.

## FAMILY EMYDIDAE.

### *TERRAPENE FORMOSA*, NEW SPECIES.

Plate 4, fig. 3.

*Type-specimen.*—The greater part of the hinder two-thirds of a carapace which belongs in the collection of the Geological Survey of Florida. Its catalogue number is 2973.

*Type-locality and formation.*—Ocala, Florida. Pleistocene.

*Diagnosis.*—Shell high and broad, with a dorsal keel, on each side of which the areas of the vertebral scutes are deeply impressed. Hinder border of carapace moderately flared outward. Shell thin.

This beautiful species is based on a carapace (pl. 4, fig. 3) which dorsally lacks the anterior portion back to the second vertebral scute, laterally the left costal and peripheral region to the ninth marginal scute and the right costal and peripheral region nearly to the sixth marginal scute. In the part of the shell preserved there are small areas missing.

All of the bones of the carapace are solidly united, so that the forms of the neural, costal and peripheral bones are unknown. The bone composing the neurals and costals is thin. At their upper ends the costals are about 4 mm. thick; at their lower ends, only about 2 mm. At the rear end of the eighth marginal scute the bone is 10 mm. thick. The rear of the carapace descends very steeply to the moderately outwardly turned hinder peripherals. The width at the rear of the eighth marginal scutes is 112 mm.; but it exceeded this somewhat over the bridges. Measured in a straight line, the distance from the front of the second vertebral scute to the rear of the carapace is 125 mm. It is estimated that the distance from the front of the carapace to the rear was about 155 mm. If this is correct, the width was .72 of the length. In a specimen of *T. carolina* the ratio is .86. While the hinder peripherals are only moderately flared outward, as seen from behind, it is different when they are viewed from below. They are turned backward so that their lower surfaces are horizontal. The very considerable thickness of the peripherals makes possible the difference noted. At the middle of the ninth marginal scute the distance from the acute free border of the peripheral to its inner border is 19 mm.

From the free border of the peripherals behind the lateral hinge-line a low but sharp keel runs forward as far as the cara-

pace is represented. This keel lies considerably above the upper edge of the lateral hinge line.

On the areas of the second, third and fourth vertebral scutes, on each side of the midline, there is a deep impression whose surface is irregular. There is left between the two impressions a conspicuous median keel; while outside of each impression, there is left a ridge. There appear, therefore, to be a median and right and left keels. The whole surface of the carapace is more or less undulating.

The sulci which separate the various scutes, especially the costals and the vertebrals, are narrow and deeply impressed. The vertebral scutes are of moderate width. The following are the dimensions:

Measurements of vertebral scutes in millimeters.

| Scute | Length | Width |
|---|---|---|
| 2 | 34 | 39 |
| 3 | 35 | 43 |
| 4 | 40 | 37 |
| 5 | 20 | 38 |

The height of the supracaudals is 13 mm.; that of the tenth marginal scute, 16 mm.; that of the eighth, 20 mm.

### *TERRAPENE ANTIPEX*, NEW SPECIES.

Plate 4, figs. 4, 5. Plate 5, figs. 1-5.

*Type-specimen.*—A hinder lobe of the plastron, No. 5460 of the Florida Geological Survey.

*Type-locality and formation.*—Vero, St. Lucie County, Florida. Pleistocene.

*Diagnosis.*—Size large, the plastron attaining a length of 220 mm. or more; of medium breadth; shell thick and heavy; carapace with its free borders curved upwards, keel over the bridges; free surfaces mostly uneven.

From Vero Dr. Sellards has sent many fragments of a large box-tortoise which appears to have been hitherto undescribed and to which is given the name *Terrapene antipex*. The type is a hinder lobe, No. 5460 (pl. 5, fig. 1), in which all the bones are consolidated into one mass. The course of the hypoxiphiplastral suture is barely distinguishable. The under surface is concave,

thus indicating a male. The figure referred to gives a view of the upper surface of the hinder lobe. This lobe has a length of 136 mm. along the median line; the length, taken across the lateral hinges, is 133 mm. At the midline in front the thickness is 9 mm.; but backward this increases to 15 mm. The lateral hinge lines are 46 mm. long. The horn-covered surfaces, behind the lateral hinges, are 24 mm. wide and the thickness of the bone at the inner border of the surface, is 15 mm.

Seen from below, the hypoplastron has a length of 53 mm., the xiphiplastron, a length of 80 mm. The sulci separating the various scutes run a rather irregular course, especially the median sulcus. Measured on the midline the abdominal scutes are 40 mm. long; the femorals, 24 mm.; the anals, 71 mm.

A part of another hinder lobe of a male, No. 5902, was 140 mm. wide; but only 8 mm. thick at the midline in front. The abdominals are 50 mm. long; the femorals, 21 mm. In a damaged hinder lobe of a female, No. 5461, the width is 120 mm.; the thickness in front, 10 mm. The abdominals are 45 mm. long; the femorals 13 mm.; the horn-covered surface above is 18 mm. wide.

Figure 2 of plate 5 represents of two-thirds the natural size a portion of an anterior lobe which evidently belonged to this species. Its size agrees with that of the type hinder lobe. The width at the hinge line is 130 mm. The length at the midline was not far from 90 mm. The epiplastral lip is mostly gone; but its width was close to 55 mm. The horn-covered upper surface is 18 mm. wide. The hinder two-thirds of the free border is acute. The boundaries of the entoplastron are made out with difficulty. The bone was circular, with a diameter of 44 mm. The courses of the sulci are much as in a specimen of *T. triunguis* at hand.

On plate 4, figure 4, is represented the lower surface of a hinder lobe which is referred to this spceies. It was found near the coast, about 28 miles south of St. Augustine, by Mr. Fred R. Allen, 113 King street, St. Augustine. The length along the midline is 122 mm.; the width, 116 mm. The abdominal scutes are 46 mm. long; the femoral only 13 mm. Nevertheless, there appear to be no good reasons for not referring this specimen to the species here described.

A fragment, No. 4435, from 20 miles north of St. Augustine (pl. 4, fig. 5), shows a part of the right side of the carapace. There are seen a part of the area covered by the first costal scute,

the rear of the first marginal scute, the second and third marginals, and most of the fourth. At the sulcus between the second and third marginals the thickness is 13 mm. In this specimen the border at the third marginal is not much curved upward but in three other specimens it is considerably curved. The upper surface is rough.

Figure 3 of plate 5 presents a view of a fragment on which are wholes or parts of the third, fourth, fifth and sixth marginal scutes. This fragment shows that there is a rather prominent keel which lies above the bridge and runs through the marginals shown. Figure 4 of the same plate presents a view of a strip of the second costal scute, a considerable part of the third marginal and parts of the seventh and eighth marginals. The upper surface of this fragment, No. 5478, is relatively smooth. This piece and another, No. 5469, present the lateral hinge line. The surface of the hinge is flat and 8 mm. wide. The border of the carapace which bears this hinge is turned inward at nearly a right angle with that part of the peripherals which is above the lateral keel. This keel is nearly on a level with the upper edge of the lateral hinge and distant from it about 15 mm.

A fragment of the carapace, No. 1782, has only feeble indications of sutures. A part of the area occupied by the fifth vertebral scute shows that the latter had a width of 45 mm. At the free edge of the bone the eleventh marginal was 20 mm. long, the twelfth, 17.5 mm. The greatest height of the former was 26 mm.; that of the twelfth, at the midline, 15 mm. The hinder part of the tenth scute had a height of 27 mm. The border of the carapace, as here represented, is moderately flared outward, more than in *T. ornata,* about as much as in *T. major.*

Another fragment, No. 5480, (pl. 5, fig. 5), presents both eleventh peripheral bones, the pygal and the suprapygal. The sutures are open. The suprapygal is nearly triangular, 38 mm. wide and 27 mm. high. The pygal is 20 mm. wide, 21 mm. high, and 10 mm. thick. The peripherals are 26 mm. wide on the free border and 28 mm. high. They are moderately flared outward. The eleventh marginals were at least as high as the eleventh peripheral and the twelfth marginals are just as high as the pygals. The fifth vertebral scute was at least 40 mm. wide.

Unfortunately, besides the piece just mentioned, we have

nothing representing the median portion of the carapace; so that it is not known whether or not there was a median keel.

This species differs from *T. formosa* in various respects. It appears to have attained a greater size and to have had a thicker and heavier shell. It appears to have been narrower in proportion to the length. The border of the carapace at the lateral hinge line, as stated above, is turned inward at nearly a right angle with the part of the peripherals above the lateral keel. In *T. formosa* the border is directed downward and only a little inward; so that the lateral keel is placed high above the lateral hinge.

*Terrapene canaliculata* (Hay, Foss. Turtles N. A., p. 363, figs. 463-465) more closely resembles *T. antipex* than *T. formosa;* but the lateral keel is much more conspicuous, the free borders of the peripherals are more strongly recurved and the shell is still thicker and heavier. It is to be noted here that the peripheral illustrated by figure 463 of the work cited belongs to the left side, instead of the right.

It is evident that none of the above mentioned box-tortoises belong to *T. putnami* (Foss. Turtles N. A., p. 361, figs. 459, 460). This was a still larger animal than *T. antipex,* having had a plastron 146 mm. wide. The hypoplastron was, proportionately, much thicker than that of the species last mentioned. It is possible that the fragment of the carapace referred (as just cited, fig. 461) provisionally to *T. putnami* belongs really to *T. antipex;* but the rear of the carapace (fig. 462) is very different from the one above described from Vero, No. 5480; for in the latter the pygal or twelfth pair of marginal scutes rise to the upper border of the pygal bone; in that of figure 462, little more than to half the height of that bone.

### *TERRAPENE INNOXIA,* NEW SPECIES.

Plate 6, figs. 1-4.

*Type-specimen.*—A complete carapace, No. 7080, of the Florida Geological Survey.

*Type-formation and locality.*—Pleistocene. Vero, St. Lucie County, Florida.

*Diagnosis.*—Carapace thin, relatively narrow, highest at middle of length, sloping hardly more rapidly backward than forward; nuchal bone not excavated; hinder peripherals little or not at all flared outwards; vertebral scutes of moderate width; hinder marginal scutes of moderate height.

In the collection made by Doctor Sellards at Vero, Florida, are several portions of the carapace of a box-tortoise which appears to differ from any of the described species, but which does resemble considerably female specimens of *T. major,* a common species of Florida. Two of the specimens from Vero furnish nearly complete carapaces. These have the numbers 7079 and 7080. In both, all the bones are thoroughly consolidated, so that no sutures are to be seen. In the one numbered 7079 the furrows separating the dorsal dermal scutes are so indistinct that these boundaries cannot in all cases be made out. In many places, too, the costal scutes appear to have been broken up into numerous minute patches. On this account the carapace numbered 7080 is taken as the especial type of the species (pl. 6, figs. 1, 2).

In order to facilitate comparisons between this species and its existing relative, possibly descendant, *T. major,* the following table of measurements is provided. Two specimens of *T. major,* a female and a male are measured, so that some of the variations which this species undergoes may be observed.

Measurements of carapaces.

| | T. innoxia | | T. major | |
|---|---|---|---|---|
| | No. 7079 | No. 7080 | No. 29335 ♀ | No. 29337 ♂ |
| Length from front of nuchal bone to rear of pygal | 125 | 119 | 128 | 145 |
| Width at middle of lateral hinge of plastron | 84 | 80 | 87 | 105 |
| Height of carapace at same point | 55 | 55 | 62 | 70 |
| Length of nuchal scute | 10 | 7 | 9 | 12 |
| Width of nuchal scute | 4.5 | 4 | 2 | 3.5 |
| Length of first vertebral scute | 25 | 27 | 26 | 29 |
| Width of first vertebral scute, in front | 32 | 27 | 24 | 27 |
| Length of second vertebral scute | 28 | 28 | 28 | 33 |
| Greatest width of 2nd vertebral scute | 32 | 30 | 31.5 | 38 |
| Length of 3rd vertebral scute | — | 25 | 29 | 32 |
| Greatest width of 3rd vertebral scute | — | 34 | 35 | 41 |
| Length of 4th vertebral scute | — | 26 | 32 | 37 |
| Greatest width of 4th vertebral scute | — | 24 | 32 | 34 |
| Length of 5th vertebral scute | 22 | 20 | 23 | 27 |
| Greatest width of 5th vertebral scute | 29 | 25 | 32 | 34 |

In a fragment numbered 7081 the fourth vertebral scute is 31 mm. long and 31 mm. wide. In another, numbered 7082, the fifth vertebral is 26 mm. long and 30 mm. wide. It will be ob-

served that the widths of the dorsal scutes in the carapace No. 7079, so far as they can be determined, are somewhat greater than in the one taken as the type. The lateral hinge-line is 26 mm. long and the bone is here only 4.5 mm. thick.

The differences which the writer observes between the Pleistocene form and the one with which it is compared are as follows:

1. In *T. major* the greatest height of the shell is behind the middle of the length. From this point the outline descends rapidly, backward. In *T. innoxia* the greatest height is at the middle of the length; and the descent is less rapid and is not much different from the descent forward.

2. In all the specimens of *T. major* at hand the nuchal bone is somewhat excavated in front for the neck. This is not usually the case in the fossil; but in a fragment No. 7083, there is a slight curving inward of the border.

3. In the existing species the nuchal scute is nearly or wholly suppressed. In the fossil it is well developed.

4. In the existing species the hinder marginal scutes are uniformly higher than they are in the fossil. The eleventh in No. 29335 is 17 mm. high; in the fossil specimen 14 mm. high.

The carapace numbered 7079 presents some features different from those of the one taken as the type. The median keel is wanting. The hinder peripherals flare outward considerably, while in the type specimen they do so hardly at all. In this respect, however, similar differences are seen among the four specimens of *T. major*. Evidently the vertebral scutes of No. 7079 were broader than those of No. 7080, but here again similar differences are found among the specimens of *T. major*. The carapace of the fossil species is thin and light, excepting the peripheral bones. Above the bridge there is in the type carapace a hardly perceptible keel passing from the anterior free border to the hinder one; in No. 7079 this is missing. This keel varies considerably among the four specimens of *T. major*.

One fragment, No. 7083, of a carapace in which the bones had not become ankylosed presents the nuchal and the first peripheral of the left side. The nuchal is 30 mm. long, and 36 mm. wide. The thickness at the border which joins the first peripheral is 7 mm. A fragment, No. 7084, comprises the bones on which lie the second, third, fourth, and a part of the fifth marginals. This

differs from the other specimens in having the surfaces more uneven.

Another fragment, No. 7082, of those referred to this species, shows the sutures between the bones. Between the last neural and the suprapygal the eighth costals join for a space of 9 mm. The furrow between the fourth and the fifth costals crosses the last neural. The suprapygal is 19 mm. wide; the pygal 16 mm. wide.

In none of the specimens referred to this species does the tenth marginal come at all near the fifth vertebral scute, a character which differentiates the species from Cope's *T. eurypygia.*

No. 5471 of the collection (pl. 6, fig. 3) is an anterior lobe of the plastron. Its size, shape, and thickness suggest that it belonged to *T. innoxia.* It presents no characters by which it may be distinguished from the same part in *T. major.* No. 7085 (pl. 6, fig. 4) is the left xiphiplastral bone. It is 41.5 mm. long on the median suture and 34.5 mm. wide on the hypo-xiphiplastral suture. The anal scute extends forward nearly to the suture last mentioned. The horn-covered surface on the outer border of the upper surface is flat and 9 mm. wide.

### *PSEUDEMYS CAELATA* HAY.

Plate 2, figs. 1-7.

In the Fossil Turtles of North America, page 356, plate LVII, the writer described the species named above. The specimens are in the National Museum and were found somewhere in Levy county, Florida. The parts figured are the nuchal (made the type of the species), the first left costal, the fifth left costal, the seventh right (wrongly called the left third) and tenth peripherals, and the left hypoplastron.

In the collection of the Florida Geological Survey are several fragments of the same species. These also were found in Levy county, at what is called the Mixon locality, two miles northeast of Williston, the type locality of the Alachua formation. The parts present are the left epiplastron (3537); a part of the right hyoplastron (3420); a part of the right hypoplastron (3418); and a part of the left (3427); a fourth neural (3425), a part of the right fifth costal (3421); the right first peripheral (3415); two left second peripherals (3423, 3426); the right third peripheral (3410); a right and a left ninth peripheral (3416, 3417). These bones certainly do not all belong to the same individual. No two

pieces fit together. Seven of the pieces are here figured (pl. 2, figs. 1-7).

The epiplastral (pl. 2, fig. 1) has the sculpture better shown than that of the specimen in the National Museum, the ridges and grooves being sharply defined. Here, as in other parts, the ridges are more or less interrupted in their course. Those in the gular area are directed fore and aft; those of the humeral area are at nearly right angles to the midline of the plastron. The same is true of the upper side of the bone. At the free border the ridges are carried out into sharp tooth-like processes. The width of the gular scutes, taken together, was 52 mm. The width of the bone, from the median border to the outer angle, is 53 mm.; the thickness at the suture for union with its fellow is 11 mm.

The fragment of the right hyoplastron (pl. 2, fig. 2), does not reach the midline and falls short of reaching the hypoplastron. Furthermore, the free border in front of the axillary notch is damaged. Its sutural borders for union with the epiplastron and the entoplastron are present. The epiplastron appears not to have made so deep a notch between the hyoplastrals as in *Trachemys scripta*. The thickness at the hyoepiplastral suture is 11.5 mm. The pectoral scute had a width of 33 mm. near its outer end. The character of the very distinct sculpture is shown by the figure.

The portion of hypoplastron adds nothing to the knowledge beyond that furnished by the nearly complete bone in the National Museum; and the sculpture of the latter is better defined.

The neural bone (pl. 2, fig. 3) is quite certainly the fourth. The length on the midline is 26 mm.; the greatest width 36 mm.; the thickness, 10 mm. The upper surface is covered with numerous small tubercles and longitudinal wrinkles.

The fifth costal is represented by only the distal end. On its inner surface is a ridge against which arose the buttress from the hypoplastron.

The first right peripheral (pl. 2, fig. 4) extends back from the acute free border a distance of 40 mm. and 36 mm. along the free border. Its thickness is 11 mm. The ridges on the area of the first marginal scute run nearly parallel with the furrow between this scute and the second. Those ridges on the area of the second scute run obliquely to this furrow, forward and outward. A part of the first costal scute occupied the inner end of the bone here described.

The second left peripheral (pl. 2, fig. 5) extends 35 mm. from the free border and 33 mm. along the border. Its thickness at the anterior inner angle is 12 mm.; at the posterior inner angle, 18 mm. The upper surface is concave from the free border to the suture with the costal plate; the lower surface convex.. The other left second peripheral (3426) is not so wide from outside to inside and is somewhat thicker than the one with the number 3423. On the upper surface of these two peripherals the ridges in front of the intermarginal furrow are much broken up and irregular; behind this furrow they run parallel with the free border; above the longitudinal furrow they run at right angles with this furrow.

The right third peripheral (pl. 2, fig. 6) has lost a part of its hinder inner border. The length along the free border is 37 mm.; along the front border 37 mm. The thickness at the front end is 21 mm.; of the hinder end at the free border, 26 mm. The thickening at the hinder end of the bone is to provide for the buttress from the hyoplastron. The ornamentation of the three scutal areas is different. Above the longitudinal furrow there are descending ridges. In front of the intermarginal furrow there are irregular and anastomosing ridges; behind this furrow, there are longitudinal ridges.

The left ninth peripheral (pl. 2, fig. 7) has the free border 32 mm. long. The extent of the front border is 41 mm.; the greatest thickness on the latter 10 mm. From the upper or inner border to the free border the bone flares upward somewhat. The free border is thin and acute. Near the front end of the border for union with the sixth costal is a considerable pit for the end of the rib. Above the longitudinal furrow there are tubercles arranged in rows at right angles with one another. In front of the intermarginal furrow the interrupted ridges are parallel with the furrow; behind it they are directed outward and backward.

### *TRACHEMYS? DELICATA*, NEW SPECIES.

Plate 7, fig. 1.

*Type-specimen.*—A right fourth costal plate, No. 3738 of the Florida Geological Survey.

*Type-locality and formation.*—Near Labelle, Lee county, Florida. Pliocene?

*Diagnosis.*—Carapace rather large, a foot or more in length; the neurals thick, the costals thin beyond the neural end. Scutal

furrows narrow and shallow; the sculpture consisting of low sharp ridges.

No. 3738 of the collection of the Florida Geological Survey presents the larger part of the right fourth costal of a turtle which probably belonged to either *Trachemys* or *Pseudemys*. The bone is recorded as having come from the top of a stratum of shell marl, below an unconformity, about one-eighth of a mile straight east of Labelle, on Caloosahatchee river. The marl is thought to be probably Pliocene. The bone is much more thoroughly fossilized than those bones from the Pleistocene.

The costal (pl. 7, fig. 1) has lost the distal end. The upper end (directed toward the left in the figure) measured along the edge of the second vertebral scute, is 36 mm. wide. Where the bone joined the third neural it is 10 mm. thick, but at a distance of 25 mm. it is reduced to 4 mm. From the position of the furrow between the third vertebral scute and the second and third costal scutes it is seen that the vertebral had only a moderate width.

The sculpture is on the pattern of that of *Trachemys scripta*, but it is more delicate. The ridges are low and sharp. On the area of the third costal scute there are four of these in a line 13 mm. long. On the area of the second costal scute the ridges are irregular in direction.

### *TRACHEMYS BISORNATA* (COPE).

Plate 7, figs. 2-7.

A nuchal bone in the collection of the Florida Geological Survey, finely preserved, is referred to this species. It has the catalogue number 3735 and was found in Pleistocene deposits in Lee county. It bears this label: From above the unconformity; about 1-8 mile by land, east of Labelle, on Caloosahatchee river.

The nuchal (pl. 7, fig. 2) is larger than that of the Texas specimen described and figured by the writer (Fossil Turtles N. A., p. 353, pl. LVI, fig. 1), but the proportions are almost exactly the same. The length along the midline is 60 mm.; the greatest width, 70 mm.; the width in front, 38.5 mm.; the thickness at the lateral angles, 16 mm. The front border is acute. The front end of the first vertebral scute is 40 mm. wide. The character of the ornamentation is shown by the figure. In the one from Texas, above referred to, the transverse ridges of the areas of the right

and left first marginal scutes are more strongly developed. In the present specimen the longitudinal ridges are more prominent; but the two sets are present on the nuchals of both. The upper surface of the bone is quite uneven. Along the midline, in the area of the first vertebral scute, is a prominent rounded ridge, and this is continued forward by the elevated area of the nuchal scute. Just outside of the keel, on the area of the first vertebral scute, the surface is depressed.

To this species is referred provisionally a right third peripheral, No. 3740, found just north of Labelle on the Caloosahatchee. Figure 3 of plate 7 shows well the character of the sculpture and the relative height of the third and fourth marginal scutes. There is a well defined lateral keel. The length of the bone along the keel is 43 mm. Figures 4 and 5 of the plate present views of the two ends of the bone.

A right sixth peripheral, No. 1755, is likewise referred to this species. It came from the canal of the Indian River Farms Company, at Vero, north of this place, east of the Florida East Coast Railway bridge over Van Valkenburg Creek. The deposits are regarded as Pleistocene. The bone has a height, measured from the lateral keel and at the hinder end of the bone, of 44 mm. The length along the keel is 42 mm. In front the thickness on the keel is 5 mm.; at the rear, 13 mm. The sculpture (pl. 7, fig. 6) is identical with that of the third peripheral, above described; but it is not so strongly expressed. Figure 7 of the same plate presents a view of the hinder end of this bone.

At Vero Dr. Sellards collected the distal end of a fifth costal bone of the right side, and this is referred to *T. bisornata*. The greatest width is 42 mm.; and the bone indicates, therefore, a carapace of about 295 mm. in length, 11 inches. It resembles much the corresponding bone in *T. scripta;* but the thickening on the inner surface to receive the buttress of the plastron does not stand out so prominently.

### *TRACHEMYS SCULPTA* HAY.

Plate 7, figs. 8-10.

The numbers 3740*a* and 3740*e* are given to two bones which are referred to *Trachemys sculpta,* a species described by the writer in 1908 (Fossil Turtles N. A., p. 351, pl. LIV, figs. 4-9). The type of the species is a nuchal bone which was found in Pleisto-

cene deposits of Hillsboro county, Florida. The other bones were referred provisionally to the same species.

The two bones here described (3740*a* being a part of the nuchal, and 3740*e* the right eleventh peripheral) are recorded as coming from the north bank of the Caloosahatchee river just above Labelle. This place is in Lee county and in the township numbered 43 south, 29 east.

The hinder half of the nuchal (pl. 7, fig. 8) is missing. The part present appears to be identical with the figured type but it is somewhat larger, the distance along the front being 32 mm., instead of 29 mm. The width of the bone at the hinder edges of the first marginals is 50 mm. instead of 41 mm. The front border is somewhat more deeply notched than in the type. The greatest thickness is 16 mm. The region of the nuchal scute is elevated, as in the type. Its surface is deeply pitted. The remainder of the surface of the bone is marked by prominent and sharp ridges.

The eleventh peripheral (pl. 7, fig. 9) is complete. Its greatest height is 37 mm.; the width along the free border, 34 mm.; the thickness at the suture with the tenth peripheral 12.5 mm. The bone joined the tenth peripheral, the eighth costal, the suprapygal and the pygal. The free border is notched where crossed by the inter marginal furrows. On its outer surface are scutal areas belonging to the eleventh and twelfth marginals and the fifth vertebral. The positions of the sulci indicate that the fifth vertebral did not come down on the pygal nor the fourth costal on the tenth peripheral. The fifth vertebral area is marked by sharp broken ridges and pointed tubercles. The sharp ridges of the area of the eleventh marginal run parallel with the front edge of the bone; those of the twelfth marginal area are directed backward and downward.

The proximal end of a right third costal, No. 352 (pl. 7, fig. 10), is referred to this species. On this fragment are shown parts of the second and third vertebral scutes and a part of the second costal scute. The figure referred to shows the character of the sculpture. The width of the bone along the sulcus between the costal scute and the two vertebrals is 28 mm.

From Vero, St. Lucie county, Dr. Sellards has sent to the writer some bones which appear to belong to this species. One, No. 7102, is a portion of a nuchal like that here figured (pl. 7, fig. 8). The nuchal scute is somewhat narrower and the sculpture of the bone in general is hardly so strong. There are also two

eleventh peripherals of the left side, Nos. 4418 and 5485, which, while differing slightly from each other, preserve the essential characters of the species.

At Vero was obtained a right sixth costal bone which is referred to *T. sculpta*. The sculpture of the surface is identical with that shown by figure 9, plate LIV, of the writer's Fossil Turtles of N. A.

### *TRACHEMYS EUGLYPHA* (LEIDY)?

Plate 4, fig. 6.

From Ellenton Dr. Sellards has sent a portion of a nuchal bone which has the number 5775 and which it seems must be referred to Leidy's species named above. Most of the bone is missing behind the sulcus which runs between the first marginals and the first vertebral. Although differing in some respects from the type described and figured by Leidy (Trans. Wagner Inst., Vol. II, p. 27, pl. IV, fig. 1) it possesses many of the striking characters of that type specimen. It is extremely thick, 21 mm., at the suture with the first peripheral of each side. Just behind, at the rear of the nuchal scute, the thickness is 18 mm. The upper surface is strongly sculptured. The sulci form deep and sharp cuts. The nuchal scute area is 26 mm. long and 9 mm. wide. It ends in front in a sharp point, instead of being obtuse as in the type.

While the sculpture of the upper surface resembles somewhat that of *T. sculpta* the bone differs in being much thicker.

The type was found in Peace Creek deposits, which formerly supposed to belong to the Pliocene are now regarded by Dr. Sellards as undoubtedly Pleistocene.

### *TRACHEMYS? NUCHOCARINATA*, NEW SPECIES.

Plate 6, fig. 5.

*Type-specimen.*—The anterior portion of a nuchal bone, No. 4437 of the collection of the Florida Geological Survey.

*Type-locality and formation.*—Florida Coast Line Canal, 20 miles north of St. Augustine. Pleistocene.

*Diagnosis.*—Nuchal bone furnished with a strongly developed median keel.

The portion of a nuchal bone which is taken as the type of this species lacks the hinder part, but it is so peculiar that it can hardly be confused with any other nuchal.

The length cannot be determined, but it was quite certainly

close to 46 mm. The extreme width is 57 mm.; the width along the anterior border is 32 mm. The greatest thickness in the border which joined the first peripheral is 11 mm. The bone along the anterior border is acute, and this border is notched in the midline. The upper surface of the bone is concave on each side of the median rounded keel. This keel is unusually prominent and projects well forward between the marginals of the first pair. The nuchal scute is extremely narrow on the upper surface; but on the lower side of the bone it widens posteriorly to 11 mm. The front width of the first vertebral scute is 46 mm. It narrows backward as far as the bone extends and was probably urn-shaped. The sulci are rather sharply and deeply impressed. The surface of the carapace was probably somewhat uneven.

### *PSEUDEMYS FLORIDANA PERSIMILIS*, NEW SUBSPECIES.

Plate 5, figs. 6-8.

*Type-specimen.*—A pair of epiplastral bones, No. 7098 of the Florida Geological Survey.

*Type-locality and formation.*—Vero, St. Lucie County, Florida. Pleistocene.

*Diagnosis.*—Gutter for the neck in the epiplastral lip more deeply excavated than in *P. floridana* and the border immediately outside of gular scutes less acute.

In the collection made by Dr. Sellards at Vero is a pair of epiplastral bones which resemble very closely the corresponding parts in specimens of *Pseudemys floridana*. Some differences, possibly not of great value, appear to exist. In order that these differences may be kept in mind and that the literature which may accumulate around this fossil form may be in a manner isolated, it is thought best to give it a subspecific name. Some of the peculiarities of the epiplastrals (No. 7098) will be seen from the figure (pl. 5, fig. 6). The epiplastral lip is 56 mm. wide. The width of the anterior lobe at the outer ends of the sutures between these bones and the hyoplastrals is 107 mm. The length of each of the sutures is 32.5 mm. The width of the entoplastron was 49 mm. The greatest thickness of the two bones on the suture uniting them is 13.3 mm. The thickness on the epi-hyoplastral suture is 11 mm. These measurements agree quite well with those made on the two shells of *P. floridana*, except that the thickness on the common suture in these does not exceed 11 mm.

The gutter for the neck is more deeply excavated than in either of the two shells mentioned and several others examined. Of the free border of each epiplastral the anterior two-thirds is much more obtuse than in the specimens of *P. floridana*. As in the latter, the horn-covered area on the upper surface of these bones is very narrow, being only 7 mm. wide at the epi-hyoplastral suture and only 4 mm. at the midline in front.

In the collection, with the number 7099, is a left xiphiplastral bone which is referred provisionally to this sub-species (pl. 5, fig. 7). The length along the median suture is 68 mm.; the width along the hypo-xiphiplastral suture is 61 mm. The corresponding measurements of the two mentioned shells of *P. floridana* do not differ much. The greatest thickness at the hypo-xiphiplastral suture and about 20 mm. from the free border is 11 mm. As in the case of *P. floridana*, the width of the horn-covered area on the upper surface and at the front of the bone is 8 mm. The depth of the notch at the outer end of the femoro-anal sulcus is much greater than in *P. floridana*, but it may be that this is not normal. A right third costal plate, No. 7100, is shown on plate 5 (fig. 8). Its width at the outer end is 48 mm. It appears to agree in all respects with the corresponding bone of the shells of *P. floridana* at hand.

### *CHELYDRA LATICARINATA*, NEW SPECIES.

Plate 6, figs. 6-7.

*Type-specimen.*—The sixth left peripheral, No. 7094 of the Florida Geological Survey.

*Type-locality and formation.*—Vero, St. Lucie County, Florida. Pleistocene.

*Diagnosis.*—Peripheral bones considerably thicker than those of *C. serpentina;* those over the bridges with a sharp keel; upper surfaces smooth.

Among the chelonian bones collected at Vero are ten which appear to have belonged to the genus *Chelydra*. Three of the bones are parts of costals, five are peripherals, one a neural, and one is the inner portion of the left hyoplastral. A study of these bones makes it evident that two species are represented. As the type of the one above named a bone, No. 7094, the sixth left peripheral (pl. 6, fig. 6) is taken.

This bone has a length of 42 mm. It indicates that the length of the carapace was close to 315 mm. about 12 inches; therefore,

not so large as some specimens of *C. serpentina*. The width at its front end is 30 mm.; while that of a specimen of *C. serpentina*, with carapace 240 mm. long, is hardly 20 mm. The greatest thickness, at the hinder end, is 13 mm.; in the case of *C. serpentina*, only 6 mm. In individuals of *C. serpentina* there is a narrow ridge, sometimes obsolete, usually inconspicuous, which runs along on the bridge peripherals from the free border in front to that behind. In the species here described this ridge is very prominent. The surface above this ridge is much flatter than it is in the existing snapping turtle. The border of the bone below the keel mentioned is 12 mm. wide; in the specimen of *C. serpentina* used for comparison, only 6 mm. wide. The surface of the type bone is smooth.

A bone numbered 5943 (pl. 6, fig. 7) is the left eighth peripheral. Its length is 44 mm.; its width at the middle of the length is 34 mm., the thickness 11.5 mm. In the carapace of *C. serpentina* used for comparison these dimensions are respectively 31 mm., 16 mm., and 5.5 mm. The upper surface is somewhat flatter, the lower considerably more convex than in *C. serpentina*. The eighth and ninth marginals at their junction are 21 mm. high; in *C. serpentina*, 15 mm.

Another hinder peripheral, No. 5508, seems to be the tenth of the left side. It is shorter than the one last described, only 36 mm. The width is nearly the same at the two ends, 29 mm., but the upper edge is slightly eroded. It may have formed a jagged suture with the costals. The thickness is 11 mm. The surfaces are smooth. There is no notch in the free border where it is crossed by the sulcus between the corresponding marginals, differing in this respect from most specimens of *C. serpentina;* but in old individuals the notches, except the one in the eleventh peripheral of each, are often wanting.

### *CHELYDRA SCULPTA*, NEW SPECIES.

Plate 4, fig. 7; Plate 6, figs. 8-9.

*Type-specimen.*—A ninth right peripheral, No. 5510 of the Florida Geological Survey.

*Type-locality and formation.*—Vero, St. Lucie County, Florida. Pleistocene.

*Diagnosis.*—Ninth peripheral not so thick as that of *C. lati-*

*carinata;* much thicker than in *C. serpentina;* border not notched; upper surface sculptured.

The ninth peripheral here considered (pl. 6, fig. 8) is 38 mm. long and 30 mm. wide at the ends; 27 mm. wide at the socket for the costal. It belonged to an individual whose carapace was close to 12 inches in length.

Inasmuch as we have at hand the hinder end of the eighth peripheral referred to *C. laticarinata* and the front end of the ninth of *C. sculpta* it is easy to compare them. The two bones are nearly of the same length, that of the first mentioned species being 44 mm. The thickness of the bone at the hinder end in *C. laticarinata* is 11 mm.; in *C. sculpta* 9 mm. The ninth marginal scute, on the hinder end of the eighth peripheral of *C. laticarinata,* has a width of 28 mm.; on the front end of the ninth peripheral of *C. sculpta,* the width is only 20 mm. On the lower side of the eighth peripheral of *C. laticarinata* the surface which was originally covered with horny material is 23 mm. wide; on the front end of the ninth of *C. sculpta* only about 12 mm. The upper surface of the peripheral of *C. laticarinata* is smooth; in *C. sculpta* it is varied by the presence of pits and grooves. By its inner border this bone was joined by a jagged suture with the sixth and seventh costal bones. This bone presents no indication whatever of a notch in its free border.

A left seventh peripheral from Vero with the number 7090 (pl. 6, fig. 9) has a length of 33 mm. and a thickness of 10 mm. at each end. The inner border is injured, so that the width cannot be determined; it was at least 23 mm. The rear of the seventh marginal is 11.5 mm. high. Differences in form between this bone and the eighth peripheral described above, differences seen especially on the underside, may be due to differences in age and size; but the upper surface of the seventh is strongly pitted and ridged; and it is, therefore, referred to *C. sculpta.*

The three fragments of costals can be only provisionally assigned. One, No. 7091, the upper third of apparently the right fourth costal (pl. 4, fig. 7) has a width of 29 mm. There is present a lateral carina running along outside of the vertebral scutes, as in *C. serpentina.* Mesiad of this is a longitudinal depression more marked than in the existing species. Descending behind the sulcus between the second and third costal scutes is a broad groove which is only faintly indicated in *C. serpentina.* The

whole hinder half of the costal bone is sculptured by ridges and grooves which run fore-and-aft.

The other fragments of costals, Nos. 7092 and 7093 appear to have belonged to younger individuals. They seem to show that the lateral dorsal carinae were more strongly developed than in *C. serpentina.*

It is impossible to say to which species the neural and the hyoplastral bone belonged.

Of the turtles described in this paper from the locality at Vero. Florida, the following according to the records of the Florida Geological Survey were found in place in horizon No. 2 of the published section:*

| | |
|---|---|
| Terrapene innoxia | Testudo sellardsi |
| Chelydra laticarinata | |

The following species were found not in place.

| | |
|---|---|
| Testudo luciæ | Trachemys bisornata |
| Gopherus præcedens | Trachemys sculpta |

The following species have been obtained from the next later or overlying deposit, No. 3 of the section:

| | |
|---|---|
| Pseudemys floridana persimilis | Terrapene antipex |
| Terrapene innoxia | Chelydra sculpta |

## ADDITIONAL NOTE.

After this paper had taken on page form Doctor Sellards sent to the writer, for examination, a small collection which he had lately secured at Vero, and which furnishes some additional information. From all the materials examined the following turtles have been identified from the stratum which Doctor Sellards has called No. 3.

| | |
|---|---|
| Gopherus polyphemus | Pseudemys floridana persimilis |
| Terrapene antipex | Chelydra sculpta |
| T. innoxia | Chelonia mydas |

*Amer. Journ. Sci. Vol. xlii, p. 6, July, 1916; and this Volume, text-figure 2.

The bones referred to *Gopherus polyphemus*, the land tortoise now existing in Florida, present some differences when compared with recent skeletons, but with more materials, recent and fossil, these differences might disappear.

In the last lot received is a nearly complete carapace and considerable parts of two others of *Terrapene innoxia*. These were considerably broken up in getting them out of the ground. The shells are thin and delicate. Let us suppose that such shells had originally been buried in stratum No. 2 and had been disturbed in their partially unmineralized and soft condition. They could not have failed to be broken into fragments and scattered far and wide.

*Chelydra sculpta* is a species very distinct from the existing snapping turtle. As shown by the materials just received, it appears that all the peripheral bones were joined to the costal plates by jagged sutures. In *Chelydra serpentina* there are between the two sets of bones considerable fontanelles. In both species the bones are thin and fall apart readily on maceration. The shell could not suffer burial and redeposition. Now, in the new lot there are seven bones of one carapace. To the nuchal a right and a left first costal join accurately. The fourth and fifth costals of the right side belong together without doubt. That snapping turtle must have lived when stratum No. 3 enveloped it.

Out of six chelonians, then, found in that stratum at least three are extinct. Other fragments in the collections appear to indicate additional extinct species, but they do not justify final conclusions. In the opinion of the writer this stratum, No. 3, belongs to the Pleistocene and not to the later part of it.

*Bystra nanus*, gen. sp. nov. Type specimen. Slightly less than natural size. View of shell from the right side and from below. P. 53.

Plate 2.

Figs. 1-7. *Pseudemys caelata.* Various bones. Natural size. P. 64.

1. Left side of epiplastron, showing lower surface. Fla. Surv. coll. No. 3537.
2. Fragment of the right hyoplastron, showing the lower surface. Of the upper border of the figure the left half is for union with the right epiplastron; the right half for union with the entoplastron. No. 3420.
3. A neural bone, probably the fourth. No. 3425.
4. First peripheral of the right side, upper surface. No. 3415.
5. Second left peripheral. No. 3423.
6. Right third peripheral, part missing. No. 3410.
7. Left ninth peripheral. No. 3417.

Fig. 8. *Hipparion plicatile.* Piece of right side of upper jaw, with three molars. Natural size. P. 41.


Plate 3.

Figs. 1-4. *Testudo ocalana.* One-half natural size. P. 45.

1. Left half of epiplastron, seen from below. Type. No. 4299.
2. Right half of hyoplastron, seen from above. No. 4292.
3. Right first costal plate. No. 4288.
4. A hinder peripheral, probably the eighth, presenting a view of its front end. No. 4311.

Figs. 5-8. *Testudo incisa.* Various parts. One-half natural size. P. 46.

5. Left half of xiphiplastron. Seen from below. No. 4287.
6. Left seventh peripheral and part of eighth. No. 4286.
7. Right seventh peripheral, showing inner face. No. 4297.
8. Right eighth (or ninth) peripheral, showing anterior end. No. 4305.

Fig. 9. *Testudo distans.* Type entoplastron. Times .46. No. 4289. P. 48.

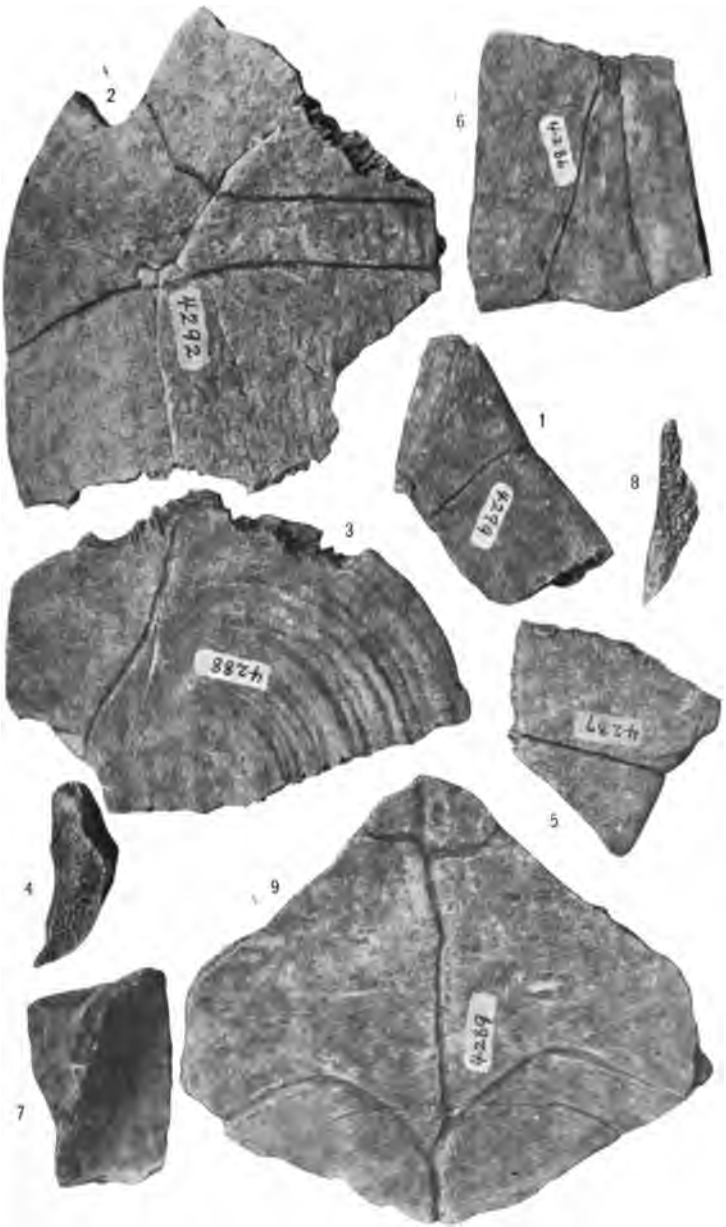


Plate 4.

Figs. 1,2. *Gopherus praecedens.* Type. Left xiphiplastral bone. Two-thirds natural size. No. 5463. P. 55.

1. Seen from below.

2. Seen from above.

Fig. 3. *Terrapene formosa.* Type. Hinder two-thirds of the carapace. One-half natural size. No. 2973. P. 57.

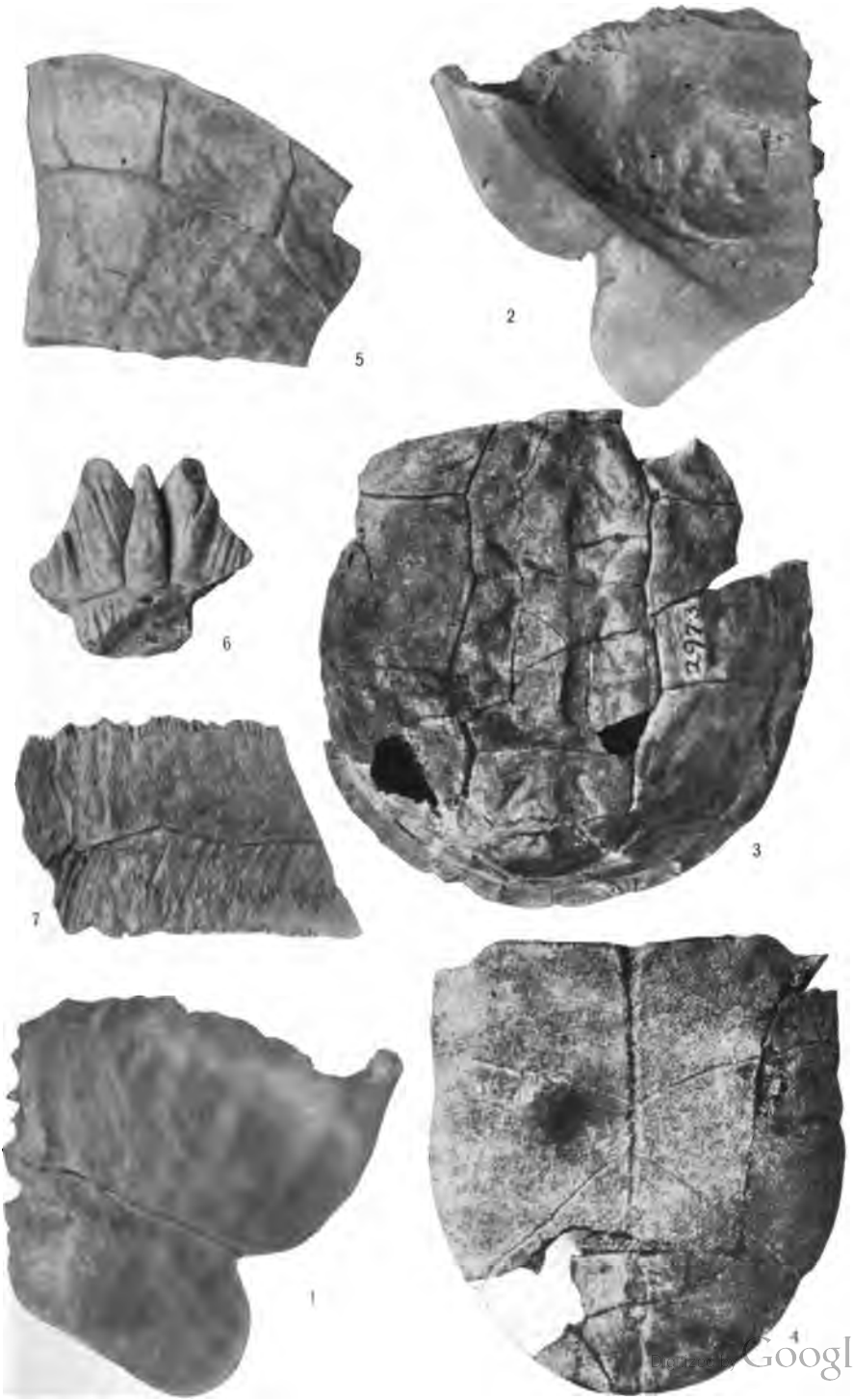
Figs. 4,5. *Terrapene antipex.* Two-thirds natural size. P. 58.

4. Hinder lobe of plastron. Allen specimen.

5. Right side of front of carapace. No. 4435.

Fig. 6. *Trachemys euglypha?* Part of nuchal bone. Two-thirds natural size. No. 5775. P. 70.

7. *Chelydra sculpta?* Part of supposed right fourth costal plate. Two-thirds natural size. No. 7091. P. 73



## Plate 5.

Figs. 1-5. *Terrapene antipex*. Parts of carapace and plastron. P. 58.

1. Hinder lobe of plastron seen from above. No. 5460. One-half natural size.
2. Part of front lobe, seen from above. No. 5462. One-half natural size.
3. Part of right side of carapace. Times .63. No. 5255.
4. Part of right side of carapace. Times .6. No. 5478.
5. Rear of carapace. Times .6. No. 5480.

Figs. 6-8. *Pseudemys floridana persimilis*. P. 71.

6. Epiplastral bones seen from above. No. 7098. Type.
7. Left xiphiplastral bone seen from above. No. 7099.
8. Right third costal plate. No. 7100.







## Plate 6.

Figs. 1,2. *Terrapene innoxia.* Type. Two-thirds natural size. No. 7080. P. 61.

1. View of carapace from above.
2. View of carapace from below.

Figs. 3,4. *Terrapene innoxia.* Parts of plastron referred. Two-thirds natural size. P. 64.

3. Anterior lobe seen from above. No. 5471.
4. Left xiphiplastral bone seen from above. No. 7085.

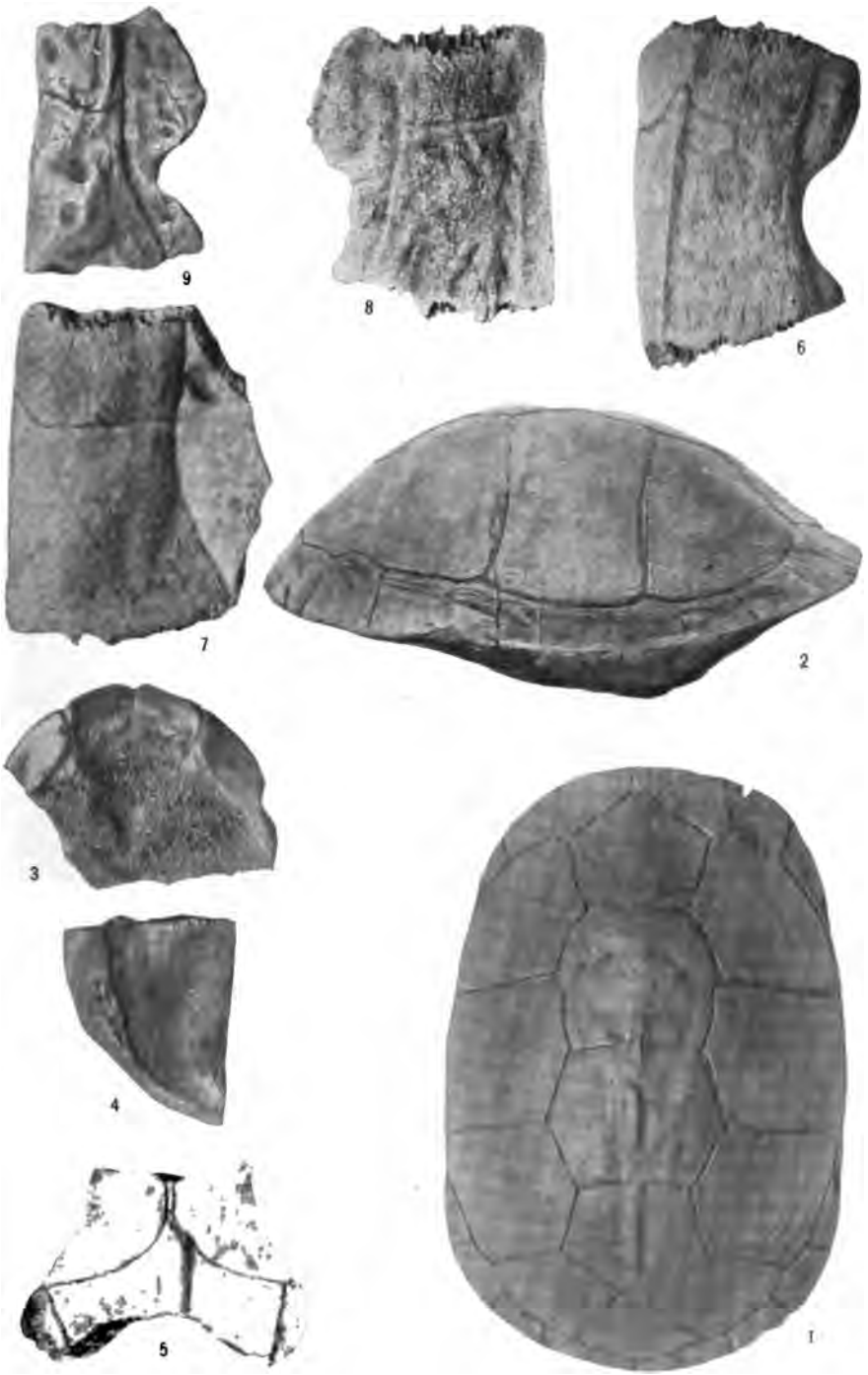
Fig. 5. *Trachemys? nuchocarinata.* Type. Two-thirds natural size. Part of nuchal bone seen from above. No. 4437. P. 71.

Figs. 6,7. *Chelydra laticarinata.* Natural size. P. 72.

6. Sixth left peripheral bone seen from above. Type. No. 7094.
7. Left eighth peripheral, No. 5943, seen from above.

Figs. 8,9. *Chelydra sculpta.* Natural size. P. 73.

8. Right ninth peripheral seen from above. Type. No. 5510.
9. Left seventh peripheral seen from above. No. 7090.



## Plate 7.

All the bones of this plate are slightly less than the natural size.

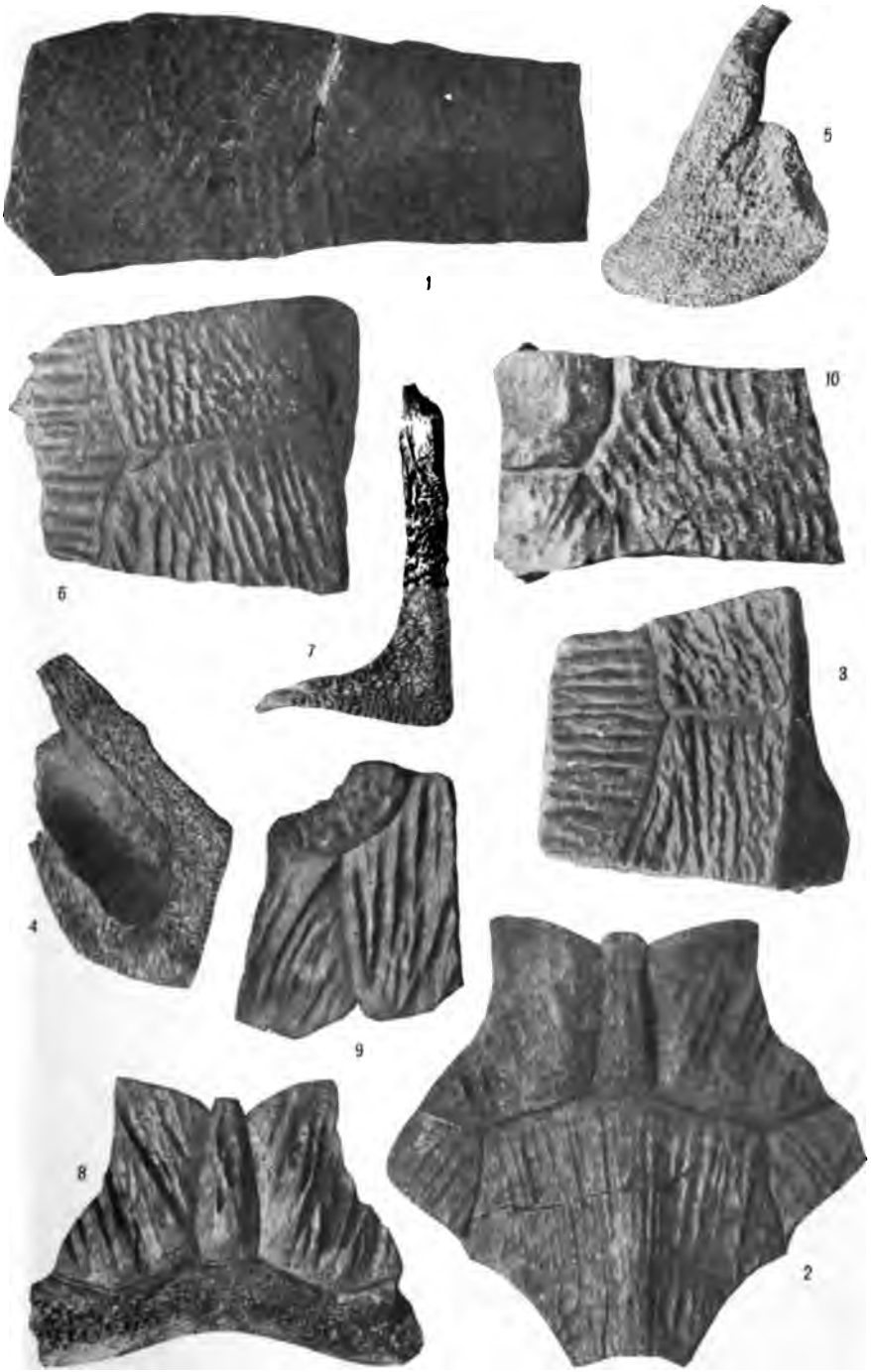
Fig. 1. *Trachemys? delicata.* Type. Right fourth costal, with distal end missing. No. 3738. P. 66.

Figs. 2-7. *Trachemys bisornata.* P. 67.

2. Nuchal plate, No. 3735, showing upper surface.
3. Right third peripheral plate, showing outer surface. No. 3740.
4. Same bone, seen from behind. Shows sutural border for the fourth peripheral (on upper and right-hand parts of figure) and for hyoplastron and its buttress (on lower part of figure).
5. Same bone as that of figures 3 and 4, showing the front end, which joins the second peripheral.
6. Sixth right peripheral, showing outer surface. No. 1755.
7. Same bone, showing the hinder end, for union with seventh peripheral.

Figs. 8-10. *Trachemys sculpta.* Three bones of carapace. P. 68.

8. Anterior part of nuchal bone. No. 3740*a*.
9. Eleventh right peripheral, showing outer surface. No. 3740e.
10. Proximal end of right third costal, showing outer surface. No. 352.



## Plate 8.

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Fig. 7. Section across the border of the hinder lobe of the plastron at the hypo-xiphiplastral suture.

Fig. 8. Lines showing form of surface on outer face of the anterior third of the border of the xiphiplastron in *T. crassiscutata* and in *T. sellardsi.*

*a,a* Shows longitudinal convexity of the border described in *T. crassiscutata.*

*b,b* Shows longitudinal concavity of the border in *T. sellardsi.*

*c,c* Shows vertical convexity of the border in *T. crassiscutata.*

*d,d* Shows very slight vertical convexity of border in *T. sellardsi.*


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2


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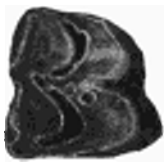
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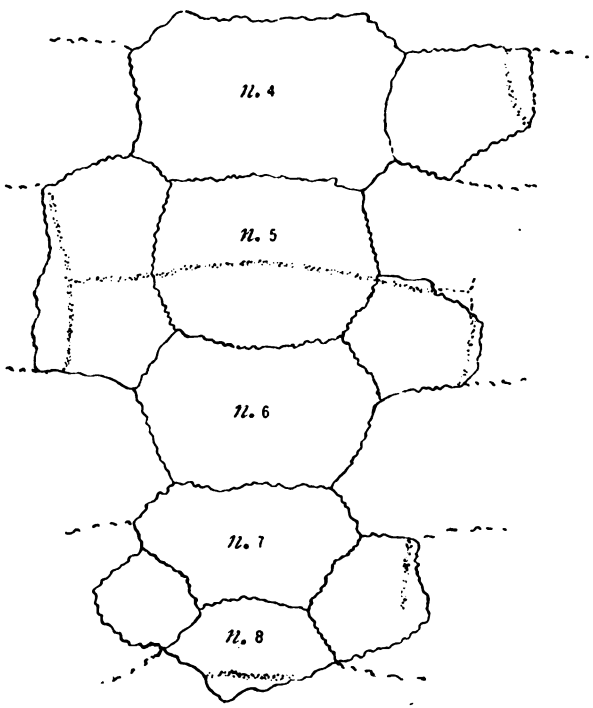

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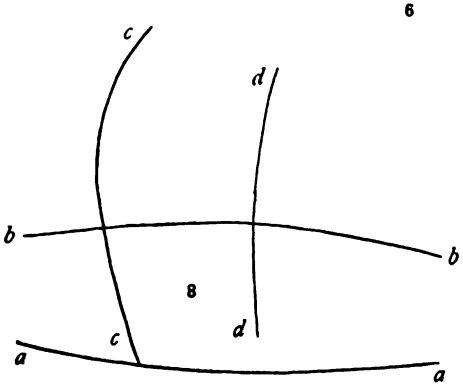


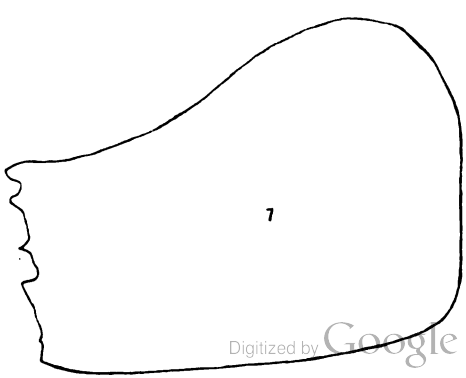

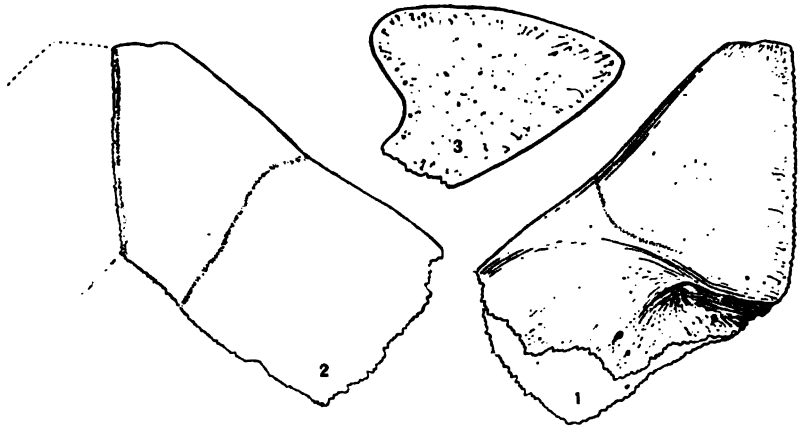


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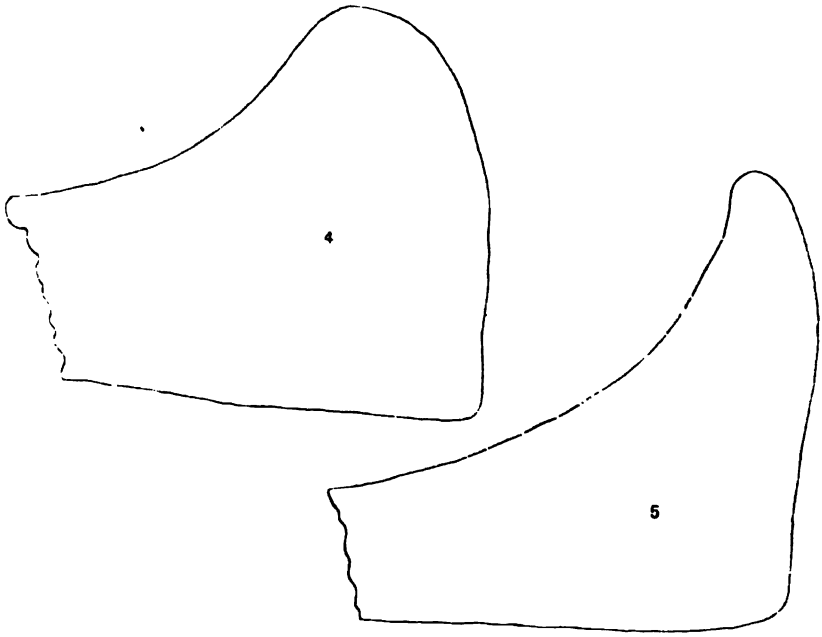


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Fig. 5:—*Testudo luciae.* Section at same place as in Fig. 4. Two-thirds natural size. Fla. Surv. coll. No. 1807. P. 52.

# FOSSIL VERTEBRATES FROM FLORIDA: A NEW MIOCENE FAUNA; NEW PLIOCENE SPECIES; THE PLEISTOCENE FAUNA.

(PLATES 10-14.)

BY E. H. SELLARDS.

# CONTENTS.

# FOSSIL VERTEBRATES FROM FLORIDA: A NEW MIOCENE FAUNA; NEW PLIOCENE SPECIES; THE PLEISTOCENE FAUNA.

(PLATES 10-14.)

E. H. SELLARDS.

## INTRODUCTION.

Attention was first effectively called to the vertebrate fossils of Florida in the early eighties. Among those who were active in collecting material from Florida at that time were J. Frances LeBaron, John C. Neal, Samuel T. Walker, W. H. Dall, L. C. Johnson, Joseph Willcox and J. B. Hatcher.

In 1881 J. Frances LeBaron made a collection of fossil vertebrates from Peace Creek which was forwarded to the Smithsonian Institution together with pebble phosphate rock for which the collection was chiefly made. This material ultimately reached Professor Leidy and formed a part of the Peace Creek collections studied by him. Collections of Pliocene vertebrates were made by Dr. J. C. Neal from localities near Archer for the Smithsonian Institution in 1883, and for the Academy of Natural Sciences of Philadelphia in 1885. Additional collections from the localities near Archer were made for the United States Geological Survey by W. H. Dall in 1885; by L. C. Johnson in 1887, and by J. B. Hatcher in 1889. In 1888 Joseph Willcox in company with Wm. M. Meiggs, visited the Peace Creek beds. Phosphate mining from the bed of the river was then in progress and through the assistance of T. S. Moorhead, who was operating one of the mines, Mr. Willcox was able to secure a very important collection of the fossils of that locality. During the same year Mr. Willcox obtained the very interesting lot of material afterwards described by Professor Leidy from the rock quarries at Ocala, Florida. In addition to these important localities Mr. Willcox also obtained vertebrate fossils from the Caloosahatchee River, Sarasota Bay and Stump

Pass. In recent years the collections from Florida have been added to very materially by the Florida State Geological Survey.

The vertebrate material from Florida has been studied chiefly by Professor Joseph Leidy, his work on the Peace Creek, Ocala, and Archer collections being classic. The final report on the material from the Archer localities, which was not fully completed at the time of Professor Leidy's death was edited and revised by Professor Frederick A. Lucas. In addition to the studies referred to, the literature contains frequent critical references to the Florida fossils by Cope and later paleontologists. A list of papers relating to the Florida vertebrates will be found in the subsequent pages of this paper.

The early collections of vertebrate fossils in Florida were all made from localities on the Gulf Coast or western side of the Peninsula. Throughout this part of the State the Pleistocene beds are thin, and the rivers for the most part cut through the Pleistocene and into the older formations. The result is an unfortunate mixing in many of the localities on the western slope of the peninsula of Pleistocene and earlier vertebrates, which has led to not a little confusion in the literature regarding the supposed range of species. Inasmuch as considerable progress in the study of the geology of Florida has been made in the twenty years or more since Professor Leidy's papers were written, it has seemed worth while to re-examine these localities in the light of our present knowledge of the stratigraphy of the State. This has seemed the more desirable since not only has additional material been derived from old localities, but several important new localities have been discovered.

From the Alum Bluff formation a new vertebrate fauna has been obtained, while in the collections from the later formations are several hitherto unknown species.

Among important new localities for Pleistocene vertebrates are those found on or near the Atlantic Coast, where the Pleistocene is well developed and where the conditions are such as to preclude the possibility of the mixing of Pleistocene and earlier vertebrates, thus eliminating all confusion as to the stratigraphic position of the fossils. An added significance is given to these new localities by the recent discovery at Vero, in St. Lucie County, of fossil human remains in association with the Pleistocene vertebrates*.

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* Amer. Journ. Sci., (4), xlii, pp. 1-18, July, 1916; and this Volume, pp. 121-160).

## STRATIGRAPHIC SUCCESSION.

The Florida section includes the succession from the Eocene or the Lower Oligocene to the recent, and the discussion of localities which follows is in the order of the natural sequence as nearly as that has been determined.

### EOCENE OR LOWER OLIGOCENE. OCALA FORMATION.

The Ocala formation is represented in Florida by extensive and very pure limestones from which has been obtained, however, but scanty vertebrate material. Fish remains are present but are observed as a rule only in localities where the rock has disintegrated, the more resistant parts, especially the teeth of sharks and rays, remaining after the limestone has disappeared. Of land mammals none have been obtained, while of marine forms, only *Basilosaurus* (*Zeuglodon*) has been found, remains of this genus having first been discovered imbedded in limestone at Ocala in 1888 by Mr. Joseph Willcox (Leidy, 1889, p. 13).

In 1913 Dr. C. W. Cooke obtained parts of a jaw from the pit of the Florida Lime Company near Ocala, which has been identified by J. W. Gidley as *Basilosaurus cetoides*. In 1914 the writer obtained through Mr. Franz Weston from pit No. 12 of the Cummer Lumber Company, near Newberry, some whale vertebrae which have been determined by Mr. Gidley as *Basilosaurus brachyspondylus*.* This specimen was found in the hard rock phosphate beds, very close to the underlying limestone from which evidently it was derived. Since zeuglodons have heretofore been known from the Jackson formation of the Eocene, their presence in the Ocala formation which in recent years has been regarded as Oligocene is of much interest, particularly as the species appear to be identical with those of the Jackson formation.

### UPPER OLIGOCENE AND MIOCENE. CHATTAHOOCHEE AND ALUM BLUFF FORMATIONS.

The upper Oligocene of Florida includes at the base impure clayey limestones, the Chattahoochee formation, which later gives place to the calcareous clays, calcareous and phosphatic sands, and fuller's earth clays of the Alum Bluff formation. In addition to the terrestrial material further evidence of the nearby land areas in

* Letter of Nov. 11, 1914.

Florida is furnished by the inclusion in the limestones of the upper Oligocene near Tampa of a rather abundant and diversified land and fresh-water invertebrate fauna, and in the Alum Bluff formation of land plants found at Alum Bluff on the Apalachicola River, as well as by the land vertebrates described in this paper.

## A NEW MIOCENE FAUNA.

Early in November, 1915, the Geological Survey received notice through Mr. E. B. Epps of the discovery of fragments of vertebrate fossils from a well on the Griscom plantation about 15 miles north of Tallahassee (Sec. 32, T. 3, N., R. 1 E.). On November 2 this locality was visited by Messrs. Epps and R. M. Harper, and on November 4 and November 20 by Messrs. Epps, H. Gunter and the writer. Subsequently collections at this locality were made by the writer and others. A few very interesting fossils were secured, the best preserved of which are here described.

After passing through the surface materials which consist of coarse red, clayey sands, 15 to 20 feet in thickness, the well from which these fossils were obtained enters the gray phosphatic sands and clays characteristic of the Alum Bluff formation and terminates at the depth of about 60 feet in hard limestone, probably of the Chattahoochee formation. The vertebrate fossils are imbedded in the gray phosphatic sands and are believed to have come chiefly from a depth of from 25 to 50 feet.

During the present year a few vertebrate fossils have been obtained at the fuller's earth mine at Midway, in Gadsden County. Although few in number, the fossils found at this locality are characteristic and represent the same fauna as that found on the Griscom plantation. In addition the writer in 1908 obtained from the fuller's earth mine at Quincy a well preserved lower cheek tooth of *Merychippus*, and a few other less characteristic fossils.

Although only a few species are represented, the new fauna obtained at these localities is nevertheless of special interest since it includes the earliest Tertiary land vertebrates obtained in the eastern United States. The evidence afforded by the vertebrate fossils as to the age of the formation is likewise very welcome. In addition to the vertebrates the Alum Bluff formation contains marine invertebrates, and it is of interest to compare the land and marine faunas thus associated.

## DESCRIPTION OF SPECIES.

### EQUIDAE.

#### *PARAHIPPUS LEONENSIS*, SP. NOV.

Pl. 11, figs. 3, 6-9, and 12.

Among the fossils from the Griscom plantation is a horse represented by a permanent tooth from the right upper jaw, probably $M^1$, two lower cheek teeth, an astragalus and a first median and a first lateral phalanx. This horse is referred to the genus *Parahippus* and to the new species *P. leonensis*. A horse, probably the same species, is represented in the collection from the fuller's earth mine at Midway by a right astragalus, a second phalanx, a proximal part of a metacarpal, and a fragment of a tooth. The tooth from the upper jaw, Florida Survey collection No. 5084, is selected as the type of the species.

The tooth selected as the type is but little worn and serves well to show the characters of the species. The exterior margin is marked by a prominent median rib. The metaloph is fully connected with the ectoloph. From the anterior wall of the metaloph a complex fold reaches across and touches or almost touches the posterior wall of the protoloph thus forming a well marked crochet. The prefossette is closed or nearly so by the crochet. The postfossette is also closed by the large hypostyle, the walls of which show complex folding. The protocone is large, oval and slightly elongated anteroposteriorly. The hypocone although not so large as the protocone, is prominent and is noticeably elongated anteroposteriorly. The inner walls of the protocone and hypocone are not abrupt but are sloping. The protoconule is compressed and tends to assume a cresentic position; it is separated from the protocone by a constriction formed chiefly by a fold in the anterior wall of the protoloph. The metaconule is separated from the hypocone by a less pronounced constriction than that which separates the protoconule from the protocone. A light cingulum borders the depression which separates the protocone and the protoconule. A light coating of cement is seen in the inner median valley.

MEASUREMENTS.

| | |
|---|---|
| Anteroposterior diameter of tooth, probably $m^1$ | 16mm |
| Transverse diameter, at base | 19mm |
| Transverse diameter from summit median ridge to inner margin | 15mm |
| Height of crown, tooth but slightly worn | 13.5mm |

*Generic Relation*: This species is clearly to be referred to the Anchitheriinae as indicated by the brachyodont permanent molars having only a very light coating of cement. Of the five known American genera of Anchitheriine horses one, namely, *Mesohippus* may be omitted from consideration since the Florida species is much advanced beyond the stage represented by the species of that genus; nor can the species be referred to the European genus *Anchitherium* from which it is excluded by the pronounced fold in the anterior wall of the metaloph. From *Hypohippus* this species is excluded by the presence of a well developed crochet, as well as by the fact that the protoconule and metaconule are not so reduced as in that genus, the protocone occupying less than one half the traversed diameter of the crown of the tooth. From *Archaeohippus* as defined by Gidley* the species is seemingly excluded by the pronounced anterior fold of the metaloph, and by the fact that the prefossette owing to this fold is not continuous with the inner median valley of the tooth. It resembles *Archaeohippus,* however, in the fact that the constriction separating the protocone and protoconule is formed chiefly in the anterior wall of the protoloph.

With *Parahippus,* the one remaining known American genus of Anchitheriine horses, the species agrees in having a well defined anterior fold in the metaloph. It is unlike many of the species of that genus in the fact that the inner conules, protocone and hypocone, form no part of the inner boundary of the pre and postfossette, from which they are excluded by a pronounced development of the crochet and hypostyle. In fact the hypostyle and crochet lack but little completing the connection with the metaloph and protoloph respectively which is clearly the tendency of development in the tooth. The connection of the hypostyle is at the inner margin of the metaconule just at the constriction which separates it from the hypocone; the connection of the crochet likewise is with the inner margin of the protoconule at the constriction which separates it from the protocone. It requires only the union of the hypostyle and crochet with the metaloph and protoloph to complete the inner crescent of the tooth, thus giving a transition to the fundamental pattern of the protohippine tooth.

Of the described species of *Parahippus* this species presents ap-

* American Museum of Natural History, Bull., Vol. xxii, p. 385, 1906.

parently a rather close resemblance to *Parahippus* (*Anchippus*) *texanus* (Leidy).* From that species, however, it differs first of all in size, the anteroposterior diameter of the tooth being 16 mm. while that of the Texas species according to Gidley is 19 mm. A difference may be seen also in the protocone, which in the Florida species is more nearly circular, being but slightly elongated anteroposteriorly, while the protocone of *P. texanus* is distinctly elongated, although not in a line parallel to the anteroposterior diameter of the tooth. The walls of the crochet and hypostyle of the Florida tooth are distinctly folded while in the Texas species they are more nearly simple. The fold in the anterior wall of the metaloph (crochet) according to Leidy's statement does not actually touch the protoloph in *P. texanus* nor does the projection from the hypostyle connect with the metaloph. In the Florida species the enamel wall of the crochet touches the enamel wall of the protoloph. This is true also of the hypostyle, and in the worn tooth apparently there is connection of the dentine of the metaloph and hypostyle. The type of *P. texanus* which was taken from a well at a depth of 50 feet in Washington County, Texas, is commonly assigned to the Miocene.

To *P. cognatus,* the type species of the genus, the resemblances are perhaps hardly so close as to *P. texanus.* Of *Parahippus* (*Anchippus*) *brevidens* (Marsh) Gidley I have seen no specimens, nor does the species seem to have been illustrated. The teeth of that species, however, are slightly larger, and are described by Gidley as having a considerable investment of cement. From *Parahippus pawniensis* Gidley this species differs in that it has a strong median rib on the external surface of the molars. The metaloph in the upper teeth of *P. pawniensis,* moreover, is said to be comparatively straight, while in this species it curves backward. From *Parahippus coloradensis* Gidley this species differs in that the outer walls of the paracone and metacone are nearly smooth while in that species they are described as being strongly ribbed.

This species presents close resemblance in the structure of the upper molars to *Parahippus* (*Desmatippus*) *crenidens* Scott from

* Journal of the Academy of Natural Sciences, Phila., (2), Vol. vii. The Extinct Mammalian Fauna of Dakota and Nebraska, pp. 312-313, pl. xxi, fig. 13, 1869.

the upper Deep River beds of Montana.* (Miocene.) The Florida horse, however, probably represents a somewhat more advanced species than *P. crenidens*. First of all, the tooth, although smaller, is higher crowned; the crochet is more strongly developed; the protoloph likewise is connected with the outer wall and in the position of the protocone and hypocone, there is, however, a very close resemblance particularly to the first molar of *P. crenidens*. *P. crenidens* was perhaps a slightly larger animal as the proximal phalanx referred to this species by Scott is somewhat larger than the proximal phalanx associated with the Florida species. From *Parahippus tyleri* Loomis this species is very distinct, the shape and position of the protocone and hypocone being very different in that species.†

The species may be compared also with *Archaeohippus* (*Anchitherium*) *ultimum* (Cope) Gidley. It differs from that species, however, and is also excluded apparently from that genus by the presence of the well developed crochet, as well as by the fact that the hypostyle is much more strongly developed than is that of *A. ultimus*. The lower molar, specimen No. 5083, it may be noted, is very similar to the lower molars of *Archaeohippus* (*Anchitherium*) *agreste* (Leidy). The pronounced shelf on the inner side of the cingulum which is seen in the teeth of the two known species of *Archaeohippus* is not found on the teeth of this species.

With the milk molars of *Merychippus insignis* one may recognize very suggestive resemblances. Thus the protocone and metacone have much the same form with a tendency to enlongation anteroposteriorly. The hypostyle is similar except that in *M. insignis* it is entirely united with the metaloph while the union in the Florida species is not complete. The milk molars of *M. insignis* thus present a stage in development beyond that of the permanent molars of this species.

The teeth from the lower jaw are much worn and in their present condition there is but a faint suggestion of separation of the metaconid and the metastylid. The entostylid appears to have been about equally deveolped as in species of *Archaeohippus*. A cingu-

* The Mammalia of the Deep River Beds, Amer. Philo. Sco., Trans., Vol. xviii, pp. 88-92, 1895.

† Am. Jour. Sci., 4th Ser., xxvii, pp. 163-165, Aug., 1908.

lum is developed on the anterior and posterior sides, but no shelf is seen on the inner or outer sides of the tooth. A light coating of cement is seen in the valleys. In addition to the lower cheek teeth figured the collection contains a fragment showing a part of the outer margin of another lower molar on which, however, is preserved no additional distinctive characters. The anteroposterior diameter of the lower tooth, No. 5083, is 16 mm. The tooth, as indicated by this measurement, is therefore much larger than the teeth of a species of *Parahippus* described and illustrated by Dr. O. P. Hay on page 42 of this volume (pl. 8, figs. 1-2).

The astragalus is shortened beyond that of *Mesohippus*, thus resembling *Achaeohippus*, *Parahippus* and other more modern genera. Of the two astragali illustrated the left is from the Griscom plantation while the right is from the fuller's earth mine at Midway. The metacarpal, or metatarsal, the proximal part only of which was obtained, is a slender bone, the width of the proximal articular surface being only 18 mm. On the posterior side may be seen the roughened surface for the articulation of the splint bones. The median first phalanx, specimen No. 5083, is of relatively strong development, while the lateral phlanges are much reduced. The median groove in the proximal end of the first median phalanx is shallow, and scarcely reaches to the dorsal surface. On the palmar surface the roughened area for the attachment of the inferior sesamoid ligament is confined to the proximal one-fifth of the bone. The distal articular surface is very similar to that of the modern horse although it is perhaps less reflexed above and below. The second median phalanx, referred provisionally to this species is relatively strong. The measurements of these bones are as follows: Astragalus, transverse width 17 mm., greatest length 24 mm., median first phalanx, length 30 mm.; median second phalanx, length 20 mm.

### *MERYCHIPPUS* SP.

Pl. 11, fig. 1.

In 1908 the writer obtained from the fuller's earth mine at Quincy a single lower cheek tooth of *Merychippus*. The specimen was secured from a workman who found it while digging with a pick in the indurated sand above the fuller's earth stratum. Further evidence of its place in the deposit is afforded by the fact that

the base of the tooth contained the gray sand characteristic of the Alum Bluff formation. The tooth, as may be seen by the illustrations, is moderately hypsodont and has a coating of cement. The metaconid and metastylid are distinctly separated. The tooth is but little worn and may be referred with confidence to the genus *Merychippus*.

Professor J. C. Merriam, who has compared this tooth with the horses of the western United States contained in the University of California collection, has kindly supplied the following notes:

> Your tooth, No. 173, most closely approaches the lower dentition of one of our horses from the recently discovered fauna occurring in beds crossing the summit of the Southern Sierra of Tehachapi. One of these species I have considered the most primitive known *Merychippus*. * * * I will say in conclusion that your specimen No. 173, is very much more progressive than any Oligocene horse known to me. It is certainly very different from our uppermost John Day horses. Your specimen is also more progressive than any horse certainly referred to the lower Miocene of North America. Our fauna from the Tehachapi is presumably middle Miocene, but it might possibly be the uppermost portion of the lower Miocene. I should judge that the horizon from which tooth No. 173 came is somewhere near the lower portion of the middle Miocene, unless this is a very unusually advanced type in an old formation or an unusual survival of an old form in a late formation.

The specimen is No. 173 of the Florida Survey collection. The measurements are as follows: Greatest anteroposterior length, 17 mm.; width 7 mm. The species is no doubt new although it is desirable to secure additional material to serve as a type before naming the species.

Since writing the above the writer has received through Mr. C. C. Ruprecht, Manager of the Fuller's Earth Company, a lower molar of *Merychippus* from the fuller's earth mine at Midway. As in the tooth first obtained the metaconid and metastylid are distinct. The tooth is moderately hyposodont and has a coating of cement. The height of the crown of the tooth which is slightly worn is 16 mm.; the transverse measurement is 10 mm.; the anteroposterior measurement is 15 or 16 mm.

## CANIDAE.

### *MESOCYON? IAMONENSIS* SP. NOV.

Pl. 11, fig. 11.

A dog from the Griscom plantation is represented by a single specimen, in which is preserved the right upper sectorial and right

upper molars, one and two. The species appears to be rather close to some of the species of *Mesocyon* from the John Day beds and is referred provisionally to that genus. When compared to *M. coryphaeus* it is seen that the sectorial is placed in the jaw at approximately the same angle. The deuterocone, however, is more closely appressed. The Florida specimen indicates a dog somewhat larger than *M. coryphaeus.*

As compared to *Cynodesmus thooides* from the lower John Day beds this species differs in the sectorial tooth. The duterocone in particular adheres much more closely to the tooth. The sectorial is also better adapted as a cutting tooth being thinner and directed inward at a sharper angle. The two posterior molars, however, are very similar to those of *C. thooides,* although slightly smaller. The angulation between the molar-premolar series is perhaps more pronounced than in *C. thooides.* This species may be known as *Mesocyon ? iamonensis.* The type specimen is No. 5082 of the Florida Geol. Survey collection.

### CAMELIDAE.

#### *OXYDACTYLUS?* SP.

Pl. 11, fig. 4.

A small camel is represented in the collection from the Griscom plantation by one complete tooth and by several tooth fragments and by the proximal and distal ends of a cannon bone. The same species is perhaps represented by tooth fragments and by three astragali from the fuller's earth mine at Midway. Although broad, the cheek teeth are low crowned, and the species is provisionally referred to the genus *Oxydactylus.* The dimensions of an unworn cheek tooth, Fla. Surv. coll. No. 5073, are as follows: Greatest anteroposterior width 21 mm.; greatest transverse width 17 mm.; greatest height of unworn crown 11 mm. Associated with this tooth are two premolars which probably belong to the same animal. The anteroposterior measurement of the larger of the two premolars is 10 mm.

### HYPERTRAGULIDAE.

#### *LEPTOMERYX?* SP.

Pl. 11, fig. 2.

The small deer-like animal, *Leptomeryx,* so abundant in the White River beds of the west is apparently represented by a single astragalus, Fla. Surv. coll. No. 5097. Direct comparison of this

astragalus with the astragalus of *Leptomeryx* contained in the National Museum from Hat Creek basin, Siox County, Nebraska, representing the Oligocene, indicates no pronounced differences, and the specimen is with little doubt to be referred to that genus. The Florida specimen is possibly somewhat wider than is the astragalus of the species with which comparison was made. The dimensions of the astragalus are as follows: Greatest length 13 mm.; greatest width 7 mm. While this astragalus may represent an animal generically distinct from *Leptomeryx*, it may nevertheless be safely referred to the family Hypertragulidae.

## INDETERMINATE FOSSILS.

The remaining fossils include: A fresh-water turtle, represented by fragments of the carapace; a crocodilian, represented by teeth, parts of the jaw, vertebrae and dermal plates; a shark, represented by teeth, and an eagle ray, represented by parts of teeth; fish scales and vertebrae are also numerous. The turtle and alligator, as well as the scales of fish, have been found at Midway in place in the fuller's earth stratum. The other fossils are derived chiefly from above the fuller's earth or from a sandy matrix between the two fuller's earth strata. The presence of the vertebrate fossils in the fuller's earth deposit is evidence of the near shore origin of this formation.

## AGE OF THE ALUM BLUFF FORMATION.

The type locality of the Alum Bluff formation is at Alum Bluff on the Apalachicola River in Liberty County. With the exception of the incoherent sands at the top, the entire exposure at Alum Bluff was referred by Langdon, who first described the section to the Miocene.* The term "Alum Bluff beds" was proposed by Dall in 1892†, and was defined as including the "unfossiliferous sand and clay strata intervening between the Chipola marl and the upper fossiliferous bed at Alum Bluff." At that time the deposits were referred to the "old Miocene," in contrast to the newer or Chesapeake Miocene, found at a higher level in the same section.

*Some Florida Miocene; by Daniel W. Langdon, Jr., Amer. Journ. Sci., (3) xxxviii, pp. 322-324, 1889.

†U. S. Geol. Surv. Bull. 84, p. 122, 1892.

Subsequently the Alum Bluff formation was placed in the Oligocene following the general acceptance of that term in America.

The top surface of the Alum Bluff formation at Alum Bluff is eroded, the later formations resting unconformably upon it. A better section of this formation is seen at Rock Bluff, seven miles farther up the river, where about 90 feet consisting chiefly of phosphatic and calcareous sands similar to those at Alum Bluff are referred to the Alum Bluff formation. In this section the fuller's earth stratum comes in near the top of the exposure about 100 feet above the river. From this locality to the fuller's earth mines in Gadsden County and thence into Leon County the Alum Bluff formation is continuous and affords frequent exposures.

The invertebrate fossils found at the fuller's earth mines near Quincy, in Gadsden County, on the basis of which the deposits have heretofore been referred to the upper Oligocene, include the following:*

Cypræa, agreeing in form and size with C. pinguis Conrad from the Chipola horizon.
Murex mississippiensis Conrad? var.
Fulgur spiniger Conrad?
Modulus sp.
Crucibulum auricula Gmelin.
Arca staminata Dall.
Pecten (Nodipecten?) sp.
Cardita serricosta Heilprin.
Chione sp.
Carolia floridana.

In view of the previous reference of the Alum Bluff formation to the Oligocene on the basis of the invertebrate fossils it becomes particularly interesting to compare the vertebrate fossils which have now been obtained from the formation.

### AGE OF THE FORMATION AS INDICATED BY THE VERTEBRATE FOSSILS.

Among the vertebrates the most characteristic as well as the most valuable for stratigraphic purposes are the horses. The genus *Merychippus* is regarded as a characteristic Miocene horse, its range being from middle (or lower) Miocene to lower Pliocene. The genus *Parahippus* first appeared in formations which are near

* Vaughan, T. W., Mineral Resources, U. S. Geol. Surv., 1901, pp. 929-930, 1902; Fla. Geol. Surv. Second Annual Report, p. 98, 1909.

the dividing line between the Oligocene and the Miocene. The species, however, which show the advanced development similar to that of the Florida species, are those characteristic of the Miocene. The genus *Oxydactylus,* to which the Florida camel is provisionally referred, is known only in the Miocene. The genus *Mesocyon,* to which the canid is provisionally referred, is known from the John Day formation, although the Florida canid represents probably a more advanced species than those of the John Day beds. It would seem, therefore, as a whole, that the vertebrate fossils indicate that the Alum Bluff formation is to be referred to the Miocene. The presence of the protohippine horses in particular would seem to be decisive as to the age of the formation excluding its reference to the Oligocene.

On the basis of the invertebrate fauna, Maury correlates the Chipola marl at the base of the section at Alum Bluff with the Aquitanian of Europe, while the overlying sands of the Alum Bluff formation are placed as transitional.†

The flora of this formation is known, the fossil plants found at Alum Bluff having been described by E. W. Berry.‡ Although consisting largely of new species; the flora according to Berry finds its relationship with the Aquitanian (Miocene or transitional from the Oligocene to the Miocene, or with the next succeeding stage, the Burdigalian of Europe.

It appears, therefore, that the evidence derived from the flora is not necessarily greatly at variance with that afforded by the vertebrates. The invertebrates known from the fuller's earth horizon of the Alum Bluff formation are not numerous, and when additional species shall have been obtained, the evidence of the invertebrate fauna possibly will not conflict with that of the vertebrate fossils.

## PLIOCENE OR UPPER MIOCENE.

The marine Miocene is well developed in Florida, being represented in West Florida by the Choctawhatchee marl and in East Florida by the Jacksonville formation. The Choctawhatchee marl contains an abundance of marine invertebrates, from which the age of the formation has been definitely determined. The Jacksonville

† A Comparison of the Oligocene of Western Europe and the Southern United States. By Carlotta Joaquina Maury, Bulls. of Amer. Paleontology, Vol. 3, No. 15, 1902.

‡ U. S. Geol. Surv., Professional Paper 98, E., p. 44, 1916.

formation, although containing comparatively few fossils, is referred on the authority of Dall to the Miocene*.

The marine Pliocene deposits are also well developed in Florida and contain an abundant invertebrate fauna. The first recognized and best known of these marine Pliocene deposits is the Caloosahatchee marl, well exposed on the Caloosahatchee River, as well as on some of the other streams of Southern Florida. More recently marine Pliocene marls in Eastern Florida have been described and designated as the Nashua marl*.

In addition to these marine Pliocene and Miocene deposits, two other formations are found in Florida, which are believed to be approximately contemporaneous in age. These are the Alachua and Bone Valley formations, both of which contain vertebrate fossils. Of these the Alachua formation is the better known in literature and has usually been referred to the Upper Miocene or the Lower Pliocene. Upon the basis of vertebrate fossils the writer is inclined to refer both the Alachua and the Bone Valley formations to the Pliocene.

## THE ALACHUA FORMATION.

The Alachua formation as here used includes the "Alachua clays" of Dall, with which is combined the "Dunnellon formation" of the writer.

The term "Alachua clays" was proposed by Dr. W. H. Dall in 1885 for the clay beds in the vicinity of Archer from which at that time extensive collections of vertebrate fossils were being made. The first published account in which this term was used, however, is found in Bulletin 84 of the United States Geological Survey, page 127, 1892. The clays are there described as occurring in sinks, gullies and other depressions, and are considered by Dall as representing a remnant of a previously more extensive formation.

The term "Dunnellon formation" was first used by the writer in 1910 to designate the extensive deposits which hold the hard rock phosphates of Florida. While the prevailing phase of the Dunnellon formation is light gray phosphatic sands, the deposits include also local beds, lenses, or masses of clay, as well as phosphate rock, flint boulders, pebble conglomerate and limestone fragments. As the study of the Dunnellon formation progressed it became apparent that the vertebrate fauna of these deposits was essentially the

* Fla. State Geol. Sur. Second Ann. Rpt. p. 128, 1909.

* Wag. Free Inst. Sci. Trans. Vol. 3, pt. 6, p. 1594, 1903.

same as that of the Alachua clays, and it now seems that the Alachua clays and the Dunnellon formation are not separable, the former representing a local phase of the latter. The Alachua clays being, however, the older term it has been suggested that the deposits as a whole be known as the Alachua formation. (Sellards, 1914, p. 162).

The vertebrate fossils obtained from the Alachua clays include two rhinoceroses identified by Leidy and Lucas as *Teleoceras fossiger* var. *proterus* and *Aphelops malacorhinus;* one mastodon, *M.* (*Trilophodon*) *floridanus;* two hipparions, *H. ingenuum* and *H. plicatile;* and three species of camel originally referred by Leidy to *Auchenia* but subsequently identified as *Procamelus,* namely *P. major, P. medius* and *P. minor.* In addition Leidy reports from the deposit a tapir, a deer, *Odocoileus*, *Megatherium,* a crocodile or alligator, fragments of shell of *Emys,* scales of garfish and bones of teleosts*.

The vertebrate fossils obtained from the Dunnellon formation include *Aphelops malacorhinus, Mastodon* (*Trilophodon*) *floridanus,* two or more species of *Hipparion,* a camel, *Procamelus minor, Megalonyx, Ursus, Felis, Odocoileus* and *Parahippus.*

At Newberry in Alachua County a tooth of a horse has been obtained which Dr. Hay regards as the third left lower molar of *Equus litoralis.* From this locality also the writer has secured a number of teeth which appear to pertain to the genus *Odocoileus.* At Neals near Newberry a tooth has been collected, which probably represents a milk molar of *Tapirus terrestris.* These were taken in connection with mining phosphate rock which is found in beds of lower Pliocene age. It is quite possible that these more recent fossils have been included in the Pliocene bed owing to sinkhole formation, the associated fossils being chiefly those of lower Pliocene age. *Tapirus* is likewise reported by Leidy from the vicinity of Archer but evidence is lacking to show the actual association of the specimen with the Pliocene fossils of that locality. As a result of underground solution in the limestone rock which underlies the hard rock phosphate deposits, sinkhole formation has been active in this region, and has notably affected the surface topography.

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* *Hipparion* (*Hippotherium*) *princeps* (Leidy) has been reported from the Alachua clays but the specimen on which the species was based was taken by Mr. Willcox from Peace Creek. (Personal letter, October, 1914.)

## BONE VALLEY FORMATION.

The Bone Valley formation which lies chiefly in Polk and Hillsboro counties in southern Florida is approximately if not entirely contemporaneous with the Alachua formation. It differs, however, in that it presents a marine phase, and as a whole is marine or estuarine in origin. A description of this formation has been given and a number of the fossils illustrated in a report on the land pebble phosphate deposits contained in the Seventh Annual Report of the Florida State Geological Survey issued in 1915.

The fossils obtained from the Bone Valley formation include two species of rhinoceroses, three hipparions, a camel, two or more mastodons, a bear-like carnivore, *Agriotherium*, and a tortoise. With these land animals there is found in the deposits a gavial, an alligator, cetaceans and fishes. These fossils are obtained from the phosphate mines operating in Polk and Hillsboro counties.

## NEW PLIOCENE VERTEBRATES.

### ELEPHANTIDAE.

#### MAMMUT PROGENIUM?

Plate 10.

A mastodon new to Florida obtained recently from the Bone Valley formation is of more than ordinary interest because of the evident relationship of the species to the Pleistocene mastodon, *Mammut americanum*, to which possibly it is directly ancestral. The parts found include the lower jaws of one individual, lacking the symphysis, and the symphysis of a second individual referred provisionally to this species. These fossils were obtained by the Amalgamated Phosphate Company while mining phosphate rock from their remarkably productive pit at Brewster, Florida. The matrix, some of which was clinging to the jaw when collected, consists of a coarse pebble phosphate conglomerate. From this pit at the same level has been found *Aphelops* and *Hipparion*, thus fixing definitely the place of the mastodon in the formation. The jaw is that of a mature individual, the teeth preserved apparently being the second and third true molars. Of these the second molar is somewhat worn, while the third molar is just coming into use and shows but slight wear on the first and second anterior crests. The second

molar has three transverse crests, while the third molar has four transverse crests and a very strong talon or fifth crest.

From the teeth alone this species can with difficulty be distinguished from the well known *Mammut americanum,* of the Pleistocene. It differs, however, from *M. americanum* in the much greater length of the symphysis and in the prolongation of the jaw in front of the molar teeth. In this respect the species resembles *M. progenium* Hay from Nebraska. The Nebraska specimen, however, is obtained from deposits which are believed to be of Pleistocene age, while the mastodon from Florida is from the lower Pliocene or the upper Miocene, and it is quite improbable that the two mastodons belong to the same species. However, until better known, it is perhaps advisable to refer the Florida mastodon provisionally to *M. progenium.*

The following are the measurements of the jaw:

| | |
|---|---|
| Length from back margin of symphsysis to hinder border above the angle | 600 mm. |
| Height of jaw at front of $M_3$ | 180 |
| Thickness of jaw at front of $M_3$ | 126 |
| Length of $M_3$ | 165 |
| Width of $M_3$ | 85 |
| Length of $M_2$ | 110 |
| Width of $M_2$ | 80 |

It has been assumed by some that the American mastodon, *Mammut americanum,* originated in Europe and migrated to America. In view of the presence in the Tertiary of Florida of a mastodon which may well be ancestral to the American mastodon this assumption becomes unnecessary, and it seems quite possible that *Mammut americanum* may have originated on this continent.

## EQUIDAE.

### *HIPPARION MINOR,* SP. NOV.

Pl. 11, fig. 10.

A new hipparion from Florida is of interest because of its miniature size. The species is represented by teeth obtained both from the hard rock and from the land pebble phosphate deposits. As type of this species the writer selects specimen No. 5867 of the Florida Geological Survey collection from the pit of the Amalgamated Phosphate Company at Brewster. In addition two smaller

teeth, from the hard rock phosphate deposit, Nos. 1167 and 1246, are referred to this species.

The anteroposterior measurement of the type specimen is 13½ mm.; the greatest transverse measurement is 13 mm. The anteroposterior measurements of specimen No. 1167, which may be a milk tooth is 11 mm., while the transverse measurement is 11 mm. The enamel bordering the lakes in this small species is very much complicated. The inner column of the tooth is elipsoidal in the cross section. The species may be known as *Hipparion minor.*

A metacarpal referrable either to *H. ingenuum* or to the smaller species, *H. minor,* was referred to the writer for examination in April, 1916, by Mr. Anton Schneider. On the back side of the bone may be seen the roughened surfaces for the attachment of metacarpals two and four. This roughened surface extends from one side of the bone 140 mm. while on the other extends about 120 mm. Between these scars the bone is slightly grooved, thus differing from the same bone of *H. plicatile,* which according to Leidy and Lucas has a ridge between the two digits. At the distal end this bone is more flattened on the front surface than is that of the modern horse. There is also a groove at the outer and inner side of the trochlea, which received digits two and four. The bone is nicely preserved and the groove which received the artery may be seen lying at the side of the digit.

The measurements of this bone are as follows:

| | |
|---|---|
| Length of bone | 185 mm. |
| With proximal articular face | 23 mm. |
| Width of distal articular face | 24 mm. |

A smaller metacarpal from the hard rock phosphate deposits is indicated by specimen No. 1589, the transverse width of proximal articular surface of which is 21 mm.

Of the hipparions, four species have now been described from Florida. Of these the largest is *Hipparion princeps,* the type and only known specimen of which was found on Peace Creek and hence is of uncertain geologic age. The two species, *Hipparion plicatile* and *Hipparion ingenuum,* were described by Leidy from the Alachua clays, but are present also in the hard rock phosphate deposits and in the Bone Valley formation. Of the four species, *H. princeps* is by far the largest, while the one here described as *H. minor* is much

the smallest. The presence of the three species of hipparions in the Dunnellon and Bone Valley formations is one of the strong arguments for the essential contemporaneity of these two formations.

## URSIDAE.

### *AGRIOTHERIUM SCHNEIDERI*, SP. NOV.

Plate 12, figs. 1-2.

A new carnivore is represented in the Survey collection by a right lower jaw from the Bone Valley formation at Brewster. The specimen was obtained and presented to the State Geological Survey by Mr. Anton Schneider, Superintendent of the Amalgamated Phosphate Company. For this species the writer suggests the name *Agriotherium schneideri* in recognition of the attention that is being given by Mr. Schneider and those working under his direction to the preservation of the very important series of fossils that is being obtained in connection with mining phosphate rock. The type specimen is No. 6856 of the Geological Survey collection.

The genus, *Agriotherium* Wagner, is based on *Ursus sivalensis* and was described by Wagner in 1837.* Subsequently the generic term *Hyaenarctos*† was assigned to the same species, under which name the fossils are more commonly known in literature. The genus has not heretofore been definitely recognized in America, although Freudenberg has referred to it provisionally a sectorial tooth from the Pleistocene of Mexico.‡ In Europe the genus is found in the upper Miocene and the Pliocene. Among the species referred to *Agriotherium* (*Hyaenarctos*) according to Lydekker are *H. insignis*, lower Pliocene of Montpellier; an undetermined species from the upper Miocene of Spain; and *H. sivalensis* from the old Pliocene of England (Red Crag).†† The Asiatic species of the genus are from the Sind, Punjab and Sub-Himalayan Siwaliks (Miocene and Pliocene). The reference of the Florida specimen to this genus is necessarily provisional. When more

*Munchn. gelerten Anzeigen, 1837. According to Lydekker, from whom this foot note reference is taken, the species *Ursus sivalensis* was described by Falconer and Cautley in the "Asiatic Researches" in 1836. According to the same writer, Blainville in 1841 proposed for the species the generic names *Sivalarctos* (Compt. Rend., p. 165), and *Amphiarctos* (Osteographie, Vol. ii, pp. 96-103. Among these several terms *Agriotherium* has priority.

†Owen, Odontography, p. 505, 1840-1845.

‡Die Saugetierfauna des Pliocans und Post Pliocans von Mexiko. 1. Carnivora, by Wilhelm Freudenberg. Geol. u. Palaeo. Abh., N. F., Bd. 9, Heft 3, pp. 13-17, 1910.

††Indian Tertiary and Post-tertiary Vertebrata. Vol. ii, p. 220, 1884.

fully known the American species may be found to be generically distinct from the European species.

The jaw which serves as the type specimen of the species is from an old individual and the teeth are well worn. At the front of the jaw may be seen sockets for the three incisors which were small and crowded in the jaw. The very large canine is present although much worn. Of the premolars there is preserved $Pm_4$ and an alveolus for an additional tooth close to the canine. Whether or not the other two premolars were present cannot be determined. The jaw is well preserved and there is no indication of alveoli for the missing premolars. If these teeth were present they must have dropped out early from this jaw, the alveoli having subsequently disappeared. Of the molar series there is preserved $M_1$ and $M_2$, and the alveoli for $M_3$.

The striking features of the jaw are the very large molars and canines and the proportionate reduction of the premolars and incisors. Of the molar-premolar series the molars occupy about two-thirds, and of the entire dental series about one-half. The jaw as a whole is short, strong and its inferior margin convex.

MEASUREMENTS.

| | |
|---|---|
| Length of the jaw front to angle, about | 260 mm. |
| Height of jaw at $M_1$ | 73 |
| Width of jaw between the incisors | 40 |
| Length of molar-premolar series | 145 |
| Length of molar series from posterior margin of alveolus for $M_3$ to the anterior margin of $M_1$ | 90 |
| $M_1$ anteroposterior | 40 |
| $M_1$ greatest transverse width of heel | 23 |
| $M_2$ anteroposterior | 26 |
| $M_2$ greatest transverse width | 20 |
| $M_3$ anteroposterior measurement of alveolus | 20 |
| $M_3$ transverse measurement of alveolus | 12 |
| $Pm_4$ anteroposterior | 22 |
| $Pm_4$ greatest transverse width | 14 |
| Canine, anteroposterior | 36 |

The known old-world species of this genus have three premolars, interpreted as $Pm_2$, $Pm_3$, and $Pm_4$, thus differing from the Florida fossil in which there are but two premolars, probably $Pm_2$ and $Pm_4$. As compared to *Agriotherium* (*Hyaenarctos*) *punjabiensis,* which is of approximately the same size, the canine teeth

may be seen to be equally strongly developed; the carnassial teeth are of approximately the same size and present a general similarity in cusp arrangement. The jaw of the Florida species, however, is broader and the inferior margin is more strongly convex. A difference is noted also in the relative development of the molar-premolar series, the molars occupying relatively more, and the premolars actually and relatively less space than in that species. In general the Florida species would seem to have carried the line of specialization in this group beyond that indicated by the known European species.

Although referred to the family Ursidae, these species are not directly ancestral to the modern species of that family, but represent as indicated by the reduction in the number of premolar teeth, a collateral group of the family, their relationship to the Ursidae being comparable to the relationship of the amphicyons to the Canidae.

The presence of *Agriotherium* in America is of exceptional interest, and it is to be hoped that additional material may be obtained of this interesting fossil.

## CAMELIDAE.

### *PROCAMELUS MINOR.*

From the Alachua clays Leidy described three species of camels which were designated by him as *Procamelus major, P. medius* and *P. minor*. From the Bone Valley formation few camels have been obtained, although during the past year a single specimen has been secured at the pit of the Amalgamated Phosphate Company. The bone obtained was a proximal phalanx and probably represents *Procamelus minor*, as it agrees in size with the specimen referred to that species by Leidy. The specimen is No. 6163 of the Florida Geological Survey collection.

## PLEISTOCENE.

The marine Pleistocene is well represented in Florida and contains a large invertebrate fauna. The formations are best developed on the Atlantic and southern Gulf Coast. A very large Pleistocene vertebrate fauna is found in Florida also, and occurs widely distributed throughout the State.

## THE PLEISTOCENE VERTEBRATES.

Of the many Pleistocene localities in Florida containing vertebrate fossils, the best known, perhaps, is the Peace Creek Beds near Arcadia, in DeSoto County. The history of this locality dates back to 1881, when Captain J. F. LeBaron, while employed in making a survey for a proposed ship canal across Florida, was attracted by phosphate pebble and water worn bones found in the bed of Peace Creek. A considerable amount of this material including, it is said, several barrels, was taken from the river and shipped to the Smithsonian Institution. In 1888 active mining of phosphate began on Peace Creek and many additional fossils were thus brought to light. During 1888 Mr. Joseph Willcox visited Peace Creek and obtained at that time an important collection taken chiefly from the bed of the river brought up by the dredge in the course of phosphate mining.

*Peace Creek.*—During Pleistocene time Peace Creek was cutting its channel through Pliocene and into Oligocene beds both of which hold vertebrate fossils. As a result the Pleistocene beds of Peace Creek contain not only the fauna natural to them, but also inclusions from both the Pliocene and the Oligocene. At the present time the stream is cutting through Pleistocene, Pliocene and into the Oligocene. It has thus come about that fossils collected along Peace Creek, either from recent sand-bars or from the Pleistocene beds, present a mixture of materials, from which has resulted not a little confusion in the literature as to the range of species in the Florida Pliocene and Pleistocene.

Among the fossils from Peace Creek that may with reason be regarded as Pleistocene, since they are found in undoubted Pleistocene elsewhere, are the following:

PLEISTOCENE VERTEBRATES FROM PEACE CREEK.

*Elephas columbi.*
*Tapirus haysii.*
*Mammut americanum.*
*Odocoileus* sp.
*Bison* sp.
*Equus leidyi.*
*Equus littoralis.*
*Chlamytherium septentrionalis* (*C. humboldtii*). Coll. Wagner Free Institute.

*Megalonyx jeffersonii*, reported by Leidy.
*Manatus antiquus*, reported by Leidy.
*Hoplophorus euphractus*, reported by Leidy.

Other vertebrates obtained from this locality, the reference of which to the Pleistocene lacks confirmation, include Hipparions as well as some turtles and fishes. These are listed in Leidy's paper published in 1889*. A fauna similar to that at Peace Creek is found on Hillsboro and Manatee rivers and may be expected on many of the streams of the southern Gulf Coast.

*Caloosahatchee River.*—A few vertebrate fossils have been obtained from the Caloosahatchee River. Some of these were found in place in muck and sand lying above marine shell marls, while others were found lying loose in the river, having been washed out from the beds in which they were contained. All, however, came with little doubt from above the marine shell marls, and hence are of Pleistocene age.†

PLEISTOCENE VERTEBRATES FROM THE CALOOSAHATCHEE RIVER.

*Mylodon* sp.
*Elephas columbi.*
*Equus fraternus*, reported by Leidy.
*Bison* sp., reported by Leidy.

PLEISTOCENE VERTEBRATES FROM OCALA.

In 1888 Mr. Joseph Willcox obtained a very interesting small collection of fossils from a crevice in the limestone at Ocala and in recent years additional collections from this locality have been made by the Florida State Geological Survey. The openings in the limestone represent solution channels. The fossils are found

* Wagner Free Inst. Sci., Trans., Vol. 2, pp. 19-31, 1889.

†In his extended paper on the Geology of Florida, Bull. 84, U. S. Geol. Surv. p. 129, 1892, Dr. Dall has inadvertently referred to *Bison latifrons, Elephas columbi* and *Equus fraternus* as having been obtained from the Pliocene beds of the Caloosahatchee River. The horse and elephant remains were collected by Mr. Joseph Willcox, who states that the elephant remains were in place above the shell marls and that the horse was lying loose near the edge of the water and had fallen from above. (Personal letter, Oct., 1914.) The writer has also taken *Elephas columbi* and *Equus sp.* from the sand and muck above the Pliocene and Pleistocene shell marl of this river.

imbedded in sandy clay matrix which has washed into and filled the openings in the rock.

The Pleistocene fossils obtained at Ocala include the following:

| | |
|---|---|
| *Equus leidyi.* | *Sylvilagus* sp. |
| *Bison* sp. | *Procamelus* sp. |
| *Odocoileus* sp. | *Elephas columbi.** |
| *Dasypus* sp. | *Machairodus floridanus.** |

The camel from this locality was regarded by Leidy as probably identical with the *Procamelus minor* from the lower Pliocene at Archer. If this is true it may indicate either a survival of this species from the Pliocene, or may be an inclusion of a Pliocene fossil from beds formerly present at this locality. It seems probable that the tooth represents a Pleistocene species as indicated by association with the other Pleistocene fossils, and in that case is likely to represent a species distinct from *Procamelus minor.*

*Sarasota Bay.*—A number of Pleistocene fossils have been found on the Gulf Coast on and near Little Sarasota Bay. The collections have been made chiefly by Mr. Joseph Willcox, who obtained dermal scutes of *Chlamytherium septentrionalis,* and teeth of *Elephas columbi* and *Equus* sp. The horse teeth are large and the enamel is folded in a complicated manner, but as the two teeth found are from the lower jaw it is difficult to determine to what species they belong. At Stump Pass east of Little Sarasota Bay, Mr. Willcox found a horn core and radius of *Bison* sp. This Bison presumably is the one which Leidy refers to as *Bison latifrons.*†

*Wakulla Spring.*—A part of a skeleton of a mastodon or an elephant was obtained from Wakulla Spring by Mr. John L. Thomas. The parts preserved include some of the bones of the pelvis, the distal end of the femur, a complete tibia and a foot bone. It is reported that a much more complete skeleton of a proboscidian was obtained from this spring many years ago and was lost in transportation, the ship in which it was carried having been de-

* Report by Leidy. Wag. Free Inst. Sci., Trans., Vol. 2, pp. 13-17, 1889.

†Wag. Free Inst. Sci. Trans., Vol. ii, p. 12, 1889. The locality is given by Leidy as Rocky Creek, 30 miles north of Sarasota Bay, which, however, is a mistake, as the specimen according to Mr. Willcox was found at Stump Pass.

stroyed off the Florida Keys. The tooth of *Mammut americanum* has been obtained also from Little River in Gadsden County.

*Withlacoochee River.*—The Withlacoochee River cuts through the Pleistocene and Pliocene and into the Eocene. Among the fossils dredged from the river which may be referred to the Pleistocene since they are known from undoubted Pleistocene elsewhere are the following:

Pleistocene vertebrates from the Withlacoochee River:

*Bison* sp.
*Tapirus haysii?*.
*Mammut americanum.*
*Elephas columbi.*
*Odocoileus* sp.
*Trichechus manatus.*
*Equus leidyi.*
*Ursus* sp.
*Chlamytherium septentrionalis.*

## LOCALITIES FOR PLEISTOCENE VERTEBRATES ON OR NEAR THE ATLANTIC COAST OF FLORIDA.

The several new localities for Pleistocene vertebrates on or near the Atlantic Coast are similar in their stratigraphic position. The fossils in all cases are found either in the Pleistocene shell marl which borders the Atlantic Coast or in the sand, clay and muck beds which lie above this marl, the greater number of specimens coming from above the marl. That the shell marl is of Pleistocene age has been fully established by a study of the invertebrate fossils. As early as 1824 Thomas Say reported upon the shells contained in this marl at St. Augustine, where it is known as "Coquina rock." In 1908 in connection with co-operative work carried on by the Florida State Geological Survey and the United States Geological Survey, collections of invertebrates were made from the shell marls at Eau Gallie, Titusville, Mims, Ormond, West Palm Beach and at many other localities. A list of the invertebrates from the marl at Eau Gallie showing it to be of Pleistocene age will be found on page 151 of the Second Annual Report of the Florida Geological Survey.

It is known also that these Pleistocene shell marls form a continuous bed extending many miles inland. Thus they have been

* Say, Thomas, Fossil shells found in shell mass from Anastasia Island. (Contained in "Description of a Testaceous Formation at Anastasia Island" by Dietz, T.) Acad. Nat. Sci., Phila. Jour. iv, pp. 78-80, 1824.

identified from well drillings at Kissimmee in Osceola County, and are found extensively in the vicinity of Fellsmere in the northwestern part of St. Lucie County. It is probable in fact that they underlie the whole of the St. Johns River valley extending thence south to the Everglades. The thickness of the Pleistocene of the Florida East Coast likewise is considerable. Thus from the well at Ormond invertebrates were obtained at a depth of 66 and 68 feet which were believed to indicate the Pleistocene age of the beds, while at West Palm Beach Pleistocene shells were obtained to a depth of about 70 feet.*

The fossil vertebrates on the Atlantic Coast are thus shown to be Pleistocene since they are found in deposits which lie upon marine Pleistocene shell marl. Of special importance in this connection is the fact that the position of these beds is such as to preclude the possibility of the mixing of earlier fossils with those of the Pleistocene period. An opportunity is thus afforded of obtaining a representation of the undoubted mid or late Pleistocene vertebrate fauna of Florida.

*Daytona.*—From the marl pits worked for road material at Daytona, the writer has obtained through Mr. Morris, the tip of a tusk of a mastodon or elephant and from Dr. Carroll, the rib of a cetacean, probably representing the genus *Balaenoptera.* Mr. Morris has in his possession also a tooth of *Elephas columbi.* All of these specimens were taken from marl pits near Daytona.

*Fellsmere.*—A few fossil vertebrates have been found in connection with the construction of drainage canals at Fellsmere. Among the species recognized were *Mammut americanum* and *Elephas columbi,* both being represented by teeth. As in the case of the other localities on the Atlantic Coast, the vertebrate fossils are found either in or upon Pleistocene shell marl. The same fauna is found at Eau Gallie about 30 miles north of Fellsmere, where the teeth of *Elephas columbi* and *Equus complicatus* have been collected from the Hopkins' Drainage Canal.

*Palm Beach Canal.*—From the Palm Beach Canal, constructed in connection with the drainage of the Everglades, Mr. J. L. Hayes has obtained for the State Geological Survey teeth of *Elephas columbi* and *Equus complicatus,* and a femur of *Bison* sp. The writer also obtained from this canal about eight miles west of the crossing of the Florida East Coast Railroad, several teeth of

* Fla. State Geol. Surv. Second Annual Report, p. 152, 1909.

*Mammut americanum.* The vertebrate fossils are imbedded in the sand and muck beds which lie above the Pleistocene shell marl. That these large land animals were able to make their way still farther south along the Atlantic Coast during the late Pleistocene is indicated by some fragmentary limb bones of a proboscidian obtained from the Miami River in Dade County.

*St. Augustine.*—A limited number of vertebrate fossils were obtained from the banks of the Inland Waterway Canal at Station 120, 20 miles north of St. Augustine. The position of the beds at this locality is entirely similar to those at other localities along the Atlantic Coast, the vertebrates being found in sand and muck which rests on Pleistocene shell marl.

PLEISTOCENE VERTEBRATES FROM STATION 120, INLAND WATERWAY CANAL.

| | |
|---|---|
| *Mammut americanum.* | *Bison* sp. |
| *Elephas columbi.* | *Odocoileus* sp. |

The same fauna has been obtained from the Inland Waterway canal at Allen's farm, 20 miles south of St. Augustine. The position of the beds here is the same as that of the other localities on the Atlantic Coast, the fossils being found in sand and muck which rests upon Pleistocene shell marl. At this locality a tooth of *Mammut americanum* was taken by the writer in place in the bank. The other specimens were found on the bank, having been thrown out by the dredge. Fresh-water shells are found associated with the vertebrates, the canal at this place probably cutting through an old pond. A cetacean vertebra obtained at this locality was thrown out presumably from the Pleistocene shell marl.

Pleistocene Vertebrates from Allen's Farm, 20 miles south of St. Augustine:

*Mammut americanum.* Teeth, Florida Survey collection 4515 and collection of F. R. Allen, St. Augustine.

*Elephas columbi.* Teeth, collection of F. R. Allen.

*Mylodon* sp. Tibia, collection of F. R. Allen.

*Equus* sp. Leg bone, collection of F. R. Allen.

Cetacean vertebra. Collection of F. R. Allen.

*Vero.*—A very important new locality and the one from which the greatest number of Pleistocene vertebrates have been obtained is that discovered in 1913 at Vero in St. Lucie County. This lo-

cality is described and the mammalian species listed in the subsequent pages of this volume in connection with an account of fossil human remains. Although more species are represented the fauna at this locality is essentially that which has already been listed as characteristic of the Pleistocene of Florida.

## DESCRIPTION OF A NEW DOLPHIN.

Plate 14.

Through the courtesy of Professor John F. Baerecke, the writer has been permitted to include in this paper a description of an excellently preserved skull of the dolphin, *Globicephalus*. This skull, which represents apparently a new species, was found while excavating for the foundation of the Codrington Building in DeLand. It was imbedded in sand at a depth of about 10 feet, according to the statement of Professor Baerecke, who was present at the time the skull was taken from the ground.

Pliocene and Miocene shell marls underlie the city of DeLand. This skull, however, comes from the sands above these marls, and while the skull may be of Pliocene age, it seems more probable that it belongs to the Pleistocene, especially as the bones are but slightly mineralized, and on the whole have the appearance of being very recent. Furthermore the species is rather closely related to the living species of the genus. In addition it may be noted that at Orange City Station, a few miles west of DeLand, shell marls are found which are regarded as probably of Pleistocene age.* Moreover, in the marl pits at DeLand an unconformity is found at the top of the Pliocene shell marl, this break very possibly representing the dividing line between the Pliocene and the Pleistocene.

*Globicephalus baereckeii sp. nov.*—The characters which distinguish this species from the modern forms are best seen at the base of the skull, where the articular condyles are larger and stand more nearly vertical than those of the recent species. The foramen of the skull is likewise more nearly oval than that of the modern species. The transverse measurement of the foramen is 66 mm.; vertical, 55 mm. The total length of the skull is 57 cm.; length of rostrum to the maxillary notch, 28 cm.; width of rostrum at base, 22.5 cm. The sockets for seven teeth are seen in the jaw, and there may have been two or three more teeth as the tip

* Fla. State Geol. Surv., Second Annual Report, p. 149, 1909.

of the rostrum is injured. For this species the writer suggests the name *Globicephalus baereckeii.* The type specimen is in the collection of Stetson University at DeLand.

## SUMMARY.

The vertebrates of the Alum Bluff formation as indicated by the species obtained from the fuller's earth horizon indicates the Miocene age of the formation. The vertebrates obtained from the Alachua and Bone Valley formations (hard rock and land pebble phosphate deposits) indicate that the two formations are approximately contemporaneous in time, and are to be referred either to the upper Miocene or to the lower Pliocene, the probabilities apparently being in favor of their being of Pliocene age.

With regard to the Pleistocene vertebrates of Florida it may be said in conclusion that the mixing of faunas on Peace Creek and at some other localities on the Gulf Coast of Florida is due to the fact that the streams cut through the thin Pleistocene deposits and into the older formations. More satisfactory localities for studying the Pleistocene vertebrates are found on and near the Atlantic Coast, where Pleistocene deposits containing vertebrate fossils rest upon marine Pleistocene shell marl in which are found few land fossils, and where there is accordingly no opportunity for the mixing of faunas. At these localities, the fauna is found to present none of these anomalies erroneously attributed in the existing literature to the Pleistocene of the Gulf Coast of Florida. On the contrary it is found to be a normal Pleistocene fauna containing, however, a very considerable number of species relating to the South American fauna.

## BIBLIOGRAPHY AND REVIEW OF PAPERS RELATING TO THE FOSSIL VERTEBRATES OF FLORIDA.

The following list includes only those papers that relate to fossil vertebrates of Florida. For a more complete bibliography of Florida Geology the reader may consult the following reports: Florida State Geological Survey, First Annual Report, pp. 73-108, 1908; Third Annual Report, pp. 363-366, 1910; Fifth Annual Report, pp. 67-80, 1913; Sixth Annual Report, pp. 410-416, 1914. The entries in the bibliography are arranged in chronological order or as nearly so as is practicable, and the bibliography as a whole is preceded by an author's index. The date of publication which follows the name indicates the place of the author's paper in the bibliography.

### AUTHOR'S INDEX.



### LIST OF PAPERS ARRANGED CHRONOLOGICALLY.

1884. Walker, Samuel T.:

On the Origin of the Fossil Bones Discovered in the Vicinity of Tise's Ford, Florida. (Extract from a letter to Professor Spencer F. Baird.) U. S. Nat. Mus. Proc., Vol. 6, pp. 427-428, 1883.

The locality referred to, Tise's Ford, is on Peace Creek, 17 miles by river (8 miles by land) above Fort Ogden. The first fossil bones were reported 7 miles by river above Fort Ogden. From this point broken fossils were found on all sand-bars.

1884. Leidy, Joseph:

Vertebrate Fossils from Florida. Acad. Nat. Sci. Phila. Proc., pp. 118-119, 1884; Science, Vol. 3, p. 606, 1884.

In this paper Dr. Leidy reports briefly upon a collection of vertebrate fossils received for examination from the Smithsonian Institution. The collection was made by Dr. J. C. Neal of Archer, Florida, the material having been obtained from a bed of clay occupying a ridge in the pine forest. The bones were found over an irregular area about 100 feet long by 30 feet wide, and to a depth of seven feet. The collection included (1) a young mastodon; (2) a rhinoceros; (3) a tapir; (4) a llama as large as a camel; (5) a calcaneum much like that of *Cervus americanus;* (6) remains of a crocodile, vertebra of a teleost fish, and several other undetermined bone fragments.

1885. Leidy, Joseph:

Rhinoceros and Hippotherium from Florida. Acad. Nat. Sci. Phila. Proc., pp. 32-33, 1885.

This paper contains a brief account of additional fossils received from Dr. Neal from the same locality as that referred to in the preceding paper. Dr. Neal reports that he had revisited the locality in company with Professor L. C. Johnson. It was in this letter that Dr. Neal suggested that the deposits holding the fossils formed originally the border of a lake or lagoon. *Rhinoceros proterus* is mentioned as a new species; and is based on a tooth contained in this lot of material. The species *Hippotherium ingenuum* is proposed, based upon an upper molar, "perhaps the fourth large one of the series." A figure and measurements of the tooth are given. The other forms mentioned as represented in this collection are a crocodile, a carnivorous animal about the size of a fox, and a llama.

1885. Neal, J. C.:

(Discovery of another bed of fossil bones in the Alachua Clays). Communicated to Joseph Leidy. Proceedings of the Philadelphia Academy of Natural Science, March 24, 1885. Reported in Am. Nat. Vol. 19, p. 834, (1-8 p.) 1885.

The new locality referred to in this paper, said to be twenty miles from the locality previously reported, is evidently that on Hallowell's plantation, northwest of Archer, and hence approximately twenty miles north of the locality on Mixon's plantation. A bed of cinders and charred bones was reported two or three feet below the surface.

1886. Leidy, Joseph:

Mastodon and Llama from Florida. Acad. Nat. Sci. Proc., pp. 11-12, 1886.

This paper contains notice of receipt of additional vertebrate fossils from Florida. This lot of material was collected by Dr. W. H. Dall from near Archer and was submitted for identification by the United States Geological

Survey. In this paper the Florida Mastodon is described as *Mastodon* (*Trilophodon*) *floridanus*, and measurements of the teeth are given. The tusk is noted as having a band of enamel. The llama remains are distinguished as *Auchenia major, minor* and *minimus*, measurements of the astraguli being given for each. The presence in the collection of the astralagus of a *Megatherium* is also noted.

1886. Leidy, Joseph:

An Extinct Boar from Florida. Acad. Nat. Sci. Phila. Proc., pp. 37-38, 1886.

In this communication Dr. Leidy establishes a new genus and species, *Eusyodon maximus*, based on a tusk resembling that of a hog. The locality from which the specimen was obtained is not given, altho the context shows that it came from near Archer, Florida. The specimen which was figured, was subsequently recognized as the lower tusk of a rhinoceros.

1886. Leidy, Joseph:

Caries in the Mastodon. Acad. Nat. Sci. Phila. Proc., p. 38, 1886.

Describes briefly the effect of Caries in the tooth of *Mastodon floridanus*.

1887. Leidy, Joseph:

Fossil Bones from Florida. Acad. Nat. Sci. Phila. Proc., pp. 309-310, 1887.

In this communication Professor Leidy acknowledges receipt of two barrels and three boxes of fossil bones from Florida submitted by the United States Geological Survey. The collection was made by L. C. Johnson from Mixon's bone-bed ten miles east of Archer (near Williston). *Hippotherium plicatile* is described in this paper and is based on an upper molar which is figured. Measurements are also given. The genus and species *Eusyodon maximus* established in a preceding paper, is here recognized as an error, being based upon the lower tusk of a rhinoceros.

1887. Dall, W. H.:

Notes on the Geology of Florida. Am. Jour. Sci. (3) vol. 34, pp. 161-170, 1887.

This paper, page 164, contains a reference to the Alachua clays remaining on the hilltops. The manner of occurrence of the fossils is also briefly described.

1887. Heilprin, Angelo:

Explorations on the West Coast of Florida and in the Okee-

chobee Wilderness, with special reference to the Geology and Zoology of the Floridian Peninsula. Wag. Free Inst. Sci. Trans. Vol. i, 134 pp., pls. 19, 1887.

Contains an account of fossil human remains found on Little Sarasota Bay, and includes also the first account of the Caloosahatchee River section.

1889. Leidy, Joseph:

Fossil vertebrates from Florida. Proc. Acad. Nat. Sci. Phila., pp. 96-97, 1889.

In this paper Leidy refers to parts of a mandible and vertebrae of a Zeuglodon found imbedded in limestone at Ocala and to remains of saber-tooth tiger, horse and elephant found in a crevice in the limestone. He reports also on fossils from Peace Creek, and names the new species *Glyptodon* (*Chlamytherium*) *septentrionalis*.

1889. Leidy, Joseph:

Notice of some Fossil Human Bones. Wag. Free Inst. Sci. Trans. Vol. 2, pp. 9-12, 1889.

The human bones described in this article were found on the shore of Sarasota Bay. The material was collected by Heilprin and Willcox, 1886, Willcox, 1887, and previously by Judge Webb. The human bones, although changed to limonite, derived evidently from the ferruginous sandstone in which they are imbedded, are nevertheless believed to be recent. The associated invertebrates are all of living species.

In this paper, page 12, is noted the discovery by Mr. Willcox of a horn-core and a radius of *Bison latifrons*, found on Rocky Creek, thirty miles north of Sarasota Bay. This reference to the occurrence of *Bison latifrons* is evidently a mistake, as Mr. Willcox states that the only *Bison latifrons* collected by him was taken from Stump Pass near Grove City.

1889. Leidy, Joseph:

Description of Mammalian Remains from a Rock Crevice in Florida. Wag. Free Inst. Sci. Trans. Vol. 2, pp. 13-17, 1889.

The fossils described in this paper were obtained by Mr. Joseph Willcox at Ocala, Florida, in 1888. They were taken from a crevice in the rock exposed in quarrying limestone on the property of F. M. Phillips. The limestone referred to is the Ocala formation. The fossils found in the crevice of the rock, however, are of much later date, being probably Pleistocene. The fossils found here include the following: (1) Saber-tooth tiger, described as *Machairodus floridanus* sp. nov.; (2) *Equus fraternus* Leidy. The remains of the llama consisted of a single inferior molar tooth believed to pertain to the smallest of the three species previously described from the vicinity of Archer. These three

species which in the original description were designated *Auchenia major, minor* and *minimum* (Proc. Acd. Nat. Sc., p. 11, 1886) appear in the final paper (Wag. Free Inst. Sci. Trans. iv, p. viii, 1896) as *Procamelus major, medius,* and *minor.* Two elephant teeth were obtained, probably representing *Elephas columbi.*

In this paper, page 17, it is noted that Mr. Willcox has obtained specimens representing *Equus fraternus* from the Caloosahatchee River.

On page 13 of this paper is noted the discovery of portion of the mandible of *Zeuglodon* "or, perhaps, *Squalodon,*" obtained by Mr. Willcox from the limestone in a quarry of B. T. Richards at Ocala.

1889. Leidy, Joseph:

Description of Vertebrate Remains from Peace Creek, Florida. Wag. Free Inst. Sci., Trans. Vol. ii, pp. 19-31, 1889.

The fossils described in this paper were taken from a sand-bar exposed at low water in Peace Creek near Arcadia. They were obtained chiefly by Joseph Willcox, supplemented by additional collections by Wm. M. Meiggs, and T. S. Moorhead, and were dredged up in the process of mining river pebble phosphate rock which is taken from the bed of the stream. In addition to the collections made near Arcadia, Professor Leidy refers to other specimens previously received for examination from the Smithsonian Institution. These latter fossils are possibly those collected from Peace Creek by J. Frances LeBaron and shipped to the Smithsonian Institution in 1881.

1889. Leidy, Joseph:

The Saber-tooth Tiger of Florida. Acad. Nat. Sci. Phila. Proc., pp. 29-31, 1889.

Describes *Drepanodon floridanus,* and notes occurrence of *Auchenia minor.*

1889. Cope, Edward D.:

An Intermediate Pliocene Fauna. Am. Nat. Vol. 23, pp. 253-254, April, 1889.

In this paper, which relates to the collection of fossil vertebrates from Oregon, the fauna described from Florida by Leidy is mentioned, p. 254, as probably of Loup Fork or upper Miocene age.

1890. Leidy, Joseph:

Fossil Vertebrates from Florida. Acad. Nat. Sci. Phila. Proc., pp. 64-65, 1890.

Receipt is acknowledged of seven boxes of fossil bones and teeth from Archer, collected by J. B. Hatcher under the direction of Professor Marsh and submitted for identification by the United States Geological Survey. No species not previously reported are recognized in the collections.

1891. Dall, W. H.:

On the Age of the Peace Creek Beds, Florida. Acad. Nat. Sci. Phila. Proc., p. 120 (1-3 p.) 1891; (letter read at meeting of Feb. 1891) abst. Am. Geol. Vol. 7, p. 382, (4 lines) 1891.

This paper relates to the position of the Peace Creek beds which are stated to lie under marine Pliocene, corresponding in part to the Caloosahatchee marl and in part older. The bone bed is said to overlay or to be mixed with older Pliocene phosphatized rock. The fossils mentioned are mastodon, manatee, horse, glyptodon and turtle.

1891. Gidley, J. W.:

Tooth Characters and Revision of the North American Species of the Genus Equus. Amer. Mus. Nat. Hist., Bull. Vol. 14, pp. 91-142, pls. 18-21, figs. 1-25, 1891.

1892. Cope, Edward R.:

(Note on the fossils of the Alachua clays) contained in U. S. Geol. Surv. Bull. 84, p. 130, 1892.

In this note Cope expressed the opinion that the Alachua clays are intermediate in age between the Loup Fork and the Equus beds of the West. The comparative table included, however, shows that in arriving at this conclusion Cope considered the fossils from Archer, Ocala, and Peace Creek as coming from a single formation, which of course is erroneous.

1892. Cope, Edward D.:

On the Phylogeny of the Vertebrata. Proc. Amer. Philos. Soc., Vol. xxx, pp. 278-279, with 2 figs. in the text.

In this paper the genus *Tomolobis* Cope was proposed, being based on the jaw of a horse obtained by Willcox from the Caloosahatchee River. This specimen was afterwards identified as *Equus fraternus,* (Cope, 1896, p. 458).

1892. Dall, W. H. and Harris, G. D.:

Correlation Papers: Neocene of North America. U. S. Geol. Survey, Bull. 84, 1892.

The Geology of Florida is described by the senior author, pp. 85-158. The terrestrial fauna of Florida as known at that time is summarized on pp. 127-133.

1892. Leidy, Joseph:

(List of Vertebrata from Florida.) U. S. Geol. Sur. Bull. 84, pp. 129-130, 1892.

The list of vertebrates from Florida given by Dall (1 c. p. 129) was supplied as indicated by the context by Professor Leidy.

1893. LeBaron, J. Frances:

Discussion following paper by Walter B. Davidson on The Geological Origin of Phosphate of Lime in the United States and Canada. Amer. Inst. Min. Eng. Baltimore meeting, February, 1892, published 1893.

Contains an account of the discovery of the pebble phosphate on Peace Creek in 1881.

1893. Eldridge, George H:

A Preliminary Sketch of the Phosphates of Florida. Am. Inst. Min. Eng. Trans. xxi, pp. 196-231, 1893. Read before the American Institute of Mining Engineers at Baltimore meeting, February, 1892, published 1893.

1893. Shaler, N. S.:

Residual Ablation Deposits. (Contained in paper on "A Preliminary Sketch of the Phosphates of Florida," by George H. Eldridge.) Am. Inst. Min. Eng. Trans. xxi, 1893.

Regards the Florida pebble phosphate deposits as residual ablation deposits which have been moved about more or less by stream action.

1896. Leidy, Joseph and Lucas, F. A.:

Fossil Vertebrates from the Alachua Clays of Florida. Wag. Free Inst. Sci. Trans. Vol. 4, pp. 61, pls. 19, 1896.

This paper includes Professor Leidy's final studies of the fossils of the Alachua clays. The paper after Professor Leidy's death was completed and edited by Professor F. A. Lucas. The species recognized in this paper by Leidy and Lucas as occurring in the collections from the vicinity of Archer, Florida, are the following: (1) *Aphelops fossiger*, sub-species *proterus* (*Rhinoceros proterus* (Leidy); (2) *Aphelops malacorhinus* Cope (*Rhinoceros longipes* Leidy); (3) *Procamelus major* (Leidy); (4) *Procamelus medius* (Leidy); (5) *Procamelus minor* (Leidy); (6) *Mastodon floridanus* Leidy; (7) *Hippotherium gratum;* (8) *Hippotherium plicatile;* (9) *Megatherium* sp.; (10) *Equus major.* (*Hippotherium princeps* Leidy); (11) Tapir; (12) Crocodile or Alligator; (13) Fragments of the shell of *Emys,* scales of a Garfish, and several bones of a teleost.

In this paper, page x, it is stated that no remains of carnivora occur; nor is the deer which had been mentioned in previous reports again referred to. The horse tooth identified in this report as *Equus major* (*Hippotherium princeps*

Leidy) was collected on Peace Creek by Mr. Joseph Willcox and was placed in the collection from Archer by mistake.

1896. Dall, W. H.:

(Account of the manner of occurrence of fossil vertebrates in the Alachua Clays.) Contained in introduction to "Fossil Vertebrates from the Alachua Clays," by Joseph Leidy and F. A. Lucas. Wag. Free Inst. Trans. Vol. 4, pp. xi-xiv, 1896.

In this paper Dr. Dall states that the first to call attention to these fossils was Dr. J. C. Neal of Archer, who communicated with Professor Baird in 1883. The localities noted by Dr. Neal as reported by Dall were "(1) Mixon's farm, ten miles south and one and a half miles east of the railway station at Archer (near Williston); (2) Hallowell's place, ten miles north and two miles west of the station (near Half Moon); (3) pond, about a quarter of a mile from the station. Later Dr. Neal reports another about two miles northwest of Mixon's, on a clay ridge in an old field."

1896. Cope, Edward D.:

On some Pleistocene Mammalia from Petite Anse, La. Proc. Amer. Philos. Soc. xxxiv, pp. 458-468, pls. x-xii.

In this paper, pp. 456-466, the horse from the Caloosahatchee River in Florida, which previously had been described as the type of the new genus *Tomolobis* Cope, is recognized as *Equus fraternus*.

1899. Lucas, Frederick A.:

The Fossil Bison of North America. U. S. Nat. Mus. Proc., Vol. 21, pp. 755-771, pls. 65-84, 1899.

In this paper a reference to Florida occurs on page 767, where it is mentioned that *Bison latifrons* has been reported from Peace Creek and from the Withlacoochee River. The exact locality is not given.

1907. Hrdlicka, A.:

Skeletal Remains Suggesting or Attributed to Early Man in North America. Bureau of Amer. Ethnology, Bull. 33, pp. 1-113, pls. i-xxi, figs. 1-16, 1907.

In this report all known occurrences of fossil man in Florida are reviewed and the probable geologic horizon discussed.

1907. Vaughan, T. W.:

Report on the localities at which were found the Fossil Human Remains Found on Sarasota Bay. Bureau of Amer. Ethnology, Bull. 33, pp. 64-66, 1907.

1908. Hay, O. P.:

The fossil turtles of North America. Carnegie Inst., Publication No. 75, 1908.

In this volume Dr. Hay has described several new species of turtles from Florida.

1909. Matson, G. C. and Clapp, F. G.:

A Preliminary Report on the Geology of Florida. Florida State Geol. Surv. Second Annual Report, pp. 21-173, pls. 2-8, figs. 1-2. One map. 1909. Prepared in co-operation between the United States Geological Survey and the Florida State Geological Survey, under the direction of Thomas Wayland Vaughan.

This paper contains many references to both the hard rock and the pebble deposits. The name Bone Valley Beds is proposed for the pebble phosphate deposits.

1909. Osborn, Henry Fairfield:

Cenozoic mammal horizons of western North America, with faunal lists of the Tertiary Mammalia of the West by William Diller Matthew, U. S. Geol. Survey, Bull. 361, 138 pp., pls. 3, 15 figs., 1909.

Reference to Florida occurs on page 80 and 115, where the "Archer formation" of Florida (in part) is regarded as homotaxial with the Peraceras zone of the Ogalalla formation (upper part), which is regarded as the last phase of the Miocene or the first phase of the Pliocene.

1910. Sellards, E. H.:

A Preliminary Paper on the Florida Phosphate Deposits. Fla. State Geol. Sur. Third Annual Report, pp. 21-41, pls. 1-5, 1910.

1910. Osborn, H. F.:

The Age of Mammals in Europe, Asia and North America, 635 pp. New York, 1910. The MacMillan Company.

The Alachua clays and Peace Creek beds are described in this volume (pp. 346-348, 366-368). In connection with the discussion of the Alachua clays it is stated, (p. 347) that Dall had found Pliocene beneath these deposits. [This, however, is an error, as Dall has not reported Pliocene beneath the Alachua clays. On the contrary he states that these deposits rest upon the Eocene and Miocene.]

1910. Vaughan, T. Wayland:

A Contribution to the Geologic History of the Floridian Plateau. Carnegie Institution of Washington, Publication No. 133, pp. 99-185, 1910.

1913. Scott, W. B.:

A History of Land Mammals in the Western Hemisphere, 693 pp. New York, 1913. The MacMillan Company.

The Alachua clays of Florida are placed in the Lower Pliocene, while the Peace Creek beds are referred to as upper Pliocene or lower Pleistocene (p. 127).

1913. Matson, G. C. and Sanford, Samuel:

Geology and Ground Waters of Florida. U. S. Geological Surv., Water Supply Paper 319, 445 pp., pls. 1-17, figs. 1-7, one map, 1913. Prepared in co-operation between the United States Geological Survey, under the direction of Thomas Wayland Vaughan.

In this report the Bone Valley formation is regarded as probably Pliocene and somewhat older than the Caloosahatchee marl, and in part at least contemporaneous with the Alachua clays.

1913. Gidley, J. W.:

(Notes on the relative ages of the beds at Archer, at Mixon's and at Ocala, Fla., and their correlation with deposits of the western-plains region.) Included in Geology and Ground Water of Florida, U. S. Geol. Survey, Water Supply Paper 319, pp. 142-143, 1913.

The beds at Archer and Mixon's are regarded as upper Miocene or lower Pliocene, their fauna corresponding in point of development with that of the Republican River formation of Kansas and Nebraska. The fauna of the Peace Creek beds suggests Pleistocene or late Pliocene.

1913. Hay, Oliver P.:

Notes on some fossil horses, with descriptions of four new species. U. S. Nat. Mus. Proc., Vol. 44, pp. 569-594, pls. 69-73, 1913.

Two new species of fossil horses are described from Peace Creek, Florida, *Equus leidyi* and *Equus littoralis*.

1913. Sellards, E. H.:

Origin of the Hard Rock Phosphate Deposits of Florida. Fla. State Geol. Sur. Fifth Annual Report, pp. 23-80, pls. 1-9, two maps, 1913.

A number of the fossil vertebrates of the hard rock phosphate deposits are listed and illustrated in this report.

1914. Sellards, E. H.:

Relation Between the Alachua Clays and the Dunnellon Formation of Florida. Fla. State Geol. Sur. Sixth Annual Report, pp. 161-162, 1914.

The Alachua clays and the Dunnellon formation are regarded as parts of a single formation which may be known as the Alachua formation.

1915. Sellards, E. H.:

A New Gavial from the Late Tertiary of Florida. Amer. Jour. Sci., Vol. xl, pp. 135-138, Aug., 1915.

The fossils described in this paper are from the Bone Valley formation.

1915. Sellards, E. H.:

Chlamytherium septentrionalis, an Edentate from the Pleistocene of Florida. Amer. Jour. Sci., Vol. xl, pp. 139-145, Aug., 1915.

1915. Sellards, E. H.:

The pebble phosphates of Florida. Fla. State Geol. Surv. Seventh Annual Report, pp. 25-116, 1915.

A number of the vertebrate fossils found in the land pebble and the river pebble deposits of Florida are illustrated in this report.

1916. Sellards, E. H.:

On the Discovery of Fossil Human Remains in Florida in Association with Extinct Vertebrates. Amer. Jour. Sci., Vol. xlii, pp. 1-18, July, 1916.

In this paper is described fossil human remains found in association with Pleistocene vertebrates at Vero in St. Lucie County.

1916. Sellards, E. H.:

A New Tortoise and a Supplementary note on the Gavial, Tomistoma americana. Amer. Jour. Sci., Vol. xlii, pp. 235-240, September, 1916.

*Mammut progenium?*. Top view of the lower jaws, and external view of the right lower jaw. Approximately one-fifth natural size. From the Amalgamated Phosphate Company, Brewster, Fla. Surv. coll. No. 6160.

## FOSSILS FROM THE ALUM BLUFF AND THE ALACHUA FORMATIONS.

PLATE II.

All illustrations on this plate one and one-sixth times natural size.

Fig. 1: *Merychippus* sp. Lower cheek tooth. From the fuller's earth mine at Quincy. Fla. Surv. coll. No. 173------p. 87

Fig. 2: *Leptomeryx* sp.? Astragalus referred provisionally to the genus *Leptomeryx*. From the Griscom plantation. Fla. Surv coll. No. 5097----------p. 89

Fig. 3: Second phalanx of the median toe of a small horse. From the fuller's earth mine at Midway. Fla. Surv. coll. No. 6869 ----------p. 87

Fig. 4: *Oxydactylus* sp. Cheek tooth. From the Griscom plantation. Fla. Surv. coll. No. 5073----------p. 89

Fig. 5: Astragalus of camel referred provisionally to *Oxydactylus*. From the fuller's earth mine at Midway. Fla. Surv. coll. No. 6871----------p. 89

Fig. 6: First median phalanx associated with *Parahippus leonensis*. From the Griscom plantation. Fla. Surv. coll. No. 5080 ----------p. 87

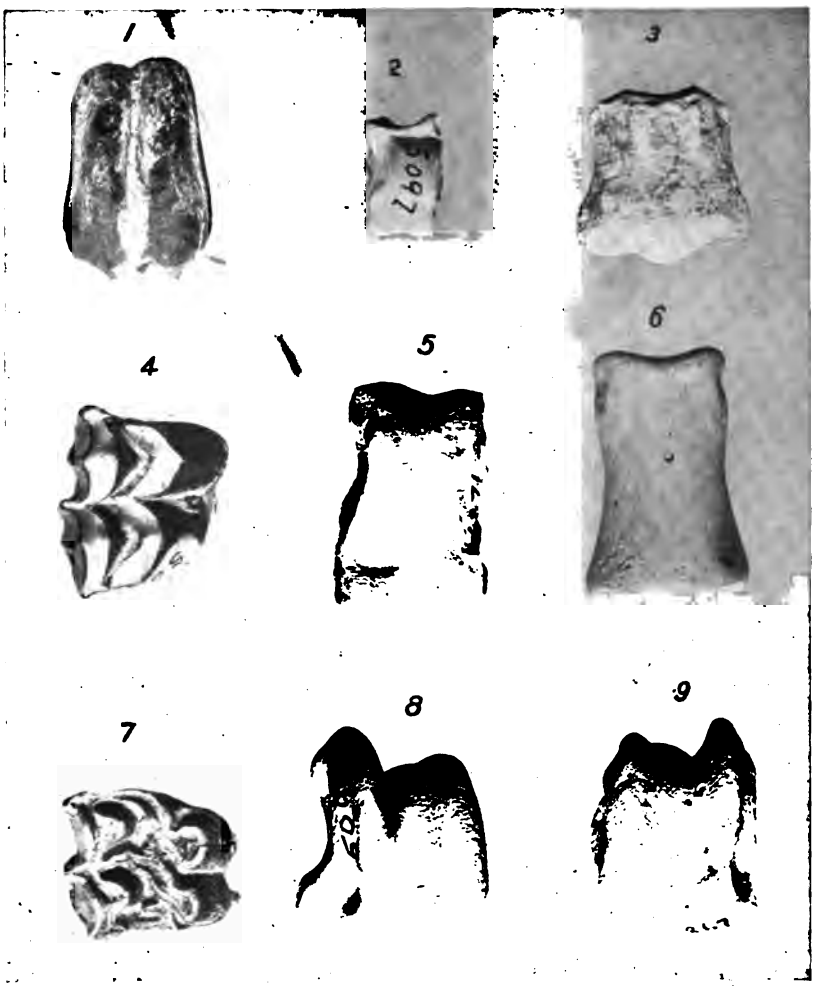
Fig. 7: *Parahippus leonensis*. Type specimen. Right upper cheek tooth, probably $M^1$. From the Griscom plantation. Fla. Surv. coll. No. 5084----------p. 83

Figs. 8-9: Astragli referred provisionally to *Parahippus leonensis*. From fuller's earth mine at Midway. Fla. Surv. coll. No. 6867; No. 5095 from the Griscom plantation----------p. 87

Fig. 10: *Hipparion minor*. Type specimen----------p. 96

Fig. 11: *Mesocyon iamonensis*. Type specimen. From the Griscom plantation. Fla. Surv. coll. No. 5082----------p. 88

Fig. 12: Lower cheek tooth associated with *Parahippus leonensis*. From the Griscom plantation. Fla. Surv. coll. No. 5083--p. 83




FOSSILS FROM THE BONE VALLEY FORMATION.
URSIDAE.

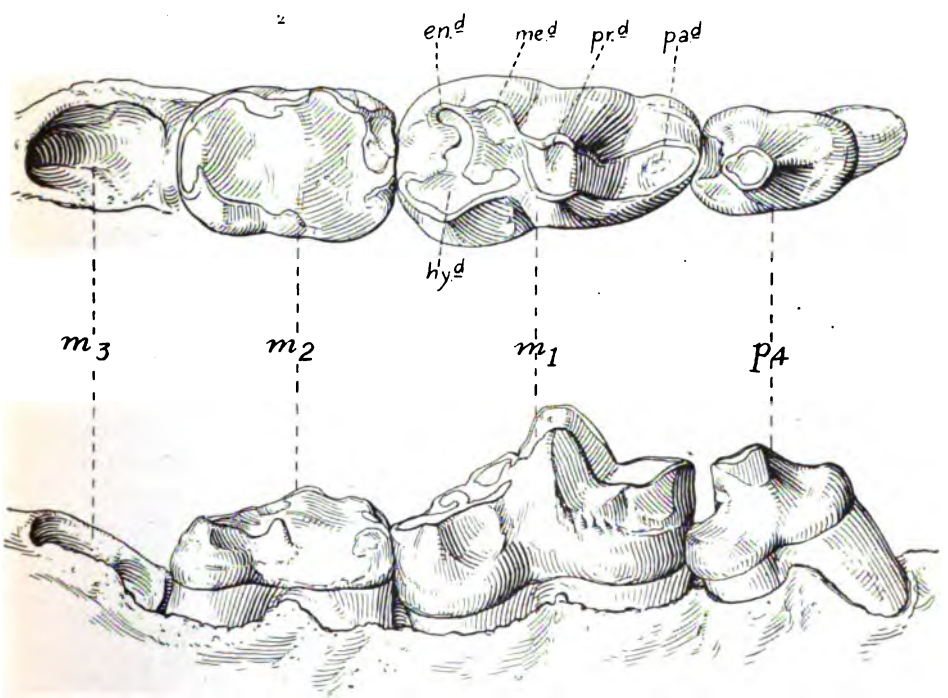
PLATE 12.

*AGRIOTHERIUM SCHNEIDERI*, sp. nov .....p. 98

Fig. 1: Exterior and top view of the right lower jaw of the type specimen. Approximately two-fifths natural size, the full length of the specimen as preserved being 260 mm. Fla. Surv. coll. No. 6856.

The lower margin is convex and the jaw has great depth below the molars. The canines are extraordinarily large; the molars are greatly developed; the premolars are reduced in number as well as in size, only two being present; of these the anterior premolar, located just behind the canine is wanting in this specimen although its place in the jaw is indicated by an alveolus. $Pm_4$ is relatively large, the anteroposterior measurement being fully one-half that of $M_1$.

Fig. 2: The molars and $Pm_4$, natural size. The largest tooth of the series is the carnassial, $M_1$. As in the old world species of the genus the paraconid and protoconid are large and although rather thick afford an effective shearing blade. The metaconid is reduced and is placed well behind the protoconid. The hypoconid is large and receives heavy wear, while the entoconid is reduced The heel or talonid of $M_1$ is wide exceeding the width of $M_2$, in this respect differing from modern bears in which $M_2$ is the broadest tooth of the series.



## FOSSILS FROM THE ALUM BLUFF, ALACHUA AND BONE VALLEY FORMATIONS.

PLATE 13.

All illustrations on this plate twice natural size.

Fig. 1: *Mesocyon? iamonensis.* Type specimen. Showing two upper molars and the carnassial. Fla. Surv. coll. No. 5083

Figs. 2-3: *Parahippus leonensis.* Type specimen. View of the grinding surface and exterior side of the cheek tooth. Fla. Surv. coll. No. 5084. The object shown in front of and at the outer side of the crochet is not a structural feature but represents an elongated pebble lodged in the prefossette, which should perhaps have been omitted from the drawing.

Figs. 4-5: *Merychippus.* sp. Lower cheek tooth from the fuller's earth mine at Midway. Fla. Surv. coll. No. 7527.

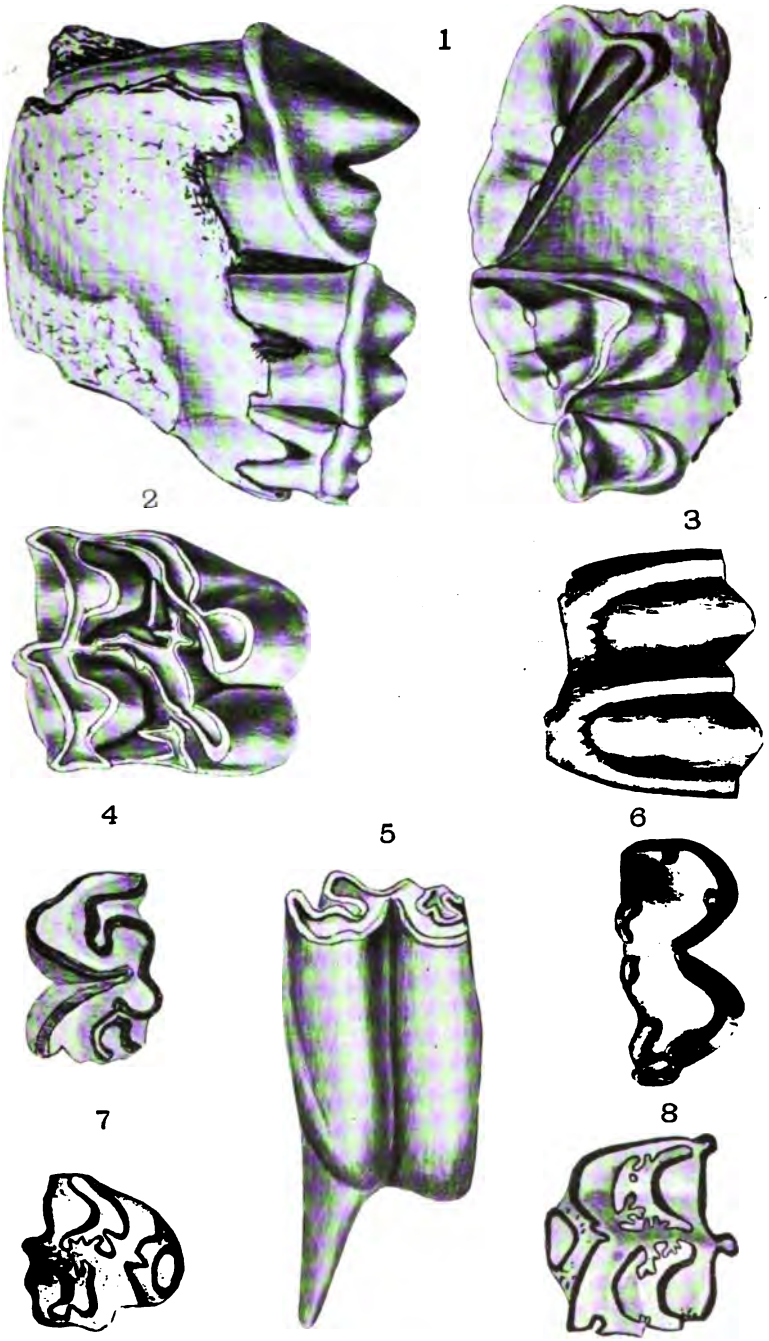
Fig. 6: *Merychippus* sp. Lower cheek tooth from the fuller's earth mine at Quincy. Fla. Surv. coll. No. 173.

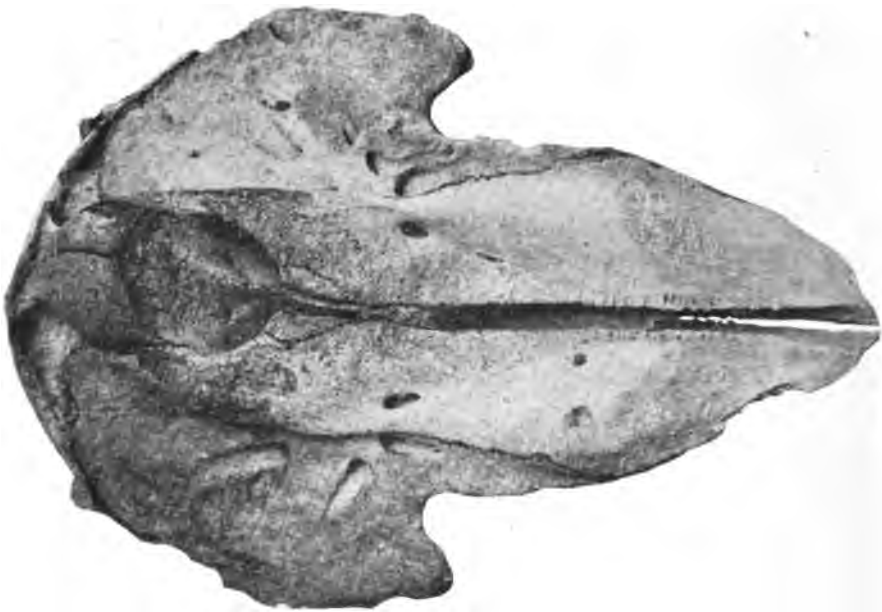
Fig. 7: *Hipparion minor.* Paratype. From the Alachua formation (hard rock phosphate deposits), Neals. Fla. Surv. coll. No. 1167.

Fig. 8: *Hipparion minor.* Type specimen. From the Alachua formation, Brewster. Fla. Surv. coll. No. 5867.

After the present paper had been put into page proof the writer obtained well preserved upper cheek teeth of *Merychippus* from the fuller's earth mine at Midway which are thus associated with the lower cheek teeth illustrated on this plate. The upper cheek teeth are short hypsodont and are provided with cement. The protocone is small and is distinctly flattened anteroposteriorly and is separated, as may be seen in the unworn tooth, for a short distance from the protoconule. The hypocone likewise is small and is placed well back on the inner margin of the tooth. In the worn tooth it may be seen that the enamel bordering the lakes is strongly crenulated, and that the protocone is united with the protoconule The anteroposterior measurement of the cheek tooth is 17 mm.; transverse 15 mm.; height of crown of unworn molar 21 mm.

In comparing *Merychippus* and the associated vertebrates with the invertebrates listed on page 91, it is well to bear in mind that while both faunas appear to come from the same formation, the fossils were not found in immediate association, and there may be some difference in level, or even possibly a stratigraphic break between the two faunas.





*Globicephalus baereckeii*, sp. nov. Type specimen. View of top and base of skull. About one-fifth natural size. Actual length of skull, 570 mm.

# HUMAN REMAINS AND ASSOCIATED FOSSILS FROM THE PLEISTOCENE OF FLORIDA

(Text-figures 1-15; plates 15-31)

BY E. H. SELLARDS

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## ILLUSTRATIONS.



## PLATES.

# HUMAN REMAINS AND ASSOCIATED FOSSILS FROM THE PLEISTOCENE OF FLORIDA.

(Text-figures 1-15; plates 15-31).

E. H. SELLARDS.

A new and very important locality for vertebrate, invertebrate, and plant fossils was found in 1913 at Vero on the Atlantic Coast in Central-Eastern Florida. The feature of especial interest at this locality is the presence of fossil human remains in association with the Pleistocene vertebrates. Human remains have been found at this locality in two separate strata which differ in age, the one being superimposed upon the other. The contemporaneity of man and the Pleistocene fossils is based not upon a single discovery, but upon successive discoveries including bones from two human skeletons and in addition flints and implements made by man. The geologic conditions at this locality fortunately are favorable for a correct placing of the fossils as the older human remains are here found in a fresh-water stratum which rests upon marine shell marl and is overlaid by a laminated fluviatile deposit. Although lying near the surface the possibility of the human bones representing a recent burial is excluded by the fact that the overlying laminated stratum is undisturbed. The condition of preservation as well as the abundance of the associated Pleistocene fossils is such as to show that they could not have washed into this deposit from an older formation. There is thus conclusive evidence that the human remains and the associated fossils are contemporaneous. These associated fossils, including mammals, birds batrachians, reptiles and fishes, afford incontestable evidence of the Pleistocene age of the deposits.

Of the mammalian species of this fauna a few, including chiefly small inconspicuous animals, have persisted to the present time, while the larger animals, including the elephants, mastodons, camels, horses, bison, tapirs and sloths have suffered extinction. With the exception of bison which are native to North America, horses which have been re-introduced from Europe and canids which are

world wide in distribution, the existing relatives of these extinct species are now found in Central and South America, in Asia or in Africa.

A preliminary paper by the writer relating to human remains from the Pleistocene of Florida, published in the American Journal of Science, July, 1916, contains the records of excavations at Vero to the close of May, 1916. A second paper published in Science contains notice of discoveries made in June, 1916. The present publication includes results obtained at this locality to the close of September, 1916.

The occurrence of fossils at Vero first became known as a result of the construction of a drainage canal made by the Indian River Farms Company. Throughout the greater part of its course this canal which extends from the coast several miles inland, cuts through the surface materials including sand, marl, and muck beds, and into marine shell marl. In the marine marl, invertebrates are found in abundance and in an excellent state of preservation, while in the sands, fresh-water marls, and muck beds, vertebrates and fresh-water invertebrates are not infrequently preserved. The chief locality for vertebrate and plant fossils, however, is at the public road crossing one-half mile north of Vero, where the canal cuts into an old stream bed. The canal enters the stream bed about 500 feet west of the crossing, and follows it while passing under the bridge and for 500 and 600 feet beyond, or for a total distance of about 1,000 feet (sketch map, fig. 1).

## ACKNOWLEDGMENTS.

Notice of the occurrence of fossils at Vero was brought to the writer's attention in November, 1913, by Mr. Isaac M. Weills, the presence of fossil bones in the canal having been reported to him by Mr. F. C. Gifford. Mr. Weills, with the assistance of Mr. Frank Ayers, has constantly watched the canal banks and has thus obtained the fossils as they were exposed. Among others who have contributed fossils from this locality, are Messrs. F. C. Gifford, E. J. Wood, J. McCullers, N. F. McCall and J. W. Welch. To Messrs. Weills and Ayers in particular are due the very important results that have been obtained, Mr. Ayers' close watch of the canal bank having been rewarded by the fortunate discovery of the human re-

mains while they were still in place in the undisturbed wall of the canal. Additional collections at this locality have been made by H. Gunter and the writer. Acknowledgments are due to the officials of the U. S. National Museum, the American Museum of Natural History and the Philadelphia Academy of Sciences, for facilities afforded in consulting collections. The turtles of the Pleistocene of Florida contained in the Florida State Geological Survey collection, including those found at Vero, have been identified and described by Dr. O. P. Hay of the Carnegie Institution. The photographs included in this paper, except those of plates 15, 16 and 17 were made by E. P. Greene. The chemical analyses have been made by L. Heimberger, under the direction of R. E. Rose, State Chemist of Florida. The drawings illustrating specimens have been made by Sydney Prentice, and those showing geologic sections by H. Gunter. The fresh-water invertebrates found in the stratum containing human remains have been identified by Dr. Paul Bartsch of the National Museum. The co-operation and assistance thus received is very much appreciated.

## THE GEOLOGIC SECTION AT VERO.

It is desirable, before describing the human remains, to consider the general geologic section at Vero, as well as the late geologic history of this part of the Atlantic Coast. The marine shell marl into which the canal cuts, number 1 of the section shown in text-figure 2, is a part of the extensive series of marine marls which border the Atlantic Coast, beginning on the north near St. Augustine, where the marl is known as "Coquina" rock, and extending south to the Everglades of Florida, beyond which the shell marls give place to the shallow-water limestones of extreme southern Florida. These marls and limestones are known by their invertebrate fauna to be of Pleistocene age*. To this extensive deposit of marine shell marl bordering the Atlantic Coast, the writer in 1912 applied the term Anastasia formation, this name having been selected because of the fact that the shell marl was first quarried and described on Anastasia Island near St. Augustine†.

The sands which as a rule overlie the shell marls are in part of marine origin, having acumulated in shoal waters, or as beaches

* A list of the invertebrate fossils from this shell marl at Eau Gallie, about 40 miles north of Vero, is given on page 151 of the Second Annual Report of the Florida Geological Survey. 1909.

† Fla. State Geol. Surv., Fourth Annual Report, p. 18, 1912.

and dunes, at the time the sea withdrew from the land, and are thus contemporaneous in age or nearly so with the marine shell marls. However, in ponds, streams and lakes fresh-water marls, sand and muck deposits accumulated which rest upon and hence are of somewhat later age than the marine marls, and it is in deposits of this kind chiefly, as would be expected, that the land and fresh-water fossils are preserved. A more detailed account of a section through a stream bed at Vero will be given in connection with the description of the fossil human remains.

## THE GEOLOGIC HISTORY OF THE FLORIDA EAST COAST.

The geologic history of the Florida East Coast will be considered in this paper only in so far as it affects the locality under discussion. It is known that the early Pleistocene included a period of great submergence during which the extensive marine marls and limestones of eastern and southern Florida were deposited. Following the accumulation of these early Pleistocene formations the peninsula was lifted in relation to the strand-line to a level somewhat above its present elevation. This period of probably slight emergence was followed by a depression, proof of which is derived from many sources and is conclusive. Shaler long ago noted the fact that the important harbors of Florida are flooded river valleys*. Vaughan likewise has called attention to the submerged channels of both the Atlantic and the Gulf Coasts which, together with other evidence, lead him to conclude that both the mainland and the Keys of the Florida East Coast stood at the time of maximum Pleistocene emergence as much as 30 feet above the present strand-line†. The existence of a Pleistocene cypress swamp in Hillsboro Bay, 20 feet below the present sea level, and of a peat bed at the same depth near the Florida Keys on the Atlantic Coast, has been noted by the writer. Additional evidence of changes of level may be adduced from physiographic features in the interior of the State, particularly from the lakes of the "Lake Region" of Florida, the basins of which probably originated through sinkhole formation at a time when the land area stood higher that at present.‡ The land

* The Geological History of Harbors, U. S. Geol. Surv., 13th Ann. Rept. pt. 2, pp. 190-192, 1893.

† Sketch of the Geologic History of the Florida Coral Reef Tract and Comparisons with Other Coral Reef Areas, Washington Acad. Sciences, Vol. iv, p. 30, 1914.

‡ Florida State Geol. Surv., Seventh Annual Report, p. 56, 1915; ibid., Sixth Annual Report, p. 155, 1914.

fauna found in the stream beds and ponds of the Atlanta Coast of Florida, therefore, represents that part of the Pleistocene following the deposition of the marine shell marl.

## THE DEPOSITS CONTAINING VERTEBRATE FOSSILS.

The excavations as well as the timber growth show that the old stream bed or valley at Vero has a width of from 350 to 500 feet for a distance of about three-fourths of a mile from the Indian River, which is itself an inlet from the Ocean. The stream valley, however, is very shallow, the material which fills it having at the present time a thickness of not more than from four to six feet. At the time the canal was cut, a sluggish stream, known as Van Valkenburg's Creek, following an ill-defined channel, flowed through the valley which had been aggraded to within three or four feet of the surrounding land level. The fill in the stream valley includes, as shown in the accompanying sketch (fig. 2), two successive fluviatile deposits. From the sketch map (fig. 1) it will be seen also that the broad valley is formed, near the place where the fossils are found, by two tributaries which enter, one from the north and one from the south. These streams originate only a few miles inland and their course is controlled by the Pleistocene beaches and dunes which here parallel the coast. The position of the original stream may have been determined by a natural depression or inlet from the ocean which possibly accounts for the great width as compared to the shallow depth of the valley. The possibility of the stream having in former times been fed by a spring also suggests itself, especially as the number of vertebrates found in this locality seem to imply some kind of a fresh-water resort.

## SECTION THROUGH THE STREAM VALLEY.

The section through the stream valley, as exposed in the banks of the canal at the place where the human remains are found, is represented by text-figure 2. The section as here shown does not extend directly across the stream, but as will be seen by referring to the sketch map (fig. 1), runs approximately parallel to the general course of the valley from the union of the two tributaries to the crossing of the Florida East Coast Railroad, a distance of 512 feet. Number 1 of the section represents the marine shell marl which is common to this part of the State, and is cut into by the

canal here as elsewhere. The material next following the marl, number 2 of the section, includes cross-bedded river-wash sand, partially decayed wood and muck, sand stained brown by organic matter, and at places fresh-water marl rock. The distinctly cross-bedded sands of this stratum are found near the base, and it is here chiefly that the decayed wood and muck occur lying in stream channels in the shell marl. The brown sand contains in places many fresh-water shells, and grades into the fresh-water marl which in places includes at the top as much as two feet of rather hard rock. Vertebrate and fresh-water invertebrate fossils occur throughout this bed from the cross-bedded sands at the

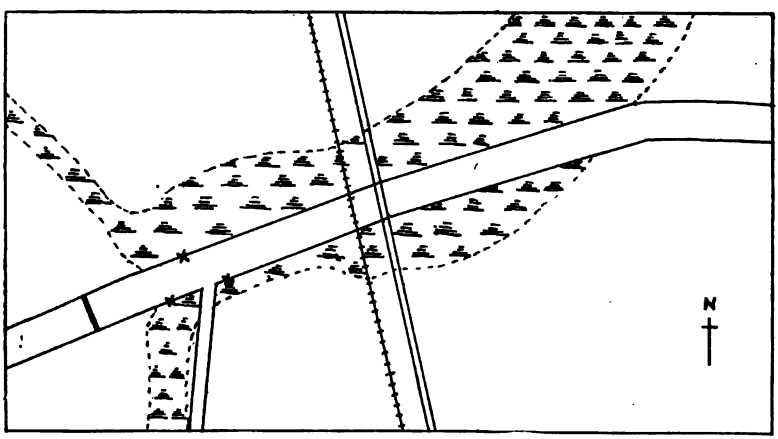



FIG. 1. Sketch map showing the locality at which human fossils were found at Vero. Scale, 1 inch equals 300 feet. The location of the human remains in the canal bank is indicated in the sketch by a cross. The margins of the broad valley are indicated by the dotted lines, and the swamp growth in the valley by the conventional character. The canal follows the stream valley while passing under the Florida East Coast Railroad and the public road. The modern stream in this valley followed an ill-defined, anastomosing and frequently changing channel.

base to the marl rock at the top. It is from this bed also that the first human fossils found at Vero were taken.

Resting upon this sand and marl bed and in places cutting into it is an alluvial deposit consisting chiefly of vegetable material intermixed with sand, grading at the top in places as is true also of the bed beneath, into a fresh-water marl. The average aggrading of the stream valley by this alluvial material amounts to about

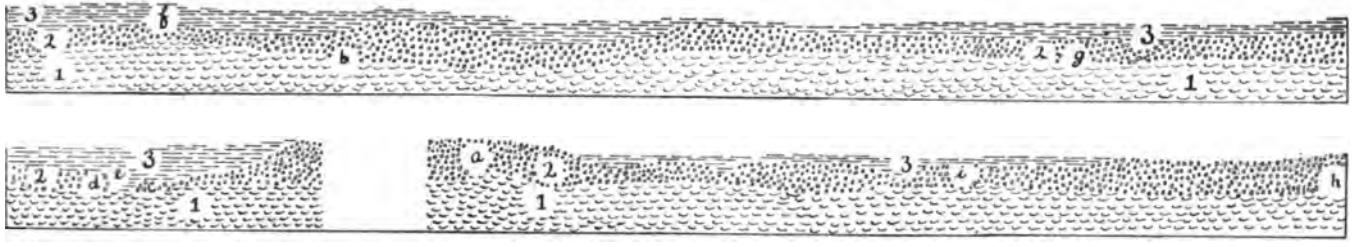



Fig. 2: Sketch showing the strata exposed in the canal bank at Vero. Horizontal scale 1 inch equals 73 feet; vertical scale 1 inch equals 25 feet. The section here represented is that of the north and south banks of the canal from the Florida East Coast Railroad bridge west a distance of 512 feet (See sketch map fig. 1.) The break in the sketch indicates the entrance of the lateral canal from the south. The base line is drawn at water level in the canal which at that time stood 18 feet below the top of the railroad track. The strata exposed are: (1) A marine shell marl found generally throughout this part of the State and cut into by the canal here as elsewhere; (2) a fresh-water sand, muck, and marl bed containing fresh-water invertebrates, plant and vertebrate fossils including human remains; (3) an alluvial bed consisting of incoherent sand, muck and vegetable material containing plant and animal fossils and human remains.

Human skeletal remains have been found in stratum No. 2 at *a* and at *c*. Markings on a bone and on a proboscidian tusk were found in this stratum at *b*. Flints and bone implements were found in this stratum at *c* and at *d*. Human skeletal remains, pottery and implements were found in stratum No. 3 at *e* and at *f*.

two feet, although locally where the stream cut deeply into the underlying bed this deposit reaches a maximum thickness of five or six feet. This alluvial deposit contains vertebrate and plant fossils and in the fresh-water marl occasional invertebrates. Human remains are found in this deposit also, their place in the section being indicated in text-figures 1 and 2.

Between the marine marl, No. 1 of the section, and the sand and marl stratum holding human and other vertebrate fossils, No. 2 of the section, there exists no persistent well marked break in deposition. There is, however, a change from marine to fresh-water conditions, and accompanying this change one finds evidence of stream action, materials from the land having been washed in and deposited in channels in the marine shell marl. On the other hand there are places in the section where the sand and shell beds of the marine deposits dove-tail into the succeeding fresh-water deposits in such a way as to indicate continuous deposition. It is probable that the fresh-water deposit indicated by number 2 of the section, represents at this locality, the closing phase of the marine marl formation, the change to fresh-water conditions having been brought about by a slight shifting of the strand-line.

Between this older stream deposit, No. 2, and the alluvial bed which follows, No. 3, there is on the other hand an abrupt well marked persistent break, the top surface of stratum No. 2 being extremely irregular. The alluvial bed, No. 3, the initial phase of which is represented by pronounced stream action, conforms to the irregularities of the older deposits. Stratum No. 3 represents possibly the filling of the stream channel which followed the late Pleistocene depression referred to on page 126.

One of the abundant and easily recognized fossils of stratum No. 2 is the Columbian elephant, *Elephas columbi,* and for convenience of reference this stratum may be known as the *Elephas columbi* zone or horizon. An abundant fossil in stratum No. 3 is a deer which is referred provisionally to the modern *Odocoileus osceola* and this stratum may be known as the *Odocoileus osceola* zone.

## THE HUMAN REMAINS.

At the time of the discovery of vertebrate fossils at Vero in 1913, the writer suggested to Mr. Weills, who had reported the fossils, the possibility, which at that time seemed remote, of finding human bones in a bed containing such considerable numbers of land vertebrates. The subsequent pages of this paper will show

how fruitful of results, following this chance suggestion, have been the efforts of those who were collecting there.

## FIRST DISCOVERY OF HUMAN REMAINS IN THE OLDER STREAM DEPOSIT, STRATUM NO. 2 OF THE SECTION.

Text-figure 3; pl. 18, fig. 1; pl. 19, fig. 4; pl. 20, fig. 1; pl. 21, fig. 6.

In October, 1915, Mr. Ayers, while examining the stratum which contains the vertebrate fossils, found some bones in place which seemed probably to belong to a human skeleton. In order to verify the place of the bones in the section he then called Mr. Weills, and together they removed the bones. The parts of the skeleton obtained include the right and left femur, lacking the extremities; right patella; left tibia and fragments of the right; right fibula; right calcaneum; right and left astragalus; left navicular; external cuneiform of the right foot; right metatarsals one to four; left metatarsals three to five; a part of the shaft of the left humerus; right os magnum; three metacarpals; and three phalanges. All of these bones pertain apparently to the same specimen, representing a small individual. From the lower margin of the lesser tuberosity to the upper margin of the inner condylar notch, the femur measures 29 cm., the corresponding measurement on the femur of a large modern adult being as much as 32 cm. The extremities of the larger limb bones of this skeleton are but poorly preserved, a condition common to many of the bones in this sand, although the bones found in muck in this bed are as a rule more nearly complete.

The section of the bank at the place where these human bones were found is as follows:

| | Feet. | Inches. |
|---|---|---|
| Sandy hard marl rock | 1 | 3 |
| Sand stained brown by organic matter | 3 | 9 |
| Marine shell marl to water level in the canal | 5 | 9 |

The marl rock and the brown sand beneath represent stratum No. 2 of the general section (text-figure 2), the alluvial bed, No. 3 of the section, being absent at this place. The human remains were imbedded in the brown sand about three feet from the base or two feet from the ground surface as it existed previous to the construction of the canal.

That the sands in which the human remains are found represent a continuation of the stratum holding the other vertebrate fossils

there can be no question, as the section is continuous along the canal bank and the deposits identical in appearance. *Elephas columbi, Equus leidyi* and other extinct species are found at an equal or higher level in the beds on either side of the human remains. From the marl rock which lies at the top of the section the writer obtained within six feet of the place where the human skeleton lay, a premolar tooth of a fox, representing not the common gray fox of that region, but either an extinct species, or possibly the red fox, *Vulpes pennsylvanicus,* which at present is not known in Florida. In immediate association with the human bones were the scapula and astragalus of a deer which is also found elsewhere in the sand, being one of the common fossils of the bone bed. In addition a hyoid bone of the sloth, *Megalonyx jeffersonii,* and pieces of the teeth of the mastodon, *Mammut americanum,* have been collected from the canal bank at the place where the human bones were found.

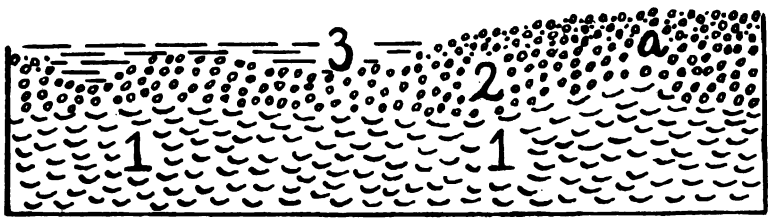



FIG. 3. Sketch to show the location of the first human skeletal remains found at Vero. Horizontal scale 1 inch equals 30 feet; vertical scale 1 inch equals 10 feet. At this place in the south bank of the canal 330 feet west of the railroad bridge, stratum No. 2 of the general section grades at the top into a hard sandy, marl rock having a thickness of 15 inches. The human bones as indicated in the sketch were below the hard rock and were imbedded in the brown sand.

## MINERALIZATION OF THE BONES.

The chemical analysis of fossil bones is usually considered as affording important contributory evidence of age. In the present instance the opportunity for comparative analysis is particularly good, since it is possible on one hand to compare the fossil human bones with the recent human bones from the Indian mounds, and on the other with the bones of animals, known to be of Pleistocene age, found in the same bed as the human bones. Accordingly, analyses have been made at the writer's request in the State Labora-

tory under the direction of the State Chemist. The results of the analyses are presented in the following table. All of the analyses included in this table were made at the same time and by the same methods.

Analysis of Recent and Fossil Bones from Vero, Florida.

| | No. 1. | No. 2. | No. 3. | No. 4. |
|---|---|---|---|---|
| Specific gravity | 2.0627 | 2.8357 | 2.6293 | 2.7505 |
| Moisture at 100° C. | 10.72 | 2.07 | 4.09 | 3.89 |
| Volatile matter | 19.59 | 8.92 | 8.22 | 10.30 |
| Phosphoric acid $P_2O_5$ | 27.24 | 32.27 | 30.88 | 32.00 |
| Calcium oxide, CaO | 39.75 | 46.80 | 45.69 | 48.31 |
| Insoluble matter, silica, etc. | 0.60 | 1.11 | 3.61 | 1.39 |
| Iron and aluminum oxides | 0.13 | 3.71 | 1.85 | 0.76 |

No. 1 is from a recent human tibia taken from an Indian mound near Vero. Fla. Surv. coll. No. 5537. No. 2 is from the right tibia of a man taken in place in the Pleistocene bed at Vero. Fla. Surv. coll. No. 5200. No. 3 is from the femur of *Canis* sp. from the stream bed at Vero. Fla. Surv. coll. No. 5449. No. 4 is from the front part of the jaw of *Megalonyx jeffersonii,* from Vero. Fla. Surv. coll. No. 4374.

The specific gravity was obtained from the finely powdered bone by the gravity bottle. The moisture, taken at 100°C., includes, as will be recognized, any other constituents sufficiently unstable to be driven off at that temperature. Volatile matter, likewise, represents the constituents driven off when the sample is maintained at red heat in a muffle for several hours, and necessarily includes carbon dioxide, and possibly other constituents in addition to the organic matter. The phosphoric acid, calcium oxide, and iron and aluminum oxides were determined by standard methods. The analyses show, as may be seen from the table, that the fossil human bones are quite as well mineralized as are the associated bones of the Pleistocene animals.

Since the stratum holding the bones lies near the surface the possibility of the human bones having been placed in it by burial must be considered, although in case of a burial it seems probable that more of the skeleton would have been found. Since being dug the canal has gradually widened by the caving of the banks, and at the place where the human bones were found the rock at the top of the section had broken from the ledge and lay inclined on the canal bank, having moved somewhat from its original position. When in place, however, this rock rested above the human bones. The sand

in which the bones were imbedded had not been disturbed. Moreover, the human bones are thoroughly mineralized, and it is highly improbable that a recent skeleton, if placed in these beds, would have become equally as well mineralized as the much older Pleistocene bones. Without doubt the mineralization of the bones is the result of the slow chemical changes by which bones are altered while being fossilized, a process which at this locality has affected alike, although in a slight varying degree, all of the bones of the deposit.

## DISCOVERY OF BONES SHOWING MARKINGS WHICH APPARENTLY WERE MADE BY TOOLS.

Text-figure 4; pl. 22, figs. 1-3.

While excavating in stratum No. 2 of the section at Vero, in April, 1916, the writer obtained a fragment of bird bone and a tip of a proboscidian tusk which have markings which apparently were made by tools. These two specimens were both found in

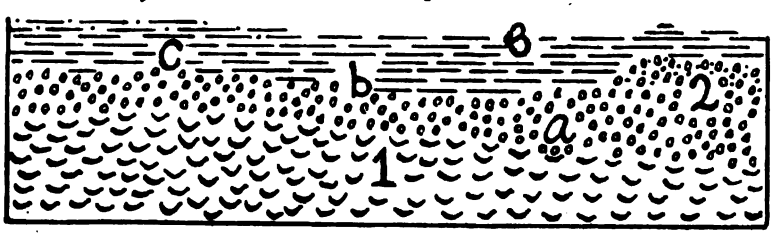



Fig. 4. Sketch showing the section of the canal bank at the place, north bank 370 feet west of the railroad bridge, where the specimens showing the markings were obtained. At this place stratum No. 2 cuts into the shell marl, No. 1, and the fossils were found in a local accumulation of muck near the base of stratum No. 2. Of the bird bones from this locality some were found near the base of the stratum, while others were taken from the sand at a higher level.

place near the base of stratum No. 2 on the north bank 370 feet west of the bridge and were removed from the bank by Isaac M. Weills. The two specimens are illustrated herewith (plate 22).

The fossils in immediate association with these specimens include the following: *Equus* sp., a femur; *Smilodon* sp., sabertooth; *Odocoileus* sp., tooth; *Tapirus haysii?*, part of a jaw; *Didelphis virginiana*, jaw; *Procyon* sp., tooth; *Equus leidyi*, tooth; *Sylvilagus* sp., teeth; *Sigmodon* sp., teeth; *Neofiber* sp., teeth; *Alligator mississippiensis?*, complete skeleton; and in addition fish, bat-

rachian, snake and bird bones as well as acorns and fossil wood. The bird found at this place is described on page 146.

The section at the place where these fossils were taken is as follows:

| | Feet. |
|---|---|
| Sand and marl, stratum No. 3 | 3 |
| Brown sand, some muck, stratum No. 2 | 2 |
| Marine shell marl to water level | 4 |

## SECOND DISCOVERY OF HUMAN REMAINS IN THE OLDER STREAM DEPOSIT, STRATUM NO. 2, OF THE SECTION.

Pl. 16; pl. 17, fig. 2; pl. 20; figs. 2-5; pl. 21, figs. 3, 5.

While excavating in the south bank of the canal at the locality 465 feet west of the bridge, the writer in June, 1916, found human bones in place in the older stream deposit, stratum No. 2 of the section. The section at this place is as follows:

| | Feet. |
|---|---|
| Alluvial deposit consisting of alternating beds of sand and muck, representing No. 3 of the general section | 2½ |
| Dark colored sand, representing No. 2 of the general section | 1½ |
| Shell marl, representing No. 1 of the general section to water level, about | 4 |

The exposure in the canal bank at the place where these bones were found is shown in the accompanying sketch and in the photographs (plates 16 and 17). The top surface of stratum No. 2 here as elsewhere is irregular, the irregularities being filled by the overlying deposits. At the spot where the human bones were found, owing to stream-wash previous to the deposition of the overlying deposit, the fresh-water stratum, No. 2 of the section, is only 18 inches thick. The human bones were found in this sand, about 10 inches above the base. The overlying alluvial beds are stratified and as usual conform to the irregularities of the underlying formation. The human bones at this place were found and removed by the writer, in the presence and with the assistance of Isaac M. Weills and Frank Ayers. The first bone found was a right astragalus; the second bone taken in place was the right external cuneiform which lay at the same level and about ten inches from the astragalus. About twelve inches farther back in the bank was found a piece from the right pubes and a part of the left ilium including that part of the bone which articulates with the sacrum.

Upon sifting the sand in which these bones were imbedded there was obtained in addition two phalanges, a section from a limb bone and some other human bone fragments.

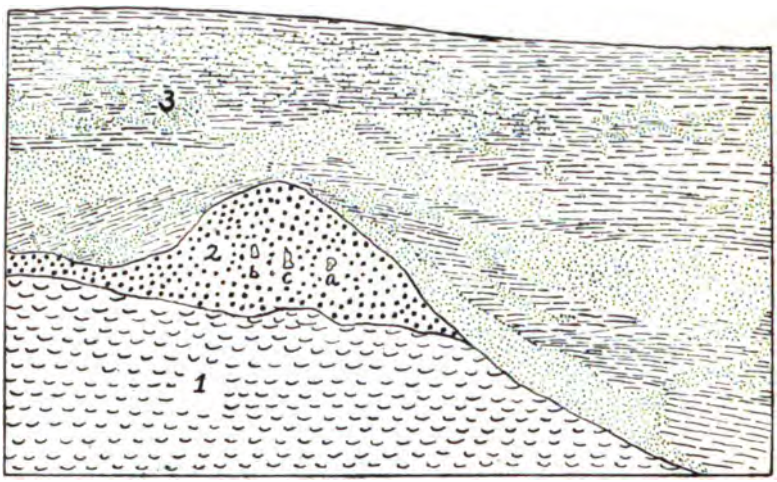



FIG. 5. Detail of section of the bank on the south side of the canal from about 458 to 468 feet west of the bridge. Scale vertical and horizontal, 1 inch equals 2½ feet. 1, 2 and 3 represent strata 1, 2 and 3 of the general section. Human bones are found in stratum 2 at *a* and at *b*. The scapula of a deer was found at *c*. The overlying material consists of alternating layers of sand and muck which had not been disturbed. These conform to the irregularities of the underlying formation. For a photograph of this section see plate 16.

The dividing line between strata 2 and 3 of the general section here as elsewhere is well marked and unmistakable and the human bones lay in stratum No. 2. The overlying laminated deposit is undisturbed and hence the bones cannot represent a recent burial. The vertebrates associated with these bones are listed in a subsequent paragraph.

## DISCOVERY OF THE FLINTS IN STRATUM NO. 2.

Text-figures 7-11.

In stratum No. 2 at the locality on the south bank, 460 feet west of the bridge, Frank Ayers found in place a thin sharp-edged flint which undoubtedly is a spawl from the manufacture of some kind of a flint implement. The place of this flint in the bed is about a foot farther in the bank than the human bones and three or four feet farther east. This flint is illustrated in the accom-

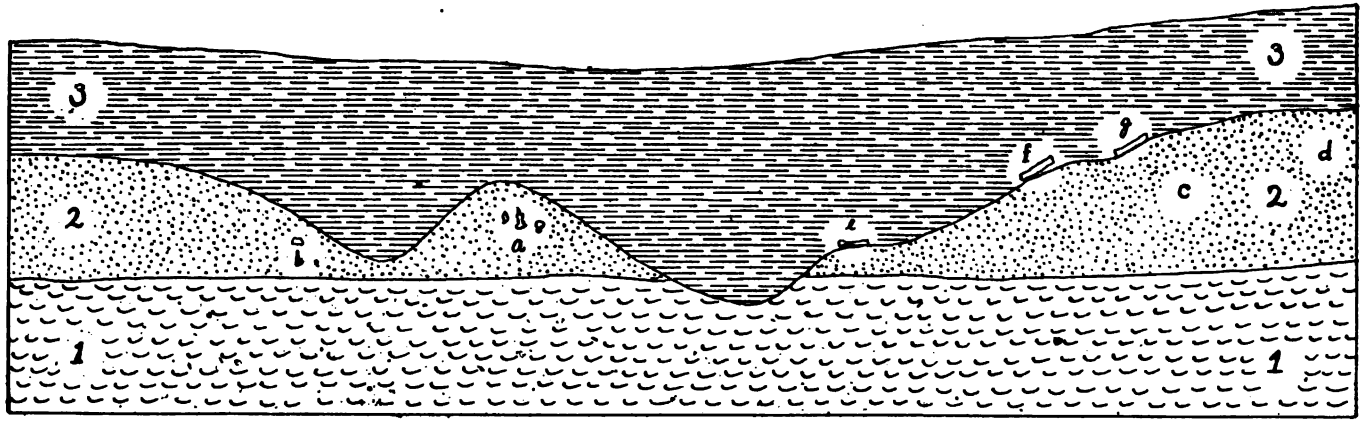



Fig. 6: Sketch showing the strata exposed in the south bank of the canal from 452 to 580 feet west of the bridge. (Horizontal and vertical scale 1 in. equals 4 feet). Nos. 1, 2 and 3 in the sketch represent strata 1, 2 and 3 respectively of the general section. At one place near the middle of the exposure, stratum No. 2 is cut out by stratum No. 3. The dividing line between 2 and 3 here as elsewhere is well marked and is unmistakable. Human bones are found in stratum No. 2 at *a*, this being the place from which the writer obtained a human astragalus, an external cuneiform and parts of the pelvis in place, as well as some other bones and flints from siftings. At *b* in this stratum was found the flint spawl illustrated by fig. 11. The type specimen of the turtle, *Terrapene innoxia*, Hay, was found in this stratum at *c*. The foot bone of the horse (plate 29) was found at *d*. Other fossils obtained in this stratum are listed on page 139. Bone implements were obtained from the sand near *a* and near *d*.

Stratum No. 3 consists of alternating beds of sand and muck which conform to the irregularities of the underlying deposits. Human bones were found at the contact line between 2 and 3 at *e*, *f* and *g*. A number of other bones were also found in this stratum lying at or near the contact line. This stratum contains also numerous bone implements, pottery and a few arrow heads and ornaments. A photographic reproduction of this section may be seen on plates 16 and 17.

Text-figures 7-13.

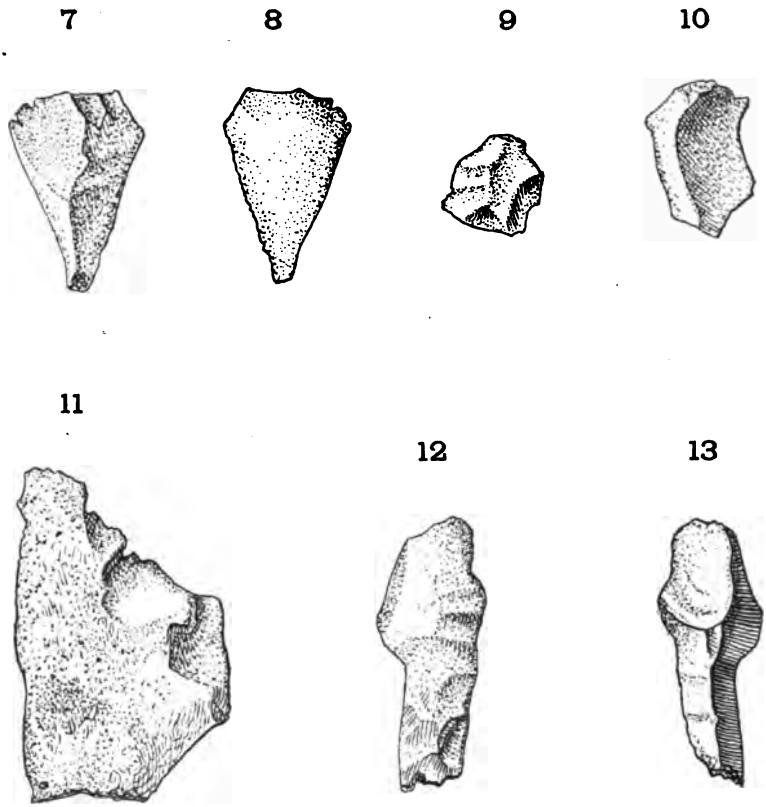



FIG. 7. Small flint worked on one side, obtained from siftings from the sand in which human bones were imbedded in stratum No. 2, south bank 460 feet west of bridge. Fla. Surv. coll. No. 7049.

FIG. 8. Same specimen showing the unworked side.

FIG. 9. Small flint worked on one side, same locality as fig. 6. No. 7055.

FIG. 10. Small flint worked on one side, same locality as figs. 6 and 8. No. 6987.

FIG. 11. A flint spawl taken in place in stratum No. 2, south bank, 458 feet west of the bridge. No. 6964.

FIG. 12. Small flint worked on both sides found at the contact line between strata 2 and 3 of the section, on the north bank of the canal, 450 feet west of the bridge. No. 7008.

FIG. 13. Opposite side of same specimen.

All of the specimens of figures 7-13 are twice the natural size.

panying figure 11. Upon sifting the sand from this stratum at this locality five additional small flints were obtained. They may be spawls although it seems more probable that some of them at least are small implements. Three of these flints are illustrated in figures 7-10.

FOSSILS ASSOCIATED WITH THE HUMAN REMAINS IN STRATUM NO. 2.

The vertebrate fossils found with the human bones first discovered at Vero have already been mentioned. In the following list is given those which have been found in stratum No. 2 in association with human bones, flints and implements on the south bank of the canal from 460 to 470 feet west of the bridge. The bones found in place in stratum No. 2 at this place include the following: *Odocoileus* sp., left scapula and teeth; *Elephas columbi,* tooth fragments; *Equus leidyi?,* part of a tooth; *Tapirus haysii?,* part of a tooth; and *Didelphis virginiana,* part of the lower jaw. Upon sifting the sand the followng additional species were obtained: *Sylvilagus* sp., teeth and part of lower jaw; *Dasypus* sp?, dermal plate; *Sigmodon* sp., teeth; *Neofiber alleni,* teeth; *Chlamytherium septentrinalis,* dermal plates; *Blarina* sp.; *Cryptotis floridana;* bird, humerus and part of radius; *Alligator mississippiensis?,* teeth, dermal plates; batrachian, leg bone; snake. jaw and fangs; as well as acorns and fragments of wood. Of these fossils the scapula of the deer was found within a few inches of the human astragalus and at the same level, while the other specimens were found nearby, none of them being more than five feet from the human bones.

In considering these vertebrate fossils it is well to bear in mind that stratum No. 2, here as elsewhere in the section, rests upon a marine shell marl in which few if any land fossils are found. It is evident, therefore, that the vertebrate fossils did not wash out of this underlying formation. Nor can it be assumed that the vertebrate fossils washed in from Pleistocene beds found elsewhere. Although fragmentary, the bones are not water-worn as they would be had they been transported from a distance after being fossilized. That the human bones cannot represent a recent burial is evident from the undisturbed condition of the laminated beds lying above this stratum.

## DISCOVERY OF BONE IMPLEMENTS IN STRATUM NO. 2.

Text-figure 6; pl. 21, figs. 4 and 7.

With the small flints obtained from sifting the sands in which the human bones were imbedded, was found a piece of a bone implement. Subsequently while sifting the sand from this stratum about ten feet farther to the west (475 feet west of the bridge) a second small implement, and also a small flint was found. The bone implements are polished and nicely finished. The second implement found which is practically complete, is sharp pointed at one end and beveled at the other, probably for insertion into a shaft. While neither of these implements were found in place, the sand was carefully handled and there was little or no chance of their coming from any stratum other than No. 2 of the section.

The fossils found at this place include the following: *Elephas columbi,* part of teeth; *Odocileus* sp., teeth; *Equus* sp., foot bone; *Dasypus* sp., dermal plate; *Chlamytherium septentrionalis,* foot bone; *Didelphis virginiana?*, tooth; *Sylvilagus* sp., teeth, snake, vertebrae; turtle, parts of carapace; alligator, teeth; and acorns and plant stems.

## FIRST DISCOVERY OF HUMAN REMAINS IN STRATUM NO. 3.

Pl. 17, fig. 1; pl. 18, fis. 2-3; pl. 19, figs. 1-3; pl. 21, figs. 2, 9.

In February, 1916, Mr. Ayers obtained a human right ulna which, although not found in place, was recognized as having been derived from the bank, since the degree of mineralization was similar to that of the associated vertebrate fossils. The skeleton from which this bone came, however, was not located at that time. Again in April, 1916, Mr. Ayers found the distal end of a humerus, which, although not in place, had recently fallen from the bank. The discovery of this bone led to the location in the bank of other bones belonging to the same skeleton to which belongs also the ulna found three months earlier. The place of these bones in the section may be seen from the photograph (fig. 1, plate 17), which shows the left ulna, femur and radius as they lay in the bank. All of these bones were at the base of stratum No. 3, lying at the contact line between this and the next older stratum. By reference to the general sketch showing the canal banks, (fig. 2) and to the more detailed sketch (fig. 6) it will be seen that at this place the

later stream deposits, stratum No. 3 of the section, cuts sharply into the older formation, and for a short space cuts entirely through stratum No. 2 and into the shell marl beneath.

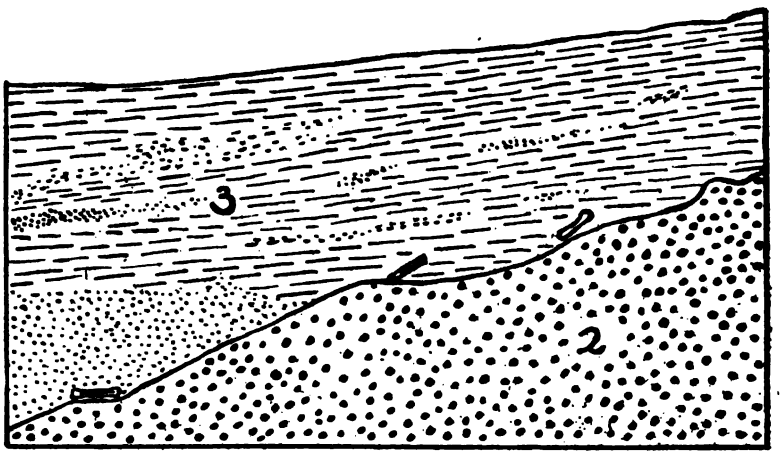



FIG. 14. Detail of the section of the south bank from about 470 to 478 feet west of the bridge. Horizontal and vertical scale, 1 inch equals about 2 feet. Human bones are found at or near the contact line between strata 2 and 3. The strata Nos. 2 and 3 correspond to strata 2 and 3 of the general section. No. 3 is an alluvial deposit made up of alternating layers of sand and muck which were undisturbed. For a photograph of this exposure see fig. 1, Pl. 17.

The bones from this skeleton were taken from the bank by Ayers, Weills and the writer. In addition to the ulna and humerus, there were obtained from cavings from the bank a part of a sphenoid bone, scapula, and a left upper incisor; and in place in the bank the left ulna, a femur, radius, base of a jaw, parts of the skull and two metatarsals. The first bone found in place was the left ulna, of which the proximal part only was present, although the distal part lacking the extremities was later obtained a few inches farther back in the bank. The bone next found, the left femur, of which only a part of the shaft is preserved, was lying near the ulna and at about the same level. Another piece from the shaft of this bone was obtained the following June, having been found several feet farther back in the bank. The radius, of which the proximal part only was obtained, was found five feet north of east of the ulna, and at the same place in the section, that is at the bottom of the bed of sand and alluvial material. Owing to

the slope of the bed at this place, however, this bone lay at an actual level fully two feet lower that the ulna. The jaw and the parts of the skull were found chiefly between the ulna and the radius and from a few inches to two feet farther back in the bank. One of the foot bones, a fifth metatarsal, was taken about eight feet east of the ulna and at an actual level, owing to the change in slope, above that of the radius and approximately the same as that of the ulna. Above the human skeleton four feet of alluvial material are found at this place, consisting of alternating layers of sand and muck, which in places grade into soft fresh-water marl having a thickness of as much as two feet. Fossil plants including leaves, stems and seeds are found in the muck bed. The plants, apparently, are but little changed from their original condition. While excavating in this bank in June, addititonal pieces of the skull were found as well as a part of the shaft of the right femur and an additional incisor tooth.

By reference to the text figures and to the description of the fossils it will be seen that the bones of this skeleton lying at the contact line between strata 2 and 3 are found on either side and around the bones found in place in the older stratum No. 2 The position leads to the suggestion that the bones lying at the base of stratum No. 3 were derived from stratum No. 2, and that only one skeleton is represented by the two finds. This may be true, since there is no duplication of parts, and a large individual is represented in each instance. It is well to remember, however, that human remains characterize stratum No. 3. A fact indicated by an abundance of pottery, many bone implements, arrowheads and other small flints.

### ADDITIONAL HUMAN REMAINS FROM STRATUM NO. 3.

Pl. 21, fig. 8.

While excavating in the north bank of the canal 419 feet west of the bridge, Mr. Weills in April, 1916, obtained at the contact line between strata Nos. 3 and 2 a single human toe bone. From the same bank 450 feet west of the bridge and at approximately the same place in the section Mr. Weills obtained in June, 1916, an unworn human molar tooth. Since the canal at this place is fully 100 feet wide from bank to bank it is doubtful if these specimens, although at the same place in the section, belong to the skeleton found directly opposite in the south bank.

### FOTTERY, FLINT AND BONE IMPLEMENTS FROM STRATUM NO. 3 OF THE SECTION.

Pl. 21, fig. 1; pl. 23, figs. 1-13.

A considerable amount of broken pottery is found in this horizon particularly at the locality on the south bank 450 to 475 feet west of the bridge. Bone implements are also numerous and were made evidently to serve a diversity of purposes. Well worked flint arrowheads are found also as well as occasional spawls from the manufacture of flints. The pottery, flints and bone implements, however, are not confined to this locality on the south bank but are found also in the same horizon on the opposite side of the canal.

The fossils associated with the human remains in stratum No. 3, which are numerous, are discussed in the subsequent pages.

## FOSSILS ASSOCIATED WITH THE HUMAN REMAINS.

The fossils found at Vero are numerous and varied and the study of the collections obtained there necessarily requires time and the co-operation of specialists in various branches of paleontology. However, the following notes will serve in a general way to indicate the classes of plants and animals present in the deposits which contain the human remains. Enough of the fossils are listed, particularly of the turtles, birds and mammals, to fully establish the Pleistocene age of the formation.

### PLANT AND ANIMAL FOSSILS FROM STRATUM NO. 2 OF THE SECTION.

#### PLANTS.

Pl. 29, fig. 5.

Plant remains in stratum No. 2 of the section at Vero are not numerous. In this respect this horizon differs from the alluvial bed which follows in which is found an abundance of plant stems, seeds and at places well preserved leaves. The only recognizable plants obtained from this horizon are acorn cups, although in places are found stems and pieces of wood. The plant stems upon exposure to the air shrivel up; the wood also has a tendency to fall to pieces upon drying.

#### INVERTEBRATES.

Fresh-water invertebrates are abundant in stratum No. 2 of the section and have been collected from several places in the bank.

The species present are given in the accompanying list. These have been identified by Dr. Paul Bartsch, who states that all of the species are represented in the recent fauna. This is in marked contrast to the vertebrates among which are many extinct species.

With the land and fresh-water invertebrates are found a number of marine species represented chiefly by young or small shells which were probably accidentally included at the time the deposits accumulated. From the marl rock near the top of the stratum was obtained a single specimen of *Ostrea,* which, however, was probably introduced into the formation either by man or in some accidental manner.

LAND AND FRESH-WATER INVERTEBRATES FROM STRATUM NO. 2 OF THE SECTION.

Polygyra auriculata Say.
Polygyra septemvolva Say.
Polygyra pustula Fer.
Polygyra jejuna Say.
Polygyra thyroides Say.
Euglandina truncata Brug.
Omphalina (fragment).
Zonitoides arboreus Say.
Zonitoides minusculus Binn.
Vitrea indentata Say.
Helicodiscus parallelus Say.
Strobilops labyrinthicus Say.
Bifidaria contracta Say.
Succinea campestris Say.
Planorbis trivolvis Say.
Planorbis glabratus reticulatus Dall.
Planorbis glabratus Say.
Planorbis alabamensis avus Pilsbry.
Lymnaea parva Lea.
Lymnaea techella Hald.
Physa heterostropha Say (young).
Physa gyrina Say.
Ancylus tardus Say.
Campeloma decisa Say.
Campeloma genicula Conr.
Vivipara georgiana Lea.
Ampullaria depressa Say.
Pisidium abditum Hald.
Terebra dislocata Say.

## THE VERTEBRATE FAUNA.

The vertebrate fauna from Vero is obtained from the fresh-water stratum, No. 2, and from the fluviatile deposit No. 3, none of the material so far as definitely known having been derived from the underlying marine marl. The vertebrate fossils occur in considerable numbers, although as is usually true of stream deposits, the skeletons are for the most part disassociated. While all classes of vertebrates are represented the mammals are by far the most abundant.

### FISHES.

Fish bones and teeth are found in this stratum in some abundance although in a fragmentary condition. Sharks are represented by isolated teeth, while vertebrae of fish are numerous.

## BATRACHIANS.

Batrachians are represented in this stratum by limb bones and vertebrae. The parts obtained are for the most part fragmentary and hence difficult of identification.

## REPTILES.

The reptiles present include snakes, lizards, turtles and an alligator. Snake vertebrae are particularly abundant. The collection contains also a fang of one of the poisonous snakes. Among the crocodilian bones from this horizon is a nearly complete skeleton of an alligator which is close to or identical with the modern *Alligator mississippiensis**.

The turtles found at Vero have been described by Dr. O. P. Hay and the following list of species is taken from his paper. (This volume, pp. 39-76.) Those species that have been found in place in stratum No. 2 are indicated by the use of the dagger. The remaining species are referred provisionally to this horizon although some of them may have been derived from either the marine shell marl beneath or from the overlying deposits. Of the seven species recognized five are new. A list of turtles from the next succeeding horizon, No. 3, will be found on a subsequent page.

TURTLES FROM STRATUM NO. 2 IDENTIFIED BY DR. O. P. HAY.

| | |
|---|---|
| Terrapene innoxia.† | Gopherus praecedens. |
| Chelydra laticarinata.† | Trachemys bisornata. |
| Testudo sellardsi.† | Trachemys sculpta. |
| Testudo luciae. | |

The complete carapace which forms the type specimen of *Terrapene innoxia,* as well as the second specimen which served as a paratype in Dr. Hay's description of the species were taken by the writer in place in stratum No. 2 in the south bank of the canal about 480 feet west of the bridge. The exposure in the bank at the place where these two specimens were taken is seen in text-figure 6. A third carapace of this species has been found in stratum No. 3. The type specimen of *Chelydra laticarinata* Hay was taken in place in the north bank of the canal 370 feet west of the bridge. The section at this place is given in text-figure 4. *Testudo sellardsi* is the more common of the two large tortoises found at this locality. The specimens which serve as the type of this species were thrown out by the dredge, hence their exact position in the

* This alligator differs somewhat from the modern species although further comparison must be made in order to determine its relationship.

canal bank is not known. However, additional specimens derived from stratum No. 2, were thrown out by the workmen while repairing the foundation for the railroad bridge.

## BIRDS.

Two species of birds have been obtained from stratum No. 2 of the section. One of these, a small bird, is represented by a humerus and part of a radius found at the locality on the south bank of the canal, 465 feet west of the bridge, while sifting the sand in which the human bones were imbedded. The second species is a large bird of which a number of the bones of the wings have been obtained. Of these bones, the humerus was found lying loose on the bank, while the other bones were taken in place from the north bank, 370 feet west of the bridge. The bird bone illustrated to show engravings (fig. 3, pl. 22) was found at the same place in the bank and was very probably a piece from a wing bone of this species.

### JABIRU? WEILLSI, SP. NOV.

Pl. 26, figs. 1-4; text-figure 15, p. 157.

The relationship of the large bird found in stratum No. 2 appears to be with the storks and the species is referred provisionally to the genus *Jabiru*. When compared to the recent *Jabiru mycteria* (*Mycteria americana*) the bones of the wing, although approximately the same in circumference, are found to be longer and hence proportionately more slender than those of that species. The metacarpal bones of the fossil bird are flattened while those of the recent species are more nearly oval in cross section, in this respect approaching *Ciconia* rather than *Jabiru*. The corocoid is small as compared with the wing bones, and it is not impossible that more than one species is represented.

Measurement of wing bone:

| | |
|---|---|
| Length of humerus | 280 mm. |
| Least circumference of humerus | 90 |
| Length of ulna (estimated) | 270 |
| Least circumference of ulna | 38 |
| Length of metacarpal bones | 150 |
| Least circumference of the larger metacarpal | 29 |

The species is named for Mr. Isaac M. Weills, who has contributed so largely to the development of the vertebrate fauna found

at Vero. The type specimen is a humerus. Fla. Surv. coll. 5961: Paratypes, right and left metacarpals, 6781 and 7022; and part of a corocoid, 6782.

MAMMALS.

The mammals are more abundant in genera and species as well as in the number of individuals than any other class. Twenty-five mammalian species have been recognized from stratum No. 2 and the number is being constantly added to as collecting progresses. A striking feature of the fauna of this horizon is the number of large extinct mammals found in it. A list of the mammals from this horizon is given on page 158.

PLANT AND ANIMAL FOSSILS FROM STRATUM NO. 3 OF THE SECTION.

Fossil plants are more abundant in stratum No. 3 than in the older deposit, the muck beds of this stratum being better adapted to their preservation. Acorn cups, acorns and other seeds are numerous, as are stems and pieces of limbs; in places also where the conditions are favorable, leaves are well preserved. The plant remains indicate a diversified flora representing a hammock type of vegetation, the term "hammock" being used in Florida to apply to a mixed timber growth which usually includes a number of deciduous species. This type of vegetation occupies limited areas and contrasts with the pine lands which are extensive.

Invertebrate fossils are rare in this horizon, although occasionally a shell is found in the fresh-water marl which in places lies at the top of the section.

The fish, batrachian, and reptillian fossils of this horizon are apparently similar to those of stratum No. 2. Snake vertebrae are abundant. An alligator present is probably *Alligator mississippiensis*. Of the turtles which are abundant in number of specimens, Dr. Hay recognizes the following species:*

| | |
|---|---|
| Terrapene innoxia. | Pseudemys floridana persimilis. |
| Terrapene antipex. | Gopherus polyphemus |
| Chelydra sculpta. | Chelonia mydas |

Of these turtles the first three mentioned are recognized as new species and are not known in the existing fauna. The re-

*On the basis of the turtles Dr. O. P. Hay regards stratum No. 3 of this section as of Pleistocene age and representing not the later part of the Pleistocene (this volume, p. 76).

maining species, *Pseudemys floridana persimilis,* is regarded by Hay as a variety of the modern *Pseudemys floridana.* A nearly complete carapace of the extinct species, *Terrapene innoxia,* was found in this horizon.

Bird bones, although by no means numerous, are found in greater diversity than in stratum No. 2, and more than one species is repreesnted. The large extinct bird, *Jabiru ? weillsi,* which characterizes stratum No. 2, has not been found in this horizon.

Mammals in stratum No. 2 as in the older horizon are numerous. The species recognized are given in the list on page 158. All of those mentioned in this list were found in place and in association with human remains, flint and bone implements.

## NOTES ON MAMMALS INCLUDING DESCRIPTION OF A NEW CANID

### DIDELPHIS.

An oppossum is represented in the collection from both strata 2 and 3 of the section by parts of the lower jaw and by detached teeth. The material that has been obtained apparently affords no characters upon which the species may be separated from the modern *Didelphis virginiana.*

### MEGALONYX.

Pl. 25, fig. 2; pl. 30, fig. 6.

The sloth, *Megalonyx jeffersonii,* is represented by a part of the lower jaw, a right upper canine tooth, molar tooth, hyoid bone, axis, astragalus, first median phalanx and the claw of a lateral digit. Of these bones the hyoid bone, fig. 2, pl. 25 was obtained in association with the first human remains found at Vero in stratum No. 2 on the south bank 331 feet west of the bridge.

### CHLAMYTHERIUM.

Pl. 28, figs. 4-6; pl. 30, fig. 7.

The armadillo-like edentate, *Chlamytherium septentrionalis,* is found in both strata 2 and 3 of the section and is represented by a right lower jaw, part of a left lower jaw, a foot bone and numerous dermal scutes. The dermal scutes and foot bone were found in stratum No. 2 near the human remains.

### DASYPUS.

Pl. 29, figs. 1-2.

The armadillo, *Dasypus,* is found in both strata 2 and 3 and is represented by dermal plates. This armadillo is found also in the Pleistocene cave deposits at Ocala, Florida.

### EQUUS.

Pl. 29, fig. 9.

Horses of the genus *Equus* are particularly abundant in stratum No. 2, and probably include three species. Of these a large horse represented in the collection by upper and lower cheek teeth and an astragalus is probably to be identified as *Equus complicatus*. A moderate sized horse, *Equus leidyi* is represented by many cheek teeth, some of which have been found with the fossil human remains. Some smaller teeth and foot bones are identified provisionally as representing the small horse *Equus littoralis*.

### TAPIRUS.

A tapir, probably *Tapirus haysii*, is represented in the collection by parts of two lower jaws and a number of detached teeth. Among the bones associated with the human remains in stratum No. 2, was a part of a tooth of this tapir.

### PECCARY.

Pl. 30, fig. 2.

A peccary is represented by two cheek teeth and a left tibia. Of these one tooth was found in place in stratum No. 2, the other specimens having washed from the bank.

### CAMEL.

Pl. 30, fig. 5.

A camel is represented in the collection by two upper cheek teeth, part of a distal end of a cannon bone and first phalanx. This camel apparently is distinct from the Pliocene camels of Florida, as well as from the recent llama of South America.

### ODOCOILEUS.

Pl. 25, fig. 3; pl. 27, figs. 1-2.

With the first skeleton obtained at Vero was found a right scapula and an astragalus of a deer, while with the second skeletal remains obtained from stratum No. 2 was found a left scapula. In addition a number of cheek teeth as well as parts of the antler have been found. The deer of this horizon is probably specifically

distinct from the deer which is so abundant in the next succeeding horizon (No. 3). The scapula of the deer found in stratum No. 2 is larger and the corocoid process is broader than is that of the deer in the succeeding horizon.

### BISON.

An extinct bison is represented in the collection by a number of teeth, the distal end of a humerus, and some foot bones. While none of these bones have been found in place the species is probably to be referred to stratum No. 2.

### ELEPHAS.

Pl. 25, fig. 1.

The Columbian elephant, *E. columbi,* is one of the very abundant fossils of stratum No. 2. The skeleton is usually disassociated and the bones are frequently broken or imperfectly preserved, although a few complete teeth and limb bones have been found. The plates of the teeth of this elephant are apparently somewhat coarser than are those typical of the Columbian elephant as known elsewhere, there being only about five plates per 100 mm. In this respect the teeth resemble those of the Imperial elephant, *Elephas imperator.*

### MAMMUT.

Pl. 31.

The American mastodon, *Mammut americanum,* is abundant in this deposit. The collections include of this species a lower jaw, parts of the skull, molar teeth, and left half of the atlas. The condition of preservation of the mastodon remains is similar to that of the elephant. The skeleton is usually scattered, although occasionally complete teeth and bones are found.

### NEOTOMA.

The genus, *Neotoma,* is represented by a lower jaw, in which unfortunately the teeth are lacking, obtained from stratum No. 3.

### NEOFIBER.

Pl. 29, fig. 7.

The Florida water-rat, *Neofiber alleni,* is represented in stratum No. 2 by several detached teeth, and in stratum No. 3 by a number of lower jaws and parts of skulls.

### SYLVILAGUS.

Pl. 29, figs. 3 and 6.

A rabbit referable probably to the genus, *Sylvilagus,* is represented in the collections from stratum No. 2 by detached teeth and by a part of a jaw. Of these the jaw and some of the teeth were found at the locality from which human bones were obtained. The jaw and teeth of the rabbit are smaller than those of the rabbit found in stratum No. 3 and possibly represent a distinct species.

### SIGMODON.

Pl. 29, fig. 4.

The genus, *Sigmodon,* is represented by several detached teeth from stratum No. 2 and by a number of jaws and teeth from stratum No. 3.

### BLARINA.

From stratum No. 2 the writer has obtained a single jaw of the shrew, *Blarina.* In size and general proportions this species suggests the modern *Blarina previcauda peninsulae.* Fla. Surv. coll. No. 7525.

### CRYPTOTIS.

A single well preserved lower jaw obtained from the sand in which human remains were imbedded represents a shrew which apparently is identical with the modern *Cryptotis floridana.* Fla. Surv. coll. No. 7526.

### SCALOPUS.

The genus, *Scalopus,* is represented by a lower jaw obtained from stratum No. 3. The species is very similar to and probably identical with the modern *Scalopus aquaticus australis.*

### HYDROCHOERUS.

The capybara, *Hydrochoerus,* is represented by cheek teeth. The species apparently is distinct from the modern species of South America, being somewhat larger. The specimens representing this genus have not been found in place, but doubtless are to be referred to stratum No. 2.

### LUTRA.

The otter has been found in place only in stratum No. 3, but is probably to be expected also, as indicated by specimens found

along the canal bank in stratum No. 2. The species apparently is identical with the modern *Lutra canadensis.*

### SMILODON.

Pl. 28, fig. 1; pl. 29, fig. 8.

A saber-tooth tiger, referred provisionally to the genus, *Smilodon,* is represented by a saber-tooth, a carnassial tooth and a foot bone. Of these the saber-tooth was found in place in stratum No. 2 at the same locality and one foot or more above the level at which the specimen showing engravings on bone and on tusk were obtained.

### VULPES.

Pl. 30, fig. 4.

From both strata 2 and 3 have been obtained teeth of a fox which is very close to, if not identical with the red fox, *Vulpes pennsylvanicus* which at the present time is not known to occur in Florida. The specimen from stratum No. 2 consists of a single premolar tooth imbedded in marl rock. That in stratum No. 3 includes a part of the lower jaw containing two premolar teeth.

### PROCYON.

A raccoon which apparently is not separable from the modern species, *Procyon lotor,* is found in stratum No. 3. From stratum No. 2 the writer has obtained a single molar tooth, representing the same or a very closely related species.

### LYNX.

Pl. 28, fig. 3.

A lynx from stratum No. 3 is represented by a tibia and a lower jaw. This lynx differs from the modern lynx now found in Florida by a large canine which crowds upon and reduces the space available for the incisors; the diastema between the canine and the premolars is reduced, the jaw as a whole is thicker, and the teeth more closely crowded than in the modern species.

### CANIS.

#### CANIS AYERSI, SP. NOV.

Pl. 24; pl. 30, figs. 1 and 3.

Among the vertebrate material obtained at Vero is a large wolf represented in the collection by a skull and a femur, found in

place in the north bank of the canal in stratum No. 2, 100 feet west of the rairoad bridge. In addition there has been found of this species a premaxillary, a sectorial and a canine tooth, a tibia, femur, ulna and scapula, the duplication of parts indicating the presence of more than one individual. The skull and femur were found by Frank Ayres and were collected by Ayres and Weills.

In size this wolf approximates the great wolf from the Mississippi Valley described by Leidy as *Canis dirus*, the type of which is in the collection of the Academy of Natural Sciences of Philadelphia. Through the courtesy of the officials of the academy the writer has had the opportunity of comparing the Florida wolf with the type specimen of that species. At the Rancho La Brea deposits in California is found, in the most remarkable abundance, an equally large wolf which has been regarded as specifically identical with *Canis dirus*. The comparison of the Florida wolf with this great wolf of the Pacific Coast has been greatly facilitated by having at hand a complete skeleton of the latter species, representing, however, more than one individual, kindly furnished by Professor J. C. Merriam of the University of California. Professor Merriam's Memoir on the Canidae of Rancho La Brea in which is included the careful comparative study of the skeleton of this wolf has likewise been of great assistance.

A comparison of the skulls indicates that while the Florida and California wolves belong to the same group of species within the genus, they are nevertheless distinct. Although less massive the skull of the Florida wolf is fully as long as and presents many of the striking characteristics of the California wolf. Among structural features common to the two species are the high very thin sagittal crest and the pronounced backward extension of the inion. In the Florida wolf, as in the California wolf, a depressed area is observed in the skull at the front of the zygomatic arch. There is also the same shortening of the posterior part of the skull, the measurements from the posterior border of the glenoid cavity to the posterior margin of the articular condules being practically the same.

With the exception of the canine and second molar the dentition of the upper jaw of the Florida wolf is complete. In the specimen illustrated the incisors are worn and their characters obscured, although on a second specimen, No. 4389, the second upper incisor is preserved and is but slightly worn. This tooth has a small cusp on the external side while on the median side the cusp

is very small or lacking. The premolars and the first molar teeth are approximately of the same size and are closely similar in structure to those of the California wolf. The deuterocone of $Pm^4$ is much reduced. The hypocone of $M^1$ is reduced; a metaconule is present while a protoconule is scarcely to be distinguished. As a rule the premolar teeth of the California wolf are more closely crowded in the jaw than are those of the Florida wolf. This, however, is not invariable as some of the large individuals of the California wolf have the premolar teeth well spaced.

The limb bones of the Florida wolf are scarcely to be distinguished from those of the California wolf, and until the skull was found it was not known that the species were distinct. A femur of the Florida wolf measures in length 225 mm.; and ulna, 277 mm.; a tibia, 248 mm. With the exception of the ulna which is unusually long, the bones, as indicated by these measurements, are intermediate in length between those of large and small individuals of the California species.

While the wolves agree in those characters which have been mentioned, important differences are observed in the skulls by which the species may be separated. The most pronounced differences are found in the length of the snout, the Florida species being a narrow snouted wolf, while the California wolf is broad snouted. Differences may be noted also in the posterior region of the skull. In his Memoir on the Canidae of Rancho La Brea,* Merriam brings out the fact that in the California wolf the two ridges which form the lambdoidal crest converge sharply above the occiput, while in most recent forms they sweep outward widely before uniting at the union. The convergence of these ridges is not so pronounced on the Florida wolf as on the California wolf.

The differences in the skull between the two species of wolves is brought out in the following table of measurements in which is included also such measurements as can be obtained from the type specimen of *Canis dirus*. The measurements on specimens 10834 and 10856 of the collection of the University of California are taken from Professor Merriam's Memoir on the Canidae of Rancho La Brea.

*Memoirs of the University of California, Vol. 1, No. 2. The fauna of Rancho La Brea, Part 2. Canidae, by John C. Merriam, 1912.

COMPARATIVE MEASUREMENTS OF THE SKULLS OF WOLVES OF THE *CANIS DIRUS* GROUP.

| Length of skull and skull parts. Anteroposterior measurements. | C. dirus Type | Fla. Wolf No. 7166 | Cal. Wolf Cal. 10834 | Cal. Wolf Cal. 10856 | Cal. Wolf Fla. Coll. |
|---|---|---|---|---|---|
| Full length of the skull on the plane of the palate | | 300 mm. | 295*ap* | 310*ap* | 292 |
| Front of premaxillae to hinder end of occipital condyles | | 273 | 267 | 282 | 265 |
| Front of premaxillae to posterior nares | | 153 | 141 | 155 | 145 |
| From canine alveolus to back of the last molar | 116 | 113ap | 104ap | | 108 |
| Canine alveolus to anterior margin of $M^1$ | 93 | 85 | 78ap | | 83 |
| Anterior margin of $Pm^2$ to posterior margin of $Pm^4$ | 73 | 71 | 68ap | | |
| Space between incisor and $Pm^1$ | | 3 | | | 5 |
| Space between $Pm^1$ and $Pm^2$ | | 7 | 4ap | | 3 |
| Space between $Pm^2$ and $Pm^3$ | 7 | 5 | 2ap | | 1 |
| Space between $Pm^3$ and $Pm^4$ | 2 | 2 | 2ap | | 3 |
| **WIDTH OF SKULL AND SKULL PARTS.** | | | | | |
| Width of skull across zygomatic arches | | 160. | 164.5 | 175*ap* | 164 |
| Least diameter between superior borders of orbits | | 56 | 54.1 | 64.9 | 64 |
| Width measured between outer sides superior sectorials | | 91 | 96.2 | 107.5 | 96 |
| Width across nose, measured between outer sides of basis of canines | | 48 | | 67.3 | 60 |
| Width of snout at real $Pm^1$ | | 46 | | | 53 |
| Height of skull, measured vertically from inferior margin of auditory bullae to top of sagittal crest | | 90 | | | 90 |
| **MEASUREMENTS OF THE TEETH.** | | | | | |
| $I^1$ greatest transverse diameter | | 6 | | | |
| $I^2$ greatest transverse diameter | | 8 | | | |
| $I^3$ greatest transverse diameter | | 11 | | | 11 |
| $P^1$ greatest anteroposterior diameter | | 8 | 9.4 | 10.2 | 9 |
| $P^2$ greatest anteroposterior diameter | 14.8 | 14.5 | 16.2 | 16 | 15 |
| $P^3$ greatest anteroposterior diameter | 18.2 | 17 | 18.1 | 19 | 18 |
| $P^3$ greatest transverse diameter | 8 | 7.5 | 7.9 | | 8 |
| $P^4$ greatest anteroposterior diameter | 32ap | 30 | 30.7 | 32 | 30 |
| $P^4$ greatest transverse diameter | 14.5ap | 15 | 15 | 16 | 13 |
| $M_1$ greatest anteroposterior diameter | | 20 | 18.7 | 20 | 18.5 |
| $M_1$ greatest transverse diameter | 22 | 23 | 23 | 24 | 23 |

From the table of measurements it may be seen that as regards length, the skull of the Florida wolf is intermediate between that of large and small individuals of the California wolf. With regard to width, however, the skull of the Florida wolf is throughout more narrow than that of even the medium sized California

wolves. The breadth across the zygomatic arches is contained in the length of the skull from the premaxillaries to the occipital condyles of the California wolf, about 1.6 times; of the Florida wolf about 1.7 times. The differences are more pronounced when measurements across the nose or jaws are compared. The width measured between the outer sides of the superior sectorials is contained in the length of the skull of the California wolf 2.6 times; of the Florida wolf 3.0 times. Of the two skulls, measurements of which are recorded in columns 2 and 5 of the table, that from Florida, although the longer of the two, is actually narrower throughout, and noticeably so across the nose, the increased length of the skull being found entirely in front of the posterior nares.

It is thus shown that of the *Canis dirus* group of wolves at least two species are represented, that of the Atlantic Coast being distinct from that of the Pacific Coast.

The species, *Canis dirus,* was established by Leidy upon a single bone, a left maxillary, and hence it is by no means easy to determine its limitations. With regard to the probable relationship of the Florida wolf it may be noted that between the type locality of *C. dirus* at Evansville, Indiana, and Florida no effective barrier intervenes. The fossils listed by Leidy as being in asssociation with *C. dirus* are *Megalonyx jeffersonii, Tapirus haysii, Equus americanus,* (*E. complicatus*), *Bison americanus* and *Cervus virginianus.* If more complete material of *Canis dirus* is subsequently obtained from the type locality, it is possible that the Florida wolf may be found to be identical with that species. However, since this cannot be determined from the fragmentary type of *Canis dirus,* and since that specific name is now associated with the wolf of California it seems preferable to describe the Florida wolf under a distinct name.

Although not found in immediate association with the human remains this wolf is from the stratum which contains human bones, and it is a pleasure to be able to name this fine new species in honor of Mr. Frank Ayres by whom the fossil human remains at Vero were first found. The species may, therefore, be known as *Canis ayersi.* The specific characters are as follows:

Size large, exceeding that of the Mexican timber wolf, *Canis mexicanus,* or the gray wolf, *Canis occidentalis* and equalling that of the extinct *Canis dirus.* Snout slender, premolar teeth spaced, not being crowded in the jaw. Carnassials large, $Pm^4$ with but

slightly developed deuterocone. Sagittal crest high, inion extended posteriorly.

Type. A skull and a femur. Fla. Surv. coll. No. 7166. Paratypes: Left premaxilla, 4389; left upper carnassial, 5146; canine tooth, 4410; left femur, 5449; left tibia, 5912; right ulna, 5451 and right scapula, 5182. All from the Pleistocene at Vero, Florida.

### CANIS SP. CF. C. LATRANS.

Pl. 28, figs. 2, 7 and 8.

The large wolf, *Canis ayersi,* has not been found in stratum No. 3. The canid of this later horizon is a smaller species of which as yet has been obtained but an imperfect representation. The limb bones of this species, of which the humerus, radius and tibia are known, appear rather more stocky than those of coyotes. The sectorial tooth, however, the only part of the dentition known is very similar to that of *Canis latrans.*

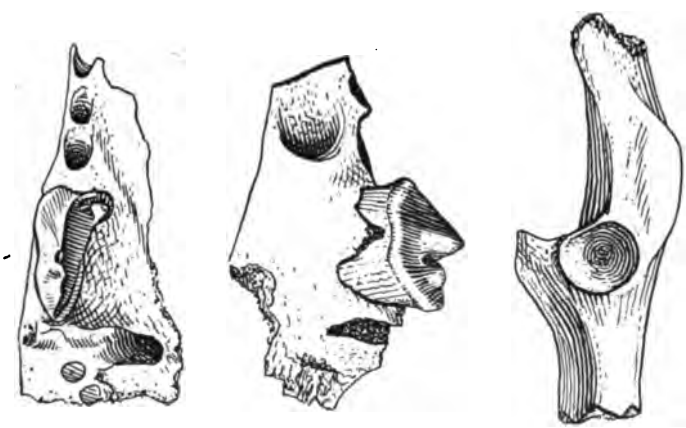



Fig. 15:—Top and side veiw of *Canis* cf. *latrans* (a and b), from stratum No. 3; and part of a corocoid of *Jabiru? weillsi* (c) from stratum No. 2. All natural size.

### LIST OF MAMMALS FROM STRATUM NO. 2.

In the following list those species that have been found in place in stratum No. 2 are indicated by the use of the dagger. The remaining species although not found in place are referred to this horizon as their probable source. Of these mammals the first fourteen have been previously listed as having been found in direct association with the human skeletal remains.

Didelphis virginiana.†
Megalonyx jeffersonii.†
Chlamytherium septentrionalis.†
Dasypus sp. ?†
Equus leidyi.†
Tapirus haysii?†
Odocoileus sp.†
Mammut americanum.†
Elephas columbi.†
Neofiber alleni.†
Sylvilagus sp.†
Sigmodon sp.†
Cryptotis floridana.†
Blarina sp.†
Vulpes pennsylvanicus?†
Equus complicatus.†
Peccary indt.†
Smilodon sp.†
Canis ayersi, sp. nov.†
Procyon lotor?†
Equus litoralis.
Cameloid indt.†
Bison sp.
Hydrochoerus sp.
Lutra canadensis.

### LIST OF MAMMALS FROM STRATUM NO. 3.

In the writer's original list of species from Vero reference was made to a rabbit from stratum No. 3 of the section, representing a new genus, the generic characters being found in the structure of the first lower molariform tooth. Specimens of this rabbit subsequently obtained indicate that the seemingly unusual structure of this tooth in the jaw first obtained is due to imperfect preservation and that the rabbit is to be referred to the normal Leporidae, probably to the genus *Sylvilagus* as defined by Nelson.* The species agrees rather closely with the modern *Sylvilagus* (*Limnolagus*) *palustris,* although the re-entrant folds of enamel on the front of the first lower molariform tooth are seemingly less distinctly crenulated than are those of the modern species.

Didelphis virginiana.
Chlamytherium septentrionalis.
Dasypus sp.?
Odocoileus osceola.
Neofiber alleni.
Sylvilagus sp.
Sigmodon sp.
Neotoma sp.
Scalopus sp.
Vulpes pennsylvanicus?
Canis sp. cf. C. latrans.
Procyon lotor?
Lutra canadensis.
Lynx sp.
Ursus indt.

*The Rabbits of North America by E. W. Nelson, North American Fauna No. 29. U. S. Department of Agriculture, Bureau of Biological Survey, 1909.

In addition to the species here listed the writer has obtained from Stratum No. 3 parts of the teeth of *Elephas columbi*, *Mammut americanum*, *Tapirus haysii?* and *Equus leidyi?*. Owing to the fact that the teeth found are broken (although not water-worn) the writer hesitates to refer these species definitely to stratum No. 3. The considerable number of specimens found, however, and especially the large pieces of the teeth of *Mammut americanum* that have been obtained, render it probable that some or all of these species continued their existence in Florida up to the time of the deposition of stratum No. 3. This suggestion is strengthened by the undoubted presence of several species of extinct turtles in this horizon. The cultural stage of man contemporaneous with stratum No. 3 was quite advanced as indicated by the presence of pottery, ornaments and a diversity of bone implements. These artifacts are numerous in this horizon, and as the deposit is stratified and undisturbed it is quite impossible that they could have been placed there by burial.

## SUMMARY.

In considering the fossil human remains from Florida interest centers chiefly in the horizon represented by stratum No. 2 of the section at Vero, this being the earliest stage in which human remains have been found. That this horizon is of Pleistocene age and that man was then present in Florida is determined by the observations recorded in this paper, of which the following paragraphs contain a summary.

In October, 1915, skeletal remains of man were found in place in stratum No. 2 of the section in the canal bank at Vero at the locality indicated by *a* in text-figure 2; in April, 1916, a bird bone and the tip of a proboscidian tusk on which are found markings which apparently were made by a tool were taken in place in this stratum at the locality indicated by *b;* in June, 1916, skeletal remains of man and a spawl from a flint implement were taken in place in this stratum at the locality indicated by *c*, and while passing the sand from this stratum through a sieve several additional small flints and two bone implements were found at localities *c* and *d*. At locality *a* the stratum holding the human remains grades at the top into a hard marl rock. At localities *b*, *c*, and *d* the stratum holding the human remains is overlaid by an alluvial deposit, No. 3 of the section. This overlying deposit is stratified and was undisturbed above the human bones. These observations, as well

as the mineralization and manner of occurrence of the bones, establish the fact that the human remains are fossils normal to this horizon and were not introduced into it by burial.

That this horizon holding the human remains is of Pleistocene age is shown by the fauna. The fossils found with or near the human remains in this horizon include such characteristic Pleistocene species as *Megalonyx jeffersonii*, *Chlamytherium septentrionalis*, *Equus* sp., *Tapirus haysii?*, *Mammut americanum*, and *Elephas columbi*. From this horizon as a whole has been obtained a large vertebrate fauna including many extinct species.

With regard to culture, the men of the stage of the Pleistocene represented by stratum No. 2 of the section at Vero were then making flint implements, a fact fully established by the discovery in place in the Pleistocene bed of a spawl from such an implement. They apparently were also making bone implements, two of which have been obtained from screenings from the Pleistocene deposit. They probably had also acquired the art or custom of engraving on bone, this conclusion being supported by the discovery in place in the Pleistocene bed of a bone and of a proboscidian tusk having markings which seemingly were made by tools. Further support of this fact is derived from the presence in the formation of small flints obtained from screenings which may have served as tools for this purpose.

By these discoveries in Florida the contemporaneity of man with a Pleistocene fauna is definitely established for the first time in America.

Fig. 1: North bank of canal at Vero. To the left is seen the pine timber of the uplands, while at the center and on the right in the background is seen the mixed vegetation growth including many cabbage palms which characterizes the stream valley. At water level is marine shell marl, above which is the sand and marl stratum, No. 2 of the general section. Above this is a dark colored alluvial deposit which is from 2 to 4 feet thick. The height of the canal bank is from 8 to 10 feet.

Fig. 2: View of the south bank of the canal showing one of the localities at which excavations were made for fossil human remains. A close view of the bank at this place is given in plates 16 and 17.

## LOCATION OF HUMAN REMAINS.

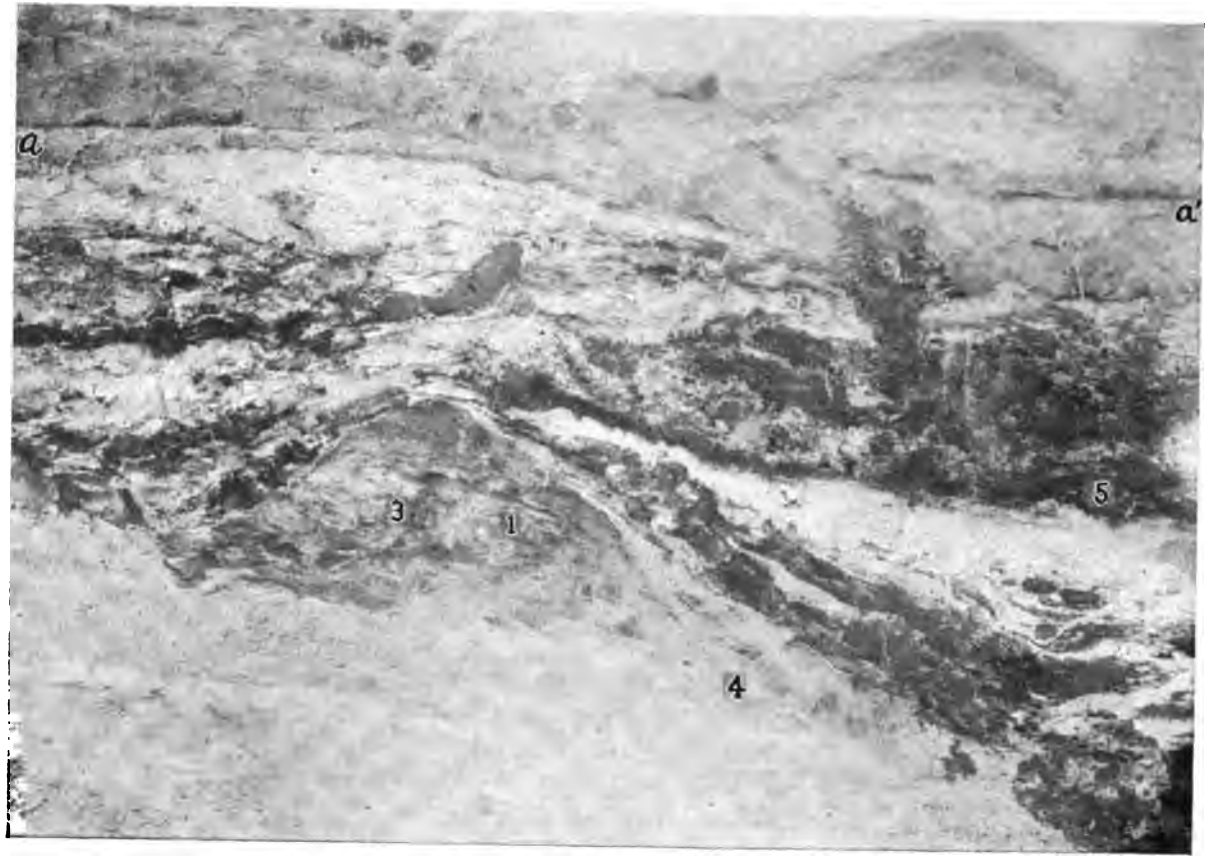
(DESCRIBED IN THE TEXT, PP. 135-136).

Plate 16.

Photograph of the south bank of the canal from about 458 to 468 feet west of the bridge to show the place of human remains in stratum No. 2. The human astragalus lies just at the right.of (1). The human external cuneiform lies at (3). The left scapula of the deer, *Odocoileus* sp., lies between these two bones and at the level of the astragalus. The laminated deposits which lie above the human remains are undisturbed, and as may be seen in the photograph, conforms to the irregularities of the older deposit.

Stratum No. 1 of the general section, the marine shell marl, is indicated in the photograph by (4). Nos. (1) and (3) lie in stratum No. 2 of the section; stratum No. 3 is indicated by (5).

The original surface is near the line a-a′, the material above this line having been thrown up by the dredge. Scale of photograph, 1 inch equals about 1.6 feet. The vertebrate fossils associated with the human bones in this stratum and at this place are listed on page 139.



## LOCATION OF HUMAN REMAINS.

(DESCRIBED IN THE TEXT, PP. 140-142.)

Plate 17.

Fig. 1: Photograph of the south bank of the canal from about 469 to 478 feet west of the bridge to show the place of human remains at the contact line between strata 2 and 3. Although taken at a different time this photograph supplements that of plate 16. Stratum No. 2 may be seen in this photograph as the brown sand rising abruptly in passing from left to right. Stratum No. 3 of the general section presents a laminated appearance characteristic of that deposit which consists of alternating layers of sand and muck. The proximal part of a left ulna is seen at (1); the proximal part of a shaft of a left femur at (2), and the left radius lies at (3). Subsequently parts of the skull and other bones were taken from farther back in the bank. The original surface is indicated approximately by the tape line, material above this level having been thrown out by the dredge. Scale of photograph, 1 inch equals about 2.2 feet. The vertebrate fossils associated with the human remains in this stratum are listed on page 158.

Fig. 2. Photograph of the south bank connecting the exposures shown by pl. 16 and fig. 1 of pl. 17. At the left, is seen stratum No. 2 (1); at the right (6) the brown sand of this stratum again comes into view. For a few feet the alluvial bed No. 3 of the general section rests upon the marine shell marl, stratum No. 2 at this place being entirely cut out. See text-figure 6, p. 137. Scale of photograph, 1 inch equals 2.6 feet.

Fig. 1

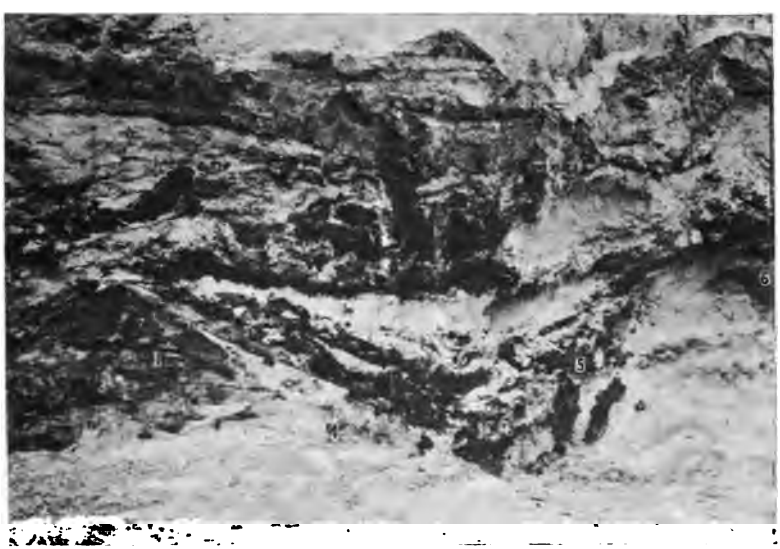


Fig. 2

## FOSSIL HUMAN REMAINS.

PLATE 18.

Fig. 1: Left tibia of man found in place in stratum No. 2 in the south bank, 331 feet west of the railroad bridge. Seven-tenths natural size. Length of bone as preserved 265 mm. Fla. Surv. coll. No. 5196. Other bones of this same individual obtained at this locality are listed in the text. The right femur is shown in pl. 19, fig. 4; the right astragalus in pl. 20, fig. 1; the right calcaneum, pl. 21, fig. 6. Associated fossils are shown in pl. 25, figs. 2 and 3 ----------p. 131

Fig. 2: Right ulna lacking the distal one-fourth; exterior view, very slightly reduced; length of bone as preserved 20 cm. Fla. Surv. coll. No. 5815. Although not taken in place this ulna was subsequently found to belong with the skeleton found in the south bank 470 feet west of the bridge----------p. 140

Fig. 3: Same bone, anterior view.

Additional bones from the same individual as figs. 2 and 3 are illustrated in the subsequent plates as follows: Pl. 19, figs. 1, 2 and 3; pl. 21, figs. 2 and 9?. Fig. 8 of pl. 21 is from the same horizon, although from the opposite bank of the canal. Implements from this horizon are shown on pl. 21, fig. 1 and on pl. 23. Fossil vertebrates from this horizon are shown on pl. 27, fig. 1; pl. 28, figs. 2, 3, 4, 5, 7 and 8; pl. 29, figs. 4, 6 and 7; and pl. 30, fig 4.

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## FOSSIL HUMAN REMAINS.

PLATE 19.

All figures on this plate seven-twelfths natural size.

Fig. 1: Proximal part of left radius. Found in place near the contact line between strata 2 and 3 in the south bank. Actual length of specimen 145 mm. Survey coll. No. 6703. This bone is seen in place in the bank in the photograph, pl. 17-------p. 140

Fig. 2: Distal part of left humerus. Same locality as the preceding. Actual length of specimen 155 mm. Fla. Survey coll. No. 6713. (Field No. 53.)----------p. 140

Fig. 3. Left femur. Taken in place near the contact line between strata 2 and 3 in the south bank. Fla. Survey coll. No. 6702. The proximal part of this bone is seen in place in the bank in the photograph, pl. 17. An additional part of the shaft (beyond the break) was subsequently found farther back in the bank. Actual length of specimen as preserved, 287 mm.----------p. 140

Fig. 4: Right femur. Found in place in stratum No. 2 in the south bank, 331 feet west of the railroad bridge. Actual length of specimen as preserved, 307 mm. Fla. Survey coll. No. 5198-p. 131

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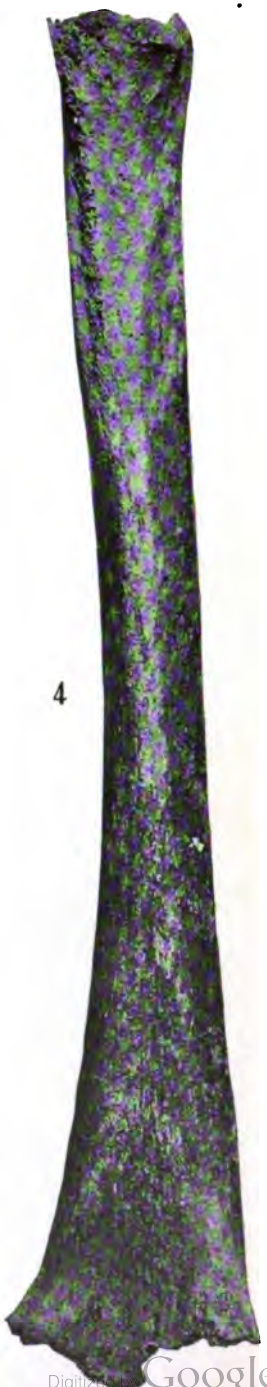

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## FOSSIL HUMAN REMAINS.

### PLATE 20.

All figures on this plate are approximately natural size.

Fig. 1: Right astragalus from south bank of canal 331 feet west of the bridge. Actual length of specimen 50 mm. Fla. Survey coll. No. 5223----------p. 131

Fig. 2: Right astragalus taken in place in stratum No. 2, south bank of canal, 462 feet west of the bridge. Actual length of specimen 62 mm. Fla. Surv. coll. No. 6954----------p. 135

Fig. 3: Right external cuneiform. Same locality as fig. 2. Actual length of specimen 100 mm. Fla. Surv. coll. No. 6955 p. 135

Fig. 4: Part of left ilium. Same locality. Found in place. Actual length of specimen 100 mm. Fla. Surv. coll. No. 6956-p. 135

Fig. 5: Section from limb bone. Same locality. Obtained from siftings. Actual length of specimen 49 mm. Fla. Surv. coll. No. 6958----------p. 136

The place in the bank from which the bones illustrated in figs. 2-5 were taken is shown in the photograph, pl. 16. Additional bones from this individual are illustrated on pl. 21, figs. 3 and 5; associated flints are shown in text-figures 7-11; associated bone implements are shown on pl. 21, figs. 4 and 7; engravings on tusk and bone from the same horizon are shown on pl. 22. Vertebrate fossils from this horizon are illustrated on pls. 24 to 31 except as otherwise indicated.

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## FOSSILS HUMAN REMAINS AND IMPLEMENTS.

**PLATE 21.**

**All illustrations on this plate somewhat reduced.**

Fig. 1: Arrowhead found in stratum No. 3, south bank 470 feet west of the bridge. Actual length of specimen 64 mm. Fla. Surv. coll. No. 6927----------p. 143

Fig. 2: Ascending ramus of right lower jaw from stratum No. 3, south bank, 470 feet west of the bridge. Actual width of ramus of jaw 36 mm.; angle of jaw to tip of coronoid process 70 mm. Fla. Surv. coll. No. 6704----------p. 140

Fig. 3: Part of metatarsal from south bank 462 feet west of the bridge. From stratum No. 2. Obtained from siftings. Fla. Surv. coll. No. 6960----------p. 135

Fig. 4: Piece of bone implement from south bank about 462 feet west of the bridge. From stratum No. 2. Obtained from siftings. Fla. Surv. coll. No. 6963----------p. 140

Fig. 5: One of the phalanges from the south bank about 462 feet west of the bridge. From stratum No. 2. Obtained from siftings. Actual length of specimen 31 mm. Fla. Surv. coll. No. 6959 ----------p. 135

Fig. 6: Right calcaneum from stratum No. 2, south bank 330 feet west of bridge. Actual length of specimen 68 mm. Fla. Surv. coll. No. 5226 ----------p. 131

Fig. 7: Bone implement from stratum No. 2, south bank 480 feet west of the bridge. Obtained from siftings. Fla. Surv. coll. No. 6981 ----------p. 140

Fig. 8: Molar tooth from stratum No. 3, north bank 450 feet west of the bridge. Fla. Surv. coll. No. 7010----------p. 142

Fig. 9: Canine tooth from stratum No. 3, south bank 465 feet west of the bridge. Fla. Surv. coll. No. 6925----------p. 142

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## ENGRAVINGS.

### PLATE 22.

All illustrations on this plate are one and a fourth times natural size.

Figs. 1-2: Engravings on a proboscidian tusk from the Pleistocene of Florida. The tusk on which these markings are found is probably a lower tusk of *Mammut americanum*. That it is a proboscidian tusk is clearly evident by the characteristic structure. The specimen was found near the base of the stratum No. 2 on the north bank of the canal 370 feet west of the bridge and was taken from the bank in the presence of the writer by Isaac M. Weills. The section of the canal bank at this place and also a list of the associated fossils is given in the text. Actual length of tusk 133 mm. Fla. Surv. coll. No. 6789. (Field No. 101.) p. 134

Fig. 3: Fragment of bird bone showing markings. Same locality as the tusk. Fla. Surv. coll. 6783. The bird represented is probably *Jabiru? weillsi*. sp. nov., the type specimen of which was found at the same place in the bank.

The section of the canal bank at the place where these specimens were found is shown in text-figure 4.

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## WOOD AND BONE IMPLEMENTS AND ORNAMENTS.

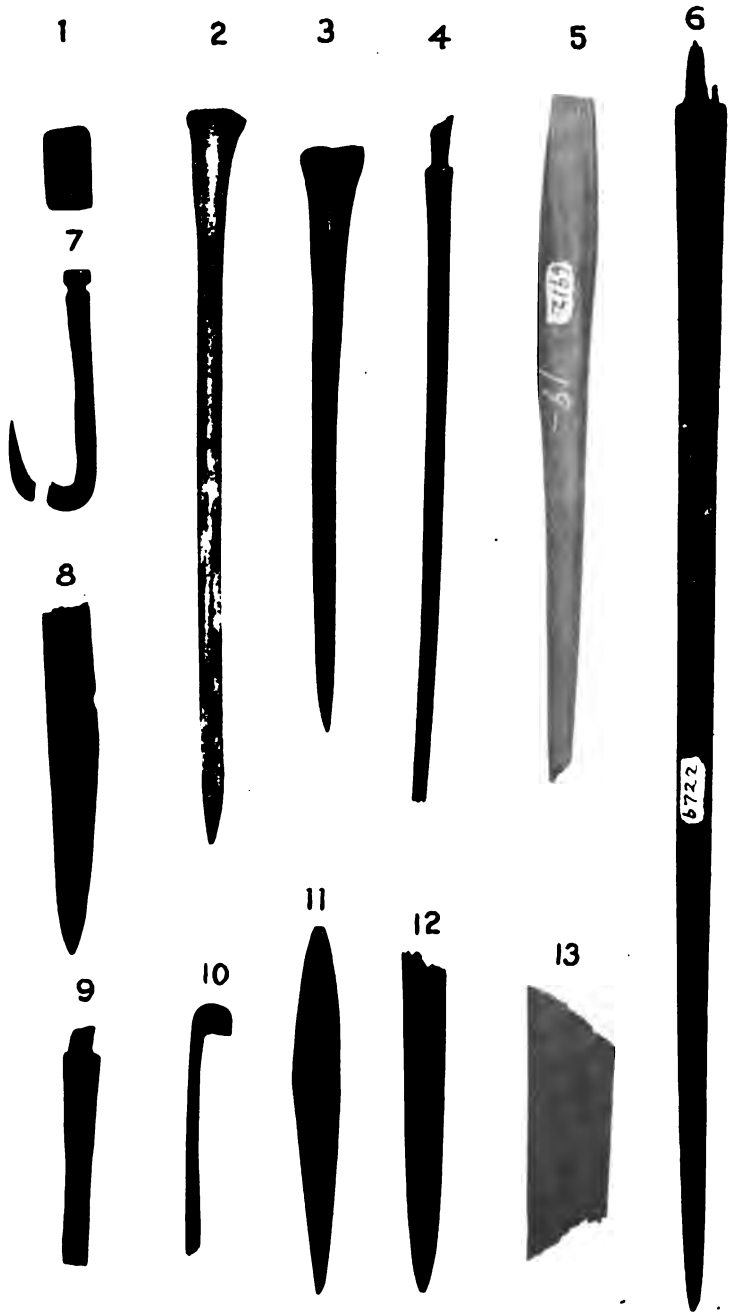
PLATE 23.

All illustrations on this plate, approximately two-thirds natural size.

Fig. 1: An ornament made probably from a section of an alligator tooth. From stratum No. 3, south bank 460 feet west of the bridge ----------p. 143

Figs. 2-5, and 7-13: Bone implements from stratum No. 3, south bank 450 to 470 feet west of the bridge. Fla. Surv. collection ----------p. 143

Fig. 6: Wood implement. Same locality. Fla. Surv. coll. No. 6722 ----------p. 143



FOSSILS ASSOCIATED WITH HUMAN REMAINS.

PLATE 24.

*Canis ayersi*, sp. nov. Type specimen. From stratum No. 2, south bank, 100 feet west of the bridge. Three-fifths natural size. Fla. Surv. coll. No. 7166----------p. 152

A characteristic feature of this wolf by which the species is separated from the equally large wolf of the Pleistocene of California is the long and relatively narrow snout. Additional bones from this species are illustrated on pl. 30, figs. 1 and 3.

## FOSSILS ASSOCIATED WITH HUMAN REMAINS.

PLATE 25.

Fig. 1: *Elephas columbi.* Lower jaws. This species is one of the abundant fossils in stratum No. 2. The specimen here illustrated, however, was found 3 miles west of Vero, and was imbedded in the canal bank in a matrix of brown sand which rests upon the marine shell marl. Fla. Surv. coll. No. 6824. Length of right jaw as preserved 600 mm.; length of tooth of right jaw 220 mm. ----------p. 150

Fig. 2: *Megalonyx jeffersonii.* Hyoid bone. From stratum No. 2, south bank, 330 feet west of the bridge. Found near fossil human remains. Fla. Surv. coll. No. 5212. Natural size--p. 148

Fig. 3: Scapula of deer found in immediate association with human bones in stratum No. 2, 330 feet west of the bridge. Natural size. Fla. Surv. coll. No. 5199. The large size of the scapula as compared to the scapula of the deer common in stratum No. 3 suggests that the species may be distinct----------p. 149

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BIRD BONES ASSOCIATED WITH HUMAN REMAINS.

PLATE 26.

Figs. 1-4: *Jabiru? weillsi,* sp. nov.----------p. 146

Fig. 1: Humerus. Times .65. Actual length of bone 180 mm. From the north bank, thrown out by the dredge. Fla. Surv. coll. No. 5961. Collected by Isaac M. Weills.

Fig. 2: Corocoid. Found in place in stratum No. 2. Fla. Surv. coll. No. 6782. Approximately one-half natural size. Actual length of specimen 57 mm. This bone is shown natural size in text-figure 15, p. 157.

Fig. 3: Metacarpals. Approximately one-half natural size. Actual length of bone 150 mm. Fla. Surv. coll. No. 7022.

Fig. 4: Ulna. Approximately one-half natural size. Fla. Surv. coll. No. 6780.

Fig. 5: Right humerus of small bird, slightly reduced. Actual length of bone 35 mm. Fla. Surv. coll. No. 6979. This bone was obtained from siftings from the sand in which the human bones were imbedded----------p. 146

The bird represented by these bones, figs. 1-4, has a longer and more slender wing than that of the modern stork, *Mycteria americana.*

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## FOSSILS ASSOCIATED WITH HUMAN REMAINS.

PLATE 27.

All illustrations on this plate are natural size.

Fig. 1: *Odocoileus osceola*, left scapula. From stratum No. 3, north bank, 370 feet west of the bridge. Fla. Surv. coll. No. 7017 ----------p. 158

Fig. 2: *Odocoileus* sp. Left scapula. From stratum No. 2, south bank, 462 feet west of the bridge, in immediate association with human bones. Fla. Surv. coll. No. 6965. The deer found in stratum No. 2 differs, as indicated by the scapula, from that of stratum No. 3, and may possibly represent a distinct species_p. 149

Fig. 3: Photograph showing plant remains from bed No. 3 of the section at Vero. The plant remains are found from one to two feet above the human bones. In addition to the plants the slab illustrated shows the scale of a fish and the tibia of an insect_p. 147



## FOSSILS ASSOCIATED WITH HUMAN REMAINS.

PLATE 28.

All illustrations on this plate are approximately four-fifths natural size.

Fig. 1: *Smilodon* sp. Saber-tooth. From stratum No. 2, north bank, 370 feet west of the bridge. Length of specimen, 67 mm. Fla. Surv. coll. No. 7023----------p. 134

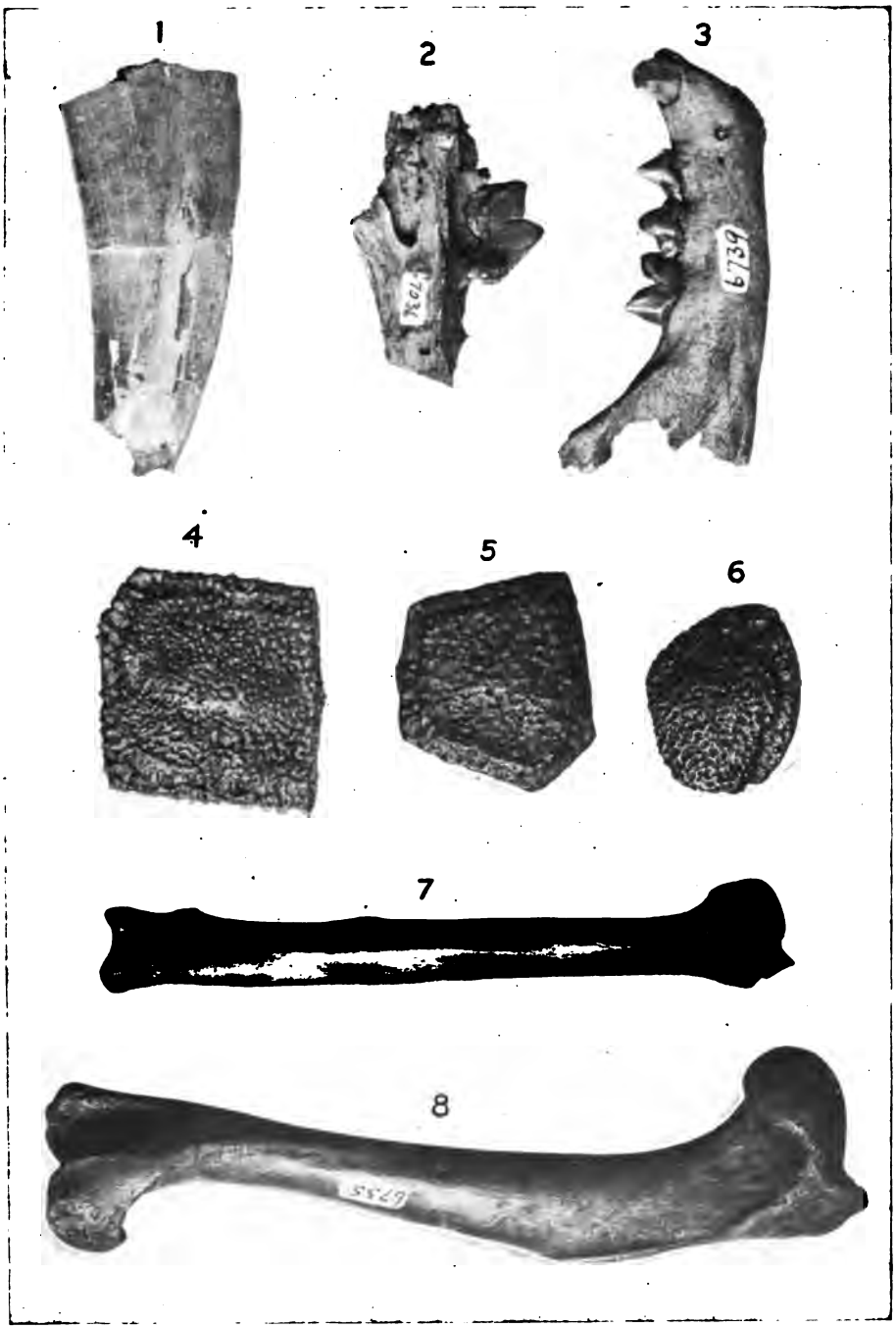
Fig. 2. *Canis* sp. cf. C. *latrans*. Sectorial tooth. From stratum No. 3, north bank, 450 feet west of the bridge. Fla. Surv. coll. No. 7036----------p. 157

Fig. 3: *Lynx* sp. Lower jaw. From stratum No. 3, south bank, 465 feet west of the bridge. Fla. Surv. coll. No. 6739-p. 152

Figs. 4-5: *Chlamytherium septentrionalis*. Dermal plates. From stratum No. 3, south bank, 465 feet west of the bridge. Fla. Surv. coll. Nos. 6753 and 6752----------p. 148

Fig. 6: *Chlamytherium septentrionalis*. Dermal plate. From stratum No. 2, south bank, 465 feet west of the bridge. Width of plate 33 mm. Fla. Surv. coll. No. 6970----------p. 148

Figs. 7-8: *Canis* sp. Left radius and right humerus. From stratum No. 3, south bank, 450 feet west of the bridge. Fla. Surv. coll. Nos. 6736 and 6735. Length of radius, 113 mm.; length of humerus, 132 mm.----------p. 157



FOSSILS ASSOCIATED WITH HUMAN REMAINS.

PLATE 29.

Figs. 1-8 slightly enlarged; fig. 9 reduced.

Fig. 1: *Dasypus* sp. Part of dermal plate. From south bank, stratum No. 2, 462 feet west of the bridge. Fla. Surv. coll. No. 6990 ----------p. 148

Fig. 2: *Dasypus* sp. Dermal plate. From Pleistocene cave deposits at Ocala. Introduced for comparison. Fla. Surv. coll. No. 6033.

Fig. 3: *Sylvilagus* sp. From south bank, stratum No. 2, 462 feet west of the bridge. This specimen from stratum No. 2 differs from the rabbit from the next later horizon in that the first molariform tooth is much smaller and stands more nearly vertical in the jaw. Fla. Surv. coll. No. 6968.

Fig. 4: *Sigmodon* sp. Lower jaw. From south bank, stratum No. 3, 460 feet west of the bridge. Fla. Surv. coll. No. 6941 ----------p. 151

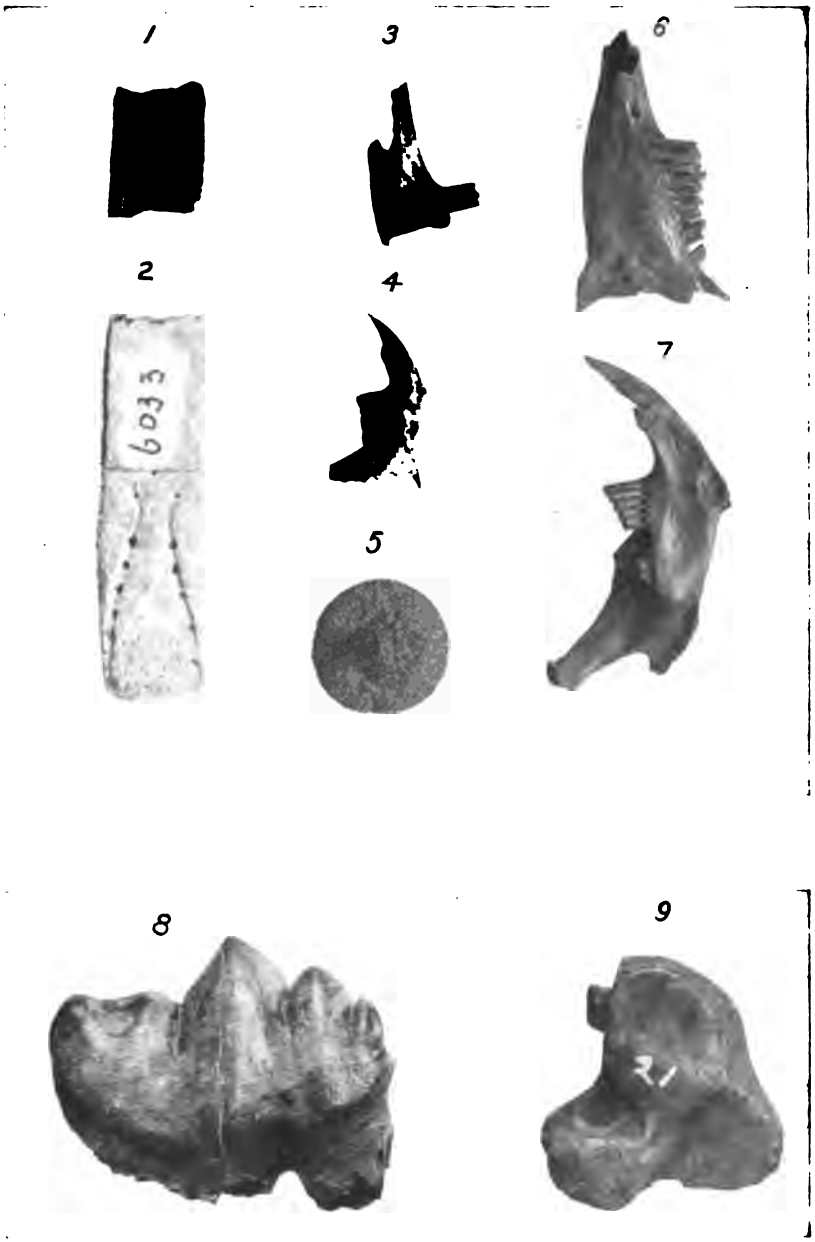
Fig. 5: Acorns from stratum No. 2. Fla. Surv. coll. No. 6986 ----------p. 143

Fig. 6: *Sylvilagus* sp. (cf. *Sylvilagus palustris.*) From south bank, stratum No. 3, 470 feet west of the bridge. Fla. Surv. coll. No. 6934 ----------p. 157

Fig. 7: *Neofiber alleni.* The specimen here illustrated was found not in place, although teeth, jaws and parts of the skull of this species are found in both strata 2 and 3. Fla. Surv. coll. No. 4390 ----------p. 150

Fig. 8: *Smilodon* sp. Carnassial tooth. Fla. Surv. coll. p. 152

Fig. 9: *Equus* sp. Foot bone of horse found in stratum No. 2, south bank, 480 feet west of the bridge at the place indicated by *d* in text-figure 6----------p. 149



FOSSILS ASSOCIATED WITH HUMAN REMAINS.

PLATE 30.

Fig. 1: *Canis ayersi.* Sp. nov. Paratype. Right premaxillary ----------p. 152

Fig. 2: Peccary indt. Tibia. Fla. Surv. coll. No. 5450-p. 149

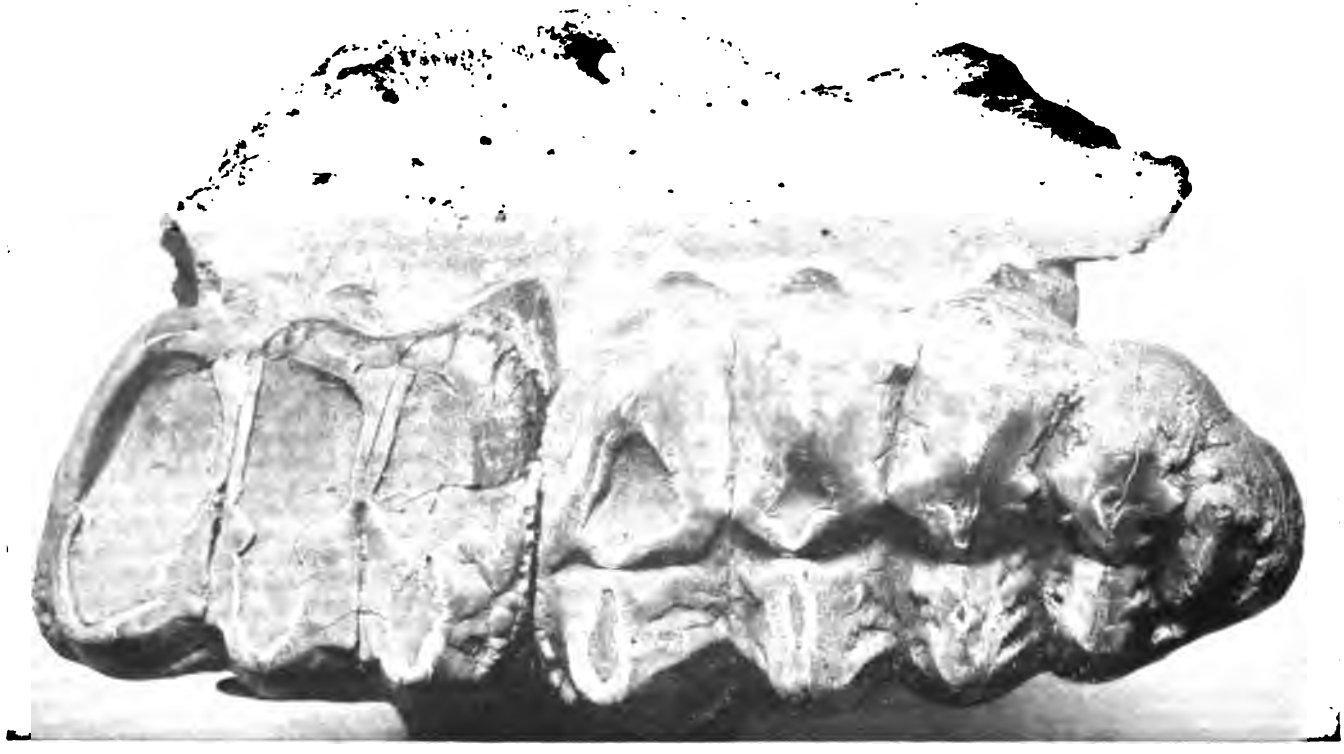
Fig. 3: *Canis ayersi.* sp. nov. Femur of type specimen. Length of bone 255 mm. Fla. Surv. coll. No. 6166------p. 154

Fig. 4: *Vulpes pennsylvanicus?* Part of lower jaw from stratum No. 3, south bank, 450 feet west of the bridge. Length of specimen 50 mm. Fla. Surv. coll. No. 6738----------p. 152

Fig. 5: Camel indt. Proximal phalanx. Fla. Surv. coll. p. 149

Fig. 6: *Megalonyx jeffersonii.* Claw. Fla. Surv. coll.-p. 148

Fig. 7: *Chlamytherium septentrionalis.* From stratum No. 2, south bank, 480 feet west of the bridge. Fla. Surv. coll. (field No. 21) ----------p. 148



*Mammut americanum* found in stratum No. 2 of the section at Vero. Approximately one-half natural size. Fla. Surv. coll. No. 6852. Contributed by J. W. Welch.

# General Index

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